



ESRI® Technology and INSPIRE

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ESRI Technology and INSPIRE

An ESRI White Paper

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ESRI Technology and INSPIRE

Introduction

Purpose and Organization of This Paper

This document describes how ESRI® geographic information system (GIS) software products and solutions align with the Infrastructure for Spatial Information in Europe (INSPIRE) vision for European geospatial information sharing and—more specifically—how they provide a technical foundation for activating that vision. The information presented is intended to provide a basic overview and frame of reference for further technical inquiry and discussion.

The generic concept of spatial data infrastructures (SDI) and the INSPIRE program for a European spatial data infrastructure are both outlined at the outset of this document. An overview of ESRI software and solutions that support spatial data infrastructures generally—and can support INSPIRE in particular—is presented in that context. A review of selected existing spatial data infrastructure programs based on ESRI software and solutions concludes the document.

What Is a Spatial Data Infrastructure?

The term *spatial data infrastructure* (SDI) was coined in 1993 by the U.S. National Research Council to denote a framework of technologies, policies, and institutional arrangements that together facilitate the creation, exchange, and use of automated geospatial data and related information resources across an information-sharing community. Such a framework can be implemented narrowly to enable the sharing of geospatial information within an organization or more broadly to enable the sharing of geospatial information at a national, regional, or global level. In all cases, an SDI will provide an institutionally sanctioned, automated means for posting, discovering, evaluating, and exchanging geospatial information by participating information producers and users.

INSPIRE—Initiative for a European SDI

INSPIRE Vision

A European SDI—known formally as the Infrastructure for Spatial Information in Europe—is envisioned and chartered by a European Union (EU) directive that binds member states in a common SDI-building effort.

The INSPIRE vision anticipates a geospatial information infrastructure that delivers a full range of integrated geospatial information services, enabling users to identify and access geographic information from participating data producers throughout Europe (and the rest of the world) in an interoperable way for a variety of uses. The target users of INSPIRE include European policy makers, planners, and managers and their organizations along with the general European public.

The underlying INSPIRE concept is for a World Wide Web-based infrastructure of technologies and permissions that will tie existing and future European geospatial information producers and users together in a single geospatial information-sharing community to improve European decision making and operations at all levels of endeavor in service of a productive and sustainable Europe.

***INSPIRE
Current Status***

In the context of EU's INSPIRE directive, member states are currently engaged in a common effort to determine the technologies, policies, and institutional arrangements that will form the underpinnings for INSPIRE.

This "transposition" phase of INSPIRE activity is focused on detailing the technical and institutional foundation for INSPIRE and, according to the EU INSPIRE directive, is due for completion 15 May 2009. In response to the directive, EU member states are in the midst of ongoing information gathering and decision-making activities designed to confirm specifications related to SDI-building technologies, policies, and institutional arrangements.

As part of this current work, a systematic EU effort to define and prepare INSPIRE implementation rules is being undertaken. These implementation rules are being elaborated by experts in the topic areas of metadata (catalog information describing individual geospatial information items), data standards and specifications, network services, data and service sharing, and monitoring and reporting. The Joint Research Centre (JRC) of the European Commission (the Spatial Data Infrastructures unit of the Institute for Environment and Sustainability of the JRC in Ispra, Italy) is acting as the technological and scientific advisor for the INSPIRE implementation and, in this capacity, is providing guidance to the INSPIRE specifications drafting teams.

This white paper has been produced to introduce ESRI's SDI technologies for consideration in the context of the current EU specification development efforts.

**ESRI Technology
for SDIs**

Overview

ESRI has long focused its technology development path on the creation of solutions that contribute to building and positioning the world's geospatial information resources for responsible and effective use. Over the last three decades, automated mapping, GIS, and spatial data communication technologies developed by ESRI have been implemented throughout the world—including in Europe—contributing significantly to a global reservoir of electronically enabled geospatial information.

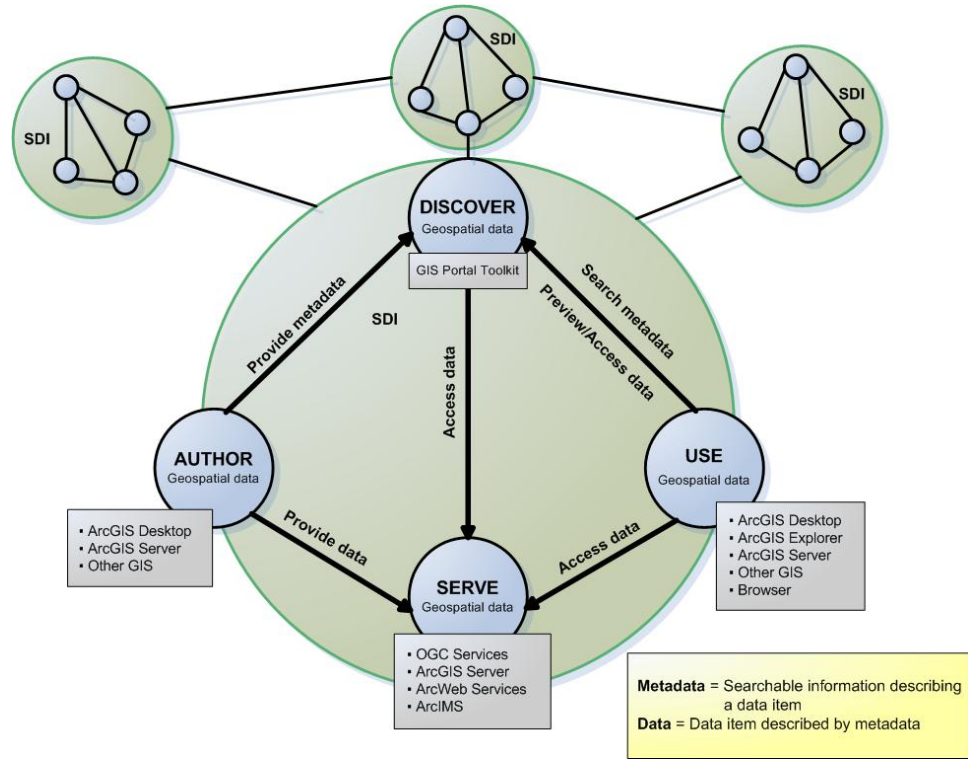
The current generation of standards-based ESRI technology enables these existing nodes of automated geospatial information and GIS capability to be made available on the World Wide Web in a distributed GIS context. In short, ESRI technology now enables the large repository of electronically enabled geospatial information currently maintained throughout Europe to be made available throughout the world generally, and in Europe specifically, using spatial data infrastructures such as INSPIRE.

The new ESRI technologies that make existing and new ESRI GIS databases and functionality easily available for participation in the SDI context are

- ArcGIS® Server—Stages geospatial data and applications for easy service to both internal and external SDI participants
- ArcGIS Explorer—Provides direct access to selected map services using SDI links
- The GIS Portal Toolkit—Provides a Web-based metadata catalog that points to registered data items and enables users to view map services made available by their owners

The new ESRI generation of open standards-based tools provides spatial data producers with the ability to serve their data to the World Wide Web (or local intranet networks) and allows spatial data users to capture that information for use in their local enterprise GIS environment or GIS desktop environment. In short, ESRI technology at all levels now provides the technological keys for participation in SDI information-sharing communities.

Figure 1
ESRI Solutions for SDI-based Information Sharing and Use Activities



The new ArcGIS Server and GIS Portal Toolkit technologies are outlined below along with an overview of ArcGIS Desktop tools.

ArcGIS/ArcGIS Server

ArcGIS technology includes the ArcGIS Desktop suite of GIS tools, ArcGIS Explorer, and the ArcGIS Server suite of GIS software. This family of software is generally used to structure and support geospatial information development, management, and use activities within an institution, business, government agency, or other organizational entity. Each organizational entity represents a potential geospatial information-sharing node in the SDI context and, using the current generation of ESRI technologies, is ready-made for SDI participation.

ArcGIS Desktop

ArcGIS Desktop tools provide a complete system for authoring and using geospatial information. They are standards based, open, and interoperable and comprise a commercial off-the-shelf (COTS) product.

ESRI desktop capabilities provide the potential for independent individuals to participate directly as SDI users via the World Wide Web and for individuals in a full-capability distributed GIS organization to participate as both SDI users and producers. As such, individuals who develop and use geospatial information at the desktop level represent the broadest tier of potential SDI participants.

ArcGIS Server ArcGIS Server is a complete and integrated server-based GIS. It comes with out-of-the-box, end user applications and services for spatial data management, visualization, and spatial analysis.

ArcGIS Server complements ArcGIS Desktop by enabling GIS analysts to cost-effectively author maps, globes, and geoprocessing tasks on their desktops and publish them to ArcGIS Server using integrated tools. GIS functions and data can be delivered as services throughout the enterprise or made available in a broad SDI context.

ArcGIS Server offers the following advantages to an organization:

- Lower cost of ownership through centrally managed, focused GIS applications that can scale to support many users.
- Browser-based access to GIS.
- Integration with other enterprise systems such as customer relationship management (CRM) or enterprise resource planning (ERP) systems using industry-standard software. ArcGIS Server provides a complete foundation for geospatially enabling a service-oriented architecture (SOA).
- Support for interoperability standards in both the GIS domain (Open Geospatial Consortium® [OGC®]) as well as the broader information technology (IT) domain.
- Ability to create custom applications using .NET or Java™.
- Data and services staging for ready participation in an SDI context

ArcGIS Explorer ArcGIS Explorer is a freely available, lightweight desktop GIS that can be used as a client for ArcGIS Server.

In an SDI context, ArcGIS Explorer provides direct access to services published on the World Wide Web, enabling users to view and combine maps from SDI geospatial data producers at their desktop. ArcGIS Explorer can also be used with a variety of GIS services such as those published using ArcIMS®, ArcWebSM Services, and Web Map Service (WMS). In addition, ArcGIS Explorer can use local data such as shapefiles, file geodatabases, KML, JPEG 2000, GeoTIFF, MrSID®, IMG, and other image formats.

Figure 2
ArcExplorer Sample Screen Shot



In an ArcGIS Server environment, ArcGIS Explorer can integrate a rich world of GIS datasets and server-based geoprocessing applications. It does this by accessing the full GIS capabilities of ArcGIS Server including geoprocessing and 3D services.

With ArcGIS Explorer, users can

- Explore data for the entire world seamlessly.
- Fuse local data with data and services from ArcGIS Server, ArcIMS, Open Geospatial Consortium WMS, and ESRI-hosted ArcWeb Services.
- Perform GIS analysis using tasks (e.g., visibility, modeling, proximity search).
- Answer geographic questions about the maps generated and share the results with others.
- Use maps and data from the user's own secure servers.

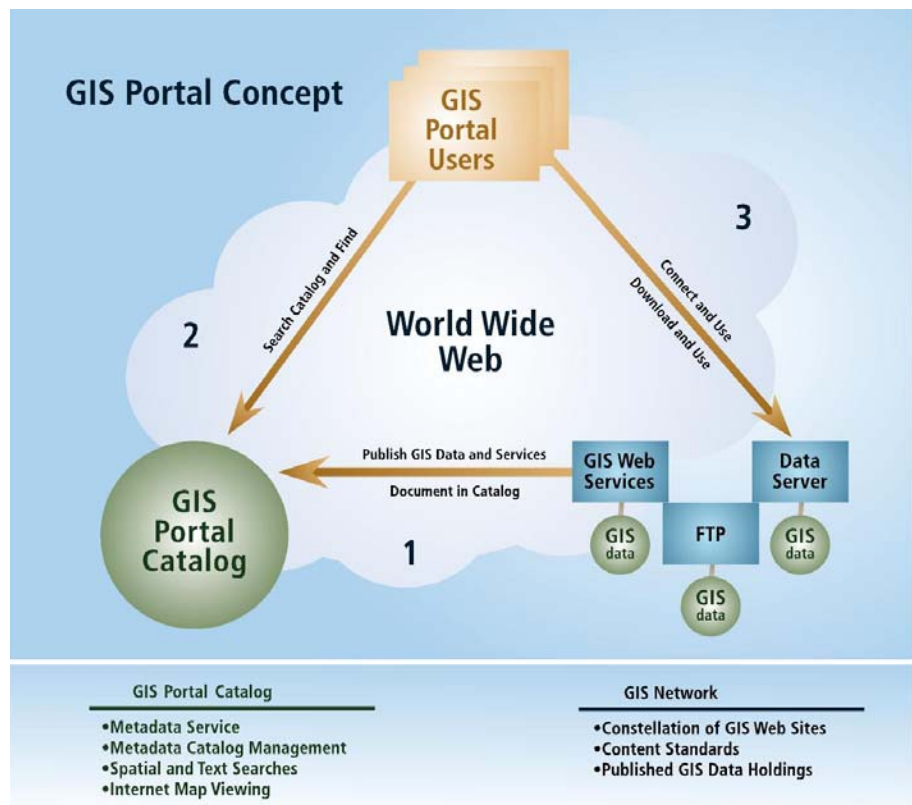
ArcGIS Explorer is available as part of ArcGIS Server. Users of ArcGIS Explorer can access the beta version of ArcGISSM Online Services, which provides a series of ready-to-use online map, globe, and other GIS services.

GIS Portal Toolkit

ESRI has developed its GIS Portal Toolkit specifically to provide a technical mechanism—a geospatial information portal—for posting, discovering, and exchanging existing geospatial information resources maintained in ESRI or other standards-based environments in support of both broadly based SDIs and more narrowly framed local and organization-specific data-sharing communities.

At its root, GIS Portal Toolkit is a special-purpose Web site-building technology designed to provide central "switchboards" for SDI-based data-sharing communities. It connects geospatial data producers and users by (1) enabling producers of geospatial information resources to create and post metadata records (citations describing their information resources); (2) enabling users of geospatial information resources to search for and discover metadata records that cite the particular resources that will be helpful to them; and, most important; (3) enabling users to view geospatial information or otherwise access the geospatial information resources cited by the metadata records, regardless of where or how those information resources are maintained. Figure 3 illustrates this basic concept.

**Figure 3
GIS Portal Toolkit Geospatial Information Portal Concept**



GIS Portal Toolkit assumes that the discoverable information resources cited in the portal will consist of a wide range of information resource types. These will include not only Web-accessible maps and GIS application services but also physical maps, documents, and other information resource types that are not necessarily Web accessible.

ESRI's GIS Portal Toolkit strategy has been to create generic software consisting of core functionality organized into a framework of components that is configurable by design to address each unique SDI circumstance. The various components anticipate implementation-specific configuration and modification of select files and tables to enable (1) conformance to the specific environment where it is being installed and hosted, (2) creation of an SDI-specific look and feel for the interface (for example, integration of EU or INSPIRE Web site graphics and interface standards), and (3) activation of host-selected functionality options.

GIS Portal Toolkit User Functionality

The components of GIS Portal Toolkit work together and individually to provide a range of functionality that enables end users to

- **Discover GIS data resources produced by others**—GIS Portal Toolkit implements functionality that enables users to discover and select information resources that are of particular interest to them. In addition to traditional term-based searches, the toolkit functionality enables users to find information items (1) within a topic of interest by selecting a focused interest "channel" that preconsolidates information resources or (2) within a geographic area the user draws on a map or that pertains to a user-defined place-name or address.

The results of any GIS Portal Toolkit search are displayed as summary statements derived from the metadata records citing each found information item; the user can then elect to display more detailed descriptions of each information item or the full metadata record itself.

From either the summary or detailed results displays, GIS Portal Toolkit includes functionality that enables the user to (1) link directly to the Web site that hosts the cited information item if that option is made available by the information item publisher or (2) view the information item (as described below) if it is a "live" map available from a service maintained by the information item publisher.

- **View geospatial data resources produced by others**—GIS Portal Toolkit provides functionality that automatically retrieves and displays mapped data maintained on Web-accessible map services if metadata about that mapped data has been published on the portal and if the target map service is maintained by the data publisher. When a user elects to view mapped data described by a search result (summarized metadata), a GIS Portal Toolkit Map Viewer window automatically pops up and the requested data is loaded atop a default basemap.

The information the toolkit requires to make this happen is included in validated and published metadata records if the cited information item consists of what the toolkit recognizes as live data or maps and if it is maintained as described in the metadata on a Web-accessible server.

If users elect to examine information items other than live data or maps (for example, document files or mapped data viewable only by using an application maintained on the publisher's Web site), they can link to the Web site where a data item is maintained if that opportunity is provided by the publisher.

The opportunity to view live data or maps or link directly to a publisher's Web site to view an information item is provided in association with each search result.

- **Make maps combining GIS data produced by others**—The GIS Portal Toolkit (GPT) Map Viewer enables users to combine mapped data from different live map sources, conform it to a single map projection and extent, and overlay it on a single basemap. This can be done by combining map services selected from a drop-down list of Web-accessible map services available through the GPT Map Viewer interface and/or by selecting live maps that have been discovered during a metadata search.

Map layers included in a live map that is added to a Map Viewer map are listed in the Map Viewer legend, and the user can select which layers to include or omit on the map display.

Once a map is completed, the GIS Portal Toolkit functionality provides a Save Map function that enables users to save the map they have created for use in subsequent Map Viewer sessions. The toolkit functionality also enables users to save the map to their own computer or network as an Open Geospatial Consortium Web Map Context file.

- **Obtain data resources from data services maintained by others**—Any information item that is cited in metadata published on a portal based on GPT is obtainable if the publisher of the information item makes it available. Live map images or composite map images created with GPT Map Viewer functionality can be downloaded to a user's system after the map is saved. Other information items, including any data associated with a map image, can be obtained (if made available by the publisher) by using the option to link to the publisher's Web site.
- **Expose one's own GIS data resources for discovery by others**—GIS Portal Toolkit functionality enables any Web-based geospatial information producer authorized by an administrator of a portal based on GPT to publish metadata describing the information on that portal. Unless a GIS Portal Toolkit portal administrator determines otherwise as a policy matter, publishers create their own metadata and make their own determinations

about how and to whom the information described in their metadata is made available.

As administrator-approved publishers on a particular portal based on GPT, data producers have three basic options for posting their metadata. They can (1) create their metadata using ArcCatalog™ or an independent XML editor and upload the records to the target portal based on GPT, (2) create their metadata and post it using a GIS Portal Toolkit online metadata entry form, or (3) make their metadata available on a Web server and register for external harvesting by the administrator of a portal based on GPT using a GIS Portal Toolkit metadata harvesting tool.

GIS Portal Toolkit includes functionality that can be engaged to automatically validate submitted metadata records against applicable metadata standards (Federal Geographic Data Committee [FGDC], ISO 19115, ISO 19139). Publishers are informed of metadata records that fail this automatic validation. GIS Portal Toolkit also provides functionality that enables an administrator of a portal based on GPT to review and approve all technically validated metadata records before final posting to the portal.

- **Register as a portal user**—GIS Portal Toolkit functionality provides the option for users to register. By design, the basic toolkit functionality does not require user registration for basic search and search results viewing. The option to register, however, is provided to enable the managers of a portal based on GPT to customize access to advanced functionality and selected data based on user name and ID.

GIS Portal Toolkit Management

Three principal management roles are anticipated by GIS Portal Toolkit functionality:

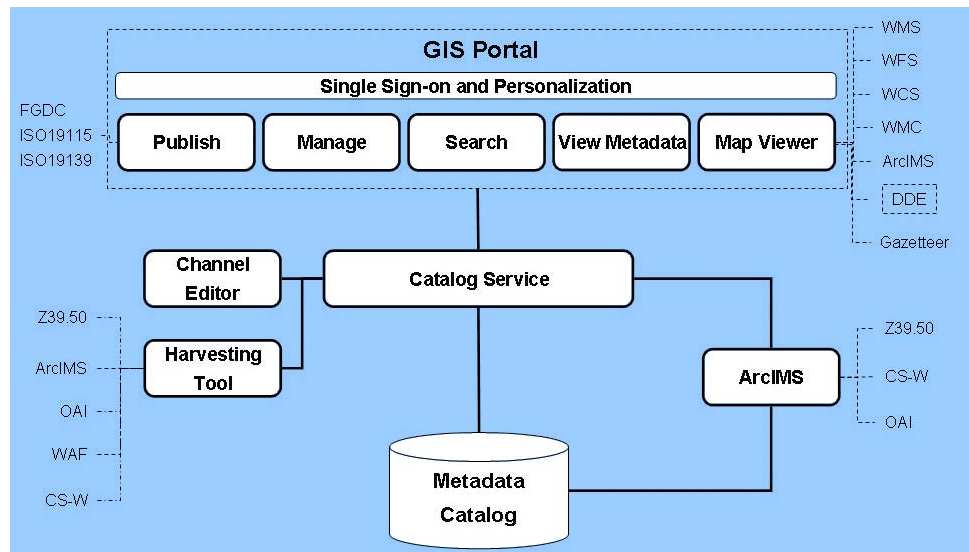
- **Administrator**—A suite of GIS Portal Toolkit functionality has been designated for the exclusive use of an administrator or manager of a GIS Portal Toolkit-based portal. The administrator functionality enables the person or persons who manage a portal to exercise control over all metadata publication, data security, user registration, special interest channel creation and management, portal use tracking, and other aspects of portal operations. Administrators are required to be registered users, and administrator function options are provided on the administrator's home page upon login based on the administrator's User-ID and password.
- **Publisher**—Publisher-specific GIS Portal Toolkit functionality is restricted to users who are designated as publishers by a portal administrator. Publisher functionality enables publishers to post and manage their metadata records using special toolkit functions available only to them. Publishers are required to be registered users, and publisher function options are provided on their home page upon login based on the publisher's User-ID and password.
- **Channel steward**—GIS Portal Toolkit functionality that is specific to the management of special interest channels of information is restricted to use by

channel stewards who are designated by a portal administrator. This functionality enables channel stewards to develop and manage content within a specific channel that is created for them by the portal administrator. Channel stewards are required to be registered users, and channel steward function options are provided on their home page upon login based on the channel steward's User-ID and password.

GIS Portal Toolkit Support for International Standards

A fundamental objective of GPT is to provide a means for referencing and accessing geospatial information that is distributed and made available using a variety of technologies. To this end, GPT functionality supports all principal metadata standards and electronic data communication standards. It also has capabilities that integrate data made available in a large variety of formats. Figure 4 is a diagram of GIS Portal Toolkit components that portrays the toolkit's principal points of communication and the associated data communication standards, protocols, and formats that are supported.

**Figure 4
GIS Portal Toolkit Standards Support**



ESRI Technology for INSPIRE

Overview

ESRI's ArcGIS and ArcGIS Server technology as outlined above provide geospatial data creation, integration, and use capabilities that anticipate the kind of geospatial data and analysis needs of EU. ESRI's GIS Portal Toolkit anticipates the kind of geospatial data resources sharing envisioned by the EU's INSPIRE directive. These technologies provide essential building blocks for the spatial data infrastructure EU intends to implement.

These building blocks, together with the reservoir of geospatial data that has been developed in Europe over the past few decades using ESRI and other GIS

technologies—if harnessed by EU in the INSPIRE context—can provide a ready head start for implementation of INSPIRE's technical infrastructure sooner rather than later.

Existing Technology

ESRI SDI technology can provide INSPIRE with a complete information system of scalable, high-performance capabilities for authoring content, publishing services, and searching for and exchanging geospatial information resources. GIS nodes, based on both ArcGIS and ArcGIS Server and already present throughout Europe, create geospatial data for sharing via an INSPIRE portal (or hierarchy of local community portals) based on GIS Portal Toolkit.

These ESRI technologies are designed for use in a world of standards-based GIS technologies, communication protocols, and data formats created by a variety of vendors and organizations. As such, they are flexible and anticipate a range of requirements and specifications such as may ultimately be established by the INSPIRE member states during their current explorations and deliberations.

The advantage to INSPIRE is that these ESRI technologies are currently operational and available for immediate implementation, testing, and review.

Existing Geospatial Resources

INSPIRE also has the advantage that technologically available geospatial information resources are in place in organizations and governments throughout Europe today.

ESRI and ESRI technology have been instrumental in building many of the automated geospatial information systems that have been implemented in Europe and are each candidates for participation in INSPIRE as geospatial information resources nodes. ESRI's familiarity with and participation in European GIS development over the past 30 years enable ESRI to understand the circumstances in which INSPIRE was envisioned and the circumstances in which it is being built. Together with its technology base, this provides ESRI with experience and resources that can contribute significantly to the successful realization of the INSPIRE vision.

Case Studies— ESRI-Based Solutions in Europe Today

Two selected examples of regional SDIs—based on ArcGIS and GIS Portal Toolkit—currently operating in Europe are described below.

Regione Lombardia, Italy

Regione Lombardia is supporting its GIS strategy by setting up its regional SDI as a node for INSPIRE. The main goal is to involve both local public administrations and private companies in the process of disseminating and sharing geographic data and services that are already widely available.

The core part of the regional SDI is the Lombardia GeoPortal where users can publish or search for geographic data, applications, and services. The main component of the geoportal is the Metadata Catalog of Data and Services, which has been implemented to be compliant with the international standards ISO 19115 and ISO 19139. In addition, the geoportal offers general services including

map viewers and tools for downloading and performing coordinate transformations. Additional services will be added to support the requirements of an increasing number of users over time.

The Lombardia GeoPortal has been implemented by customizing ESRI's GIS Portal Toolkit to be compliant with both the Italian and the INSPIRE metadata profiles. The geoportal stands on top of the Regional Enterprise platform for Geographic Information Services (REGIS), which consists of a technological infrastructure based on ArcIMS, ArcGIS Server, and basic services used as "LEGO bricks" to build geographic solutions.

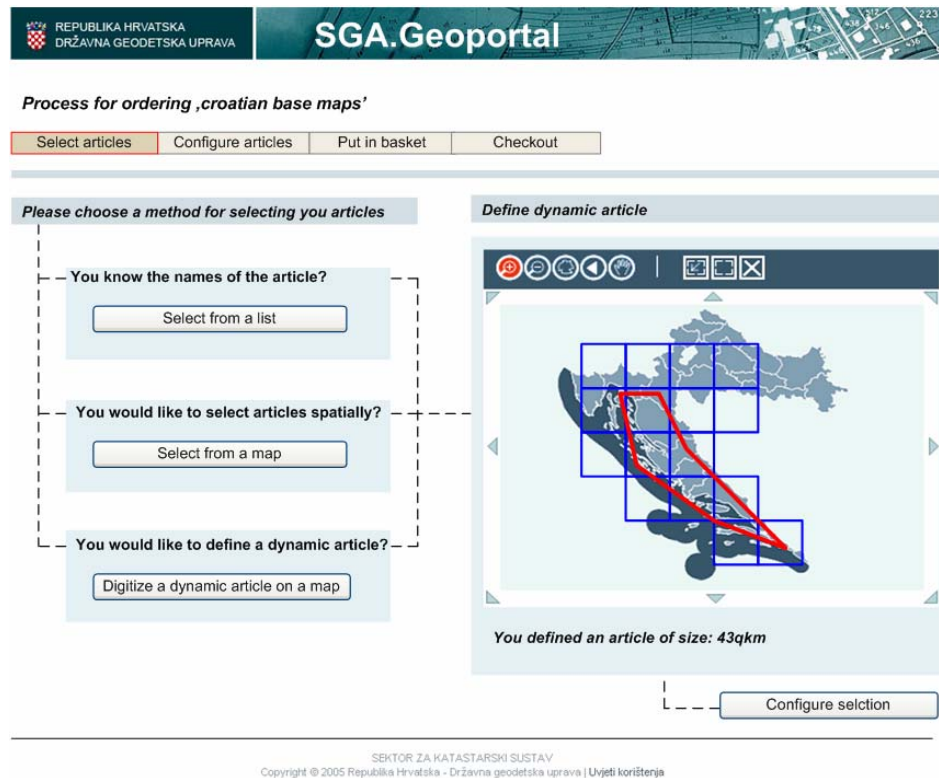
Figure 5
GPT-Based Lombardia GeoPortal Home Page



National Geoportal for Croatia

The Croatian State Geodetic Administration (SGA) is responsible for establishing a National Spatial Data Infrastructure (NSDI). The establishment of the NSDI will promote the development of national databases and their connection into a single information system that will allow agencies to use the data effectively and complement it with their own data. To fulfill these requirements, SGA is establishing a geoportal. The first release of SGA's geoportal includes the Central Registry of Spatial Units, a 1:5,000-scale orthophoto map, the 1:5,000 scale Croatian basemap, cadastral maps in raster form, and the Database of Permanent Geodetic Control Points.

Figure 6
GPT-Based SGA Geoportal Geospatial Information Search Page



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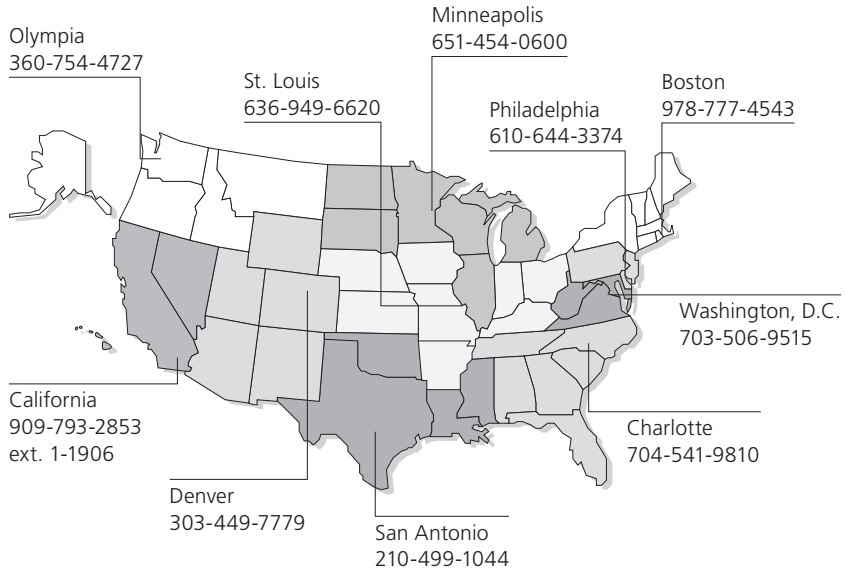
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