

iSpatial White Paper

v 3.x



Table of Contents

- About iSpatial..... 3
 - Collaborate..... 3
 - Author 3
 - Search..... 3
 - Manage 3
 - Share 3
 - Integrate..... 4
- iSpatial Use Cases & Example Deployments..... 5
 - Media Management – NBC Universal..... 5
 - Logistics and Supply Chain Management – Proctor and Gamble 5
 - Utilities/Energy – Willbros Engineering 5
 - State and Local Government – Lexington, KY 5
- Common Requirements iSpatial Addresses..... 6
- Typical Technical Approaches 7
- iSpatial Detailed Front-End and Server Side Features 8
 - iSpatial Front-End User Interface Features..... 8
 - iSpatial Server-Side Components..... 9
 - About the iSpatial Developer’s License..... 12
 - Business Model 13
- Example of an iSpatial Implementation..... 13
 - Example Architecture..... 15
- Conclusion..... 16

About iSpatial

iSpatial is a web-based collaborative visualization platform that leverages Google Earth, Maps, OGC Services, and Open Source Geo software to solve complex problems using a flexible, task-based approach.

Providing far greater utility than most dashboard tools, iSpatial's core functionality of search, authoring, sharing, and content management gives users the ability to create rich experiences around data and information critical to their work. This is exemplified by features such as complex monitoring and alerting, selective visualization of real-time information, slideshow presentations that help organize information in meaningful narratives, and finally live user collaboration to develop multiple shared common pictures.

While focused on interaction via a web interface, iSpatial has a complimentary sibling product named Ubiquity that extends full spatial functionality to a native mobile platform and provides a feature rich mobile framework. iSpatial delivers the means for organizations and their users to collaborate and integrate geospatial data and enterprise content within a rich web-based experience. The following is a snapshot of iSpatial's capabilities:

Collaborate

Author

- Create, annotate, and organize vector data: points, lines, corridors, rectangles, circles, polygons, and multi-geometries (3d volumetric)
- One-click ingest of data in various geospatial formats: KML, ESRI Shapefile, CSV, and GeoJSON

Search

- Search geospatially (current view, circle, rectangle, polygon), temporally, and using keywords and attributes
- Combinations of above features at one time for complex searches
- Reach across shared GIS data holdings using custom agents and query providers via the Core Services SDK

Manage

- Configure monitoring conditions, complex rules, and specialized alerts
- Near-real-time data updates
- Connect to existing data stores and feeds inside and outside of a user's organization

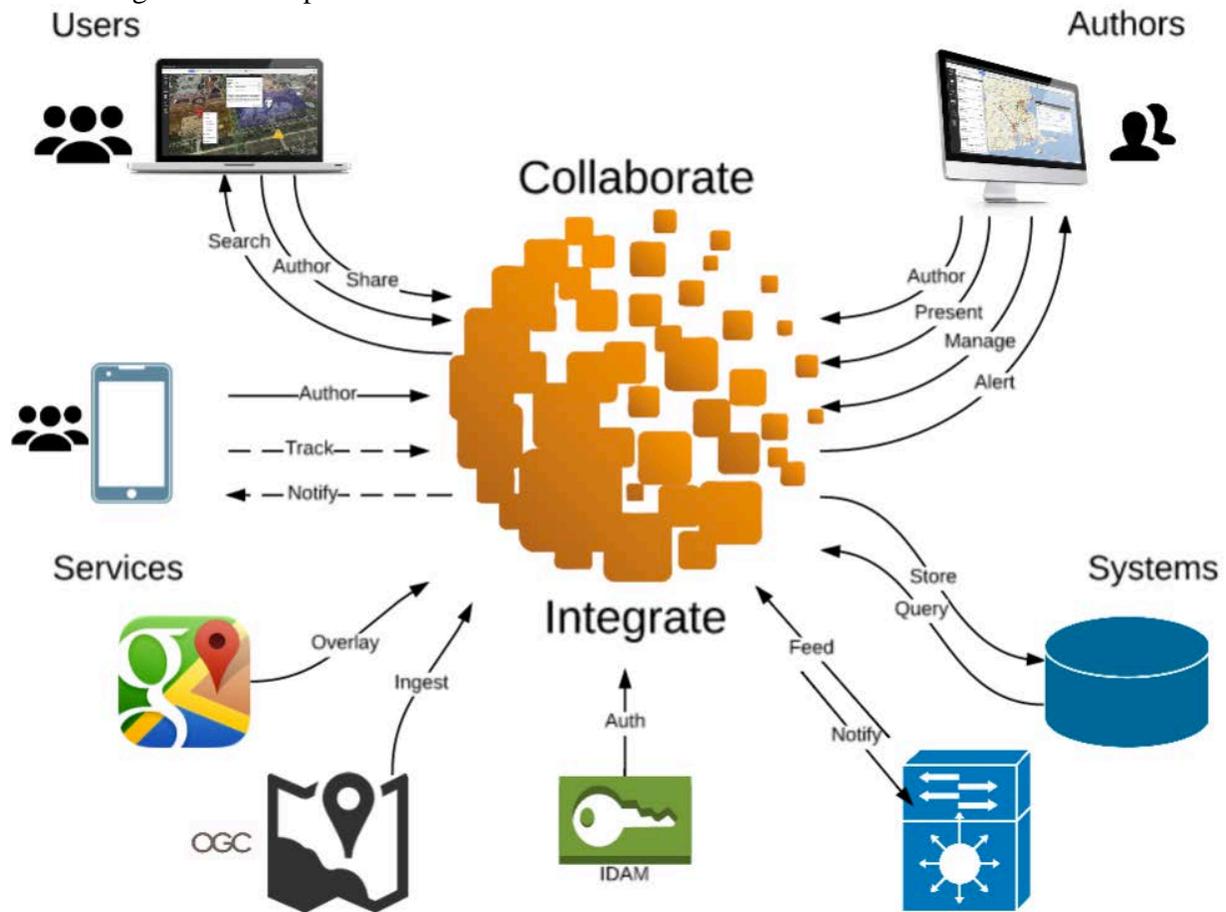
Share

- Access external content, WMS/WMTS/KML, within iSpatial from other services

- Share content within iSpatial with other iSpatial users
- Session Sharing for real-time collaboration of geospatial content within iSpatial
- Create slide show presentations of map views and data visualizations

Integrate

iSpatial can be configured for specific customer needs and workflows either in the front-end user interface or in back-end capabilities. Built with a shared-nothing architecture, iSpatial components use lightweight, secure communications between web, mobile platforms, and enterprise infrastructure, in the cloud and on-premises. Commercial customers can often take advantage of reusable customizations developed by Thermopylae including features like integrated Jabber/XMPP chat, UDP Video Streams, live-tracking of public web feeds, metered-access APIs as well as subscription data feeds such as analytics, geocoding, predictive weather reports, public disaster alerts, global shipping tracking, GPS vehicle and mobile-device tracking. iSpatial's Core Services provides integrated security with standard enterprise IDAM systems, safeguarding all assets with common authentication and authorization. Robust IT departments can make use of TST's Core Services SDKs to develop completely customized integrations leveraging TST's secure and efficient communications infrastructure. Virtually all data accessible via the web and from within the firewall can be integrated with iSpatial.



iSpatial Use Cases & Example Deployments

iSpatial has been utilized in multiple customer scenarios around a variety of use cases. Designed for users that typically don't use maps in their day-to-day work, iSpatial provides powerful data management and visualization capability in an easy to use and intuitive geospatial tool. The following are some representative examples:

Media Management – NBC Universal

- Spatial search, retrieval, visualization of events and staff in close proximity
- Staff management with locations of deployed staff
- Physical asset tracking management
- Multiple staff-coordinator collaboration
- Heads-up display of media stories and staff assignments
- Integration with enterprise single-sign-on via SAML, OAuth2, Active Directory and LDAP

Logistics and Supply Chain Management – Proctor and Gamble

- Visualization of product supply chain, both product en route and distribution
- Bi-directional interface with mobile applications for alerting and communicating if changes occur in the supply chain
- *Cloud to ground* concept for exposing enterprise information to smart phones, enabling access to data from anywhere
- Established *zones* for pushing mobile application functionality and specific content to regional management, staff and labor force
- Collaboration with GIS departments to expose their products to a larger audience in a user-friendly and intuitive way

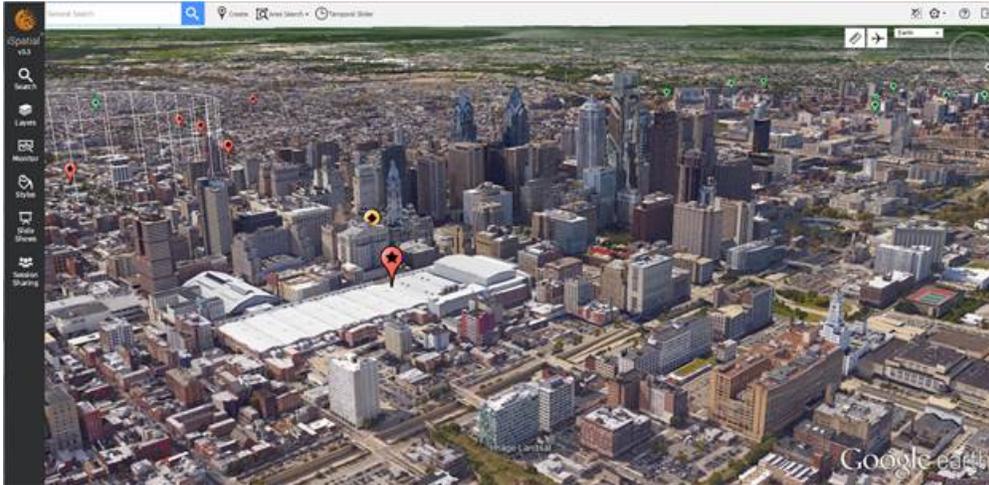
Utilities/Energy – Willbros Engineering

- Customized integration with utility lines, pipelines, and delivery infrastructure to show status of assets using convenient dashboards
- Search, retrieval, and visualization of datasets at local and regional levels
- Integration with remote equipment via supervisory control and data acquisition systems

State and Local Government – Lexington, KY

- Manages the aggregation of digital data for a city, county, or state
- Multi-department visualization of facilities, projects, and events so all groups understand the impacts of other adjacent activities
- *Situational awareness* for planning, disaster preparedness, emergency response, and executive insight into day-to-day operations
- Streamlined collaboration between municipality, county, and state officials

- Seamless exchange of spatial information in cooperation with disparate elements of state and local governments.

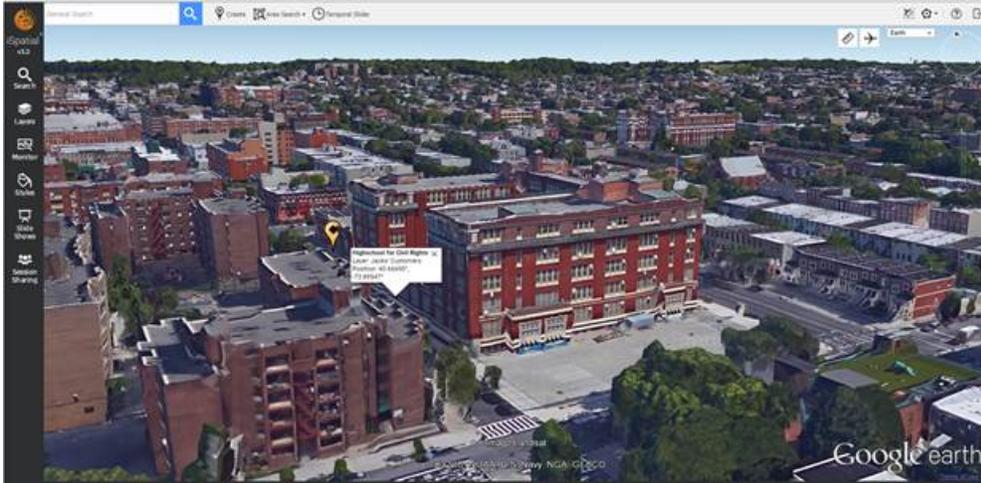


Common Requirements iSpatial Addresses

In general, users have a need to do more with spatial content than tools have allowed in the past. Converging business intelligence and operations information in a dynamic environment allow space and time to be unifying elements across a variety of datasets. Real-time business data can be overlaid on historic trends to highlight areas where business decisions may be necessary to enhance efficiency and reduce cost. 2D and 3D intuitive mapping interfaces provide more “real estate” for users to maintain situational awareness, collaborate with others, display areas and specific data about areas over time, establish alerts related to activity within areas, and maintain near-real-time secure access to critical information, business intelligence, logistics, and operations data such as big-data analytics, supply chain anomalies, security management, and live tracking of staff and assets.

Business analysts, operations, and decision makers need a fully integrated and customizable, singular visualization capability to support their work with access to relevant data from internal and external sources to inform stakeholders and business decision makers.

Access to this capability must be secure but also seamless. Advanced user authentication allows for access to different datasets based on a single sign-on such as is implemented on the open web with OAuth2 and within the enterprise with SAML. IT security and sharing are two sides of the same coin, in that ease of access as well as protected access to data and to the system itself are both paramount to its adoption across the enterprise. These critical path items are recognized as key elements of iSpatial integration within the enterprise’s cybersecurity environment.



iSpatial has the ability to support one area of a business (e.g., asset tracking) but is also able to rapidly integrate with other areas, such as field staff management, task tracking, localized customer interest, and logistics management. Core iSpatial functionality adds value within a business through the ability to perform tasks within one interface in a simple and intuitive manner. Some of these tasks include:

- Automatically stream relevant data from various systems into one operational dashboard.
- Enable effective management of the enterprise, visualization of sales, logistics, business development, and enterprise analytics.
- Creation of web-based dashboards to centralize production status and labor tasking.
- Providing an overarching view with near-real-time spatial visualization of business unit operations.

Typical Technical Approaches

When iSpatial is applied, there are three common initial steps that occur:

In the first step, customers identify what core features and capabilities iSpatial offers as a commercial off-the-shelf (COTS) product, discuss common integration and customization approaches of iSpatial within enterprises using our SDK components, and describe other pre-existing off-the-shelf systems integrations and customizations to iSpatial available for reuse to reduce the cost of non-recurring engineering (NRE) while meeting existing requirements.

Identification of deltas that may exist between the out-of-the-box capabilities and customizations is the second step that occurs. This focuses on items that would require NRE in order to integrate with technical standards, specifications, and enterprise architecture while augmenting enterprise capabilities.

Third, future planning to identify areas in which iSpatial may substantially reduce time and cost. This focuses on both inherent current and future features of the product, customizations and extensions developed around improved enterprise awareness, and customization and extensions developed in collaboration with other partners, suppliers, and customers. Leveraging these additional components expands the breadth of requirements within other departments of the enterprise that iSpatial can holistically meet.

iSpatial Detailed Features

iSpatial Front-End User Interface Features

iSpatial's user interface provides the following out-of-the-box capabilities:

- Mapping Canvas Support
 - Support for Google Earth API (3D)
 - Support for Google Maps API (2D)
 - Google Maps for Work
- Measuring Tools - iSpatial's measurement tool allows you to calculate the length of a segmented line (e.g., driving distance between two points) or the area covered by a rectangle, circle, or polygon, as well as their perimeter lengths. Horizontal and side lengths of a rectangle and the radius of a circle can also be displayed. These measurements can be calculated in kilometers, meters, miles, and feet.
- Layers Pane - The Layers pane is used to organize content.
 - My Layers - The My Layers tab displays layers created by the signed-in user. iSpatial users can organize their content in a logical folder structure by creating folders, then creating layers within folders.
 - Shared Layers - The Shared with Me tab displays folders and layers that users have elected to share with other iSpatial users.
 - External Layers - The External tab displays content that exists outside of iSpatial including WMS, WMTS, and KML.
- Authoring Content - Authoring gives users the ability to add content to the map. These items can mark points of interest, supply routes, territories, and more.
 - Geometry options include:
 - Point
 - Line
 - Corridor
 - Polygon
 - Circle
 - Rectangle
 - iSpatial content, both authored and ingested, can have additional information describing the items, making searching for items more detailed and flexible. Items can also be formatted so that different types of shapes have different appearances, making it easy to differentiate between item types at a glance.
 - Title, Description, Date-time
 - Key-value attribute pairs (KVP)
 - Height, Width
 - Style (color, thickness, opacity, iconography, etc.)

- Style Editor - iSpatial's Styles feature allows users to create custom styles to differentiate items from one another visually to better suit their particular needs. Additionally, dynamic iconography from an external HTTP service can be applied based on specific feature attributes.
- File Ingestion - iSpatial's ingest service allows you to import existing content into iSpatial, making it an ideal central repository for all of your geospatial data, regardless of where it was created or kept in the past. Upon ingest, the content is organized into layers, making it easy to manage the data. iSpatial ingest supports the following popular geospatial data formats:
 - KML
 - KMZ
 - Shapefile
 - GeoJSON
 - CSV Using WKT Format
 - CSV Using GeoJSON Format
 - CSV Using Physical Addresses
- Spatial Search and Discovery - iSpatial's search tools allow the user to search for items in several ways including:
 - By item name, description, or key-value pair
 - Within a geographic area in the shape of a rectangle, circle, or custom polygon
 - Within existing authored content shapes
 - By date-time periods
 - By a combination of all above options at one time for a robust complex search
- View of Temporal Data - All iSpatial content has a date stamp field. By default, the date stamp is empty, however, you can set date stamps and use iSpatial's Temporal Slider feature to control content visibility by time period, creating a time-lapse- effect showing the change in objects over time.
- Monitor Data - iSpatial's Monitor feature allows you to target content of interest, set monitoring rules, create alerts, and perform actions when rules are triggered.
 - Live Tracking - Users can subscribe to live updates on any feature in iSpatial, whether a live track being updated in near real-time, or a folder of content another user has shared and is making frequent updates to.
- Presentations - Users can create slideshows in iSpatial in advance so that during presentations the view will transition to the next slide without having to search or navigate through existing layers or search results to show the desired content.
- Shared Session/Common Picture - iSpatial's sharing feature allows users to share their current view of the map with other users. As the host navigates the globe, changes view options, and manipulates layers, the participants see the same perspective and activities in near-real-time. Sharing is useful for intelligence briefings, rehearsing logistics operations, demonstrating business scenarios, and familiarization.

iSpatial Server-Side Components

iSpatial is built upon TST's Core Services framework to leverage efficient and secure communication between mobile, web, and enterprise services across all platforms. Core Services (which is also utilized by our mobile product, Ubiquity) provides the infrastructure and SDKs to extend these capabilities to your mobile devices, web applications, and enterprise systems. Ubiquity

provides native application functionality and provides a feature-rich framework that extends iSpatial to the mobile domain.

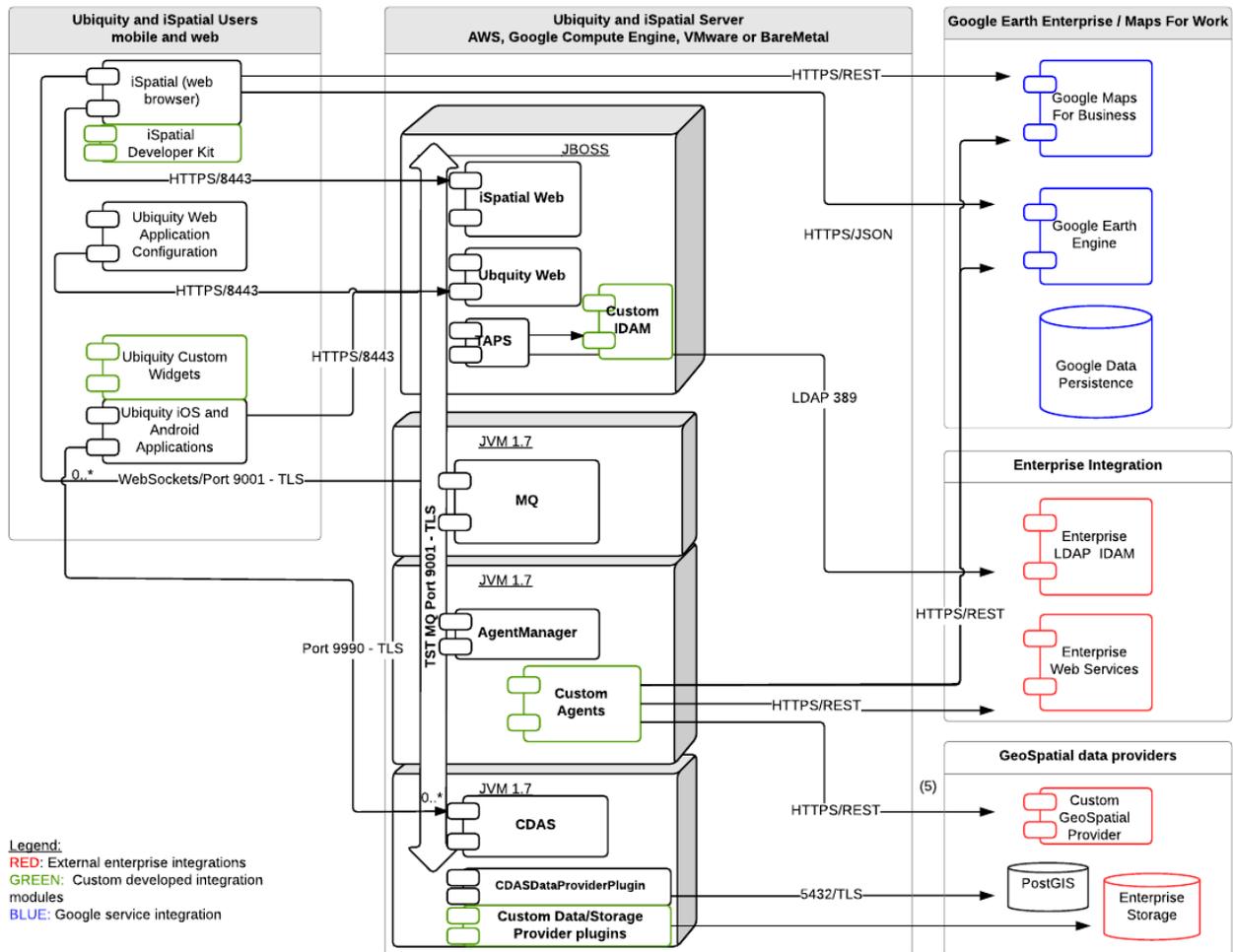


Figure 1 - Core Services Communications - Components, Ports and Services

Core Services provides SDKs for building custom software components to access alternate sources of geospatial data, safeguard access to your systems using current authentication techniques, and to develop custom business logic. These SDKs include CDAS (Common Data Access Services), TAPS (Thermopylae Authentication Proxy Service), MessageQueue, and Agent Plugin frameworks.

iSpatial’s user interface can be completely customized by modifying the JavaScript, HTML, and CSS sources included in the iSpatial web application.

Core Services Platform Stack and SDKs

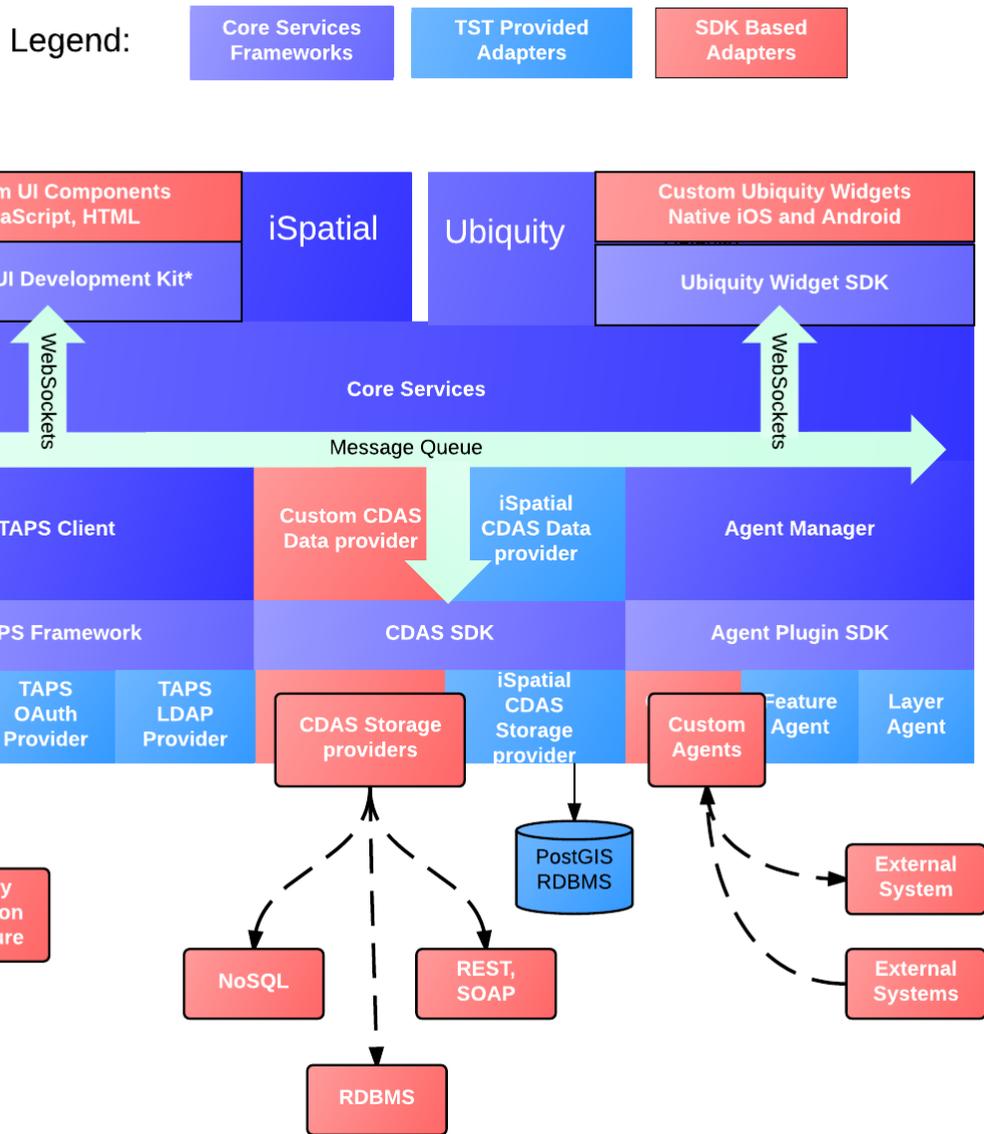


Figure 2 - iSpatial and Core Services and SDK Component Adapters

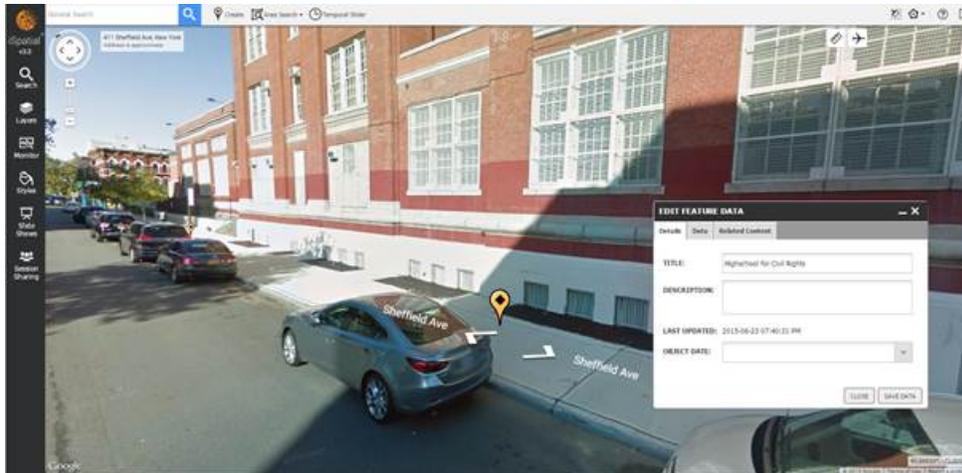
TAPS SDK

Thermopylae Authentication Proxy Service (TAPS) is Core Service's security framework. All core services communication is encrypted and authenticated, and by using TAPS, iSpatial and Ubiquity can be configured to integrate with enterprise IDAM systems such as LDAP, Active Directory, and OAuth2. The TAPS SDK allows you to build adapters to any custom or legacy IDAM system in your enterprise.

CDAS SDK

Common Data Access Service (CDAS) is the underlying data storage and retrieval framework, and all data used by Ubiquity and iSpatial is accessed using this SDK. Extensions to CDAS require two components: a CDAS Data Provider and a CDAS Storage Provider.

CDAS Storage Providers are the components that communicate and adapt an external data source, e.g., a database, file system, or web-based API. CDAS Data Providers convert the native data served by the storage provider into JSON, which is the canonical data format used between all Core Services components. The data provider interfaces also support asynchronous notification from the underlying data store so that external systems can trigger behavior in iSpatial or Ubiquity.



Agent Plugin SDK

Core Services employs the actor model for all internal business logic, meaning that small actors/agents receive messages that invoke small bodies of stateless business logic with minimal side effects, propagate subsequent messages to other agents, and finally publish responses intended for clients of Core Services. This programming model is very efficient and eliminates the complexity of developing multithreaded code.

AgentManager is the host for all Core Services agents, which are built with the Agent Plugin SDK. This SDK provides documentation and examples of how to develop and deploy your own custom agents to incorporate custom behavior and business logic into iSpatial and Ubiquity.

MessageQueue

MessageQueue (MQ) is the main communication bus between all Core Services components. Messages from web clients and mobile devices are encrypted and transmitted over non-blocking WebSockets (and optionally traditional sockets) using the pub/sub paradigm. MQ's message formats are described in the API documentation in the MessageQueue SDK.

About the iSpatial Developer's License

The iSpatial user interface can be extended using the Developer's License, which is available for purchase as a separate license from TST. This license includes full access to all of the JavaScript,

HTML, and CSS source code of the iSpatial web application. Detailed knowledge of the ExtJS framework is required for customizing the user interface.

Business Model

TST has developed integrated extensions to iSpatial around multiple use cases under contract for multiple commercial customers. Through this experience, TST has developed the extensibility to a maturity level that enables enterprise customers' IT departments to employ the same SDKs, tools, and services to rapidly and comprehensively integrate iSpatial into their unique IT infrastructure.

Areas of emphasis and extensions include prior, current live, and future business intelligence platform data, integrated open-source and off-the-shelf GIS product visualization, integrated access to multiple data-sources on a single platform, report templates for standardization of GIS presentation within iSpatial, advanced workflow automation through extension to iSpatial AgentManager and Monitor capabilities, and embedded data/view sharing in other tools or as standalone URL-based visualization (which could be highly beneficial in embedding in a “dashboard” or SharePoint-based tools).

Our hybrid business model for the enterprise is to leverage core technology to meet key requirements, while building in extensibility for maximum re-use of both the base off-the-shelf software and any custom or proprietary components developed on top of it.



Example of an iSpatial Implementation

iSpatial supports three concurrent strategies (listed in order of maturity) for interacting with other systems, services, and data via the following iSpatial Core Services components (shipped with each instance of iSpatial and extensible through the iSpatial SDK) and ships with its own database, referred to as the iSpatial GeoIndex, which is implemented using Postgres with spatial extensions and abstracted via Common Data Access Service (CDAS).

Leveraging the iSpatial GeoIndex that is included in the product in conjunction with the approaches below demonstrates how iSpatial can quickly deliver capability, then modify/transition to other data stores within an organization over time as necessary.

Integration with Authoritative Data Sources via Common Data Access Service (CDAS)

CDAS was designed to allow iSpatial to be extended in order to integrate directly with multiple authoritative data stores for (federated) query and Create, Update, Delete (CRUD) where applicable.

Customers can first identify which data sources should be accessible in a query-only fashion. This is common with data sources that contain authoritative final products that end users may not modify (such as finished business intelligence reports, customer and employee records, etc.) but wish to query and visualize in conjunction with information from other data sources.

Integration with these external data sources is accomplished by developing CDAS Query Providers which provide an abstraction to whatever service mechanism the store supports for query (JDBC, REST, SOAP, Thrift, WebSockets, etc.). This allows an iSpatial user to query as many data stores as there are CDAS Query Providers.

Integration with Data Sources that Support Query and CRUD

In addition to Query Providers, CDAS also supports CRUD operations on remote data stores via development of custom CDAS Storage Providers, which (subject to authentication and authorization) allows other non-iSpatial back-end data stores to be used in addition to or in place of iSpatial's out-of-the-box database.

As necessary, CDAS Storage Providers could be utilized to allow users to CRUD data within these third-party data stores.

The above two approaches are designed to allow both federated query (whenever possible, access data in place) and native persistence (CRUD) to multiple sources when appropriate. This scenario is common to iSpatial deployments where users need to query multiple remote data stores from iSpatial's user interface, but also have permission to edit/modify/create on certain data sources.

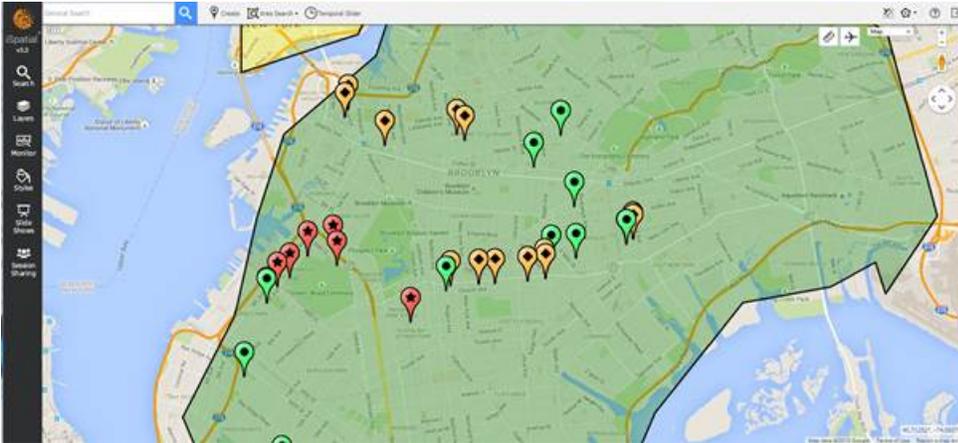
Integration with Real-time or Frequently Updated Feeds

iSpatial's Agent Manager component handles business logic, processing, ingestion, etc. when server-side processing is required.

Core Service's ingest agents allow iSpatial to connect to data feeds and provide local storage using iSpatial's default database (GeoIndex) or to alternate CDAS Storage Providers (persistence to a non-iSpatial datastore of the customer's choosing). In instances when live-tracking of objects (in very near-real-time), analytics (tell me when thing A intersects geometry B), and historical query on feeds/data sources that typically do not store historical data (regional sales and weather, for example) are required this approach can be utilized.

This option allows customers to selectively add data to iSpatial's database (or other stores for which CDAS Storage Providers have been configured) when the data sources being ingested do not provide one or more of the following:

- an option for historical query or live filtering of the feed or,
- a performant option for query or filtering (or comms/bandwidth at the deployed location make this too cumbersome or non-performant).



Integration with Enterprise Services and Applications

iSpatial's MessageQueue (MQ) acts as a lightweight enterprise service bus (ESB) for iSpatial back- and front-end components. The iSpatial user interface, for example, both subscribes and publishes to WebSocket MQ *channels* when a user has a request and expects a response. Similarly, the back-end components (agents within AgentManager) utilize MQ channels to communicate with other agents, the iSpatial UI, TAPS (for authentication and authorization), and CDAS (for data access).

This would represent an option for both service-to-service and UI-level interactions that can be orchestrated between the iSpatial front end and other services or applications. These interactions can either be facilitated via the MQ WebSocket API, REST or other Web API invocations, allowing the iSpatial UI to both send and receive requests with other services, completing bypassing the back-end iSpatial components.

This approach is less desirable as most deployments of iSpatial want very rich and mature back-end service functionality versus a more traditional HTML based "mash-up" style front-end experience, but is something we recognize may be required to meet specific architecture requirements.

Example Architecture

Based on our understanding of various themes and trends for enterprise architecture, the diagram below illustrates just one example of how iSpatial could be integrated.

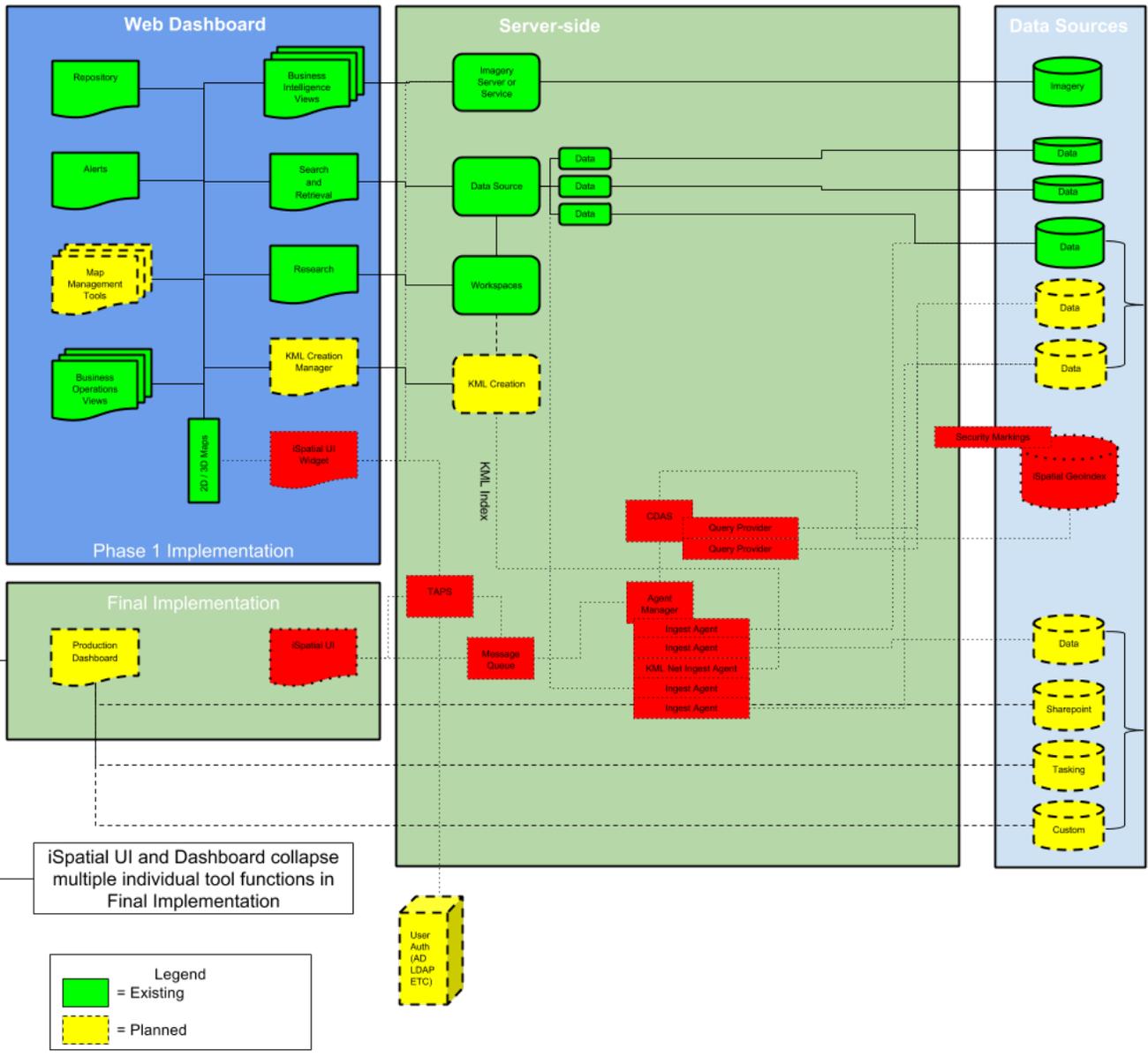


Figure 3 - Example iSpatial Architecture

Conclusion

iSpatial supports a breadth of use cases and provides off-the-shelf capability that leaves no ambiguity about what is being delivered. It maps to many current enterprise requirements and is available through a variety of enterprise options that provide immediate user capability, long-term road map for planning, distributed development costs between a broad user base, and reduced long-term sustainment costs.