

iSpatial White Paper

Intelligence Community and Defense Intelligence Focus

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About iSpatial

iSpatial, is a web-based collaborative tool that leverages Google Earth, Maps, OGC Services, and Open Source Geo software in a flexible, task-based approach to solving common problems. iSpatial is a state of the art visualization platform, and can be integrated with multiple existing data source to expose data in a geo-temporal, user-defined environment.

Designed to provide far greater utility than most Common Operating Picture (COP) tools, in addition to basic functions like search, authoring, editing, and content management, iSpatial allows users to create customized experiences around the information and knowledge most critical to them. This is accomplished by key features including the ability to set criteria for monitoring on underlying data for alerting, selective visualization of real-time information as it occurs, the ability to create presentations which organize spatial information in a meaningful manner to other users, and finally through live user collaboration and development of multiple shared common pictures within the tool.

iSpatial allows organizations to offer a rich web-based application which provides access to additional organizational enterprise data and content and offers the following core functionality:

Authoring

- Create, annotate, and organize vector data (point, line, corridor, rectangle, circles, polys, multi-geometry [3d volumetric]) objects
- One-click ingest to import data from multiple file formats (KML, SHP, CSV, and GeoJSON)
- Fuse data sets to create new insights

Search

- Powerful data discovery across shared GIS data holdings via CDAS Query Providers
- Define and search geospatially (view, circle, rectangle, poly), temporally, and with terms or attributes and values
- Reach across systems and data sets via development of custom Ingest Agents or Query/Storage Providers via iSpatial core services libraries

Manage

- Configure rules, boundaries, and alerts
- Near-real-time data updates

Share

- Access content as WMS/WMTS/Network-link KML within iSpatial from other GIS tools or services

- Share content within iSpatial with other iSpatial Users
- Session Sharing for real-time collaboration over Geospatial content within iSpatial
- Presentations - create meaningful reusable presentations of core content and views

iSpatial can be extended and customized around specific customer needs and workflows via extension of both back- and front-end capabilities. Additionally, our Government customers can often take advantage of customizations developed under contract to other Government customers including features like integrated Jabber/XMPP chat, UDP Video Streams (FMV), and live-tracking of COT/MTI/JBFSA feeds.

iSpatial Use Cases & Example Deployments

iSpatial has been deployed in multiple government and commercial customers around a variety of spatial information, improved situational awareness, intelligence, and planning use cases. The following are some representative examples

US Southern Command J2

- Knowledge Management
- Spatial search, retrieval, visualization of J2 Intelligence Products on SIPR/JWICS
- HA/DR Common Operating Picture (COP) support in collaboration with SOUTHCOM J9
- Force management with locations of staff deployed in SOUTHCOM AOR and for disaster response force accountability
US Department of State - Diplomatic Security Service (DSS)
- Personnel Security Detail Mission Planning & Discovery
- Coordination with Intelligence & Analysis Division
- Common Operating Picture (COP) on SIPR
- Live PSD Mission Overwatch (BLUE FORCE tracking)
- Integration with Intelligence Sources for improved mission SA and pre-mission planning.

US Army G2 / INSCOM Windshear Program

- Visualization of mobile tactical intelligence units
- Bi-directional interface with MI mobile applications for intelligence collection and situational awareness
- “Cloud to Ground” concept for exposing enterprise intelligence to mobile ground forces
- Established “zones” for pushing mobile application functionality and specific intelligence to ground forces based on their context.

US BICES-X

- COP / Common Intelligence Picture (CIP)
- Search, retrieval, visualization of Intelligence Products.

Defense Threat Reduction Agency (DTRA)

- Bio-surveillance of medical trends/outbreaks
- Tracking teams/materials associated with WMD

Defense Intelligence Agency (DIA)

- Collection Management
- Enterprise Knowledge Management (supporting SOUTHCOM J2 requirements)
- Situational Awareness

National Security Agency (NSA)

- Unified COP / CIP for visualizing data
- Global facility visualization and management

IC and DoD Requirements Mapping to iSpatial

In general, users have a need to do more with spatial content than individual tools have allowed in the past. Convergence of intelligence and operations information in a dynamic environment and evolutions in technology allow time and space to be unifying elements across a variety of data sets. 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 that area over time, establish alerts related to activity in areas, and maintain near real time access to key intelligence and operations data such as GCCS, MIDB, Record Message Traffic RMT/M3, Quellfire, CRATE, and others.

Analysts, operators, and planners need a fully integrated and tailorable, single battlespace visualization capability to support theater Improved Situational Awareness, C2 of Intelligence, C2 of ISR, and C2 of C2. The capability must access relevant data from the Intelligence Community, DoD, and Law Enforcement needed to inform theater Command and Control.

Access to the aforementioned capability must be secure but also seamless. Modern user authentication allows for access to different data sets based on a single sign-on such as is implemented on JWICS with PKI. The utility of a tool can be almost as simple as its ease of access; access to data and to the system itself are paramount on secure networks to ensure user adoption. These critical path items are recognized as more important elements of the user’s “hierarchy of needs” when it comes to Command and Control (C2) of intelligence, situational awareness, and other requirements.

In recent user engagement with DoD/IC using the iSpatial product, one Technical Director summed it up best when he stated...

“The way we do analysis (with existing tools) is largely focused on how to transmit the information via PowerPoint which hampers our ability to do sound analysis. This tool

would allow us to get back to doing foundational analytical processes thereby allowing us to think more critically [versus spending time on developing a PPT].”

We believe this represents a core recognition that overarching IC/DoD requirements represent a picture of what many users across the Defense Intelligence, National Agencies, and broader DoD community need. Accessing, managing, sharing, exporting, presenting, and collaborating around spatial data seamless and in a granular fashion will act as a force multiplier for various intelligence disciplines.

The adjacent benefit to intelligence and operations personnel could meet currently unidentified requirements that come from collection management and targeting activities. The core iSpatial functionality could even add value to logistics, engineering, and operations activities within the overall Unified Commands through the ability to more simply perform tasks including:

- Automate relevant feeds into C2 of Intelligence Dashboards
- Enable effective command and control of the Intelligence Enterprise of sensors, networks, decision aids, and analytic capacity
- Creation of a web-based dashboard to centralize production tasking and product dissemination
- Providing a "Common Intelligence Picture" (CIP) with near-real-time visualization of component and National collection platforms, capabilities, and tasking

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 the DoC/IC enterprise using our SDK components, and describe other pre-existing GOTS customizations to iSpatial available for use within this effort that may reduce cost of Non-Recurring Engineering (NRE) while meeting existing requirements.

Second, identification of deltas that may exist between the out of the box capabilities and customizations occurs. This focuses on items that would require NRE in order to integrate within a Defense Intelligence technical standards and specifications architecture while improving Situational Awareness Requirements.

Third, future planning to identify areas 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 SA, and customization and extensions developed in collaboration with other government customers. Leveraging these additional components expands the breadth of requirements within other elements of the IC community that iSpatial can holistically meet.

What iSpatial provides

iSpatial is a combination of rich web-based application and robust server-side components that allow organizations to rapidly deploy powerful applications around spatial information.

iSpatial Front-End User Interface Features

iSpatial's core 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 Earth Enterprise
 - 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. These measurements can be calculated in kilometers, meters, miles, and feet.
- Layers Pane - The Layers pane is used to organize global content. Initially, content is organized by creator, but it can be reorganized using a global folder structure to group like items logically for easier access.
 - 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 the 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 linked content that is stored outside of iSpatial including WMS, WMTS, and Network Link 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, and DTG
 - Object KVP/Attributes
 - Object Heights/Widths
 - Object Style (color, thickness, opacity, iconography, etc.)
- Style Editor - iSpatial's Styles feature allows users to create custom styles to differentiate items from one another graphically to better suit their particular needs.

Additionally, dynamic iconography from an external service HTTP service can be applied based on specific feature attributes (2525B symbol id for example).

- 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 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
 - Within content within a layer
 - By time frame
- View of Temporal Data - All iSpatial content has a date stamp field, controlled by the **Object Date** field in the **Edit Data** window. By default, the date stamp is blank. However, you can add date stamps and use iSpatial's Temporal Slider feature to control content visibility by time frame, 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 alertes, 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 prepare slideshows in iSpatial in advance so that during presentation the viewer pane will transition to the next view without having to search or navigate through existing layers or search results to present the desired visualization.
- Shared Session/Common Picture - iSpatial's sharing function allows users to share their current view of the globe 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 operations, demonstrating tactics, familiarization, and more.

iSpatial Back-End Server-Side Components

iSpatial is built upon TST's Core Services framework to leverage efficient and secure communication of geospatial data between mobile, web and enterprise services. Core

Services provides the infrastructure, frameworks and SDKs to extend these capabilities to your mobile devices, web applications and enterprise systems.

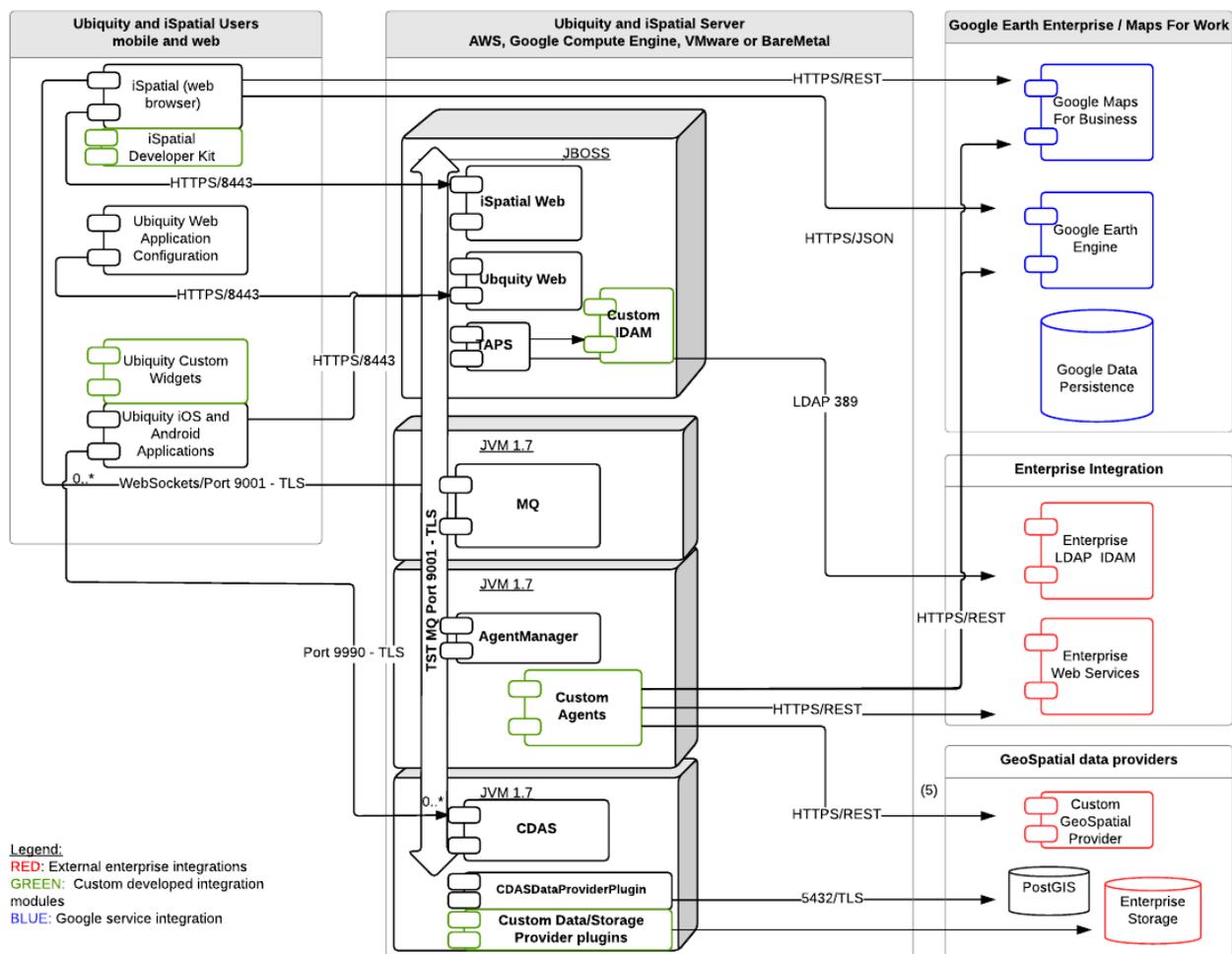


Figure 1 - Core Services Communications - Components, Ports and Services

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

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

Core Services Platform Stack and SDKs

iSpatial is built on TST's Core Services SDKs (which is also utilized by our mobility product, Ubiquity), which offer the benefits of secure and extremely efficient communication across

all platforms.



Figure 2 - iSpatial and Core Services and SDK Component Adapters

TAPS SDK (iSpatial 3.4 and later)

TAPS is Core Service's security framework. 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. This part of the CDAS adapter must implement the storage provider interface as described in the SDK documentation.

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 applications. 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 agents/actors receive messages to invoke small bodies of stateless business logic with minimal side-effects, and propagate subsequent messages to other agents, and finally produce responses to clients of Core Services. This programming model is very efficient and eliminates the complexity of developing multithreaded code.

Agent Manager 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. Pending authorization with TAPS, messages from web clients and mobile devices are encrypted and transmitted over non-blocking websockets (and optionally traditional sockets). MQ's message formats are described in the MessageQueue 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 and CSS source code of iSpatial's web-based visualization. Detailed knowledge of Javascript and the Ext JS framework is required for customizing the user interface.

iSpatial Customizations Available for Re-use

In addition to core iSpatial functionality, the following enhancements were added during the DIA/DAE/Lighthouse effort that are potentially portable to meet JIOC-IT requirements as part of an integration within the DI2E architecture.

- Alerting
 - Fully integrated with DAE Third Party Alerting Service
 - Subscribe
 - List Subscriptions
 - Alert the user
 - Plot Features that triggered alert.
- Slide Shows
 - Added bullet point (HTML editor) to Slides
 - Added list of layers used in each slide to edit dialog.
- Display of Classification in layers and features
- Changed “Session Sharing” to “Common Picture”
- Added ability to pull GEE tiles from a different server than where the FusionMaps JavaScript Source is located (allowing targeted FusionMaps API control).
- Integration with DIAS via PKI certificate through EZSecurity

Additionally, during our engagement with Special Operations customers, several core capabilities were developed that can be re-used (with government PM approval) and could provide the following features:

- COT/MTI UDP Feed Ingestion Agent of live or historic ISR data
- Platform/Spypoint Integrated NRT tracking representation
- Integrated VLC Video Plugin “floatable” FMV viewers over mapping canvas
- Integrated Jabber/XMPP user-to-user and “room” chat

Furthermore, as we continue to engage with our customers within the IC, additional improvements and features will be in development which may directly or partially address broader requirements across the community now and in the future.

Business Model

As aforementioned, TST has developed GOTS extensions to iSpatial around multiple use cases under contract to other government customers. Additionally, over the balance of the fiscal year, additional customizations around similar use cases can be contributed and re-used to address new and existing requirements.

Areas of emphasis and extensions include prior, current live, and future ISR platform data, integrated FMV/ISR product visualization, integrated access to multiple ISR sensors on a single platform, report templates for standardization of content production within iSpatial, advanced workflow automation through extension to iSpatial Agent Manager 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 DoD/IC is to leverage core technology we have invested in to meet key requirements, while leaving extensibility for maximum re-use of both the base COTS software and any GOTS 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 store/database, referred to as the iSpatial GeoIndex, which is implemented using Postgres/GIS DB and abstracted via CDAS.

Leveraging iSpatial's existing datastore/GeoIndex that ships as part of the product in conjunction with the approaches below demonstrate how iSpatial can quickly deliver capability, then modify/transition to appropriate authoritative stores 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 CRUD (where applicable).

Customers can first identify which data sources should be accessible in a query-only fashion. This is common with data sources which contain authoritative final products that end users may not modify (such as finished intel products, MIDB 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 (e.g. JDBC, REST, Thrift, WebSocket, 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 back-end database.

An necessary, CDAS Storage Providers could be utilized to allow users to create, read, update, and delete (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 quite common for iSpatial deployments in which a user wants to query multiple remote data stores (facilitated via CDAS Query Providers) from iSpatial's user interface, but also has rights to edit/modify/create on certain data sources (facilitated by CDAS Storage Providers).

Integration with Real-time or Frequently Updated Feeds

iSpatial's Agent Manager component handles business logic, processing, ingestion, etc. when server-side processing of some nature needs to occur.

Core Service's ingest agents allow iSpatial to connect to data feeds and provide local storage within iSpatial's out-of-the-box database (GeoIndex) or to existing 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 (COT/MTI for example) are required this approach could be utilized.

This option allows customers to selectively add data to iSpatial's own DB/GeoIndex (or other stores for which CDAS Storage Providers have been defined) 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 Other DoD/IC Components and Applications

iSpatial's MessageQueue (MQ) acts as a lightweight ESB for iSpatial back and front-end components - the iSpatial user interface, for example, both subscribes to events (via WebSockets) and publishes events to MQ WebSocket Channels when a user sends a query request and receives a query response. Similarly, the back-end components (agents within Agent Manager) utilize MQ Channels to communicate with other agents, the iSpatial UI, TAPS (for authentication and authorization), CDAS (for data access), etc.

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 or another WebSocket based API completely, such as CMAPI, allowing the iSpatial UI to both send and receive requests with other services, completing bypassing the back-end iSpatial components.

This approach is less mature as most of our deployments of iSpatial want very rich and mature back-end service functionality versus a more traditional OWF "mash-up" style, but is something we recognize might be required to meet specific architecture requirements of the gaining environment.

Example Architecture

Based on our understanding of various themes and trends in the DoC/IC today for enterprise architecture, the below diagram illustrates just one example on how iSpatial would be integrated.

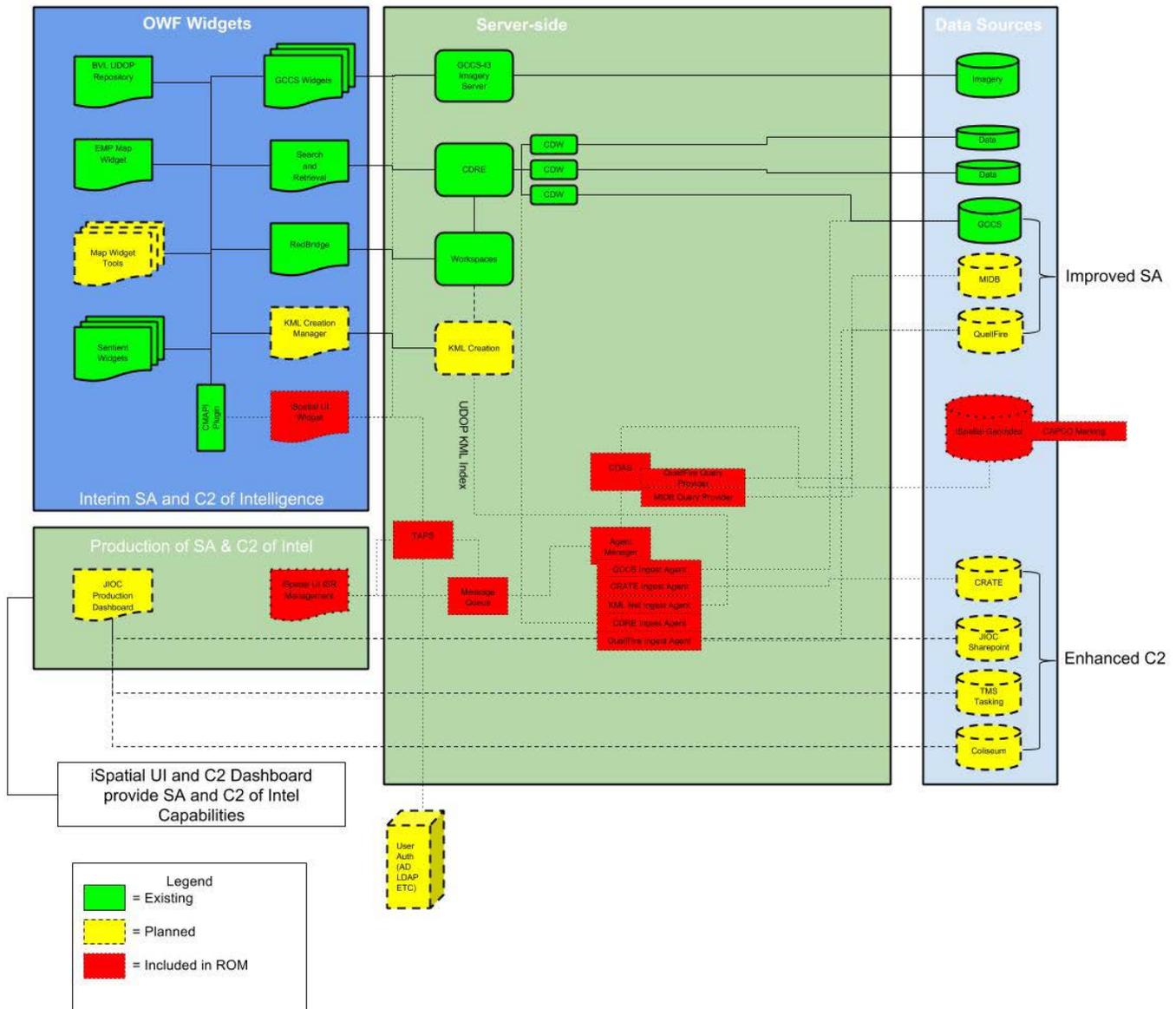


Figure 3 - Example iSpatial Architecture

Conclusion

iSpatial has a breadth of use cases and provides currently developed capability that leaves no ambiguity about what is being delivered. It maps to many current DoD/IC 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.