HEXAGON

White Paper

END-TO-END GEOSPATIAL SOLUTIONS FOR MILITARY LAND C2 OPERATIONS

15 April 2019

Contents

Limitations of Traditional GIS Capabilities

Military forces often manage and distribute their geospatial data, intelligence, and real-time information using isolated stovepipe applications and bespoke, non-standard services. This is despite the increasing focus on standards and initiatives like NATO's Federated Mission Network (FMN). Consequently, forces suffer interoperability problems and are finding it hard to deliver the rich map, intelligence, surveillance, and reconnaissance (ISR) services demanded for accuracy and efficiency of operations.

While command and control (C2) systems at headquarters level are commonly based on high-bandwidth networks, in contrast, their tactical mobile forces employ national Battle Management Systems (BMS) that are frequently based on low-bandwidth radio networks. Consequently, sharing mission plans, reports, and real-time geointelligence and information between command levels is often difficult. It is made all the worse because systems often lack interoperability, having been built based on bespoke, vendor-designed standards.

These limitations are significant because Shared Situational Awareness (SSA) and the use of common foundation mapping and key geointelligence are essential for sound decision making. In today's highly maneuverable warfare, the use of geospatial and military standards can be a key force enabler and significantly helps to overcome the now commonplace information exchange limitations.

There is a clear need for an enterprise-level solution that can efficiently connect to and manage geospatial data, geospatial analytics, information products, and real-time information. However, **traditional GIS capabilities can be cumbersome, require specialist support, and need powerful hardware and power supplies to drive them. These demands can be hard, if not impossible, to meet in the deployed land environment.** A more agile and open solution is required.

Breaking Out of the Stovepipe – Open Standards and Best-of-Breed

Apart from the interoperability benefit, the use of open standards reduces risk, maximizes return on investment, and future-proofs critical Land C2 systems. In today's world, national military forces increasingly need to cooperate with coalition forces and non-government organizations (NGOs) in conflict areas or when dealing with natural disasters. Open standards are the natural enabler of this kind of cooperation, and it is often the military that limits such critical information exchange. This is not just caused by classification concerns – even the exchange of basic unclassified products can be problematic.

A logical consequence of the use of open standards is the advantage of competition and the possibility to implement a best-of-breed architecture.

Competition - Competition among providers of standards-based location intelligence products improves the diversity of commercial offerings available for Defense applications and the subsequent quality of any selected capability.

Best-of-breed - Open standards allow combining products of differing vendors, each with varying strengths. In the Land C2 area, this means that one product can be used, for example, for the creation of geospatial data (map making and cartographic workshops). At the same time, another is used for the management, distribution, exploitation, and analysis of that same data while dealing with demanding dynamic feeds that are now more commonplace.

The worldwide Open Geospatial Consortium (OGC) is the authoritative source for standardization of the geospatial community. Both Hexagon's Geospatial division and Luciad (now part of Hexagon) are proud to be founding members of the organization. Luciad also helped co-define new open standards and on many occasions has been the first geospatial vendor to provide open commercial support for these standards.

Available Geospatial Technologies

GIS has always been a crucial element of any Defense infrastructure. However, traditional GIS products are not well equipped to fully handle the challenges of today's Military Land operations. **Moreover, the demands of today's warfighter evolve at such a pace that flexible technology is required – technology that not only satisfies the requirements of today, but also provides the basis for Agile development to exceed the needs of tomorrow.** Some of the technological challenges ahead are highlighted – and how Luciad Portfolio technologies are available to ensure mission success and reduce the total cost of ownership.

Luciad Portfolio offers a unique platform for the geoinformation and intelligence of your unit. Our standards and performance baseline, combined with Application Programming Interfaces (APIs), lets you deal with many datatypes, whether proprietary or open source data from any platform. Luciad Portfolio software is both commercial off-the-shelf (COTS) and components-based and is ideally suited for adaptation to meet the evolving requirements of any modern Land C2 system.

Geospatial Challenges for Today's Military Land C2 Operations

Founded by several C2 experts with backgrounds in the Defense industry and NATO, Luciad (now part of Hexagon) has been supplying COTS components-based solutions to Defense professionals worldwide for decades. During this time, Luciad technology rose to the challenge of meeting Defense needs and leads the field in delivering highly accurate and performant systems. Military decision makers often struggle with having to combine multiple legacy systems in a single workflow, and delivering the right capability can prove to be a key force enabler. Luciad Portfolio solutions respond to these challenges through many components, including the following key points.

Avoid the Restrictions of Geodatabases

Many of today's classical GIS vendors work with a "geodatabase." This is a common information model, proprietary for each GIS product. The geodatabase, which is often closed, manages all geospatial objects, rules, and relationships. Such "black-box" technology may work for basic civilian applications but is unfit for advanced Defense needs.

Today's warfare operations typically imply intensive use of near real-time and real-time data from an increasing number of ISR sensors on the battlefield. These data sources can be moving tracks, radar feeds, live imagery, incident reports, and other sources. Moreover, today's land operations can quickly range from peace enforcement or support to conventional warfare, or asymmetric warfare in unpredictable locations. The ability to operate in unfriendly environments and under cyber-attack while sharing information across coalition network domains demands reliable and robust geospatial infrastructure, and Luciad Portfolio technology provides the key components to deal with such scenarios.

The common thread in today's warfare operations is the requirement to connect to, visualize, and analyze any data source on the fly. This precludes preprocessing and optimizing the data – both of which are inherent when working with geodatabases and conventional mapping engines. Conventional GIS systems with internal geodatabases can cause many headaches:

- Difficult or even impossible to ingest custom formats.
- Difficult (for example, force tracking) or even impossible (for example, radar feeds) to handle real-time data efficiently because of the need for preprocessing in the geodatabase. Adding heavy "event processors" often does not solve the problem, but adds to the complexity and will certainly induce latency.
- Lack of extensibility due to the "black-box" nature of the geodatabase.
- Lock-in effect with the geodatabase, which provokes a strong dependency on the GIS vendor.

Saving Lives Through High Precision

Accuracy in C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) systems is key and assumed by the user. This is because such systems can be used, for example, to assess the damage that will be caused by a weapon in order to minimize impact on the local population, or to mensurate coordinates for precision weapons use. In other words, this necessary accuracy has the potential to determine the safety of uncountable lives.

This is where problems often arise. Some of the world's largest GIS providers openly warn on their developer pages and user forums that reprojections and recalculations of data can lead to inaccuracies of up to tens or hundreds of meters compared to the original source data. In practice, this can mean the difference between targeting the enemy or innocent civilians. It can also mean the difference between being protected from enemy fire or exposed to it.

Technology is needed that maintains the accuracy of the source data through any number of reprojections and recalculations. Such retained accuracy is impossible to attain by GIS technologies that work with geodatabases where all source data needs to be translated into proprietary "black box" formats.

For this reason, Luciad Portfolio technology does not work with geodatabases, but rather ingests all data in its native format, and with great success. Luciad technology is certified by leading Defense organizations worldwide to ensure the source data accuracy and integrity down to three centimeters anywhere in the world; but in reality, our systems are even more precise.

Satisfying the Needs of the Geo-Specialist, the Commander, and the Warfighter Staff

In today's networked environment, collaboration across joint and coalition forces must be seamless to allow the timely exchange of critical information between many actors, each with specific workflows and needs.

For instance, geo-specialists focus on the rapid generation of information products and dissemination of these to the warfighter, ideally through advanced web services. Commanders need a classical Common Operating Picture (COP) where very different layers of information are easily fused and displayed, including many combinations of live and static foundation information. The G2 and G3 warfighter staff focus on the immediate access to a variety of real-time data sources to provide them rich information that can ensure Situational Awareness (SA). This information needs to be delivered in a modern user interface and presents information in context so that users can understand what they are being presented in visually appealing displays, using intuitive controls.

Adherence to open and military standards, such as OGC standards and NATO STANAGs, is critical in this respect, as it makes it easier to exchange geospatial information. This increases the flow of geospatial data between the field and headquarters, which is vital for intelligence analysis and SA, both of which help to inform the Commanders' decision making.

But more is required than just open standards. Classical GIS tools only address part of the needs of the Defense community and address each of those needs with separate products. As a result, GIS products are often an amalgamation of poorly-compatible or non-compatible products, each offering a piece of functionality in the patchwork of requirements. In fact, it is not uncommon to find GIS solutions that require an operator to change displays (or even applications) to toggle from a 2D to a 3D projection, or to edit or convert data from one format to another.

What is required instead is a solid set of APIs or versatile "building blocks" for users to rapidly develop and deploy integrated open solutions that respond to and can evolve with the needs of all military users involved.

Fighting Off the Same Data - Not the Same Map

Integration of the existing GIS technology platforms of a land army can help create a “single point of truth” for operational information through the entire command chain, from the highest strategic level to the lowest tactical level. This is often referred to as the concept of “fighting off the same map.”

But for true network-enabled operations, more is needed. Forces need to be “fighting off the same data” instead. “Fighting off the same data” is a dynamic data management process that takes the “single point of truth” concept a step further through added personalization; operators can allow actors in the Land command chain to have appropriate access to the necessary views and information relative to their specific operational responsibilities and clearance levels. Essentially, these operators create “themes” of geospatial data that provide the right streamlined information to the right people, customized to fit user profiles and operational status. This approach to “tailor” informational displays to create a User Defined Operating Picture (UDOP) is not new, but the technology of today can now deliver on such goals and truly mix any combination of data sources. Ultimately, with this platform, personnel can access the most accurate and up-to-date geospatial data to successfully fulfil mission-critical operations faster and with enhanced efficiency – a true force multiplier.

Preparing for Exponential Data and User Growth

Today, Land C2 systems deal with “Geospatial Big Data” – an amalgamation of datasets that spread across multiple systems and that are so large and complex that traditional data processing applications are inadequate. Challenges include analysis, capture, data correlation, search, sharing, storage, transfer, and visualization.

Moreover, the number of users needing to access geospatial data has grown exponentially. Geospatial systems are no longer a tool of the geo-specialist, but are used throughout the Defense enterprise and are embedded more and more into C2 systems.

Every warfighter is a potential consumer of, and contributor to, geospatial data, so systems must enable data collection and analysis from a variety of users, including non-GIS specialists.

Support for the Military Domain

Geospatial data used to be static in nature, reporting only what was. With the accumulation of available historical data, users now want to be able to make rapid and easy temporal comparisons between the situation “now” and “then” to help visualize what is. How has the enemy progressed? Has critical infrastructure been destroyed? Modern location intelligence solutions must go beyond 2D and 3D and embrace real-time information such as temporal data (4D) that can be combined with up-to-the-second analytics capabilities (5D) for full situational awareness. This goes beyond what was and what is, to show the user what can be, what should be, and what will be.

Due to the surge of a wide variety of types of sensors (radar, UAV, unmanned ground sensors, and so forth) that are collecting data, advanced real-time capabilities are needed that can potentially handle hundreds of thousands of moving tracks with a sub-second update rate, and live imagery at a rate of 60 frames per second.

The increasing use of point cloud technology (Lidar) in GEOINT operations has generated the need for big data capabilities able to handle millions of static points.

Much of this data needs to be displayed using the symbology sets to which the military is accustomed, such as MIL-STD-2525 or APP-6.

And finally, in today’s world of coalition operations, standards for data sharing, such as NATO Vector Graphics format, are also essential.

Flexibility in Design

IT visionaries and IT research firms agree – our world is moving quickly to an “API economy”, a place where users can quickly interweave and integrate web technologies using open interfaces and Agile development tools.

In sheer contrast to today’s API economy, classical GIS technology is typically designed to be a finished COTS end-user product that lacks a simple, components-based design.

Even when GIS products are equipped with an API, that API is typically not modular, but merely configurable. This means that some basic parameters can be changed, but there is little possibility to truly adapt and integrate the technology into the architecture as envisioned by the customer. As a result, classical GIS vendors often need to impose and define their own architectures, requiring systems architects to be involved from the outset of the project to adapt the overall system to the geospatial technology. However, the overall Defense system architecture should dictate the geospatial technology – and not the other way around. In several major Defense projects, the absence of true APIs in some of the conventional “Commercial Joint Mapping Toolkits” (CJMTK) has led to unacceptable delays of multiple months or even years. On one occasion, a delay of 24 months caused by difficulties using a CJMTK was turned around in just over three months by Luciad (now part of Hexagon).

In summary, with conventional GIS, it is not uncommon to see entire Defense projects stranded due to geospatial obstacles stemming from a lack of customizable technology. Hexagon provides solutions to overcome these obstacles.

Incremental Growth, Maintainability, and Total Cost of Ownership

Military users can agree on the importance of their systems’ longevity. Land C2 systems are often procured to remain in service for long periods of time, sometimes decades. Over time, many changes will need to be made to the system. This can range from adding support for a new data format to complementing the system with an entirely new sub-system.

Today, users want their system to evolve continuously, adapting to an evolving technical environment, changing user behavior, and new requirements. Hard-coded or proprietary systems often do not offer the flexibility required for such incremental growth. Software must be capable of being evolved using new software components that have been developed to maintain backwards compatibility. And even GIS systems that announce themselves as customizable, components-based COTS solutions often need to add an entire suite of different software products or sub-sets of products to deal with specific changes in requirements.

Total cost of ownership (TCO) is a logical corollary of the above factors. For Land C2 professionals, it is of paramount importance that their geospatial infrastructure has a logical, foreseeable cost structure without liabilities that can suddenly impact budget planning and financial management. These liabilities would almost certainly limit the potential for evolutionary development due to spiraling costs.

A Single Military Land Operations Platform

Connect, Analyze, Visualize, and Act with Luciad Portfolio

Luciad Portfolio is a complete product ecosystem with server, cloud, desktop, browser, and mobile technology to supply integrated solutions for all types of land operations. All Luciad Portfolio tools have been conceived from the ground up to support military systems, whether focused on conventional warfare or civil-military collaboration.

A wide variety of **Data Connectors** allow users to ingest every type of data, including satellite imagery, raster base maps, vector data such as boundaries or street data, and real-time feeds such as friendly force tracking (FFT), live radar feeds, or streaming video imagery. All of this data can be accessed in any form (open standards or proprietary standards) and from any source – whether that be directly from the sensor or from existing GIS systems, and whether in file form or exposed as a web service.

Figure 1: Data Connectors allow users to connect to any type of data, including imagery, raster base maps, vector data such as street data, and domain data such as 3D buildings, maritime maps of coastal areas, airport infrastructures, etc. – in 2D and/or in 3D.

Luciad Portfolio technology was purposely developed to offer an **in-memory, native connection to any data**. This is radically different from many traditional GIS vendors that have based their offerings on their own proprietary formats. For instance, Luciad technology is a driving force behind OGC GeoPackage, which is rapidly replacing traditional formats such as Esri Shapefile or SDTS formats. GeoPackage was carefully designed to facilitate widespread adoption and use of a single simple file format by both commercial and open-source software applications — on enterprise production platforms as well as mobile hand-held devices. GeoPackage is an OGC standard, and Luciad (now part of Hexagon) was instrumental in both defining the standard and in being the first vendor to offer strong, worldwide support.

All Luciad Portfolio products are geared towards **Open Standards**. These include, among others:

- OGC Web Map Service (WMS) and Web Feature Service (WFS), Geography Markup Language (GML), and Keyhole Markup Language (KML)
- National Geospatial-Intelligence Agency (NGA) standards such as Compressed ARC Digitized Raster Graphic (CADRG), DTED, and National Imagery Transmission Format (NITF)
- North Atlantic Treaty Organization (NATO) geospatial data specifications such as Digital Geographic Information Exchange Standard (DIGEST) and NATO Vector Graphics (NVG)
- Military symbology standards such as MIL-STD-2525 and APP-6
- World Wide Web Consortium (W3C) standards including HTML5

Each Luciad Portfolio product has a unique purpose within today's Defense system architecture.

- Luciad technology allows users to connect to the most disparate data sources, whether static or real time.
- On the back-end or server-side, large datasets can be managed, fused, and served with LuciadFusion. And server-side web processing services can offer real-time calculations and complex analyses.
- On the front-end or client-side, users can access the relevant situational picture and carry out local analysis using either LuciadLightspeed, LuciadRIA, or LuciadMobile.
- In line with a spirit of openness and best-of-breed categorization, all Luciad Portfolio tools can also connect to and interoperate with other geospatial technologies using any data source at all.

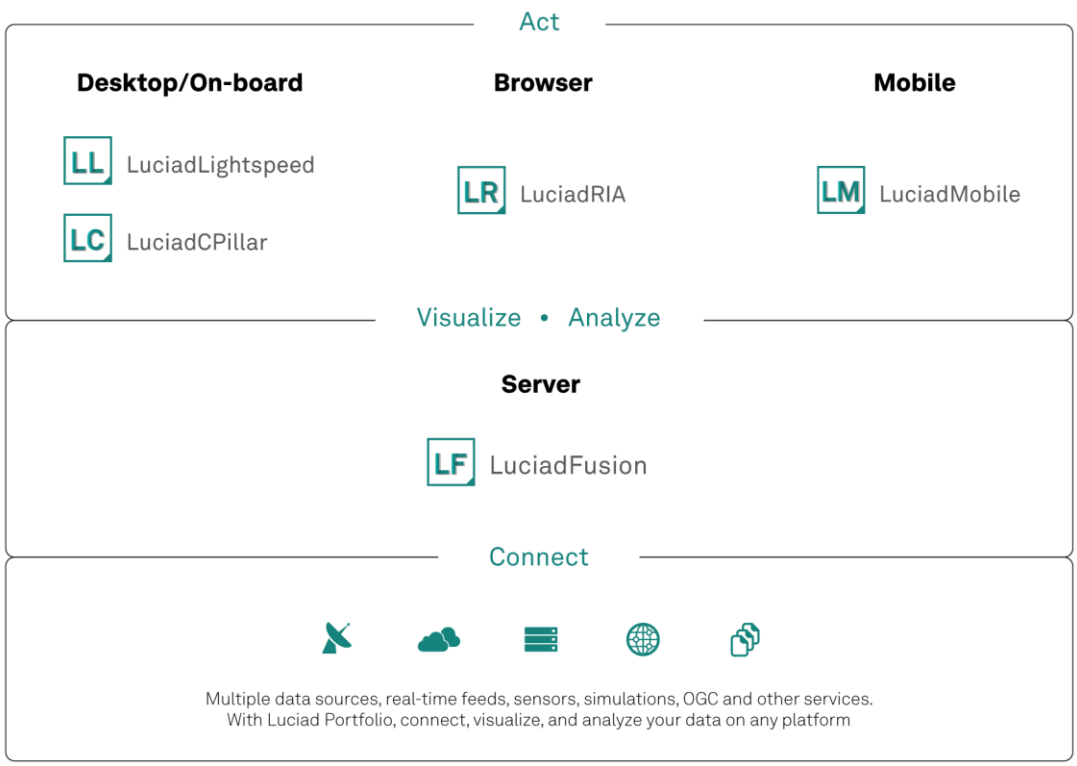

Figure 2: Luciad Portfolio technology relationship diagram

High-Performance Data Management and Data Server Solution

LuciadFusion can be at the heart of any enterprise-wide Defense architecture. It is a server application equipped with integration components and is designed to manage, fuse, and serve your geospatial data.

Users can manage their data intelligently, store and process a multitude of data formats, and feed data to numerous applications. With features including powerful automatic cataloging, as well as quick and easy data publishing, users can design, portray, process, and set up advanced maps in a few simple clicks.

LuciadFusion offers intuitive data management for non-GIS specialists and faster data processing than with any other commercial solution. Organize your data so that all users have one-click access to a data set specifically optimized for their needs.

Connecting directly to more than 200 data formats, the ready-to-use server solution installs quickly to start processing large volumes of data, fetching regular updates, and publishing an impressive number of data formats. LuciadFusion Studio, a browser application, provides an integrated data preview for quick and simple data publishing.

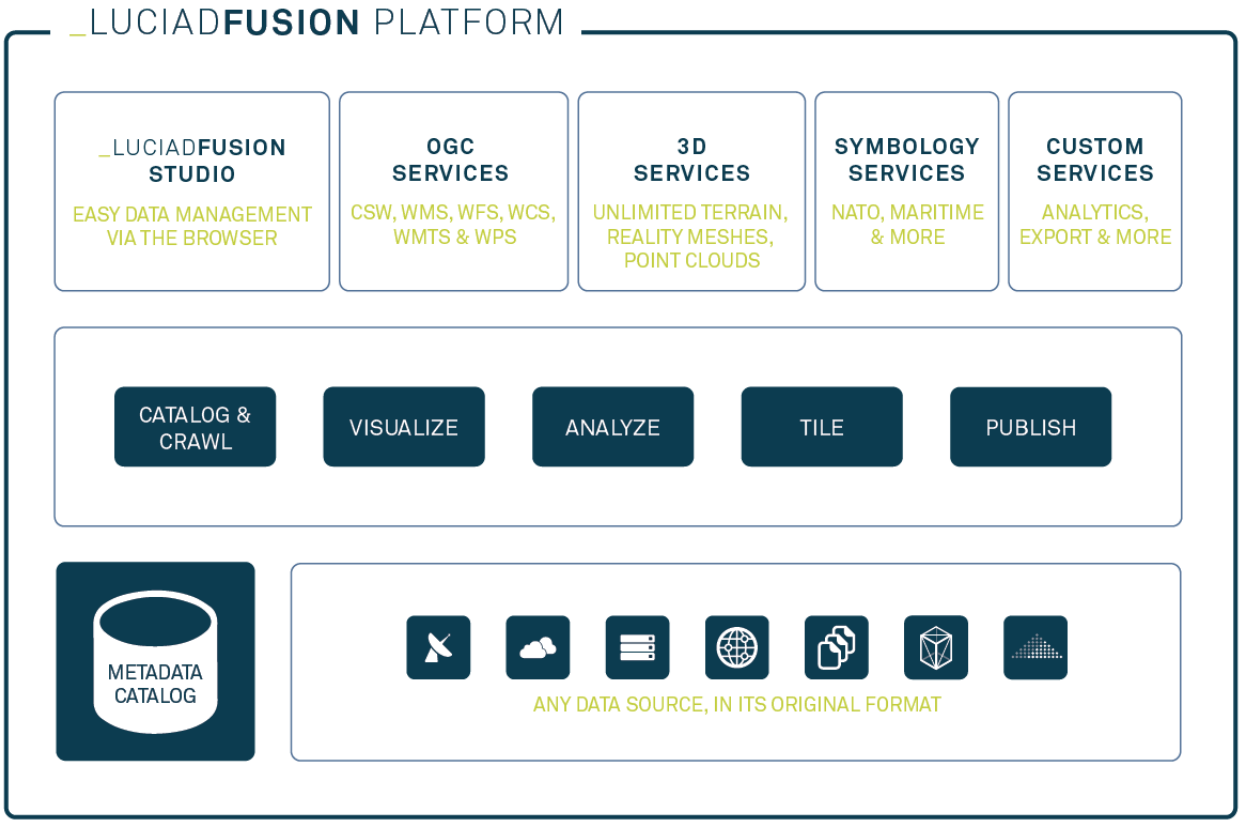

Figure 3: With LuciadFusion, manage, visualize, analyze and publish data in its original format on any platform

LuciadFusion server is impressively fast and is so easy to use that non-specialists can use it with minimal training. Key benefits include:

Built for Users – Publish data quickly to any service, and quickly upload, find, and publish data through LuciadFusion Studio's intuitive web interface. LuciadFusion Studio is the fastest and most user friendly OGC service platform to install, create services with, and serve data. Serve maps faster with the quickest tiling engine for elevation, (multispectral) imagery, weather data, and more.

Connect to 200+ Data Formats – Connect to any database, work with domain-specific formats and standards, directly serve Earth observation multi-spectral imagery, handle dynamic 4D data such as weather data, include military symbology MIL-STD-2525 and APP-6, and combine vector and raster data in one single product.

Add Custom Formats, Styling, and Analytics – Bring in new custom formats easily with LuciadFusion's API, add custom styling to optimize the way your data is shown and improve SA, and create new services for data, symbologies, and server-side processing and analysis.

Rely on Full OGC Open Standards Support – Serve any data over open standards, rely on full support for OGC standards including OGC 3D Tiles, OGC SE (SLD), OGC WMS, OGC WFS(-T), OGC WMTS, OGC WCS, OGC GeoPackage, OGC NetCDF-CF, and OGC CSW. Plug-and-play WMS, WFS, WMTS, or WCS by dragging and dropping to serve in less than one minute − no coding required.

Manage Data Dynamically – Connect to data sources and LuciadFusion can find new data with automatic data discovery. Keep data organized with data crawling, data discovery, and metadata gathering, manage

and serve data from any location, and monitor data sources and set up scheduled crawling to automatically find new data.

Deployable on any Platform – Whether deployed locally (from USB drive, or on-board a vessel or aircraft) or on any server, trust in LuciadFusion's built-in security, and run LuciadFusion on Windows and Linux, Amazon AWS, in a Docker container, and more.

Out-of-the-box COP – Share a Common Operating Picture (COP) that combines background imagery, military symbology, NVG files, and any additional data, and combine any number of data sources in any format using any reference within a single COP tailored to any user need.

Figure 4: LuciadFusion is often used by Defense organizations to manage and serve very large amounts of vector data (street data) combined with detailed satellite imagery and elevation data.

Geospatial Data Exploitation and Real-time Analysis

LuciadLightspeed is one of the flagship Luciad Portfolio products. Thanks to its unique in-memory approach, it is renowned as the fastest geospatial application in the world, able to handle vast amounts of point data (up to 10 million static points) and dynamic data (up to 500,000 moving objects with a sub-second refresh rate).

Today, LuciadLightspeed is used in a wide variety of Land C2 applications, from the operational to the tactical and mobile environments, and also including:

- Logistics systems
- Sensor and weapons planning tools
- Site protection tools
- Embedded BMS for vehicle platforms
- Dismounted BMS for special forces and forward operating units

Figure 5: Using LuciadLightspeed, users can:

Top row, left to right - (1) handle very large amounts of 3D building shapes; (2) handle and combine land data with domain maritime data such as maritime or coastal maps; (3) handle complex airport infrastructures; (4) carry out domain military line-of-sight and route planning calculations with tactical graphics; (5) perform density pattern calculations.

Bottom row, left to right - (1) perform hypsometry calculations and combine this with other calculations such as helicopter landing zones; (2) sensor planning and/or viewshed analysis; (3) complex vector data sets; (4) 'warping' live UAV imagery in real time onto any map, 2D or 3D, with centimeter precision; (5) situational pictures of any data.

LuciadLightspeed can function as a separate desktop solution for advanced users to ingest data from LuciadFusion for further data exploitation. It can also function as an integrated part of LuciadFusion such that all data exploitation is carried out on the server-side. It boasts all the capabilities required by operational Land C2 users, including:

- Full support for drawing, editing, and changing the entire set of official military symbols and tactical graphics (MIL-STD-2525, APP-6)
- Ability to easily add support for creating range cards, planning of helicopter landing zones, etc.
- Advanced calculation capability for terrain analysis, viewshed / line-of-sight / coverage analysis, and route and cross-country analysis.

Figure 6: Luciad Lightspeed server-side performs Cross-Country Route Calculations by combining line-of-sight enemy sensor avoidance with military grid maps and symbology, tactical graphics, and 3D.
Like all Luciad Portfolio products, LuciadLightspeed is fully web services-enabled.

A Fully Web-Based Tool for Creating Advanced Land C2 Portals

LuciadRIA follows HTML5 standards and requires no plug-ins. Tens or even hundreds of thousands of users can access an easy-to-use, intuitive Defense portal.

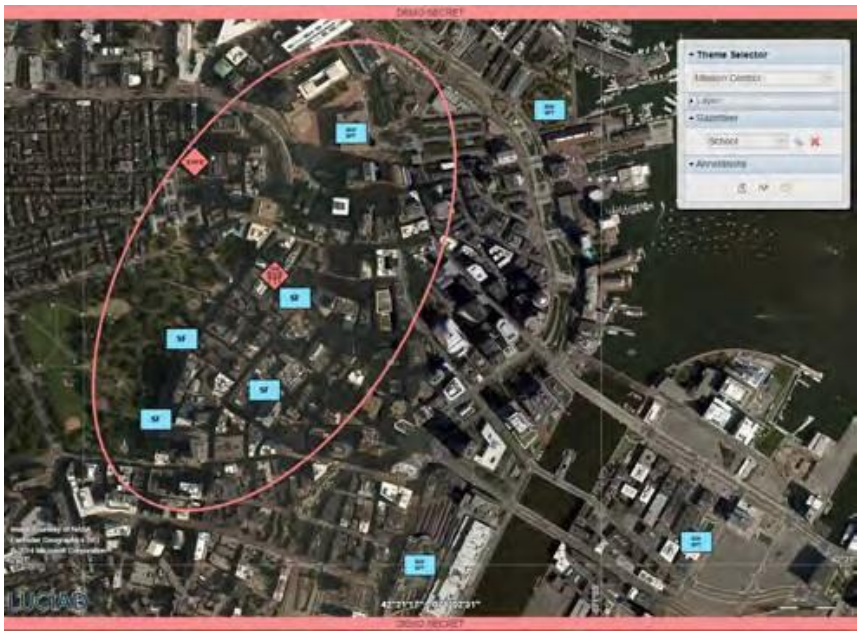

Figure 7: LuciadRIA Common Operational Picture with military symbols. The oval indicates an Area of Uncertainty around a zone with terrorist and special forces activity.

Unlike traditional GIS portals that only deliver very limited (static) information, LuciadRIA has been designed from the ground up to deliver a “desktop-like” experience – entirely in the browser, and with a performance that exceeds most of today’s in-service desktop, thick clients. This means that LuciadRIA can offer:

- Full drawing and editing support for all military symbology and tactical graphics
- Support for thousands of moving tracks and point clouds of millions of points
- Temporal analysis capability with intuitive “time sliders”
- Integrated 2D/3D visualization model

LuciadRIA is deployed by leading international organizations such as EUROCONTROL and NATO, and the first two HTML5-based systems at NATO actually rely on LuciadRIA.

For Mobile Users in the Field

LuciadMobile is Android-based solution for mobile users in the field. It has been designed and optimized for field workers needing to work in difficult conditions:

- Full integration with the functionality of Android devices such that the entire workflow (generation of pictures, geotagging, making annotations, sending the data to the server, and so forth) can be carried out on a single device
- Optimized battery and memory usage
- Designed for intermittent connectivity

Luciad Portfolio in the Defense Workflow

Mission Servers / Map Servers

Defense professionals around the globe rely on LuciadFusion for their mission servers or map servers.

The success of Luciad Portfolio technology in this market is explained by its unique open and “data-agnostic” approach. This means that Luciad technology does not impose its own proprietary data model or geodatabase. Instead, it is open to many data format types or standards and can natively connect to this data, for example in memory and without the need for pre-processing, thereby avoiding lengthy processing time and transformation errors.

Figure 8: Luciad Portfolio technology offers full mobile capability for missions in disconnected environments

Headquarters C2 / Regional Commands

Headquarters C2 applications rely on LuciadLightspeed (for the “heavyweight” desktop user) and, increasingly, on LuciadRIA (for large-scale portal applications). Both LuciadLightspeed and LuciadRIA can serve tens or even hundreds of thousands of users with access that is customized to show exactly what each user needs to see.

Deployed Commander / Battle Management Systems for Vehicle Platforms

LuciadLightspeed is a leading BMS across the globe. Luciad Portfolio technology is rapidly evicting traditional GIS products from these systems because of significant superiority in performance, domain support (e.g. military symbology and tactical graphics), and memory footprint.

Dismounted Soldier / Future Warfighter / Special Forces

LuciadLightspeed and LuciadMobile are increasingly used for local “apps,” either Windows- or Mac-based (LuciadLightspeed) or Android-based (LuciadMobile) that are deployable from laptops, smartphones, and handhelds.

Preparing for the API Economy and Network-Enabled Collaboration

Luciad Portfolio technology has always been focused on delivering software components or APIs rather than finished end-user applications. This is a major difference from many traditional GIS companies. Traditional GIS COTS products are delivered with full out-of-the-box functionality. But because they lack a

true API, they cannot be easily adapted to meet changing requirements, leaving the Defense organization with a difficult problem to solve in the face of constantly-growing and evolving threats.

At Hexagon, we have decided to do things radically differently. Luciad Portfolio focuses on building a strong foundation for developers to create user-specific geospatial and C2 products. Extreme performance and precision, maintainability, and ease of use benefit the whole code base of Luciad Portfolio products and is already built in, while also allowing customers to easily add new functional requirements into the software due to the components-based design.

Conclusion

The Land C2 sector is constantly evolving, as new threats and obstacles appear regularly, as well as emerging methodologies and standards to solve them. It is just as necessary that the C4ISR solutions used by actors in the industry evolve to meet this changing landscape.

From warfighters to geo-specialists and commanders, these individuals require real-time location intelligence capabilities as part of a standards-based, modular solution. Luciad Portfolio technology meets these requirements and more with desktop, browser, mobile, and server solutions that allow on-the-fly analysis of real-time data, and are built on components-based, configurable APIs. Developers are able to tailor these solutions to provide answers to their organization's exact questions now and in the future.

Within an enterprise, those in the field and office can easily and securely communicate data throughout the chain of command with Luciad Portfolio. With these solutions, users "fight off the same data," or access exactly the information they need for their specific operations with information customized to fit specific user profiles based on clearance levels and responsibilities. Additionally, Luciad Portfolio solutions can be used in critical intelligence across organizations and large-scale response efforts, due to the ability to incorporate military symbology and other specific standards.

All data is ingested in Luciad Portfolio solutions in their native format, leading to unparalleled accuracy during missions, which is not always possible with other GIS solutions that require data to be translated into a proprietary format prior to analysis. This enhanced accuracy can mean the difference between life and death for warfighters and civilians alike and provides unparalleled SA for quick and confident decision making.

With our easy-to-configure, components-based solutions, users are empowered to create the solutions they need for today, with the assurance that they can build upon them to discover the answers of tomorrow.

Contact Us

For more technical information on Luciad Portfolio, or to find out more about our other Defense industry solutions and services, please contact us at:

marketing.us.gsp@hexagon.com

+1 877 463 7327

https://go.hexagongeospatial.com/contact-us-today

About Hexagon

Hexagon is a global leader in digital solutions that create Autonomous Connected Ecosystems (ACE). Our industry-specific solutions create Smart Digital Realities™ that improve productivity and quality across manufacturing, infrastructure, safety and mobility applications.

Hexagon's Geospatial division creates solutions that visualize location intelligence. From the desktop to the browser to the edge, we create ACE that bridge the divide between the geospatial and the operational worlds.

Hexagon (Nasdaq Stockholm: HEXA B) has approximately 20,000 employees in 50 countries and net sales of approximately 4.3bn EUR. Learn more at **hexagon.com** and follow us @HexagonAB.

Hexagon's Geospatial Division believes the information in this publication is accurate as of its publication date. Such information is subject to change without notice.