



# HEXAGON

Product Description

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## **M.App Enterprise 2019**

Product Description

9 January 2020

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# Introduction

M.App Enterprise is a game-changer compared to other Enterprise GIS software solutions currently available in the market. Historically, enterprise GIS systems contained static maps, which were made by GIS experts in the late 20<sup>th</sup> – and early 21<sup>st</sup> century. Today's rapidly changing IT environments, easy to implement demand, and user-based functionality requires highly configurable, dynamic enterprise systems that cater to GIS professionals and non-professionals.

M.App Enterprise provides a unified geospatial enterprise platform that enables users to create applications that suit the business-specific needs and requirements of all enterprise users, from top-level managers to GIS experts and field workers. M.App Enterprise caters to large-scale deployments and features an architecture that utilizes a centralized GIS for all stakeholders to work collaboratively.

M.App Enterprise combines the best of breed capabilities available from Hexagon Geospatial server products (e.g., optimized delivery services for imagery and vector data, workflow services, and geoprocessing services) with the enhanced user experience from Hexagon Smart M.Apps.

Smart M.Apps are simple to use, lightweight map applications that solve real business problems. They provide answers and present information in a visual and compelling way. Smart M.Apps revolutionize the way we envision, experience, and communicate geographic information. These targeted, information services combine fresh geospatial content and workflows to deliver an interactive experience that includes a map and a dashboard of insightful analytics alongside it. These information dashboards allow decision-makers to make smarter, more informed decisions faster from anywhere, at any time using standard computers, tablets, or mobile devices.

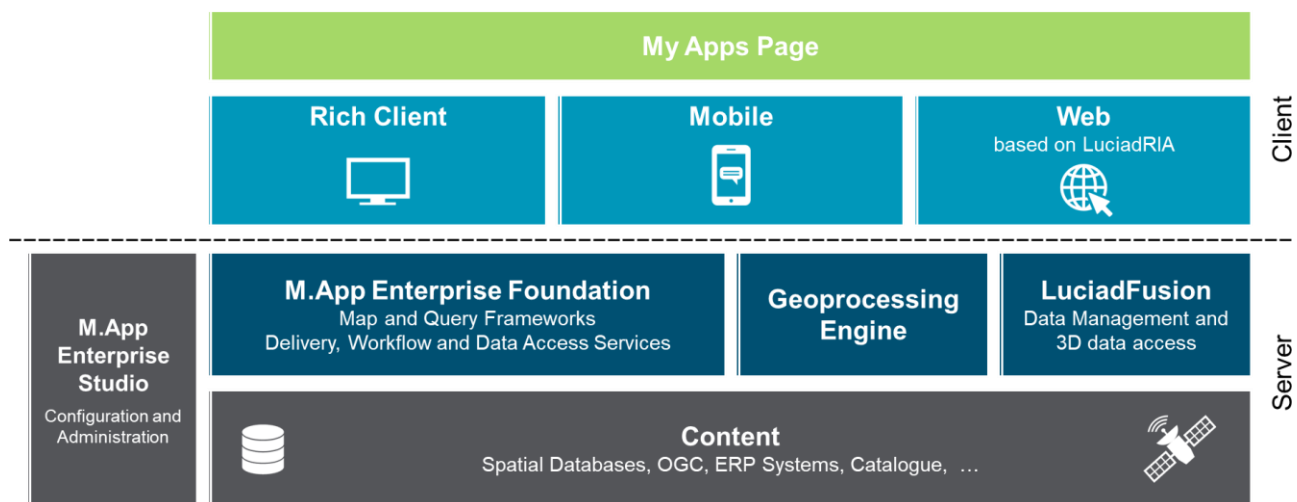
Smart M.Apps are publicly available as cloud-based apps through the M.App Exchange: the Smart M.App storefront. On the other hand, M.App Enterprise delivers a privately-hosted Smart M.App solution for organizations that want to realize the value of a Smart M.App deployment while staying within the confines of their enterprise network. With M.App Enterprise, you can access Smart M.Apps anywhere within your organization's network for real-time answers, whenever you need them, wherever you need them.

M.App Enterprise can be hosted on-premises or in the cloud. It provides an extensive development platform for third parties and system integrators to deliver innovative and industry-specific solutions, allowing the combination of multi-source imagery from free and commercial imagery content providers with large vector datasets stored in standard enterprise geospatial databases such as Oracle Spatial, SQL Server Spatial, or PostGIS.

M.App Enterprise is available in three different licensing-models: Usage-based on a packages of hours, Subscription, and Permanent. The licensing models are designed to offer flexibility and adaptability to different business models and budget orientations of the customers (CAPEX vs OPEX). Its licensing models can adapt from small to super large projects and does not introduce any limitations on the number of users, hardware specifications (nr. of cores or nr. of servers), or SaaS usage.

# M.App Enterprise Components

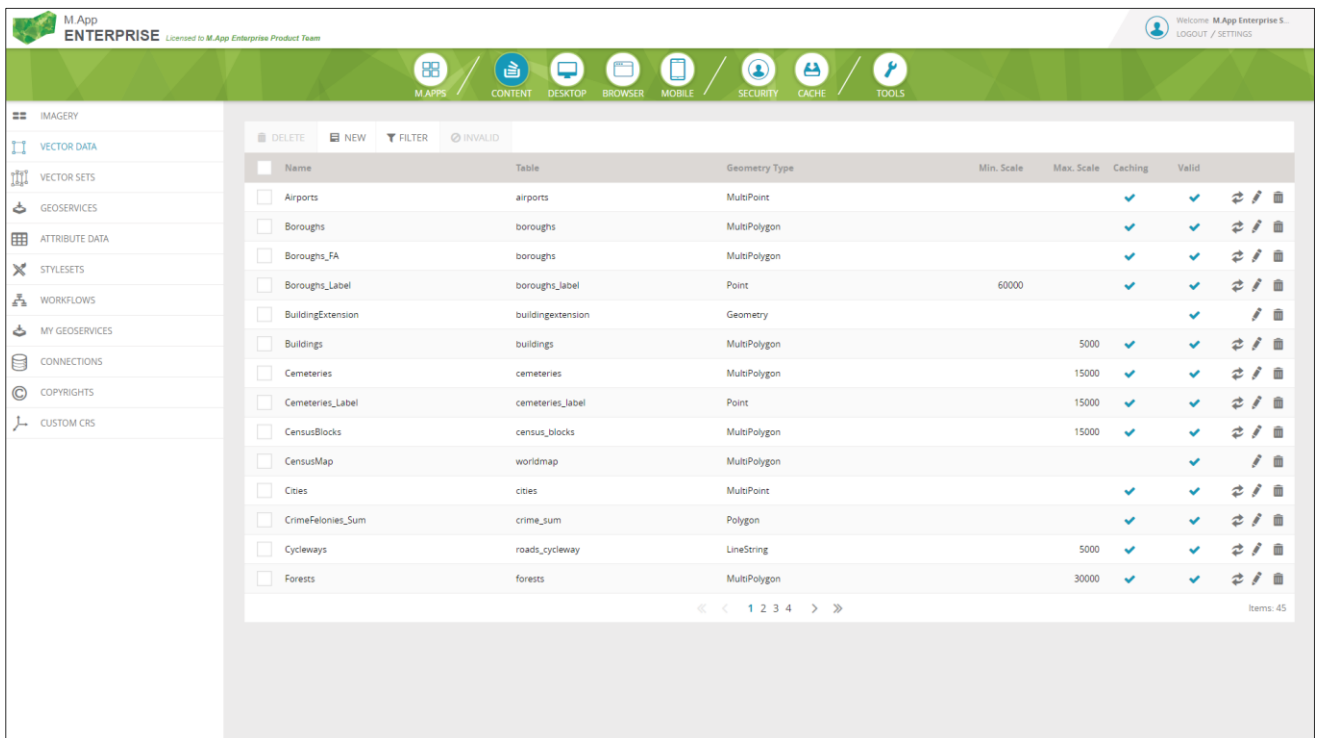
M.App Enterprise consists of the following components:



# M.App Enterprise Studio

M.App Enterprise Studio is an on-premises, web-based development environment where application developers and builders can design, configure, and administer their enterprise Smart M.Apps, including:

- Definition of enterprise security concept, including users and role management
- Configuration and administration of access permissions to Apps
- Design application layout (using predefined templates)
- Connect your content to apps (raster and vector datasets, geospatial web services, etc.)
- Define complex and scale-dependent map styles using powerful style editor fully compliant with OGC “Symbology Encoding” (SE) standard
- Configure your analytics (using predefined Business Intelligence widgets etc.)
- Model business processes to control the flow of the information using spatially enabled workflows via a graphical web-based editor (Workflow Editor)
- Create geoprocessing services using a web-based graphical spatial model editor (Spatial Workshop)
- Configure print layouts:



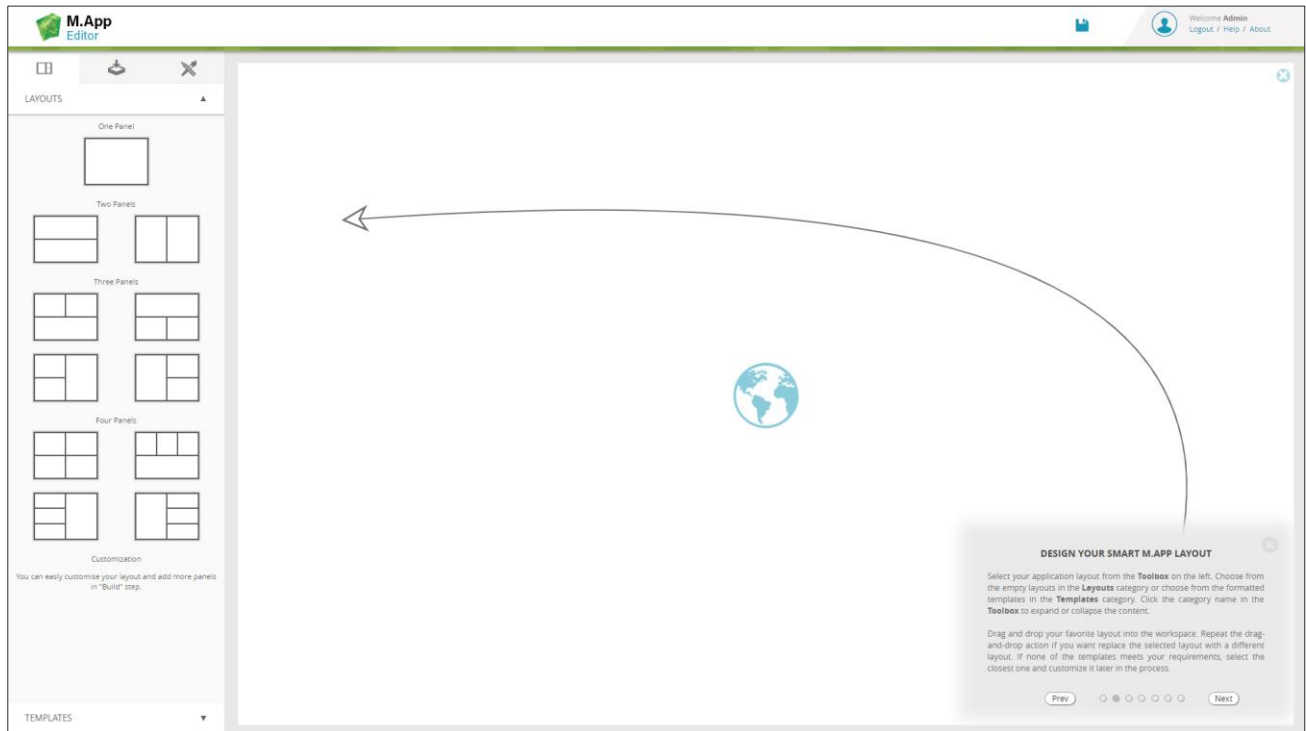
The screenshot shows the M.App Enterprise Studio interface. On the left is a sidebar with navigation options: IMAGERY, VECTOR DATA, VECTOR SETS, GEOSERVICES, ATTRIBUTE DATA, STYLESETS, WORKFLOWS, MY GEOSERVICES, CONNECTIONS, COPYRIGHTS, and CUSTOM CRS. The main area displays a table of datasets with columns: Name, Table, Geometry Type, Min. Scale, Max. Scale, Caching, and Valid. Each row includes a checkbox and action icons (refresh, edit, delete).

<input type="checkbox"/>	Name	Table	Geometry Type	Min. Scale	Max. Scale	Caching	Valid	
<input type="checkbox"/>	Airports	airports	MultiPoint			✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Boroughs	boroughs	MultiPolygon			✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Boroughs_FA	boroughs	MultiPolygon			✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Boroughs_Label	boroughs_label	Point	60000		✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	BuildingExtension	buildingextension	Geometry				✓	✎ 🗑
<input type="checkbox"/>	Buildings	buildings	MultiPolygon		5000	✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Cemeteries	cemeteries	MultiPolygon		15000	✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Cemeteries_Label	cemeteries_label	Point		15000	✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	CensusBlocks	census_blocks	MultiPolygon		15000	✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	CensusMap	worldmap	MultiPolygon				✓	↻ ✎ 🗑
<input type="checkbox"/>	Cities	cities	MultiPoint			✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	CrimeFelonies_Sum	crime_sum	Polygon			✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Cycleways	roads_cyclway	LineString		5000	✓	✓	↻ ✎ 🗑
<input type="checkbox"/>	Forests	forests	MultiPolygon		30000	✓	✓	↻ ✎ 🗑

Items: 45

M.App Enterprise Studio

M.App Enterprise Studio offers an embedded M.App Editor, allowing app builders to define the layout template for the browser app (single or multiple panels), and the type of content for each panel (Map, BI Map, Workflow, Spatial Recipe, or custom). Additional easy-to-use graphical editors are available to define map styles (Style Editor), workflows (Workflow editor), spatial recipes (Spatial Workbench) and a BI Wizard for configuring widgets and building geospatial dashboard type of apps.



M.App Enterprise Studio designing the layout of browser apps

## Content

Hexagon Smart M.Apps created with M.App Enterprise can be fuelled using different sources of content by enabling connections to different types of internal and external providers. The following content types are currently supported:

- **Imagery** – Internal imagery datasets available for the apps
- **Vector Data** – Internal vector data available from direct connections to an Oracle, Microsoft SQL Server or PostGIS database
- **GeoServices** – OGC WMS, WMTS, and WFS Services created from internal content available in any of the supported enterprise spatial database; external OGC WMS, WMTS, and WFS Services; and base mapping services (OpenStreetMaps and Here Maps), which can be made available for your app

## M.App Enterprise Foundation

M.App Enterprise's Foundation layer provides the Map and Query Frameworks, as well as the core Delivery, Workflow, and Data Access Services.

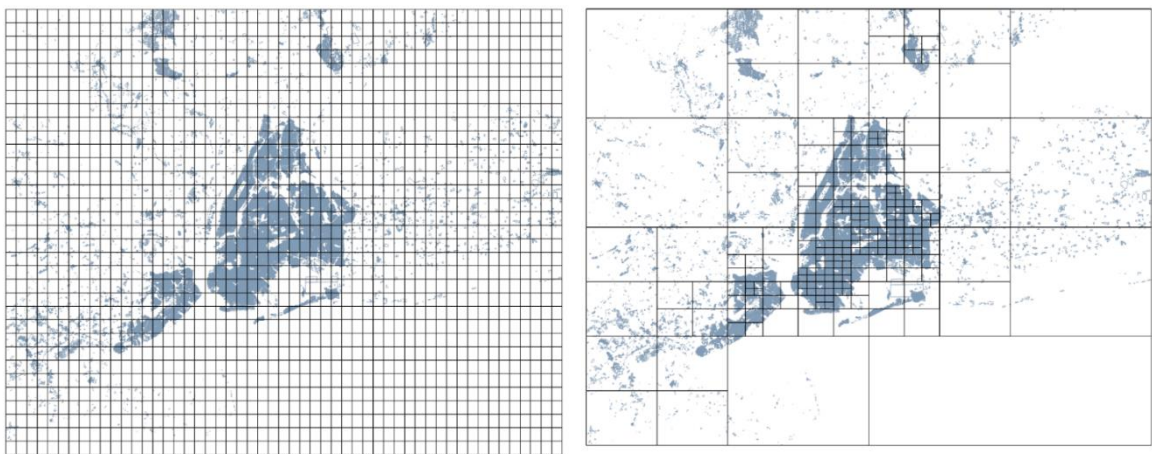
### Map Framework

M.App Enterprise is designed and implemented as a high-performance geospatial platform by using state-of-the-art development patterns, map rendering optimization techniques, and continuous performance tests that are based on over 15 years' of experience in this area. Specifically, the Map Framework includes the latest caching technologies for vector data, combining techniques such as Quadtree caching, automatic geometry simplification, and vector sets.

## Quadtree Vector Caching

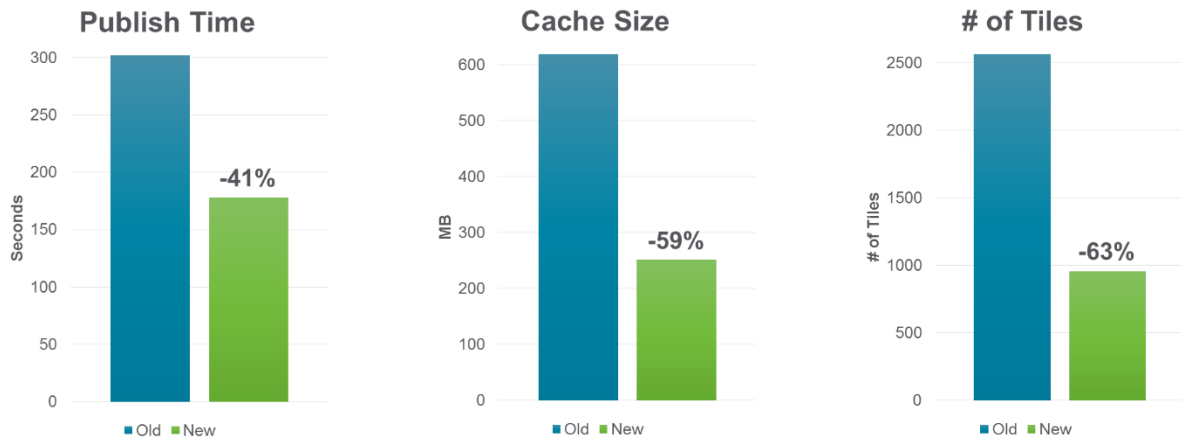
Hexagon's Geospatial division is a pioneer in vector caching techniques, which are being used and have been incrementally improved upon in our products since 2001. The original concept was to tile the area of interest in a homogenous grid (see picture below). Despite the performance improvements of using cached vector data instead of reading the original data directly from the database, this technique has revealed some limitations:

- Inefficient usage of storage and still a high payload against the database to build the cache
- Extensive I/O operations to load high-resolution grids, causing performance issues
- Try and error to identify the best cache grid size
- Because most of the spatial data isn't normally distributed, the file size of the tiles was not normalized



The latest innovations introduced in vector caching in the Map Framework include the usage of Quadtree data structures to optimize (minimize) cache size, publish times and number of tiles, the introduction of SQLite databases to store and access tiles faster, and the use of Google's state-of-the-art protocol buffers to serialize and read/write structured data streams. These combined techniques addressed all problems mentioned above and resulted in significant benefits:

- Reduced I/O operations by the introduction of SQLite databases to store and access tiles
- Guaranteed file sizes and consistent distribution:
  - Each node of the Quadtree structure has exactly four children
  - Each node has a maximum capacity. When file size is reached, the bucket automatically splits
- Significant performance gains in tile production
- Since the number of tiles has been reduced, the payload against the data source to read data and generate the tile is also minimized
- Use of Google Protocol Buffers allow the introduction of a highly efficient binary format, minimizing the overall storage size and data transfer

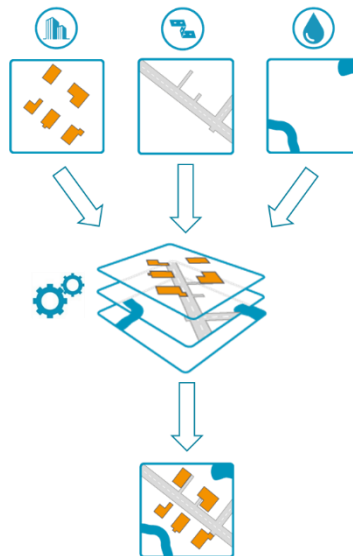


Reference system: CPU 1 Core 2.3 GHz, 6 GB RAM, Windows® Server 2012, PostgreSQL / PostGIS  
 Project Content: New York Open Data, 45 feature classes, 3 100 000 features

## Quadtree vector caching - Detailed charts of performance improvements

### Vector Sets

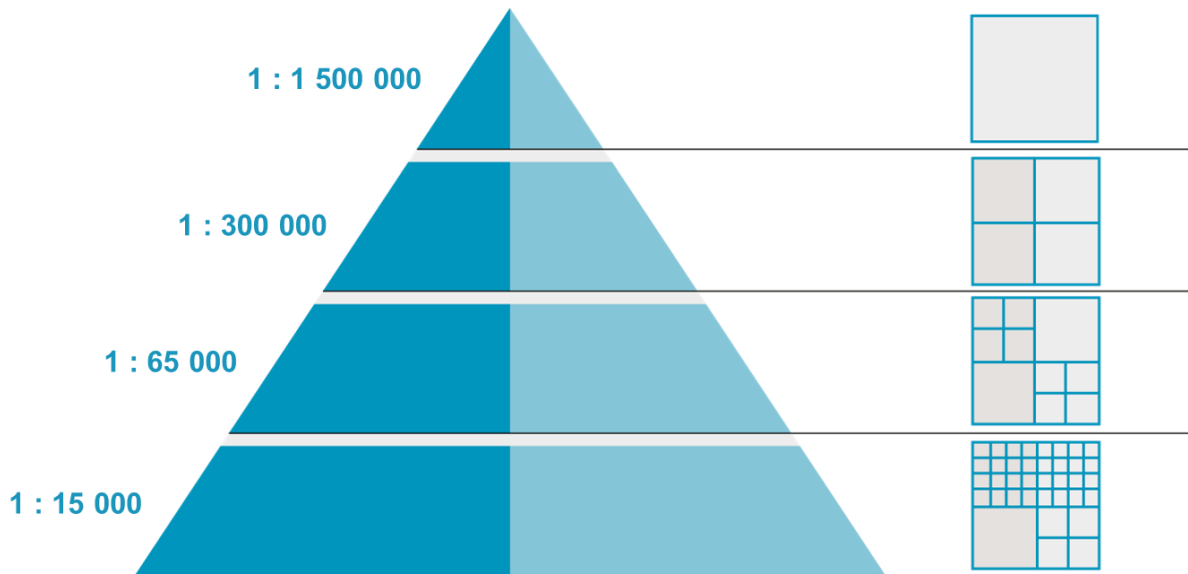
Vector sets are a recent innovation in M.App Enterprise that improve the handling of vector data. Vector sets are especially suited for static datasets or those with low-frequency update rates that are typically used as vector backdrops (e.g. topographic maps). Vector sets merge a selected number of layers from the database into a single optimized cached layer.



Vector sets – single optimized vector backdrop layer from multiple vector layers

The Vector set cache is automatically built from a combination of techniques: zoom level dependent vector cache versions, quadtree data structures, and automatic geometry simplification, which are depicted in the illustration below. As the zoom level increases, the quadtree expands as necessary, according to the spatial distribution of data. Automatic geometry simplification algorithms are applied to reach the maximum capacity of each node.



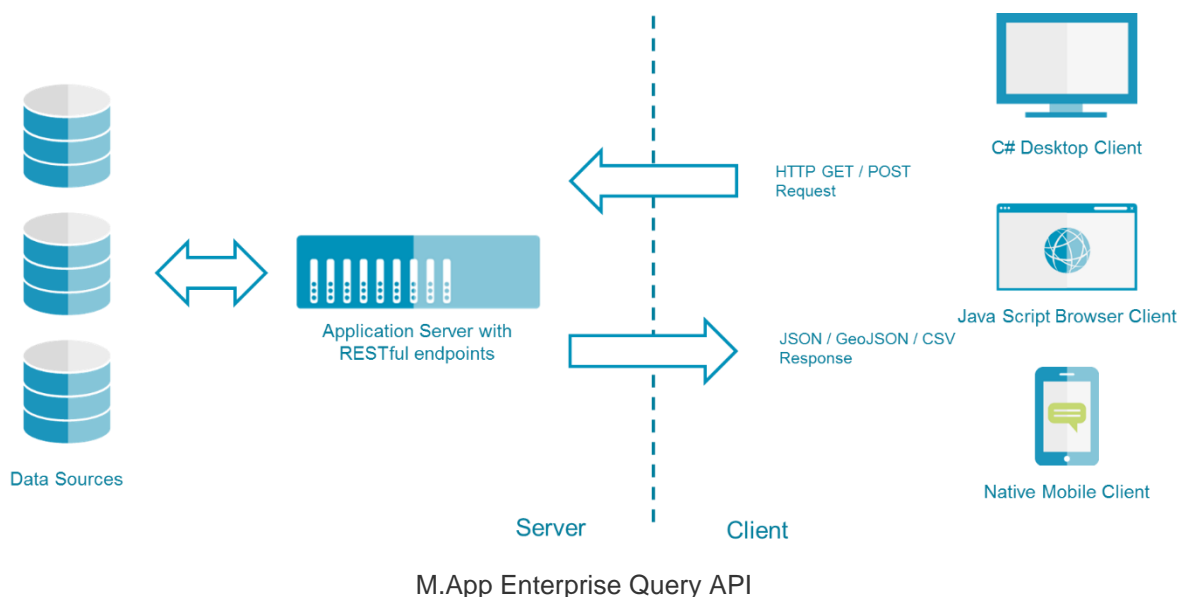


As a result, Vector Sets reduce the number of requests to the map server, reduce the cache file, and improve access and rendering speed while preserving full legend control capability (i.e. show/hide individual layers).

## Query Framework

The M.App Enterprise Query framework offers a highly flexible approach for querying data because it is not bound to a predefined set of queries typically found in other commercial solutions. The M.App Enterprise Query framework provides a powerful and easily understandable API to query attributive and spatial data, based on RESTful web services open to all programming languages.

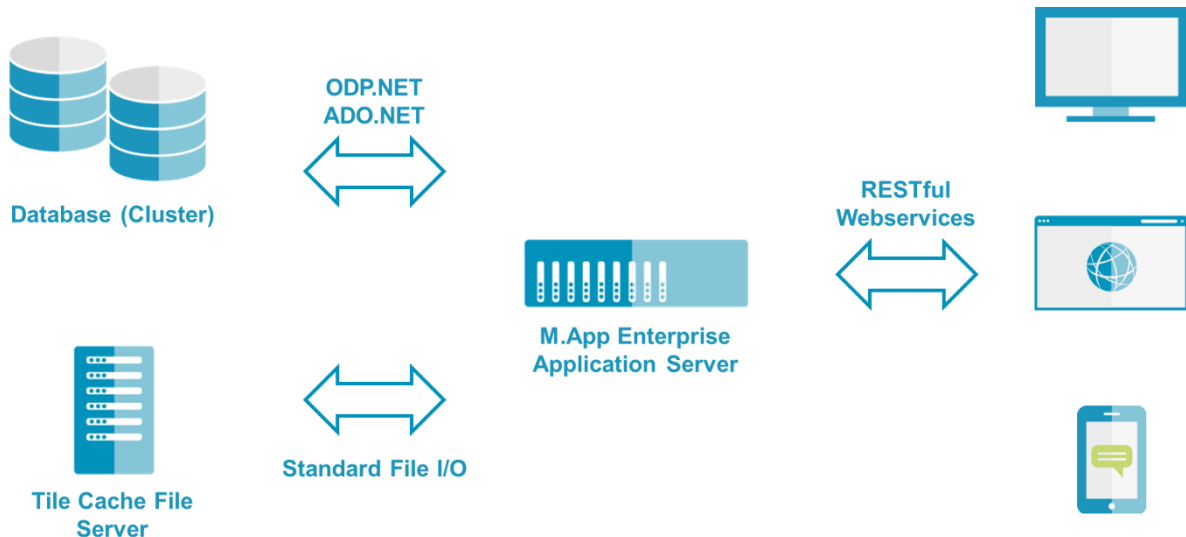
The query definition is constructed at the client-side source code based on user inputs and transformed into standard SQL syntax, which is then sent to the application server through HTTP GET/Post Requests. Multiple formats are supported for the response to be displayed at the client-side, including attributive tabular data in standard JSON and CSV formats, as well as spatial data in GeoJSON format.



## Delivery and Data Access Services

Data Access Services to databases from M.App Enterprise Foundation is performed using ADO.NET and ODP.NET. Access to Tile Cache File server is supported on standard File I/O.

Regarding delivery mechanisms of spatial data, M.App Enterprise Foundation provides RESTful web services.



## Workflow Engine

M.App Enterprise includes highly configurable rules and a workflow engine that enables organizations to implement life-cycle workflows, feature-level access control, data validation and behavior, and integration into other systems.

- **Workflow Manager**
  - Process experts pre-define report, form, and plot layouts
  - Configure geospatial processes (i.e. "workflow trees") based on XML files
  - Define automatic validation and conditions for each workflow node
  - Drive (remote control) the different clients (map content, area, scale, functions)
  - Define task-specific forms (for queries, analysis, editing, reports, etc.) using XML files including text boxes, checkboxes, drop-down lists, and context-based help
  - Integrate external applications on the server-side
  - Define workflow steps and forms based on user- and rights-management, including connection to Active Directory or LDAP
  - Define disconnected workflows and forms, which enable the end-users to capture and edit attributive and spatial data while offline from the internet.
    - A synchronization process enables posting edits back when the client reconnects
    - Project-based conflict handling can be added via Workflow definitions
  - Triggering of server processes by user workflows using XML workflow triggers
- **Graphical Workflow Designer (available from M.App Enterprise Studio)**
  - Create your unique workflow with a modern and easy-to-use graphical interface
  - Easily extend and customize your workflow
  - Enables domain experts to define their day-to-day business workflows
  - Respond faster to business requirement changes
  - Reduce time-to-market

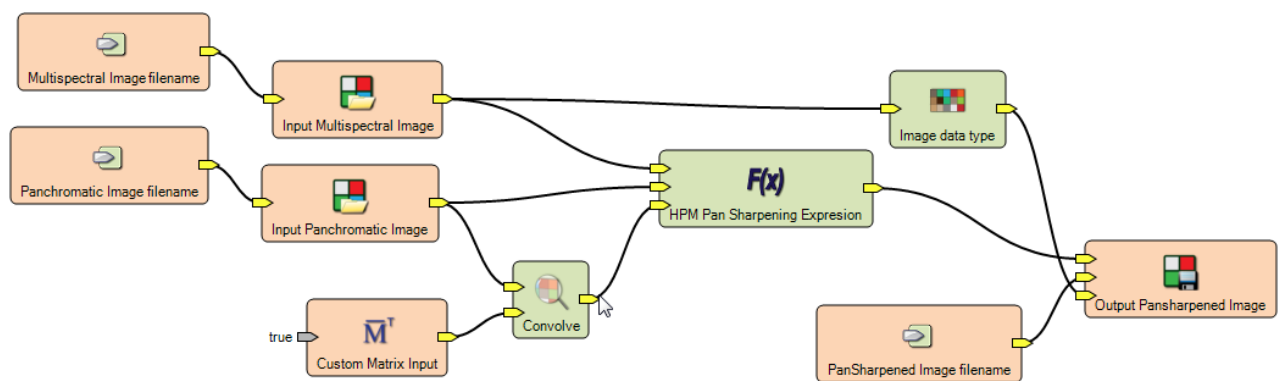
# Geoprocessing Engine

The architecture behind the geoprocessing engine consists of several key constructs: operators, spatial models, web services, and Hexagon Smart M.Apps.

As part of the Smart M.Apps Initiative, the product development teams at Hexagon's Geospatial division have undertaken a process to decompose all core product functionality into hundreds of "building blocks" (individual operators). Essentially, this strategic initiative is transforming the applications into platforms. Core functionality is no longer constrained to the desktop application; it has been liberated and made available through (private and public) cloud-based solutions.

An operator is responsible for encapsulating a computational element that performs calculations, processes data, fuses information, analyzes, or visualizes a large variety of data formats. Operators exist as components to be used by a Spatial Modeling tool (Spatial Workshop) and are primarily built using C++.

Each operator includes ports which describe the inputs, outputs, and parameters of the function. These ports dictate required and optional inputs and prerequisites, ensuring that all necessary information is available prior to executing the operator. Operators are linked together using these ports.

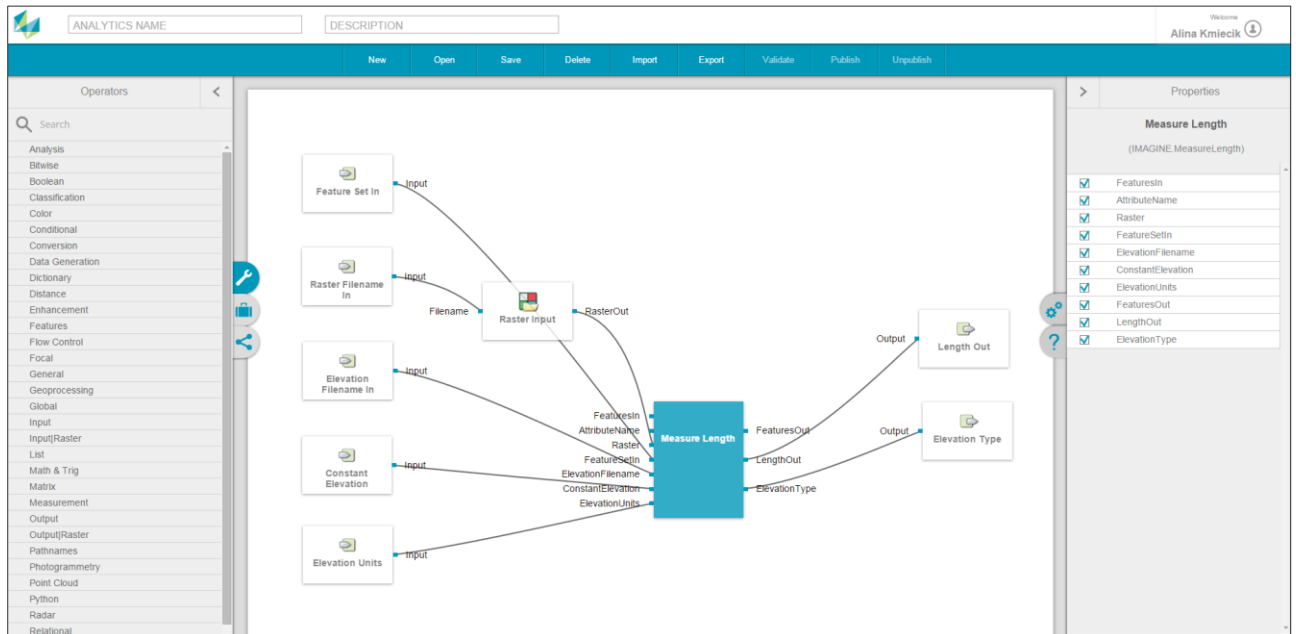


Example of operators assembled as a spatial model

M.App Enterprise comes with a full complement of operators to support a wide range of geospatial processes. However, if an organization has requirements that cannot be met with the existing set, new operators can be developed. The Spatial Modeler Software Development Kit (SMSDK) allows for the creation of new operators using a C++ development environment. This can be used to create operators that incorporate third-party algorithms, allowing for very powerful and seamless integration with the rest of the geospatial operators.

Using the Spatial Workshop web-based authoring environment integrated into M.App Enterprise Studio, operators are assembled into spatial models that execute specified geospatial workflows by defining relationships to data sources and other operators and models. Models may perform combinations of raster, vector, and point cloud operations. Models assemble sets of operators into more complex algorithms and relate to datasets and inputs and generate results. Existing models can be customized so that organizations can create important variations of them for specific purposes or create entirely new models.

These models and the services created when they are published can be strung together in sequence, nested, and reorganized in many ways to support specific workflows. They can be tested step-by-step during development and results viewed in real-time, thereby accelerating the authoring cycle. Finally, these models are published as a RESTful web service, making them consumable by everyone else across the enterprise.



Spatial Workshop – Web-based spatial modeling authoring tool

Through this approach, specialists and subject matter experts develop methods and algorithms, author and authenticate the models, and then publish them as web services. End-users may then execute these approved geospatial web services in a reliable and consistent manner. This mechanism provides great flexibility for taking best-of-breed algorithms from different sources (e.g., government, academia, and industry) and assembling them into services for broader use. This is a powerful force multiplier since these subject matter experts now have a mechanism to easily share their knowledge and expertise with an unlimited number of users.

Some examples of geospatial spatial model-based web services include:

- Terrain Analysis - Line of Sight, Helicopter Landing Zones, Slope Analysis, Terrain Differencing, Terrain Shading, Rough and Finished Contours, Automatic Terrain Generation
- On-demand map generation - Execute cartographic web services (CWS): Create GeoTIFF from CWS, Create Geospatial PDF from CWS
- Elevation processing - Smooth Elevation Values, Remove Elevation Spikes, Flatten Terrain, Detect Vertical Obstructions

Once these operators have been assembled into models published as services, the next critical step is to integrate them into stand-alone targeted applications, essentially creating very intuitive interfaces for accessing and executing these geospatial web services. These applications, which have been coined as Hexagon Smart M.Apps, relate one or more models/services with specific data sources. They provide a graphical user interface (GUI), and perform other processes.

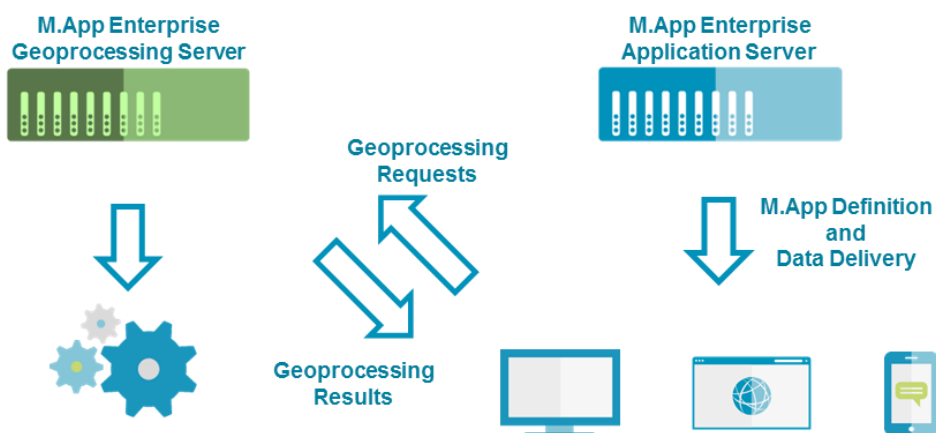
Hexagon Smart M.Apps are more intuitive and focus on user-specific requirements and workflows pertaining to the organization and apply geospatial processing as an underlying infrastructure, enabling a broader set of “geospatially-enabled” applications.

Creating applications in this manner provides an important layer of abstraction between the user interface and the algorithms responsible for geospatial processing. This flexibility allows for an unlimited amount of applications to then be developed; an important factor when we acknowledge support for a range of end-user devices and form factors, such as laptops, tablets, smartphones, and even smartwatches. This approach also allows companies and organizations to brand the end-user applications as their own and make them available via an enterprise or public marketplace. Features like these allow for organization and mission-specific

graphics and terminology to be incorporated into the user interface, thereby making for an even more intuitive user interaction.

It is important to note that while geospatial processes being executed by Hexagon Smart M.Apps use for example imagery, terrain models, and maps, some applications may purposely be designed not to provide a display of any of these items. Rather, the user interface may be a streamlined view into statistical results of a geospatial process, or some other summary-level information viewable from a dashboard on a smartphone.

In M.App Enterprise, the geoprocessing engine is separated from M.App Enterprise Foundation layer to ensure maximum application performance and protection of other application instances from geoprocessing tasks computational demand.



# LuciadFusion

LuciadFusion is an all-in-one server solution for data publication workflows and geospatial data management. LuciadFusion lets you manage data intelligently, store and process a multitude of data formats, and feed data to numerous applications, putting the power of your data at your fingertips. Features including powerful automatic cataloging as well as quick and easy data publishing allow you to design, portray, process, and set up advanced maps in a few simple clicks.

## Connect Directly to More Than 200 Data Sources

The Luciad Portfolio server solution offers intuitive data management for non-GIS specialists and fast data processing on any operating system. LuciadFusion lets you 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 so you can begin processing large volumes of data, fetching regular updates, and publishing an impressive number of data formats. The LuciadFusion Studio web interface component provides you with a friendly user interface with an integrated data preview that lets you publish data with just a few clicks.

## Organize, Manage, and Centrally Serve Geospatial Data

LuciadFusion manages data distribution centrally so that users can access data quickly and efficiently. LuciadFusion automatically configures the most appropriate settings for data fusion, and feature data can be pre-configured, fused and distributed with very detailed feature filtering and styling information. This information is stored as OGC-compliant Symbology Encoding (SE) information.

## Get an Alternative View of Terrain Data

LuciadFusion's terrain processing capabilities include the evaluation of terrain elevation data. Hypsometric calculations take elevation data as input and return results that allow you to gain detailed insight into the features of the terrain. LuciadFusion's terrain analysis engine can also calculate line-of-sight (LOS) coverage from a central location to its surrounding environment. In the resulting image, the surrounding area is styled according to the visibility of an object in the LOS area from the central location.

## Highlights of LuciadFusion

These are just a few reasons users have turned to LuciadFusion for their geospatial data challenges:

- Quickly publish large amounts of geospatial data in OGC standard formats with just a few clicks
- Eliminate publication delays, even when receiving new images every hour
- Visualize weather data with temporal information and quickly browse changing weather conditions through time
- Display critical elevation data in high resolution 3D
- Share multi-gigabyte shapefiles as WMS without rasterizing them before publishing

## Features

### Core GIS Engine

- Access and represent data in any coordinate reference system (geodetic, geocentric, topocentric, grid) and in any projection
- Perform advanced geodetic calculations, transformations, and ortho-rectification
- On-the-fly serving, fusion, and tiling of data in any coordinate reference. Accurate and correct warping of both vector and raster data

### 4D Cartesian & Geodesic Geometry Model

- Model any data format regardless of size, represent all object geometries and their metadata, and apply any data filter
- Includes support for complex geometries like geo-buffers, arcs and arc bands, radar coverage areas, and more
- Accurately visualize radar coverage beams and other sensor detection ranges as 3D volumes, and set up geofencing for those volumes

## Customizable Symbology

- Apply flexible styling (layers, icons, line styles, fill styles, transparency) to your data and customize it using the OGC-defined Styled Layer Descriptor / Symbology Encoding (SLD/SE) standards through the LuciadFusion Studio. This includes both vector and raster data
- Extend SLD or implement and plugin custom layer factories to do advanced styling using for example density plots and heat maps
- Include processing in your styling such as extracting contours from raster data before styling using fill and line styles
- Advanced labeling of vector data including on-path labeling

## CPU, GPU Image Processing Engine

- Advanced, high-performance processing and rendering of raster data, including High Dynamic Range (HDR) and multi-spectral imagery
- Apply image processing chains using a complete set of image algebra operators that can be applied to any raster imagery (including weather data, multi-spectral data), before serving the data over OGC services, or before exporting data for example to OGC GeoPackage
- High-performance accelerated OpenCL implementation for multi-core servers or GPU accelerated servers with automatic fallback to a high-performance multi-threaded CPU implementation

## Raster & Vector Connectors

- Access and serve data straight from the source in many vector and raster formats. Apply multi-leveling and tiling on any data source
- All visualization, analysis, and serving capabilities are data-agnostic, so it is complementary with any data format. Adding support for new, custom formats is a straightforward, well-documented process, but most common data formats are already supported
- Raster data: BIL, Bing Maps, BMP, DTED, ESRI TFW and JGW, ETOPO, GeoTIFF and BigTIFF, GIF, JPEG, JPEG2000 (including GMLJP2), MapInfo TAB, PNG, PPM, USGS DEM
- Vector data: CGM, Collada, ESRI Shape, GeoJSON, MapInfo MIF & MAP, LIDAR LASer and LASZip (LAZ), OpenFlight (3-D), OGC 3D tiles, OSGB 3D meshes, SVG, Wavefront OBJ (3-D), E57

## Point Clouds & Reality Meshes

- Connect to, visualize, and serve unlimited point clouds and reality meshes
- Stream as OGC 3D Tiles
- Serve reality meshes on-the-fly, directly from the source
- Tile and multi-level point clouds efficiently for optimal serving
- Out-of-the-box native support for: OSGB, LAS, LAZ, OGC 3D Tiles, E57

## OGC Standards

- Connect to several OGC web services and read data in several OGC formats
- Standards, formats, and services: OGC CSW, GeoPackage, GML, KML, WCS, WFS(-T), WMS, WMTS, OGC Filter 2.0 (Spatial filter capabilities can be enabled from the Advanced GIS Engine listed under Advanced and Pro options), OGC Symbology Encoding (SE), ISO 19115 metadata, OGC 3D Tiles

## OGC Services

- Serve any data via OGC services on the fly, directly from the source. Configure several OGC web service end points and let them monitor data updates
- Easy-to-use web frontend to manage data, metadata, styles, products, and publish services
- Support for on-the-fly WMTS for any data source as well as WMTS from pre-tiled data sets
- Support for on-the-fly 3D tiles for OSGB mesh data sources as well as processed LAS/LAZ data and E57
- OGC services: WMS, WCS, WFS(-T), WMTS, CSW, 3D Tiles

## Tiled Services

- Serve pre-tiled raster data via Luciad Tile Services (LTS) for optimal performance. Using LTS, you can send multi-dimensional or elevation data tiles for client-side analysis
- Turn unwieldy point clouds into highly efficient multi-level tile pyramids through the integrated processing capabilities for LIDAR LAS/LAZ, and E57 files



### Tiling Engine

- Fuse, tile, and multi-level large amounts of data using the tiling engine
- Build globes with detailed and accurate point-sampled terrain data, centimeter-accurate area-sampled (multispectral) imagery, and multi-dimensional weather data and imagery

### Data Management & Catalog

- Centrally organize, manage and serve all your geospatial data and styles from the LuciadFusion Studio web application, regardless of the format of that data, and let clients discover data through an OGC CSW catalog

### Data Crawling & Metadata harvesting

- Discover and aggregate all the geospatial data you have available by crawling your data repositories, and automatically collecting and generating the metadata descriptions
- Define revisit intervals to automatically update services when data changes, for example to automatically publish an updated weather forecast

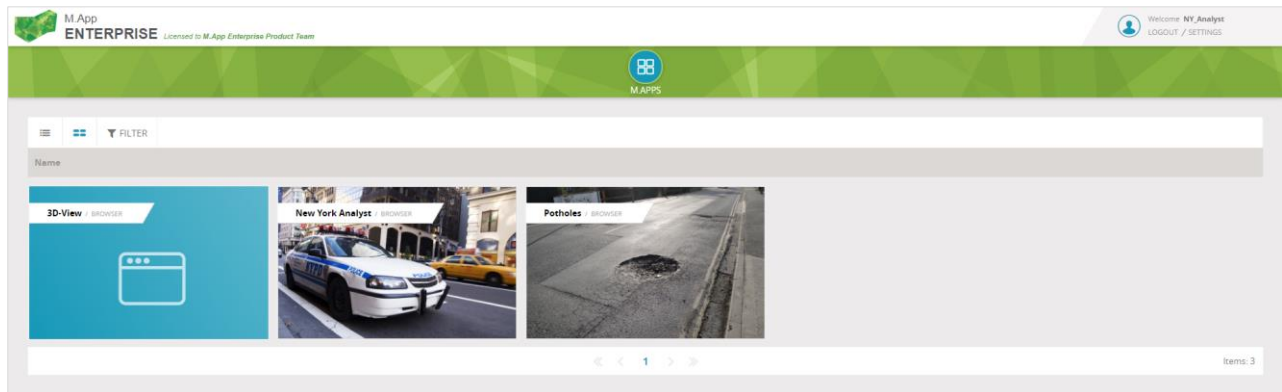
### Database Connectors

- Add support for connecting to and serving data straight from multiple spatial databases
- Database formats: IBM DB2, Informix Geodetic and Spatial Datablade, OGC GeoPackage, Oracle, PostGIS, SAP HANA, Microsoft SQLServer, SQLite



## My Apps Page

The My Apps page provides centralized access to all the apps that are assigned to a user, independently of app type. Once logged in, each user will only have access to the apps that are assigned to his or her role.



M.App Enterprise allows building different types of client applications, including:

- Desktop client provides a full set of GIS functionality designed for semi-professional users.
- The browser client offers easy to use access to geospatial data in 2D and 3D.
- Native apps to access from mobile devices (iOS and Android).

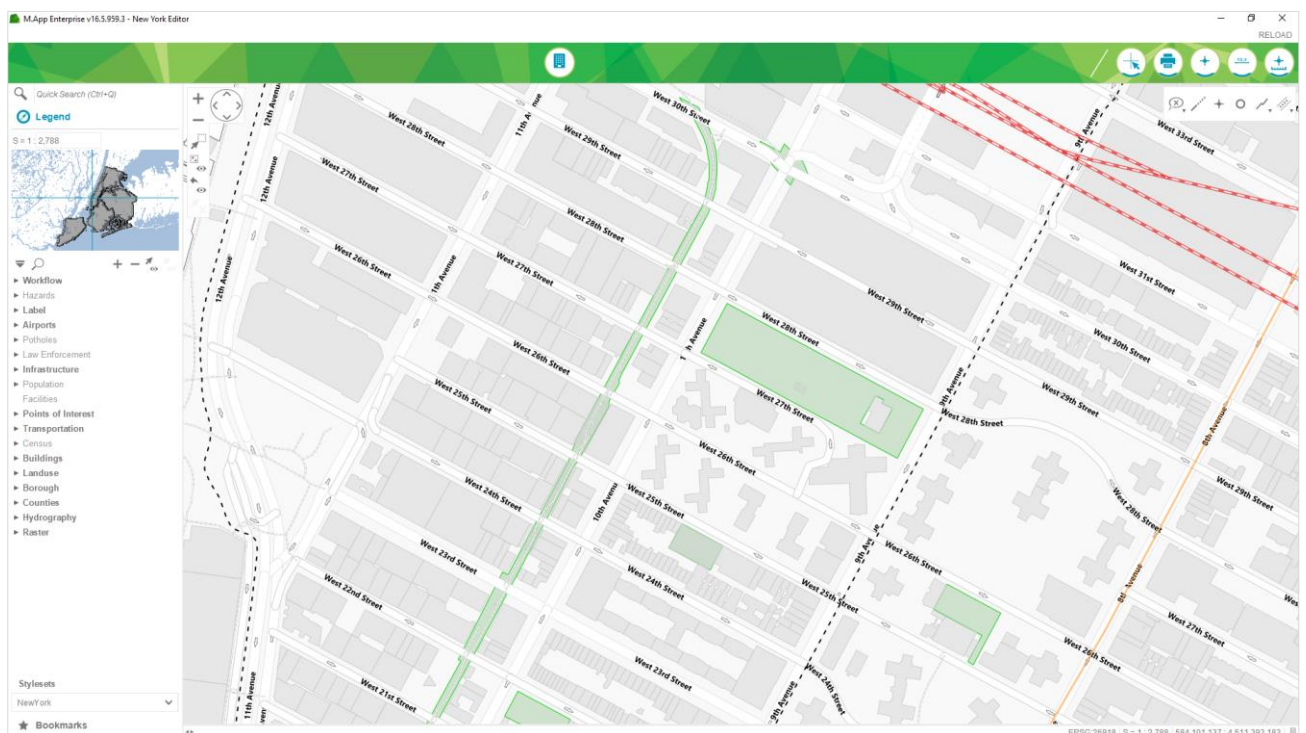
Details of main features provided by each of these types of apps are provided in the sections below

# Desktop Client

The Rich Client is a Java application running in the client-side. Deployment is based on standard Java Web Start technology, and it runs as a self-configuring and updating client. The client uses web protocols and standards for communications, but it is entirely separate and does not need to run in web browsers.

Rich Client main features includes the following:

- One-click start-up for a user to get working with the client
- Application configures automatically based on user profile
- Automatic updates without user action
- Look and feel and performance of a desktop application



## High-level Cartographic Map Display

- Extended style capabilities based on OGC standard "Symbology Encoding" (SE)
- Definition of very complex and scale-dependent styles
- Coordinate system support
  - Including support for geographic (Lat/Lon) and custom coordinate systems within the primary database (ORACLE and Microsoft SQL Server)
- Use of SVG icons to style points, line strings, and area fills
- Support of Rich Text Format (rtf) and halo effects
- Style Editor
- Raster backdrop supported by file-based image formats and web services
  - Raster format support for TIFF, JPG and PNG
  - Client-side integration of WMTS including on the fly coordinate transformation



Client-side Bing Maps (street maps, imagery and imagery with labels) integration including coordinate transformation on the fly

- Client-side ECWP integration
- Imagery is scaled and delivered on the fly (no need for pre-cached tile set)

## Measurement

Including various commands to perform point, linear, circle, and area measurements on features. The measure results are represented in the client as a working level.

- **Create and delete the following measurements:**
  - Point (coordinates)
  - Line (angle and length)
  - Cumulative distance (segment length, angle, and polyline length)
  - Circle (radius, perimeter, and area)
  - Polygon (side length, perimeter, area, and angles)

## Dimensioning

Including various commands to dimension features on the map. The dimensioning results are stored in the database and represented in the client as a working level.

- Utilize snapping with any dimensioning function
- **Simple Dimensioning** – allows you to depict the distance between two points of a feature
- **Orthogonal Dimensioning** – allows you to depict the distance between two points of a feature, drawing the line orthogonally displaced from the existing line feature
- **Free Dimensioning** – dimensioning line can be placed "free" regarding the vertical orientation
- **Radial Dimensioning** – allows you to create radial dimensions for circle and arc features
- **Chain Dimensioning** – includes Orthogonal Chain Dimensioning, Chain Absolute Dimensioning, and Chain Difference Dimensioning
- Edit/delete dimensioning text and position

## Redlining

Enables drawing new graphics on the map such as points, polylines, polygons, buffers, or text. The graphics can be stored in the database or just in the local cache directory and represented in the client as a working level. Redlining commands include:

- Draw text features, polylines, polygons, rectangles, buffers
- Edit existing redline features
- Copy existing features to the redline working level
- Delete an existing feature(s)

## Feature Selection

Enables selecting features on the map, which is essential for conducting queries. Features can be selected by clicking on the map or may be based on spatial fences represented by geometric objects such as circle or polygons.

- Select active features by:
  - Point, circular, polyline, rectangular, polygonal fence
  - Map window extent
  - Click on the map

## Attribute and Spatial Queries

Enables filtering geographic objects based on specified attributive and spatial constraints. Results of the query can be observed in the corresponding data window while objects are highlighted in the map. Results can also be sorted and exported to Microsoft Excel®, for example:

- **Search with attributive input (“Input-Query”)** – allows you to execute queries based on attributive constraints
- **Search with map selection (“Selection-Query”)** – allows you to conduct queries based on a spatial map selection; the selection could be created by clicking on objects or by defining spatial fences
- **Combined Search** – allows you to run an “Input-Query” on already pre-selected objects

## Snapping Tools

Enables accurate creation, editing, measurement, or dimensioning of features by snapping to existing vertices, midpoints, endpoints, intersections, and tangents. Most tools are also supported by assigned F keys.

- **Midpoint snapping** – allows you to snap to the midpoint of a line segment
- **Intersection snapping** – allows you to snap to the intersection point of two or more feature line segments
- **Tangent snapping** – allows you to snap to tangent points of a circle or arc
- **Perpendicular snapping** – allows you to snap one feature line to another whereat the two lines are exactly perpendicular (right-angle)
- **Vertex snapping** – allows you to snap to single points of a feature
- **Endpoint snapping** – allows you to snap to the end point of a feature
- **Detail settings** – set snapping tolerance and feature class selection and de-activate smart snapping

## Advanced Geo-caching

Use of intelligent geospatial data caching for raster and vector data, supporting high performance, and disconnected mobile editing.

- Raster and vector data cached either on the server in the LAN or on the client
- Client caches kept current through a fully automated process using timestamps, without any need for user intervention
- Manually synchronize the client and server cache
  - Statistics panel shows static and dynamic information concerning the cache synchronization process, including:
    - How many feature classes are selected and are hence considered for cache synchronization
    - How many tiles those feature classes contain, including how many of those tiles have been successfully synchronized, or synchronized with failures

## Printing

Enabling high-quality, true-to-scale printing.

- Including large-format plotting in A4 to A0 formats (Letter to E size)
- Rotate content
- Enlarge or diminish the map extract to be printed
- Specify page title, the page subtitle, and any additional info text
- Dynamic attributive information
- Page preview
- Create snapshots
- Include scale bar

## Useful application tools

- Bookmarks
  - Create, delete, import, and open user-defined map configurations.
    - Save your current map settings (i.e. the map extract and contents) at any time, and then call them back up again later
    - Capture thumbnail automatically from the map for visual context in the bookmark
- Smart Search



- Use a single point of input to search and set legend entries, bookmarks, queries, map center, and scale.

### Administration & IT

- Automatic delivery of applications over a web HTTPS connection
- High-level enterprise administration for users, roles, apps, etc.
- Secure data access control supporting AD and LDAP and audit trails
- Integration to external data and systems
- Client is running on any Java-enabled platform

### Security

- Supports username/password credentials to authenticate and authorize access from the client to its server application
- Data access control: security, audit-trails and access control (using feature-level attributes, geographic areas, functional groups, etc.)

## Browser Client

Browser apps offers business intelligence capabilities to provide a deeper understanding of data inside of an organization and allows non-GIS experts to leverage the power of geospatial data in 2D and 3D based on LuciadRIA technology.

Browser apps built with M.App Enterprise support the following web browsers:

- Google Chrome
- Mozilla Firefox
- Microsoft Internet Explorer 11
- Microsoft Edge

### LuciadRIA Highlights

LuciadRIA is the answer to today's demands for powerful, lightweight applications in the browser. Driven by today's most advanced web technologies, LuciadRIA uses WebGL, HTML5, and JavaScript to deliver desktop-like performance to your web applications.

With LuciadRIA, you can expect high performance and complete accuracy, with desktop-like visualization of satellite and other imagery, vector-based data, and dynamic content, such as tracks. Connect to your data via OGC web services or drag and drop common file formats. Data can be explored in a 2D or 3D map view or vertical intersection view. Combine with a timeline view for 4D analysis.

Clean design matters. LuciadRIA is the only web-based geospatial solution that allows users to go from 2D to 3D with a simple click, using the same code and the same data, while providing you with a beautiful, intuitive interface.

Using the full capability of HTML5, LuciadRIA gives users high performance imagery visualization alongside vector-based data and dynamic content such as tracks. You can also rely on the Luciad Portfolio's world-scale precision for visualization, transformation, and calculation of any data.

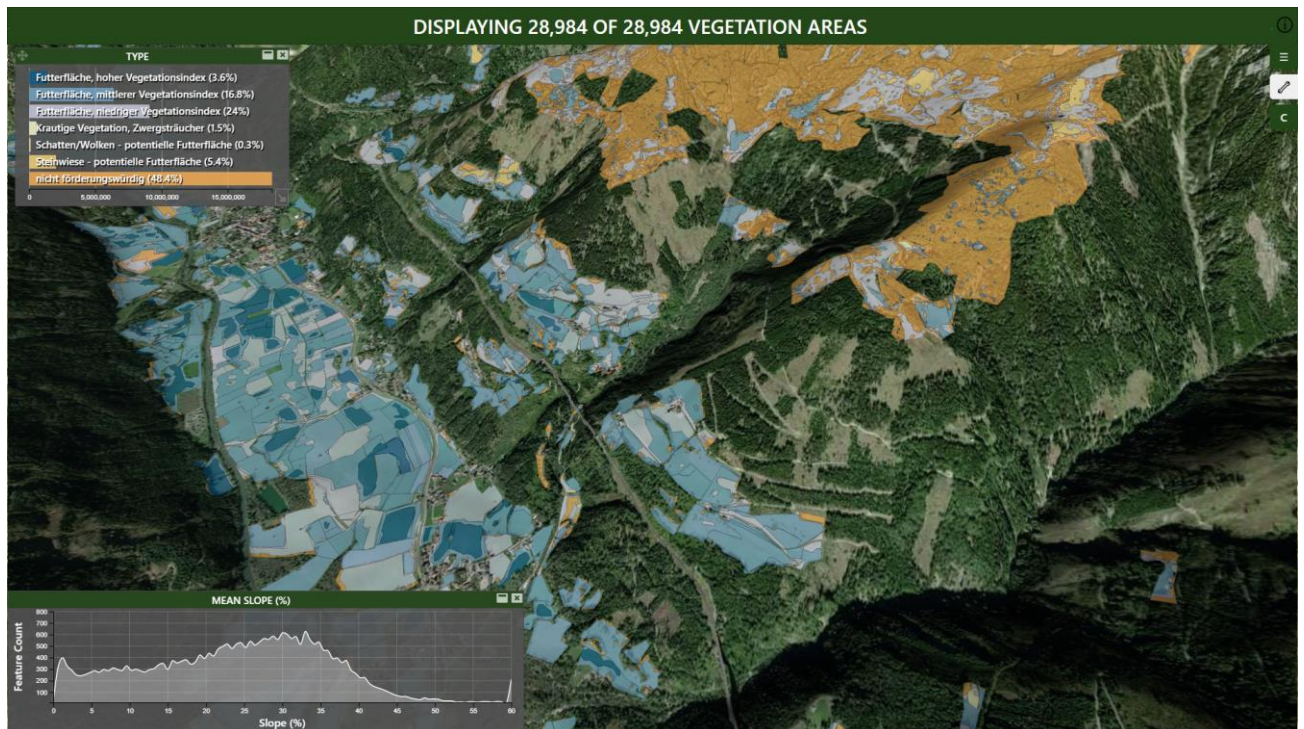
LuciadRIA supports 3D and advanced visualization capabilities thanks to hardware acceleration with WebGL technology. Through a single API, LuciadRIA provides users with the capability to develop applications for software 2D, hardware-accelerated 2D, and hardware-accelerated 3D.

- Build a standards-based, interoperable web-based solution that handles 2D and 3D
- Visually analyze millions of events or locations directly from a browser
- Handle real-time dynamic data, such as flights, vessels, or people with tens of thousands of moving assets
- Enjoy the interactivity of a desktop solution, including analytics, right in the browser without plugins
- Build a high-performance web solution that exploits graphics hardware for 2D and 3D, while also working in software mode
- Manage data and maps in different projections, including 2D polar projections and 3D, without extract-transform-load (ETL) processing
- Build mission-critical web-based solutions that handle geospatial data with the accuracy required for mission planning

### Full Vector Support in the Browser

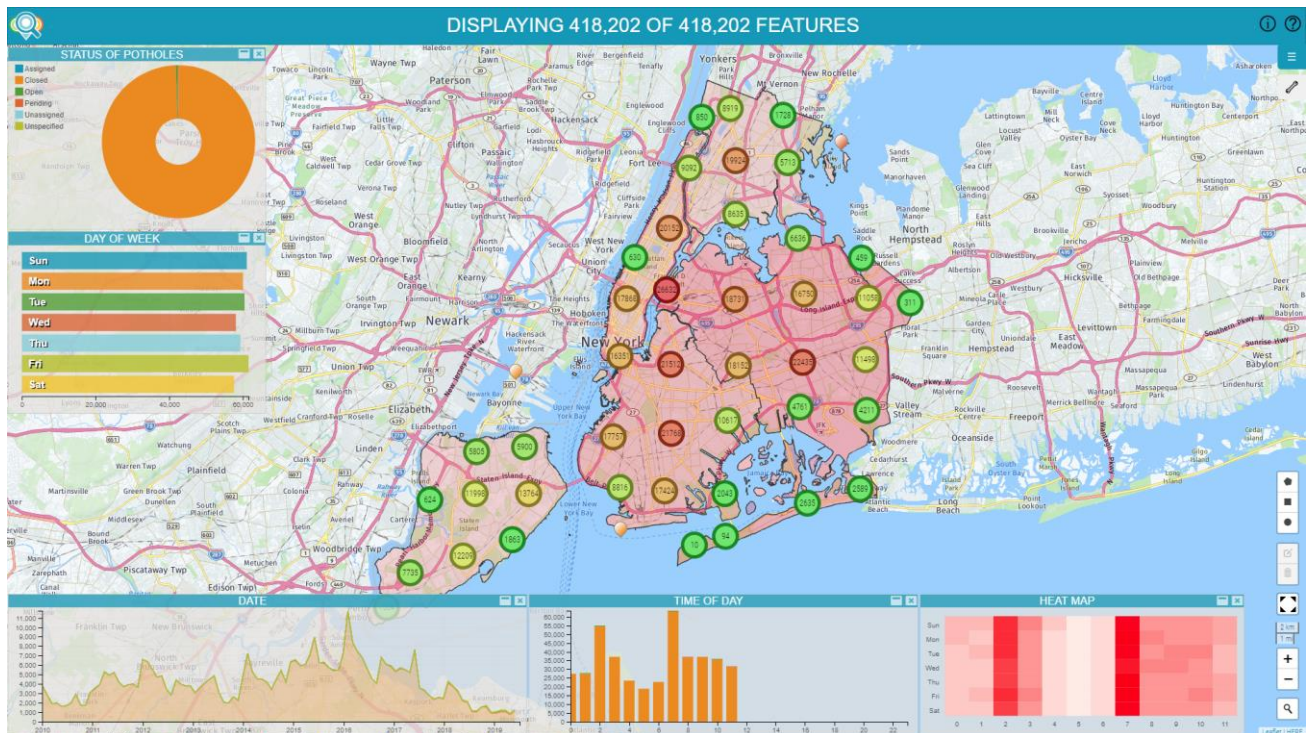
The browser vector renderer engine supports any map projection and style definitions based on OGC® Styled Layer Description and Symbology Encoding (SE) standards. It also supports the server vector caching technology previously described (quadtrees, vector sets with automatic simplification), allowing a single server cache to be consumed by all client types (rich and thin clients).





3D Browser app example created with M.App Enterprise Studio

The standard features provided in browser apps includes Map Navigation (Zoom and Pan), Legend Control (layer visibility and translucency), Measurements (show coordinates, measure area, and measure line) and Feature Info. For BI Maps, map and BI widget dynamic filtering based on selections is also enabled by default. A JavaScript API is available, providing plenty of customization options to extend the capabilities of browser apps, according to the customer needs.



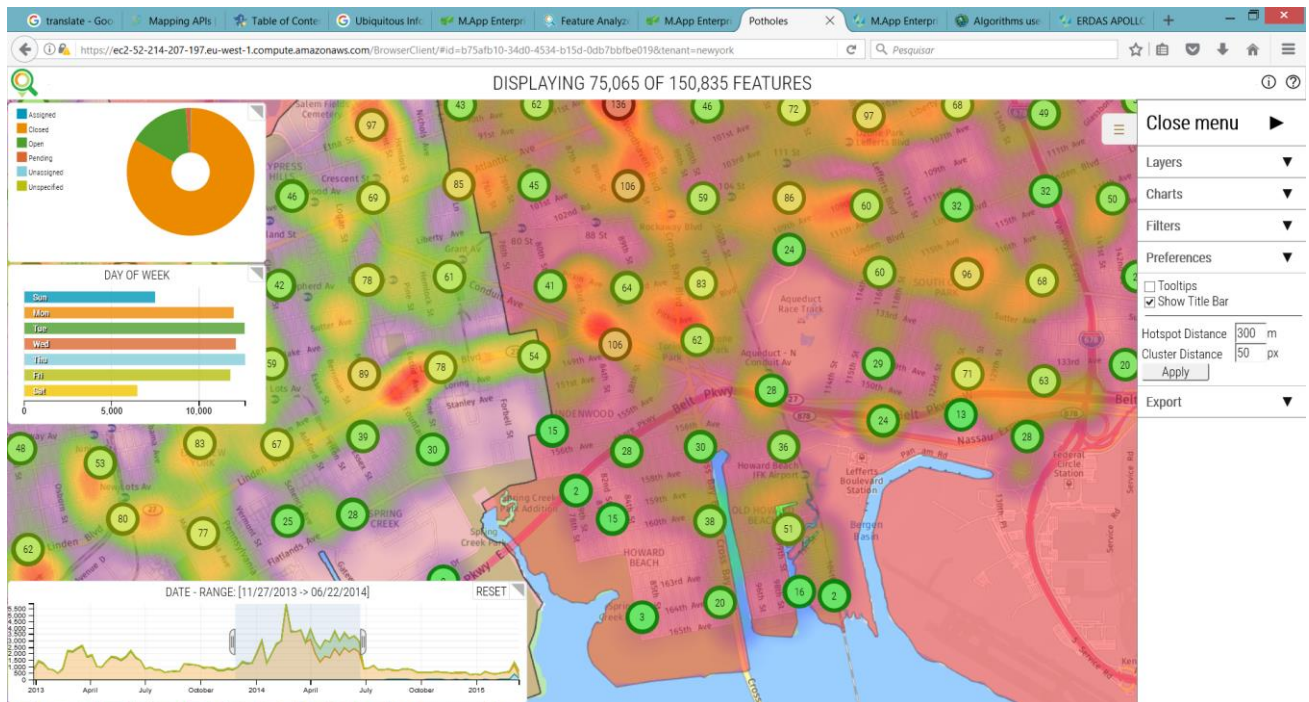
2D Browser app example created with M.App Enterprise Studio

## Feature Analyzer Views

One additional type of browser apps that can be built with M.App Enterprise Studio are the so-called Feature Analyzer Views. This type of browser apps are based on a specific template integrating a map view with a set of predefined BI widgets connected to a thematic map based on point, linear or areal features. All configuration steps are performed at M.App Enterprise Studio, including the definition of the background maps and imagery to be used, as well as the vector set layer to be used for depicting the thematic map.

Feature Analyzer is particularly suited for quickly creating Smart M.Apps from public safety incident datasets containing basic attributes such as location, incident type, status and date of occurrence. These datasets can be represented on the map as point features and hotspot maps and connected to BI Widgets for data exploration purposes. Selections made directly on the map or on the BI widgets automatically filters the data that is being displayed, providing a highly dynamic and interactive dashboard view for gaining insights about hidden patterns on the data.





Feature Analyzer example for Public Safety incidents

## Browser App Features:

- Display base map
- Display maps defined by the administrator
- Display raster and vector (coming soon) layers in a form of a map
- Layers can be created on top of the Smart M.App/M.App Enterprise data or received from any WMS, WMTS or slippy tiles service
- Support for multiple projections, any geographic or projection CRS can be used via its EPSG code
- Manipulate the legend, change order of feature classes, set their translucency
- Search for geographical names and addresses globally, addresses and geonames can be given in multiple languages
- Zoom in/Zoom out
- Map pan
- Where Am I?
- Adjust Layer visibility / Show and Hide layer
- Measurements:
  - Show coordinates
  - Measure line
  - Measure area
- Map compositions selector
- Display GetFeatureInfo with feature properties in a form
- Print a map with browser CTRL-P

## BI Features:

- Quickly create rich geovisualizations that include:
  - Base Map
  - Source data definition

- BI presentation structure (more than one BI configuration called stage can be part of one Smart M.App)
- BI map configuration
- BI widgets configuration

## BASE MAP

- Base Map selector (base map can be created on the fly)

## SOURCE DATA DEFINITION

- Define data sources (attributes and geometries):
  - From content like GeoJSON, Shapefile, CSV (attribute data only)
  - From external source like a file available on the web or an WFS
- Manage Content:
  - Browse for content using traditional folder hierarchy
  - Search by name for assets available in storage
  - Filter content
  - Display content preview with basic information about selected assets
  - Upload new content
  - Add selected content to list of favorites and then filter by favorite filter
  - Select assets to be used in Smart M.App development
- Data Preview
- Date/Time extraction from data

## BI PRESENTATION STRUCTURE

- Create applications with multiple stages representing multiple BIs in one Smart M.App
- Stage definition consists of the selected data source and the BI maps and charts configuration
- Each stage can contain more than one geometry and each geometry can have a scale range assigned. This feature allows presentations of data on different levels of administrative units based on current zoom
- Define dimensions can be used by all charts including map presentations
- Define measures can be used by all charts including map presentations
- Levels of Measurements are typically four levels of measurement that are defined:
  - **Nominal** - numerical values just name the attribute uniquely. No ordering of the cases is implied
  - **Ordinal** - the attributes can be ordered but the distances between attributes do not have any meaning
  - **Interval** - the distance between attributes does have meaning
  - **Ratio** - there is always an absolute zero that is meaningful (fractions have meaning)
  - Custom expressions (with validation)
- Define color palettes can be used by all charts including map presentations

## BI MAP CONFIGURATION

- Choropleth displays colored geometries in relation to a data variable  
Choropleth is a thematic map in which areas are colored in proportion to the measurement of the statistical variable being displayed on the map, such as population density or per-capita income  
Smart M.Apps extended the "choropleth" concept from Polygons to other GeoJSON geometries like lines and points. This way it is possible to have administrative units, roads and manholes in a single M.App!

Dimension of the choropleth must be a valid geometry key ("ID" field of the geometry file).

Measures: Beside standard numeric measures choropleths support additional nominal "measure". This allows to easily transform the choropleth into a simple thematic map where geometries are colored according to their category.

- Point map - with point maps, the geometries of all features are converted to points (based on their center-of-mass values), and these points are grouped into clusters according to their geographical proximity. The clusters are regrouped with each zoom level change, so that the map delivers meaningful information at every level.

It was not always easy to visualize and interpret phenomena if multiple features appeared close to each other on the map. With this release, Point Map geovisualizations help you solve that problem. With point maps, the geometries of all features are converted to points (based on their center-of-mass values), and these points are grouped into clusters according to their geographical proximity.

If all geometries belonging to the cluster are displayed according to current application BI filters, the caption inside the cluster is an integer number representing number of features grouped in this cluster. Otherwise, the caption shows a fraction with the numerator representing number of displayed features and the denominator representing number of all features in the cluster.

Clusters have tooltips listing their contents by value.

When the zoom is big enough, clustered point maps show colored points as in Choropleths.

Comment: all geometries are transformed to points using center of mass calculation before being rendered as clustered points.

## BI WIDGETS CONFIGURATION

### *PIE CHART*

**Description:** Unique values of the dimension column are shown as slices of the circle. Arc length of each slice is proportional to the measure value computed from the data values belonging to this slice.

**Comment:** Although it is very popular, it is often criticized. Pie charts with too many slices easily become unreadable and it is hard to compare particular quantities. Some researchers suggest using row charts instead, as it is much more natural to compare lengths than angles.

**Dimension:** Pie chart requires a nominal dimension, as its main purpose is to show how data is distributed across categories.

Selected settings:

- Radius & inner radius provided as percentage (0-100). These settings allow to make the chart look more like a donut than like a pie!
- External labels - in combination with outer radius lesser than 100, this setting allows to position slice labels offset
- Minimal angle for label - value provided in radians. This allows to control whether the labels should appear for narrow slices

### *ROW CHART*

**Description:** Row chart presents unique values of the dimension (categories) as rectangular bars with lengths proportional to their measure values. It has some advantages over pie chart:

- All the categories are listed, even if their value is very small
- This chart can have a scale shown on the X axis and it is possible to configure the number of ticks, so that it is very easy to read actual values from the chart

**Comment:** Dimension unique values (bars) are sorted lexicographically, but it can be modified with customization.

**Dimension:** Requires a nominal dimension. With ordinal dimension it can take advantage of the ordering of the categories

Interesting settings:

- Horizontal and vertical axes labels
- X axis rescaling - scale on the X axis can adapt to maximum value of the measure according to the current filter. or it can stay constant and reflect maximum value of the measure according to full data

### *BAR CHART*

It can be used as a rotated row chart in its simplest use but it has fully operational X and Y axes, which allows it to be:

- Stacked (rectangles representing one measure shown on top of rectangles representing the other measure)
- Composited with other charts (bar charts and line charts) in Composite Chart Container

Works best with an interval-like dimension (number values).

Interesting settings:

- Selection type: select one or many bars to filter the data. There is also an option to draw a range inside the chart!
- Gaps between bars in pixels (bar gaps) or relative (bar padding)
- Outer padding for ordinal (and interval) dimension values

### *LINE CHART*

This chart type requires its dimension to be numeric. Each data point of the line chart has two coordinates - the dimension value is X and the measure value is Y. Adjacent data points connect with each other by lines. It can be configured to render area under the line and to display data points.

In order to show more than one measure on the line chart, use either a composite chart or a stacked chart. Use the composite chart in order to show data series as well as the stacked chart in order to show ingredients of a particular phenomenon.

### *INFORMATION CHARTS*

These charts allow to display the information in text form.

### *TEXT CHART*

Text chart allows you to display Smart Captions: descriptive information containing numbers that dynamically adapt to the values of particular measures computed for current state of filters in the M.App. It is very easy to configure a text chart. Just type in the caption, drag and drop the measures, and add some formatting.

Text charts do not use dimensions because the measure values are always computed as aggregations, employing all the data rows in the current filter. This is similar to measure comparison charts.

### *DATA TABLE*

Data table displays all rows in the current filter for columns specified in its configuration.

### *2-DIMENSIONAL CHARTS - DOT CHART*

**Description:** Data points are positioned on the grid with axes representing dimensions. Measure is represented by coloring of the data point.

**Dimensions:** Both dimensions must be numeric.

#### *2-DIMENSIONAL CHARTS - HEAT MAP*

**Description:** Heat map is very similar to the dot chart, but it allows ordinal dimensions. For example, day numbers and hour ranges automatically extracted from the Date Time fields by the BI Wizard allow to analyze time patterns of the incident occurrences.

**Dimensions:** Ordinal

#### *CONTAINERS - COMPOSITE CHART CONTAINER*

Composite chart container allows creating complex charts that show several series of measures on the same X axis. It can combine line charts and bar charts.

#### *CONTAINERS - CUSTOM CHART CONTAINER*

Custom chart container is a placeholder for charts instantiated with the customization JavaScript code. It provides drag and drop positioning and resizing. It is possible to configure basic style properties.

Its DOM ID can be found in the Properties Panel in the "Advanced" section. There are no restrictions on dimensions or measures, as these properties are just passed to the customization code.

#### *TIME CHARTS - TIME BAR CHART*

Time bar chart is very similar to the standard bar chart, but its dimension must be time-like. This allows optimizing X-axis formatting for time-specific data.

**Dimension:** Time or time diff

#### *TIME CHARTS - TIME LINE CHART*

Almost identical to the standard line chart but optimized for displaying time-specific data.

**Dimension:** Time or time-diff

#### *MEASURE COMPARISON CHARTS*

Measure comparison charts or multi-column charts show several measures reduced to single values on one chart. This is especially useful when comparing aggregated quantities that are parts of a single phenomenon. For example, showing green space, gray space, and water in absolute values on a single chart.

When setting up these charts, dimensions are not taken into considerations just like with Text Chart. Measures are calculated for all data rows selected with the current BI application filters.

Measure comparison charts react to selection events from the other charts in order to show high level aggregated information.

- **Pie chart** - Each slice represents one measure
- **Row chart** - Each bar represents one measure
- **Bar chart** - Each bar represents one measure

# Mobile App

## Native App

- iOS, Android, Universal Windows Platform
- Shared code base
- Multiple server support
- Multiple project support
- Single app with dynamic servers or preconfigured custom app
- XML based configuration

## Themeable

- Primary color, accent color
- Advanced control/layout theming

## Form

- Different field types (Text, Date, Numeric, Picker, Image, Document, Switch, TextArea, Geometry, Master/Detail List, ...)
- Tabs
- Actions
- Help
- Responsive field layout (single column, two columns)

## List

- Different cell types (Text, Image, ...)
- Sorting
- Grouping
- Actions
- Responsive display of cells

## JavaScript based scripting

- Allows changing behavior without recompiling

## Synchronization

- Data
- WMTS Tiles

## GPS Tracks

- Managing of recorded GPS tracks
- Background recording

## Offline

- Fully encrypted
- Two-way sync
- Differential sync
- Automatic/Manual sync (often changing data vs. master data)
- Master/Detail support

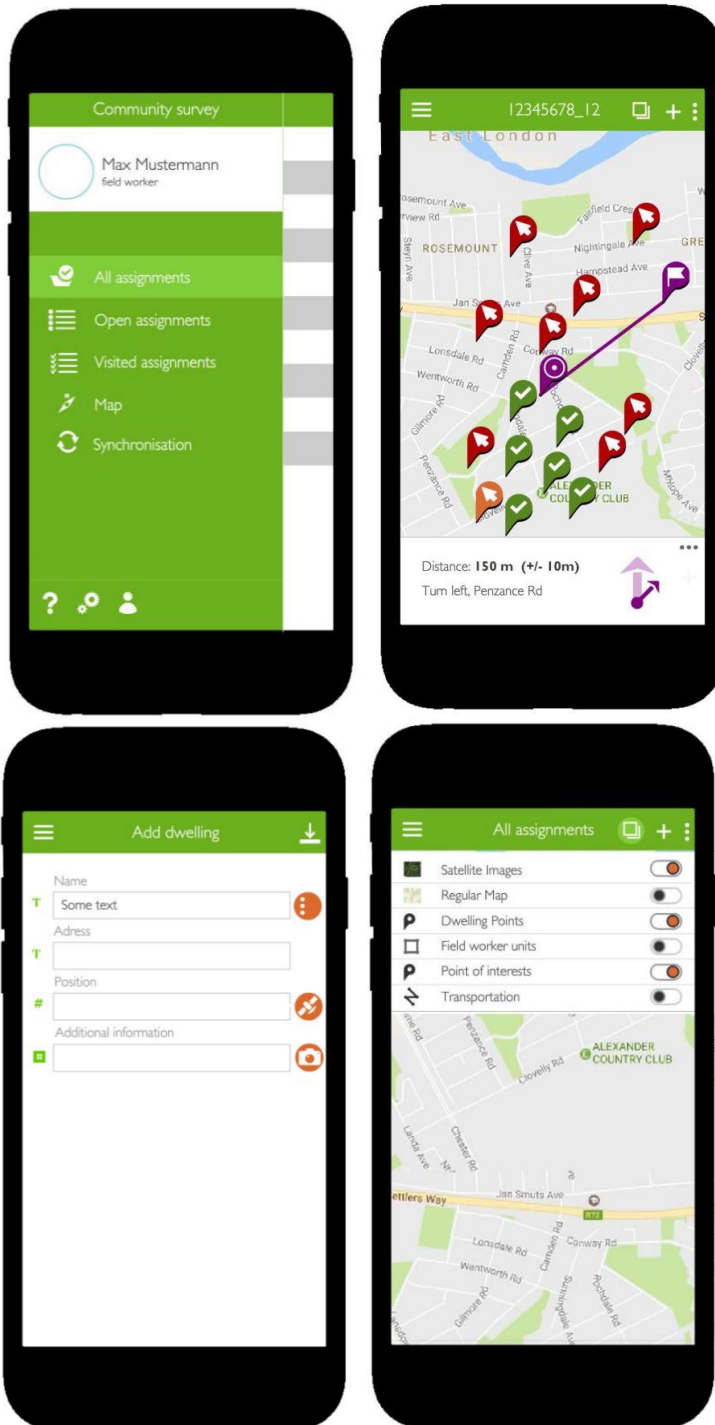
## Map

- Platform specific native map (Google Maps, Apple MapKit, UWP MapControl)
- Marker, Polyline, Polygon vector layer
- WMTS layer
- Offline capabilities

- Routing

## Server

- Fully customizable via dependency injection
- Support for SQL Server, Oracle and PostgreSQL







## Contact us



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

## About Hexagon

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous — ensuring a scalable, sustainable future.

Hexagon's Geospatial division creates solutions that deliver a 5D smart digital reality with insight into what was, what is, what could be, what should be, and ultimately, what will be.

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

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