ISA² – Action 10: ELISE Benchmarking Support

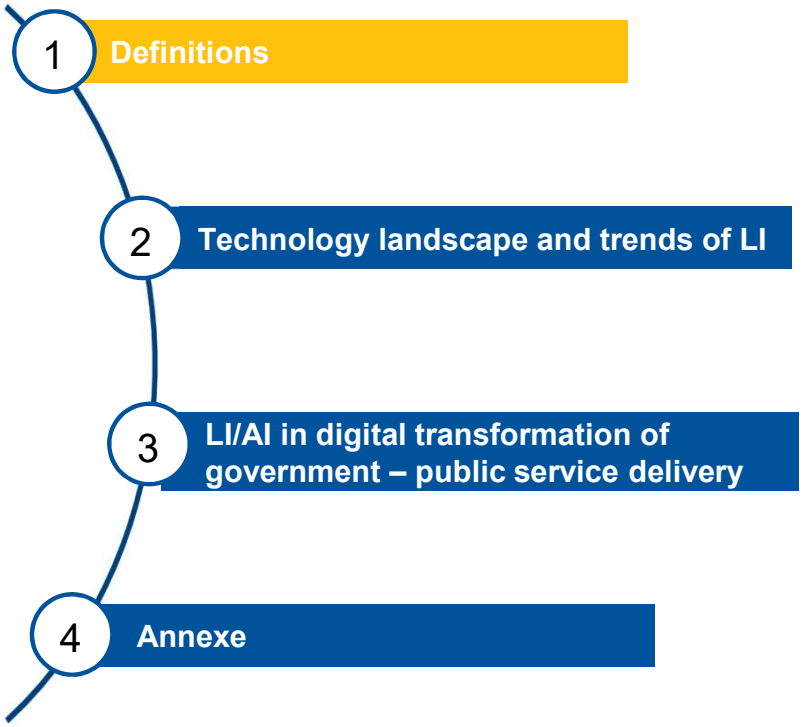
Task 2: Location intelligence

Prepared for JRC
May 2020

Clémentine Valayer
Guido Van Der Harst

Gartner®

Table of contents



Gartner

Gartner defines *Location Intelligence* as the process of deriving meaningful insight from geospatial data relationships – people, places or things

Gartner

Definitions

Location intelligence

LI is the process of deriving meaningful insight from geospatial data relationships — people, places or things — to solve particular challenges such as demographic or environmental analysis, asset tracking, and traffic planning.

LI tools consists of a combination of GIS software, web mapping solutions, position technologies such as GPS and location-based data. (Gartner)

Location intelligence and business intelligence

LI is an analytics and business intelligence (BI) tool capability that relates geographic and location contexts to business data. Like BI, LI software is designed to turn data into insight for a variety of business purposes.

Location data, coupled with analytics and BI software, can enrich information, then help organizations better analyze and visualize it.

Geospatial Artificial Intelligence

GeoAI, is the use of artificial intelligence methods, including machine learning and deep learning, to produce knowledge through the analysis of spatial data and imagery.

Positioning technologies are being positively affected by AI, affecting industries such as logistics and navigation systems (ex: processing millions of GPS points in (near) real-time)

Artificial intelligence

Artificial intelligence (AI) applies advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take actions. (Gartner)

AI is a collection of technologies that combine data, algorithms and computing power (EU White paper on AI)

Gartner

Definitions

Edge AI

Edge AI refers to the use of AI techniques embedded in IoT endpoints, gateways, and other mobile and edge devices, in applications ranging from autonomous navigation to streaming analytics

Explainable AI

Explainable AI refers to a set of capabilities that describes a model, highlights its strengths and weaknesses, predicts its likely behavior, and identifies any potential biases.

Digital Platform

A Digital Platform is a business-driven framework that allows a community of partners, providers and consumers to share, extend or enhance digital processes and capabilities for the benefit of all stakeholders involved through a common digital technology system.

Innovation

Innovate means to make **changes** in something established, especially by introducing new methods, ideas, or products.(Oxford)

innovation management as a business discipline that aims to drive a repeatable, sustainable innovation process or culture within an organization. Innovation management initiatives focus on **disruptive or step changes that transform the business in some significant way**. (Gartner)

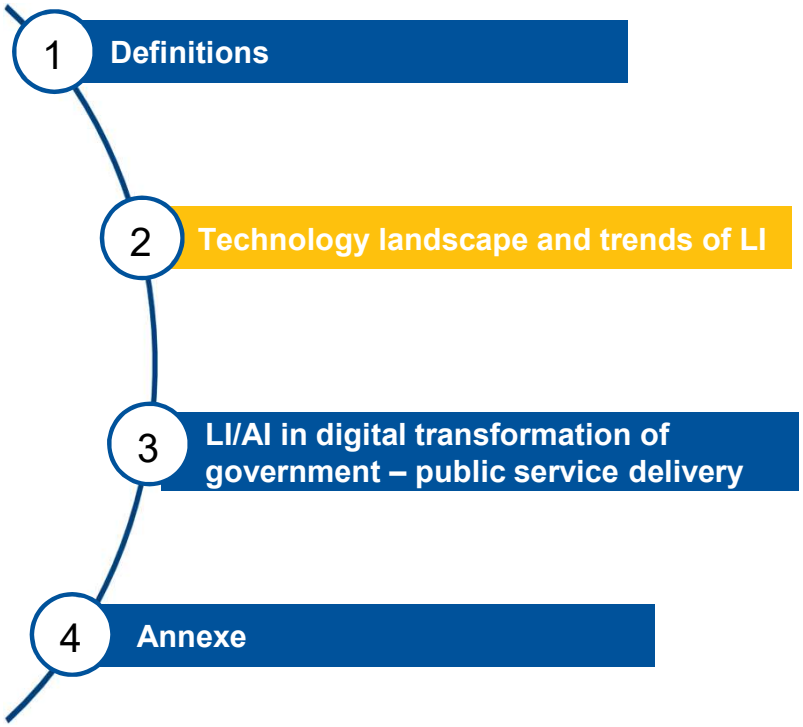
Social innovation

Social innovations are new social practices that aim to meet social needs in a better way than the existing solutions, resulting from - for example - working conditions, education, community development or health. These ideas are created with the goal of extending and strengthening civil society. (Wikipedia)

Social innovations are new ideas that meet social needs, create social relationships and form new collaborations (EC DG GROW)

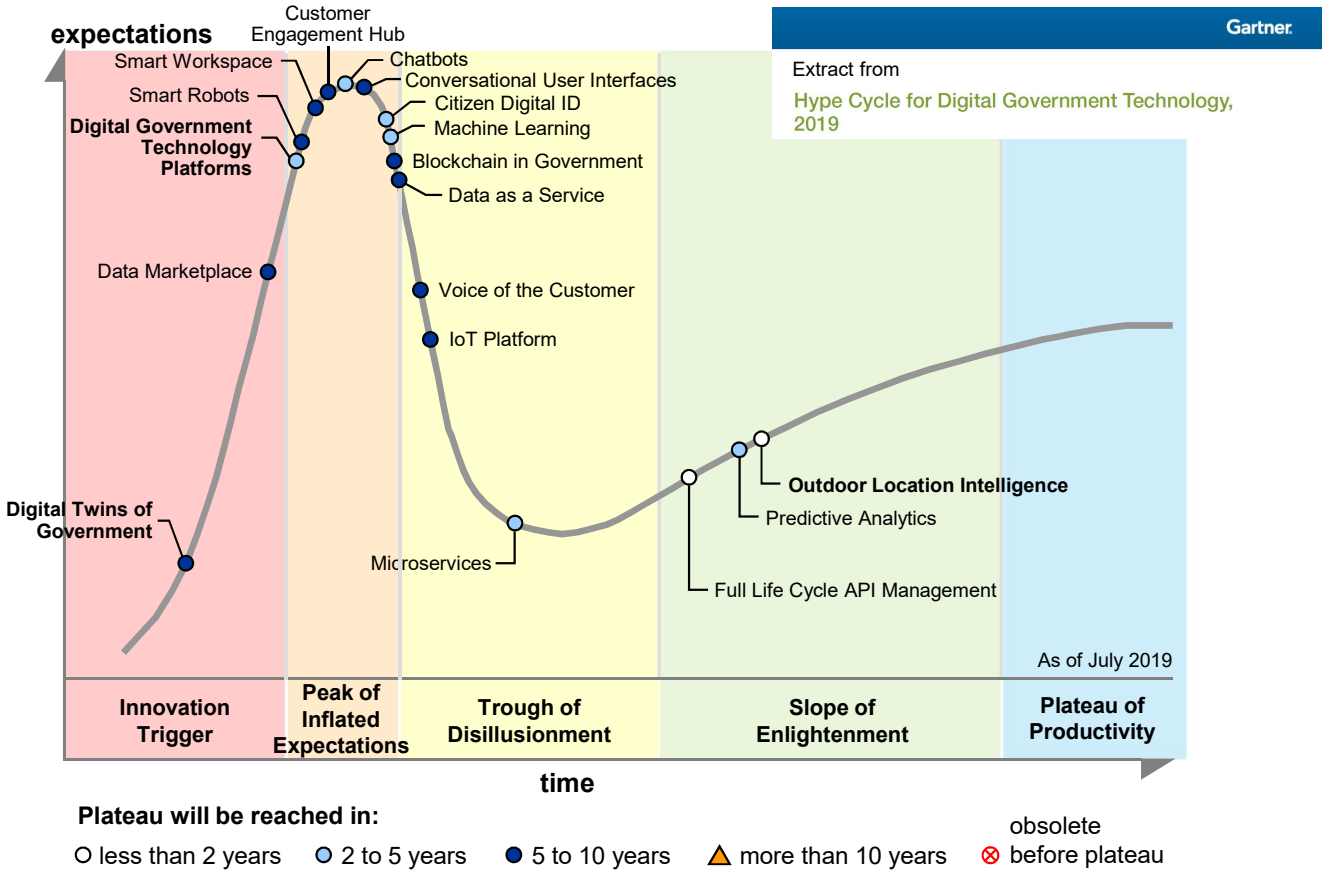
Gartner

Table of contents



Gartner

Location intelligence, digital twins and digital platforms are key digital government technology



From "Hype Cycle for Digital Government Technology, 2019," 30 July 2019 (G00370115)

With Location Intelligence and Digital Platforms maturing, Digital Twins of government are emerging, with the additional support of predictive analytics, APIs and IoT platforms.

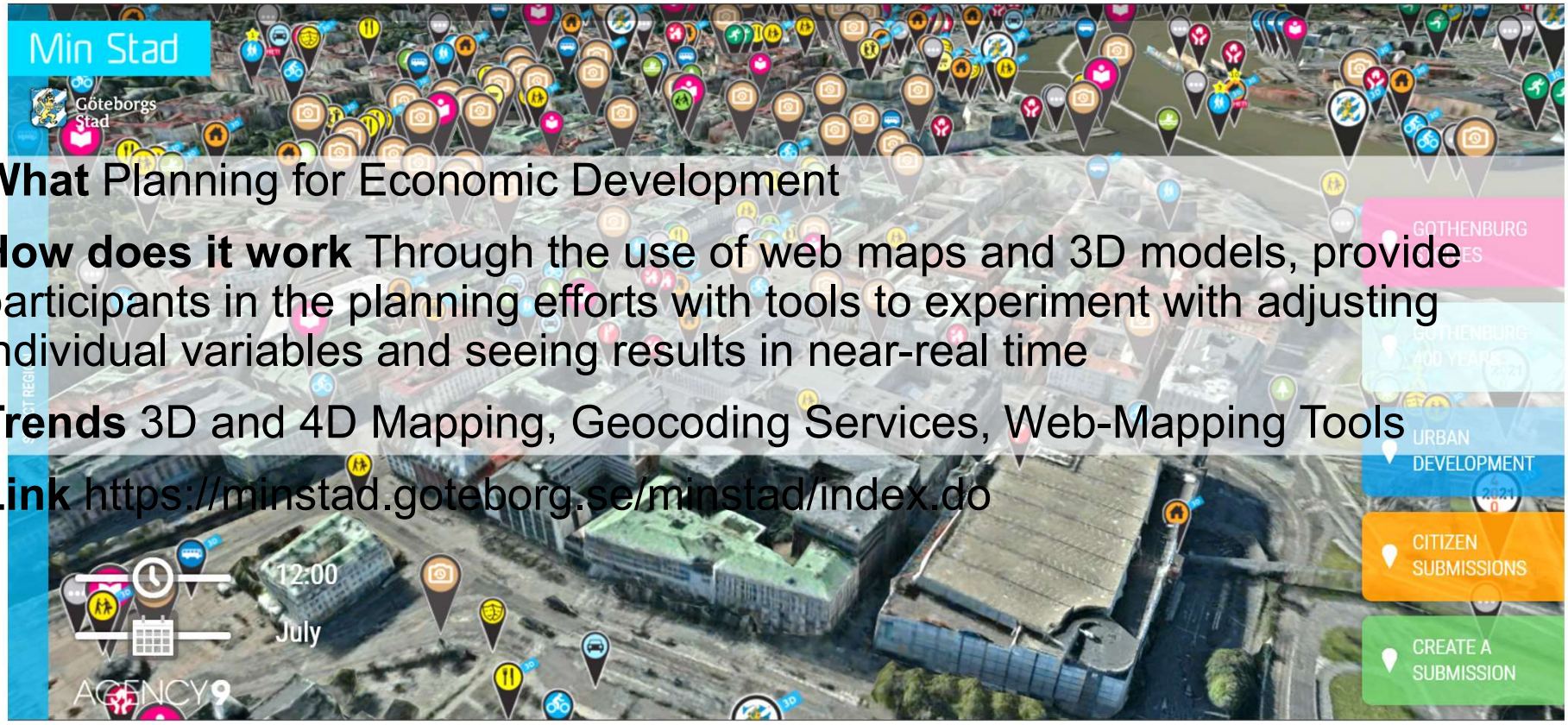
Gartner

Gartner identified trends that will shape “Location Intelligence”

Benefit	Years to mainstream adoption		
	Less than 2 years	2 to 5 years	5 to 10 years
Transformational	▪ Cloud Services for Government	▪ IoT Event Stream Processing ▪ Deep Learning Networks ▪ Machine Learning ▪ Digital Government Platforms ▪ Edge AI	▪ GeoAI ▪ Data Marketplace ▪ Immersive Analytics ▪ IoT-Enabled Applications ▪ Smart Monitoring for Public Infrastructures ▪ Digital twin ▪ Blockchain
High	▪ Multichannel Communications Tools ▪ Geocoding Services ▪ Web-Mapping Tools ▪ Smart Lighting ▪ Indoor Location	▪ Social Analytics ▪ Video/Image Analytics ▪ Open Data and APIs ▪ Predictive Analytics ▪ Building Information Modelling ▪ Commercial Drones ▪ 3D/4D Maps	▪ Real-Time Analytics ▪ Smart Transportation ▪ Explainable AI ▪ IoT Platforms
Moderate		▪ Privacy by Design	▪ Advanced Anomaly Detection

Gartner

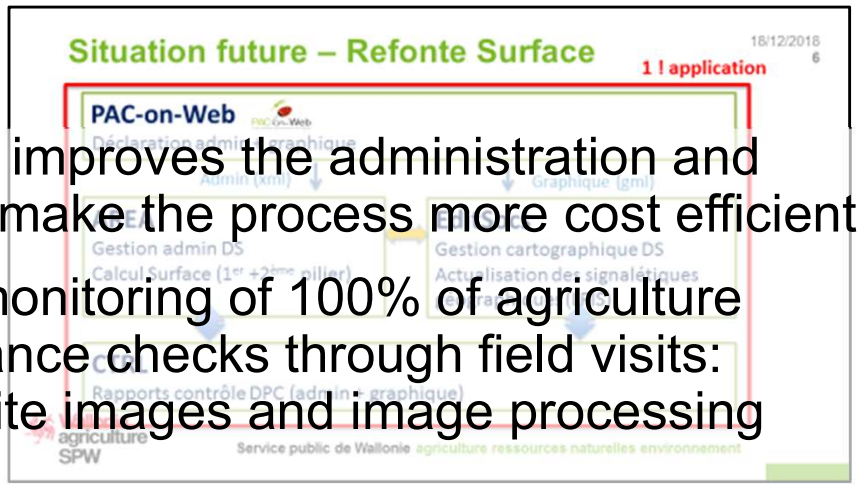
Gothenburg, Sweden – Min Stad



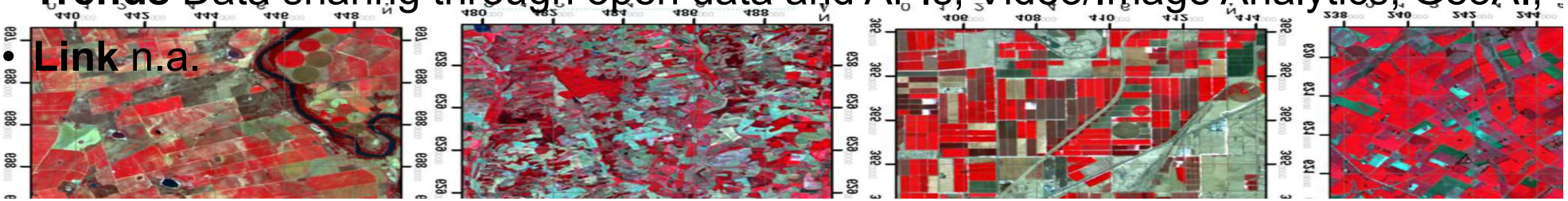
- **What** Planning for Economic Development
- **How does it work** Through the use of web maps and 3D models, provide participants in the planning efforts with tools to experiment with adjusting individual variables and seeing results in near-real time
- **Trends** 3D and 4D Mapping, Geocoding Services, Web-Mapping Tools
- **Link** https://minstad.goteborg.se/minstad/index.do

Gartner

Walloon Government – Agricultural Subsidy Compliance Monitoring

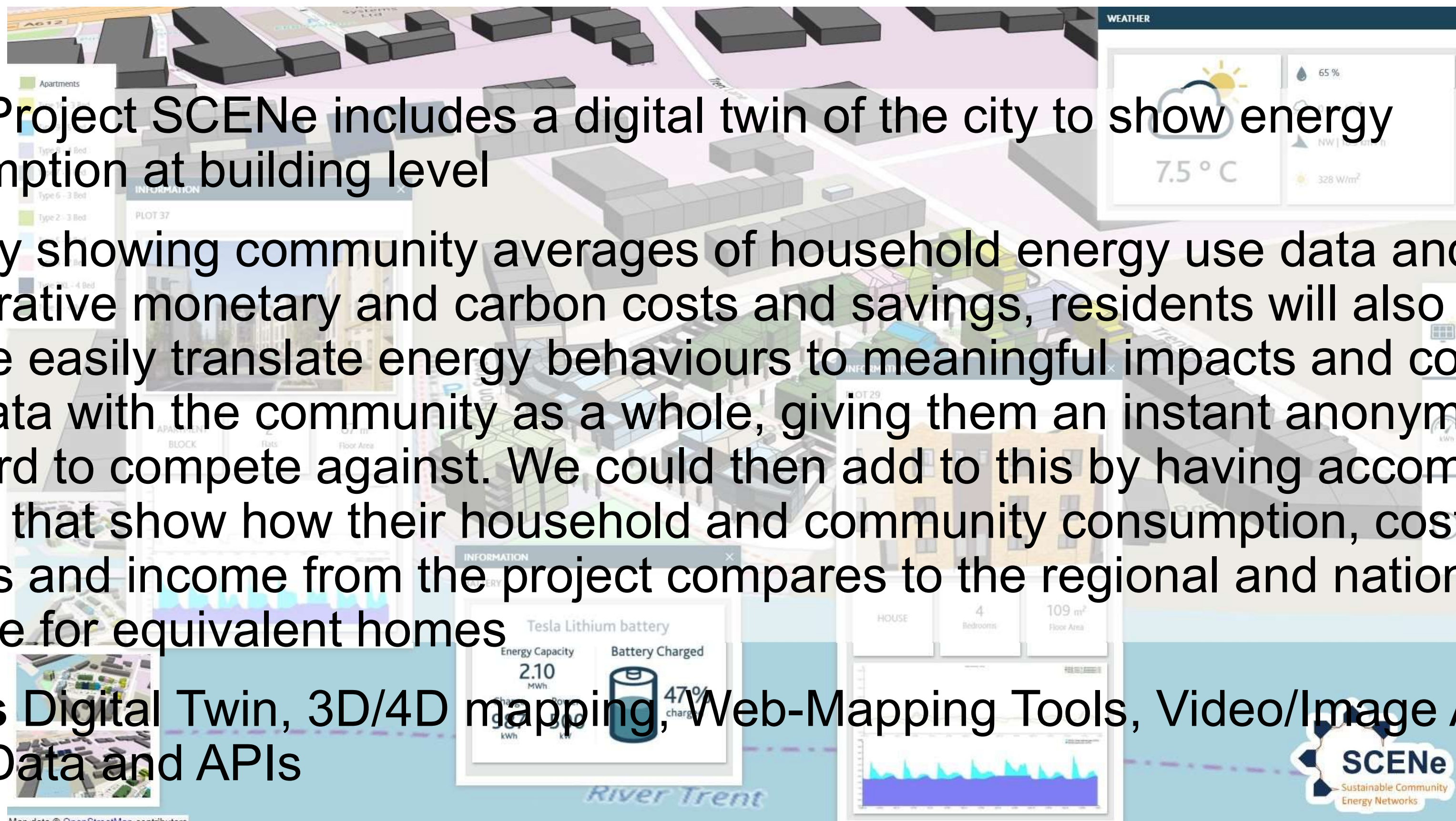


- **What** Using satellite images simplifies and improves the administration and management of agricultural subsidies and make the process more cost efficient
- **How it works** Automatic and continuous monitoring of 100% of agriculture parcels and crops vs. 5% punctual compliance checks through field visits: taxpayer's money spent better using satellite images and image processing algorithms
- **Trends** Data sharing through open data and APIs, Video/Image Analytics, GeoAI,
- **Link** n.a.



Gartner

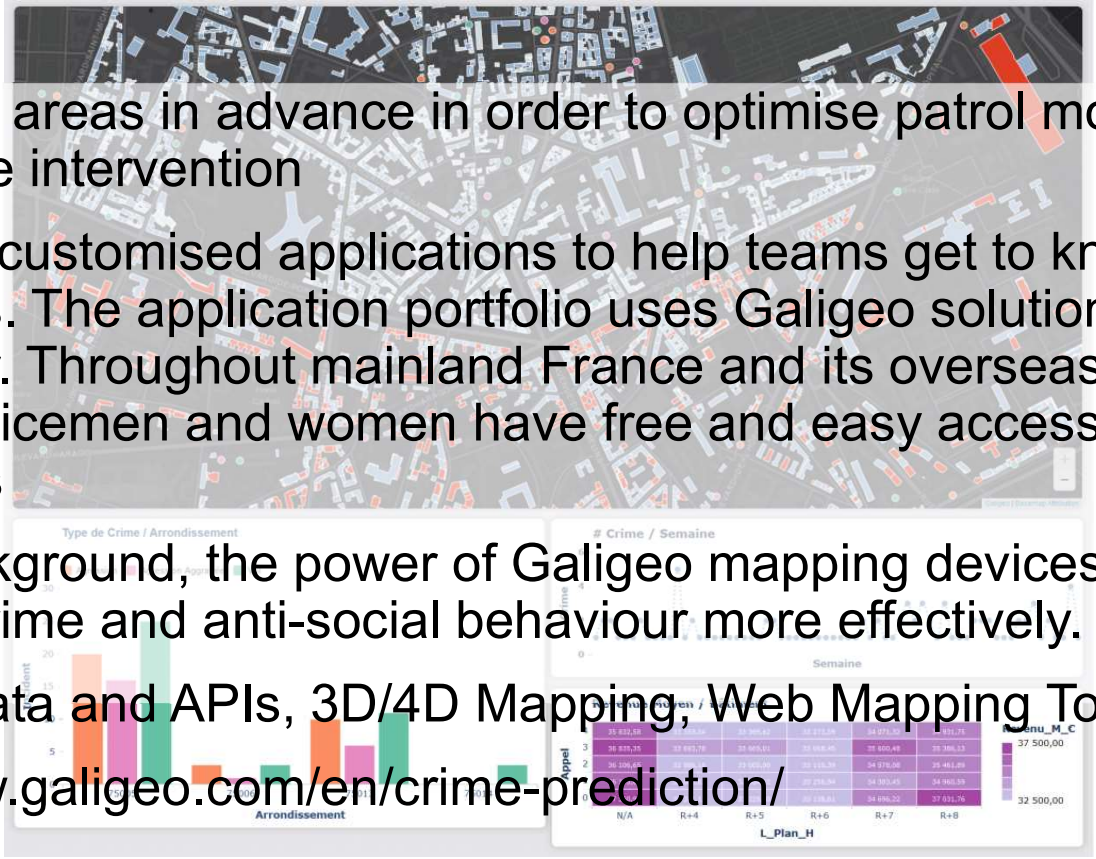
Nottingham, UK – Project SCENe



- **What** Project SCENe includes a digital twin of the city to show energy consumption at building level
- **How** By showing community averages of household energy use data and comparative monetary and carbon costs and savings, residents will also be able to more easily translate energy behaviours to meaningful impacts and compare their data with the community as a whole, giving them an instant anonymous local standard to compete against. We could then add to this by having accompanying visuals that show how their household and community consumption, costs, savings and income from the project compares to the regional and national average for equivalent homes
- **Trends** Digital Twin, 3D/4D mapping, Web-Mapping Tools, Video/Image Analytics, Open Data and APIs
- **Link** https://www.projectscene.uk/energy-innovations-community-energy-review-recent-developments/

Gartner.

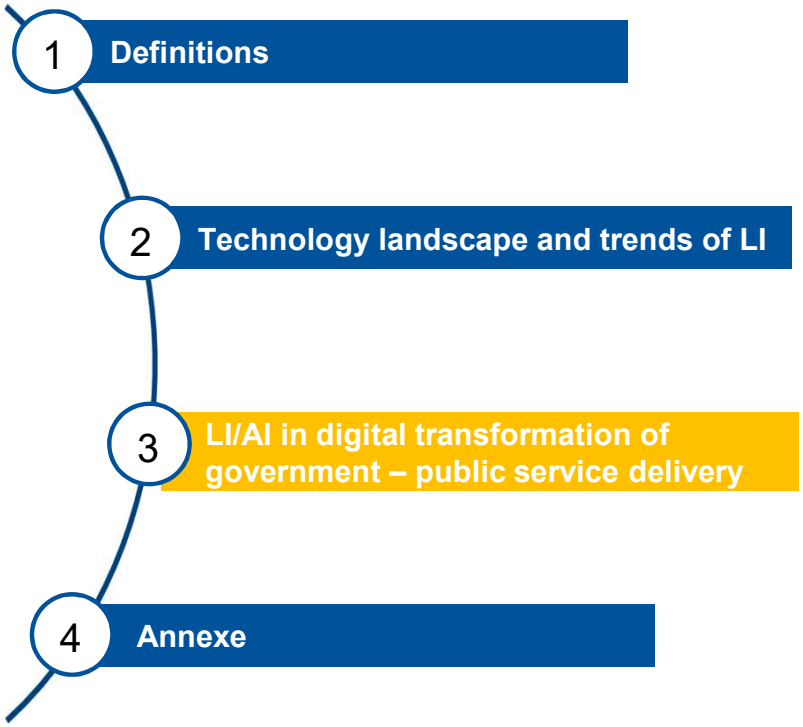
Gendarmerie Nationale, France – Crime Prediction



- **What** Target risk areas in advance in order to optimise patrol mobilisation and the success of police intervention
- **How** A series of customised applications to help teams get to know their area and plan their patrols. The application portfolio uses Galigeo solutions, such as SAP Lumira Designer. Throughout mainland France and its overseas territories, thousands of policemen and women have free and easy access to location intelligence tools
- Against this background, the power of Galigeo mapping devices can play a full role in fighting crime and anti-social behaviour more effectively.
- **Trends** Open Data and APIs, 3D/4D Mapping, Web Mapping Tools, GeoAI
- **Link** https://www.galigeo.com/en/crime-prediction/

Gartner

Table of contents



Gartner

Digital transformation of government leverages Location Intelligence in several ways

- Maximizing community and ecosystem collaboration use of geospatial and location data and services by developing a GIS data exchange, spatial- and location-based mobile apps and map-based public services.

- Engaging stakeholders in planning and policy development by leveraging 4D GIS models and web-mapping capabilities to enrich communication of impacts to constituents and partners.

- Driving data-driven decision making that uses spatial data by leveraging GeoAI and spatial analytics to develop proactive and predictive map-based models.

Gartner

The Digital Twin of Government

- The digital twin of government will provide an ecosystem with an interface for government, industry and nongovernment organisations to work together in delivering a sustainable, intelligent place to live and work through improved societal outcomes.
- Most digital twins of government today are immature compared with the potential of this technology approach. Jurisdictions that have created early versions of digital twins of government are often focused on developing a 3D or 4D GIS model of their physical environment. Available datasets may be limited in these environments. More-advanced features of solutions being leveraged by governments today include real-time event stream processing; spatial, descriptive and causal analytics; and citizen engagement tools.
- Use cases examples include:
- Using a digital twin of road and transportation systems to automate traffic management for incidents, weather and emergency response

Gartner

Case Studies on Location Intelligence in public services

City of Guimarães: Urban Platform

Flanders Region: KLIP Cable and Pipeline Information Portal

Helsinki: Digital Twin City Models

AsistenciaCovid19: Self-diagnosis and symptom tracking

Gartner

City of Guimarães: Urban Platform

Area	Policy Domain	Service owner	Organisations involved
PT – City of Guiaraes	Urban development	Ubiwhere	The municipality, citizens and other data providers

Overview of service / innovation

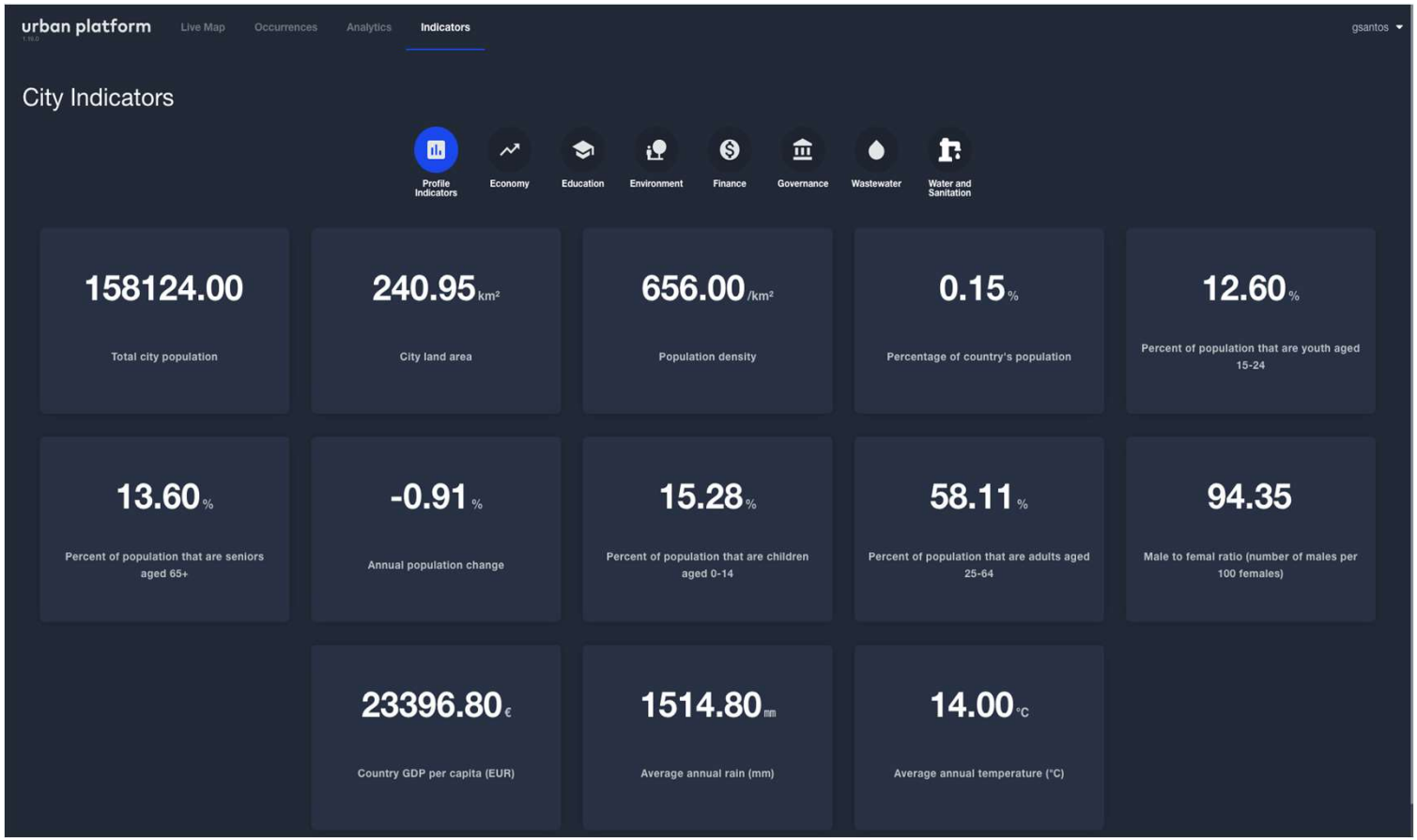
The Urban Platform provides cities with a holistic view of their urban environment which allows to monitor various indicators (reducing environmental emissions, improving the energy and mobility efficiency, etc) by displaying information of several domains in real-time in a customisable dashboard.

The Urban Platform assists the cities in meeting the Sustainable Development Goals (SDG), defined by the United Nations for 2030, by taking into account the Sustainable Cities and Communities Indicators from ISO 37120 (Sustainable Cities and Communities - Indicators for city services and quality of life) and 37122 (Sustainable Cities and Communities - Indicators for Smart Cities), among other indicators.

With these goals in mind, the Urban Platform presents itself as an aggregating solution for the different sectors of a city (mobility, environment, tourism, energy or waste), helping to fulfill these goals while supporting the digitisation of the city. The real-time indicators provide insight through the correlation of information designed for forecasting, reporting and impact assessment.

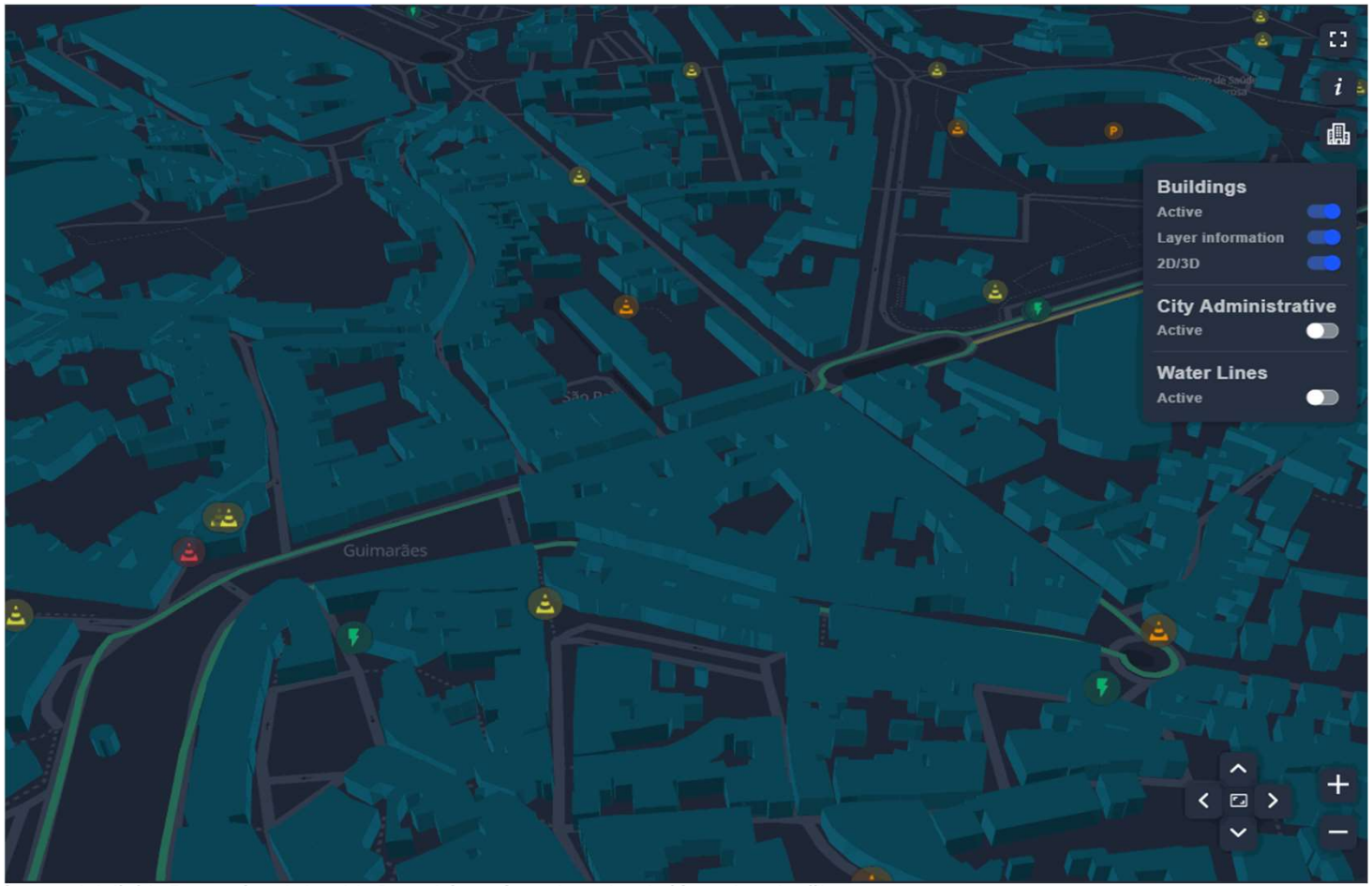
https://urbanplatform.city

City of Guimarães: Urban Platform



Gartner

City of Guimarães: Urban Platform



Gartner

City of Guimarães: Urban Platform

Location Intelligence

The platform performs cross-domain analysis – such as the impact of one occurrence to the different domains of its surrounding area (e.g.: how a large event such as a music concert has impacted the traffic and parking and, additionally, how the generated traffic affected air quality and noise in those areas).
One of the intelligent services is to compute the best route for an emergency vehicle to efficiently reach an occurrence avoiding congestion, taking into account the current state of the traffic, as well as the roads characteristics, as certain vehicles need to comply with certain restrictions. These routes should be obtained in a short amount of time, with computations being updated whenever there is a change in the road network status.

Data Sources

- ❑ Real-time traffic information (intensity and average velocity) - HERE Technologies
- ❑ Off-street Parking occupancy information - municipality via third-party IoT platforms
- ❑ Electrical Vehicle charging stations' locations - municipality
- ❑ Touristic and social events data - municipality
- ❑ Mobility and Civic Incidents and planned roadworks courtesy of the city council and the citizens' community through a mobile application.
- ❑ Air quality and Weather observations - municipality
- ❑ Foot and bicycle traffic information soon available, through IoT devices in key areas

- ❑ Geospatial data provided by the municipality:
  - ✓ Geospatial 3D information about buildings from the proprietary Geographic Information System (GIS). This data, due to its high-volume, is updated periodically or on-demand. The energy consumption of the buildings owned by the city is also provided;
  - ✓ Information and geographic boundaries of the administrative regions (e.g. parishes) (can be updated with additional demographic information regarding the zones);
  - ✓ Information and geographic representations of watercourses
- ❑ OpenStreetMaps data about the roads, etc. to support analysis (e.g. most congested roads) and geocoding features (translation of address to coordinates)

Gartner

City of Guimarães: Urban Platform

Success factors

- Using open standards for communication and data exchange - such as FIWARE's NGSI standard. Enhancing interoperability provides a competitive edge compared to plaforms that are creating data silos.
- Designing user interface and experience for non-technical or data-savvy users
- Desiging a modular architecture allowing a flexible integration of data sets with different formats and adding new features to tailor to specific cities' needs.

Challenges

- The interface needed to provide all information but prioritized according to its relevance, allowing to focus on key sectors (air quality, parking) or specific areas.
- Although the platform complies with open standards, different data sources mean diverse data structures (even if from the same domain), which make the data assimilation and analysis more complex or more time-consuming. Therefore, on top of standardisation, data harmonisation tasks are always employed before any processing and usage.
- The information available about Guimarães on worldwide data services is not at a desirable scale, and must be complemented with (or even completely replaced by) in-county sources of data, limiting interoperability and shifting the data gathering responsibility and costs to the city.
- Geospatial data correlation is a time-consuming process, especially when dealing with large amounts of data. In order to manage some data sources (e.g. 3D mapped buildings), the process has to be made as fluid as possible in order to preserve the system's resources.

Gartner

KLIP: Cable and Pipeline Information Portal

Area	Policy Domain	Service owner	Organisations involved
BE - Flanders Region	Utility services	Informatie Vlaanderen	Mains operators (cables and pipes)

Overview of service / innovation

KLIP platform allows information exchange about underground assets – mains - (localisation, colour, type,…) in a specific zone. The user files a request (form or via the API), KLIP will determine which mains operators are possibly involved and will dispatch the request to these parties. The utility operators have the legal obligation to respond to every map request from KLIP.

The target audience is everyone who is planning to do groundworks using machinery, most of the users are contractors, but citizens can apply for maps too.

The innovation brought by this platform is threefold:

- ❑ all mains operators have to deliver their data according to the IMKL-model to KLIP, they may not send paper maps/links to their own geoportals, etc.
- ❑ the users get one single map with all the relevant data about underground utility assets. This map can be viewed online and offline in an app
- ❑ users can access the IMKL-data as well (to convert the data and import them into their own systems)

https://overheid.vlaanderen.be/informatie-vlaanderen/producten-diensten/kabel-en-leidinginformatieportaal-klip

Gartner

KLIP: Cable and Pipeline Information Portal

Location Intelligence

The different types of data are harmonised using a common model. The IMKL data model is based on the INSPIRE data model for utility and governmental services. This model was extended: KLIP added more information to identify the cables and pipes in the field.

The mains operators send an IMKL-answer or mention if they do not have any asset in that particular area. The exchange is file based and fully automated

Users who integrate via services can use the public api to apply for maps, answer map requests, get the IMKL data and the .klip file to use in the KLIP app.

Data Sources

Data comes from the mains operators – which are typically very varied in types of organisations – private, public, large, small.

The information they share is mostly from private sources. KLIP uses several public background layers (e.g. the large scale reference map of Flanders).

The maps KLIP distributes have a fixed content: all the information KLIP receives from the mains operators, plus a background layer de dato the moment the map is assembled.

Gartner

KLIP: Cable and Pipeline Information Portal

Success factors

Usability of the interface is key to ensure usage without training support: the viewer is straightworward to use when the user is on the construction site.

As the mains operator's system can import the IMKL data, in reduces the amount of errors compared to mapping the data by hand (drawing).

KLIP has a was founded based on specific legislation (a decree), which ensures that the different mains operators use the platform and data model. All mains operators are accessible through one portal – KLIP – easing users' workload to access data from different operators.

Challenges

Getting all mains operators on board was a challenge. The legislation was a strong driver, and the process was eased by subcontracting IT providers to fully automate the reply process.

Data quality is an issue. Cables buried a long time ago have a tendency to "move" within the ground, making their location unprecise. For some companies maintaining private underground cables and pipes, the cost to locate their utility assets does not match the benefit derived from an accurate location.
The IMKL data model is not widely used, so the data has to be converted into another format/model before it can be imported into CAD or GIS software.

Gartner

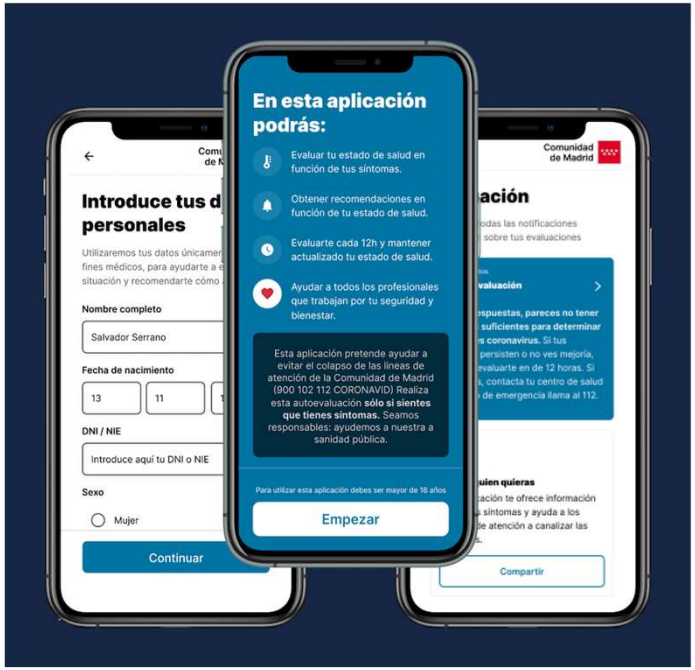
AsistenciaCovid19: Self-diagnosis and symptom tracking

Area	Policy Domain	Service owner	Organisations involved
ES – City of Madrid	Public Health	Comunidad de Madrid	Telefonica, CARTO, Ferrovial, Google, Comunidad de Madrid, Spanish government, Forcemanager, Mendesaltaren

Overview of service / innovation

AsistenciaCovid19 is a web and mobile application to help reduce the pressure on emergency systems and track the status of symptoms when people are taking care of themselves at home. It is inspired by the use of technology by China and South Korea where it has been one of the key success factors in managing the crisis, by tracking the symptoms of its citizens. The Spanish version relieves pressure on the already saturated emergency communication methods (telephone hotlines) by allowing citizens to self-evaluate COVID-19 symptoms and reveive clear recommendations for action.
The application provides a method to understand the pandemic from a spatio-temporal perspective - which is precisely where location brings value. The solution collects data from citizens and provides a spatial backend to store the data and perform analysis.
Since there wis a location element to the data being collected, the local authorities are also be able to visualize infections on an interactive map and perform geospatial analysis to determine high risk areas. With geospatial technology from CARTO being used in the backend to capture that information, the government can see how symptoms change over time and by location, allowing them to act faster in certain hotspots.

AsistenciaCovid19: Self-diagnosis and symptom tracking



https://coronavirus.comunidad.madrid/

Gartner

AsistenciaCovid19: Self-diagnosis and symptom tracking

Location Intelligence

AsistenciaCOVID19 is an end-to-end Location Intelligence solution for the management of the Coronavirus crisis using CARTO & Google Cloud (BigQuery). It provides infrastructure according to the volume of visits expected for the public app, including an automated system for data consumption to provide a dashboard to the government that is a reliable source of real-time updated information.

The following three elements provide access to the Location Intelligence features:

- ❑ Web / Mobile App: Prevents emergency phone saturation and optimizes resource allocation by collecting key data on disease progression among citizens.
- ❑ Back-office application: Performs data cleaning and preparation which allows real-time monitoring of infections, triggering emergency calls when and where necessary.
- ❑ Control planning: Dashboards to support planning, control decision making and predict outbreaks, with both private and public versions.

Data Sources

- ❑ The app captures personal information, such as: phone number, date of birth, sex, address, postal code, as well as some questions relating to symptoms they may be experiencing - with the app advising next steps.
- ❑ All data collected is encrypted and stored securely with citizens having complete control over its usage at all times.
- ❑ The data processing of personal data considered necessary in the framework of the project is what allows the government to plan preventative measures to slow the spread of the virus.
- ❑ Other data sources such as boundaries, POIs (points of interest) and human mobility data can be used in the post-capture analysis to enrich the analysis that Data Scientists will be carrying out afterwards as they study the spread and model for future predictions.

AsistenciaCovid19: Self-diagnosis and symptom tracking

Success factors

- The project, initiated by the Community of Madrid (Comunidad de Madrid) and brought together multiple technology companies (CARTO, Forcemanager, Mendesaltaren) with large corporations (Google, Telefonica, Ferrovial) allowed the team to have a wide range of skills in front & back end development, data science, UX & security.
- The team delivered the app only five days after forming. The help of the Community of Madrid and the surrounding communications campaign (both online and offline) have played a key role in promoting the app across Madrid and now across the entire country.

Challenges

- The main challenge at the moment to gather the team was the race against time, due to the exponential development of the virus and the number of infected constantly increasing.
- The app needed to be launched soon enough to be able to have an impact and reduce wait times on the emergency hotlines.
- Getting the mobile app published fast enough also proved a challenge as security checks have increased due to a growing number of scam apps being created on app stores.

Gartner

Helsinki Digital Twin City Models

Area	Policy Domain	Service owner	Organisations involved
FI City of Helsinki	Urban Development	City of Helsinki	Bentley Systems, Cadfem, Terrasolid, Terra Tech, Virtual City Systems, Aalto Helsinki Tec Univ, Helsinki Univ, Technical Univ Munich, Technical Uni Stuttgart, OGC CityGML, PostgreSQL, PostGIS, 3D City DB, Cesium, Cities of Rotterdam, Singapore, Vienna

Overview of service / innovation

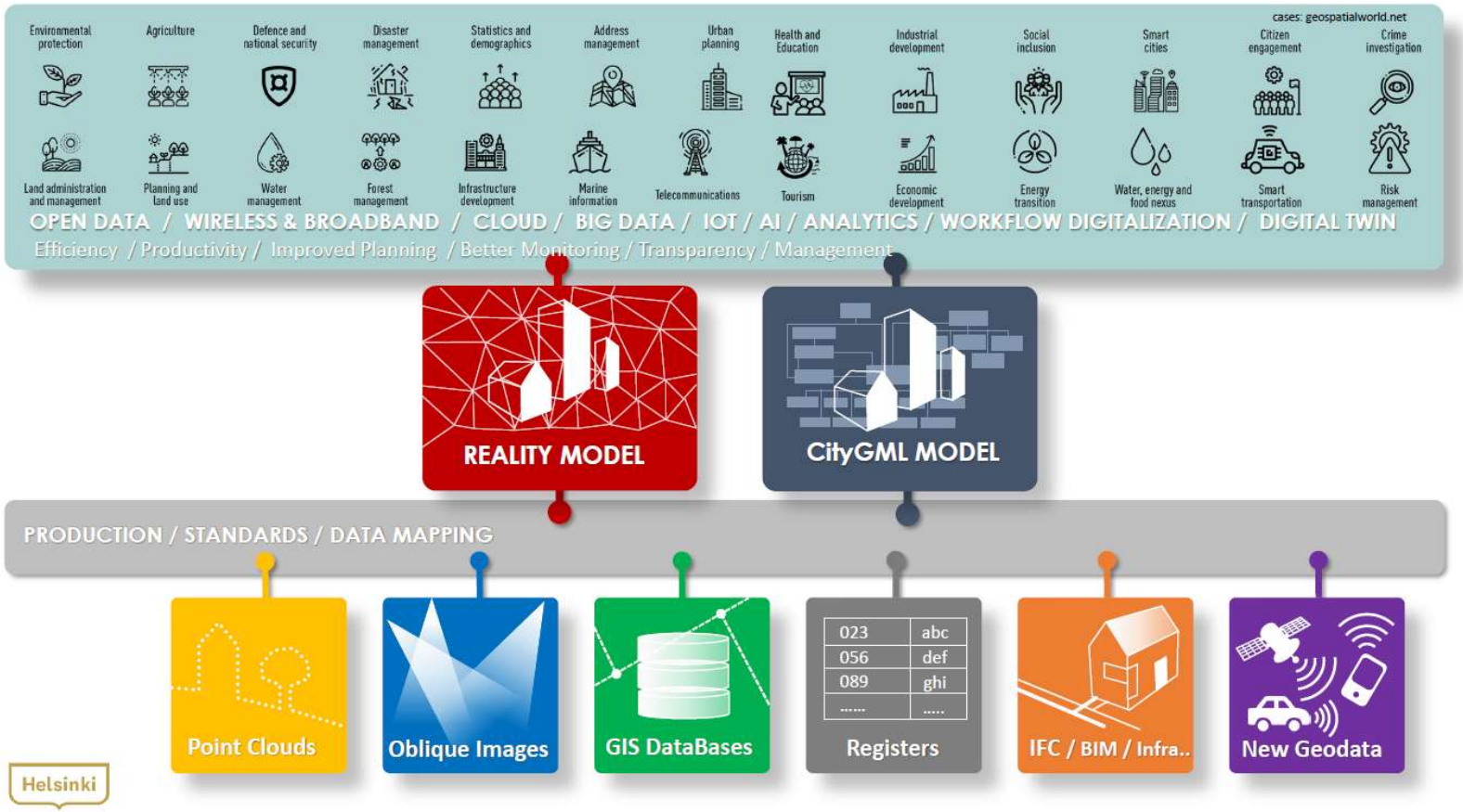
There are two next generation 3D city models of Helsinki available: a semantic City Information Model (CityGML) and a visually high-quality Reality Mesh Model. The models are available as open data (covering the whole city area 500 km2). The use of models is licensed under CC BY 4.0

- The city information model allows users to perform a variety of analyses focusing on energy consumption, greenhouse gases or the environmental impacts of traffic, for example.
- The reality mesh model can be used in various online services or as the basis for all types of design projects, such as planning the exit routes and the locations of performance stages and sales stalls for city events.

At this point, the City of Helsinki sees useful to maintain models of two different technologies as they cater to different use cases. These two Open City models are seen as part of the city´s digital infrastructure; the city of Helsinki shared these two models as open data 3½ years ago.

Gartner

Helsinki Digital Twin City Models



Gartner

Helsinki Digital Twin City Models

Location Intelligence

AI/machine learning is applied in the semi automated production process of the city models in specific software processing e.g. laser point clouds and semantic building models.
City models are multipurpose platforms catering for hundreds of use cases. Their most important features are: data quality, interoperability (according to international standards), security and openness. They provide thematic representations which support decision making. An example is the Helsinki Energy and Climate Atlas, providing a large amount of building-specific basic information, energy and repair data, as well as data on the consumption of water, district heating and electricity.
Another example is the Solar potential of Helsinki, highlighting how solar engery can be implemented in the city.

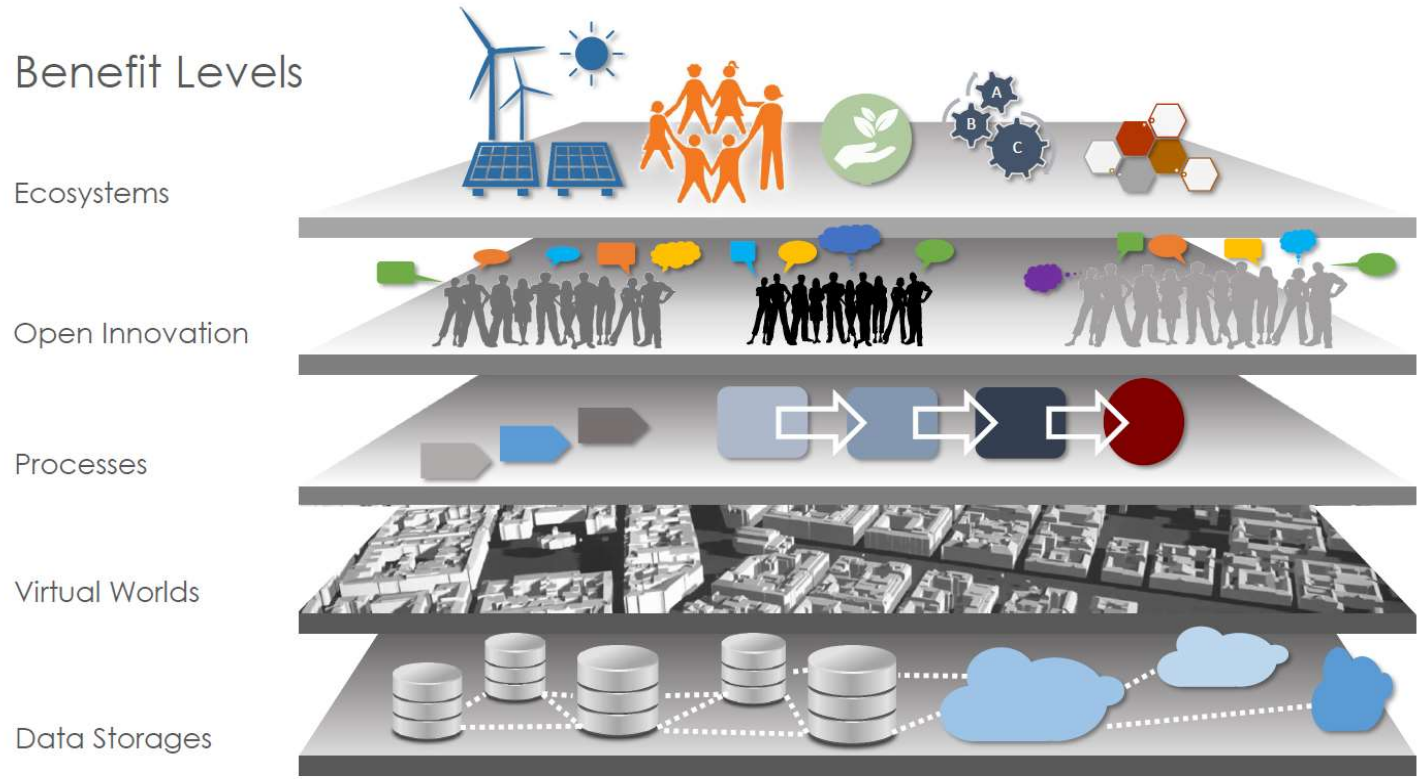
Data Sources

The data owned and collected by the city is used for modelling and analysis. It includes:

- ❑ Point Cloud data, used for creating terrain and surface (e.g. from buildings) models
- ❑ Oblique Images, used for creating textures for the CityGML-model (terrain, buildings) and processing the mesh model
- ❑ GIS Databases and Registers maintained by City Of Helsinki – building register with basic information and renovation data, energy consumption data buildings owned by the City, the Tree register, Maps etc.
- ❑ Data models of buildings IFC/BIM and infrastructure models InfraBIM, InfraGML, InfraModel etc.The city´s goal is to collect all IFC/BIM models during the building permit process.
- ❑ New Geodata from sensors, smartphones, cars, satellites, things (IOT): these new data sources offer excellent data to supplement city models, which can in the future be “real time”. The collection of IOT/sensor data close is in progress and soon implemented .

Gartner

Helsinki Digital Twin City Models



© Hyyppä, Ahlavuo, Miikki, Virtanen, Markkula, Suomisto

Gartner

Helsinki Digital Twin City Models

Success factors

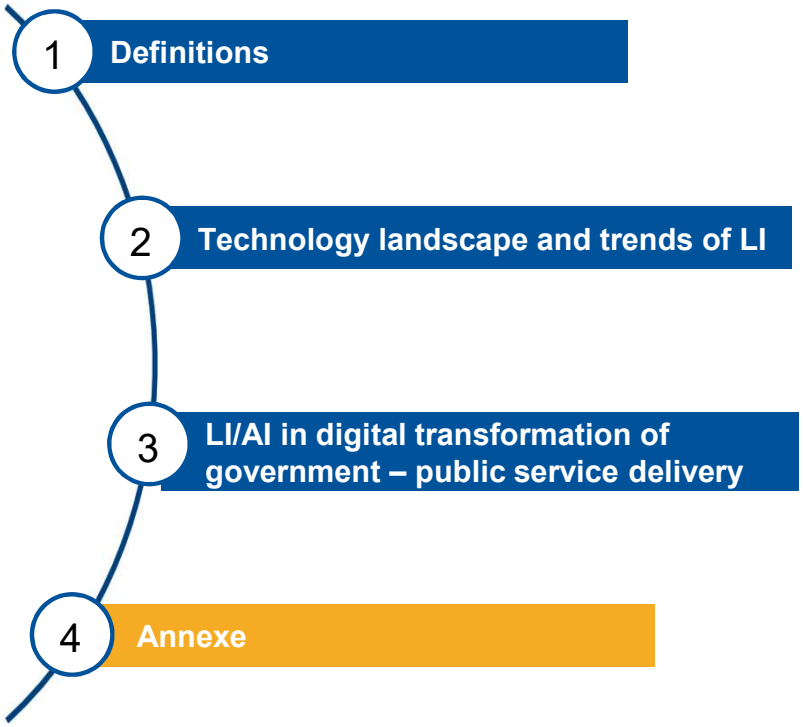
As illustrated in the previous slide, success factors stem from the benefits of a digital platform produced by combining data storages and virtual worlds. Adding processes and services – producing a digital twin – yields benefits linked to urban development modelling: efficiency, productivity, improved planning, better monitoring, transparency and management. An example is the advanced wind analysis which simulates win patterns and new buildings. In addition, open innovation is enabled by open reliable data and web delivery services provided by the City.The models and data are reused by third parties, examples include media using open data for illustrating their narrative. Supporting ecosystems and strategic goals such as Carbon neutral Helsinki by 2035 is the most important and constantly evolving Helsinki Energy and Climate Atlas was created to support this goal.

Challenges

- Data quality is essential and Helsinki faces many challenges related to this. During the mapping of existing data from the registers onto the models, errors are discovered and full correction takes years.
- International standards are developed but there are many issues linked to semantic interoperability between different models, and it will take years to acheive full interoperability. As environmental and urban challenges are huge and globally common, cooperation – as the city has done when developing the models - and open sharing are key factors to achieving success.
- The lack of human resources is a bottleneck; companies and cities are competing for the same expertise and education in these specific domains is not sufficient.
- The issue of maintaining the model and data quality needed to be solved. Trained city civil servants did the work as they processed building permits process.

Gartner

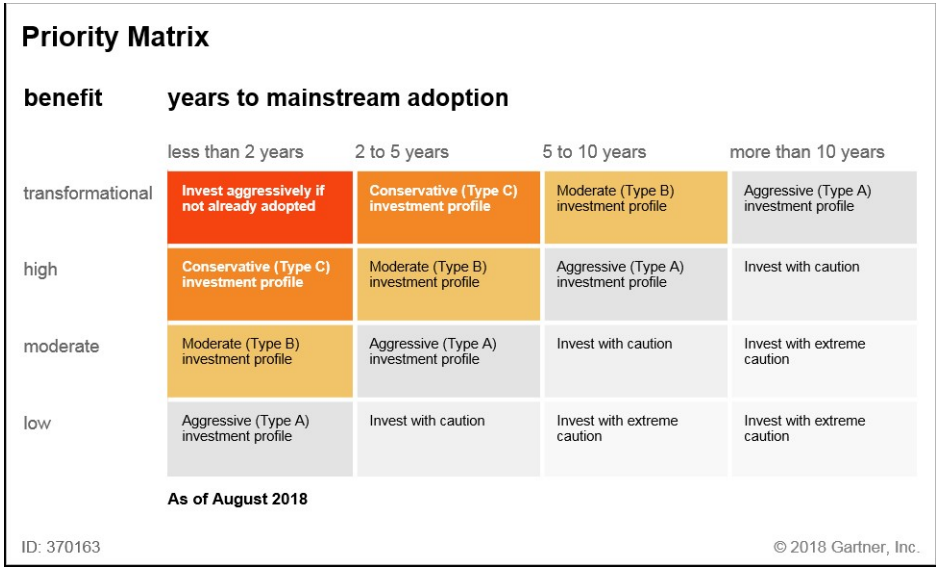
Table of contents



Gartner

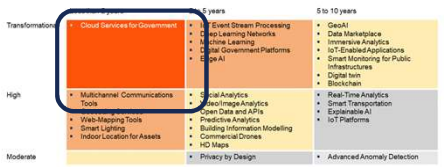
Priority Matrix explained

High-priority investments are in the top left of the Priority Matrix, where the innovations will potentially have a high impact and have reached a reasonable level of maturity.
Companies that are conservative in their technology adoption (Type C organizations) may limit their focus to this area.
Companies that are more aggressive technology adopters (Type A and Type B organizations) are likely already using innovations that will mature in less than two years. Therefore, they will probably want to evaluate innovation profiles further to the right or lower on the Priority Matrix — for example, innovations that will not be in widespread use for at least five years, but that may provide a competitive edge in the interim.



	Gartner benefit ratings
Transformational:	Enables new ways of doing business within and across industries that will result in major shifts in industry dynamics
High:	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an organization
Moderate:	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an organization
Low:	Slightly improves processes (for example, improved user experience), but will be difficult to translate into increased revenue or cost savings

Less than 2 years and Transformational



Item	Rational
Cloud services for government	Cloud computing is a style in which scalable, metered and elastic IT-enabled capabilities are provided as services using internet technologies. As business benefits of cloud have become apparent, government CIOs are shifting their stance from "cloud-first" to "cloud-only.“ The use of cloud technology is an enabler for implementing Location Intelligence.

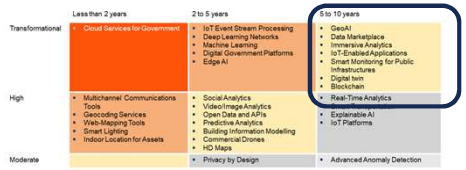
Gartner

2 to 5 years and Transformational

Item	Rational
IoT Event Stream Processing	Event stream processing (ESP) is computing that is performed on event objects for the purpose of stream data integration or stream analytics. ESP is one of the key enablers of continuous intelligence and other aspects of digital business.
Digital Government Technology Platforms	Digital government technology platforms (DGTPs) are a set of cross-cutting, integrated, horizontal capabilities that coordinate government services across multiple domains such as citizen experience, ecosystem, Internet of Things, IT systems and analytics.
Deep Learning Networks	Deep neural networks (DNNs) are large-scale neural networks, often with many processing layers. They underpin most recent advances in artificial intelligence (AI) by enabling computers to process much better complex data, such as video, image, speech and textual data.
Edge AI	Edge AI refers to the use of AI techniques embedded in IoT endpoints, gateways and edge devices, in applications ranging from autonomous vehicles to streaming analytics. The applications that are starting to see increasing adoption of edge AI include those that are latency sensitive (e.g., autonomous navigation), network availability (e.g., remote monitoring), and data intensive (e.g., video analytics).
Machine Learning	Machine learning is an AI discipline that solves business problems by utilising mathematical models to extract knowledge and pattern from data.

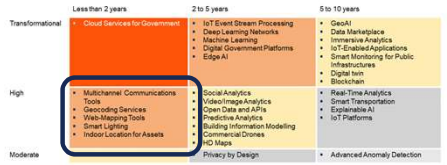
Gartner

5 to 10 years and Transformational



Item	Rational
GeoAI	GeoAI is the use of machine learning and deep learning techniques with spatial data.
Data Marketplace	Data marketplaces are interactive exchange platforms where ecosystems exchange data based on perceived value and context through an orchestrated marketplace.
Immersive Analytics	Immersive analytics applies augmented reality (AR), mixed reality (MR) and virtual reality (VR) technologies to the fields of analytics and data visualization.
Smart Monitoring for Public Infrastructures	Smart monitoring for public infrastructures refers to a solution that utilizes Internet of Things (IoT) technologies (including sensor devices and cloud-based big data analytics systems) to improve both the quality and timeliness of monitoring the integrity of public infrastructures.
Digital twin	A digital twin of government is a virtual representation of government and partner assets, people and operations to provide real-time analysis capabilities, operations automation and scenario-based planning. Many start as 4D GIS solutions; however, to reach full potential, they will need to mature to include command-and-control capabilities and leverage AI to enable scenario planning at scale.
IoT-Enabled Applications	An IoT-enabled business application is natively designed for or has been modernized to directly support IoT, such that it is integrated with IoT edge devices and platforms and it ingests and analyzes IoT data and events to produce a finding and to orchestrate a business response.
Blockchain	Each immutable record contains a time stamp and reference links to previous transactions that allow anyone with access rights to trace a transactional event at any point in its history.

Less than 2 years and High



Item	Rational
Web-Mapping Tools	Location can be a critical factor in decision making for governments, so presenting analysis as a map is often an effective tool for conveying information.
Geocoding Services	The Geocoding API is a service that provides geocoding and reverse geocoding of addresses. Geocoding is the process of converting addresses (like a street address) into geographic coordinates (like latitude and longitude), which you can use to place markers on a map, or position the map.
Indoor Location	Indoor positioning for assets provides information about the physical, interior location of fixed or mobile devices, wearables or other objects.
Smart Lighting	Smart lighting is a lighting system that is connected to a network and can be both monitored and controlled from a centralized system or via the cloud. Advanced smart lighting systems include controls, connectivity, analytics and intelligence, and usually exploit LED technology for efficiency.

Gartner

2 to 5 years and High

Item	Rational
Social Analytics	Social analytics applications assist organizations in the process of collecting, measuring, analyzing and interpreting the results of interactions and associations among people, topics, ideas and other content types on social media.
Video/Image Analytics	Video/Image analytics (or video content analytics) is the application of data science methods to automatically identify significant information contained in images and image streams.
Predictive Analytics	Predictive analytics is a form of advanced analytics that examines data or content to answer the question, "What is going to happen?" or more precisely, "What is likely to happen?" It is characterized by techniques such as regression analysis, pattern matching or predictive modeling.
Open data and APIs	Open data is the data that is made freely available for others to use, combine and redistribute. APIs in platforms enable the sharing and reuse of data.
Building Information Modelling	Building Information Modeling (BIM) is the process of managing data and information about facilities and physical infrastructure using an agreed-upon digitally enabled shared knowledge resource.
Commercial Drones	Commercial unmanned aerial vehicles (UAVs, also known as drones) are small helicopters, fixed-wing airplanes, multirotors and hybrid aircrafts that have no human pilot on board.
3D/4D Maps	3D maps can illustrate the impact of development on such quality-of-life features as views and shadows. 4D maps can also present users information about past and future state views of an area and the impact of the planned infrastructure changes on public safety or transportation .

5 to 10 years and High

Item	Rational
Real-Time Analytics	Real-time analytics is the discipline that applies logic and mathematics to data to provide insights for making better decisions quickly. For some use cases, "real-time" refers to near-real-time decisions in which the analytics are completed within a few seconds or minutes after the arrival of new data.
Smart Transportation	Smart transportation is a framework describing the movement of people and assets by modes that include vehicles, planes, trains, ships and bikes. It leverages information and environmental data to move passengers or assets.
IoT Platforms	An Internet of Things (IoT) platform is a software that enables development, deployment and management of solutions that connect to and capture data from IoT endpoints to drive improved business decisions.
Explainable AI	a set of capabilities that describes a model, highlights its strengths and weaknesses, predicts its likely behavior, and identifies any potential biases.

Gartner

2 to 5 years and Moderate

Item	Rational
Privacy by design	Privacy by Design (PbD) is a set of universal privacy principles, mandatory in certain jurisdictions including Europe (GDPR) and Canada. PbD is about protecting privacy proactively by embedding it into technology (for example, application or customer interaction design), as well as into procedures and processes (through, for example, privacy impact assessments).

5 to 10 years and Moderate

Item	Rational
Advanced Anomaly Detection	Anomaly (or outlier) detection means identifying objects, groups of objects, events or event patterns that deviate from the expected or norm. Anomaly detection is "advanced" if it leverages sophisticated mathematical techniques — machine learning or other advanced analytics — to precisely detect more-subtle anomalies, provide earlier notice of likely future anomalies, or streamline the design and development of systems that detect anomalies.

Gartner

Contacts

Client

Francesco Pignatelli
ELISE programme manager
Joint Research Center
Phone: +393481411417
francesco.pignatelli@ec.europa.eu

Gartner

Clementine Valayer
Engagement Manager
Associate Director
Gartner Consulting
Phone: +32 471 80 78 41
Clementine.Valayer@@gartner.com

Gartner

Guido Van Der Harst
Senior Managing Partner
Gartner Consulting
Phone: +31203144162
Guido.VanDerHarst@gartner.com

