Location interoperability, innovation and digital transformation

Lessons learned from ELISE Action webinar series and knowledge transfer activities

George O'Neill

Lea Ytrehus

Danny Vandenbroucke

Glenn Vancauwenberghe

Lorena Hernández Quirós (Editor)

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Contact information
Name: Lorena Hernández Quirós
Address: Via E. Fermi 2749, TP263, I-21027 Ispra (VA), Italy
Email: lorena.hernandez@ec.europa.eu
Tel.: +39 003278 6653

Name: Francesco Pignatelli
Address: Via E. Fermi 2749, TP263, I-21027 Ispra (VA), Italy
Email: francesco.pignatelli@ec.europa.eu
Tel.: +39 0332 786319

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Abstract

The Joint Research Centre (JRC) organised as part of the ELISE (***E****uropean* ***L****ocation* ***I****nteroperability* ***S****olutions for* ***e****-Government*) Action's knowledge transfer activities, a series of webinars on location interoperability, innovation and digital transformation.

The ten webinars making up the series explored various emerging technologies and trends, their interaction with location data and implications for digital public services.

The following document summarises the presentations and discussions during each webinar and some overall conclusions on the technologies explored.

Keywords

ELISE Action, ISA^2, knowledge transfer, webinar, location interoperability, digital transformation, digital public services, location intelligence, digital twins, geospatial, smart cities, location-enabled public services, geodata marketplaces, blockchain, modelling, simulation, augmented reality, virtual reality.

Executive summary

As part of the ELISE (**E**uropean **L**ocation **I**nteroperability **S**olutions for **e**-Government) Action run by the JRC (Joint Research Centre), a **series of webinars** were delivered to **explore the impact of new and emerging trends on location interoperability, innovation and digital transformation**. These webinars form part of the knowledge transfer activities under the ISA^2 ELISE action. These knowledge transfer activities aim to build the knowledge of relevant stakeholders on relevant topics and help develop a collaborative community in which innovation and co-creation can emerge.

The webinars present new topics and trends concerning the location domain and provide information on state-of-the-art solutions and technologies that support innovation and digital transformation. In total, ten webinars were delivered between April 2020 and April 2021, covering the following topics:

- ***Location Intelligence and Partnerships to support the Sustainable Development Goals (SDGs)*** - Providing insights into the state of play on the role of geospatial and location intelligence in achieving the SDGs and examined how ecosystems and partnerships can fill the data gap.
- ***Digital Twins – are they ready to embrace the benefits of Location Information?*** - Exploring the importance of "geospatial" and "interoperability" in creating and managing digital twins.
- ***Geospatial Data and Artificial Intelligence – a deep dive into GeoAI*** - Exploring key advancements within Artificial Intelligence technologies and demonstrating their current application and relevance in various public policy areas.
- ***Location Intelligence for cities and regions: preparing the ground for smart places of the future*** – Presenting the state of the art and future perspectives on the use of location data and technologies by local and regional governments.
- ***Monitoring and understanding emerging geospatial technologies*** - Presenting the importance of systematic monitoring and understanding of emerging geospatial technologies.
- ***Location-enabled public services*** – Presenting the growing momentum of location-enabled public services by exploring opportunities and challenges for public services.
- ***Geodata marketplaces supporting location intelligence*** - Exploring the concept of geodata marketplaces and provided insights to the current state of play of such marketplaces and some concrete examples of state of the art solutions.
- ***Blockchain and the proof of location supporting digital government*** – Investigating the role of blockchain and “proof of location” in supporting digital government and location-enabled public services. The webinar mainly looked at the use of blockchain to support proof of location and the use of location data for other blockchain-enabled applications and services.
- ***Geospatially enabled modelling, simulation and prediction*** - Presenting past and new developments in modelling, simulation and prediction in the geospatial field.
- ***Immersive realities and location for better public services*** – Exploring the role of virtual, augmented, mixed and extended realities in supporting and enhancing location-enabled public services.

The webinars have **raised awareness of various emerging technologies, techniques and approaches** that leverage location data. A common challenge across several of these topics is the need for **multidisciplinary expertise** and collaboration. Many of the new technologies and approaches explored - for example, immersive technologies, modelling, and simulation - require expertise from multiple sectors and organisations. Another common challenge is to **focus standardisation efforts**, with collaboration between different standardisation organisations ensuring the new technological approaches developed are interoperable. Despite these challenges, the technologies, techniques and approaches highlighted have a high potential to contribute to new or enhanced digital public services.

The webinars covered various topics and introduced ELISE Action stakeholders to emerging topics in the geospatial domain. They have contributed to the knowledge transfer objectives of the ELISE Action, educating its stakeholders of developments in many relevant technological fields and helping to build an informed community. **Webinars are a successful format that should be continued**. Future webinars could cover topics related to APIs, cloud, fog and edge computing, the internet of things, and autonomous things.

The following recommendations should be taken into account for the organisation of future webinars under the ELISE Action or its successors.

Box 1: Recommendations for future webinars

- Maintain webinar length at one hour maximum;
- Invite guest speakers. Ideally, these speakers should have practical experience in the topic being discussed;
- Make use of polling and to increase participant engagement;
- Ensure the webinar runs as scheduled to allow sufficient time for a concluding Questions and Answers session;
- Schedule the webinars at regular intervals (e.g. once a month on the same day and time). Share the topics of the webinars in advance as feasible (e.g. the topics for the upcoming three webinars);
- Collect information on participants, including whether they primarily work inside or outside the geospatial domain.

1 Introduction

1.1 The ELISE Action and Knowledge Transfer

ELISE (**E**uropean **L**ocation **I**nteroperability **S**olutions for **e**-Government) is one of the actions of the European Interoperability Programme ISA[2]. It aims to promote location interoperability across sectors and borders. Interoperability "*allows administrative entities to electronically exchange meaningful information in ways that are understood by all parties*" [1]. It is essential to the uptake of innovative approaches and technologies to create location-enabled public services.

The ELISE Action is run by the Joint Research Centre (JRC), the European Commission's science and knowledge service. The JRC conducts research and provides independent support to help tackle the big challenges facing the European Union today. The ELISE Action focuses on four specific objective areas:

Policy support | **Emerging trends and technologies** | **Interoperable frameworks and solutions** | **Building a knowledge base**

The ELISE Action produces and delivers publications, events, ready-to-use tools and other outputs to foster location interoperability that are made available in the **European Commission's collaborative platform "Joinup"** within the ELISE's collection[2].

Figure 1: ELISE collection in Joinup platform

[1] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/glossary/term/interoperability
[2] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/about

To stimulate the importance and awareness of **location interoperability** the **engagement with the stakeholders is crucial**; for this reason, **Knowledge Transfer activities are** key to the ELISE Action[3].

Knowledge transfer is the process of disseminating knowledge from one individual, team, or organisation to another to, for example, solve problems, foster innovation, or increase efficiency.

The ELISE action has its own knowledge transfer lifecycle which encompasses the creation and exploitation of knowledge in a continuum.

ELISE produces and delivers outputs, such as publications, events or tools that contribute to achieving the desired outcome, for example, raising awareness on the benefits of applying location interoperability practices.

Outcomes and impacts are difficult to measure as they rely, to a great extent, on the perception of the stakeholders.

For this reason, it is so important to nurture the ELISE action stakeholder community to understand and meet their real needs. Only this way can outcomes be achieved, and societal impacts can happen.

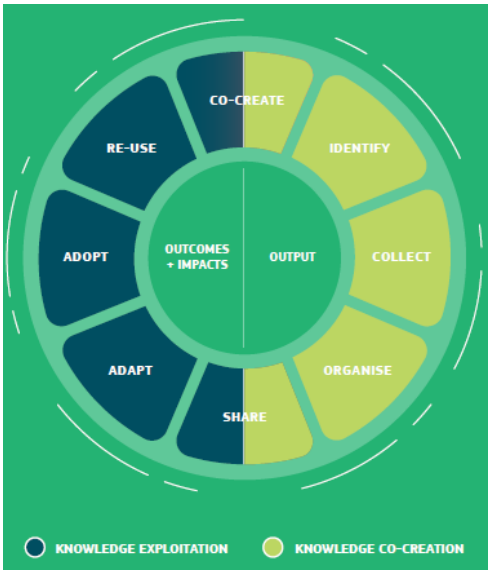


Figure 2: ELISE Action Knowledge Transfer lifecycle

The ELISE knowledge transfer activities focus on:

- Establishing a mutually beneficial collaborative community with its stakeholders;
- Creating an interactive environment enabling co-creation and open innovation to emerge;
- Turning outputs into actionable knowledge;

In line with these aims, a **series of webinars[4] were delivered between April 2020 and April 2021**.

The purpose of the webinars has been to analyse new topics and trends concerning the location domain and provide information on state-of-the-art solutions and technologies that support innovation and digital transformation.

The webinars were open to the general public and were attended by various stakeholders (see the "measured impact" section for each webinar).

1.2 Purpose and structure of this document

The purpose of this document is to provide a summary of the webinars conducted under the "*ELISE Knowledge Transfer: Digital Transformation and the Future of SDI*" contract.

The document is structured according to the following sections:

- Introduction - providing the context and purpose of the document (section 1);
- Overview of webinars (section 2);
- Reporting on webinars (section 3);
- Conclusions (section 4).

[3] Specifically through the contract "*ELISE Knowledge Transfer: Digital Transformation and the Future of SDI*" under the Framework Contract DI/07624 - ABC IV Lot 3

4 https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/elise-webinars-series

2 Overview of Webinars

Ten webinars were carried out in total between **April 2020 and April 2021.** They are grouped according to three general categories: **data exchange** (2 webinars), **technology** (6 webinars) and **public services** (2 webinars).

In total, **490 stakeholders** between attendees and guest speakers joined the live webinars. For those webinars for which an audience segmentation is available, national public administrations were the most represented stakeholder group (30%), followed by Academia/Research (15%), European Public Administration (14%), Private sector – SME (12%), Regional/Local Public Administration (11%), Other (10%) and Large enterprise (8%).

The table below provides an overview of the webinars carried out throughout the contract.

Table 1: Overview of Webinars

Webinar #	Title	Category	Date	Attendees	Segmentation	Short Description
1	Location Intelligence and Partnerships to support the SDGs	Data exchange	30/04/20	66	Not available	The webinar provided insights into the state of play on the role of geospatial and location intelligence in achieving the SDGs and examined how ecosystems and partnerships can fill the data gap.
2	Digital Twins – are they ready to embrace the benefits of Location Information?	Technology	22/06/20	54	— Academia/Research: 27% — Private Sector – SME: 20% — European Public Administration: 17% — National Public Administration: 13% — Regional/Local Public Administration: 10% — Private Sector – Large enterprise: 3% — Other: 10%	This webinar aimed to explore the importance of "geospatial" and "interoperability" in creating and managing digital twins.
3	Geospatial Data and Artificial Intelligence – a deep dive into GeoAI	Technology	09/07/20	80	— Academia/Research: 23% — National public administration: 20%	The webinar on GeoAI explored key advancements within AI technologies and demonstrated their current application and relevance in various public policy areas.

Webinar #	Title	Category	Date	Attendees	Segmentation	Short Description
					— Regional/Local Public Administration: 15% — Private sector – large enterprises: 13% — Private sector – SME: 12% — European Public Administration: 10% — Other: 5% — 4Private individual: 1%	
4	Location Intelligence for cities and regions: preparing the ground for smart places of the future	Public services	03/09/2020	57	— Private sector – large enterprises: 28% — National public administration: 24% — Academia/Research: 17% — European Public Administration: 17% — Regional/Local Public Administration: 7% — Private sector – SME: 7%	This webinar presented state of the art and future perspectives on the use of location data and technologies by local and regional governments.
5	Monitoring and understanding emerging geospatial technologies	Technology	24/09/20	35	Not available	The webinar showed the importance of systematic monitoring and understanding emerging geospatial technologies. Guest Speaker Gobe Hobona from the Open Geospatial Consortium (OGC) explained how the TechTrends works, while Danny Vandenbroucke discussed the major drivers and trends, gave some examples and interoperability challenges.

Webinar #	Title	Category	Date	Attendees	Segmentation	Short Description
6	Location-enabled public services	Public services	05/11/20	41	Not available	The webinar demonstrated the growing momentum of location-enabled public services by exploring opportunities (data availability, volunteered information and improved processes) and challenges (data maturity, interoperability and others) for public services.
7	Geodata marketplaces supporting location intelligence	Data exchange	14/01/21	40	— Private sector - large enterprise: 4% — Private sector – SME: 16% — National public administration: 48% — Regional/local public administration: 20% — EU public administration: 4% — Consultant – freelancer: 8%	The webinar explored the concept of geodata marketplaces and provided insights into the current state of play of such marketplaces and some concrete examples of state of the art solutions.
8	Blockchain and the proof of location supporting digital government	Technology	18/02/21	54	— Academia/Research: 12% — Citizen/private person: 12% — Regional/local public administration: 4% — Small and medium enterprise: 12% — Large enterprise: 4% — National public administration: 24% — EU public administration: 16% — NGO/CSO: 4% — Other: 12%	This webinar looked into the concept of blockchain and proof of location as supporting digital government and location-enabled public services by looking at two roles of blockchain in the location domain; proof of location and the use of location data for other blockchain-enabled applications and services.

Webinar #	Title	Category	Date	Attendees	Segmentation	Short Description
9	Geospatially enabled modelling, simulation and prediction	Technology	21/01/2021	34	Not available	The webinar presented past and new developments in modelling, simulation and prediction in the geospatial field. It zoomed in on two detailed examples: 1) the use of prediction methods for weather forecasting with Guest Speaker John Little from the UK Met Office and 2) the use of Agent-Based Modelling in the transportation sector. The webinar also touched upon the interoperability challenges
10	Immersive realities and location for better public services	Technology	15/04/2021	29	— European Public Administration: 20% — National Public Administration: 53% — Regional/Local Public Administration: 7% — NGO: 7% — Private Sector – SME: 7% — Academia/Research: 7%	Exploring the role of virtual, augmented, mixed and extended realities in supporting and enhancing location-enabled public services
n/a	Average/summary	— Public services: 2 — Technology: 6 — Data exchange: 2	n/a	49	— Academia/Research: 15% — European Public Administration: 14% — Private sector – SME: 12% — Large enterprise : 8% — National Public Administration 30%	n/a

Webinar #	Title	Category	Date	Attendees	Segmentation	Short Description
					— Regional/Local Public Administration 11% — Other 10%	

3 Reporting on Webinars

This section provides a short report on each webinar carried out between **April 2020 and April 2021**.

Each report consists of the following elements:

- Webinar details, including title, date of the webinar, and a link to publicly available supporting materials;
- A summary of the topic covered, which describe the agenda and case studies examined as part of the webinar;
- A summary of the Question and Answers session (Q&A) and discussions, when such data is available;
- An overview of impact, based on registrations, actual attendees and segmentation according to the attendees' email domains and responses to polls (if any);
- A conclusion drawing links between the exposed topic and the ELISE central topics: location interoperability, digital transformation and innovation.

Webinar #1. Location Intelligence and Partnerships to support the Sustainable Development Goals

Webinar details

Title	Location Intelligence and Partnerships to support the Sustainable Development Goals	
Speakers	Martina Barbero and Lea Ytrehus (Deloitte Belgium)	
Event announcement		https://joinup.ec.europa.eu/node/702594
Supporting materials	Slides	https://joinup.ec.europa.eu/node/702747
	Video	https://www.youtube.com/watch?v=Vc00ZRM0chE
Date of the webinar	30/04/20	
Keywords	Location interoperability, location intelligence, SDGs, ecosystems, partnerships	

Summary of the topic

The webinar on Location Intelligence and Partnerships to support the Sustainable Development Goals (SDGs) provided insights into the state of play on the role of geospatial and **location intelligence** in achieving the SDGs and examined how **ecosystems** and **partnerships** can fill the data gap. This webinar aimed at explaining the links between location intelligence, ecosystems and SDG 17 on partnerships and how these elements brought together can unlock the potential of geospatial data in sustainable development.

Figure 3: Sustainable Development Goals

Source: UN

The webinar was structured in six sections:

First, the section "*Context and definitions: what is the link between geospatial and the SDGs*?" provided context on the SDGs, their relation to geospatial, terms and definitions and key international efforts for global geospatial management.

Secondly, the section "*Partnerships and data ecosystems as enablers for sustainable development*" gave the audience insights into the essence of SDG17[5] and the data ecosystem that drives development in this field. The following case studies were highlighted:

- Monitoring and reporting aided by geospatial in Ireland: Ireland Sustainable Development Hub (Ordnance Survey Ireland, the Central Statistics Office and Esri Ireland)[6].
- Humanitarian assistance and monitoring powered by geospatial: HungerMap LIVE (World Food Program and Alibaba Cloud).[7]
- Involving citizens for addressing sustainable development: The Atlantic Water Network of open water sources in Canada.[8]

The **third section, "*Partnering on solutions: applying location intelligence for development*",** defined location intelligence as *"more than analysis of geospatial information or geographic information systems alone, it is the capability to visualise spatial data to identify and analyse relationships*."[9] Moreover, the section described what is required by stakeholders to unlock its potential for the SDGs (**collect, connect, protect**.) Lastly, the following case studies were showcased:

- Location intelligence for development: responses to Covid-19, highlighting the Covid-19 Mobility Monitoring Project[10], the Social Distancing Scoreboard[11] and ShopSafe.[12]
- Location intelligence for development: AI detected fields and crops (OneSoil)[13]
- Non-profit initiatives powered by geospatial information (Ocean Cleanup)[14]

The fourth section outlined the "*Challenges ahead: institutionalising partnerships and solidifying ecosystems*", highlighting that geospatial multi-stakeholder, technology, and data-centred approaches could help address sustainable development challenges more effectively. However, it remains crucial to continue increasing awareness of key stakeholders about the advantages of sharing data, addressing sustainability and institutionalisation of partnerships and ecosystems, ensuring flexibility and customisation in the data governance and ecosystem approaches, and continuing efforts for increased capacity building.

The key take-away messages and conclusions were the following:

- New trends around geospatial (use of EO, Big Data and AI) can strengthen its role in SDG beyond monitoring and statistical purposes.
- Data ecosystems and location intelligence are relevant. While much literature on SDGs already focuses on data ecosystems, location intelligence in practice is still less explored.
- A definition of location intelligence should be commonly understood.

Lastly, the JRC highlighted the ELISE contribution to SDGs. In general terms, it was stated that the ELISE contribution to the SDGs is mainly through the development of frameworks and tools that promote the interoperability and efficiency of location data sharing among organizations. In this context, the ELISE Energy and Location Applications[15] activity was highlighted as particularly relevant. Its overall aims are: to use location-based data to support stakeholders involved in energy policies' lifecycle and, to leverage location-based data at the building level to scale up the methodologies to assess energy consumption and performance as required

[5] https://sustainabledevelopment.un.org/sdg17
[6] https://irelandsdg.geohive.ie/
[7] https://hungermap.wfp.org/
[8] https://atlwaternetwork.ca/
[9] Del Carmen A., "What is Location Intelligence." (2016) Available at: https://carto.com/blog/what-is-location-intelligence-and-its-benefits/
[10] https://covid19mm.github.io/
[11] https://www.unacast.com/covid19/social-distancing-scoreboard
[12] https://play.google.com/store/apps/details?id=com.endare.supermeter&hl=en
[13] https://map.onesoil.ai/2018#2/44.35/-43.66
[14] https://theoceancleanup.com/
[15] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/energy-location-applications

by the European Directives in energy efficiency. This is done by adopting common structured data models and data access mechanisms, and using and reusing datasets and IT infrastructures for reporting, monitoring, and planning.

Summary of Q&A discussion

Not available.

Measured impact

Registrations	79
Attendees	66
Segmentation[16] (more frequent email address domains)	— Gmail: 13 attendees — ec.europa.eu: 6 attendees — bkg.bund.de: 4 attendees
Polling insights	N/A

Conclusions

The webinar concluded by emphasising the need for functioning data ecosystems and further research on the field of location intelligence.

Well-functioning partnerships and ecosystems are a key pillar to achieve the SDGs on location interoperability. Geospatial data and location intelligence, supported by ecosystems and partnerships, play an essential role since they can provide regular, consistent and objective information and real-time monitoring and basis for decision-making. Interoperability is of the essence to ensure internal working and external transferability. The webinar discussed the UNGGIM call for action (2019)[17] and its focus on standards, quality and accessibility as fundamental prerequisites for interoperability.

ELISE promotes the digital transformation of Government by leveraging geospatial data, spatial technology and spatial skills. In line with this, the webinar showcased many public sector case studies to showcase the value of geospatial data, spatial technology and skills to provide value to our society and achieve the SDGs. For example, the Atlantic Water Network case study[18] demonstrated how to engage citizens to participate in data collection activities to strengthen their geospatial databases. The Irish government also uses geospatial story maps to track and monitor their progress on the SDGs through Ireland Sustainable Development Hub.[19]

Overall, **the webinar promoted innovation in the fields mentioned above by exploring the state of the art** literature, looking forward and showcasing real examples of how innovative approaches to data ecosystems and location intelligence are used to monitor, track, and implement initiatives related to the SDGs.

[16] The numbers in this "segmentation" section do not sum to the total number of the attendees, but rather the majority groups of attendees. The remaining numbers were spread across a range of domains..
[17] UNGGIM, "A call for political action in Europe." (2019)
[18] https://atlwaternetwork.ca/
[19] https://irelandsdg.geohive.ie/

Webinar #2. Digital Twins - Are they ready to embrace the benefits of Location Information?

Webinar details

Title	Digital Twins – are they ready to embrace the benefits of Location Information?	
Speakers	Glenn Vancauwenberghe, Danny Vandenbroucke (SADL/KU Leuven)	
Event announcement		https://joinup.ec.europa.eu/node/702838
Supporting materials	Slides	https://joinup.ec.europa.eu/node/702879
	Video	https://www.youtube.com/watch?v=WmBaRjT6XcE
Date of the webinar	22/06/20	
Keywords	Digital twins, applications, interoperability, geospatial data, digital twin initiatives	

Summary of the topic

The webinar on **digital twins** presented the state of play on developing and deploying digital twins in Europe and how they rely on geospatial data, data infrastructures and technologies. The webinar aimed to increase the participants' understanding of the digital twin concept, introducing digital twin applications at different geographical levels. The webinar highlighted how geospatial data, standards, and technologies are essential for creating and managing digital twins.

The webinar presentation started by discussing the context and **relevant definitions and frameworks on digital twins.** In the policy context, the European Data Strategy[20] underlines the importance of data to implementing digital twins: "*data will fuel the wide implementation of transformative practices such as the use of digital twins*". The academic literature shows a significant increase in the number of publications related to digital twins since 2017. This increase is in line with Gartner's 2018 Hype Cycle for Emerging Technologies[21], where digital twins were at the Peak of Inflated Expectations. Finally, the latest UN-GGIM vision report on Future Trends in geospatial information management named digital twins among the technologies playing a prime role in disrupting the geospatial domain[22].

The visibility of the digital twin notion has increased in recent years. However, **the concept itself is not new**. The core ideas behind digital twins were already introduced in 2002 with the notion of a "*mirrored spaces model*". In this model, the distinction between real space and virtual space is made, with exchanges and flows of data from the real space to the virtual space and a flow of information from the virtual space to the real space. This mirrored spaces model had all the key elements of today's Digital Twins. While the digital twin idea is commonly thought to have been developed in 2002, digital twin technology has been used since the 1960s. NASA used basic twinning ideas for space programming by creating physically duplicated systems at ground level to match the systems in space. Nowadays, **digital twin applications exist in different domains and sectors,** such as manufacturing, industry, space & aerospace, energy, construction, transport, healthcare and sports.

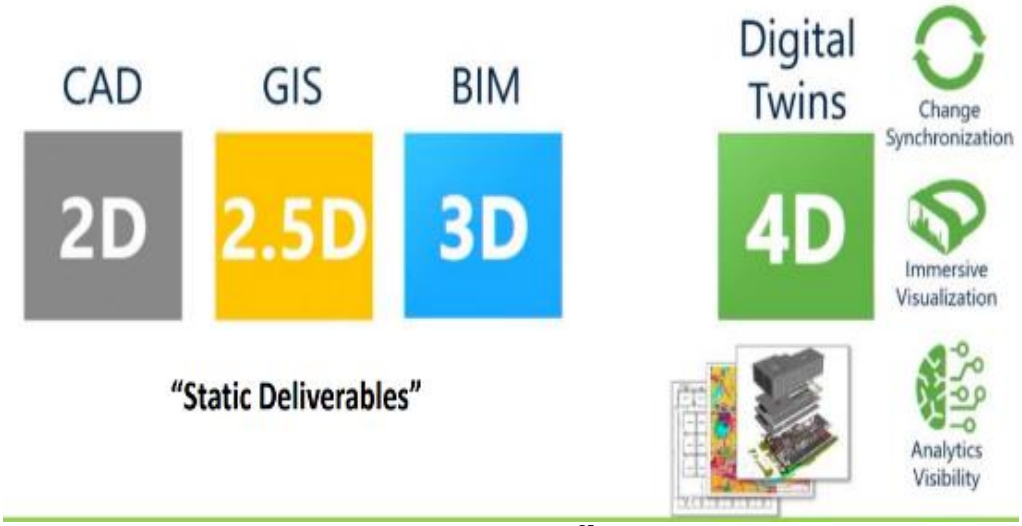
[20] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[21] https://www.gartner.com/smarterwithgartner/5-trends-emerge-in-gartner-hype-cycle-for-emerging-technologies-2018/
[22] https://ggim.un.org/future-trends/

A digital twin can be defined then as an integrated simulation of a real-life system that uses models, sensor information and input data to mirror, predict and control the activities and performance of its corresponding physical twin[23]. Two essential elements stand out:

There is a connection between the physical model and the corresponding virtual model or virtual counterpart, and this connection is established by generating real-time data (e.g. through using sensors).

It is important to note that there are more simple forms of digital twins and more advanced ones. Elements that **differentiate the simple digital twins from the most advanced ones** include the frequency at which the virtual and physical twins are synchronised, the number of parameters, their accuracy and level of abstraction, the autonomy of the system, the intelligence of the system and the ability of the twin to learn from data automatically[24]. Identifying the key elements of digital twins allows understanding what digital twins are and comparing their development level. Figure 4 shows how digital twins fit into the evolution from 2D to 4D, including change synchronization, an immersive visualization and advanced analytics.

Figure 4: Evolution from 2D to Digital Twins



Source: Bentley[25]

The second part of the presentation focused on **digital twins that strongly rely on geospatial data and technologies**, named "*location-enabled digital twins*" in this webinar. Several digital twin applications and initiatives supporting the development of these applications were presented. These included the European Commission plans to develop a digital twin of the Earth and a digital twin of the ocean; national initiatives to build country-wide digital twins[26]; and digital twins of cities, buildings and the underground[27]. Initiatives to develop and use location-enabled digital twins exist at different levels, with different scales and application fields. These **digital twins are used for various purposes, such as running simulations and preparing what-if scenarios**, i.e., investigating the outcomes of changes in particular parameters.

The third part of the webinar presentation addressed the interoperability challenges of digital twins. An overview of **geospatial datasets essential for digital twins** was provided, including geometric and graphical data, geospatial reference data, asset attributes (natural, physical, social, economic), management data and real-

[23] Definition based on: Kraft, E. M. (2016). The air force digital thread/digital twin-life cycle integration and use of computational and experimental knowledge. In *54th AIAA Aerospace Sciences Meeting* (p. 0897).

[24] https://www.arup.com/-/media/arup/files/publications/d/digital-twin-report.pdf and https://www.theiet.org/media/4719/digital-twins-for-the-built-environment.pdf

[25] Bentley, B. (2019). The Year in Infrastructure 2019 Awards. Bentley Systems, Singapore, 2019.

[26] https://www.geonovum.nl/over-geonovum/actueel/geosamen-wijs-met-locatie-werkplaats-digital-twin

[27] https://digitalunderground.sg

time asset performance and utilisation data[28]. Based on the minimum capabilities (connection, visualisation, integration, analysis and security), a digital twin has to provide **several geospatial technologies and developments that are crucial to developing location-enabled digital twins**. Some of these are spatial data infrastructures, sensor web enablement, geo-visualisation, GeoAI and secure access mechanisms. Digital twins also require new ways to handle data as static and dynamic data need to be combined.

Furthermore, 2D, 3D, and 4D data and models are needed. Interactions between different elements are important, and the real world should be modelled and simulated. The latter not only requires a lot of power but also brings many interoperability challenges. In conclusion to this part of the webinar, it was mentioned that **technical, semantic, organisational and legal interoperability remain critical requirements for the successful development of digital twins**. Standardisation bodies in the geospatial domain are aware of these requirements and are already actively working and collaborating on effective ways to address them. Several local and regional governments are also collaborating to prepare solutions for achieving interoperability of data, systems, and services between cities through 'simplified' standards and common building blocks.

In the fourth and final part of the presentation, **key challenges and priorities for the future** were presented. Existing spatial data infrastructures & ecosystems should evolve and be upgraded to enable the creation and use of location-enabled digital twins. As different communities are looking at and/or dealing with digital twin developments, it is essential to bring these communities and involved actors together. The creation and operation of these digital twins also require new skills and competencies, which should be identified first and afterwards introduced in existing or new education and training programs.

Summary of Q&A discussion

During the presentation itself and in the Q&A session afterwards, several participants shared their **views on ongoing digital twin implementations, key challenges and possible next steps.** Among the existing digital twin initiatives mentioned by the participants were R&D initiatives on this topic by the European Space Agency and the national demonstration smart city project by the South Korean Government, which has an important digital twin component.

In the discussions, some key challenges in developing and implementing digital wins were raised:

How to maintain real-time connections? How to deal with conflicting information from sensors? How to demonstrate clear business value for the organizations that must collaborate in the technical implementation of a digital twin? How to correctly model the physical system a Digital Twin is connected to? And how to deal with the many competing standards?

During the Q&A session, two experts in geospatial standardisation gave their view on challenges in implementing digital twins. Bart De Lathouwer, president of the Open Geospatial Consortium (OGC), underlined the **importance of interoperability, as gigantic amounts of data need to be brought together**. In Digital Twins, fast-moving data will be combined with slow-moving data bringing its own particularities. Bart mentioned that in one of the following initiatives of OGC, the Location Powers Summit, the topic of Urban Digital Twins would be central. He also noted that besides many work and discussions on digital twin and related issues within OGC, OGC is also working together with the ISO/IEC JTC1, ISO TC211, SMART, OASC, FIWARE and other relevant actors and bodies.

Peter Parslow, open standards lead at Ordnance Survey and strongly involved in the geostandardisation activities of the International Organization for Standardization (ISO), first explained the work and activities related to Digital Twins under ISO. Peter also briefly discussed the **UK approach on digital twins[29]**, which should be seen as a federal digital twin, setting out key principles and interoperability approaches to manage and set together different digital twins. He also raises the questions of whether – in some cases – standards

[28] https://www.anzlic.gov.au/resources/principles-spatially-enabled-digital-twins-built-and-natural-environment-australia

[29] https://www.cdbb.cam.ac.uk/news/approach-delivery-national-digital-twin-united-kingdom

might hinder the implementation of digital twins, referring to the fact that there might be too many relevant standards.

Andrea Halmos, policy officer at DG CONNECT, addressed the topic from the perspective of the EC, aiming to **help local and regional governments set up digital twins**. Key elements in the EC approach will help create the necessary capacity for these governments and develop building blocks – as part of a modular structure – to help local governments quickly identify interesting use cases and quickly scale up solutions. Andrea also mentioned the work on creating a smart communities data space, which aims to make local data throughout Europe easily discoverable, accessible and re-usable.

Measured impact

Registrations	92
Attendees	57
Segmentation (more frequent email address domains)	— Gmail: 13 attendees — Ec.europe.eu: 7 attendees — ogc.org; deloitte.com; Geospatialmedia.net: 4 attendees
Polling insights	**What is your affiliation? (30 respondents)** — Academia/Research: 27% — Private Sector – SME: 20% — European Public Administration: 17% — National Public Administration: 13% — Regional/Local Public Administration: 10% — Private Sector – Large enterprise: 3% — Other: 10% **Have you attended any of our webinars in the past? (30 respondents)** — No: 63% — Yes: 37% **What is your current level of knowledge on digital twins? (30 respondents)** — Very high: 3% — High: 30% — Medium: 37% — Low: 27%% — Very low: 3% **In your opinion, what are the biggest challenges of Digital twins? (23 respondents)** — Lack of standards/interoperability: 74% — Quality of data: 48% — Lack of data availability: 30% — Lack of funding: 17% — Other: 13% **Are you aware of any other initiative of Digital Twin you would like to share with us? (23 respondents)** — No: 74%

	— Yes: 26% **In your opinion are Digital Twins ready to embrace Location information? (23 respondents)** — Yes: 74% — No: 26% **How would you rate this webinar? (19 respondents)** — Very satisfied: 31,5% — More than satisfied: 31,5% — Satisfied: 37% **What would you like to see next? Select the topics you are more interested in. (19 respondents)** — Smart cities: 63% — Internet of things (IoT): 42% — Digital Platforms, Services and Products in the geospatial domain: 42% — Spatially-enabled Public services: 36% — Citizen generated data and GDPR/Privacy: 26% — Virtual and augmented realities: 26% — Smart contracts & Proof of location: 15,7% — Spatial Literacy for closing the Digital Skills Gap: 11%

Conclusions

The webinar concluded by emphasising the following key messages:

— Geospatial data, tools and technologies should be seen as the fuel for digital twins at different levels and in different domains

— Further investigation and assessment are needed of the current state of geospatial data, standards and technologies relevant to Digital Twins.

— Existing spatial data infrastructures & ecosystems should be further upgraded to enable the creation and use of digital twins

The webinar highlighted **several aspects of digital twins as a driver of innovation and digital transformation.** The idea of using virtual models to optimise products and services and develop new products and services is not new. Compared to these virtual models, digital twins are different in many ways. There is the real-time data connection – in both directions – between the digital twin and the physical world, the increased number of parameters with higher levels of accuracy and abstraction, and very high levels of intelligence and autonomy.

Digital twins create a virtual replica of a physical product or process that can predict when the production or maintenance of this product will fail. An important innovation provided by these digital twins is the advanced simulation capabilities. Highly complex "*what-if*" simulations can be designed, considering real-world conditions and performing vast numbers of simulation processes. Looking at the public sector will **enable new ways of policymaking and public service delivery and transform public administrations' underlying processes and practices**.

The webinar strongly focused on the interoperability challenges and solutions required for making this innovation and transformation possible. **Semantic, technical, organisational and legal interoperability are key requirements for developing individual digital twins and will become even more essential for integrating different digital twins.** Interoperability solutions developed and applied in the geospatial

data domain, such as the standards developed and promoted by the relevant Standards Developing Organisations (SDOs) and used in many Spatial Data Infrastructures, could address these interoperability challenges. However, additional interoperability efforts are required. To illustrate this, the ISO/IEC JTC 1/AG 11 Digital Twin Working group[30] defined a set of tasks to prepare digital twins' standardisation activities better. These include identifying current technologies and reference models deployed in digital Twins, assessing the current state of standardisation activities relevant to digital twins, identifying standardisation issues of Digital Twin to be addressed further, and engagement and collaboration with standards-setting organisations that are involved in digital twins standardisation.

Important to note is that not only the SDOs are looking at and working on the interoperability challenges of digital twins. Various local, regional and national governments are collaborating on solutions to address these interoperability challenges jointly. One solution is the so-called **Minimal Interoperability Mechanisms** (MIMs), which aim to achieve interoperability based on a minimal common ground.

[30] https://www.iec.ch/dyn/www/f?p=103:14:6241977571296::::FSP_ORG_ID,FSP_LANG_ID:25023,25

Webinar #3. Geospatial Data and Artificial Intelligence – a deep dive into GeoAI

Webinar details

Title	Geospatial Data and Artificial Intelligence – a deep dive into GeoAI	
Speakers	Dhananjay Ippharti, Sebastiaan van der Peijl, Lea Ytrehus (Deloitte Belgium)	
Event announcement		https://joinup.ec.europa.eu/node/702854
Supporting materials	Slides	https://joinup.ec.europa.eu/node/702919
	Video	https://www.youtube.com/watch?v=lZa3WHQ0rUU
Date of the webinar	09/07/20	
Keywords	AI, ML, GeoAI, geospatial data, technology	

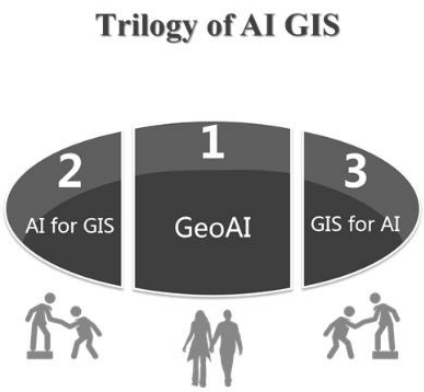
Summary of the topic

The webinar on Geospatial Data and Artificial Intelligence – a deep dive into GeoAI, **explored several key advancements within AI technologies** and aimed to demonstrate their current application and relevance in central public policy areas.

The webinar was structured as described below to give the audience a complete understanding of the context, origin, political and technical environment, and examples of real cases and interoperability challenges.

First, GeoAI was introduced together with some key terms and definitions. According to Gartner, *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*[31]. The increased availability of geospatial data, the advancements of AI, and the availability of massive computing power has resulted in the mounting relevance and potential of GeoAI. The concept was placed in the broader framework of AI-intra relationships as a sub-discipline of AI that uses machine learning to extract knowledge from spatial data.[32]

Figure 5: GeoAI



Source: Supermap

Second, the origin and future trends of the concept were presented. GeoAI is a concept that dates back to the mid-nineties (Black, 1995) and is an established field in itself. It is expected to continue to help create more powerful and intelligent applications.

Third, the technical and political environment was presented together with the key enablers and advancements in the field of GeoAI. The policy context focussed on the EU policy and drivers of interoperability and standards. The technical context provided insights into three key areas for the uptake of GeoAI; Big data and analytics, massive computing power; and human-systems integration.

[31] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/glossary/term/geoai
[32] UNGGIM, Future Trends Report (2020).

The fourth section entailed an interactive presentation of real examples of GeoAI. The audience voted for their top three choices of seven case studies proposed, selecting the following case studies:

- GeoAI to close the map gap: Facebook and OSM's initiative "*Map with AI*" and its interface RapiD
- GeoAI in health and environment: the German IT company Breeze Technologies tackles pollution with AI-enabled tracking
- GeoAI in public health and environment: the PILSE project and its mHealth application Pulsair

Following this, **interoperability efforts and challenges were presented**. This included the state of play on standards and interoperability in Europe, such as OGC GeoAI DWG and ISO, and the key elements to tackle to move forward on semantic interoperability.

Finally, the **key take-aways and conclusion** provided the key opportunities and challenges for the uptake of GeoAI and summarised the most important messages.

Summary of Q&A discussion

During the Q&A session, the webinar attendees had the chance to ask questions to the JRC and presenters. The two questions raised were mainly evolving how EU policy treats geographical data. The JRC explained the important role of the INSPIRE Directive. The presenters specified that while INSPIRE treats static data, GeoAI also integrates dynamic data and process data. In this sense, the INSPIRE directive is key for GeoAI, but the field also requires additional political regulation and direction.

Measured impact

Registrations	149
Attendees	80
Segmentation[33] (email address domains)	— Gmail: 17 attendees — Hexagon.com: 7 attendees — Nls.fi: 4 attendees
Polling insights	**What is your affiliation? (60 respondents)** — Academia/Research: 23% — National public administration: 20% — Regional/Local Public Administration: 15% — Private sector – large enterprises: 13% — Private sector – SME: 12% — European Public Administration: 10% — Other: 5% — Private individual: 1% **How familiar are you with the concept of GeoAI? (60 respondents)** — I know the basics: 58% — I have heard of it, but do not know it very well: 17% — I know the concept very well: 17% — I have never heard of it: 8% **What challenges do you see for the uptake of AI for geospatial? (32 respondents)**

[33] The numbers in this "segmentation" section do not sum to the total number of the attendees, but rather the majority groups of attendees. The remaining numbers were spread across a range of domains..

	— 56% voted regulation issues of data protection, privacy, liability and discrimination coupled with large variances in adoption and use in EU countries remain pertinent. — 19% voted interoperability for public services — 16% voted the human dimension of tryst — 13% votes common standards **How would you rate this webinar? (32 respondents)** — Very satisfied or more than satisfied: 33% — Satisfied: 39% — Partly satisfied: 25% — Not at all satisfied: 3%

Conclusions

The webinar concluded by emphasising the following key messages:

- Increased availability of geospatial data, the advancement of AI and the availability of massive computing power has created momentum for the digital exploitation of geospatial data.
- AI technology presents new opportunities to integrate, exploit, and use geospatial data for geospatially-informed insights and predictions.
- Through the examples given, we see that the GeoAI techniques employed can build public sector capabilities in moving from reactive to predictive and thereby produce new and innovative solutions.
- While GeoAI can be a tool for increased growth, efficiency, security and more, challenges related to regulation, interoperability and standards remain.

The elements central to the ELISE action (location interoperability, digital transformation and innovation) were addressed throughout the webinar. For example, **location intelligence**, a key aspect of location interoperability, **plays an essential role in GeoAI**. This is because GeoAI combines artificial intelligence and geospatial information to create more intelligent applications and systems. As demonstrated in the examples given in the presentation, such solutions can be employed in a wide array of policy areas and contribute to the move towards Digital Government. Concerning location interoperability, Estonia's AI strategy (KrattAI[34]) employs GeoAI solutions for agricultural monitoring and aims at improving the interoperability of such government solutions.

Geospatial data could be leveraged by coupling it with exponential AI technologies to achieve more efficient solutions regarding digital transformation. There are some **fundamental challenges to realizing this transformation (i.e. interoperability, standards, human trust and regulation**). However, there are also opportunities such as market growth, the contribution of such digital technologies in accelerating the European Circular economy and its potential role in addressing both local and global challenges.

Last, innovative approaches were promoted by demonstrating real application areas where companies and governments have used new solutions and technologies to produce deeper, new and more accurate findings. For example, the case study of Facebook Artificial Intelligence and OpenStreetMap's Map with AI[35] has allowed for mapping 300 000 miles of previously unmapped roads in Thailand in 18 months. These initiatives demonstrate how innovation can create benefits.

[34] More information at: https://en.kratid.ee/in-english
[35] Https://mapwith.ai/#13/-7.95604/31.59543/0/55

Webinar #4. Location Intelligence for Cities and Regions: preparing the ground for smart places of the future

Webinar details

Title	Location Intelligence for Cities and Regions: preparing the ground for smart places of the future	
Speakers	Glenn Vancauwenberghe, Thérèse Steenberghen (SADL/KU Leuven)	
Event announcement		https://joinup.ec.europa.eu/node/702594
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703053
	Video	https://www.youtube.com/watch?v=XTvQL1Qa6-E
Date of the webinar	03/09/20	
Keywords	Smart places, smart cities, location intelligence, interoperability, local and regional government	

Summary of the topic

The webinar on Location Intelligence for Cities and Regions presented state of the art and future perspectives on location data and technologies by local and regional governments. The webinar aimed to demonstrate how location intelligence is vital for turning subnational governments into smart places.

The webinar opened with an introduction to the concept of smart places by looking first at different perspectives of "*smart places*" and "*smart world*". Following this, the policy and technological context in which *smart places* and smart subnational governments operate were illustrated. In the context of this webinar, the European Commission definition of smart cities was adapted for smart subnational governments:

> "Smart municipalities, cities and regions are places where traditional networks and services are made more efficient with the use of digital and *telecommunication* technologies for the benefit of its inhabitants and business".

Regarding technological context, it was stated that local and regional initiatives are rapidly developing and leveraging disruptive technologies such as artificial intelligence (AI), the internet of things (IoT), 5G, robotics, blockchain, and others. However, it is important to understand the local and regional governments' capacity to deal with these new technologies and deliver new solutions varies greatly. Moreover, to develop smart cities sustainably, a shift in focus is required from a technology-dominated approach to a more human-centric and holistic approach.

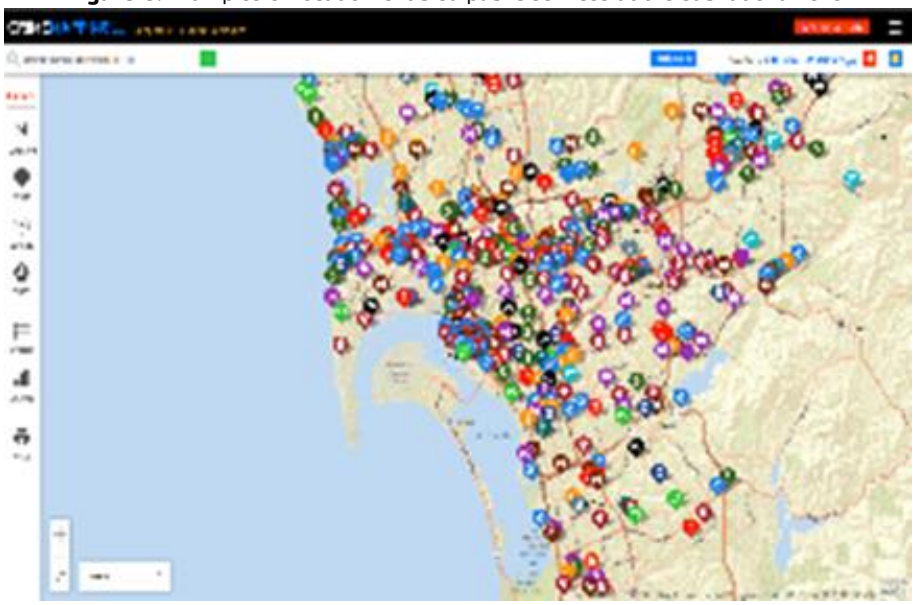
The key message on the policy context for smart places is that **digital government and interoperability strategies can only be successful with a solid sub-national component**. The latter requires policy alignment between different levels and between generic and more thematic policies.

The **second part of the presentation focused on the role of local and regional governments in digital services**. In Europe, there are more than 80.000 local and regional governments, which together are responsible for 50% of public investments, receive 25% of tax revenues and are major public employers. These subnational governments have a wide range of responsibilities in crucial domains such as education, spatial planning, economic development, social affairs, health, culture, recreation and public transport. While there are important differences between municipal and regional governments, but also between governments in rural areas and those in urban areas, all subnational governments play a key role in tackling various urgent challenges: mobility, housing, ageing, climate action, social segregation, environmental footprint, etc.

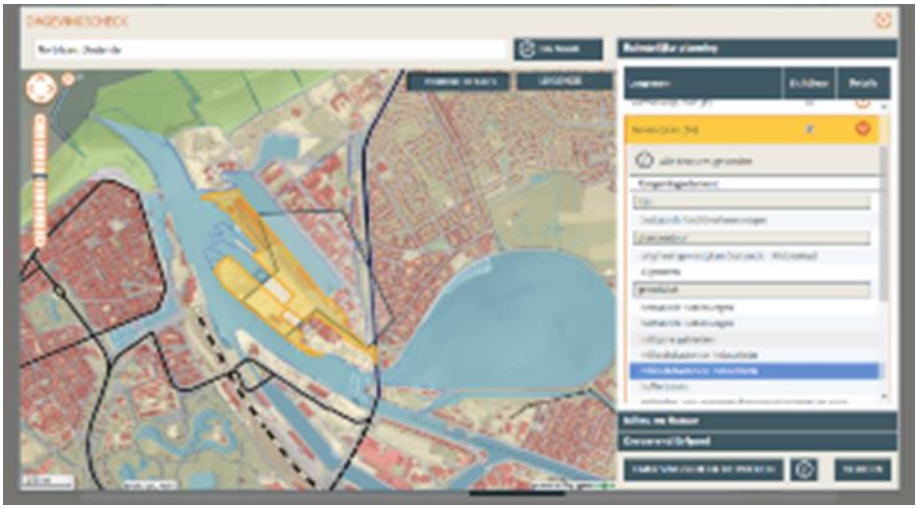
From a service delivery perspective, these subnational governments are supporting and interacting with citizens during many key life events, such as birth, starting school, starting higher education or training, transitioning to work, marriage, having a family, retiring, caring for someone, or the death of a loved one. Especially in recent years, they have strongly invested in digitalising their services in a drive to modernise, increase their internal efficiency, improve citizen experience and facilitate access to information.

The **third part of the presentation focused on the role of location intelligence in supporting digital services by subnational governments**. Local and regional governments increasingly rely on location data and technologies to design and deliver services around key events in citizens and businesses' lives. Starting or changing schools, starting up a business, building a house and reporting a crime are examples of location-enabled services provided by subnational governments. Figure 6 shows two examples of such location-enabled services.

Figure 6: Examples of location-enabled public services at the subnational level



Location-enabled crime reporting



Location-enabled building permit procedure

Source: CrimeMapping.com & Omgevingsloket.be

The recent European Data Strategy enhances geospatial opportunities. Many existing initiatives in the geospatial domain – such as INSPIRE and national Spatial Data Infrastructures – already support many of the key elements

proposed in the strategy. Also important is the strong local and subnational component in many of these elements, particularly in creating **common European data spaces**. In this light, the initiative is taken to create a **'smart communities' data space**.

Location intelligence supports subnational governments in transforming into digital governments, enabling new ways of delivering public value and making services and government procedures digital by design.

In the **fourth part of the presentation, three cases were presented in which location intelligence enables digital transformation** in smart local & regional projects. Each of these cases addressed a particular type of challenge in the realisation of smart local and regional places:

- The **ObjectTypeLibrary** from the Flanders Regional Public works Department focused on the "physical infrastructure and standardisation challenges."[36]
- The **FINEST Twins platform** for cross-border collaboration between Helsinki and Estonia addressed the establishment of a "*collaboration ecosystem*."[37]
- The **Ilsac-Watts smart energy solution** in France illustrated how location intelligence is critical to improving the "*quality of Life citizens and the competitiveness of a rural area*."[38]

The **fifth and final part of the webinar presentation provided a set of recommendations on how to make the shift towards more intelligent subnational governments**. While the subnational governments themselves clearly play a role in this transformation process, national governments and the European Commission can support this process considerably.

Summary of Q&A discussion

During the Q&A session, the webinar attendees could ask questions, comment on the webinar presentation, and address the topics. A **question was raised on the advancement of the Digital Services developed through the Urban Agenda for the EU** and different Agencies of the EU to provide technology to different local and regional administrations, allowing these administrations to implement their programs using common resources. A DG CONNECT policy officer replied to this question by referring to several re-usable instruments made available by the Digital Transition Partnership, including the Digital Neighbourhood Instrument[39], the DigitalServices4EU tool[40] and the *Living-in.eu* movement[41] (supporting the implementation of interoperable urban data platforms). The policy officer also referred to many other re-usable tools relevant at the local level, such as the Connecting Europe Facilities (CEF) building blocks[42], several tools available on the Joinup platform[43] and the European Interoperability Framework for Smart Cities and Communities.

A second question was raised on **how to assess, measure and compare the "*smartness of a place*"** in general and, in particular, the contribution of location intelligence in making a place smarter. The DG CONNECT policy officer referred to the Digital Economy and Society Index (DESI) used by the Commission for comparisons at the national level. DESI is a composite index that summarises relevant indicators on Europe's digital performance and tracks EU Member States' evolution across five main dimensions: Connectivity, Human Capital, Use of the Internet, Integration of Digital Technology, Digital Public Services[44]. For the local level, as part of the *Living-in.eu* initiative, the Local and Regional Digital Indicators (LORDI) is a collaborative effort led by ESPON, the European Commission (EC) and the Committee of the Regions (CoR) to develop a methodology and indicator

[36] For more information, see: https://wegenenverkeer.data.vlaanderen.be/
[37] For more information, see: https://forumvirium.fi/en/finest-smart-city/
[38] For more information, see: https://www.enr-citoyennes.fr/structures-reseaux/isac-watts/
[39] https://ec.europa.eu/futurium/en/digital-transition/digital-neighbourhood-instrument
[40] https://www.digitalservicesfor.eu
[41] http://living-in.eu
[42] https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Smart+Cities
[43] https://joinup.ec.europa.eu
[44] https://digital-agenda-data.eu/datasets/desi/indicators#:~:text=The%20Digital%20Economy%20and%20Society,Digital%20Technology%2C%20Digital%20Public%20Services

framework to support policy makers, businesses and citizens to better understand digital transformation at local level. This work is still ongoing but aims to cover over 700 cities.

Measured impact

Registrations	92
Attendees	57
Segmentation[45] (more frequent email address domains)	— Gmail: 17 attendees — ec.europe.eu: 7 attendees — Hexagon.com: 5 attendees
Polling insights	**What is your affiliation? (29 respondents)** — Private sector – large enterprises: 28% — National public administration: 24% — Academia/Research: 17% — European Public Administration: 17% — Regional/Local Public Administration: 7% — Private sector – SME: 7% **How familiar are you with the concept of Location Intelligence? (29 respondents)** — I know the basics: 41% — I have heard of it, but do not know it very well: 24% — I know the concept very well: 35% **EU policies and related initiatives on digital government and/or data strategies should better recognize subnational governments and their potential contribution to these policies (31 respondents)** — Strongly agree: 36% — Agree: 48% — Don't' know: 16% **How would you assess the current level of use of location intelligence (or smartness) in subnational governments in Europe? (32 respondents)** — Very high: 3% — High: 6% — Moderate: 63% — Low: 25% — Very low: 3% **Who should take the lead in making the shift from traditional to smart subnational governments? (25 respondents)** — Cooperation process of all: 56% — National governments: 28% — Subnational governments: 8% — European Commission: 8%

[45] The numbers in this "segmentation" section do not sum to the total number of the attendees, but rather the majority groups of attendees. The remaining numbers were spread across a range of domains..

How do you see ELISE contributing to turning local and regional governments into smart places? (25 respondents)

- Exchange of best practices: 36%
- Training and capacity building: 36%
- Provision of guidelines and guidance documents:20%
- Performing studies on the related topics: 8%

Conclusions

The webinar concluded by emphasising the role of location intelligence in transforming local and regional governments into smart governments. **Changes and innovations drive this transformation in the way governments are dealing with geospatial data, using geospatial technologies and organising their processes.**

- Traditional governments are characterised by a higher number of closed data silos, including independent data formats and data models and a lack of mechanisms to enable effective data sharing. To become smart governments, local and regional governments should become data-driven organisations, relying on near real-time data from many different sources and delivering open data through open standards.
- Traditional governments use more traditional GIS solutions to support the management, analysis and visualisation of location data. Smart governments take advantage of technological advancements that significantly change how they collect, manage, exploit, and share location data. They rely on relevant emerging technologies in the geospatial domain, such as automation, IoT, big data, artificial intelligence, immersive technologies, etc.
- Smart government organisations also establish and rely on solid data ecosystems to fully unlock location data's value in collaboration with other key stakeholders. In this way, they distinguish themselves from the governments relying on the traditional top-down models of decision making and service delivery.

These transformations were shown through three different cases of location intelligence for smart local and regional governments. What these cases also showed was **the decisive importance of location interoperability for realising smarter governments**. Data from various sources and standards need to be combined, integrated, and shared with relevant stakeholders, including citizens. **The interoperability challenges** go beyond semantic and technological interoperability and **include several organisational and legal interoperability aspects.**

Webinar #5. Monitoring and understanding emerging geospatial technologies

Webinar details

Title	Monitoring and understanding emerging geospatial technologies and their impact on interoperability	
Speakers	Danny Vandenbroucke (SADL/KU Leuven) and Gobe Hobona (OGC)	
Event announcement		https://joinup.ec.europa.eu/node/703022
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703053
	Video	https://www.youtube.com/watch?v=J2EYDOZrsvo
Date of the webinar	24/09/2020	
Keywords	Technology Trends, monitoring trends, disruptive technologies, geospatial technologies, location interoperability	

Summary of the topic

The webinar on "*Monitoring and understanding emerging geospatial technologies*" provided an overview of the technological and non-technological trends that impact the geospatial sector today. The objective was not on all the individual trends per se but rather to provide the audience with an insight into their drivers and ways to monitor trends and maintain an overview of them and their impact on architecture and standards. The webinar was structured as follows.

First, the speakers introduced the key messages from the webinar: many technological and other trends are emerging, while others are becoming 'mature'. It is often difficult to see the wood for the trees. There is a need for a Technology Trends Watch (TTW) to monitor and understand interconnected trends. The new developments require reviewing the 'traditional' Spatial Data Infrastructure (SDI) architectures and how standards are developed.

In the second part, the speakers explained the link between the major drivers and trends. The overview was based on discussions within the geospatial community, and the United Nations – Global Geographic Information Management (UN-GGIM) in particular:

- New data sources and analytical methods
- Technological advancements
- The evolution of user requirements
- The industrial shift and the legislative (and political) environment

Everything happens somewhere, and geospatial technology is becoming mainstream. There is a need for all people, not only experts, to directly access near real-time information. The latter will influence dramatically the way we manage and handle geospatial information in the context of the global economy.

Third, the central part of the webinar focused on the need for monitoring and assessing (technological) trends. It provided an overview of how different players do this and zoomed in on two cases. This third part started with the meaning of trends and disruptive technologies, highlighting that some trends might be there for a while, while others might appear 'suddenly'.

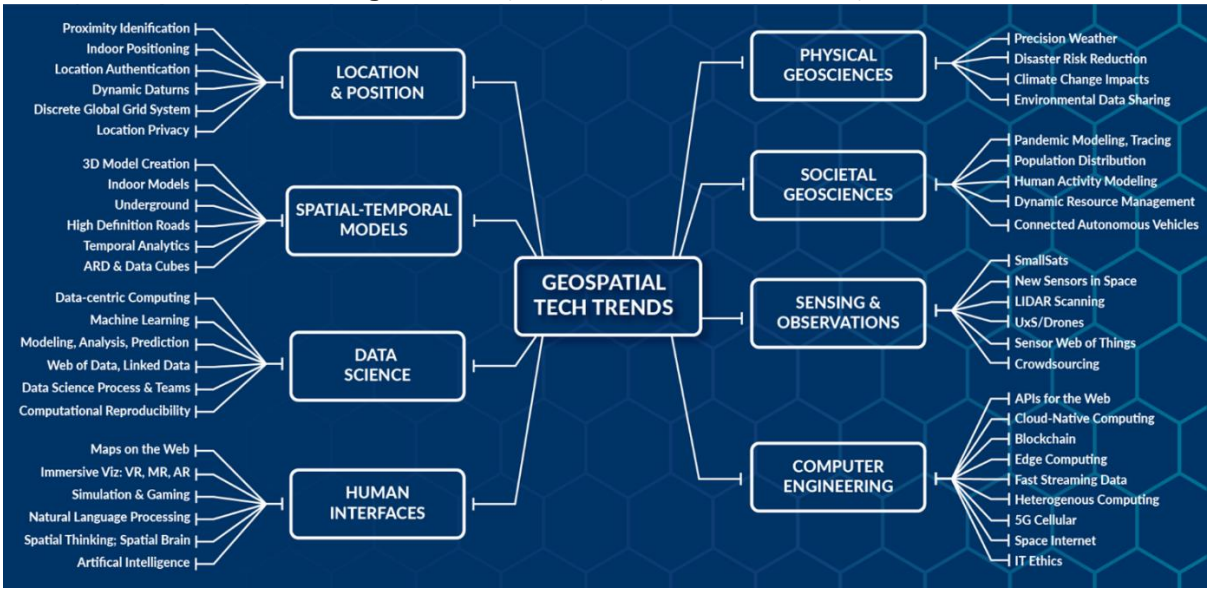
Next, the reasons for monitoring trends were presented. Trend monitoring occurs in different shapes and formats: from frequent individual studies such as those from Deloitte, PWC, and Gartner to more comprehensive technology trends watches, such as one by the Open Geospatial Consortium (OGC). The latter case was explained

in more detail by the guest speaker from OGC. The OGC and the geospatial community use the OGC TTW to decide when and how to prepare new standards and plan internal R&D.

Another example where a TTW is necessary is in the context of skills development (W*hat are the concepts that need to be integrated into (new) curricula at universities or in vocational training initiatives?*) Individual organisations and companies are also interested in this issue, as illustrated by the examples of ESA and Airbus, who have their 'own' technology trends watch.

The fourth section zoomed in on how the individual trends should be understood. Starting from the OGC TechTrends MindMap - *see Figure 7: The Open Geospatial Consortium MindMap* - two examples were given on how different trends are interconnected and can be explored to get acquainted with them and to test their applicability in (research) projects. The first example tried to understand how children behave (spatially) in traffic by making use of spatial thinking (and spatial brain), agent-based modelling, digital twins and 3D city models, as well as immersive geo (AR, VR ...). The former would allow taking measures in schools and urban planning. The second example zoomed in on how big data and data analytics using Machine Learning can help process and provide answers on how refugees are moving. In this case, also IT ethics aspects were relevant.

Figure 7: The Open Geospatial Consortium MindMap



Source: [Geospatial Technical Trends] **(Copyright OGC, 2020)**

The last (fifth) part of the webinar discussed the interoperability efforts and challenges of technological trends. The impact on architectures of 'traditional' SDI's was highlighted: not only changes in the data tier, in which more dynamic data influence the way we store, manage, handle and provide access to data. Also, the application layer is affected. The latter is reflected in how standardisation itself occurs: more collaboration between standardisation bodies and emerging new standardisation initiatives are observed. The speakers raised the idea of having more experimental collaborative environments for testing, improving and implementing new technologies and trends.

Finally, the key takeaways and conclusion provided the key opportunities and challenges for monitoring and understanding technology trends and summarised the most important messages.

Summary of Q&A discussion

The Q&A section was short. **One question was on whether "*spatial is still special*".** It was stressed that nowadays, spatial data and technology has become mainstream; therefore, it is better to avoid the term 'special'. Developers and users from across society can now use location data to address challenges that previously could not be addressed or had to be addressed by experts only. Geospatial is now going beyond the niche market it once was and entering homes, reaching everyone.

The presenters agreed to this and pointed out that location and spatial thinking should be everywhere. It should start with the youngest citizens by learning about geospatial at schools. The technological trends will make this possible and allow everyone to use location information for many purposes. COVID-19 has also made clear some key basic concepts for everyone, such as distance, spatial clustering of outbreaks, etc. Location information will become even more mainstream since everything is happening somewhere.

A representative of ISO/TC 211 raised the **issue of collaborative initiatives between standardization bodies** and saw the need for doing more. Examples of ISO/TC 211 were given related to the "*Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)*" (ISO/TC 59/SC 13) and Intelligent Transport Systems (ISO/TC 204) for which joined Working Groups have been set-up. For example, the Geographic Data Files (GDF) standard (ISO/TR 14825) is the common basis for work between TC 211 and TC 204. Danny Vandenbroucke agreed with this and suggested that it would be useful to have a more complete 'mapping' of all the relevant SDO's and how they are interconnected. Examples of collaboration are good to reach interoperability.

Measured impact

Registrations	Not known
Attendees	Around 35
Polling insights	The polling information was lost, so only the "*interesting topics*" poll was captured **What other topics would you like to see covered in webinars (20 answers)** — API's for the Web (4) — Cloud, fog and edge computing (1) — Data analytics and Machine Learning (3) — Digital Twins and 3D model creation (3) — Immersive visualization techniques (AR, VR …) (1) — Indoor models and positioning (2) — Modelling, advanced analysis and prediction methods (5) — Sensor web and (event) data streams (1) — It seems that especially "*Modelling, advanced analytics and prediction models*" gained most of the interest.

Conclusions

Geospatial technology trends are influenced by different factors, including economic, legal and political drivers. There is **a clear need and interest for a consistent technology trends monitoring system** that allows continuous analysis of emerging technologies, how they are interconnected and might be applied in different contexts. The fact that technology trends can evolve rapidly means that we should not wait to look into them to apply them. We can experiment with new technologies in different test environments to better understand them before implementing them. However, the full impact of the major technology trends on geospatial technology and interoperability is not entirely clear yet and requires further investigation. From one of the polls, it became clear that there is a huge interest in specific trends such as Modelling, advanced analytics, prediction methods, and APIs for the web. Therefore, it is helpful to plan webinars on some of these topics and regularly refresh/repeat them because changes and further developments occur all the time. Another important conclusion from the discussion is that geospatial became mainstream (rather than remaining 'special') and that new technologies make it possible to have geospatial embedded or even part of the solutions (e.g. GeoAI).

Webinar #6. Location enabled public services

Webinar details

Title	Location enabled public services	
Speakers	Sebastiaan van der Peijl and Lea Ytrehus (Deloitte Belgium)	
Event announcement		https://joinup.ec.europa.eu/node/703340
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703545
	Video	https://www.youtube.com/channel/UCGDfmutw18fuxntkK0gsvjg
Date of the webinar	05/11/20	
Keywords	Digital public services, location enablement, geospatial data, public sector, public services	

Summary of the topic

The webinar on location-enabled public services focused on demonstrating the growing momentum of location-enabled public services by exploring the context, opportunities and challenges for the public sector.

On the one hand, data availability, volunteered information, and improved processes provide unprecedented opportunities for public services. On the other hand, we see that data maturity, interoperability and other challenges must be addressed.

To best demonstrate these trends, the **webinar started with the context and definitions of location enablement**. The presentation started by defining location data and linking it to location enablement. Location enablement is about "*getting access to and integrating location data and information to improve processes*".[46]

To demonstrate such growing momentum, the following elements were highlighted:

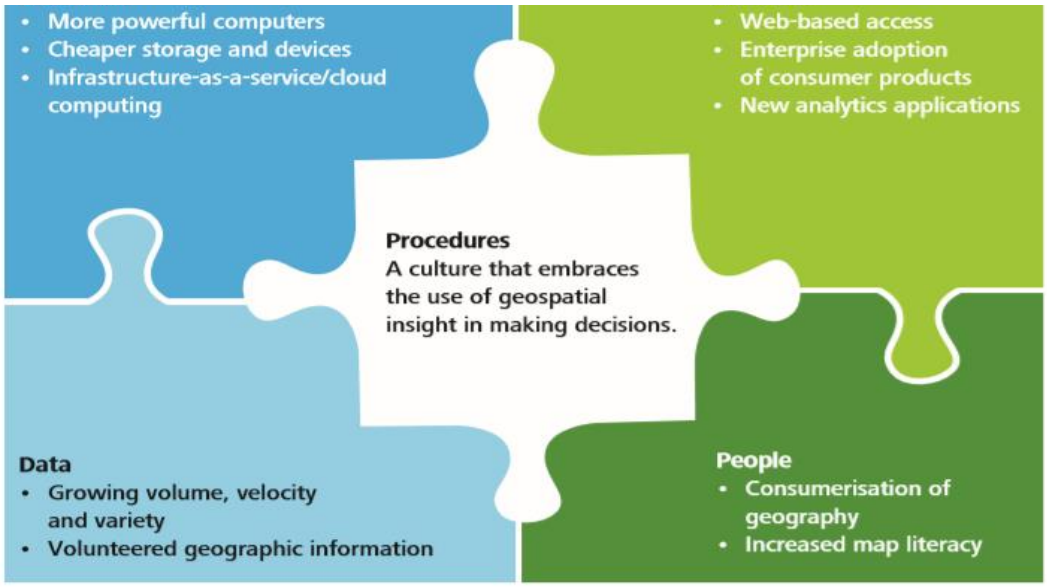
- that most public sector information already has a spatial component and
- the potential that the spatial/location dimension has in deriving new insights, tools, services and improving those that already exist.

By adding some policy context, focusing mainly on Digital Europe and a technical context, explaining the relevance of Spatial Data Infrastructures (SDIs) and other existing and emerging assets, it was demonstrated that the necessary tools for location enablement are already there.

Second, the webinar highlighted the public sector's opportunities and challenges. On the one hand, there is potential to improve services, increase efficiency, enable collaboration and engage more with the public. On the other hand, to get there, it is crucial to consider the need for open data, standards and interoperability, trust, privacy & data protection, and strengthening the technical capabilities of the public sector to realise the ambition of location-enabled public services.

[46] Vandenbroucke, D., Vancauwenberghe, G., Boguslawski, R. and Pignatelli, F., Design of location-enabled e-government services, EUR 30220 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-18939-8, doi:10.2760/860082, JRC119730.

Figure 8: Drivers for the public sector



Source: Deloitte LLP

Third, the webinar provided concrete use cases for the audience to better understand what location-enabled public services may look like in practice. First, brief examples were given for a few sectors: transport, construction & urban planning, social services and environment. Then, the presenters moved on to two in-depth case studies.

The first case study presented was "*Locally volunteered data for better services: the case of FixMyStreet*". FixMyStreet is an open-source software that allows citizens (at the local, regional or national level) to report problems and automatically forwards the report to the relevant authority to fix the problem. It was built by a not-for-profit social enterprise to develop digital technologies that help people be active citizens.

The FixMyStreet case was selected because it demonstrates the opportunities to employ a collaborative approach and user-centric design. It is an example of a case engaging the public, increasing efficiency and delivering cost savings, and providing a service in which location data is relevant, available, and brings added value.

The **second case study presented was "*Open data for better public services in practice: Transport for London (TfL)*".** The case study provides a prime example of how publishing open data creates a virtuous circle that benefits those using and delivering transport networks in the Capital Transport. A Deloitte study from 2017 on TfL was used as the primary source of information[47]. In 2007, TfL made available their data as *Open data* to be freely used, re-used, and redistributed by anyone to support operational service improvements, increased transparency and innovation, and the development of new customer-facing products and services. The intention was to challenge existing ways of working.

The Transport for London (TfL) case illustrates in concrete terms some key success factors of location-enabled public services and how public-private partnership can lead to significant improvements of services for all stakeholders involved. It was highlighted that the collaborative approach between public and private stakeholders resulted in access to new (citizen-generated) data. The ecosystem has led to increased efficiency, substantial cost savings, improved service quality and added value for all stakeholders (private, public, citizens).

Summary of Q&A discussion

There was limited interaction from the audience for the questions and answer sessions, so the webinar presenters and moderator used the time to further detail the case studies. The FixMyStreet representative

[47] Deloitte, "Assessing the value of TfL's open data and digital partnerships," (2017).

shared information on the platform's future, its growing popularity and the potential to employ new technologies to improve the software further.

Measured impact

Registrations	50
Attendees	41
Segmentation (email address domains)	n/a
Polling insights	**Which of the challenges you see the most relevant? (up to 2 choices)** — Standards and interoperability (13/21) — Open data maturity (11/21) — Enhancing trust and ensuring privacy & data protection (9/21) — Strengthening technical capacities to provide user-centric design and collaborative approaches (6/21) — Which of the opportunities you see the most relevant (up to 2 choices) — Improve service quality and effectiveness (14/21) — Enable collaboration (10/21) — Focus on efficiency and deliver cost savings (8/21) — Engage the public (3/21)

Conclusions

To conclude, four messages were highlighted. Namely:

— There is **growing momentum** for the uptake of location-enabled public services due to their availability and potential to improve existing services and products and boost new ones.

— To meet the **needs of tomorrow**, collaborative approaches to design and user-centricity are fundamental. To achieve this, the correct prioritisation and performance indicators must be applied.

— By **capitalising** on the availability of data, software, hardware, volunteered information and processes, there are **significant collaborative opportunities, cost efficiencies and service quality improvements** to be made.

— There is a **need to improve** interoperability between services and across borders, improve data maturity, focus on trust, privacy & protection in policy, and strengthen technical capacities to **minimise the gaps in the local, regional, national, and cross-border contexts.**

The link between location interoperability, digital transformation and innovation was an overarching theme throughout the webinar. Location interoperability was highlighted both as part of the context of SDIs and existing tools for location enablement across public services but also as a key challenge to overcome. It was emphasised that standards and interoperability remain a key challenge and a necessary tool to capitalise on current opportunities. The index from the *Location Interoperability Framework Observatory*'s 2020 report was presented to show the maturity level of location interoperability.

Webinar #7. Geodata marketplaces supporting location intelligence

Webinar details

Title	Geodata marketplaces supporting location intelligence	
Speakers	George O'Neill and Lea Ytrehus (Deloitte Belgium) Jill Saligoe-Simmel (Esri) Valdis Karulis (Geodata hub) Javier Perez Trufero (Carto)	
Event announcement		https://joinup.ec.europa.eu/node/703900
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703941
	Video	https://www.youtube.com/watch?v=CFga2f6bNiU
Date of the webinar	14/01/21	
Keywords	Geospatial, marketplaces, data ecosystem, interoperability, data exchange	

Summary of the topic

This webinar explored geodata marketplaces and how they support location intelligence. By deep-diving into the context, definitions, opportunities and three case studies of geodata marketplaces, the webinar provided insights into the current state of play of geodata marketplaces and concrete examples of the state-of-the-art solutions.

The **first section of the webinar was dedicated to the context and definitions of geodata marketplaces**. Key definitions for ecosystem thinking and data marketplaces were provided. The exchange of location information[48] is not new, but new developments building on data as a platform[49] (data, rather than the application, is the commodity being exchanged) and ecosystems thinking are creating increased opportunities for public services and businesses to access spatial information at lower cost and derive new insights that support location intelligence. [50] This allows unprecedented data availability and accessibility and leads to a new paradigm where users may obtain personalised, domain-specific information and where providers and users meet in the same virtual space.

The **second section explored the opportunities associated with the move towards increased location intelligence**. Some of the key opportunities discussed were:

- Greater collaboration with other organisations and public-private partnerships;
- Focus on efficiency and deliver cost savings through governmental geospatial "*one-stop shops*";
- Improved service quality and effectiveness through better access to information.
- Creation of ecosystems allowing for better access to data;
- Increased efficiency and cost savings in delivering new and innovative products, tools and business models;
- Engagement of the public through volunteered information.

[48] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/glossary/term/location-information

[49] https://www.techopedia.com/definition/28915/data-as-a-platform-daap

[50] https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/glossary/term/location-intelligence

To understand the positive implication of such opportunities, the concept of location intelligence and how this is linked to ecosystems thinking and geodata marketplaces was explained. Ecosystems centred around sharing, exchanging, using, and reusing data are essential to provide an environment for creating, managing, and sustaining such geodata marketplace initiatives. Location intelligence is derived from processes boosted by new technologies that allow diverse inputs to be turned into location intelligent outputs. By collecting, connecting and protecting data through sustainable ecosystems, we can derive new and deeper geospatial insight. As a result, both private and public actors are picking up on this, and new and innovative tools, platforms and business models are growing. In sum, geodata marketplaces encapsulate ecosystems thinking and serves as an enabler for location intelligence.

The **third part of the webinar focused on Esri's living atlas**[51], presented by Jill Saligoe-Simmel, product manager for SDI and INSPIRE. She explained that their living atlas comprises a curated collection of 8000 different types of datasets, where much of the data is publicly available, some are subscriber content, and some are premium content. The living atlas is a marketplace enabled by geospatial infrastructures such as cloud storage and web services. Moreover, geospatial infrastructures govern access and enable a kind of social network for data.

The living atlas is integral to ArcGIS software, which is the basis of field apps and business apps, and allows for ease of use for community participation. The geospatial infrastructure enables new types of ecosystems thinking and supports data improvements. In sum, the living atlas helps new ways of bringing together data from different sources and keeping such data continuously updated. Therefore, it constitutes a form of geodata marketplace that puts ecosystems thinking into practice.

In the fourth part of the presentation, Geodatahub and Carto presented their solutions that encapsulate the geodata marketplace concept. Geodatahub was initially an EU-funded project. It is run by two partner companies in Estonia and Latvia. Valdis Karulis presented the case study from Geodatahub. The platform focuses on adding value to businesses based on geographic data by providing a self-service portal. This portal has data from different formats integrated conveniently for software implementors via APIs. Companies use the platform for needs regarding location (i.e. for delivery services), maps (i.e. for applications) and directions (i.e. for route optimisation). Geodatahub is an example of a geodata marketplace as the seller and buyer come together in one virtual space where the commodity is sold.

Carto[52] built a location intelligence platform to let actors solve geospatial problems themselves. Javier Perez Trufero presented their marketplace and data observatory. He explained that the marketplace provides different interfaces for different users (data scientist, data analyst, developers) and datasets from multiple sources and a wide range of categories. The data observatory allows users to save time on gathering and cleaning data, and the aim is to provide a one-stop-shop for spatial data and supporting technology. The platform integrates data from a range of third-party providers, from Vodafone to Mastercard.

Summary of Q&A discussion

The audience had posed several questions in the chatbox during the presentation. An attendee asked **about how Geodatahub ensures data updates with providers and whether they integrate INSPIRE resources**. It was explained that Geodatahub follows up with data providers to ensure data is up to date and that focus is put on the data necessary for business. When asked about the pricing plan, Mr Karulis explained that their most popular pricing is the "*development*" plan. This plan allows anyone to test the solution for free, after which a micro subscription is the most popular option.

The speakers were also asked about **which metadata standard they have applied**. In the case of Esri, Ms Saligoe-Simmel explained that ArcGIS supports ISO/INSPIRE and other metadata standards and DCAT catalogue vocabularies, expanding to other, e.g. DCAT-AP. In the case of Carto and its data observatory, it was explained that they started from a schema and then added proprietary attributes.

[51] https://livingatlas.arcgis.com/en/home/
[52] https://carto.com/

Last, a question was asked regarding **which type of APIs is the most requested** from the guest speakers' respective organisations.

Mr Karulis explained that the most requested APIs are addresses, validation and base maps. For Esri, it is primarily Esri REST feature services, OGC WFS and WMTS, and they anticipated emerging demand with OGC API Features.

Measured impact

Registrations	61
Attendees	40
Segmentation (email address domains)	n/a
Polling insights	**Are you familiar with the concepts of Geodata marketplaces or data marketplaces in general?** — I'm familiar with a concept of data marketplaces only 12% — I'm familiar with both concepts 44% — I know both concepts very well8% — I'm not familiar with either of concepts 36% **What is your affiliation?** — Private sector - large enterprise 4% — Private sector - SME 16% — National public administration 48% — Regional/local public administration 20% — EU public administration 4% — Consultant - freelancer 8%

Conclusions

The conclusions of the webinar were as follows:

— Geodata marketplaces is a concept building on developments over the past decades; virtual marketplaces, digital platforms and more have paved the way for new and improved ways of exchanging, providing and using data.

— Geodata marketplaces are powered by ecosystems thinking. New and innovative models, creating interactive and living marketplaces, are made possible by sustainable ecosystems of actors working together.

— Geodata marketplaces encapsulate ecosystems thinking and serve as an enabler for location intelligence. By exchanging data through geodata marketplaces, we can derive new and deeper geospatial insight.

This webinar focused primarily on digital transformation and innovation. By highlighting the opportunities for both the private and public sectors when applying geodata marketplaces, the uptake of new innovative solutions such as geodata marketplaces is promoted.

The development, deployment and uptake of new technologies is a cornerstone of the European Digital Strategy, and state of the art solutions developed by large companies and SMEs alike can play a key role in pushing such transformations forward. In this context, the study provided concrete examples of how such solutions are brought to the market and emphasised the opportunities associated with collaborative networks and ecosystems. Location interoperability was introduced in discussions on standards and infrastructure and was of particular interest to the audience in the Q&A session.

Webinar #8. Blockchain and proof of location supporting digital government

Webinar details

Title	Blockchain and proof of location supporting digital government	
Speakers	George O'Neill and Lea Ytrehus (Deloitte Belgium) Damien Scanlon (Deloitte Ireland) Katya Zavyalova (CCO) and Ryan King (CEO) of FOAM	
Event announcement		https://joinup.ec.europa.eu/node/703995
Supporting materials	Slides	https://joinup.ec.europa.eu/node/704067
	Video	https://www.youtube.com/watch?v=o68S-z88GjE
Date of the webinar	14/01/21	
Keywords	Blockchain, technology, proof of location, smart contract, interoperability	

Summary of the topic

This webinar explored the concept of blockchain and proof of location as supporting digital government and location-enabled public services. The webinar showed two roles of blockchain in the location domain, namely *proof of location* and the use of location data for other blockchain-enabled applications and services.

Blockchain can be used to support decentralised and privacy-friendly "*proof of location*" services attesting to someone or something's presence at a certain geographic location at a certain time. The "proof of location" can be a relevant feature for smart contracts solutions. Smart contracts are agreements between two people in the form of computer code that runs on the blockchain. They can provide increased certainty, transparency and automation in transactional public services.

The **first part of the webinar provided definitions and explained why blockchain matters and fields of application**. For the purpose of the webinar, blockchain was defined as "*a type of distributed ledger in which value exchange transactions (in bitcoin or another token) are sequentially grouped into blocks. Each block is chained to the previous block and immutably recorded across a peer-to-peer network, using cryptographic trust and assurance mechanisms*"[53].

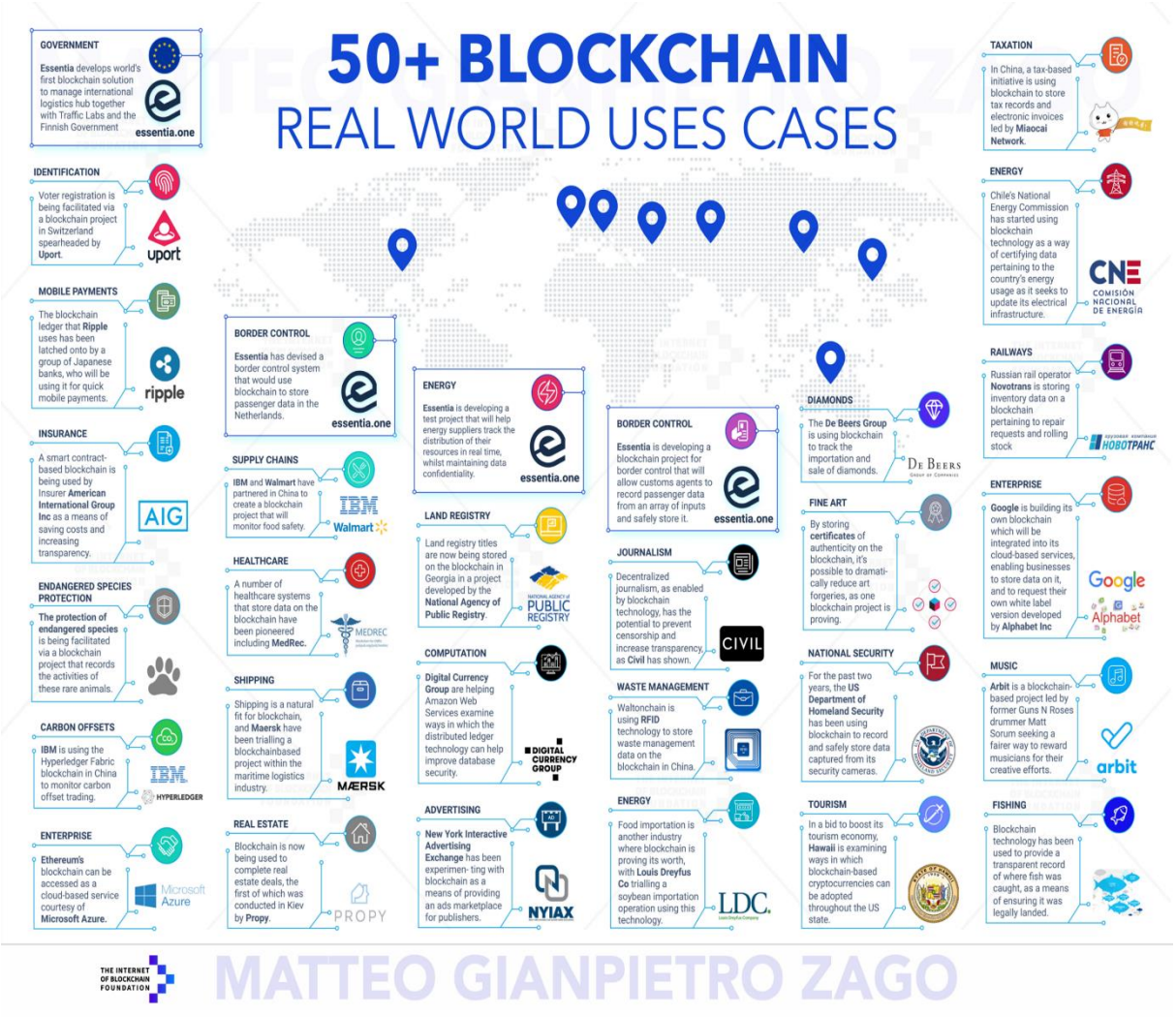
Proof of location is defined as "*a digital certificate that attests someone's presence at a certain geographic location, at a certain time*"[54].

In terms of application areas, examples and benefits were briefly discussed in the sectors of financial services, insurance, public services, supply chain and sustainability.

[53] ALLESSIE D, SOBOLEWSKI M, VACCARI L, PIGNATELLI F (Editor), Blockchain for digital government, EUR 29677 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00581-0, doi:10.2760/942739, JRC115049

[54] M. Amoretti, G. Brambilla, F. Medioli and F. Zanichelli, "Blockchain-Based Proof of Location," 2018 IEEE International Conference on Software Quality, Reliability and Security Companion (QRS-C), 2018, pp. 146-153, doi: 10.1109/QRS-C.2018.00038.

Figure 9: Geospatial blockchain applications



Source: Medium.com

The **second section consisted of a description of the EU policy context and interoperability aspects of blockchain**. A range of European policies and initiatives are supporting the uptake of blockchain at the European level. For example, the EC Blockchain Strategy, European Blockchain Services Infrastructure[55]. Regarding interoperability, it is argued to be essential to the success of blockchain in enabling digital government. This is because innovation across services and solutions requires blockchains to communicate with one another. This can only happen by continued support to the development, uptake and dissemination of commonly agreed-upon standards for blockchain and distributed ledger technologies. Efforts are being made in this field, notably by the OGC Division Working Group on Blockchain and Distributed Ledger Technologies[56] and the ISO Technical Committee on Blockchain and Distributed Ledger Technologies[57].

The **third section tackled the concept of proof of location** (see definition above.) It was emphasised that a range of public and private services require users or devices to demonstrate their location to access them or for the service to work properly. Blockchain could be the preferred option for location-based public services when there is a particular need for security and transparency.

[55] https://digital-strategy.ec.europa.eu/en/policies/blockchain-strategy
[56] https://www.ogc.org/projects/groups/bdltdwg
[57] https://www.iso.org/committee/6266604.html

As part of the webinar, guest speakers from FOAM[58] joined to speak about their business model based on proof of location on the blockchain. Katya Zavyalova (CCO) and Ryan King (CEO) explained that FOAM is working to provide a location service that provides secure and ubiquitous location information through blockchain. Other key features of FOAM location is their open-source standard ensuring there is "*no central point of failure*", a tamper-resistant way of sharing location data and providing presence claims through digital certificates that are fraud-proof. Use cases within mobility, IoT, supply chain and location intelligence were touched upon.

The **fourth section explored the use of blockchain for location applications, specifically smart contracts**. A smart contract is an agreement between two people in the form of a computer code. It runs on the blockchain, and is stored on a public database and cannot be changed. In this way, smart contracts can increase the transparency, security and efficiency of issuing contracts. It was also explained that proof of location could be added as a condition in the contract code.

With regards to location-enabled services, this solution can, for example, be impactful for supply chain and land registry solutions. As a case study, a track and trace solution developed by Deloitte was presented. In Ireland, the regulator for agri-food needed reliable and timely data on the maintenance of records related to animals' health and treatment and data associated with product production. The blockchain developed could track animals, their behaviours and foodstuff. Moreover, by leveraging a smart contract functionality, validation rules were defined to assess data inputs' accuracy and reliability into the platform.

Summary of Q&A discussion

The webinar ended with a lively discussion. One participant enquired about the rationale behind using blockchain for FOAM and not just cryptography. It was explained that it related to the economic incentives of the radios. In particular, there is a staking mechanism where the radio operators need to stake FOAM tokens to participate, which serves as a Service Level Agreement. The radio nodes will have economic incentives to follow the rules to avoid punishment. Ryan King further elaborated that the location data on the blockchain adds privacy, interoperability with other blockchain applications, and smart contracts. When asked what differentiates FOAM from other similar applications, the presenter explains that FOAM focuses on solely new types of location authentication (non-GPS).

Measured impact

Registrations	99
Attendees	54
Segmentation (email address domains)	n/a
Polling insights	**What is your affiliation?** — Academia/Research – 12% — Citizen/private person – 12% — Regional/local public administration – 4% — Small and medium enterprise – 12% — Large enterprise – 4% — National public administration – 24% — EU public administration – 16% — NGO/CSO – 4% — Other – 12%

[58] https://foam.space/

What is your level of knowledge on blockchain?

- I know it very well – 14 %
- I know it rather well – 21%
- I know a little – 52%
- I do not know it – 14%

Have you ever heard of "*proof of location*" on the blockchain?

- Yes – 41%
- No – 59%

Have you ever heard of "*smart contracts*"?

- Yes – 62%
- No – 38%

Conclusions

The conclusions drawn during the webinar were the following:

- Proof of location, smart contracts and location-enabled blockchain services could bring significant benefits to the public sector and support the digital government transformation.
- The architectural setup of blockchain applications such as proof of location and smart contracts can increase trust and security.
- Continued technical and strategic work is required to support the uptake of blockchain in the public sector. This includes further work on standards, interoperability and an enabling policy environment.
- Ongoing projects explore new use-cases and possibilities, but public sector delivery at scale is yet to happen. Nevertheless, ongoing developments show clear value for citizens, businesses and public authorities.

The webinar focused on location interoperability by explaining why interoperability matters in blockchain and the current state of play in working towards standards and interoperable solutions. As mentioned, it was emphasised that there is a need for continued support to the development, uptake and dissemination of commonly agreed-upon standards for blockchain and distributed ledger technologies.

Concerning digital transformation and innovation, blockchain technology is recognised by the European Commission as one of the key emerging technologies that are shaping the future. As stated by Roberto Viola, Director-General, DG CONNECT: "*Europe's ambition is to set the gold standard for blockchain technologies. We have implemented a strong regulatory and policy framework that supports sustainable blockchain innovation as well as the start-up and scaleup ecosystems. Administrations across Europe play a trailblazing role in implementing this exciting and essential new technology.*"[59]. Throughout the presentation and as part of the conclusions, the need for continued support to upscale innovation and enable large-scale uptake was emphasised.

[59] https://ec.europa.eu/digital-single-market/en/news/european-blockchain-strategy-brochure

Webinar #9. Modelling, simulation and prediction

Webinar details

Title	Geospatially enabled modelling, simulation and prediction	
Speakers	Danny Vandenbroucke (KU Leuven) and Chris Little (UK MET Office)	
Event announcement		https://joinup.ec.europa.eu/node/703928
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703950
	Video	https://www.youtube.com/watch?v=rrg55wKroGQ
Date of the webinar	21/01/2021	
Keywords	Geospatial modelling, simulation and prediction; weather forecasting; agent-based modelling; geospatial interoperability; location intelligence	

Summary of the topic

The webinar **started with some high-level messages**:

- Modelling, simulation and prediction are not new: GIS has always been an advanced technology to model and simulate, but recent developments create new challenges and opportunities.
- Some sectors are more advanced concerning the integration of models, simulations and prediction techniques.
- Specific efforts are needed for reaching interoperability in modelling, simulation and prediction.

The webinar aimed to provide examples showing how many sectors are evolving towards integrating models, simulation and predictive techniques: weather and climate, transport and mobility, health (COVID-19), water and forest management, security and disaster management … and many more.

Section two focused on some key definitions, including the similarities and differences between modelling, simulation and prediction. In the TechTrends mindmap of OGC, two branches are relevant:

- modelling, analysis and prediction and
- simulation and gaming.

Modelling, simulation and prediction are different but interconnected concepts and techniques. "*Modelling*" is the devising or use of abstract or mathematical models, while "*simulation*" is the imitation of a situation or process and prediction is the action of predicting something in the future (future state or behaviour).

Besides those three key concepts, there is also "*forecasting*" that predicts or estimates a future event or trend. Modelling and simulation require interaction with a representation of the real world, while prediction largely depends on user interaction. Moreover, simulation and prediction aim to analyse some phenomenon while modelling establishes the domain of analysis.

Modelling can be done from different perspectives: static, i.e. by describing a quantity that characterises the state of a physical system (Lagrange function) or dynamic, i.e. allowing interactions with the real world according to a pathway (Eulerian trail).

Section three looked back to the past since modelling, simulation and prediction are not entirely new in the geospatial field. A geographic information system (GIS) is a framework for gathering, managing, and analysing data.

Rooted in the science of geography, GIS integrates many types of data. It analyses spatial location and organises layers of information into visualisations using maps and 3D scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships, and situations—helping users make smarter decisions.

GIS technology emerged in the 70s and evolved gradually into real modelling engines, although GIS and models were still separated (different software). For decades, GIS has been used, such as hydrological and hydraulic modelling for simulating floods and traffic modelling to simulate traffic flows, congestions, etc. In flood modelling, this usually resulted in generating a 'static' layer that can then be handled in a GIS to map and analyse with other data. However, this type of modelling has significant limitations:

- GIS and models are still separate – GIS layers, other data (e.g. weather data) are used as input to the model, the output is going back to GIS;
- The need to regularly run the model, with new data, because of new human intervention (e.g. new dykes in case of flood models) and
- From simple 'models' (risk assessment based on a DTM) to more complex ones (integrating hydrology, hydraulics …). The simple ones provide limited insights. This type of modelling also required a lot of manual work/interventions.

The speakers zoomed in on two examples in section four: weather forecasting and agent-based modelling for traffic management. Weather forecasting is a 'classical' example that most citizens are familiar with. Forecast is based on a series of physical laws like, for example, Newton's law on motion, the hydrostatic law, the first law of thermodynamics, etc. Weather forecasting is about complex, interrelated phenomena: temperature, pressure, humidity, visibility, cloud, wind, snow, rain … Several operational websites provide this service, some examples are: global weather forecasting (windy.com), severe weather information centre (https://severeweather.wmo.int/, WMO), tropical storms (WMO, http://www.wmo.int/pages/prog/www/tcp/index_en.html).

Some considerations should be made:

- some of the parameters are harder to forecast (e.g. rain);
- the issue of scale is important, and
- The models need to deal with uncertainty.
- Forecasting is more and more following an integrated approach for hazard prediction, monitoring and risk assessment, including potential impacts on the economy/society.

The second example pertains to agent-based modelling in the transportation sector, specifically in traffic management (parking management). Finding parking spaces is a problem almost everywhere in the world. A study in the UK (Daily Mail[60], 2017) found out that drivers spend two days a year trying to find a parking space - and it costs motorists £733 each in time and fuel. In Belgium, SUSTAPARK was set up to develop a method and a tool for providing strategic advice on urban parking planning, evaluation & simulation based on agent-based modelling techniques. The latter refers to simulating actions and interactions of autonomous individuals (agents) in a network to predict the actions of complex phenomena (Dieussaert et al.[61], 2009). Simulation characteristics were as follows:

- One day periods for data collection.
- A temporal resolution of one second.
- A spatial resolution at the level of the street segment.
- A group of agents representing the driver population and agents' movements based on activity schedules.

The modelling required an 'intelligent' road network consisting of geospatial and non-geospatial data. The modelling itself included:

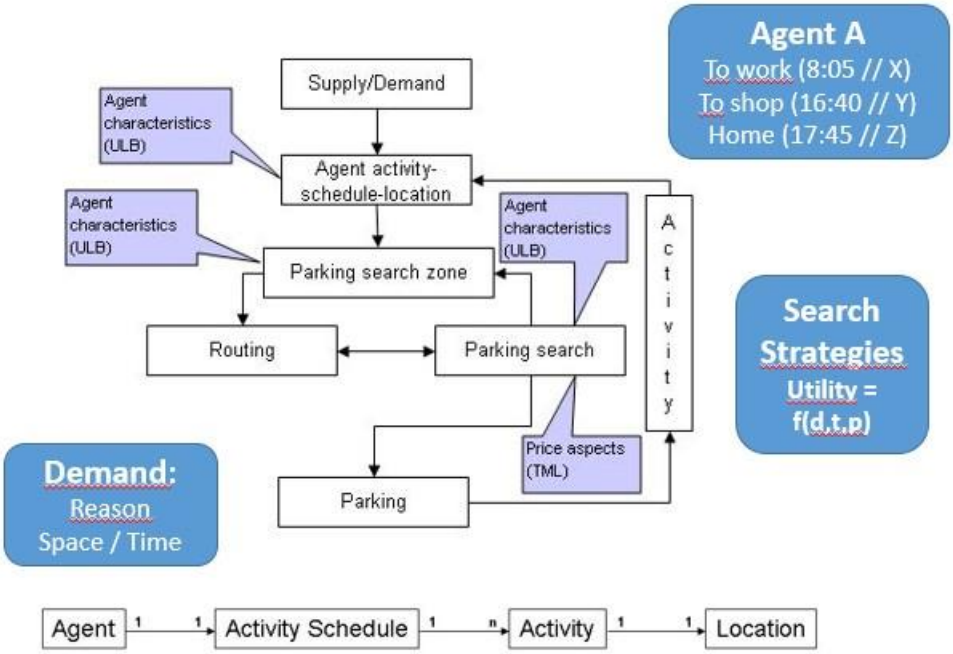
- supply and demand for parking spaces;
- detailed activity logs of drivers;

[60] The Daily Mail referred to a study by Inrix which was using own surveys and keeps a database with traffic information.

[61] Karel Dieussaert, Koen Aerts, Thérèse Steenberghen, Sven Maerivoet, Karel Spitaels . SUSTAPARK: An agent-based model for simulating parking search, AGILE Conference 2009

— parking search behaviour data, etc.

Figure 10: Agent-Based Modelling techniques for finding optimal new parking spaces



Source: Dieussaert et al., 2009[62]

Agent-Based Modelling in SUSTAPARK has been used, among others, to plan new (central) parking spaces to implement pricing schemes. Other things could be added, such as integrating different transport networks (multi-mode) or ecological parameters.

Section five summarised some of the interoperability challenges. An overview was given of the different Standards Development Organisations (SDO) active in the field. Although the overview was far from complete, it included the OGC with several relevant Domain Working Groups (DWG) currently active:

— Interoperable Simulation and Gaming DWG;
— Meteo & Ocean DWG;
— hydrology DWG …

ISO/TC 204 on Intelligent Transport Systems (ITS) was given as an example for the transport sector. Dedicated standardisation initiatives also exist, such as OpenMI.org. Several OGC standards, such as Web Processing Services (WPS), are used in the context of modelling, while the OpenMI Association is an SDO active in the field of hydraulic and hydrological modelling. As part of GEOSS developments (Earth Observation), the Geo model web initiative was mentioned.

Finally, section six identified some conclusions and challenges.

— The use of modelling, simulation and prediction techniques is not entirely new to the geospatial world; GIS has always been used to analyse, model, and simulate.
— Modelling, simulation and prediction techniques are used in many application domains: climate change, weather forecasting, transport modelling, the spread of pandemic diseases, environmental and water managemen …

[62] Karel Dieussaert, Koen Aerts, Thérèse Steenberghen, Sven Maerivoet, Karel Spitaels . SUSTAPARK: An agent-based model for simulating parking search, AGILE Conference 2009

— Several geospatial standards are available or under development to support modelling, simulation and prediction activities: OGC and dedicated initiatives exist or have seen the light recently.

There are also challenges:

— There is the growth of vast amounts of data from sensors, satellite imagery …, which provides new opportunities for more advanced MSP; at the same time, this is a challenge.
— Recent technological developments (SWE, IoT, AI …) will make future modelling, simulation and prediction richer and more robust, leading to improved usability.
— Finally, the dedicated initiative to evolve towards a dynamic web of models rather than a web of data/information is promising and should get more attention.

Summary of Q&A discussion

One participant raised the **issue of loosely versus tightly coupled models** for simulating and predicting phenomena or behaviour. The loosely coupled models are fine, but they are limited in what you can do with them. In meteorology, they must be tightly coupled since they require a lot of real-time data, which takes time and which is costly. Results are needed in almost real-time. That is why OpenMI as a solution for models does not apply to the meteorological world.

One question was raised, which initiated a long discussion: ***"How to prepare and communicate uncertainties to the end-users and different communities of the models, simulations and predictions****?*" The meteorological world is trying to handle this, although it is not easy. If a MET Office predicts that the next day there is a 50% chance for rain, this might be true for some parts of the country, but not for others, e.g. uphill they might have the full day of intense rain, while the other side of the mountain they see no rain at all. So the user perception will be that the prediction is erroneous. So location, but also time, might play a role and affect the probability. However, people are used to weather forecasting and already include an error margin when they hear the predictions. This might be different for the case of flooding: "*Is my house in a flood risk area, and how exact is this?*" How to visualise this uncertainty. In the case of flood mapping, which is used for taking political or administrative decisions (e.g. delivering a building permit or not), some techniques take this uncertainty into account. For example, in Belgium, insurance companies take the modelled flood risk areas into account but add a buffer around them as a margin to deal with a certain extent of uncertainty. According to Little, it is even more complex because time plays an important role.

In some cases, flooding takes days before it becomes visible (after the rainfall). In other cases, it is a matter of minutes. Also, cultural aspects play a role. For example, in Japan, citizens react immediately, e.g. when a tsunami alarm is given; in the UK, people are not trained for such situations.

Another question has to do with the **software and frameworks used for modelling**. In the case of flood modelling, SHE/MIKE and similar software were mentioned. In contrast, for SUSTAPARK, the modelling was done within a regular GIS. The amounts of data in the latter case were limited since the focus was on the city of Leuven, not the entire country.

Another question raised was, "***What about the preservation of modelled, simulated or similar data? How to preserve data over a longer period of time? Is it useful/necessary****?*"

In the case of agent-based modelling, preserving the data over a long time might be limited. Still, in other cases, such as weather forecasting and weather data and flood simulations, this might be more relevant. For example, weather forecasting and flood modelling also rely on historical data, while the mapping for a specific place at a specific time is less relevant over time. For some applications, such as climate change modelling, historical data is crucial. Additionally, the interoperability challenge is a key issue. Suppose you want to compare situations at local levels or across borders. In that case, you need to work with similar models, and data input needs to be standardised.

The last question was related to the **link between modelling, simulation and prediction and the use of AI**. Examples were given of the use of Artificial Intelligence (AI) for Agent-Based Modelling (ABM) in traffic

management and to automate some of the processing. So AI for ABM is already being applied to some extent, but it is clear that much more is possible.

Measured impact

Registrations	59
Attendees	34
Polling insights	[No polls organised]

Conclusions

The use of modelling, simulation and prediction techniques is not new to the geospatial world. GIS has always been used to analyse, model, and simulate. However, current environmental, societal, and economic challenges lead to more complex questions to be answered, processed and analysed. Consequently, models, simulators… are becoming more sophisticated as well. They are used in many application domains: climate change monitoring, weather forecasting, transport modelling, the spread of pandemic diseases, environmental and water management… Several geospatial standards are available or under development to support modelling, simulation and prediction activities: OGC and dedicated initiatives exist or have seen the light recently. The vast amounts of data and new technological developments, among others Artificial Intelligence, will help to make the modelling, simulation and prediction even more precise and close to reality. One of the significant challenges raised during the Q&A is how one can deal with the uncertainty aspects: how to measure and communicate them? And, will people using the information coming from the models be able to understand this uncertainty?

Webinar #10. Immersive realities and location for better public services

Webinar details

Title	Immersive realities and location for better public services	
Speakers	Danny Vandenbroucke (KU Leuven) and Vincente Bayarri (GIM Geomatics)	
Event announcement		https://joinup.ec.europa.eu/node/704224
Supporting materials	Slides	https://joinup.ec.europa.eu/node/703950
	Video	https://www.youtube.com/watch?v=PPsLH5oodIQ
Date of the webinar	15/04/2021	
Keywords	Immersive visualization, Virtual Reality, Augmented Reality, Mixed Reality, Geospatial interoperability	

Summary of the topic

Over the past years, new visualisation techniques have seen the light: Virtual Reality (VR), which has been used for many years, e.g. in flight simulators, to simulate the approach of an aeroplane to the runaway of an airport. More recently, especially with the development of powerful smartphones and other mobile devices, Augmented Reality (AR) emerged as a technique to combine pictures or videos on the screens with information from the internet (e.g. restaurant, hotel and other information in a street view).

These techniques are combined and applied in different sectors such as spatial planning, military exercises, aeronautics, environmental monitoring, (city) tourism, management of cultural heritage sites, underground assets, etc.

There is a huge potential to integrate those techniques in location-enabled public services. The webinar provides examples, zooms in on a few of them, and looks into the key interoperability challenges and ongoing efforts.

The **webinar started with a few key take-ways messages**:

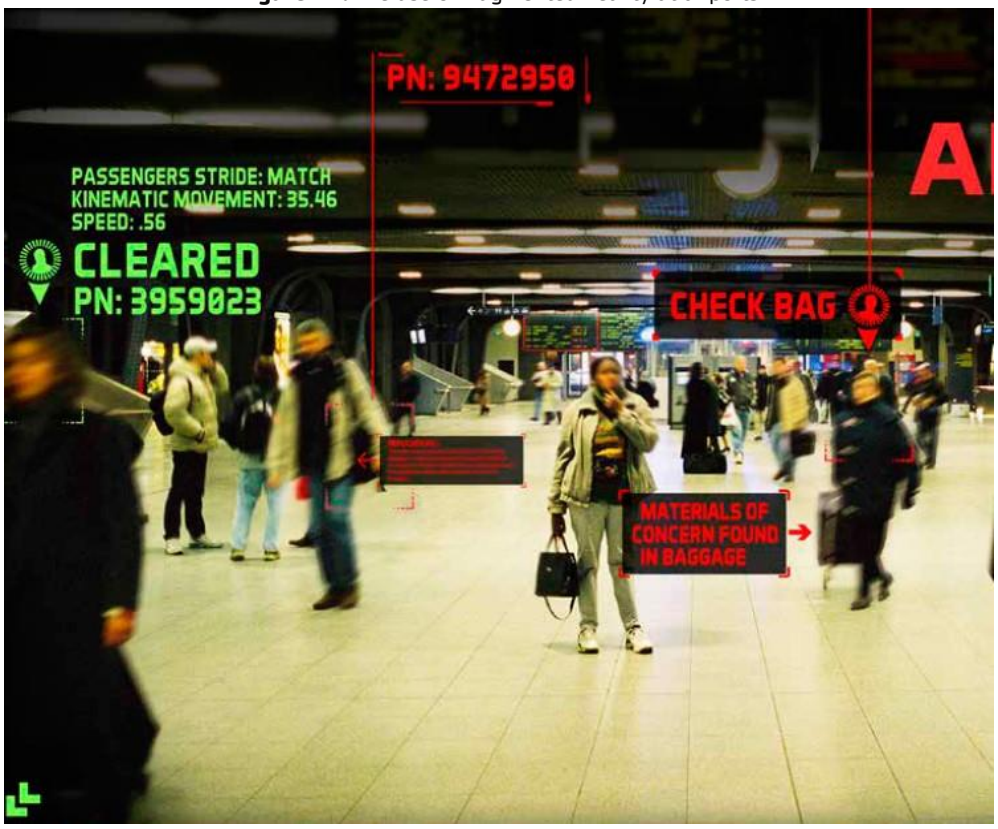
- Immersive visualisations exist for some time: first VR, then AR and more and more MR. They very often have a location component.
- VR, AR, MR … are based on technological developments, both hardware- and data-related developments.
- Although relatively few are operational, there are many applications, including in the public sector, while more opportunities lie ahead. Examples can be found in security, health, tourism, transport, spatial planning, emergency, education …

Section one (Virtual, Augmented, Mixed and Extended Reality. *What are they?*) made clear the different forms of immersive visualisations.

Virtual Reality (VR) refers to a *computer-generated simulation in which a person can interact within an artificial three-dimensional environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors. In this simulated artificial environment, the user can have a realistic feeling experience* (Mitchell, 2020). Many VR examples can be given from the entertainment sector, the military, aeronautics, commercial applications.

Augmented Reality (AR), on the other hand, is an *interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities including visual, audio …* (Schueffel, 2017). The same fields of application emerge here, although tourism and cultural heritage sectors are prominent.

Figure 11: The use of Augmented Reality at airports



Source: Deloitte, 2013[63]

Virtual Reality is a little bit older, and more (scientific) publications exist. According to the Gartner hype cycle, they are both over the top of the curve. **Mixed Reality** *is a blend of physical and digital worlds, unlocking the links between human, computer, and environment interaction. This new reality is based on advancements in computer vision, graphical processing power, display technology, and input systems* (Microsoft, 2020). The dimension that is added here is the interaction that takes place between computers and the (physical) environment: it can be location, object recognition, light, sound, etc. Consequently, Mixed Reality is moving between the virtual and real worlds. Extended Reality is used as an umbrella term for all the different types of realities.

Influential in all these developments is that they are based on hardware and data developments. Hardware includes, among others, more powerful computers and computer graphics, gaming consoles, mobile developments (smartphones, tablets, smartwatches…), sensors, holographic & immersive devices, eyewear… and more. 'Soft' developments include modelling, simulation, prediction; gaming industry; 3D visualisation and BIM; Digital Twins; integrated applications; dynamic data flow & big data, etc.

Section two zoomed in on immersive visualisation for public services and highlighted that immersive visualisations are not only limited to the entertainment sector. Several examples were given to illustrate the applicability of immersive visualisation techniques in spatial planning, defence, management of cultural heritage, tourism, management of underground assets and conducting public works, etc.

— The example of the city of Helsinki providing potential tourists with a tour of the city during different seasons was showcased. The Finish VR application starts from the Digital Twin that is being developed for the city. "*Virtual Helsinki - Sound of Seasons*" takes the audience through all four seasons of the year. The experience starts with Helsinki's famous landmark, the empire-style Senate Square and the White Church.

[63] Doolin, C., Holden, A. and Zinsou, V. (2013). Augmented Government. Transforming Government Services through Augmented Reality (Deloitte). https://www2.deloitte.com/content/dam/Deloitte/us/Documents/public-sector/us-fed-augmented-government.pdf

The tour continues to the home of architect Alvar Aalto, the father of Nordic design. Finally, you will end up admiring the city skyline and the nature of Lonna Island[64].

- The other example provided was in the healthcare sector, a joint initiative of the New York Times, scientists and public sector bodies to create awareness among the public about social distancing and wearing masks and the effect on the spreading (and containment) of the virus. Scientists are learning about the novel coronavirus in real-time, and those who study similar respiratory illnesses say that until it is better understood, no guideline is likely to offer perfect safety. Instead, understanding the possible transmission routes for the virus can help us see why keeping our distance is important[65].
- The third example was on the transport sector and security at airports, particularly in the US; AR is used to screen passengers[66].

The section ended with the question of how one can measure governments' readiness to embrace those technologies by answering five questions:

1) Who in the organisation requires real-time information?;
2) What are the technology and data requirements? Do we have these?;
3) What are the human resources required?;
4) What are the risks for my organisation in using AR, VR ... and
5) What impact will the technology have on my mission-critical activities.

During **section three of the webinar, two examples were presented in more detail: one on underground asset management and the other on cultural heritage.**

The first case study is linked to the ARinfuse (Erasmus+ project), which aimed to infuse augmented reality for geospatial information management in the context of utility underground infrastructures. ICT connected with GNSS, GIS and geodatabases, and AR/VR offers the possibility to convert the geospatial information of the underground utilities into a powerful tool for field workers, engineers and managers. The project worked on several real-world cases in Cyprus, Belgium and Italy. A series of training modules and an AR tool were developed. Data and technological challenges were also described during the webinar, including how they were tackled in the different pilots. A video was shown on AR for managing the underground in a similar case in Spain. The second case study related to VR application for preserving the cave of Altamira developed and presented by Vincente Bayarri from GIM Geomatics (Spain). The Strategy of the Management System: "*Altamira 8D*" was presented and discussed and then illustrated through an animation. The data collection and integration cycle was explained and illustrated, resulting in an impressive 3D model of the cave. The whole system is in use by the museum of Altamira with some relevant figures: the premiere in the temporal exposition "*The art of reproducing Art*" (December 2018) was seen by 100.000 visitors, while the internet videos attracted 74.500 visualisations.

In section four, some interoperability efforts and challenges were highlighted. The most relevant standardisation initiatives in VR, AR and MR, were presented in the first place. These include SDO's such as ISO - Computer graphics, image processing and environmental data representation (ISO/IEC JTC 1/SC 24), Institute of Electrical and Electronics Engineers (IEEE) with the P2048.1-5 series of standards, as well as ETSI.

The Open Geospatial Consortium covers several relevant aspects too; its TechTrends watch covers and follows different aspects such as Immersive Visualisation: VR, MR, AR; LIDAR Scanning; Edge Computing; 5G Cellular; Indoor Positioning; 3D Model Creation; Indoor models; Underground; Simulation and Gaming; and Web of Data, Linked Data. Several Standardisation Working Groups are active in these related fields, including the Geopose and MUDDI SWG. Other consortia's role was mentioned: Web3D, KHRONOS Group and the Open AR Cloud Association. One of the major challenges was highlighted: i.e. the discoverability of AR resources.

[64] http://www.virtualhelsinki.fi/
[65] https://www.nytimes.com/interactive/2020/04/14/science/coronavirus-transmission-cough-6-feet-ar-ul.html
[66] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/public-sector/us-fed-augmented-government.pdf

The **webinar ended with some key take-ways messages and the main challenges** that lie ahead.

- Immersive visualisation techniques have existed for some time. They can take different forms: from entirely virtual (VR) to forms that are closer to the real world (AR). Mixed Realities (MR) seem to be the most promising development.
- VR-AR-MR can be exploited fully when dedicated hardware devices such as specialised eyewear are used. However, also more common devices such as smartphones bring immersive visualisation technology usable by all.
- Public Authorities and Governments can use the technologies to enhance existing public services or create new innovative services for citizens in many domains.

The challenges and priorities mentioned were also threefold.

- VR, AR, MR require high-quality base data, of which a lot is location-based. 3D is a must, while the right attributes must be available to create 'real-world' user experiences.
- Implementing immersive visualisation technology requires good multidisciplinary collaboration and expertise in the field of ICT, computer vision (VR, AR, MR), location data and technologies, etc.
- There are still existing barriers that impede the use of VR, AR, MR based content, among others: the discoverability of such content. There is a clear need for standardisation as well, with several SDO's involved.

Summary of Q&A discussion

Several questions were raised after the presentation. The first question related to the data integration challenge in the Altamira case. For this case, **very diverse data was collected and integrated, including analogue data from scientific publications, which is not so obvious. How was this done**? Vincente Bayarri responded to this question. Since the cave was discovered in 1968, scientists and other people have been working in the cave, collecting a lot of information of different nature: topographic maps, 3D data with ground penetration radar technology, GPS measurements, data from drones, but also data on the weather, excavation, art-artefacts with their position and description, pollen-studies, pictures, etc. The data scientists created a kind of data container to capture and integrate all these data, but it was feasible since it was spread over a long period.

A public data provider posed a second question: **what can such a provider do to prepare data for VR/AR.** Danny Vandenbroucke stressed that the ARInfuse project was not an operational project but allowed to learn from their case-based set-up in Cyprus, Belgium, Italy. It became clear that they needed to prepare the data by pre-processing them and completing missing data, e.g. some attributes. So, it is correct that not every existing spatial data infrastructure is ready to implement immersive visualization techniques. Several conditions must be met. First, 3D is a must for implementing VR/AR. Several European SDI's are working towards this (one of the participants in the webinar from the NL indicated a full 3D dataset, the BAG – Building and Addresses for the whole territory: https://3dbag.nl/). Furthermore, there is also a need for a specific Quality Assurance procedure. It would be good to have some guidance documents (checklists) on assessing existing geospatial datasets on their readiness for VR/AR/MR. Finally, the Helsinki example also showed that when and SDI has evolved towards a Digital Twin, the latter is an excellent starting point for implementing VR/AR/MR.

The last question related to **how Altamira's life data, e.g. on crowd control, could be integrated**. Vincente Bayarri explained that the project looks into this since the cave is becoming more vulnerable because of the changing weather patterns. So in view of the sustainability of the cave, information is being gathered on visitors and on mechanisms to monitor visitor flows better. Of course, this requires adding another layer of information (part of 7D and 8D of the model applied).

Measured impact

Registrations	51
Attendees	29
Polling insights	**Sectors attendees (Poll 1 – 15 answers):** — European Public Administration 3 — National Public Administration 8 — Regional/Local Public Administration 1 — NGO 1 — Private Sector – SME 1 — Academia/Research 1 **Prior knowledge (Poll 2 – 18 answers):** — I heard about VR/AR/MR but had a very superficial knowledge 14 — I worked myself with VR 2 — I consider myself expert an expert in the domain of immersive visualisation 2
	Several polls were held along the webinar **Most promising sectors for VR/AR/MR (Poll 3 – 20 answers)** — Military 1 — Healthcare 2 — Environmental monitoring 1 — Tourism & Culture 5 — Education 3 — Transport & Mobility 1 — Spatial planning 7 **Main barriers for implementing VR/AR/MR (Poll 4 – 15 answers)** — A lack of expertise and skills for implementing these techniques 5 — Time consuming work to bring together, prepare and manage the data 4 — A lack of high-quality 3D data 3 — VR, AR and MR are still seen as “nice-to-have” but not a necessity, the benefits are not clear 3 (**Planned) activities on VR/AR/MR (Poll 5 – 13 answers)** — Tests are currently occurring, but no operational implementation yet 4 — Some departments are planning to test the techniques 5 — Management is thinking about it, or it is part of their strategy 3 — Not at all 1

Conclusions

Although **immersive visualisation techniques** have existed for some time, they **have recently received more attention in the geospatial field** (even though the Gartner curve indicates they are in the downwards part of the curve). Immersive visualisation techniques can take different forms: from entirely virtual (VR) to forms that are closer to the real world (AR). Mixed Realities (MR) seem to be the most promising development. VR-AR-MR can be exploited fully when dedicated hardware devices such as specialised eyewear are used. However, also more common devices such as smartphones bring immersive visualisation technology usable by all. Public Authorities and Governments can use the technologies to enhance existing public services or create new innovative services for citizens in many domains such as security, health, tourism, transport, spatial planning, emergency, and education.

The examples shown in the webinar illustrate that **VR, AR, MR require high-quality base data**, of which a lot is location-based. It is clear, also from the Q&A session, that 3D is a must, while the right attributes must be available to create 'real-world' user experiences. The Altamira case (VR) example shows that **implementing immersive visualisation technology requires good multidisciplinary collaboration and expertise** in ICT, computer vision (VR, AR, MR), location data and technologies, etc. Finally, there are still existing barriers that impede the use of VR, AR, MR based content, among others: the discoverability of such content. There is a clear need for standardisation as well, with several SDO's involved. From the discussion, it also became clear that public authorities might need some support in the form of guidelines on assessing the readiness of their data (infrastructure) for implementing VR/AR/MR.

From the polls, it can be learned that most attendees work for national public authorities (53%) and that the majority (78%) heard about VR/AR/MR but had a very superficial knowledge before the webinar. The question in which sector VR/AR/MR might be most useful/applicable, spatial planning (35%) and tourism/cultural heritage (25%), scored highest. The most significant barrier to implementing immersive visualization techniques is a lack of expertise and skills (33%). Finally, almost 70% of the attendees said their organisation plans or already tested VR/AR/MR.

4 Conclusions

4.1 Location interoperability, digital transformation and innovation

Based on the individual webinar reports, some conclusions can be drawn and lessons learned regarding the added value, challenges and outlook for each of the technologies and approaches explored in the webinars. In addition, the links of these topics with location interoperability, digital transformation and innovation can be extracted.

- The webinar on *"**Location Intelligence and Partnerships to support the Sustainable Development Goals (SDG)**"* demonstrated that innovative approaches to data ecosystems using location data and technologies could support the achievement of the SDGs. This requires well-functioning partnerships, which will require increased awareness of key stakeholders about the advantages of sharing data and addressing sustainability and institutionalisation of partnerships and ecosystems. Looking ahead, new trends in geospatial (use of EO, Big Data and AI) show high potential for an increased role of location data in promoting the SDGs, going beyond monitoring and statistical purposes.
- The second webinar, ***"Digital Twins – are they ready to embrace the benefits of Location Information?"*** illustrated that location data and technologies are the fuel for Digital Twins. These technologies allow more advanced simulation and prediction taking into account real-world conditions and using real-time data. They can be drivers of innovation and digital transformation of Government. However, a fundamental challenge is to address interoperability issues in the context of Digital Twins developments through specific standardisation efforts.
- The webinar ***"Geospatial Data and Artificial Intelligence – a deep dive into GeoAI"*** highlighted how two technologies can be integrated to create powerful and innovative tools for better and more timely decision making and policymaking. GeoAI techniques can further public sector capabilities in moving from reactive to predictive, producing new and innovative solutions. To realise digital transformation, key challenges remain, such as interoperability through standardisation, human trust and regulation. However, there are also considerable opportunities looking ahead, including market growth, with these technologies can contribute to the European Circular economy and help address both local and global challenges.
- The fourth webinar zoomed in on ***"Location Intelligence for Cities and Regions: preparing the ground for smart places of the future"***. Smart governments take advantage of technological advancements that significantly change how they collect, manage, exploit, and share location data. Relevant emerging technologies include IoT, big data, artificial intelligence, and immersive technologies. Smart government organisations unlock the falling value of location data by establishing solid data ecosystems and collaborating with other key stakeholders. The speakers showcased very well through several examples of how cities and regions can become smart. A challenge is to ensure policy alignment between different levels of government, including a range of subnational organisations.
- The ***"Monitoring and understanding emerging geospatial technologies"*** webinar illustrated the need to continuously follow up, understand and test new technological and non-technological developments. This allows governments to make more informed decisions on when a new technology can and should be implemented and used within their different administrative work processes and support decision and policymaking. It is important to understand how different technologies can be used together and define implementation cases. Key challenges include adapting traditional SDIs to allow storage, management, handling, and access to more dynamic data. In addition, greater collaboration between standardisation bodies and new standardisation bodies is required.
- The sixth webinar on ***"Location enabled public services"*** investigated the potential of these services. Capitalising on data availability, software and hardware, volunteered information, and processes can lead to significant collaborative opportunities, cost efficiencies, and service quality improvements. However, to get there, there is a need to improve interoperability between services & borders, improve data maturity, focus on trust, privacy & protection in policy and strengthen technical capacities. It is also necessary to minimise the gaps at the local, regional, national levels and across the borders. Despite these challenges, there is growing momentum for the uptake of location-enabled public services
- The webinar ***"Geodata marketplaces supporting location intelligence"*** illustrated the link between location interoperability, digital transformation and innovation. Although geodata marketplaces have already existed for a while, recent developments have paved the way for new and improved ways of

exchanging, providing and using data. Ecosystems are set up around these marketplaces, allowing for greater collaboration can lead to improved service quality and effectiveness.

- The eighth webinar, ***"Blockchain and proof of location supporting the digital government",*** zoomed in on the potential for blockchain to support the government's digital transformation. The architectural setup of blockchain applications can increase trust and may be the preferred option for location-based public services when there is a particular need for security. Meanwhile, smart contracts can enable further automation and trust between multiple parties. Additional work on standards, interoperability and an enabling policy environment is required in this area. Ongoing developments show already clearly the value for citizens, businesses and public authorities.
- The *"**Geospatially enabled modelling, simulation and prediction"*** webinar demonstrated through various examples how techniques for modelling, simulating and predicting future states can help decision-making and policy-making. Location data and technologies can help define different scenarios based on (near) real-time data. New technological developments are timely since current environmental, societal, and economic challenges lead to more complex questions to be answered, processed, and analysed. Challenges include implementing cross-sectoral and multi-disciplinary collaboration to fit and operate increasingly sophisticated and complex models and simulators.
- The last webinar, ***"Immersive realities and location for better public services"****, zoomed in on Virtual, Augmented and Mixed Reality techniques*. These techniques can be used to enhance existing location-enabled public services or create new innovative services. Supporting devices are required to implement solutions with immersive visualisation techniques. These can go from 'simple' smartphones up to specialized eyewear and can be implemented in various domains: from tourism over spatial planning to the management of underground assets. A key challenge for these techniques is collecting the high-quality base (location) data they often require. Collection must be done in a standardised way to overcome interoperability issues. Work is also needed to promote the discoverability of VR, AR and MR content.

Overall the webinars have contributed to raising awareness of various emerging technologies, techniques and approaches that leverage location data. Looking ahead, a common challenge to address is the need to promote multi-disciplinary collaboration. Further exploitation and development of the new technologies and approaches examined often require expertise from multiple sectors and organisations, such as VR/AR/MR, modelling, and simulation. In addition, further focus on standardisation efforts, including collaboration between different standardisation organisations required to ensure the new technological approaches developed are interoperable. Despite these challenges, the technologies, techniques and approaches highlighted have a high potential to contribute to new or enhanced digital public services.

4.2 Lessons learned on *Transferring Knowledge*

The ten webinars succeeded in reaching a large number of stakeholders. Over the year, **490 participants** took part in the ten webinars organised. For the most part, the highest attended webinars were organised at the start of the year. The **lower attendance during the later webinars may in part reflect webinar "fatigue**", with some participants only willing to attend a limited number of such events. It is worthwhile considering whether the right balance between the total number of webinars organised and the depth of each one was found. However, the lowest number of webinar participants was 29, suggesting that **there remained a demand for the format and content shared**, even with many webinars. Another factor driving attendance may also be the extent to which there is already some awareness of the topic by the target audience. Illustrating this, among the highest attended webinars were those focused on artificial intelligence, blockchain, and smart cities.

Important elements taken into account while scheduling the webinars included **avoiding calendar clashes** with important events attended by the targeted stakeholders or with holidays. It is preferable to maintain a regular schedule (e.g. once a month at the same date and hour). **An indicative calendar of the topics to be tackled should be published** and scheduled as far in advance as feasible, for example, for the upcoming three months. No particular issues were encountered with the timing of the webinars (generally 14h on Thursdays). The webinar length was restricted to one hour for all webinars, which proved a good duration – longer risks losing participant attention. At the same time, shorter may not allow for the proper elaboration of the topic.

The most common category of participants was representatives of national public administrations. This is a key stakeholder group to attract to promote common thinking and eventual joint action on emerging geospatial issues explored. The polling data collected did not indicate how participants worked – whether directly in the geospatial domain or in some other domain. For future work, this is information worth collecting as one priority going forward may be the communication of the relevance of geospatial technologies and data to those working in other domains.

Polling has proven valuable for keeping participants engaged in the webinar content. The Q&A sessions were also a good way to enable this. Care should be taken to ensure the webinar runs on time to avoid these concluding Q&A sessions being cut down in time. The **involvement of guest speakers was also a successful feature** of the later webinars, ensuring additional expertise on the specific topics investigated and added value to the webinars. The ideal guest speaker has practical experience with the technology or approach being discussed (i.e. they have worked directly on a project using that technology or approach.

Box 2: Recommendations for future webinars

- Maintain webinar length at one hour maximum;
- Invite guest speakers. Ideally, these speakers should have practical experience in the topic being discussed;
- Make use of polling and to increase participant engagement;
- Ensure the webinar runs as scheduled to allow sufficient time for a concluding Q&A session;
- Schedule the webinars at regular intervals (e.g. once a month on the same day and time). Share the topics of the webinars in advance as feasible (e.g. the topics for the upcoming three webinars);
- Collect information on participants, including whether they primarily work inside or outside the geospatial domain.

Overall, the webinars covered various topics and introduced various stakeholders to emerging topics in the geospatial domain. They are a successful format that should be continued. They have contributed to the knowledge transfer objectives of the ELISE Action, educating its stakeholders of developments in a number of relevant technological fields and helping to build an informed community. Future webinars could include APIs, cloud, fog and edge computing, internet of things, and autonomous things.

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Annex A – List of case studies analysed during the webinars

Table 2: List of case studies

Webinar	Case study	Presenter	Link
Location Intelligence and Partnerships to support the Sustainable Development Goals	Ireland Sustainable Development Hub (Ordnance Survey Ireland, the Central Statistics Office and Esri Ireland).	Lea Ytrehus (Deloitte Belgium)	https://irelandsdg.geohive.ie/
	HungerMap LIVE (World Food Program and Alibaba Cloud)	Martina Barbero (Deloitte Belgium)	https://hungermap.wfp.org/
	The Atlantic Water Network of open water sources in Canada	Martina Barbero (Deloitte Belgium)	https://atlwaternetwork.ca/
	Location intelligence for development: responses to Covid-19, highlighting the Covid-19 Mobility Monitoring Project, the Social Distancing Scoreboard and ShopSafe.	Martina Barbero (Deloitte Belgium)	https://covid19mm.github.io/ https://www.unacast.com/covid19/social-distancing-scoreboard https://play.google.com/store/apps/details?id=com.endare.supermeter&hl=en
	OneSoil: AI detected fields and crops	Lea Ytrehus (Deloitte Belgium)	https://map.onesoil.ai/2018#2/44.35/-43.66
	Ocean Cleanup	Lea Ytrehus (Deloitte Belgium)	https://theoceancleanup.com/
Digital Twins – Are they ready to embrace the benefits of Location Information?	Destination Earth	Glenn Vancauwenberghe (KU Leuven)	https://ec.europa.eu/digital-single-market/en/destination-earth-destine
	Digital Twin of the Ocean	Glenn Vancauwenberghe (KU Leuven)	https://marine.copernicus.eu/news/ocean-and-its-digital-twin-whats-copernicus-marine
	National Digital Twin for the United Kingdom	Glenn Vancauwenberghe (KU Leuven)	https://www.cdbb.cam.ac.uk/news/approach-delivery-national-digital-twin-united-kingdom

Webinar	Case study	Presenter	Link
	New South Wales (NSW) Spatial Digital Twin	Glenn Vancauwenberghe (KU Leuven)	https://nsw.digitaltwin.terria.io/
	Digital twin of the city of Zurich	Glenn Vancauwenberghe (KU Leuven)	https://www.stadt-zuerich.ch/portal/de/index/politik_u_recht/stadtrat/weitere-politikfelder/smartcity/english/projects/zwilling.html
	Digital Underground	Glenn Vancauwenberghe (KU Leuven)	https://digitalunderground.sg/
	OneGeology 4.0	Glenn Vancauwenberghe (KU Leuven)	http://www.onegeology.org/docs/newsEvents/digital-Twin-leaflet.pdf
	DUET (Digital Urban European Twins)	Danny Vandenbroucke (KU Leuven)	https://www.digitalurbantwins.com/
Geospatial Data and Artificial Intelligence – a deep dive into GeoAI	OpenStreetMap Map with AI	Dhananjay Ippharti (Deloitte Belgium)	Https://mapwith.ai/#13/-7.95604/31.59543/0/55
	Breeze Technologies	Lea Ytrehus (Deloitte Belgium)	https://www.breeze-technologies.de/
	PulsAir	Lea Ytrehus (Deloitte Belgium)	http://www.project-pulse.eu/
Location Intelligence for Cities and Regions: preparing the ground for smart	The ObjectTypeLibrary from the Flanders Regional Public works Department	Thérèse Steenberghen (KU Leuven)	https://wegenenverkeer.data.vlaanderen.be/
	The FINEST Twins platform for cross-border collaboration between Helsinki and Estonia	Thérèse Steenberghen (KU Leuven)	https://forumvirium.fi/en/finest-smart-city/
	The IIsac-Watts smart energy solution in France	Thérèse Steenberghen (KU Leuven)	https://www.enr-citoyennes.fr/structures-reseaux/isac-watts/

Webinar	Case study	Presenter	Link
places of the future			
Monitoring and understanding emerging geospatial technologies	Technology Trends watch of the Open Geospatial Consortium (OGC)	Gobe Hobona (OGC)	https://www.ogc.org/OGCTechTrends
	EO4GEO: Monitoring technology trends for skills development	Danny Vandenbroucke (KU Leuven)	http://www.eo4geo.eu/
Location enabled public services	FixMyStreet	Lea Ytrehus (Deloitte Belgium)	https://fixmystreet.org/
	Transport for London(TfL)	Lea Ytrehus (Deloitte Belgium)	http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf
Geodata marketplaces supporting location intelligence	Esri's living atlas	Jill Saligoe-Simmel (Esri)	https://livingatlas.arcgis.com/en/home/
	Geodata hub	Valdis Karulis (Geodata hub)	https://www.geodatahub.eu/
	Carto's data observatory	Javier Perez Trufero (Carto)	https://carto.com/spatial-data-catalog/
Blockchain and proof of location supporting digital government	FOAM	Katya Zavyalova (CCO) and Ryan King (CEO) of FOAM	https://foam.space/
	Blockchain track-and-trace solution for Irish regulators	Damien Scanlon (Deloitte Ireland)	No link available
Geospatially enabled	Weather forecasting	Chris Little (UK Met Office)	No link available

Webinar	Case study	Presenter	Link
modelling, simulation and prediction	Agent-based modelling in traffic management	Danny Vandenbroucke (KU Leuven)	Karel Dieussaert, Koen Aerts, Thérèse Steenberghen, Sven Maerivoet, Karel Spitaels . SUSTAPARK: An agent-based model for simulating parking search, AGILE Conference 2009 https://agile-online.org/conference_paper/cds/agile_2009/agile_cd/pdfs/133.pdf
Immersive realities and location for better public services	Using Augmented Reality for managing underground assets	Danny Vandenbroucke (KU Leuven)	https://www.arinfuse.eu/
	The past in the future: Virtual reality to know the Altamira of the past	Vicente Bayarri (GIM Geomatics)	https://www.culturaydeporte.gob.es/mnaltamira/en/cueva-altamira/recorrido-virtual.html

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