



Advancing Role of Geospatial Knowledge Infrastructure in World Economy, Society and Environment

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Introduction

The 4th Industrial Revolution (4IR) is characterized by, amongst other things, Big Data, Artificial Intelligence, advanced robotics, automation, the web, smart technologies, and digital disruption. Several elements of the human, physical and digital environments have merged in the 4IR, leading to unprecedented societal changes. These changes embrace all aspects of life and living, including government policies and services, leisure, work, poverty, and industry and its products.

Users, human and machine, now want contextualised on-demand knowledge. As geolocation becomes ubiquitous, time and place become ever more powerful data attributes in providing that knowledge by helping answer the what, where, when, how, and why of things. Problems are solved, opportunities grabbed, services delivered, and decisions made through a partnership of users, data, technologies, and people interconnected through the web. The geospatial sector is at the core of this digital ecosystem.

“We don’t know when the next epidemic will strike, but I believe we can protect ourselves if we invest in better tools, a more effective early detection system, and a more robust global response system. There are also some interesting advances that leverage the power of computing to help predict where pandemics are likely to emerge and model different approaches to preventing or containing them.”

(Bill Gates)

To generate value, this digital ecosystem needs to integrate many varied data sources, including real-time, improved analytical capabilities, and make a move from data to knowledge services to solve real-world challenges, whether for humans or machines.¹ The geospatial sector is central to this, whether one off COVID-19 tracing apps or long term enablement of safe automated vehicles and drones on city streets.

4IR is changing the world and the geospatial sector must change with it. New technologies, varied data sources and user demand will require a next-generation geospatial infrastructure that embraces automation, dynamicity and real-time delivery of knowledge. There is just too much information for humans to process on their own in the time available to them. This paper introduces the way to enhance future value by releasing “the power of where”², that is, Geospatial Knowledge Infrastructure (GKI).

GKI provides the geospatial dimension to the 4IR technology, data and knowledge ecosystem, ensuring that the geospatial sector meets emerging user expectations. This paper starts a discussion that will continue through 2020, outlining the shape of geospatial knowledge in the decade ahead.

The Global Challenge

Much has been written about the major global challenges we all face; this is the context in which GKI operates. Let's shortlist some of the most pressing of these challenges of the next decade, all of which are linked:

1. Climate change is altering the very fabric of the earth's ecosystem on which we all depend. After decades of wrangling, many nations are now moving to implement carbon neutral policies. Hard, evidence-based decisions will have to be made by governments, businesses and citizens.
2. Urbanisation is making massive new demands on existing cities, particularly as their populations age. On the other hand, cities are also driving wealth and creating new economic opportunities. The sheer confinement of cities, people, assets and resources increases need for evidence-based decision-making that spans the long term to immediate.
3. Inequality is growing. The richest are getting richer and wealth is concentrated in fewer hands. This inequality is equally within and between nations. Despite the assumption that new technology will help developing nations 'leapfrog' rich nations, more must be done to make this happen.
4. 4IR is changing the social fabric of societies, work and leisure, with the sense of community and identity changing. Governments are accountable in different ways as they seek to drive policies in a rapidly changing world.
5. At a time when local issues can become global at the release of a tweet, the growth of national agendas signals a retreat from globalisation. However, for now we remain local and global citizens, all part of an interconnected global village where knowledge improves outcomes.
6. Geopolitical uncertainty is on the rise. Security in its widest sense is a pan-society activity — from terrorism to water security, from cyber to pandemic. 4IR technologies have as much potential to do 'harm' as to 'do good', especially as much conflict is a 'battle for minds'.
7. Technology and innovation are driving new business models and a new 'data economy', where innovation including new services and applications that derive knowledge are becoming increasingly valuable. Geospatial is ubiquitous in the new economy as 'location' becomes a powerful integrator.

Tomorrow's World

Technology

Technology affects all business sectors — from agriculture to infrastructure, the ocean economy to retail, health to transport. Data and applications are the common themes in the 4IR technology revolution. Data increasingly has location and time attributes, thanks in large part to GNSS, which has democratised position for human and machine alike. Data is exchanged, value is added and measured, money is made, but the real user value is the knowledge derived from the data.

Over the next decade 4IR technology will continue to develop:

- There will be improvements in GNSS and greater positioning quality.
- Sensors will be everywhere, from space to smartphones and cars and even clothes and food products, all geolocating data. This will lead to an explosion in the volume of geospatial data.
- The above, coupled with connectivity through technologies such as 5G and satellites, will empower human and machine users but also increase concerns about cyber- security and privacy.
- Real time data from sensors and 'on-the-fly' edge computing analysis will enable automatic updating of foundation geospatial information and knowledge on the Cloud.
- The journey towards automation under the sea, on the ground, in the air and space, in factories and in digital services such as finance and retail will continue.
- Continuing development of AI/ML applications and modelling will enable the 'knowledge-on-demand' that is increasingly expected by society, with immersive technologies aiding rapid understanding and decision-making. Predictive knowledge will be derived at a higher speed and scale than can be consumed, and trust will become essential for adoption by a wider population.
- The partnership between people and machines will change faster than at any time since 1IR, and impact lives, jobs and skills directly or indirectly.
- The increasing pace of change is leading to increasing innovation and disruption. New businesses are agile and can meet niche requirements, some of which quickly become mainstream.



The Second Machine Age will be a bigger transformation and have greater impact than even the first industrial revolution.

(Erik Brynjolfsson and Andre McAfee - MIT Centre for Digital Business)



- The complexity of the knowledge ecosystem and the range of use-cases are such that no one organisation or company will deliver end-to-end solutions; partnerships and collaborations will be commonplace, increasingly cross-sector.
- Governments and institutions will struggle to adapt policies and regulations.

Businesses will develop new digital products, services and experiences, and seek new markets. Internally, worker experiences will be enhanced and operations streamlined. Planned changes will be accelerated in the

pressure-cooker of the Covid 19 pandemic as end-to-end online workflows and user experience have become essential. But we must realise that even though easy wins have been achieved, AI cannot yet replace human judgement and widespread trust in automation is some way off.

Knowledge

Knowledge on Demand. With the emergence of new technologies and a global move towards automation and the Internet of Things (IoT), data is a rapidly growing commodity. Processes can

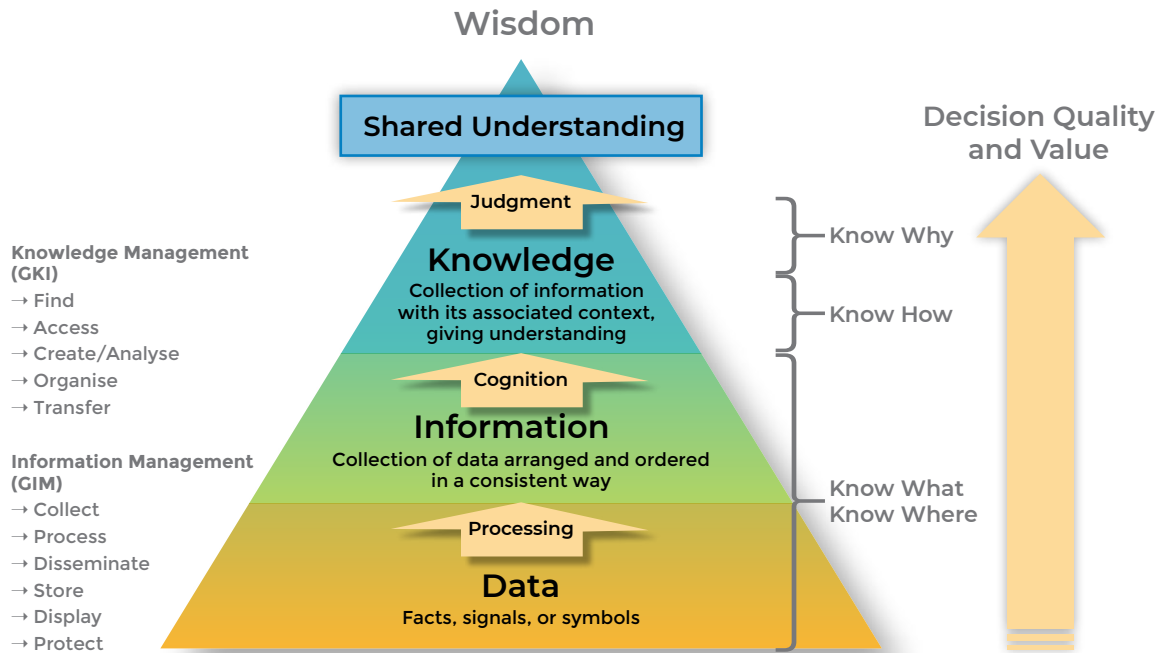


Figure 1: The Knowledge Management Cognitive Pyramid demonstrates the relationship between data and knowledge. 4IR technologies increasingly enable knowledge to be generated 'automatically', improving decision-making and adding value.

organise and extract this into information but the end user seeks knowledge, not data. With knowledge, decisions are made and benefits accrued. Furthermore, in this connected 'on-demand, now' world there is an increasing desire for immediate answers to human and machine questions. Value therefore lies in effective and efficient methods to extract user-specific knowledge from vast amounts of data, information and existing knowledge. This derived knowledge needs to be trusted, contextualised for the user and their situations, available in required timeframes and, for people, achievable with natural language queries.

Data, Information, Knowledge. The Data-Information-Knowledge-Wisdom (DIKW) pyramid in Figure 1 explains the conceptual relationship between data, information and knowledge. It exposes how GKI builds upon Geospatial Information Management (GIM) and implies that the geospatial sector

needs to be close to the decision-maker and user to drive better decisions and add value.

Cognition. Cognition derives knowledge from information and is described as “the mental action or process of acquiring knowledge through thought, experience and the senses”³. Cognition encompasses processes such as judgment, evaluation, reasoning, problem solving, comprehension and production of language, based on various knowledge constructs. Over the last decade AI has progressed sufficiently for some of these thought processes to be simulated using self-learning algorithms that use data mining, pattern recognition and natural language processing. This will develop further as a powerful combination of the semantic web and analytical and integrative techniques, including AI, and help in deriving knowledge for new sectors and use-cases.

The Geospatial Response

The geospatial sector has taken great strides over the last 40 years, be it GNSS, GIS, EO or provision of quality government, commercial and participatory geospatial data on a global scale⁵. In some countries, NSDIs have opened access to wider sources of geospatial data, for anyone knowing where to look. But geospatial digital divide still remains a major issue across the world. The United Nations Integrated Geospatial Information Framework (UN IGIF) has been developed to help all nations realise benefits of the creation, management and use of geospatial information, and in particular to help bridge the geospatial digital divide⁶. The government-focused initiative is the basis to get to 'where nations need to be today'.

The established geospatial sector is challenged to transition into the 4IR era, with other sectors taking the initiative. The halcyon days of the late 20th and early 21st century, when great geospatial data, SDIs and traditional GIS were leading edge, are behind us; geospatial is one element of a vast and growing digital world. Applications like retail and ridesharing have developed outside the traditional geospatial sector, embracing user need, connectivity, analytics, data and location. Innovative geospatially-enabled businesses, whilst only meeting some use cases, are the norm and set high user expectations.

Current geospatial concepts create, maintain, serve and share geospatial information. Today's GIM step change lies in changing production economics, with the explosion of source data combined with machine intelligence, analytics and user applications. However, over the next 10 years, tomorrow's geospatial answer should be for tomorrow's world. As described previously, it is a world of knowledge-on-demand, of real-time sensors, crowd-sourced and social-media data, of predictive analytics, global networks, the internet of things, automation, robotics, immersive experiences, and new business models.

In 'cooperation', geography and history tell the story of human endeavour; growing globalisation and connectivity has been central to this story. For millennia, maps guided exploration, supported trade, allowed us to defend ourselves, maintained the social fabrics of our societies, and influenced history. The surveyor and cartographer cooperated to give information in map form to users who contextualised this to gain knowledge and make decisions. In 2020, when knowledge and value still lie in effective and efficient methods to extract knowledge from vast amounts of geospatial data⁷, similar cooperation is needed now across a far wider geo-digital community to take another step in the human journey.



Decisions that were made during periods of very limited computing power become enshrined in practices that may be very hard to shake.

(Jack Dangermond and Michael Goodchild⁴)



Geospatial Knowledge Infrastructure – The Future

Geospatial Knowledge Infrastructure (GKI) provides the critical geospatial component to knowledge and automation. It integrates geospatial concepts, technologies and information with societal and technological change as part of the much wider digital ecosystem. Figure 2 shows GKI at the intersection between:

- the new opportunities enabled by 4IR technologies,
- cognition as the path to knowledge and
- location as a key element of analytics and data, including geospatial information.

GKI capitalises on all three to bring geospatial cognition to knowledge and automation and place geospatial at the heart of the knowledge environment.

GKI positions geospatial, a general-purpose technology, at the heart of 4IR and the knowledge economy. It ensures that the wider

knowledge ecosystem benefits fully from location, geospatial data, expertise, technologies and analytics. At the same time it ensures that the geospatial sector benefits from the wider data ecosystem and 4IR.

It is between the combinations and overlaps of technologies where disruption will likely emerge and it is virtually impossible to predict how applications may develop in just a few years.⁸ GKI sets the groundwork that helps human ingenuity to prosper and lead us to new places. It aims to ensure geospatial is everyone's business. It builds on data, GIS, NSDIs, sits on the UN-GGIM IGIF and uses the very same web infrastructure and concepts that are driving knowledge and growth. Centred on users, it helps governments, industry, academia and citizens to build a digital economy and society that can embrace knowledge and automation. Many necessary components are under consideration or are implemented in some countries, and UN-GGIM IGIF action plans may draw on some of these components.



A good decision is based on knowledge and not on numbers.

(Attributed to Plato)

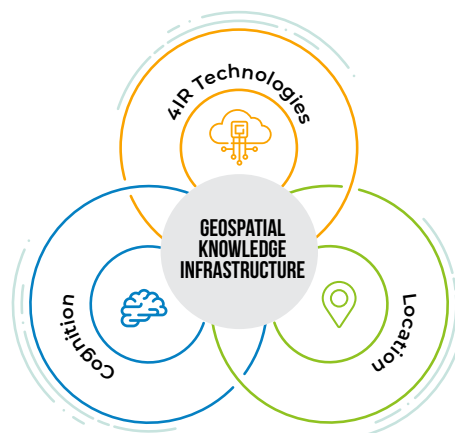


Figure 2: Geospatial Knowledge Infrastructure is aimed at drawing together 4IR technologies, location and cognition to enable future society to gain maximum social, economic and environmental value through knowledge and automation.

The Fundamentals of Geospatial Knowledge Infrastructure

Vision

Through geospatial knowledge, “the power of where” enriches the lives of all citizens by maximising social, economic and environmental outcomes in a digital world.

Definition

A Geospatial Knowledge Infrastructure enables trusted understanding, knowledge, decisions, and automation by integrating geospatial information, analytics and visualization into the knowledge and automation environments of our cooperative digital future.

GKI Goals

- Geolocated data is the ‘new norm’, with the value of geospatial analytics, technology, data and location widely understood and measured
- The geospatial sector and its data, technologies and processes are fully part of the wider knowledge/digital ecosystem, reaching all user sectors.
- Driven by users, geospatial data and technologies are at the heart of predictive analytics and modelling, giving geospatial cognition to knowledge creation and services.

- A broad, collaborative, connected and innovative geospatial sector is focused on users' future needs, cooperating and disrupting to meet them.
- Digital policies and standards are optimised to maximise value to governments, institutions, businesses and citizens, whilst protecting necessary security and privacy interests.
- Continuously updated fundamental geospatial information is available at community, national and global levels, supporting wide-ranging initiatives from knowledge-on-demand to digital twins to robotics and automation.

GKI Principles

- User-centric.
- Innovative, dynamic and agile.
- Decentralised.
- Real-time and predictive.
- Knowledge focus.
- Collaborative.

GKI Commitment

- A sustainable world where everyone and the environment benefit from geospatial knowledge.

Elements of Geospatial Knowledge Infrastructure

First and foremost, GKI seeks to add a geospatial dimension to the wider digital ecosystem, thereby mainstreaming geolocation, geospatial information, expertise, technologies and analytics. Knowledge for human and machine decision-making, of known quality, will be created through applications, analytics and models on a geospatially ready web and Cloud infrastructure.

Most knowledge services and automation will be delivered by industry, with governments providing leadership and setting an integrated policy framework to ensure that nations take an integrated approach to data and knowledge. Partnerships and collabora-

tions between cross-sector businesses, consumers and governments will co-create value. Underpinning this is a trusted foundation data infrastructure that includes continuously updated, findable and accessible fundamental geospatial data and an open positioning infrastructure. Together, these enable nations, businesses, citizens, and machines to derive the knowledge they seek to solve their problems, exploit opportunities and deliver new value.

This section looks at these elements in more detail, breaking them into GKI components, described as expectations. The complete set of elements and components of GKI are summarised in Figure 3.

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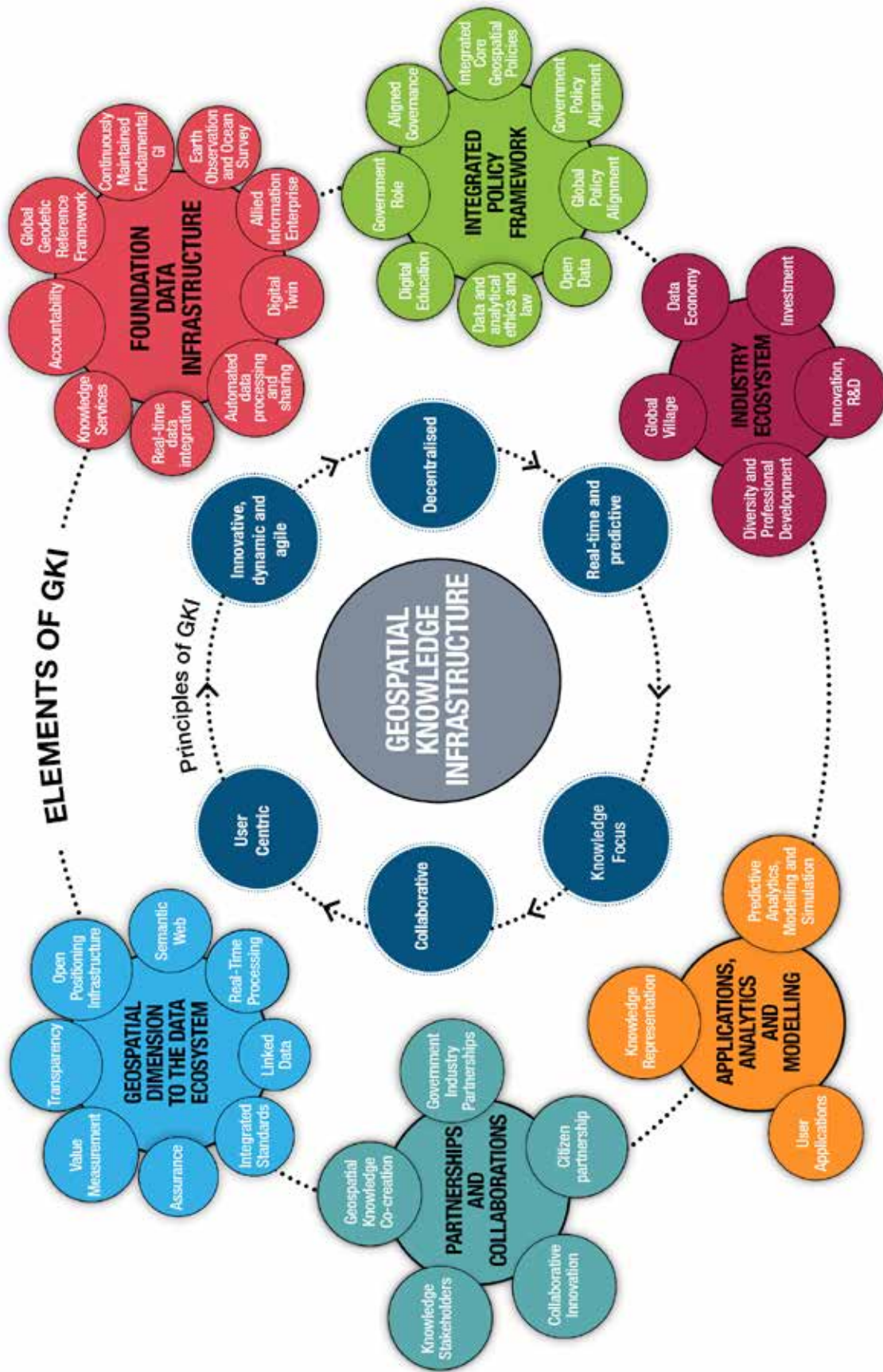


Figure 3: Elements and Components of Geospatial Knowledge Infrastructure

Geospatial Dimension to the Data Ecosystem

From individual companies to global institutions, location is the fundamental attribute within data and information, a core element of data infrastructures and business processes. Geospatial technologies and standards are seamlessly integrated into web, business and government systems and enterprises.

Value Measurement. Data-driven innovation, new business models and digital applications are changing the workings of science, governments, cities, and industry.⁹ The relative advantage of geospatial investment will be recognised and quantified by governments and business.

Transparency. Greater transparency in government, business and citizen/consumer decision-making will be enabled by trusted, authoritative geospatial information, geospatial modelling and derived knowledge. Decisions and impacts will be presented geospatially, whether through story boards or augmented reality, to increase transparency and trust.

Open Positioning Infrastructure. Nations will have positioning strategy and infrastructure to ensure all precise positioning and time needs are met. This will utilise GNSS but increasingly 5G and indoor positioning technologies will help complete the infrastructure and improve national resilience.

Semantic Web. To fully enable knowledge on demand, Semantic Web/Web 3.0 is

essential.¹⁰ Governments and industry will deliver a mainstream web-based approach to geospatial resources and location, as recommended by the Joint W3C/OGC working group in 2017.¹¹

Linked Data. Geospatial data will be machine discoverable, accessible and readable. As part of this, government agencies will publish linked geospatial foundation data through APIs.

Real-Time Processing. Data processing, analytics and knowledge creation will be undertaken automatically without human intervention, incorporating real-time data and accessing the most appropriate sources of knowledge, information, data and algorithms.

Integrated Standards. GKI sits on the web and thus collaboration with organizations providing wider web standards, such as W3C, is critical.¹² Nations and organisations will implement IHO, ISO and OGC collaborative Tier 3 and Tier 4 standards.¹³ Open standards on geospatial information licences and data quality and provenance will be in place, enabling machine/machine transactions.

Assurance. Data integration and aggregation processes are known to generate uncertainty¹⁴ and machine cognition models will need to declare assumptions/beliefs and decision-making principles. In turn a greater openness in data quality and provenance will be required and model validity will be exposed to humans and machines to enable users to understand the quality of derived knowledge.

Foundation Data Infrastructure¹⁵

Continuously updated foundation information coupled with foundation predictive analytics that generate ‘base’ knowledge (e.g. environmental forecasts¹⁶) provide the digital scaffolding for the digital age.¹⁷ Fundamental geospatial data, defined by the UN GGIM, is a sub-set of foundation information.

Global Geodetic Reference Framework

(GGRF). National geodetic infrastructures, including CORS and datums, should tie with the UN endorsed GGRF.¹⁸ CORS data will be accessible widely and nations will have in place the necessary measures, such as dynamic frameworks, to cater for automation.

Automated data processing and sharing.

Multi-source geospatial data will be processed into geospatial information, without human interaction, but at the same time meeting quality standards. Foundation Geospatial Information will be automatically updated, accessible through APIs, individual transactions enabled and machine-readable licencing introduced.

Continuously Maintained Fundamental

Geospatial Information.¹⁹ Automatically and continuously maintained, this 4D data sits across all UN GGIM fundamental data themes. It is a valuable and useable asset in its own right, is the scaffolding for digitisation and assures wider location information, geolocation, automation, analytics, and knowledge.

Earth Observation and Ocean Survey. The increasing range of space and sea/undersea sensors is complemented with rapid access and advanced analytics (in particular AI/ML) to extract information and knowledge in

near real time. Open source EO and open analytics will support developing nations

Allied Information Enterprise. Many wider thematic datasets with national public task requirements are closely related to fundamental geospatial data and will be included in national geospatial information and knowledge developments. Examples include spatial plans, crop growth, flood probability, weather and statistics.

Digital Twin. Digital Twins will replicate ‘how’ the Earth works in a structured way,²⁰ having applicability from smart cities to national communications to world health. Digital twins provide the information basis for knowledge, with data models incorporating fundamental geospatial data.

Real-time data integration. As part of this, through edge computing, machine and sensor real-time data will be processed and incorporated into foundation geospatial data.

Knowledge Services. Knowledge is recognised by nations and industry as a democratised and sustainable commodity.²¹ Geospatial organisations will enable knowledge-on-demand by providing Findable, Accessible, Interoperable and Reusable (FAIR) geospatial information services and by moving up the value chain to also deliver knowledge services.²²

Accountability. Foundation geospatial information organisations and industry will understand the liabilities associated with poor geospatial data, information, applications and knowledge, with these having been determined in regulation, legislation or courts..

Integrated Policy Framework

Governments have a major part to play in setting the frameworks for economic growth, social wellbeing and environmental protection, balancing citizen responsibilities and rights. 4IR will require new and very different and integrated policies, changing the way governments are structured and work, and policy decisions will be based on evidence, enhancing rationality.

Government Role. Recognising the value of a digital economy, governments will have clear digital strategies that enable value to be safely realised. This will ensure access to assured foundation information and will open doors for government/industry partnerships.

Aligned Governance. Aligned national digital and geospatial governance will lead the GKI journey, under ministerial stewardship.

Integrated Core Geospatial Policies. These will take into account user analytics, IoT and automation, FAIR principles and set assurance standards. They are part of, or aligned to, wider government policy to support digital innovation across industry.

Government Policy Alignment. Policy, legislation and regulation considers GKI coherently across all relevant departmental policies, especially data/digital, industry, space, science, technology, innovation and education policies, maximising two-way value generation.

Global Policy Alignment. Whilst national needs take priority, national policies will normally be aligned with international practice, particularly in areas such as licensing, geodetic frameworks, DRM, privacy and standards.

Open Data. Location will be an attribute in all government data. Standard location registers will be adopted by nations, mandated within governments and accessible to all within legal constraints. Only rarely will fundamental geospatial information be security-restricted.

Data and analytical ethics and law. To protect security and privacy, national law, regulation and legal interpretation will include clarity on how geospatial data collection, release and use, derived knowledge and geolocation can be used. Such legislation is focussed on outcomes rather than platforms. In the same way that physical infrastructure is regulated and sometimes tested by governments, so too will regulation apply to the virtual and, in safety critical applications, testing and authorisation of applications and information.

Digital Education. Geospatial cognition and analytics will be embedded into curricula at all levels, from Year 1 to post-grad, from generalist to data specialist, preparing everyone for the 'next economy'. Geospatial experts also need skills that embrace data science, automation and sensor technologies.²³

Industry Ecosystem

The top 4IR beneficiaries are the innovators and investors.²⁴ The 'geospatial sector' will further migrate into the wider knowledge/data/technology ecosystem, focusing on services and improved user experiences, and reach into other sectors for new customers and partnerships.²⁵

Data Economy. Through applications and sensors, businesses will collect geospatial data as a 'by-product', especially through automation.²⁶ This will be monetized, through aggregators and directly, with arrangements made to help balance reward across complex data and application supply chains.

Investment. Direct investment will improve when data and knowledge are valued as assets. Investment is more likely where disruption occurs, and that is more likely in collaborations that integrate new technologies.

Innovation, Research and Development. The geospatial sector will invest heavily in innovation and R&D, not just to evolve operations, products and services focused on knowledge and automation, but also specifically to disrupt and to open up new sectors.

Diversity and Professional Development. Geospatial organisations will be learning organisations – continually upskilling staff to prepare for tomorrow's roles. To be ahead of competition, to survive, organisations must be diverse and engage with a wide variety of stakeholders.²⁷ Diversity across leaders and technologists will be the norm and not discriminate based on age, sex, (dis)ability²⁸, race or religion.

Global Village. Businesses are competitive and look at value from a 'bottom line' perspective, but geospatial industries also tend to look at the social good. As the demand for knowledge increases and costs drop, the governments and the geospatial industry will provide services that benefit the global village, fully engaging local businesses to ensure local economies benefit.

Partnerships and Collaborations

Partnership is difficult and needs common purpose. The derivation of knowledge and value from integration of analytics and information, and disruption through integrating new technologies in novel ways, are two such purposes. It may also be that collaboration brings separate benefits to both parties, perhaps through data exchange.

Knowledge Stakeholders. The knowledge economy has many components: IBM describes them as data producers, data aggregators, custodians, platform owners, knowledge providers, and presenters.²⁹ It is rare for a single organisation to be built on or innovate across all these components, nor equally, to operate across all sectors. The range of stakeholders will increase considerably as knowledge and automation become the goals.

Geospatial Knowledge Co-creation.

Knowledge construction is a collaborative process to produce new understanding and knowledge. Many organisations will gain value by partners processing, exchanging and cooperatively improving this data to co-create information and knowledge, each partner taking different benefits.³⁰

Government Industry Partnerships.

Geospatial agencies will partner with industry to deliver better data, information

and knowledge. Traditional brick and mortar public-private partnerships (PPPs) may not work in a digital ecosystem, but contractual arrangements that share risk and incentivise reward will develop as data is seen in terms of financial value.

Citizen Partnership. The citizen in the “social-media” world of today is naturally interactive and collaborative, effectively the citizen is both a producer and a consumer of geospatial information and knowledge. Citizens are now a source for geospatial agencies and analytics business alike.

Collaborative Innovation. Innovation is essential in 4IR industries. It thrives on valuable problems, energy, social purpose, networks, data and resources.³¹ Digital industry will collaborate across sectors but smaller businesses will benefit through innovation programs. Governments, industry and academia will collaborate to support geospatially enabled businesses, giving developers access to foundation data APIs, technical advice, investment opportunities and support to commercialize.

Applications, Analytics and Modelling

Both geospatial experts and amateurs need to access location-based knowledge.³² Access to

many forms of data and analytics provide that knowledge. Mirroring availability of data, many algorithms and applications will be accessible on the web, open or with transaction/licence charges, to be combined with data to deliver a particular piece of knowledge.

User Applications. Consumer apps will move from hard-coded analytics to knowledge inferencing, able to interpret questions and geospatial context, retrieve trusted geospatial information and analytical resources, process the query, portray the answer, and enable feedback.

Predictive Analytics, Modeling and Simulation. Prediction through analytics and options modeling will be critical in decision-making. ‘All-source’ geospatial information, technologies and expertise will support this, both for the business decision-maker and government decision-maker.

Knowledge Representation. The representation of geospatial knowledge will expand from ‘maps’ to include, real-time storyboards, augmented reality, virtual models or any form needed by human or machine. The geospatial sector embraces and enables all these new cartographies.

How will Geospatial Knowledge Infrastructure be used?

Geospatial Knowledge Infrastructure (GKI) aims to move the geospatial sector closer to the wider 4IR data ecosystem and refocus it on delivering knowledge to support human and machine decision-making. In parallel GKI will increase the use of geospatial data, information and knowledge across business and government, setting the conditions for better evidence-based decisions.

GKI is a framework for the 'step beyond IGIF' and, like the IGIF, it is not a detailed blueprint but a coherent set of elements that all contribute to bringing geospatial cognition to the heart of the data, knowledge and decision-support ecosystem.

- Governments will adopt GKI in building policies and programmes.

- Geospatial and allied agencies will adopt GKI to move into knowledge services and to support automation.
- Businesses will adopt GKI in delivering improved decision-support services.
- GKI will bring geospatial information to the level where users will gain value through knowledge and automation.

Defining GKI is a journey, a collaboration of ideas through debate across a wide range of stakeholders. This paper exposes the GKI concept as a narrative to start that co-creative journey.

“ Really, the only thing that makes sense is to strive for greater collective enlightenment. ”

(Elon Musk)

Relationship with SDI and UN IGIF

NSDI focuses on delivering and sharing geospatial data, providing a 'create once, use many' ecosystem and making geospatial data and information accessible. In many jurisdictions, NSDIs have delivered significant local, national and regional benefits. In others, they have not proceeded

beyond an intent. But it is an information ecosystem, limiting the full benefits of location now possible in the knowledge environment. Figure 4 shows some aspects of NSDI and GKI to illustrate the journey from NSDI to GKI.

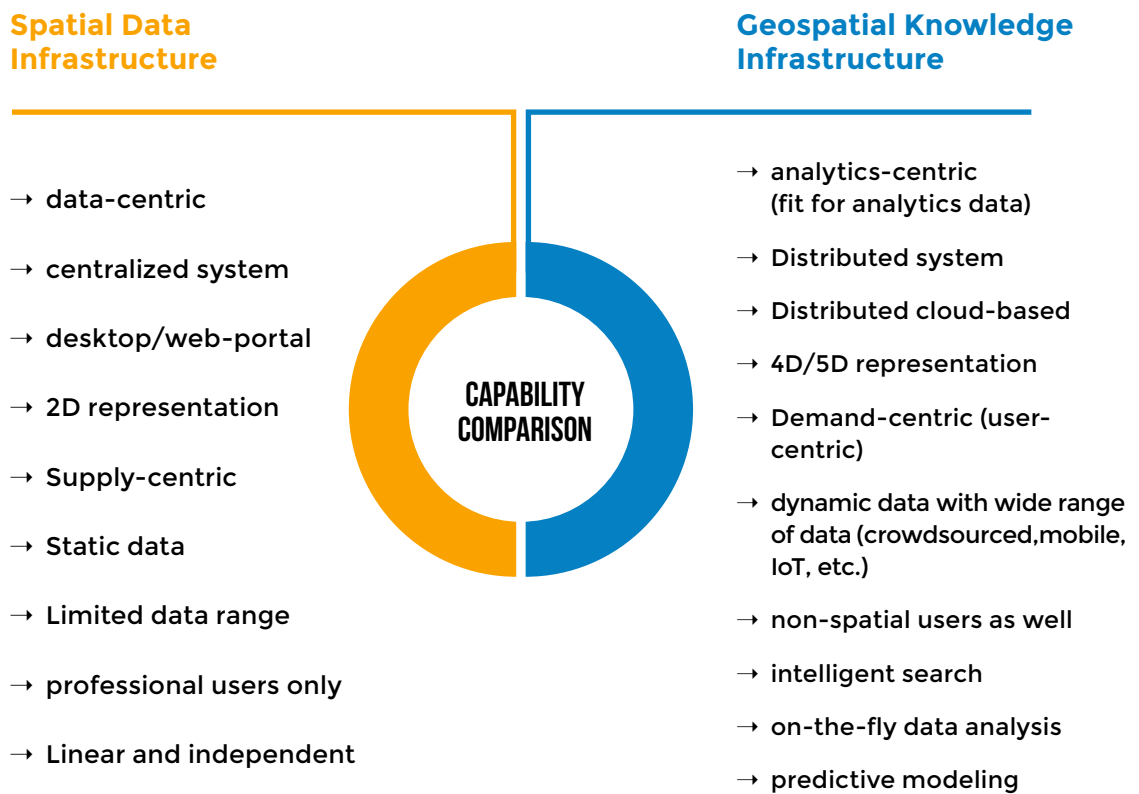


Figure 4: Comparison illustrating the difference between a typical Spatial Data Infrastructure and a Geospatial Knowledge Infrastructure

The UN IGIF aims to provide nations a holistic and effective geospatial information management capability. It is a globally endorsed framework from which nations (or other governments) can build and implement action plans that deliver geospatial information as an underpinning national infrastructure. Within a year of Part

1 being endorsed in 2018, nations were already building action plans based upon the UN IGIF or aligning national strategies with the UN IGIF. The UN IGIF comprises 9 pathways. Figure 5 demonstrates how the components of GKI all build upon these pathways.



Figure 5: GKI components all built upon UN IGIF pathways. As components are developed and proven, they can be incorporated into future versions of the UN IGIF, helping create a living document.

GKI builds upon the UN IGIF and NSDIs, but moves into the overlapping knowledge and automation environments. It considers the emerging trends in the ‘United Nations Future Trends in Geospatial Information Management: 5 to 10 Year Vision’ third

edition draft report, identified by geospatial experts around the world, and identifies how these might be operationalised.³³ As GKI is implemented, proven good practices will support the future development of the IGIF and its pathways.

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About the project

Advancing Role of Geospatial Knowledge Infrastructure in World Economy, Society and Environment

The ‘Geospatial Way’ is the future. It is the most efficient and effective way to collect, process, integrate and utilize information for overall global, national and individual development. Geospatial knowledge is the result, enabling us to identify, contextualize and understand the many challenges and opportunities facing society within a geographic context. However, realizing the potential of this future state, particularly for developing countries, requires three key enablers – partnerships, knowledge sharing and capacity building.

With the objective to project the value proposition of Geospatial Knowledge, forecast its relevance and connectivity with fundamentals of next generation economy and society, and to redefine the role of stakeholders: government, industry and civil society, the campaign on Advancing Role of Geospatial Knowledge Infrastructure in World Economy, Society and Environment was launched in January 2020. This is a three-year long project, looking at

assessment in a broader frame for the first year, detailed strategy development in the second year, and transformation in the third year.

Objective

- Projecting value proposition of Geospatial Knowledge Infrastructure.
- Forecasting its relevance and connectivity with fundamentals of next generation economy and society.
- Evolving collaborative business and functional models.
- Redefining the role of stakeholders: government, industry and civil society.
- Developing national, regional and global strategies.

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