CS322762

The Smart City Agenda: Defining a Framework for a Future 'Smart' City.

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Learning Objectives

- Discover the definition of a Smart City.
- Learn about the Smart City Standards, what they are, and how they can be applied.
- Discover the innovative companies that offer smart-city technologies and resources for city providers.
- Learn how to work with local council or government to support the strategic implementation of a smart city framework.

Description

What are the developments of smart cities, and how can they begin to change the way we deliver our buildings and infrastructure assets? This session will introduce and give an overview of the importance of smart cities. Smart-city technologies are beginning to populate the construction industry and provide solutions for government and city councils around the world. By providing a consistent methodology using governing standards, smart-city agendas can be defined. There are a variety of technology startups focused on developing solutions to enable a smart-city agenda. This session will give examples of these innovative companies and detail how they use different technologies to support how our cities are changing with increases in population.

Focused on the set of smart city standards developed in the context of the Uk to support future governmental incentives relating to Smart Cities this class will educate on how to adopt a framework relating to a smart city for smart city leaders. With this in mind the session will provide solutions to enable your business to offer more in the way of digital support to local council and government relating to smart city frameworks. The class will

also give delegates a summary of the Digital Built Britain strategy (and its Gemini principles) which are a globally exemplar strategic framework driving the UK forward to enable a 'National Digital Twin'.

Speaker

Rebecca De Cicco - Director of Digital Node/Chair of Women in BIM

Rebecca has always had a keen interest in how the digital economy impacts on the built environment. Her career began as an architect in Australia but naturally moved into technology roles where she was able to influence organisations and employees on the benefits of digital in the construction industry. After a series of successful senior roles in Architectural practices she gained her Masters in Construction Management and became a leader in BIM in the UK founding her own business as a result in 2013, Digital Node.

Digital Node aims to provide advice and insight to construction professionals all over the world on BIM, Digital Engineering and Technology led productivity. Not only do Digital Node offer strategic advice to clients like government, but also support projects all over the world on BIM management activities. The company also has a keen focus on education and training and therefore our BIM training courses are also being delivered to organisations globally focused on upskilling industry on BIM Process, management and technical solutions. Digital Node clients now extend from the UK to Australia, Asia, the Middle East and USA.

As a keen advocate for knowledge share Rebecca also volunteers with groups like Building Smart International and the UK BIM Alliance as well as local groups in Australia. She also regularly speaks at industry events all over the world as well as supports the Autodesk Developer Network and feedback community and other educational focused groups.

Rebecca has a strong passion for diversity in the built environment and founded the global community Women in BIM (WiB). She saw a need to create this group to address the global skills crisis in BIM and her knowledge of the amount of women leaving industry. It is her aim to be remembered as the advocate for BIM Diversity and supporting the global skills crisis by promoting and retaining Women in BIM related roles. Beginning as a not-for-profit in the UK and a community on LinkedIn, by 2019, it had grown to over 800 members globally, extending to women in Europe, the US, Australia, the Middle East, and south-east Asia.

Introduction – What is a Smart City?

A Smart City is an urban environment where technology, Internet of Things (IoT) and big data come together to offer benefits and future sustainability of how we navigate and utilise our cities.

By 2050 the global population is forecast to grow to 9+ Billion people and 80% of these people will reside in cities. This will ultimately impact on the city structure, use and infrastructure around it which will cause enormous pressure on both our third world and modern cities.

While the exact definition varies depending on the resource, the overarching mission of a smart city is to optimise city functions and drive economic growth while improving quality of life for its citizens using smart technology and accessibility to data. Value is given to the smart city based on what they choose to do with the technology, not just how much technology they may have.

According to PAS 180: 2014 (A publicly available standard, free to use and developed as a response to the UK Smart City Agenda) a city can be defined as either a 'smart city' or a 'future city. These two terms can often be seen as competing, but on the contrary are used to determine how a smart city can ultimately affect the future requirements of the cities which enable these processes to occur.

The current data and research available suggest that the future growth and health of cities and communities is challenged globally. We see increases in population which will ultimately put pressure on our resources. If we fail to address the growing number of people, the rise in poverty and the increasingly unsustainable resource use cities won't be able to function as effectively as they do today. Our cities are primary engines for global economic activity and therefore we must be very careful on how we abuse their states. Smart City solutions are the key to supporting the future state of our cities and act as the catalyst to enable them to function more effectively.

A 'Smart City' denotes the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its people. Smart Cities use digital systems and technologies to support the collation of intelligent data which can be used to support the use and the integration of systems by its citizens.

Cities must address a series of impacts to support their future. These may include:

1. Planning And Economic Development
2. Resilient clean air, water and food supply
3. Integrated data and security systems
4. Responsive transport and infrastructure networks.

5. Environment protection and sustainable resources
6. Risk Management (e.g. Climate change)
7. Sustainable waste management systems.
8. Energy Management
9. Sustainable building design and greener buildings
10. Cultural and social interactivity.

Our cities will need to procure smart city resources to address these issues which can act as a checklist to future smart city technology resources which could be procured to support a smart city agenda.

The Smart city concept integrates information and communication technology (ICT), and various physical devices connected to the IoT network to optimize the efficiency of city operations and services and connect to citizens. Smart city technology allows city officials to interact directly with both community and city infrastructure and to monitor what is happening in the city and how the city is evolving which ultimately impacts on our use and security within a city. Smart city applications are developed to manage urban interaction and allow for real-time responses to be achieved. A Smart city may therefore be more prepared to respond to challenges than one with a simple "transactional" relationship with its citizens.

Major technological, economic and environmental changes have generated interest in smart cities, including climate change, economic restructuring, the move to online retail and entertainment, ageing populations, urban population growth and pressures on public finances.

The primary goal of a smart city is to create an urban environment that yields a high quality of life to its residents while also generating overall economic growth. Therefore, a major advantage of smart cities is their ability to facilitate an increased delivery of services to citizens with less infrastructure and cost.

As the population within cities continues to grow, it becomes necessary for these urban areas to accommodate the increasing population by making more efficient use of their infrastructure and assets. Smart city applications can enable these improvements, advance city operations and improve the quality of life among residents.

Smart city applications enable cities to find and create new value from their existing infrastructure. The improvements made facilitate new revenue streams and operational efficiencies, helping governments and citizens save money.

It is estimated that the global market for smart urban services will be $400 billion per annum by 2020. At present the number of technologies, organisations and individuals supporting this sector are not high enough to sustain this growth. Organisations who are enabled with digital led productivity in the AEC industry are in a good position to support

this space and therefore it is crucial to understand the impacts, strategies and technologies available in relation to Smart Cities.

Smart City Challenges

Across the world there are a variety of challenges in relation to the future of our cities and these must be addressed as part of a smart city strategy. As noted above, there is a critical challenge and major opportunity present, with the heavy demand our on our resources to support the impacts of the future and how cities will be used, as well as the technology led organisations present to support this challenge. As an overview, some of the key challenges which present themselves include:

1. There is an increase in pressure on housing and transport systems across the world when it comes to the impacts noted.
2. Climate change will impact our cities, how this is supported by our energy systems will continue to be a challenge.
3. The nature of where citizens navigate the cities are changing, the way in which online shopping has impacted on our cities is one example.
4. Our ageing population is adding an increased burden on aged care, health and our health buildings and infrastructure.

Smart city initiatives must include those who reside in cities, or its citizens. City leaders must not only raise awareness of the benefits of the smart city technologies being implemented, but also promote the use of open, democratized data to its people. If people know what they are participating in and the benefits it can bring, they are more likely to engage with it and support how this data can be used to influence their lives.

Fostering collaboration between the public and private sector and city residents is key to creating a smart citizen who will be engaged and empowered and positively contribute to the city and community. New and innovative collaboration methods can improve engagement. Smart city projects should include plans to make the data transparent and available to citizens, often through an open data portal or mobile app. This enables residents to engage with the data and understand what it is used for. Through a smart city app, residents may also be able to complete personal chores, such as viewing their home's energy consumption, paying bills and finding efficient public transportation.

One of the biggest challenge smart cities face is the problem of connectivity. The thousands or millions of IoT devices scattered across the city would be defunct without a solid connection and the smart city itself would be dead.

Furthermore, public transit, traffic management, public safety, water and waste management, electricity and natural gas supply can be unreliable, especially as a system ages and grows. However, the importance of these operations will only increase as the city expands and the demands on its infrastructure increase. These systems must be constantly maintained and tested to ensure their proper functioning.

Smart cities are also challenged by finding ways to attract and keep residents without a cultural fabric. The cultural essence of an area is oftentimes what attracts residents the most; this is something that cannot be programmed or controlled with a sensor. Therefore, smart cities may falter because they cannot provide a sense of authenticity, distinctiveness or place.

Modern cities will continue to evolve and it is crucial that we address the challenges we face to enable future cities to function as well as we need them to. Having an understanding of these challenges as well as solutions to support them is a key consideration to make when working alongside smart city providers. As an industry in AEC we will be forced to not only support smarter ways to design and build our assets, but also how these assets function with the wider environment and the city they are built in.

Smart City Characteristics

A smart city would have many characteristics to support the future of it and how its citizens function within it. Some examples of a smart city and its characteristics may include:

1. Having a technology-based infrastructure system;
2. A strong focus on environmental initiatives;
3. A high functioning public transportation system and accessibility to it;
4. A confident sense of urban planning
5. People (citizens) who live and work within the city and utilise its resources.
6. Accessibility to data about buildings and infrastructure assets.

A smart city's success depends on its ability to form a strong relationship between the government, including its bureaucracy and regulations, and the private sector. This relationship is necessary because most of the work that is undertaken to create and maintain a digital, data-driven environment occurs outside of government. Surveillance equipment for busy streets could include sensors from one company, cameras from another and a server from another. Interactions are crucial to support the smart city agenda and must be considered when reviewing how a smart city functions.

The way in which cities characteristics are determined may also vary depending on where in the world it resides. This is especially important to third world cities where the impacts of population increase will ultimately affect these cities the most. A consideration must be made to assess the current smart city strategy of a developed versus a non-developed city and the strategies around these will vary.

Smart cities utilise their web of connected IoT devices and other technologies to achieve their goals of improving the quality of life and achieving economic growth. Successful smart cities follow four steps:

1. Collection - Smart sensors throughout the city gather data in real time.

2. Analysis - Data collected by the smart sensors is assessed in order to draw meaningful insights.

3. Communication - The insights that have been found in the analysis phase are communicated with decision makers through strong communication networks.

4. Action - Cities use the insights pulled from the data to create solutions, optimize operations and asset management and improve the quality of life for residents.

Smart City Features

Emerging trends such as automation, machine learning and the IoT are driving smart city adoption.

Theoretically, any area of city management can be incorporated into a smart city initiative. A classic example is the smart parking meter that uses an application to help drivers find available parking spaces without prolonged circling of crowded city blocks. The smart meter also enables digital payment, so there's no risk of coming up short of coins for the meter.

Also in the transportation arena, smart traffic management is used to monitor and analyse traffic flows in order to optimize streetlights and prevent roadways from becoming too congested based on time of day or rush-hour schedules. Smart public transit is another facet of smart cities, used to ensure public transportation meets user demand. Smart transit companies are able to coordinate services and fulfill riders' needs in real time, improving efficiency and rider satisfaction. Ride-sharing and bike-sharing are also common services in a smart city.

Energy conservation and efficiency are major focuses of smart cities. Using smart sensors, smart streetlights dim when there aren't cars or pedestrians on the roadways. Smart grid technology can be used to improve operations, maintenance and planning, and to supply power on demand and monitor energy outages.

Smart city initiatives also aim to monitor and address environmental concerns such as climate change and air pollution. Waste management and sanitation can also be improved with smart technology, be it using internet-connected trash cans and IoT-enabled fleet management systems for waste collection and removal, or using sensors to measure water parameters and guarantee the quality of drinking water at the front end of the system, with proper wastewater removal and drainage at the back end.

mart city technology is increasingly being used to improve public safety, from monitoring areas of high crime to improving emergency preparedness with sensors. For example, smart sensors can be critical components of an early warning system before droughts, floods, landslides or hurricanes.

Smart buildings are also often part of a smart city project. Legacy infrastructure can be retrofitted and new buildings constructed with sensors to not only provide real time space management and ensure public safety, but also to monitor the structural health of buildings. Attaching sensors to buildings and other structures can detect wear and tear and notify officials when repairs are needed. Citizens can help in this matter, notifying officials through a smart city application when repairs are needed in buildings and other

public infrastructure, such as potholes. Sensors can also be used to detect leaks in water mains and other pipe systems, helping reduce costs and improve the efficiency of public workers.

Smart city technologies also bring efficiencies to urban manufacturing and urban farming, including job creation, energy efficiency, space management and fresher goods for consumers.

Smart cities rely heavily on the Internet of Things (IoT). The reason for this is the opportunity for connected data on all elements which constitute a city, including the Built Environment, Citizens and internal framework. The use of data analytics is becoming common place now for those city leaders looking to develop and implement new solutions to enable greater productivity. Anther impact on the smart city agenda is the use of Edge computing which is becoming more common place in the smart city discussion. Some other examples of technologies which will impact the smart city agenda include:

1. Application Programme Interfaces (API's)
2. Artificial Intelligence
3. Cloud Computing
4. Machine Learning
5. Mesh Networks
6. Machine to Machine Interactions.

Smart City Impacts

As of 2008 more than half of the world's population lived in cities and it is predicated that this will rise to 70% by the year 2050. As a result we will see extreme pressure on our cities to sustain this growth including the way we use our infrastructure and data to enable ease of use. Cities are complex entities where many stakeholders may impact on the way the city is used, the data shared and the future development of systems and technologies. Governmental impacts are very important but there are also a number of other strategies in place which impact on the Smart City solution.

A City can be divided into three key areas which ultimately are managed and utilised differently across the globe;

1. Structure: The combination of the environment, infrastructure and built systems (Buildings).
2. Interactivity: Functions including Economic impact, Cultural impacts and information share.
3. Society: Civil and Governmental impacts of people who live and work in our cities.

The smart city impacts would relate to these three key areas and there must be a solution to how smart city characteristics can be enabled across these areas. Although there is much focus on the structure (e.g. our physical infrastructure) there must also be education around how technologies supporting the sharing and collation of data can be achieved. Communication on how smart city solutions can impact on citizens is also crucial as societal impacts are a heavy burden on how smart cities function and their support structure.

Smart City Standards & The Gemini Principles.

The UK Government is committed to helping cities response to the current challenges which are present in the way we use and navigate our cities. As a result to this response, and to enable export opportunities for organisations, people, technologies and businesses across the UK, the Smart City standards were developed. A standard developed through industry need, a PAS (or Publicly Available Specification) is developed to support future processes or requirements in a particular topic. The smart city suite of standards were developed from 2014 to support the Governmental response and acknowledgement of the UK's smart cities and creating a framework to be adopted within these documents. The smart city standards can be summarised as follows:

PAS 180: 2014 Vocabulary - *Terms, definitions and key ideas surrounding the Smart City Framework.*

PAS 181: 2014 Smart City Framework - *Guide to establishing strategies for smart cities and communities*

PAS 182: 2014 Smart city concept model – *Guide to establishing a model for data interoperability.*

PD 8100: 2015 Smart Cities Overview – *Guide.*

PD 8101: 2014 Smart Cities – *Guide to the prole of the planning and development process.*

These documents listed above have worked to support the UK Smart city agenda, but it is imperative to note that they can also be used as a framework across other regions of the world with little to no guidance when it comes to setting a framework for a future city.

A major impact relating to the Smart City Agenda in the UK is also the development of the Gemini Principles, a term used to define the process of developing a 'National Digital Twin' within the context of the UK.

The Digital Framework Task Group (DFTG) launched the Gemini Principles in December of 2018, bringing together key topics from government, academia and industry to provide the sector with foundational definitions and values to guide the development of the National Digital Twin (NDT), an ecosystem of digital twins that are connected by securely shared data. work forms part of Centre for Digital Built Britain's remit as the national focus for the digital transformation of the built environment and can be seen as exemplar globally as it comes closely to the smart city agenda.

The NDT will be a national resource for improving the performance, service and value delivered by the UK's infrastructure; delivering benefits to society, business, the environment, and the economy. CDBB has been tasked with delivering the information management framework to underpin the NDT, and a series of pilot digital twins.

The Gemini Principles will guide the development of the framework and the NDT. They are organised under three overarching headings: purpose, trust and function.

There are overarching principles developed to support the industry in developing digital twins in an aligned way that can form part of the National Digital Twin. These include:

• They are simple, but their implications are far-reaching and challenging.
• They are descriptive of intent but agnostic on solutions, so they are meant to encourage flexibility for innovation and development over time.

The Gemini Principles do not try to answer all the key questions about the NDT. Rather, they set a context within which those questions can be identified and addressed. Likewise, the Gemini Principles do not attempt to define the relative importance of the individual principles, which may vary over time. Ongoing dialogue on this subject between industry, society and government is a valuable process and should be encouraged.

The session will continue to elaborate on the framework for the Gemini Principles and some of the current work being undertaken to support the development of the NDT.

Smart City Strategy

When developing a strategy for a smart city it is imperative to address current policies in place which may ultimately impact of the future needs and requirements for a city. Every city is difference and not only do smart city strategies support developed cities but also third world and the systems may vary between them.

Guiding principles which will create the smart city agenda focuses on how smart city leaders should address a strategic framework. Key considerations to consider may include:

1. To create a clear and compelling vision for the future of the city.
2. Take a citizen centric approach to all aspects of design and delivery as well as data accessibility and security.
3. Enables a harmonious and inclusive digitization of city systems and spaces.
4. Embeds openness and sharing in a way a city functions.

A smart city integrates data sets and systems to enable great connectivity. The physical components of a city must be connected in order to allow technology led productivity. Therefore technologies which enable greater connectivity between a city's infrastructure can help to enables more smart city interactions. BIM and Digital Engineering/VDC for public buildings and infrastructure must act as a catalyst for the connectivity between smart things. As a city operates openly and data about our buildings and infrastructure will continue to be connected, there must be a link toward these systems and physical entities. It is therefore recommended that the following should occur when developing a smart city framework:

1. Integration with existing policies for BIM/DE/VDC.
2. Interoperability focus to ensure our smart spaces can be linked to the accessible data and our cities.
3. Greater connectivity of buildings to city systems.
4. A strategy toward updating existing buildings and infrastructure data sets to allow for connectivity between citizens occupying or using building/infrastructure systems.

Many organisations and government alike would need to consider a policy for a smart city to enable the future requirements of smart city components such as infrastructure, building, citizens and open data.

Without a clear set of guidelines there may be an ad hoc and inconsistent approach toward implementing smart city technologies and requirements and therefore this must also include how the data is shared and protected. While enabling a smart city agenda there must be a strategic vision to continually review, update and keep up to speed with the uptake of technology led improvements as well as the skills needed to make a smart city work effectively.

Smart City Technologies & Organisations

As noted above, the future city requires new technologies, processes, tools and components to be able to sustain the demand for a smart city agenda. With this in mind, there are a variety of organizations and technology led start-ups all focused on the smart city agenda and the way services can be offered to support this.

A variety of smart city organisations are listed below to allow you to understand the types of services they accommodate in the smart city space.

Digital Node

Digital Node is a consultancy offering advice, support and insight on digitized solutions to the global construction industry. The company works with clients all over the world to support them in their implementation of Building Information Modelling (BIM) and Digital Engineering (DE) solutions.

The aim of the company is to address the shortage of BIM and DE skills in construction today, and to support organisations in their implementation of digital solutions for the work they undertake. The UK has been at the forefront of BIM and Digital construction methods for some time and the consolidation of UK Government policy towards BIM can be used as a framework for other regions.

The company has been working with asset owners, construction industry professionals and educational bodies in the UK since 2014. Working on both building and infrastructure projects the company has been supporting the UK Government's objective to achieve UK BIM Level 2.

British Standards in relation to BIM are now being used across Australia. Digital Node works with clients across both regions and therefore has an in-depth understanding of the framework for digital in Australia and of how the UK approach could support this drive.

Bulweria

Bulweria, with offices in the City of London, has developed a fully integrated mobility platform. The system is an integrated platform and can be adapted to all forms of transportation. The system is not hardware specific and can operate with hardware supplied by any vehicle manufacturer.

This platform currently operates over 2000 electric cars in the Italian cities of Milan,

Rome, Florence and Modena. Bulweria systems are also working in Moscow and China and trials are taking place in many other parts of the world, including Madrid where the same platform is now managing the 'scooter share' system being implemented in that city.

A major client, based in Paris and operating over 1.5m vehicles throughout the world, is using the platform to manage their own client fleets. This has enabled the fleet user to reduce the number of cars on the road while simultaneously improving the utilisation of the remaining fleet.

The company's latest initiative sees it working with property developers who want to develop integrated mobility services within residential and commercial new build schemes.

Captiva Minds Communication Group Ltd.

Captive Minds' Loqiva is designed to be the primary interface through which essential civic and commercial services can be delivered to citizens in a modern Smart City. It is currently being used in a flagship Smart City programme in New York City, USA.

The core user-experience is provided through a free-to-download smartphone app for iOS and Android, which is/can be branded for each city. Every citizen enjoys a unique experience, as content is personalised and contextualised to present users with the most relevant information, based on data points including interests, demographics, location, time and real-time weather. The smartphone app can also interact with other Internet of Things devices in the locality to produce a variety of off-app experiences, including personalised content for digital displays.

Civic services on the platform include modules that manage personalised local news aggregation, enable GPS-tagged photo issue reporting (such as graffiti/fly-tipping), and deliver policy consultation through demographically targeted surveys.

Commercial services include visitor attraction mapping, a location- driven rewards system with in-app location alerts and personal notification centre used for council notices like tax reminders. With citizen card details stored on the platform, one-touch card payments to pay for local services such as gyms, transportation, parking, council tax and fines are also possible.

Citi Logik Ltd.

Citi Logik is an award-winning British technology company, focused on helping public sector clients to understand the movement of citizens by vehicle, on foot and by public local transport.

The company has unique access to anonymised data from the Vodafone 3/4G network, which supports the creation of a comprehensive, high-value understanding of the urban planning environment and the demand placed on local transport networks.

With the support of Innovate UK, Citi Logik has developed an advanced web-based analytics service called 'CitiWatch' and has recently deployed the first ever real-time mobile network analysis of road networks within a UK local authority using the existing 3/4G infrastructure.

CitiWatch requires no CAPEX or new sensors. It replaces expensive roadside surveys and legacy infrastructure and has access to real time and historic data in compliance with ICO and EU privacy guidelines.

The Office for National Statistics is also testing CitiWatch capability as a potential replacement for census analysis of travel patterns.

Doordeck

Doordeck replaces key cards, fobs and access passes with the one 'card' everybody is already carrying – their smartphone. With little or no new hardware, the company can make any electronic lock cloud- based, giving users a new and innovative way to control their space.

Doordeck is better for users and better for building managers. Managers no longer have to rely on old-fashioned cards, expensive hardware and limited software. For users, besides being freed from having to carry another card around, Doordeck gives them extra features and ease of use that exceeds a regular card. Widgets, NFC access and fingerprint functionality make it quicker and safer than before to unlock their office.

The company is proud to be one of the most advanced and secure keyless solutions on the market, not only for the Internet of Things industry, but for the security industry as well. The platform works with ANY electronic lock, is secured with defence-level 2-factor authentication and uses a new pricing model that removes large upfront costs.

Doordeck are pleased to be championed by Cisco and by a Cisco Certified Partner.

Grid Smarter Cities

Grid Smarter Cities is an ecosystem of smart solutions, connecting communities and people with transport, parking, goods and services. The company is making lives easier for everyone and making cities smarter, more efficient and inclusive.

There are a number of interconnecting companies under the Grid umbrella, including Omnia (Telematics and Fleet Optimisation), assist-Mi (disability access and assistance app), Kerb (virtual kerbside management) and Skiptrac (skip distribution and waste management solution).

In 2017 Grid was ranked 15th on the IP100 Intellectual Property League Table, for their patented solutions that offer the unique ability to carve out new space in the Smart City landscape, proactively solving the problems that others cannot.

Over the past 18 months the company has also won a number of Innovate UK grants and contracts, including rail, fuel, delivery as a service, virtual kerbside management and freight optimisation.

Grid envisages the city of the near future as "digital, connected and convenient". Its expertise, products and partners aim to deliver this vision by looking at how cities and communities manage space more productively for the benefit of people and businesses and at how an interconnected world can manage the mobility of people and vehicles to optimise efficiency.

IMGeospatial

IMGeospatial provides world class, innovative geospatial analytics to people and businesses.

The company has developed unique artificial intelligence algorithms that are capable of autonomously extracting actionable business intelligence from a range of satellite datasets. This intelligence supports critical decision-making in a world where geospatial analytics has become the tool of choice across all business and commercial sectors.

IMGeospatial can provide customers with game-changing opportunities to access actionable business intelligence in weeks rather than months (or longer). The company has customers throughout the UK and US, demonstrating that there is a requirement for

its services across the globe. IMGeospatial satisfies the need for accurate, cost-effective, timely, resilient and actionable business intelligence for customers, no matter which sector they operate in, or their geographical location.

Benefits from choosing IMGeospatial's cost-efficient range of products include unprecedented accuracy of up to 95% and resilience with datasets renewed at either 3, 6 or 12-month cycles.

The company identifies where a change in an Area of Interest (AoI) has occurred, using readily-available satellite imagery, thus offering valuable insights to aid critical decision-making.

Inavya Ventures Ltd.

Inavya Ventures is a London-based company, established in 2015. With UK government R&D funding and private investment, Inavya has created AVATR – an AI and machine-learning technology that enables an individual to use their mobile phone to create, own and manage a digital version of their self, which the individual can then choose to share with others so as to receive highly-personalised and contextualised services in return.

The company's current commercial focus is global healthcare. For physicians, AVATR saves time and improves clinical outcomes via easy- to-use tools to deliver personalised medicine. For patients, AVATR enables high-quality interpersonal communication with clinical

staff and the delivery of personalised and contextualised healthcare outside of hospital.

Inavya is currently running a demonstrator in Singapore to support remote cardiac care. From this hub, the company has access to a clinical network that spans over 40 countries globally. Inavya is also leading on a UK-Brazil Newton Fund project, where AVATR is positioned to support health and wellbeing services for the city of São Paulo.

Inavya intends to scale-up its operations in 2018, is exploring opportunities in London, Rome and Shanghai and very much welcomes collaboration and investment opportunities with colleagues in Australia.

Just Park

JustPark has a vision for a future in which parking is effortless on every journey – removing the stress and wasted time it causes so many drivers on a daily basis and enabling cities to function more efficiently in the process.

The service helps over 1.5 million drivers find parking in seconds – with real-time and predictive information on availability, restrictions and price for 1.4 million spaces. Drivers can reserve and pay for a guaranteed space via the company's award-winning, five-star-rated apps.

For landlords, JustPark's industry-leading technology helps property owners to manage their parking assets more effectively – from office car parks to on-street bays, multi-storeys to private driveways – as well as unlocking additional spaces for drivers. Alongside making an extra income for over 20,000 homeowners, the company works with the biggest names in property and hospitality – including Savills, MarrInternet of Thingst, JLL and Hilton – and provides innovative parking solutions for the public sector, local authorities and hospitals.

Winners of the Parking Futures Award and Richard Branson's #VOOM, backed by Index Ventures and a record-breaking equity crowdfunding round, and ranked as the #1 parking app in the UK, JustPark is leading a £50bn industry into the digital age.

Multipass

MultiPass offers the **1 Mobility** platform, which is a disruptive⌈SEP⌉MaaS solution that opens new horizons for any transport operator worldwide. The platform is offered via a game-changing business model based on 'light capex' that allows transport operators of any size to deploy state-of-the-art automated fare collection in a matter of weeks and in a capital-efficient way.

1 Mobility is an integrated end-to-end platform that includes powerful cloud-based infrastructure as well as intelligent on-vehicle hubs. The 1 Mobility hub supports all transit protocols worldwide, including contactless payments that are compatible with major card payment networks. The platform's roadmap includes Smart City solutions

such as connected vehicles, dynamic route optimisation and ad hoc capacity management.

In addition to transport operators, 1 Mobility partners include global card schemes (Visa, MasterCard, Union Pay), the world's largest acquirer (Worldpay) and semiconductor company NXP, as well as several banks and automotive OEMs.

Open Energi

Open Energi is an energy technology company, using advanced automation and data-driven insight to radically reduce the cost of delivering and consuming power. The company is working across the electricity value chain, with large energy users, electricity suppliers, system and network operators, energy infrastructure developers and technology companies, to accelerate demand-side innovation and deliver its solutions at scale.

Open Energi's Dynamic Demand technology connects, aggregates and optimises distributed energy assets in real-time, maximising value for end-users and providing real-time demand flexibility to create a more sustainable energy system.

The company has been providing demand-side management services since 2011 and has grown to over 50 customers, connecting over 3,500 assets – including industrial equipment, battery storage systems and local generation – at over 400 sites across the UK. During this time, it has delivered over 590GWh of flexible capacity, helping businesses to reduce costs and cut carbon emissions.

Open Energi's new platform, Dynamic Demand 2.0, applies artificial intelligence and machine learning techniques to unlock demand flexibility, maximise on-site generation and automate energy efficiencies.

Predina Tech Ltd.

Predina is the pioneer in dynamically detecting and preventing or mitigating road accidents in real-time. The company's mission is to save lives, prevent injuries and reduce the economic costs caused by road transport accidents. By leveraging big data, Predina can help organisations work towards achieving zero transport incidents.

Predina's proprietary software uses AI algorithms together with spatio-temporal analytics and deep learning techniques to process vast amounts of structured, unstructured, numeric, image and textual data. It combines historical accident and near miss data, hyper-local weather data, real-time historical traffic data, real-time and

historical driver profiles and other contextual data to deliver predictions that have shown over 70% accuracy in real-world testing.

The Predina risk suite comprises an analytics platform, custom web dashboard and API. The predictive software specifies the risk score of accidents at any place, any time and for any driver. In addition, we predict the likely severity and cause. Our unique system predicts road accidents accurately and then mitigates risks by diverting individual drivers and vehicle fleets to safer routes, as well as helping reduce carbon emissions.

The company has built a passionate and highly-experienced team in AI (including a faculty fellow of the Alan Turing Institute), risk modelling and transport. Advisors have a wealth of relevant sector and business experience, and include individuals from McLaren and

Ford. Lead clients include one of the largest industrial gas companies in the world.

SEaB Energy Ltd.

SEaB Energy is the first to market with a unique, highly mobile, containerised small-scale anaerobic digestion (AD) solution. The FlexibusterTM and MuckbusterTM create energy, water and fertiliser from on-site organic waste, offering disruptive onsite alternatives to centralised waste processing, thereby removing the necessity and costs, diesel consumption and carbon emissions of transporting waste.

The fundamental design criteria of the patented FlexibusterTM and Muckbuster TM is to simplify the transportation, installation and operation of AD systems. Arriving fully assembled in 20ft shipping containers with only final interconnects necessary, the systems can be operational shortly after delivery. Contract partners around the world support the units' production and maintenance on a local level, keeping it affordable especially for developing markets. The energy produced can be used locally in the form of electricity and heat, or can be sold back to the grid for profit. The pasteurisation process allows the sole by-product of the process to be sold as a nutrient-rich fertiliser.

SEaB Energy believes that micro-AD has a key role to play in achieving both zero-waste policies and national renewable energy objectives. The company's vision is to be the market leader in standard on-site equipment for recycling organic waste into energy around the world.

Sunamp Ltd.

Sunamp was founded to respond to the need for low to zero-carbon heating, cooling and hot water systems in buildings. The company has successfully reached commercial stage in 2014 with SunampPV and they are now investing heavily in international growth.

Sunamp manufactures a novel high-efficiency heat energy storage technology – the 'Heat Battery'. This uses phase-change material to store between four and sixteen times more heat than an equal sized hot water tank. During a phase-change, such as the transition between liquid and solid, a large amount of heat is stored or released. The result is a high energy-density high power-density thermal store. Heat Batteries can be integrated with various energy sources, such as solar photovoltaic and thermal panels, grid electricity, heat pumps, gas boilers, waste heat and more. The concept is now being explored in sectors as diverse as heating buildings at lower cost, industrial processing and automotive design.

Sunamp's ultimate goal is deployment of its technology in innovative products that reduce fuel poverty, energy consumption and carbon intensity of heating / cooling systems by harnessing free or low-cost renewable heat.

Upside Energy Ltd.

Upside Energy's cloud platform uses advanced algorithms and AI to coordinate devices that households and businesses already own, including in backup power supplies, home battery systems, electric vehicles, hot water tanks and heating and cooling systems, to match demand for energy with the available supply.

Upside Energy was created for a challenge prize run by the UK's National Grid in 2014. It has since won a number of awards, including the £150k 2017 Shell Springboard prize for low carbon innovation. It has raised £2m of grant funding from Innovate UK, £1.2m of seed equity and closed a £5.4m Series A funding round in December 2017.

This approach lets the energy system make better use of both conventional and renewable generation, saving both costs and emissions. System operators pay Upside Energy to create these savings and the company shares that revenue with the owners of the devices it controls.

Westfield Technology Group

Westfield Technology Group is one of the UK's leading autonomous vehicle providers. The company is known globally for its niche vehicles and has over 20,000 of its sports cars in the field. Westfield was the first niche vehicle company in the UK to obtain Small Series Type Approval for its vehicles, processes and premises.

Westfield has developed the POD in conjunction with Heathrow Airport and utilises the base technology platform from the work completed by Ultra PRT – where the system has completed over 5 million kilometres in a live commercial environment at Heathrow Terminal 5.

The company has now developed and manufactured a fully autonomous POD that can currently run on private roads/cycle paths. It also manufactures the GTM vehicle (M1 vehicle), and (in conjunction with Johnstons Sweepers) makes an autonomous road sweeper that can detect foreign objects. The company also enables platooning of vehicles (a virtual train) to reduce congestion and supports trials, deployment and safety-case work with their own team.