CATAPULT Satellite Applications

Geospatial Innovation in 2020

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Geospatial Innovation 2020

Preface

"Location, location, location" — we have often heard this phrase when talking about the criteria that are important for the success of traditional retail businesses. In today's digital world, location or geography is widely recognised as being a critical consideration across all areas of business and government. The relatively recent term geospatial is often used to refer to a myriad of location-referenced data such as satellite imagery, digital maps, census data, customer locations, real-time traffic flows, and air quality.

By integrating geospatial data and technologies into business processes, both industry and government are recognising the benefits that geospatial data and analysis can offer to help make their operations and organisations more effective and efficient, or to enable the creation of new products and services. The rapid advances in satellite Earth Observation and the associated increase in the volumes of data that can be processed and analysed leads to opportunities to contribute significant business, societal, and environmental benefits.

Today, geospatial data and technologies impact our daily lives in so many ways, such as optimising the physical delivery of products and services; improving agricultural efficiencies; minimising impact of severe weather events; modelling insurance risks; improving air quality or enabling self-driving vehicles.

The Satellite Applications Catapult is in a unique position at the intersection of business, government and academia to help to ensure that UK businesses can maximise the benefits that geospatial technologies can offer.

Our broad knowledge of geospatial data and technologies ensures that we are able to offer support and advice to businesses across all industries so that the exciting opportunities for geospatial technologies to make a difference can be maximised.

I hope that you find this report interesting and look forward to helping to support you to geospatially-enable your organisation.

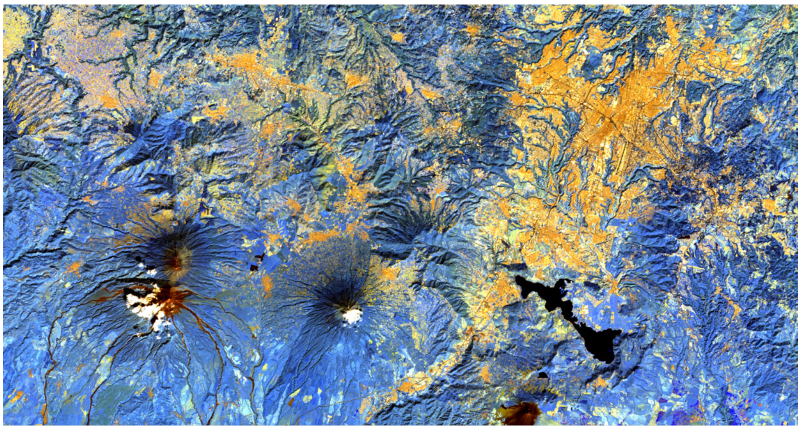
PETER BEAUMONT

DIRECTOR, GEOSPATIAL INTELLIGENCE, SATELLITE APPLICATIONS CATAPULT

Geospatial Innovation 2020

Introduction

Geospatial Innovation (GI) — which consists of exploiting and analysing imagery and other geospatial data, typically captured by satellites — may have its roots in military and defence initiatives, but its use has broadened greatly in recent years as Earth Observation (EO) capabilities have expanded.



This Sentinel-2A false colour image, captured in November 2017, exploits the short wave infrared bands to highlight lava flows on Volcán de Fuego. **Data © ESA. Image © Terri Freemantle.**

Prior to the major advancements in Artificial Intelligence (AI) and other emerging technologies that are now integrated with Geospatial Innovation, satellite data was difficult to come by. Images were attainable mainly to those working on Government-funded projects. Others who wanted to use the data had to purchase it, and it was not cheap.

This lack of access limited the usefulness of geospatial technology and Earth Observation. But the further we get into the new millennium, more satellites are operating, collecting much more data, and the access to the data is increasing.

For example, the European Union and the European Space Agency (ESA) developed the programme and launched its first satellite, Sentinel 1A, in 2014. It now has seven satellites in orbit and provides free images to academics and entrepreneurs for developing commercial applications. In the United States, the Landsat programme, the world's longest-running provider of Earth Observation imagery, also allows users to access its data for free.

While there's a lot more data to make use of, there's still the question of how to make use of it, and that is where organisations like Satellite Applications Catapult come in.

The Catapult aims to "innovate for a better world" while supporting industry in the United Kingdom by accelerating the growth of satellite applications. It believes it can drive economic growth through the commercialisation of Geospatial Innovation and Earth Observation research. Part of achieving this is its ability to parse an increasingly large amount of data and clearly convey its value to prospective partners.

"There's such a massive amount of data now coming from lots of satellites, and it's difficult for an end-user — unless they really understand the technology — to know which dataset should be used to solve their problem," says Peter Beaumont, the Catapult's Director of Geospatial Intelligence.

Geospatial Innovation 2020

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As Dan Wicks, Head of Earth Observation at the Catapult, puts it, the job is to "know what data and information is out there that can be exploited" to help companies and other organisations "increase productivity and efficiency whilst cutting costs or develop new revenue streams."

Geospatial Innovation is continuing to move beyond the Government and military into private-sector areas like telecommunications, transportation, agriculture, public health and safety, where it can be used to improve the quality of everyday life in addition to spurring economic growth. These are the kinds of initiatives Satellite Applications Catapult is focusing on, some of which include:

Agriculture

Actions taken from satellite data analysis can help detect and control pests and disease, understand water and nutrient status, plan crop nutrition programmes, inform in-season irrigation, predict yields and estimate harvest timing.

"Satellites power agriculture, providing users across the supply chain with the data, connectivity and locational information to support the sector in achieving an optimised and sustainable food production system," says Mark Jarman, the Catapult's Head of Agriculture.

Sustainable Finance

Geospatial data, including satellite and climate data, can provide key elements of the information that is needed to evaluate risks, opportunities and impacts of unsustainable investment opportunities to deploy sustainable finance effectively.

Getting financial markets to integrate climate change, as well as environmental and social sustainability, into decision-making can help financial institutions appropriately manage risk, reduce losses and improve the resilience of the financial system as a whole. More and better information is needed for markets, institutions and players to efficiently allocate capital to sustainable investment alternatives.

Sam Adlen, Chief Strategy Officer at the Catapult, said: "Our vision is to have the world's largest asset owners, asset managers, banks, and financial regulators all using [sustainable finance] to assess risks, opportunities and impacts across different aspects of financial sector decision-making. This will be driven by a vibrant UK ecosystem of providers and products."

Health and Wellbeing

Satellite applications can deliver transformational change in the way that healthcare services are delivered. The Catapult is presently targeting the NHS across the UK to demonstrate its ability to diffuse satellite-based innovation. Among its focuses is to improve the efficiency of ambulances and reduce conveyancing.

"Satellite applications have a crucial role to play in enabling access to remote self-management solutions, providing remote monitoring and early diagnostics, and facilitating shared clinical-decision making," says John Vesey, the Catapult's Health Business Manager.

Introduction

Intelligent Transport

Exploiting Earth Observation data can generate solutions to increased congestion and passenger expectations. As the demand for movement continues to grow it is becoming increasingly necessary to utilise the current transport options in a more intelligent way.

Regarding infrastructure, significant savings could be made regarding cost and the time required to collect information on assets. Satellite data can provide the information required to map, monitor and assess road infrastructure condition and distribution as an alternative to the deployment of surveying teams on the ground.

Extractive Industries

Satellite technologies can create operational efficiencies within the mining sector whilst empowering local communities and reducing, even eliminating where possible, environmental degradation. Satellite-enabled assessments of the pre-mining environment can provide environmental insights and risk modelling.

IOD-1 GEMS being released from the ISS. **Photo Courtesy of NASA**

"We're supporting the uptake of satellite data within the mining industry in order to improve efficiencies, reduce environmental issues and build stakeholder relationships for local communities," says Estel Blay, the Catapult's Extractive Industries Business Manager.

Access to Space

The space sector has seen significant shifts in its approach to the commercialisation of satellite applications, which has opened new opportunities through the use of small satellites, on-orbit servicing and low Earth orbit constellations.

The Catapult's role is to provide opportunities for businesses to gain access to space by reducing risk and building relationships with UK-based service providers. The UK is growing capabilities to provide a full satellite ecosystem including component sourcing, satellite provision and builds, launches, in-orbit services and mission support.

GI and EO: How It Works and Where It's Headed

Peter Beaumont, Director of Geospatial Intelligence for Satellite Applications Catapult, and Dan Wicks, the Catapult's Head of Earth Observation, provide an overview of GI and EO data, identify some of the key challenges they encounter, and look ahead to the future of GI and EO.

Madagascar's Betsiboka River Delta as it was captured in December 2016 by Sentinel-2A. **Data © ESA. Image © Terri Freemantle.**

The Basics of GI and EO

Before one can appreciate all that can be achieved using Geospatial Innovation (GI) and Earth Observation (EO) data, it's important to understand how it all works on a fundamental level.

"Geospatial Innovation, as we refer to it here at the Catapult, is the analysis of data that has some form of a geographic or location component to it. That can be a satellite image that has a longitude and latitude reference system to it, it could be a postcode, an administrative or soil type boundary, or a line representing a road or geological fault" explains Beaumont.

A key component of GI is the use of Artificial Intelligence (AI) to extract as much possible from Earth observation imagery, says Beaumont. This can be done using image analysis solely on images or integrating the images with other geo datasets to help to extract the needed information.

"The way that I try to think about it is that geography provides a consistent index across all data," adds Wicks. "The question then is what value does having them in a consistent reference have? You're bringing together very different types of data sets that on their own mean nothing, but together can tell you something, and that's the intelligence part of it."

EO satellites measure emitted and reflected radiation for a given target area on the Earth's surface, across different wavelengths of the electromagnetic spectrum. It is then possible to exploit the fact that different properties on the ground demonstrate distinct interaction with certain portions of the electromagnetic spectrum.

"We're able to measure the relative intensity of radiation reflected by a feature of the Earth's surface, typically across the visible parts of the electromagnetic spectrum, from which we can infer something about that feature," says Wicks. "What we then try to do is identify a causal link between the measurement and some property of that feature, namely physical or chemical — structure, process or change."

GI and EO: How It Works and Where It's Headed

Sentinel-2B True Colour image of North West Fiji. **Data** © **ESA Image** © **Satellite Applications Catapult**

For example, when looking at vegetation in the near-infrared part of the electromagnetic spectrum — which is really sensitive to photosynthetic activity — a direct causal link can be established between the relative amount of infrared light reflected and photosynthetic activity.

"This would then have implications across multiple applications, whether it's an ecologist finding it useful for a study of biodiversity, or a farmer in the commercial world of food production knowing where a crop is growing or not growing," explains Wicks. "If you then bring in information like weather data taken from a sensor on the ground or boundary maps derived by the Rural Payments Agency or other similar geographic datasets, suddenly you've got enough information to do something clever like modelling a yield forecast for that crop."

Avoiding Data Overload

From the point of view of the Catapult's workflow, the ability to collect more and better data is a blessing and a curse. One of the key challenges is how to work efficiently with the massive volumes of data that are collected. This is where AI and machine learning is especially useful.

GI and EO: How It Works and Where It's Headed

"When you think of AI in terms of classifying an image, that's been around for decades. But the availability of massive amounts of data now combined with huge improvements in the computing power and capability has really enabled AI to be more useful," explains Beaumont. "Whereas before you were making a classification on a single image at a time, you can now process multiple images and look at changes across time."

The ability to capture higher levels of granularity in the data, whilst enabling more detail to be extracted from the data, creates further obstacles in terms of data analysis.

"The challenge is more complicated than it has been before because, with the data set of ten years ago, you were talking about, at best, up to a meter in spatial resolution, and most data sets were of a medium resolution. Today, you're getting imagery with a spatial resolution of, say, 30 centimetres," explains Wicks.

Because of this, the propensity for misclassification is really high. "That's why we need more robust and intelligent approaches to the way in which we analyse data," Wicks adds.

These excessive amounts of data can create barriers from a user's perspective as well, even for someone who already has a fundamental understanding of how GI and EO work.

"It's something that we've solved by establishing a cloud computing environment together where the images can be stored and then a user can bring their processing requirements or their algorithm to the data rather than downloading the data. This leads to massive improvements in the speed of image analysis and enables organisations to develop applications making use of the imagery as soon as it becomes available" Beaumont says.

For less-experienced users, it's up to the Catapult to make the process as accessible as possible in order to shed light on the many benefits that can be derived from the data.

"There's some degree of education required to help people understand that this technology is useful. And whilst that may not apply to a certain subset of experienced users, we need to work to understand the requirements of non-traditional users and identify where as an industry we can routinely produce data products and services that they can easily consume and understand," Wicks says.

Looking Ahead

While emerging technology has been used by the Catapult to accomplish what may have been difficult to imagine 10 years ago, there are likely to be more major leaps forward in the near future, including the potential for near real-time imaging capabilities.

"With the huge constellations of satellites being launched, we will get to the stage where there are so many sensors flying over the same point on the Earth's surface every day, that we'll have near real-time imaging capabilities. Combining that with the drones that will be around — there's no doubt there's going to be swarms of drones around in the next 10 to 20 years, and those drones will have imaging capabilities" Beaumont says.

GI and EO: How It Works and Where It's Headed

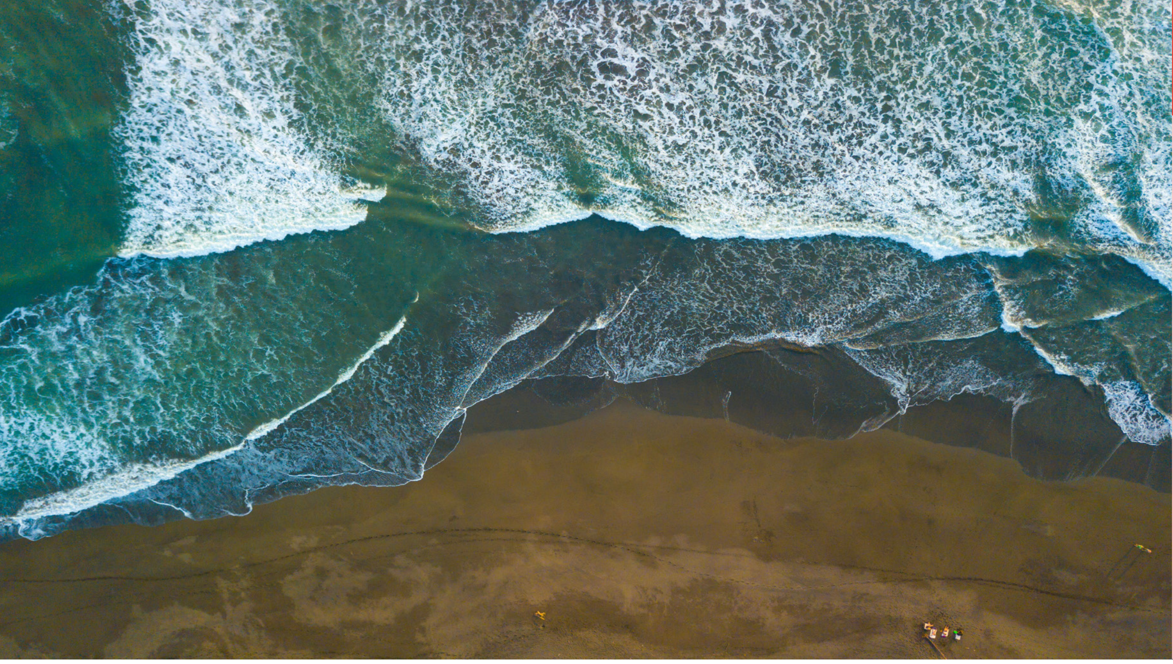
In addition to a huge jump forward in the technology itself, Wicks sees the potential for a cultural shift as well that could lead to a much wider adaptation of its use. The key is to make clear just how useful GI and EO can be for various types of organisations across many different sectors.

For example, the Catapult has worked with local UK authorities on managing planning processes related to building regulations, which presently involves a paper-driven application process and spreadsheets of data. This process could be greatly improved by applying advancing geospatial capabilities.

"Local authorities will be able to use satellite imagery to identify changes that are taking place within their areas and get notifications that construction work has started on an approved planning application. This EO-based Geospatial Intelligence would replace what they literally have staff driving around cities looking for."

Peter Beaumont is the Director of Geospatial Intelligence at the Satellite Applications Catapult. He is responsible for leading a team of technical experts across Earth Observation, geographic information systems, geospatial data science, software engineering, cloud computing and data centre operations. This team supports all areas of the Catapult activities with a focus on the exploitation of geospatial data for the benefit of business and Government, with experience in developing geospatially-enabled commercial applications across a range of market sectors. Peter is a fellow of the Royal Geographical Society.

Dan Wicks is Head of Earth Observation at the Satellite Applications Catapult. He is responsible for leading a team of experts across Earth Observation, data science and software engineering in support of the exploitation of data from Earth Observation satellites to the benefit of business, with experience in developing new geo-enabled commercial applications across a range of market sectors. Dan is a fellow of the Royal Geographical Society.



At a Glance

WHAT
Satellite-Derived Bathymetry uses sophisticated algorithms to capture depth and detail from satellite images of the ocean.

WHO
TCarta Marine

WHERE
United States & United Kingdom

CONTACT
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Mapping the bottom of the sea from space

Satellite technology makes it easier and cheaper to map remote ocean locations and governments better prepare for natural disasters

UK and US-based TCarta Marine is using satellite imagery and machine learning to map the ocean floor from space. TCarta uses sophisticated algorithms to capture depth and detail from satellite images of the ocean.

The process is called Satellite-Derived Bathymetry (SDB). The algorithms based calculations on the spectrums of light that are captured by sensors on satellites in space. These sensors collect specific wavelengths of energy as it is reflected off a surface. The computer determines the depth of the ocean by calculating the relationship between the type and volume of energy picked up by the sensor and the depth of water at set reference points.

The traditional way to map the seafloor uses sonar systems to send sound waves from the bottom of a ship to the seafloor.

TCarta's technology could make it easier and cheaper to map remote locations using satellites. TCarta is using the process to map 5,000 square kilometres in total of seafloor around the island nation of the Republic of Kiribati.

The island country is located in the Pacific Ocean and is threatened by rising sea levels. Mapping the seafloor around the island nation will help the government prepare for natural disasters.

TCarta's technology is an improvement over the older methods because previously SDB could only determine water depth in calm, clear waters, according to Goodrich. Today the company can determine depths in a variety of water conditions.

This technology is also important because it does not require researchers to travel to the area, unlike more traditional ship-borne SONAR mapping techniques.

Takeaway: With only 15 per cent of the ocean's floors mapped, satellite-based topography could greatly increase the speed at which more is done. Additionally, more in-depth understanding and examination of detail could improve conservation knowledge and business investment risk management. Eco-tech projects such as floating cities could also be tracked and placed more efficiently and safely with the use of satellite mapping and real-time data transfer capabilities.

At a Glance

WHAT
Tech solutions to fight the Illegal Wildlife Trade, including a constellation of CubeSats for low-cost monitoring.

WHO
WILDLABS Tech Hub

WHERE
Global

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Tech hub develops new solutions to combat wildlife crime

A collaborative approach uses tech solutions to push back against the Illegal Wildlife Trade and other conservation threats

The WILDLABS Tech Hub has tapped into the technological strengths of multiple companies and organisations across the globe to push back against the Illegal Wildlife Trade (IWT) and other conservation threats. Through a three-month support program, its aim is to deliver sustainable solutions to these issues.

As part of the program, WWF, Stanford University, the University of Colorado Boulder and Imperative Space are planning to launch a constellation of CubeSats, called PandaSat. The goal is to allow for low-cost monitoring of unconnected areas.

"Now is the time to come together and deploy our combined technical resources and expertise to help tackle conservation problems on a global scale," said hub member Sophie Maxwell.

Other participants in the hub include Wildlife Protection Solutions, who developed an IoT-based alert system that uses machine learning modules to spot potential poaching incidents.

Interpol, the City of London Police Fingerprint Bureau, is also providing access to its fingerprint database and AI search technology to countries dealing with high levels of wildlife crime.

The UK's Foreign and Commonwealth Office (FCO) provided the hub's initial seed funding, and further financial support has been provided by Digital Catapult, Satellite Applications Catapult and WILDLABS conservation partners.

Takeaway: One rhino is killed by poachers every seven hours, and African elephant populations are falling by 8 per cent each year. The IWT also has a detrimental impact on the livelihoods of locals that rely on wildlife-based economies. By tapping into a wide range of technological expertise, the hub believes it has the right approach to stem the tide of wildlife crime. "Only an integrated, collaborative approach will deliver sustainable solutions for tangible conservation impact," Maxwell said.

At a Glance

WHAT
Agricultural robot CEOL uses AI to analyse its environment; tracked and located via GNSS and RTK satellite positioning.

WHO
AgreenCulture

WHERE
France

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Autonomous eco-farming robot makes agriculture smarter

The AI-powered machine uses satellite geo-location data to save resources, making farming more sustainable

Margins in farming are always tight, and French company AgreenCulture's "CEOL" agricultural robot gives farmers a hand in multiple ways. CEOL uses AI to analyse its environment. This provides detailed information on everything from ground preparation and crop growth to precisely targeted fertiliser needs.

The results aim to help farmers efficiently incorporate eco-friendly approaches to their work. The robot weighs 500 kilograms and operates autonomously 24/7. It is equipped with a tank that holds seeds, water or fertiliser.

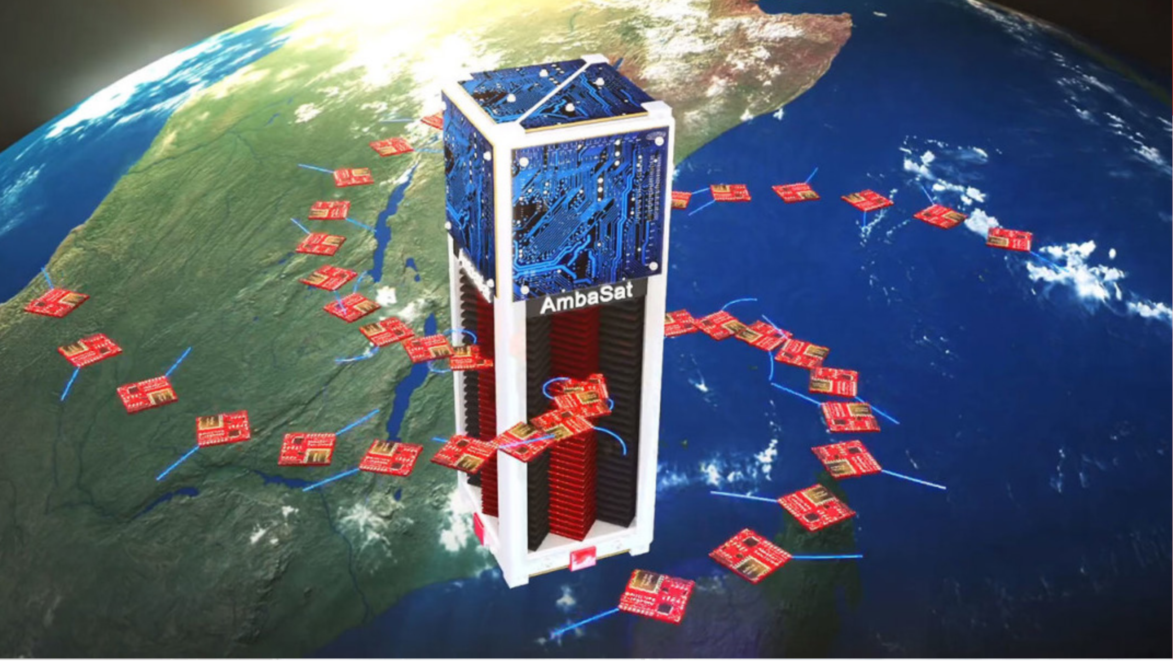
CEOL is located and tracked through a combination of the Global Navigation Satellite System (GNSS) and Real-Time Kinematic (RTK) satellite positioning.

RTK provides centimetre-level precision positioning to distribute seeds, fertiliser and pesticides with minimal waste.

As an autonomous robot, CEOL also helps protect humans from the long-term health risks associated with extended exposure to pesticides and other chemicals.

AI ensures that the robot knows the difference between a weed and the crop. Moreover, its data-gathering capabilities identify objects and conditions such as the presence of pests, potential outbreaks of disease and early effects of the current climate. On-board sensors and a camera relay real-time updates back to the farmer.

Takeaway: A lot of agricultural harvesting relies on the delicacy of human touch, with robots assisting with heavier-duty tasks including ploughing and fertilising. As technology improves, the actions and materials of farm robots become finer, allowing for more sensitive movements. AgreenCulture's year-long Challenge has already demonstrated the possibilities of autonomous farming. With no human assistance, three CEOL machines managed a 50-hectare field - working a full agricultural year, from taking initial soil samples to sowing and harvesting the maize.



At a Glance

WHAT
Personal build-and-code kits for mini space satellites.

WHO
AmbaSense

WHERE
United Kingdom

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enquiry@ambasense.com
ambasense.com

Photo: Ambasense

Build-your-own mini satellite opens space exploration to all

IoT experts AmbaSense created build-and-code kits for solar-powered Sprite satellites.

Spotted: Personal mini space satellites open up new dimensions of exploration. Space is no longer available to only astronauts and entrepreneurs. The AmbaSat-1 IoT space satellite kit provides unlimited opportunities for individual space exploration.

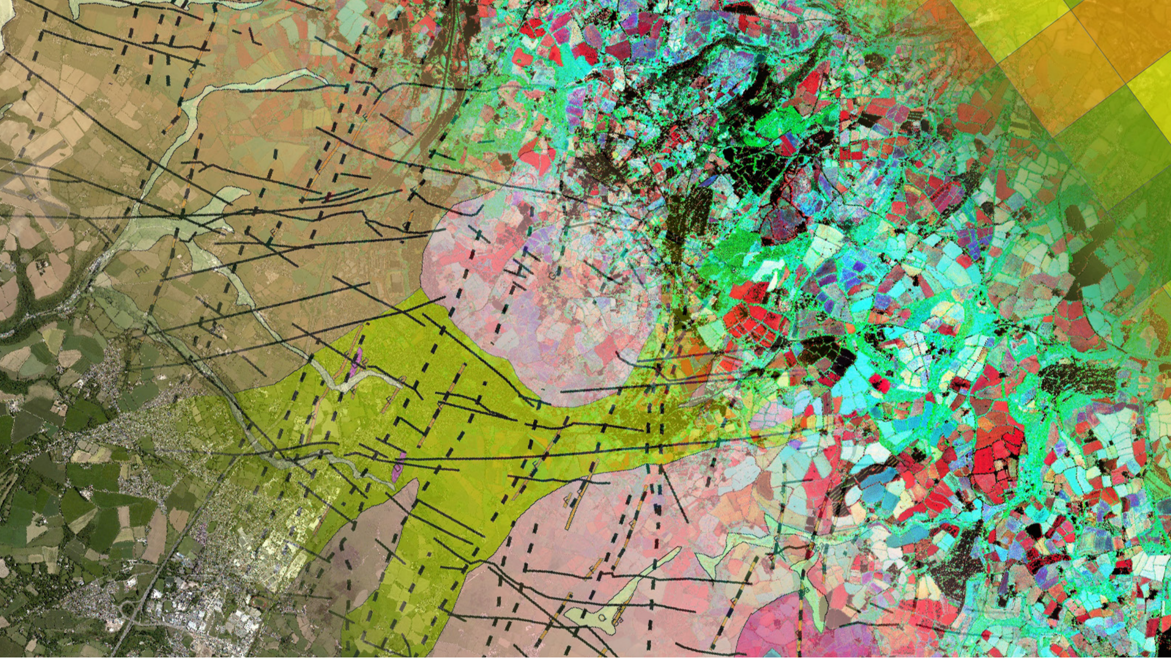
Created and built by United Kingdom Internet of Things (IoT) business and technology experts AmbaSense, funding for the kits are being raised on IndieGoGo. Classed as a Sprite satellite, the AmbaSat-1 is 35mm square and only a few millimetres thick. Using a low power wide area network (LoRaWAN) radio transceiver, the tiny spacecraft sends data back to its owner's AmbaSat internet dashboard. Makers do not have specialist equipment to monitor their satellites.

The AmbaSat-1s will be launched into low earth orbit from an Interorbital Systems rocket launch. Interorbital Systems is a rocket, satellite and spacecraft manufacturing company that also provides space launch services. Bundled into groups of 200 aboard the rocket, the AmbaSat-1s fly into orbit approximately 250 kilometres above Earth. At that point, the solar cell will power the spacecraft for three months as it circles the planet.

Makers may buy kits in various stages of completion and with a range of tools. All kits come with full construction instructions and coding support for everyone from complete beginner to advanced expert. The satellites are available as either a battery-powered option or a solar-powered version. The satellites launched into space must be solar-powered.

AmbaSat-1 is open source, and all its technology is developed in-house. The company hopes its mini-satellites make space a much more accessible area for exploration, particularly for those working to save the environment.

Takeaway: Miniature satellites provide limitless opportunities for exploration, adventure, data gathering and analysis. The build-your-own approach makes space far more accessible, which provides huge potential for educators. Whether primary school students learning basic electronics and the fundamentals of space or dedicated climate change activists and scientists, bespoke, solar-powered personal satellites open up myriad new avenues of approaches to the multitudes of global social challenges.



At a Glance

WHAT
Satellite-based techniques that could ultimately reduce the cost of lithium exploration substantially.

WHO
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Photo: Satellite Applications Catapult

Scientists spot lithium 'hot-spots' from space

This project sheds light on new, satellite-based techniques that could reduce the cost of lithium exploration substantially.

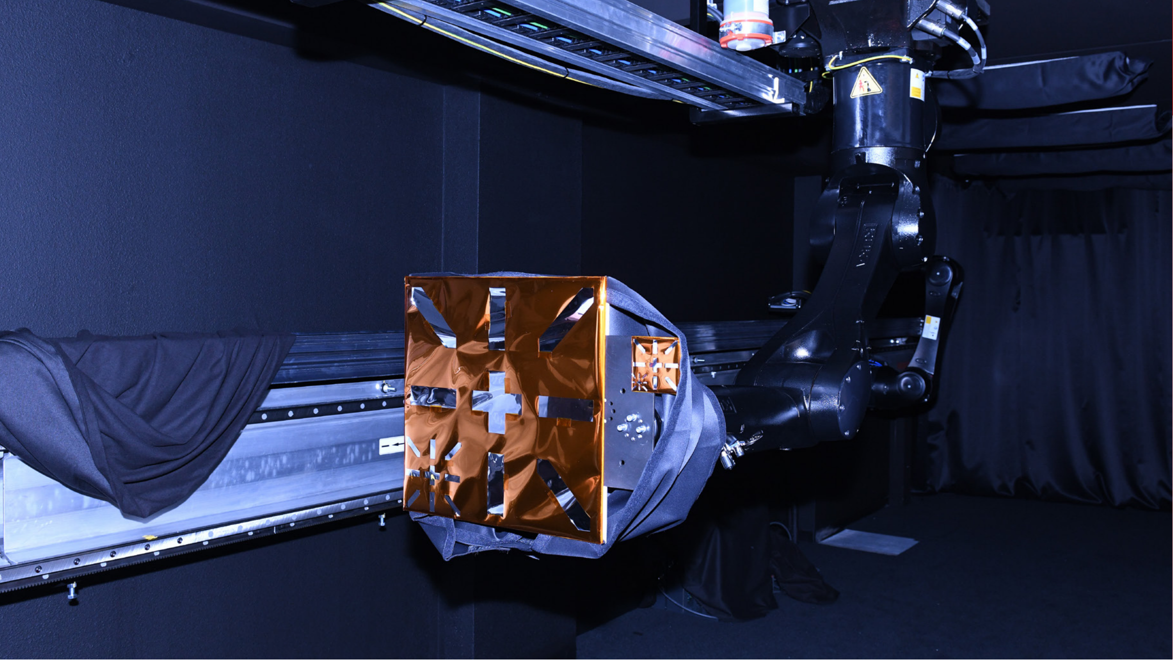
Spotted: A team of scientists, led by Satellite Applications Catapult, used satellites to indicate potential locations on the Earth's surface where lithium could be discovered. This project aimed to shed light on new, satellite-based techniques that could ultimately reduce the cost of lithium exploration substantially.

This was done by studying characteristics in vegetation and minerals and merging it with geological data. The team used a combination of techniques, including heat mapping, and was able to spot potential indicators of lithium by researching its impact on plants.

"This approach to lithium exploration, which includes the estimation of multiple surface indicators, has not been attempted before and may be highly applicable across the wider mining industry," said Dr Cristian Rossi, Principal Earth Observation Specialist, Satellite Applications Catapult, who led the study.

Experts from eleven organisations were involved in the study, which focused on two areas of Cornwall. Project partner Cornish Lithium Ltd will be working with the team to build on this initial research.

Takeaway: Global demand for lithium is expected to increase by around 400 per cent by 2025. This is partly due to its increased use in batteries that will power electric vehicles and store renewable energy. The development of remote sensing techniques like this not only has the potential to cut costs but also reduce the environmental impact of lithium exploration by allowing for more accurate targeting of prospective areas.



At a Glance

WHAT
Navigation markers for space vehicles that may make directing a refuelling ship to a satellite dock easier.

WHO
ESA and ADMATIS

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Hungary

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Photo: ESA–P. Sebirot

Glowing navigation markers help satellite support vehicles dock safely

Phosphorescent designs on the sides of satellites relay directional and distance information to approaching spacecraft.

Spotted: Despite, and sometimes because of, the ready availability of navigational technology, people get lost all the time, driving and walking. Imagine doing the same in space. New navigation markers for space vehicles may make directing a refuelling ship to a dock on a satellite much easier. A partnership between the ESA (European Space Agency) and ADMATIS (Advanced Materials in Space) created navigational markers for safer space traffic management. Earth's orbital space is getting busier, especially as commercial space travel looks more likely and satellite-based research continues apace.

Using infrared and phosphorescent materials, the Passive Emitting Material at end-of-life (PEMSUN) markers guide approaching vehicles into a satellite's dock.

The markers attach to the side of the vehicle's hull or its insulation and include smaller versions of the design within the larger image. That enables advancing spacecraft to stay on track throughout a long approach. The intricate design includes details on the satellite's position and direction and distance between the two crafts. In March, the markers underwent an initial round of lab-based tests.

The collaboration is part of the ESA's Clean Space programme. On Earth, the pioneering programme champions the use of eco materials and processes in the manufacture, build and use of spacecraft. In space, the programme examines ways to keep the Earth's orbital environment as clean, debris-free and safe as possible. Refurbishing spacecraft is one method, as is removing vehicles that are no longer functioning.

The docking markers may be especially useful in the removal of old spacecraft for transport back to Earth for reuse or recycling.

Takeaway: As well as in space, navigation markers such as these by ESA and ADMATIS could prove useful in other parts of Earth that are particularly inhospitable and unexplored. Much of the planet that is underwater remains unmapped, and humans continue to push themselves to their physical limits through extreme weather and terrain challenges. Mountaineers, sailors and natural disaster recovery teams could find the tracking capabilities especially useful in harsh temperatures and elements.

At a Glance

WHAT
An AI solution that guides maritime traffic operators along the best possible travel route.

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Deep Blue Globe

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Satellite data powers AI-optimised ship navigation

The guidance system uses readily available satellite observation data to plot the swiftest, safest ocean travel route.

Spotted: German startup Deep Blue Globe's POSEIDON AI solution guides maritime traffic operators along the best possible travel route. Using real-time satellite data, POSEIDON's autonomous navigation optimises every aspect of a ship's journey, including safety, speed and fuel consumption. As the weather changes, so too do the solution's route recommendations.

Ocean-going vessels receive continuous travel support through the combination of satellite geo-location navigation and real-time maritime traffic and weather conditions. The system helps keep sailors safer, and the environment benefits as well. Ships burn less fuel as they spend less time at sea, and the vessels stay in good condition for longer, thus helping reduce maintenance costs.

To power its route planning, POSEIDON's AI uses satellite Earth Observation data from the European Commission's Copernicus programme. The Deep Blue Globe team designed the AI-powered solution to be accessible to owners and operators of ships of any size. Crucially, the system is compatible with the Electronic Chart Display and Information System (ECDIS) used by most modern-day maritime crafts. Shipowners don't need to buy any additional equipment to take advantage of POSEIDON's intelligence.

The Deep Blue Globe team won the 2018 Galileo Masters Hesse Challenge, and the company is currently in incubation at the European Space Agency's Business Incubation Centre.

Further development of POSEIDON's abilities will help accelerate the evolution and maturation of unmanned autonomous maritime vehicle systems.

Takeaway: With the global shipping industry valued at more than USD 400 billion annually, improvements to efficiency and safety provide substantial economic and other benefits. Unmanned Autonomous Vehicles (UAV) have the potential to revolutionise commercial maritime transport. And for other teams working on the oceans, AI-powered route planning, combined with UAVs, could help researchers and emergency relief professionals needing extended access to and analysis of a variety of locations and wildlife.

At a Glance

WHAT
A new constellation of satellites will be the first network to provide full-motion colour video of Earth from space.

WHO
Earth-i

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Photo: Shutterstock

Satellite shoots full-color video for instant analysis

A new constellation of satellites aims to improve decision-making and response times in emergency situations.

Spotted: British company Earth-i built prototype satellite Carbonite-2, which is the first of 15 in a planned constellation of satellites. When completed, the constellation will be the first network to provide full-motion colour video of Earth from space. Weighing 100 kilograms, the Carbonite-2's orbit is 505 kilometres above Earth at an approximate speed of seven kilometres a second. It launched from the Sriharikota rocket launch centre in southeast India.

Carbonite-2 is the first stage for Earth-i. The satellite is designed to demonstrate and prove technology and processes in advance of the creation of the constellation. When complete, the commercial constellation (named Vivid-i) will film moving objects in Ultra High Definition colour video at a resolution of one metre.

Footage will be available for analysis within minutes of being captured. This would provide improved decision-making and response times in disaster response situations and infrastructure monitoring. According to Josef Aschbacher, director of Earth Observation programmes at the European Space Agency, "The Vivid-i Constellation will provide capabilities we haven't seen before, including full-colour video, and an assured stream of high-quality data from space to help improve both our planet and our lives on Earth."

Carbonite-2 and the Vivid-i are at the forefront of the New Space Era driven by commercial and governmental organisations wanting high-quality, up-to-the-minute images and video from space.

The uses are many and include improving investment and trading decisions, monitoring and tracking assets, tracking changes or activities in key locations and predicting future events with more certainty.

Takeaway: The crime-fighting applications of near-to-real-time colour satellite video could be numerous and include poaching, transport and trafficking. At the same time, questions around privacy, access and permissions arise, as do potential opportunities for new types of hacking. Frontiers of development provide myriad possible applications, many of which may take years and many different tests to be fully understood.

At a Glance

WHAT
A network of intelligent balloons expanding internet connectivity around the world.

WHO
Loon

WHERE
United States

CONTACT
loon.com
press@loon.com

Photo: Loon

High-altitude balloons power internet connectivity around the world

A network of giant balloons carrying redesigned cellular tower components provides internet access to remote and underserved communities.

Spotted: Loon is a network of intelligent balloons expanding internet connectivity around the world. A subsidiary of Alphabet, Google's parent company, Loon's balloons carry all the essential components of a mobile phone tower. The parts have been redesigned specifically for use during extended periods of flight. They are lightweight and run on sustainable energy.

The tennis court-sized balloons travel 20 kilometres in the air up to Earth's stratosphere, a location twice as high as the flight paths of aeroplanes. Each balloon runs on solar power, with a renewable, chargeable battery providing energy at night.

Once the balloons are in position, they travel along wind currents to create floating networks of internet signals. Ground stations providing local internet services connect to the balloons which then redistribute the connectivity. Each balloon covers nearly 2,000 square miles with its signal. Loon's AI algorithm combines real-world travel data with computer simulations to position most effectively the network of balloons.

The AI considers current weather conditions and then directs each balloon to a specific current of wind. It also decides which channel bandwidth is currently providing the strongest signal. Such autonomous decision-making creates effective, strong, connected groups of balloons.

Once a balloon has completed its work, the Loon ground team liaises with local air traffic controllers to guide it down to a safe recovery location. Each retired balloon is extensively examined, and the development of the Loon network includes extending the life of each aircraft. Companies using Loon balloons programme and manage all aspects of their aircraft and network.

Takeaway: Today, internet connectivity is a requirement for nearly everything, from farming and healthcare to education and business. Satellite connectivity supports day-to-day working requirements of those living and working in remote locations, as well as developing the capabilities of industries around the world. Sustainable development, intelligent transport and geospatial intelligence are several of many areas of business that could benefit from satellite-provided improvements in navigation, mapping and data provision.

At a Glance

WHAT
A device using quantum technologies to achieve improved signal detection sensitivity.

WHO
University of Birmingham

WHERE
United Kingdom

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Quantum gravimeter takes ultra-precise measurements of gravity force

The device could have multiple applications, including mineral extraction, sinkhole detection and exploration of disused mine shafts.

Spotted: The Gravity Sensing team from the United Kingdom's University of Birmingham successfully completed outdoor measurements with their quantum gravimeter.

Gravity and the gravitational field are directly affected by mass and any changes in mass cause variations in the gravitational field. The impact of any change is extremely small and so detecting it can be challenging. Using quantum technologies, academics are improving signal detection sensitivity and making compact instruments that are resistant to noise, drift and constant recalibration.

The team's initial goals are to take gravity sensor devices out into a real working environment and carry out detailed comparisons with existing state-of-the-art commercial devices.

Achieving these goals will show potential end-users what they can expect from quantum technology.

The quantum gravimeter, designed and built in the laboratories at the Birmingham campus, represents a significant step towards developing robust quantum technologies for use in the real world. The Gravity Imager is intended to provide higher sensitivity and reliability for multiple applications, while also reducing measurement time by enhancing the process' robustness against external noise sources.

Gravity mapping is already used by civil engineers when carrying out surveys and detecting underground features.

Potential additional applications for the gravimeter include identification of sinkholes, finding and extracting minerals, monitoring climate change and surveying disused mineshafts.

Takeaway: Nanotechnologies combined with gravitational sensors could provide essential early detection in a variety of ways and a range of fields, from healthcare to weather and construction. Cost may be one of the most potent potential hurdles to the accessibility of this technology, at least initially, so continued development of materials and processes (especially collaborations) is particularly important.

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