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SPECIAL FEATURE

GALILEO APPLICATIONS: WHAT LIES AHEAD



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THROUGH YO-YO DIETING**

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IT AND COMMUNICATION TECHNOLOGY

**BUILDING A SUSTAINABLE,
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EDITORIAL

by the editorial team

THE QUEST FOR GAME-CHANGING APPLICATIONS: WILL GALILEO DELIVER ON ITS PROMISES?

Kicked off 17 years ago, the Galileo project has finally materialised. Four additional satellites were launched in November 2016, bringing the constellation to a total of 18. Although more precision (down to the centimetre for professional services) is expected with the launch of an additional 12 satellites and upgrades of various ground elements by 2020, the current setup is enough for the whole system to have been declared operational since the end of last year.

Now, all eyes are on what truly matters: useful, groundbreaking applications that will live up to the original Galileo promise: a fully European-controlled GNSS. The first-ever such system to be controlled by civilian authorities, providing the EU with long-sought independence from American and Russian alternatives. And, last but not least, a technological prowess beating competitors in the core function of GNSS technology: precision in both localisation and event time-stamping.

In a recent interview, head of French Space Agency Jean-Yves Le Gall said about Galileo: 'This opens the door to a host of applications, some of which we cannot even imagine yet.' This capacity to conceive new kinds of applications for critical markets is, however, the very thing that will define the way people will look at Galileo over the next few years. For the EU to be able to consider European GNSS as a success, it will need substantial return on investment for the EUR 10 billion the programme has already

cost. And this is where additional investment in Galileo-related research under FP7 and Horizon 2020 will be decisive.

'This capacity to conceive new kinds of applications for critical markets is the very thing that will define the way people will look at Galileo over the next few years.'

This issue of the *research*eu results magazine* celebrates the European GNSS for all the benefits it can bring to the EU, but most importantly reflects on its potential by shedding light on some of the first Galileo-enabled technologies that will see the light of day. Results from eight projects are presented, covering key sectors including transport, infrastructure works, smart cities, logistics, disaster management, maritime surveillance and citizen-oriented applications.

This first issue of 2017 also brings a new classification of results that we think better reflects the whole spectrum of domains of

exploitation supported by EU research programmes. A total of 12 sections — some permanent and some rotating depending on their proportional weight in EU funding — will now appear in this magazine: Health, Agriculture and Forestry, Aquatic Resources, Environment, Energy, Transport, Space, Security, Information and Communication Technology, Society, Industry and Fundamental Research.

As usual, the magazine closes with a list of upcoming events hosted by or involving EU-funded research projects.

We look forward to receiving your feedback. You can send questions or suggestions to: editorial@cordis.europa.eu



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Coping with the forces beneath the Earth's crust

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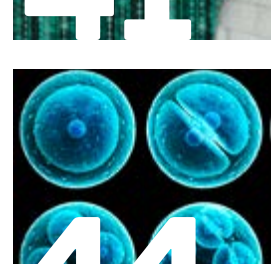
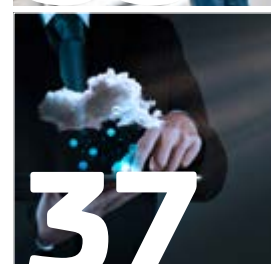
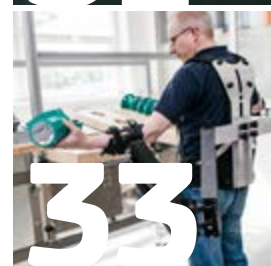
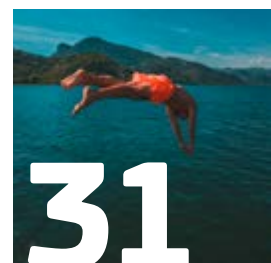
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SPECIAL FEATURE

GALILEO APPLICATIONS: WHAT LIES AHEAD

SMART CITIES GET A BOOST FROM GALILEO

The vision of a smart transport system for cities has so far given rise to many technologies, from driverless cars to automatic detection of incidents and traffic light-free transportation designs. The GHOST consortium is contributing with a solution of its own: geo-localised snapshots of 'Points of interest' (POI) reporting the likes of street lighting anomalies or road deterioration.

The idea behind GHOST (Galileo EnHancement as BoOster of the Smart CITIES) is simple yet incredibly effective. Instead of requiring heavy investment in new technologies, the consortium makes use of existing public transport solutions and connects them to a web portal by means of a camera equipped with a Galileo receiver. Once set up, the system takes pictures of predefined POIs, sends them to an image processing server that automatically detects anomalies, and reports these anomalies to relevant authorities by means of a web portal.

'At this stage of the project, GHOST is designed mainly for reporting street lighting anomalies and road deteriorations, monitoring public garbage completion levels and detecting double parking infractions or disabled parking occupied by unauthorised vehicles,' says Emiliano Spaltro, the Managing Partner of Alpha Consult — the company in charge of the project's dissemination and communication activities. 'In addition to that, other more advanced services have already been identified such as bus lane and CC area violations. These are expected to be implemented in a second stage of solution development.'

Completed in December 2016, the GHOST project culminated with a 'Test Readiness Meeting' held in Belgrade. A live-demo session was held using a bus provided by one of the project partners. 'All participants took a ride along the

predefined route for about 20 minutes. Within this time-frame, they successfully witnessed eight points of interest covering different use cases,' Srdjan Tadic, BITGEAR's Vice President and GHOST Technical Coordinator, explains.

The system's key selling point arises from the use of Galileo positioning, with a capability to perform the snapshots in total autonomy with an error range of 1 to 10 metres depending on POI size. In urban environments with increasingly high population densities, such a level of service could only be achieved thanks to the exploitation of E-GNSS technologies combined with inertial sensors through Kalman filters — an algorithm that uses a series of measurements observed over time instead of a single one to increase precision.

Another key part of the Belgrade test was the use of the smartphone application developed by the project consortium, through which they intend to appeal to citizens.

'Thanks to this app — which is free of charge and already available on app markets — and on a voluntary basis, citizens can contribute by collecting geo-localised snapshots using their smartphones when they are detecting any anomalies on city infrastructures,' Spaltro points out. 'This engagement enhances the overall system and gives a key role to individuals.'

Moving forward

Project partners are currently working on the fine-tuning of a business plan to bring GHOST technology to the most promising markets. 'Some key contacts have already been established and interested public administrations have been involved. Moreover, the consortium's commercial network will be deeply leveraged to facilitate GHOST introduction in future contracts,' Spaltro says.

In addition to public administrations and citizens, the consortium also targets the likes of garbage management companies or traffic police departments. In order to overcome potential regulatory issues such as national laws related to circulation or privacy, GHOST has carried out a risk assessment to list integration constraints and make sure that the novel system complies with existing European regulatory standards.

By taking advantage of fleet movements, GHOST proposes a competitive way to improve efficiency in city operation and infrastructure monitoring. Project partners are

confident that the system will enable a faster detection of double parking event or road deterioration, thereby resulting in a reduction of potential traffic, accidents and pollution. 'Thanks to our field tests and favourable results in the lab, we are already setting up the continuation of the GHOST project with the aim of taking the system to technology readiness level 9. The next step for us is to provide on-board image processing in real-time in order to allow the system to handle more dynamic scenarios such as bus lane infractions or congestion charging enforcement,' Christoforos Kavadias, TELETEL Project Manager and GHOST Administrative Coordinator, concludes.

GHOST

- ★ Coordinated by Teletel in Greece.
- ★ Funded by the European GNSS Agency (GSA) under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193822>
- ★ Project website: <http://www.ghost-project.eu>

NEW GNSS SOLUTIONS FOR TRANSPORT AND EMERGENCY RESPONSE SECTORS

EU-funded researchers have developed an array of practical solutions and applications that utilise the precise tracking and positioning capabilities of Galileo and EGNOS.



"The level of accuracy can be increased by using specifically designed 'navigation profiles' that take advantage of EGNOS and Signal Based Augmentation Systems (SBAS) corrections."

Global Navigation Satellite Systems (GNSS) serve as a consolidated technology for applications where precise location is needed — including the tracking of moving objects. Europe's contribution to this global initiative includes the European Geostationary Navigation Overlay Service (EGNOS) and Galileo. The robust positioning capability, signal continuity and signal integrity that these programmes provide has a profound impact on such sectors as emergency and disaster management, search

and rescue, and location based services (LBS).

To facilitate the use of European GNSS-based applications and services, the EU-funded SPARTACUS (Satellite Based Asset Tracking for Supporting Emergency Management in Crisis Operations) project is developing Galileo-ready tracking and positioning solutions for use in the transport and security/emergency response sectors. 'SPARTACUS is a modular platform connecting a network of tracking units to a local communication unit in a

way that in-field data can be remotely displayed and decision-making can be made based on the gathered information,' explains project coordinator Clemente Fuggini. 'The project replaces the use of failure-prone traditional terrestrial networks with satellite-based navigation and communication technologies that can be deployed during an actual disaster.'

According to Fuggini, one of the key innovations of the project is the ability to provide enhanced tracking and positioning functionalities where conventional satellite-based navigation systems are not properly working or are not as effective as needed — such as indoors and in urban canyons. 'This is accomplished by offering modular, scalable Galileo-ready SPARTACUS solutions that can be configured to deliver specific user-oriented services,' he says.

The SPARTACUS kit

The SPARTACUS tracking units are small satellite-based devices adapted for use with specific applications, such as the tracking of assets and moving objects (e.g. trucks) that transport critical items like relief goods during an emergency. The units, which feature an embedded satellite antenna and consume little power, come integrated with an Inertial Navigation System (INS) capable of offering dead-reckoning functions. Furthermore, the level of accuracy can be increased by using specifically designed 'navigation profiles' that take advantage of EGNOS and Signal Based Augmentation Systems (SBAS) corrections.

The project's smartphone applications are geared towards providing various functionalities based on user needs, such as logistic support and fleet management. For example, the ASIGN application collects *in-situ* mission relevant critical information (e.g. geo-tagged audio/media) and their quick transmission from the on-site

coordination centre to headquarters and back to the field. The FLARE application, on the other hand, provides accurate positioning, navigation, and guidance to emergency personnel and first responders working in outdoor and indoor environments.

SPARTACUS in action

So how does SPARTACUS look in action? Take, for example, the rail sector, which is expecting a 30% increase in total freight transport volume by 2030. In order to handle this increase, Europe must improve the efficiency and reliability of fleet management and logistic operations.

'The logistic sector is looking for precise and robust tracking solutions to trace freight across Europe and beyond, thus improving traceability and reliability of operations, especially in the case of dangerous assets and high-value assets tracking,' says Fuggini. 'For this reason, there is a growing interest in the use of GNSS as a key enabling technology

for fleet management and logistic applications.'

However, one of the main challenges to the full adoption of GNSS technology in applications involving the tracking of critical and/or dangerous goods is concern about safety in situations where GNSS signal coverage fails. 'Here, SPARTACUS provides a dead-reckoning functionality to assist/replace satellite navigation, specifically designed to operate even in the absence of GNSS coverage or during an outage in any critical scenario or during emergency situations,' explains Fuggini.

SPARTACUS

- ★ Coordinated by D'Appolonia in Italy.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/110848>
- ★ Project website: <http://www.spartacus-project.eu/>

A NEW POINT OF VIEW FOR SURVEYORS

EU-funded researchers have integrated European GNSS into drones to provide surveyors with a more advanced surveying tool.

Geo-information is a fundamental infrastructure of any modern society, with many other infrastructures and services depending on it. However, it is also expensive to create and update. As a result, European, national and local government agencies must balance a growing demand for high-resolution, up-to-date geo-information against decreasing budgets.

The EU-funded MAPKITE (EGNOS-GPS/GALILEO-based high-resolution terrestrial-aerial sensing system) project responds

to this market need by combining 'Terrestrial mobile mapping systems' (TMMS) with 'Unmanned aerial system' (UAS) mapping capabilities. The project aims to build a tandem 'terrestrial vehicle' (TV) and 'unmanned aircraft' (UA) equipped with remote sensing instruments that cooperate in collecting geo-data. The system integrates GNSS capabilities into drones and proposes a novel geo-data post-processing concept to provide surveyors with an end-to-end solution for 3D high-resolution corridor mapping.

'While terrestrial mobile mapping systems are becoming a standard surveying tool, their use is restricted due to their limited and insufficient view from the ground,' says project coordinator Pere Molina. 'On the technology side, mapping of small areas via small unmanned aircraft has become a reality, with many of the big geomatic technology companies already including UAS systems in their product portfolios.'

A tandem solution

MAPKITE includes both aerial and terrestrial components. The aerial component consists of a UA equipped with remote sensing instruments and a navigation guidance and control system. The terrestrial component consists of a human-operated TV that is equipped with remote sensing instruments and a TMMS.

This tandem system operates with the TV, computing a real-time trajectory by means of its real-time navigation system. By doing so, a set of waypoints are generated as route inputs for the UA by converting terrestrial navigation



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(time, position, velocity and attitude parameters) into UA time and space commands. This process produces a virtual tether by which the UA always follows the vehicle.

As the UA follows the vehicle at a constant flying height, both can simultaneously collect geodata. This is then post-processed via an orientation-calibration concept, resulting in the delivery of high-resolution, oriented-calibrated and integrated images of corridors and their surrounding environment.

GNSS enhanced

MAPKITE's combination of both ground and aerial based surveying systems provides users with an integrated and powerful solution. To accomplish this, the project fully exploits such GNSS technology as EGNOS and Galileo. EGNOS, the European Geostationary Navigation Overlay Service, is Europe's regional 'Satellite-based augmentation system' (SBAS). Galileo, on the other hand, is Europe's GNSS programme, providing improved positioning and timing information.

'We propose brand new ways of acquiring geo-data and processing it in order to derive geo-information that would not make sense without GNSS,' explains Molina. 'We also highlight the critical role of GNSS timing, due to the need to synchronise the TV's trajectory solution to the central time of exposure of the UA remote sensing instruments.'

A game changer

Due to its operational simplicity and cost savings, MAPKITE is set to be a game changer. For example, surveyors can cut costs by eliminating the need to independently operate terrestrial and aerial systems. 'Above all, MAPKITE can lower surveying budgets by means of its 'Kinematic ground control points' (KGCPs), which are obtained directly from the TMMS navigation solution, entailing the elimination of expensive traditional 'Ground control points' (GCPs),' says Molina. 'In short, the longer the corridor mapping mission, the higher savings are obtained with MAPKITE while keeping similar accuracy results.'

"MAPKITE's combination of both ground and aerial based surveying systems provides users with an integrated and powerful solution."

MAPKITE

- ★ Coordinated by Geonumerics in Spain.
- ★ Funded under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193827>
- ★ Project website: <http://www.mapkite.com/>
- ★ <http://bit.ly/2iBKJmw>

INTERVIEW

HIGH-PRECISION, UNDERGROUND VISUALISATION FOR INFRASTRUCTURE WORKS

Utility field work can be a real headache even with precise maps at hand. Admitting that they rapidly manage to locate the sought network, workers may end up damaging grids belonging to someone else. This type of scenario will soon be avoidable thanks to an assistive device developed under the LARA project.

The LARA device promise is to provide field workers with the ability to 'see beneath the ground'. Concretely, the device combines GNSS technology, 3D GIS technology and geospatial databases with computer graphics and Augmented Reality in order to render complex 3D models of underground networks — be it sewage pipes, gas conduits or electricity cables.

The potential impact of this technology is tremendous: according to a 2006 report (McMahon et al, 2006), utility companies from the UK alone create over 1.5 million street holes each year, often causing damage to third-party assets. All in all, these maintenance operations cost some EUR 5.8 billion to British society, and LARA hopes to bring these costs down significantly.

★ How does the LARA system work exactly?

Konstantinos Smagas: LARA is developing a software and hardware-based system that will eventually be capable of effectively managing geospatial data from underground utilities. It is combining different submodules — GNSS, Augmented Reality, 3D GIS and geodatabase



KONSTANTINOS SMAGAS

— in an integrated navigation/positioning and information system for tablets.

In practice, the LARA system will guide utility field workers in their daily operations: it will help them 'see' beneath the ground by rendering the complexity of the 3D models of the underground grid where water, gas, sewerage and



“The LARA receiver is equipped with a high precision, low power, long autonomy GNSS receiver module able to achieve accuracies at the level of a centimeter.”

electricity networks tangle. They will be able to better monitor, document and manage utility infrastructures on-site.

First, by locating the work zone on a GIS viewer, they will obtain a visual representation of the underground infrastructure and its attributes. Then, they can take advantage of the augmented reality engine to have an intuitive view of this infrastructure in 3D over a real image from the camera. Finally, after the work is done, they can use this same tool to generate reports and update existing infrastructure maps.

★ How does this increase productivity?

Being able to pinpoint underground utilities located in an excavation area prior to conducting the work is a game changer for public and private utility companies. With the LARA system, they will know exactly where is what, thereby conducting far more accurate maintenance interventions on their own underground infrastructure while keeping other neighbouring underground grids intact. Precise intervention will reduce the overall maintenance cost, minimising at the same time economic and social implications of lengthy surface works such as unnecessary traffic congestion, pedestrian disruption, material wastage, use of people's time, increased energy demand, visual intrusion and noise.

★ The project is getting close to its end. What have you already achieved so far and what do you still need to do?

At this stage, we have developed and tested our first prototype in the city of Kozani in Greece, leading all teams to work extensively on integration improvements and accuracy finetuning. As we had expected, several technical issues have been raised from work in real world situations. Some problems have been solved on the spot, while other solutions have been scheduled for the coming weeks.

In general, the results of first pilot assessment were very promising and provided valuable feedback for integration improvements, especially for our augmented reality technology which proved to be quite impressive. The final stage of the project, once we are done with this work and

have delivered the final prototype, concerns the definition and refinement of the business models to be used to successfully bring the LARA system to market.

★ What about the pilot test in Birmingham?

In both locations we have selected the areas and data-sets to be used for the pilots. Now that the pilot in Greece is behind us, we are looking forward to test the system on the areas indicated by the Birmingham City Council where a multi Low/Zero emission re-fuelling hub is planned to be constructed. In the meantime, we also use controlled testing locations in the cities of Limassol and Nicosia in Cyprus to help us perform tests on a daily basis. The results from these pilots will feed us with useful tips to be used for improving the performance of the LARA platform.

★ How was Galileo a key enabler for LARA technology?

The LARA receiver is equipped with a high precision, low power, long autonomy GNSS receiver module able to achieve accuracies at the level of a centimeter. The receiver — which consists of a GNSS module, an IMU module and the GUI — is able to work with multiple constellations including Galileo, EGNOS GLONASS and BeiDou, but Galileo is key to helping us improve accuracy, increase availability and integrity. Of course, further improvement of the accuracy was required, which is why differential correction technology (EGNOS, DGNS and RTK) are leveraged to reduce the geolocation error to around 1 cm.

★ When will this system be made commercially available?

The complexity, and consequently the value of our solution, has been gradually increasing with each prototype version we released and tested. Our goal for the moment is to launch the full prototype of the system and deliver a product very close to a commercial solution by the end of the project. Our exploitation team led by Hewlett Packard in Spain is working on a business plan that will enable a successful market entry already by the end of 2017.

★ Speaking of which, what are your plans to raise awareness among stakeholders?

It is clearly our goal to commercialise the system. Therefore, from the very beginning of the project, we drafted an active communication strategy that targeted immediate users. We took part in nine high caliber international workshops and demonstration events in Europe and co-organised an event in Malaysia.

Moreover, we have developed a stable relationship with industry-related magazines where we publish regularly, and we are preparing a commercial video for social media. Our primary users are public and private stakeholders that own or manage underground infrastructure and have complete and accurate data regarding their buried assets. Our ultimate goal is to provide these stakeholders with a plug-n-play, off-the-shelf solution that can be easily integrated into their daily operations and standardisation procedures.

LARA

- ★ Coordinated by Geolmaging Ltd in Cyprus.
- ★ Funded under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193818>
- ★ Project website: <http://lara-project.eu>
- ★ <http://bit.ly/1IXY4e5>

A SATELLITE-BASED SOLUTION TO DISASTER MANAGEMENT

Newly developed software will help to guarantee that critical visual information gets through to emergency services when disaster strikes.

Why is it that some disasters — both natural and man-made — can wreak such destruction and loss of life, while others can be efficiently contained? One key factor is whether effective management tools have been put in place. This is why the EU-funded GEO VISION (GNSS driven EO and Verifiable Image and Sensor Integration for mission-critical Operational Networks) project recently pioneered mission-critical software with the ultimate goal of saving lives and resources.

Within the framework of her SEADOG (Sea ice across Dansgaard-Oeschger events in Greenland) research, Dr Rhodes is analysing records of sea salt and methane sulphonic acid in Greenland ice cores with a view to defining whether they can be used as proxies for Arctic sea ice extent. She is investigating four ice core records for spatial and temporal variability across DO events, and exploring the controls on marine aerosol deposition over the Greenland Ice Sheet thanks to the p-TOMCAT chemical transport model.

Thanks to her findings, Dr Rhodes has optimised the p-TOMCAT model to represent modern-day sea salt aerosol deposition across Greenland. Ongoing work will identify scenarios of sea ice change consistent with ice core chemistry data across DO events.

The new solution enables users to select critical visual content taken from satellites, drones and humans on the ground for transfer over secure and safe networks. The project's geo-networking coding has been tested extensively with major disaster management organisations, and has attracted the attention of various response and relief agencies.

Completed in December 2016, the software solution is now ready to be rolled out in order to improve the effectiveness of United Nations agencies, the EU Civil Protection Mechanism as well as European police forces and emergency management authorities.

'Obtaining, understanding and communicating mission-critical operationally relevant information rapidly and reliably is a key element in effective handling of situations where many lives might be a stake, such as during an earthquake or a

flood,' explains project coordinator Harald Skinnemoen from AnsuR in Norway. 'Pictures from satellites (such as Copernicus) and drones can help decision makers better understand the reality of a dynamically changing situation.'

In order to know immediately what is happening, where and when, it is vitally important that telecommunications networks are not affected by the event itself. Satellite communication networks are the most reliable for this purpose, because wireless broadband might not be available following a major event. 'A key strength of the GEO VISION solution is that it is capable of operating seamlessly during a disaster,' explains Skinnemoen.

Smartphone-based platforms connect to 'Unmanned aerial vehicles' (UAVs) in order to obtain photos and video, in addition to receiving alarms and geo-messages. A live 'Geographic information system' (GIS) portal receives rapid mapping updates from Copernicus satellites.

Another impressive strength of the GEO VISION solution is that it focuses on sending mission-critical images. 'Normally we have to compress photos and videos in order to send over networks,' says Skinnemoen. 'This means we lose accuracy by reducing the quality, as well as time. Our solution recognises that visual data in cases of emergency is not for entertainment purposes and does not have to be beautiful, but that relevant information needs to be precise and

accurate. Network capacity is therefore devoted to content that is needed.'

In December 2016 the project team was invited by the United Nations for a Global Partnership and Networking Week, taking place in February 2017, with a view to further integrating the solution into UN operations. The project has also been invited to cooperate with GSMA, which is organising most of all the mobile operators in the world, and owns the Mobile World Congress. So far, the system has been sold to 11 countries in Africa, whilst Indonesia has acquired the solution in order to carry out search and rescue operations. In addition, Norwegian police have started to use the system, whilst other countries have also expressed a keen interest.

'We also think that this solution has potential applications for real-time remote inspection, sending documents and emails and much more,' says Skinnemoen. 'We would never have got to this successful conclusion without the excellent support of the GSA and other project experts.'

GEO VISION

- ★ Coordinated by Ansur Technologies in Norway.
- ★ Funded under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193815>
- ★ Project website: <http://www.geo-vision.space/>



GALILEO-BASED SOLUTIONS FOR URBAN LOGISTICS

EU-funded researchers are combining GNSS technology with wireless sensors and logistics information systems to set a new standard for the urban freight transport sector.



The urban freight transport sector is facing a range of challenges, including managing and monitoring the flow of freight, ensuring last-minute delivery, maximising the economic efficiency of urban distribution and minimising the sector's environmental impact. To help the EU freight transport sector mitigate some of these challenges, the EU-funded GALENA (Galileo-based solutions for urban freight transport) project is developing the integrated information system needed to coordinate the cross-supply chain community of shippers active in urban freight pooling and last-minute delivery.

Specifically, the project aims to demonstrate the possibility of using Galileo services in freight transport and logistics. Galileo is Europe's 'Global navigation satellite system' (GNSS), providing improved positioning and timing information. 'GALENA utilises a robust, GNSS-based liability binding application that enables different carrier operators to join an 'Urban Logistics Community' to timestamp, geo-locate and formalise their trip and all related events,' says project coordinator Bart Vannieuwenhuysse.

Put into practice, this means the entire process of transporting goods — from pickup to final delivery — is monitored through GALENA's indoor and Galileo-provided outdoor location services. It is this combination of GNSS-based outdoor location capabilities with traditional indoor location services that makes GALENA a unique offering for urban freight transport. So, when a pickup or a delivery happens, the item is scanned with a device that periodically reports the package's position to a supervision platform. 'With this information, we can associate items with vehicles and be aware of their position from the warehouse all the way to the final customer,' explains Vannieuwenhuysse.

A hybrid system for seamless positioning

GALENA uses some of the key features of Galileo, coupled with the security services in a handset, in order to timestamp,

geo-locate, authenticate and formalise any events related to an urban shipment involving several carriers. This includes transactions, status changes, timing and location issues, cost implications, insurance aspects, liability sharing, and last mile logistics.

A key outcome of the project is the development a mobile application for Android smartphones that provides an innovative, accurate and affordable outdoor/indoor location service that can be used with a standard scanning system. This hybrid Galileo outdoor /indoor system provides the user with a seamless, real-time tracking of a carrier's position.

'The GALENA Logistics Information System, which is based on an existing system, has been adapted so it can exchange and store end-to-end authenticated data between all stakeholders, meaning goods can be traced and managed across the entire supply chain,' says Vannieuwenhuysse. 'Stakeholders can use a web application to continuously supervise and track transactions and support the decision making process.'

A new standard

The GALENA system is the result of a true interdisciplinary collaboration. Its two-fold approach is setting a new standard for the urban freight transport sector. 'GALENA is unique in that it is the first Galileo-based solution applied to urban freight logistics,' says Vannieuwenhuysse. 'Its two-in-one technological approach is the main value of the GALENA solution and the key to its future marketability.'

As the project moves into its last phase, real-life demonstrations are being set up in order to test, validate and explore further business development possibilities. A GALENA demo is currently running in Horst, the Netherlands.

GALENA

- ★ Coordinated by Helileo in France.
- ★ Funded under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193825>
- ★ Project website: <http://www.galenaproject.eu/>

"A key outcome of the project is the development a mobile application for Android smartphones that provides an innovative, accurate and affordable outdoor/indoor location service that can be used with a standard scanning system."

INTERVIEW

A PBR/GALILEO COMBO TO DETECT AND LOCALISE ALL SHIPS IN EUROPEAN SEAS

A European project is coming close to the validation of a prototype of 'Passive bistatic radar' (PBR) technology based on Galileo transmissions. Once finalised, the new system could help relevant authorities to assure better maritime surveillance, detecting and localising, even of non-indexed ships.

Maritime surveillance is one of the key applications where a fully operational Galileo constellation could truly make a difference, through its high precision of course but also by ensuring European independence in a sector that requires the resolving of Europe-specific challenges.

One of these challenges is none other than safety. In 2014 alone, over 6000 accidents involving ships were reported to EMSA — the European Maritime Safety Agency. And while various European projects have set out to tackle the problem, existing systems are still based on AIS transponders, a collision-avoidance technology installed on vessels which communicate movement information over VHF channels.

The consortium behind the SPYGLASS (Galileo-based Passive Radar System for Maritime Surveillance) project argues that AIS is unfit for duty. Indeed, non-cooperative vessels — which often conduct illicit activities such as smuggling, illegal fishing, oil pollution or illegal immigration and are not equipped with AIS for obvious reasons — cannot be identified and positioned.

The EUR 1.3 million project builds upon the idea that the solution to this problem lies in PBR technology. This technology is low cost, allows for covert operation and reduces environmental impact. Actually, if combined with

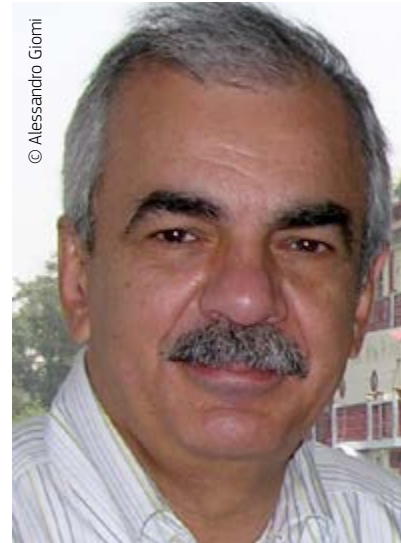
Galileo and its constellation that guarantees constant coverage of any point on Earth by several satellites, PBR technology developed under SPYGLASS has the potential to resolve the maritime safety issue once and for all.

★ What's the added value of a PBR based on Galileo transmissions?

Alessandro Giomi: Although the ability to potentially provide covert, persistent maritime surveillance has been widely proved, common 'transmitters of opportunity', such as VHF and DVB-T, rely on terrestrial transmissions. On the contrary, GNSS signals ensure a worldwide coverage, thus extending such capability to remote areas such as the open sea. Such a system can therefore operate on its own or complement existing integrated maritime surveillance systems.

★ More specifically, why is it important to resort to a European GNSS rather than, say, using GPS technology?

Apart from the fact that Galileo offers unique opportunities due to its signal structure, it is believed that a European navigation system will be heavily relied upon by European authorities for a number of services, making the integration of this technology easier.



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ALESSANDRO GIOMI

However, the technology does not exclude other navigation systems. For example, since Galileo and GPS were designed to be interoperable, a single receiver can record signals from both satellite systems with substantial improvements expected in terms of performance.

★ What did you learn from the testing of your prototype?

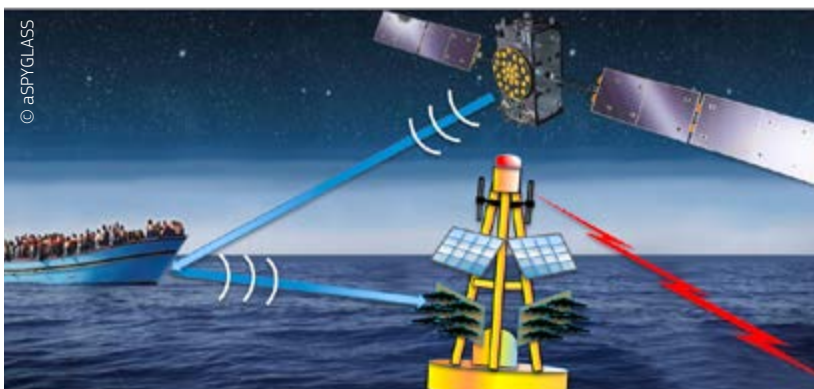
At present, we have experimentally validated theoretical calculations, showing that it is fundamentally possible to detect moving ships by their Galileo reflections, which is proof of concept of the underpinning science behind our project.

★ How does the SPYGLASS technology work exactly?

The SPYGLASS technology uses a single receiver tuned in to Galileo frequencies. The receiver can be installed on a buoy or on a tethered balloon to increase its area coverage. The receiver then records Galileo signals that naturally bounce off moving ships, and processes them to provide estimates of the ship's relative range and speed.

★ What do you still need to do before you can deliver a final product?

This project has started in a place where a number of scientific questions as well as engineering challenges should be addressed. However, our work so far has



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SPECIAL FEATURE

laid out the foundations of a final product, with the first SPYGLASS prototype now on delivery. Besides the extensive test of the prototype under different conditions and before proceeding to work on its commercialisation, two main tasks shall be accomplished: the miniaturisation of the hardware and the development of a grid of systems to improve single sensor performances.

★ **What are your plans to promote this technology to potential users?**

Potential users include those entities that have a mandate to provide public services or information related to maritime

awareness. Some of them have already been contacted and showed their interest: Italian Navy, Tributary Police and Coast Guard, as well as Greek Navy and Coast Guard. This subset is well known by the Consortium, as well as the operational framework in which it operates. A specific portfolio of services will be drafted and submitted to them at the end of the experimental campaign.

The Consortium will also investigate the possibility of providing services free of charge for a limited time duration, in order to demonstrate the actual added value within real operational environments and processes.

“At present, we have experimentally validated theoretical calculations, showing that it is fundamentally possible to detect moving ships by their Galileo reflections.”

SPYGLASS

- ★ Coordinated by Aster in Italy.
- ★ Funded under H2020-Galileo.
- ★ <http://cordis.europa.eu/project/rcn/193820>
- ★ Project website: <http://www.spyglassproject.eu>

INTERVIEW

INNOVATIVE SCOOTER RENTING SERVICE NOW POWERED BY GALILEO

MOTIT — an electric scooter renting service made available by means of a dedicated app — has come a long way since its launch in Barcelona in 2013. The system is will soon be available in Milan and is being tested in Paris. But this growth didn't come without improvements. Complaints from users having difficulties in locating their scooters have led to the conception of a Galileo receiver and its integration into MOTIT scooters as part of the G MOTIT project.



Since Uber, BlaBlaCar and other similar services have become a thing in Europe, citizens have had a chance to familiarise themselves with the concept of GNSS-powered apps that help them travel from one place to another. Around the same time, European cities have made themselves a bit greener by providing bike-renting services, where users pick up a bike from a station and drop it off at another one close to their destination.

MOTIT brings you the best of both worlds. Since 2013, this Web 2.0-stamped idea has provided citizens of Barcelona with

an app that hosts a full-blown scooter-renting service with a twist of green mindset. Unlike most scooters you'd see elsewhere, MOTIT scooters are fully electric. They can be started up with a smartphone, are provided with two helmets and oh, they can be picked up from pretty much anywhere in the city. No more finding the nearest station and walking from there, the MOTIT user can just drop the scooter off wherever he pleases — be it in front of his workplace, house or favourite shop. Once left behind, the scooter is available for pick-up by the nearest MOTIT subscriber looking for a ride.

What MOTIT still lacked until now, however, was a precise positioning system that would help users locate their scooter more accurately than GPS did.

This is where G MOTIT (Galileo-Enhanced MOTIT: an electric scooter sharing service for sustainable urban mobility) makes its entrance. Looking for a real-life application that would allow the European Commission to appeal to potential Galileo users, the project was born from the observation that the European GNSS service was exactly what MOTIT needed to keep its users happy and enable its development in other European cities.

★ **Of all solutions to tackle issues related to higher traffic levels in cities, why did you choose to invest in MOTIT?**

Marti Jofre: The service was interesting for two main reasons. The first one is that MOTIT had already demonstrated a real need

for improved localisation performance to enhance user experiences in an existing service, that is, helping users find their scooter. This is precisely what we were looking for,

“The project was extended up to March 2017, and users in Paris can already benefit from the improvements brought by the new Galileo receiver.”

as the European Commission wanted to demonstrate the benefits of the Galileo satellite navigation system for real services.

Then, we also found MOTIT very innovative at the time, even though it's true that other similar services had been launched over the previous months. There are many innovative and interesting aspects about MOTIT: First, everything is done by means of a smartphone, including activation of the scooter. The scooters are also electric, ensuring a comfortable and environment-friendly driving experience for users; and they can be parked like any private vehicle without having to look for dedicated stations — which avoids expensive investments and public space occupancy for charging infrastructure.

Other innovative aspects included the helmet already available with the scooter and, finally, that using a scooter is a fast way to travel in the city and avoid traffic jams, all this while allowing for a combination with public transport for last-mile trips.

★ **What would you say are the main barriers to its greater success?**

Actually, besides the localisation issue mentioned earlier, the main barrier for many users is the type of vehicle selected by MOTIT. Using a scooter in highly-populated cities can be a concern for users because of safety issues, but weather can also be an issue: MOTIT is a service that clearly has more potential in sunnier countries such as those in the Mediterranean.

★ **Did you receive much negative feedback about the limitations of GPS technology in tracking the nearest available scooter?**

Yes, and this feedback came both from the operator involved in the project and from other operators. Some of them have excluded certain areas of the city for offering the service, because of bad positioning performance impacting user experiences. This is mainly a problem in narrow streets of old districts.

© Marti Jofre



MARTI JOFRE

★ **How does your Galileo receiver provide an answer to these problems?**

Galileo, in combination with GPS and other satellite navigation systems, will provide increased availability of satellites and new signals. All in all, we expect that its use will result in improved availability, accuracy and reliability of the position computation.

Concretely, the project consisted in replacing MOTIT's GPS standalone receiver with a Galileo receiver fully integrated in the electronics of the motorbike. So G MOTIT was not a basic research project focusing on algorithm development, but it rather focused on technology integration and demonstration for a relevant use case.

★ **The demonstration in Paris has just started. Any learnings or feedback so far?**

We began with the demonstration in early December. The project was extended up to March 2017, and users in Paris can already benefit from the improvements brought by the new Galileo receiver. It's too soon to give any feedback on this demonstration, but we certainly hope that, once concluded and as soon as we obtain a commercial agreement with the operator, the new system will be deployed for users in Barcelona as well.

★ **What are the next steps now that the project is almost completed?**

We will try to commercialise the technology among other sharing operators. Car sharing one-way services could also be interested in this technology, just like other mobility on demand services such as ridesharing, micro-transit, etc.

G MOTIT

★ Coordinated by Pildo Labs in the United Kingdom.

★ Funded under H2020-Galileo.

★ <http://cordis.europa.eu/project/rcn/193832>

★ Project website:

<http://gmotit.pildo.com/>

<http://www.motitworld.com/>

★ <https://www.youtube.com/watch?v=SoFoqjg5qK8>
<http://bit.ly/2iIPZD>

HEALTH

EXTRA WEIGHT GAIN THROUGH YO-YO DIETING

Researchers from the EU-funded EVOMECH project have warned that repeated dieting may lead to weight gain. The brain interprets the diets as short famines and urges the person to store more fat for future shortages.

As the festive period gets well under way, many people will be consuming larger amounts of food and alcohol. In fact they're probably already considering the almost-mandatory January detox and diet regime, perhaps even as a New Year's resolution for 2017: according to US firm Nielson, losing weight and staying fit and healthy are consistently the top two New Year's resolutions.

However, researchers from the universities of Exeter and Bristol, as part of the EVOMECH (The evolution of mechanisms that control behaviour) project have warned against one particular type of intense dieting that they argue can actually cause additional weight gain. They found in a study recently published in the journal 'Evolution, Medicine and Public Health' that people who engage in 'yo-yo' dieting — a vicious cycle of weight gain and evermore severe dieting to combat such weight gain — trigger a survival mechanism hard-wired by evolution. This mechanism causes the brain to interpret repeated diets as periods of food scarcity. As a result, when a person is not actively dieting, the brain urges the body to eat more and store more fat.

They explain that animals respond to the risk of food shortage by gaining weight, which is why garden birds, including the very seasonal red robin, are much plumper in the winter, when seeds and insects are much harder to find.

The scientists constructed a mathematical model to investigate the phenomenon in a simulated animal that does not know when to expect its next meal. It showed that during times of scarcity, an animal that grabs the opportunity to put on weight has the best chance of passing on its genes.

Consequently, the researchers' model when applied to humans, who evolved in environments where reliable food

sources were both sometimes plentiful and sometimes scarce, predicts that the urge to eat increases hugely as a diet goes on. Importantly, in an age where increasing obesity rates have become one of the biggest public health concerns in the West, this urge won't diminish as weight is gained. This is because the brain becomes more convinced that it will need to make preparations for a famine.

Dr Andrew Higginson, Senior Lecturer in psychology at the University of Exeter and one of the study authors commented: 'Surprisingly, our model predicts that the average weight gain for dieters will actually be greater than those who never diet. This happens because non-dieters learn that the food supply is reliable so there is less need for the insurance of fat stores.'

'Our simple model shows that weight gain does not mean that people's physiology is malfunctioning or that they are being overwhelmed by unnaturally sweet tastes,' added Professor John McNamara, of the University of Bristol's School of Mathematics. 'The brain could be functioning perfectly, but uncertainty about the food supply triggers the evolved response to gain weight.'

So this then begs the question, what is the optimal way to lose weight? 'The best thing for weight loss is to take it steady. Our work suggests that eating only slightly less than you should, all the time, and doing physical exercise is much more likely to help you reach a healthy weight than going on low-calorie diets,' Dr Higginson advises.

EVOMECH

- ★ Hosted by the University of Bristol in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/94468>

DECISION-MAKING PROCESS COULD HOLD KEY TO NEUROLOGICAL DISORDERS

A better understanding of how we process information and make decisions could lead to new treatments for neurological diseases like Parkinson's.

Being forewarned is to be fore-armed as the saying goes, and the ability to anticipate events — from the completion of everyday tasks through to dealing with potentially life-threatening situations — means that better decisions can be made. Through some groundbreaking discoveries of how exactly the human brain deals with uncertainty, a group of EU-funded researchers has helped to shed new light on the neural mechanisms underlying these behaviours.

chemicals enable our brains to learn the changing relationships in our environment. This work provided the researchers with key insights into how we are able to flexibly and efficiently make decisions in response to changes around us; the team were able to assert for example that declining dopamine levels might explain some of the problems seen in Parkinson's disease.

Furthermore, little is known about the concerted interplay between brain regions in terms of effective connectivity, which is required for flexible behaviour. The ACTSELECTCONTEXT project was able to demonstrate that brain regions controlling our movements can be influenced by other brain regions that make computations about what is likely to happen (for example your tennis opponent's next shot), or brain regions that decide which movement may be the most rewarding (for example whether to go to the kitchen and open a packet of biscuits).

However, this influence only occurs when our decisions actually require a movement, as opposed to abstract decisions that do not require actions. Furthermore, disruption of the communication between brain regions for

decision making and those for movement control could lead to problems in turning our decisions into appropriate movements, as seen in Parkinson's patients, the team concluded.

These discoveries were made possible thanks to the involvement of 128 healthy participants, who took part in reaction time tasks designed to test how they handled uncertainty. Participants were all given either a placebo or a drug to block noradrenaline, acetylcholine or dopamine before starting the task. They were then asked to respond to a series of symbols. Probability patterns were changed without warning, forcing participants to detect new patterns and adjust their responses accordingly. The research was published this month in the open-access journal 'PLOS'.

“Brain regions controlling our movements can be influenced by other brain regions that make computations about what is likely to happen.”

Most promising of all, further research into how these mechanisms decline during healthy ageing could lead to important advances in how we treat pathological conditions such as Parkinson's disease, depression and stroke. Around 1.2 million people in Europe have Parkinson's, a progressive neurological condition that is predominantly characterised by problems with body movements. Although it is not fatal in itself, as it progresses it can lead to more serious situations such as falls, swallowing problems and difficulties thinking.

The key success of the four-year ACTSELECTCONTEXT (Action Selection under Contextual Uncertainty: the Role of Learning and Effective Connectivity in the Human Brain) project, which was completed in May 2016, has been to show how three important brain signalling chemicals affect the way that humans handle uncertainty. Noradrenaline regulates our estimates of how unstable the environment is, acetylcholine helps us adapt to changing environments and dopamine pushes us to act on our beliefs about uncertainty.

The project combined pharmacological interventions and novel computational models to determine how these three

ACTSELECTCONTEXT

- ★ Hosted by University College London in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/99080>



DISCOVERY OF AN EPILEPSY GENE NETWORK OFFERS HOPE FOR NEW TREATMENTS

New research supported by the EU-funded IGENEE and EPITARGET projects has discovered a specific gene network in the brain that is associated with epilepsy, raising hopes that new treatments for the condition can be developed.

Published in the journal 'Genome Biology' and led from Imperial College London, the study details an 'epileptic network' of 320 genes, called M30, which is associated with epilepsy. The genes in the network are thought to be involved in how brain cells communicate with each other.

The results from the study suggest that when this network malfunctions, it triggers epilepsy. The research team believes that finding medications that restore this network could provide innovative new treatments to the debilitating disorder. Indeed, the discovery should provide a new boost for epilepsy drug research as many pharmaceutical companies have halted their research into finding new medications for the condition.

'Epilepsy is one of the most common serious neurological diseases worldwide,' commented senior author Professor Michael Johnson. 'Yet despite almost 30 different drugs licensed for the condition, a third of people with epilepsy continue to suffer from uncontrolled epileptic seizures — despite taking medication. In fact, very little progress in finding effective drugs for epilepsy has been made in the past 100 years.'

The study notes that the gene network seems to malfunction in epilepsy caused by genetic causes, as well as epilepsy triggered by brain injury, such as following a stroke, tumours or infection. The condition can cause a range of symptoms, from an odd sensation or trance-like state to severe convulsions and loss of consciousness. Fifty million people are thought to suffer from it worldwide, 6 million being in Europe according to the World Health Organisation (WHO).

During the research, the research team, which was in collaboration with Duke-NUS Medical School in Singapore, used computational techniques to scan thousands of genes and mutations associated with epilepsy. They also looked at data from healthy brains, to identify networks of genes that seem to work together, and were associated with the disease. To confirm their finding that malfunctions in this gene network caused seizures, the team used additional data taken from mice. Finally, the team then computationally analysed 1 300 known drugs to predict which ones could help restore the gene network to normal — one of the drugs found was a known epilepsy treatment called valproic acid.

The study also pointed to many other drugs not previously considered as conventional anti-epilepsy medications. One of these

was withaferin A, a compound derived from a plant known as Indian ginseng that has been used in Ayurvedic medicine for centuries to treat a range of diseases, including epilepsy.

Professor Johnson added that the method used in this study, called 'network biology', where computer systems are used to identify gene networks that work together to underpin disease, may also provide opportunities for finding treatments for other conditions.

'Until recently, we have been looking for individual genes associated with diseases, which drug companies then target with treatments,' he explained. 'However, we are increasingly aware that genes don't work in isolation; identifying groups of genes that work together, and then targeting these networks of genes, may lead to more effective treatments. Our proof of concept study suggests this network biology approach could help us identify new medications for epilepsy, and the methods can be applied to other diseases.'

Funding for the study was part provided by the EPITARGET (Targets and biomarkers for antiepileptogenesis) and IGENEE (Identification of pathways and genetic drivers for childhood epileptic encephalopathies by integrating whole-exome sequencing and gene network approaches) projects, themselves funded under FP7. Whilst the IGENEE project, coordinated from Imperial College London, officially ended in August 2016, the EPITARGET project will continue until October 2018.

"Our proof of concept study suggests this network biology approach could help us identify new medications for epilepsy, and the methods can be applied to other diseases."

EPITARGET / IGENEE

- ★ Coordinated by Lund University in Sweden / Imperial College of Science, Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-HEALTH / FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/111305>
- ★ <http://cordis.europa.eu/project/rcn/187995>
- ★ EPITARGET website: <http://www.epitarget.eu/>

LEG MOVEMENT RESTORED USING INNOVATIVE WIRELESS NEURAL INTERFACE



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Three EU-funded projects — NEUWALK, WALK AGAIN and E-WALK — have contributed to the development of a wireless 'brain-spinal interface' that bypasses spinal cord injuries and restores intentional walking movement to a temporarily paralysed leg.

Recently published in the journal 'Nature', the study was conducted by scientists and neuroengineers in an international collaboration led by the Ecole Polytechnique Fédérale Lausanne, Switzerland which also coordinates the WALK AGAIN (Multi-pronged Strategies to Regain Voluntary Motor Functions after Spinal Cord Injury) and

E-WALK (Spinal cord rehabilitation enhanced by the use of data-driven and dynamic cortical state models) projects. Together with Brown University, US, Fraunhofer ICT-IMM, Germany — coordinator of the NEUWALK (Neuroprosthetic interface systems for restoring motor functions) project — and Medtronic, the team built upon technologies developed at Brown and tested in collaboration with the University of Bordeaux, Motac Neuroscience and Lausanne University Hospital.

‘The system we have developed uses signals recorded from the motor cortex of the brain to trigger coordinated electrical stimulation of nerves in the spine that are responsible for locomotion,’ commented David Borton, assistant professor of engineering at Brown and one of the study’s lead authors. Whilst the system has been tested on two macaques, it is hoped that a similar system will soon be designed for humans with spinal cord injuries.

The ability to walk is made possible by a complex interplay among neurons in the brain and spinal cord, where electrical signals originating in the brain’s motor cortex travel down to the lumbar region of the lower spinal cord. There, they activate motor neurons that coordinate the movement of muscles responsible for extending and flexing the leg. An injury to the upper spine can cut off communication between the brain and lower spinal cord, meaning the motor cortex and spinal neurons are unable to coordinate, causing the loss of the ability to walk.

The new system used a pill-sized electrode array implanted in the brain to record signals from the motor cortex and a wireless neurosensor sends the signals gathered by the brain chip wirelessly to a computer that decodes them and sends them back, again wirelessly, to an electrical spinal stimulator implanted in the lumbar spine, below the area of injury. That electrical stimulation, delivered in patterns coordinated by the decoded brain, signals to the spinal nerves that control locomotion.

To calibrate the decoding of brain signals, the brain sensor and wireless transmitter were implanted into healthy macaques. The signals relayed by the sensor could then be mapped onto the animal’s leg movements, showing that the decoder was able to accurately predict the brain states associated with extension and flexion of leg muscles. Combining their understanding of how brain signals influence locomotion with spinal maps, the researchers then tested the entire system on two macaques with lesions that spanned half the spinal cord in their thoracic spine. When the system was turned on during a period when the animals had no control of their affected leg, they began to spontaneously move their legs whilst walking on a treadmill. Kinematic comparisons with healthy controls showed that the lesioned macaques, with the aid of brain-controlled stimulation, were able to produce nearly normal locomotor patterns.

‘Doing this wirelessly enables us to map the neural activity in normal contexts and during natural behaviour,’ Borton

said. ‘If we truly aim for neuroprosthetics that can someday be deployed to help human patients during activities of daily life, such untethered recording technologies will be crucial.’

Moving forward, there is now hope that a similar system will be developed for humans, however there are some hurdles that still need to be overcome. Whilst this study successfully relayed signals from the brain to the spine, the system developed lacks the ability to return sensory information to the brain. The team were also unable to test how much pressure the animals were able to apply to the affected leg.

‘There’s an adage in neuroscience that circuits that fire together wire together,’ commented Borton. ‘The idea here is that by engaging the brain and the spinal cord together, we may be able to enhance the growth of circuits during rehabilitation. That’s one of the major goals of this work and a goal of this field in general.’

NEUWALK / WALK AGAIN / E-WALK

★ Coordinated by Fraunhofer in Germany / Ecole Polytechnique of Lausanne in Switzerland.

★ Funded under FP7-ICT / FP7-IDEAS-ERC / FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/95307>

★ <http://cordis.europa.eu/project/rcn/97067>

★ <http://cordis.europa.eu/project/rcn/108197>

★ NEUWALK website: <http://www.neuwalk.eu/>

★  <http://bit.ly/2ivdpyi>

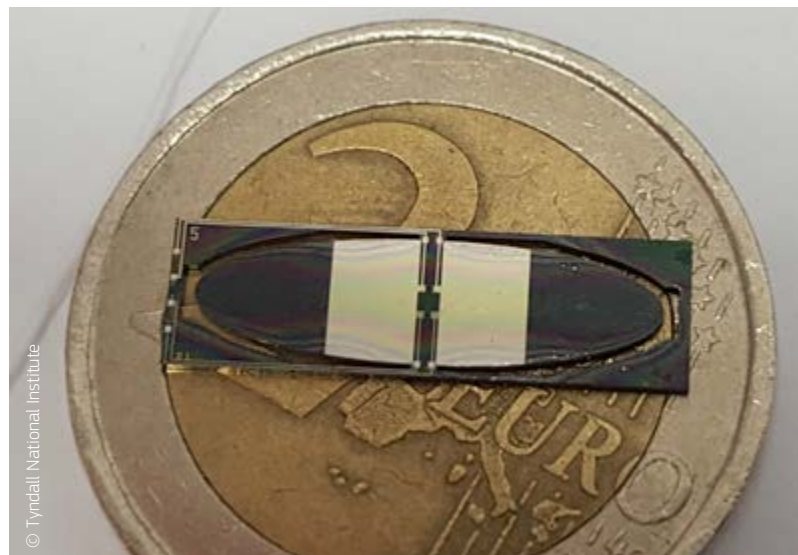
PIEZOELECTRIC ENERGY HARVESTING SCALED DOWN

New engineering techniques have helped EU-funded scientists to extract and store energy from vibrations as tiny as the beating of a human heart, opening the way to self-powered pacemakers.

Energy harvesting at low frequencies was difficult in the past due to the brittle nature of materials from which harvesters are made. In particular, the limited stiffness of conventional silicon and all piezoelectric materials hindered the development of vibration harvesting systems that operate below 100 Hz. This lack of durable energy harvesting systems in the low-frequency range was the focus of MANPOWER (Energy harvesting and storage for low frequency vibrations).

‘The main objectives were the development of materials and electronic structures for the two core components of a low-frequency energy harvester: the energy harvester and the charge storage device’, noted Dr Cian Ó Murchú coordinator of the EU-funded project. The targeted vibration frequency range was from 20 to 30 Hz. To this end, nanotechnologists, and communications technology experts worked together with physicists to develop a technology that harnesses the energy of heart vibrations.

MANPOWER partners developed self-oscillating polymeric substrates and optimised piezoelectric materials that can be used at



H E A L T H

the scale needed. A vibrating cantilever, which was created out of these materials, responds to the motion of a beating human heart. Although the technology was already available at larger scales for mechanical and industrial use, the next step of their work was to adapt this for use in a self-powered pacemaker.

The size constraints were one of the main challenges to overcome during MANPOWER. 'As the size of the energy harvester shrinks, the power that can be generated is also reduced. The initial power requirements for the pacemaker were considerably higher than that achievable by the tiny energy harvester. However, we were able to meet the specification provided with a combination of design and material optimisation together with improved circuitry,' explained Dr Ó Murchú.

An implantable device also required biocompatible packaging technologies to integrate the full system and theoretical modelling to assess components' reliability and project their lifetime. Before the project's end, the prototype pacemaker package

including a three-axis accelerometer was implanted into a sheep's heart for *in vivo* testing.

The results promise a better life for heart patients. Pacemakers that rely on vibrational energy harvesters are small enough to be implanted into the heart wall and can function for a much longer period than conventional pacemakers' batteries. According to Dr Ó Murchú, the 'MANPOWER energy harvester can be applied to other sources of low-frequency vibration, such as human motion, vehicle engines, ship motion and waves.'

MANPOWER

- ★ Coordinated by University College Cork in Ireland.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/110688>
- ★ Project website: <http://www.themanpowerproject.eu/>

TWINS HELP FIND GENETIC LINK TO JOINT PAIN

The development of EU-funded gene sequencing tools has helped analyse data on twins that have promising implications for diagnosing chronic joint pain.



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Scientists at the Department of Twin Research and Genetic Epidemiology at King's College, London (KCL) found a link between changes in marks on the outside of DNA and chronic widespread joint pain. This is one of the main symptoms of fibromyalgia, a chronic condition that causes fatigue and widespread pain in muscles and bones but whose causes are poorly understood.

Part-With heritability known to play a role, the scientists scrolled through data from 400 twin volunteers from the 13,000 Twins UK registry, which is known to be representative and comparable to the UK population in behaviour lifestyle factors and susceptibility to disease. Using twin pairs where one twin has chronic widespread pain the scientists compared the DNA with that of the healthy twin to establish differences and identify DNA biomarkers associated with the condition.

According to their paper published in the open access journal PLOS ONE on 10 November 2016, the researchers were able to identify three genes where the patterns of marks on DNA (DNA methylation) differed between those with and without chronic widespread pain.

Dr Frances Williams, one of the authors of the study from the Department of Twin Research and Genetic Epidemiology, KCL, commented: 'Fibromyalgia is influenced by genetic factors but there are many complicated steps between gene and disease. Identifying measurable epigenetic links is a major step forward. In addition, the results will inform future research in fibromyalgia as well as other chronic pain syndromes, such as irritable bowel syndrome.'

The genetic markers they were able to identify could help to eventually develop a blood test to diagnose the debilitating disease. Currently no

diagnostic tests are available for fibromyalgia, which cannot be detected using scans or x-rays.

With only limited medical treatment for the condition at present, fibromyalgia 'is not only a huge burden for sufferers, but is also difficult to treat and is costly for society overall,' the researchers say in their paper. Around 12% of the UK population is afflicted with chronic widespread musculoskeletal pain.


Stephen Simpson, director of research and programmes at Arthritis Research UK also commented on the research: 'There are millions of people in the UK who are living with the pain of fibromyalgia. This really exciting research is an important step forward in our understanding how epigenetic differences between individuals can influence our likelihood of developing fibromyalgia and chronic widespread musculoskeletal pain.'

The RADIANT (Rapid development and distribution of statistical tools for high-throughput sequencing data) project officially ended in November 2015, but its applications have helped speed up and transform genomic studies, such as the research into fibromyalgia. The project received just over EUR 3.6 million in EU funding.

RADIANT

- ★ Coordinated by the University of Manchester in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/105701>

NOW ON CORDIS



CORDIS
RESULTS
PACK

A BIOMASS BOOST TO EUROPE'S BIOECONOMY

The EU is strongly promoting the growth and development of a sustainable European bioeconomy, of which one of its core components would be the greater uptake of biomass — organic materials to produce chemicals, materials, energy, pharmaceuticals, and many other sustainable and innovative products. This shift to biomass is being underpinned by substantial R&D efforts under FP7 and Horizon 2020.

Increasing the production and mobilisation of biomass can have a number of highly positive benefits for the EU's economy and wider society. These include contributions to the EU's fight against climate change, ensuring European (and global) food security, building blocks for new and sustainable raw materials, as well as helping to diversify the EU energy sources. The cultivation and sourcing of biomass will also benefit the EU's long-term economic growth and would be a key generator of new and highly-skilled jobs, all within the broader context of a flourishing and vibrant bioeconomy.

In particular, the agricultural sector will have a crucial role to play in bringing biomass's full potential to fruition. Many promising avenues are currently being explored and supported by the European Commission, such as the development of industrial crops able to grow on marginal lands, new methods being pioneered on crop diversification, and the growth of multi-purpose crops (i.e. providing both food but also non-food outputs).

As part of the wider picture, it is planned that these efforts will provide the agricultural sector with the knowledge and expertise needed to

support resource-efficient and resilient strategies and solutions for biomass production that allow for increased biomass production but without compromising sustainability targets or local ecosystems.

This CORDIS Results Pack is thus focusing on eight EU-funded projects that have been leading the way in integrating novel biomass solutions into the wider European bioeconomy.

Selected projects include **EUROPRUNING**, which has developed a truly innovative pruning-to-energy value chain and the **ITAKA** project that has used camelina oil to produce sustainable commercial biojet fuel that has the potential to power more than just the aviation industry. Meanwhile, the **GRASSMARGINS** project has identified the optimal perennial grasses to cultivate as biomass crops on marginal non-arable land, whilst the **OPTIMA** consortium has cultivated high-yielding perennial grasses capable of serving as the source of many exciting new bio-based products.

<http://cordis.europa.eu/article/id/400181>

SOCIETY

EUROPEAN AND CENTRAL ASIAN COUNTRIES ARE NOT DOING ENOUGH TO TACKLE CORRUPTION

In a newly published report that was supported by the EU-funded ANTICORRP project, Transparency International has highlighted how citizens in Europe and Central Asia view corruption as one of the biggest problems facing their country.

The report, entitled 'People and Corruption: Europe and Central Asia 2016' begins by highlighting how corruption is a central reason as to why support for populist and nationalist movements has grown in Europe since the beginning of the financial crisis. The failure of governments to properly address corruption and their complicity in corrupt or clientelist schemes feeds the belief amongst citizens that traditional democratic institutions — governments, political parties, etc. — are failing to deliver on promises of prosperity and equal opportunity for all and thus can no longer be trusted.

Alarming findings

For the report, part of a regional series from Transparency International's Global Corruption Barometer and the largest and most comprehensive survey of its

kind, the NGO spoke with nearly 60000 people across 42 countries in Europe and Central Asia via face-to-face and telephone surveys about the current state of public sector graft. Their findings show that over a quarter of citizens see politicians, government officials and business executives as highly corrupt, and nearly three in five citizens think that wealthy individuals have too much influence over government decisions. One in three citizens in the region think that corruption is one of the biggest problems facing their country, with the figure rising to two in three in Moldova, Spain and Kosovo.

The survey also showed that people are highly dissatisfied with the way governments are tackling the corruption risk in Europe and Central Asia. Over half (53%) said that their government is doing badly at fighting corruption, whilst less than a quarter (23%) say they are doing well.

The governments of Ukraine (82%), Moldova (84%), Bosnia and Herzegovina (82%) and Spain (80%) were judged worst by their citizens. Armenia, Lithuania, Russia and Serbia were also found to have severe corruption problems.

Bribery was also found to be too common an experience for many households in the region, and the report writes that on average, one in six households paid a bribe for access to public services. Although few households paid bribes when coming into contact with public services in EU Member States, rates were significantly higher the further east one travelled; the highest rates were in Tajikistan (50%), Moldova (42%), Azerbaijan, Kyrgyzstan and Ukraine (38% for each). In the EU, Romania had the highest rate of reported bribery at 29%, followed by Lithuania with 24%.

On a more positive note, 'standing up' and 'speaking out' are seen as the best ways to fight corruption. Reporting corruption or refusing to pay bribes is seen as the most effective action citizens can take, with reporting corruption being seen as particularly effective in the EU+ (which includes Greenland and Switzerland) at 24%. Still, 27% of citizens in Europe and Central Asia feel resigned to the fact that they cannot effectively do anything to fight corruption, and fear of the consequences keeps many (30% of respondents) from actively reporting corruption.

Comprehensive recommendations to fight corruption

Following these results, the report recommends that countries and the EU institutions need transparent rules on lobbying and a public lobbying register so that policy decisions can be better scrutinised. Information on lobbying activities must be published and easily available. It also argues that countries,

particularly EU accession countries and members of the Commonwealth of Independent States (CIS) must reduce executive influence over the judiciary and prosecutorial services. This would be achieved through transparent and objective systems for the appointment, transferral and dismissal of judges and prosecutors.

Finally, the report argues that more citizens should be encouraged to report corruption through the adoption and enforcement of legislation to protect whistleblowers based on international standards. Government and the private sector need to support whistleblowers and reporters of corruption and ensure appropriate follow-up to their disclosures.

Transparency International is a consortium member of the ANTICORRP (Anticorruption Policies Revisited. Global Trends and European Responses to the Challenge of Corruption) project which is investigating the factors that promote or hinder the development of effective anticorruption policies and

"The report recommends that countries and the EU institutions need transparent rules on lobbying and a public lobbying register so that policy decisions can be better scrutinised."

impartial government institutions. The project has received nearly EUR 8 million in EU funding and is due to end in February 2017.

ANTICORRP

- ★ Coordinated by the University of Gothenburg in Sweden.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/project/rcn/103252>
- ★ Project website: <http://anticorpp.eu/>

A SOCIOCULTURAL COMPARISON OF CHINESE CHILDREN

An EU-funded study has probed the development of Chinese children in the context of drastic socio-demographic change, giving rise to new empirical knowledge about child development and child rearing practices.

The IIDEV (The Dynamics of Independence and Interdependence in Chinese Children's Development) project used a multidisciplinary method that combined anthropology and developmental psychology. Empirical knowledge based on thorough ethnographic understanding of children's learning environments was produced. Comparisons with other social and cultural environments were also made possible.

Ethnographic fieldwork and field experiments were carried out in two communities in Jiangsu, China. The focus was on seven to nine year-olds. Participant observations were conducted in the communities which had many similarities in terms of demographics and lifestyle. Yet they were also different as regards to economic class.

Initial training involved fieldwork and various facets of cooperation which were observed in comparative terms. The main findings produced from this work show that cultural, social and socioeconomic elements in children's learning environments influenced the patterns of cooperation, inter-dependence and competitiveness.

Children from the working-class community had more opportunity to interact with peers and individuals of various ages. By contrast, the children of the middle-class community were involved in activities designed for children or under adult supervision. This showed how children from the working class community were more flexible and adaptable, whereas children from middle class communities relied on adult direction in order to cooperate. Regarding competition, students from the elite school relied on winning in order to have fun.

The results can pave the way towards further research into a cross-cultural comparison with the UK, with a focus on the dynamics between cooperation and conflict.

IIDEV

- ★ Coordinated by the London School of Economics and Political Science in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/187742>



STUDYING REMNANTS OF STAR CARR'S EARLY CIVILISATION BEFORE IT'S TOO LATE

Known as the richest and most important Mesolithic site in Great Britain, Star Carr is still holding many secrets that archaeologists are eager to reveal before it's too late. Indeed, peat desiccation, fluctuating water tables and unprecedented levels of acidity are deteriorating the site at a worrying pace.

Over 10 000 years ago, hunter-gatherers in Yorkshire were hit by rapid global warming that marked the end of the last Ice Age and probably dramatically changed their lifestyles. Since the early 1940s, archaeologists from across the world have been gathering evidence and artefacts from this early civilisation, and now the POSTGLACIAL (After the Ice: Postglacial hunter-gatherer lifeways) project is using cutting-edge methods of scientific analysis at the biomolecular level to uncover otherwise invisible acts of craft, cross-craft interaction, subsistence and symbolic activities.

Nicky Milner, coordinator of the project, details his race against time and its importance for the scientific community.

★ **Why is it important to find out more about the consequences of the end of the last Ice Age on hunter-gatherers?**

Nicky Milner: We are studying a period of time (10 000-8 000 BC) when climate fluctuated significantly. Our aim has been to understand how people lived at this time and how they responded to climate and environmental change. At the start of the Holocene, there was a very rapid and dramatic rise in temperature which had a substantial impact on Northern Europe, creating new environments that people could move into. These are our ancestors, who settled into these lands at the end of the last Ice Age.

★ **You describe your research as a race against time. How successful would you say POSTGLACIAL has been in this race?**

Unfortunately we know very little about this period and the most interesting information comes from sites with organic preservation — these are usually peat bogs where the lack of oxygen in the deposits allows plants, bone and antler to survive. Not only do we find archaeological sites with rare artefacts made from organic material which show us how people were living many thousands of years ago, but we can also

access local climate and environmental records at high resolution.

However, due to changing water tables the peat bogs are disappearing or deteriorating. In terms of our site, Star Carr, we have excavated as much as we could with the resources we have and taken a series of cores through the ancient peat deposits to reconstruct climatic and environmental conditions, so we have managed to save some of this important record which has changed our interpretations significantly. But what remains will be lost over the next decades, and more worryingly, there are many other sites across Europe where the same thing will be happening: Europe's Stone Age heritage is disappearing below ground all the time. So, through our ERC funding, we have been successful in our race against time with Star Carr, but we should remember that this is a potentially ongoing, serious problem for many bog sites in Europe.

★ **Do you feel like there is an actual chance of uncovering all of the site's mysteries?**

Unfortunately, no. We have only scratched the surface with our excavations, and overall there is probably

about 90% of the site left to excavate. However, what we have aimed to do is to examine one area which is rich in archaeology by using a range of state-of-the-art techniques and forensic approaches, in order to recreate what life would have been like 11 000 years ago.

★ **What can you tell us about your findings so far?**

Through our ERC funding we have been able to excavate a large area of the lake-edge settlement and made some extraordinary discoveries: 11 000 years ago people were building houses on the dry land (the oldest known houses in Britain), creating large platforms on the edge of the lake (the earliest known carpentry in Europe) and we have uncovered some very rare and intriguing artefacts, such as an engraved pendant which is the oldest Mesolithic artwork in Britain. We also found headdresses made from red deer skulls, thought to be used in ritual practices.

In addition, a team of scientists are currently working on the climate and environmental data which we will link into the radiocarbon dating of the site, in order to understand how changing



climate and environment might have affected people between 10 000 and 8 000 BC.

★ **What are the most relevant learnings for the current context of climate change?**

We are still in the process of linking together our data but what will be interesting is to see how people reacted to climate change and environmental change in the past, how resilient were they? How did they adapt their technologies? To what extent did they need to move because of change? Although these people would have been physically like us, they would have behaved very differently and had a very different set of skills and equipment, for instance they were living by hunting and gathering their food and did not have pottery. Nevertheless they were resourceful and could adapt. It is therefore hard to compare with today, though it makes

an interesting case study to think through what is happening today.

★ **What are your plans after the end of the project? Will you be taking this research further?**

Unfortunately, this is probably the last research which can take place at Star Carr because many of the deposits are deteriorating so rapidly. However, there are other sites which can be studied and which can help elucidate this period further. These people are our ancestors, they settled down in the northern lands of Europe and there are many connections with our lives today: they built houses, kept domesticated dogs, wore jewellery etc. Uncovering this exciting archaeology gives all Europeans a chance to look into their past, and understand where they came from. However, this work is still a race against time, as long as the deterioration of peat bogs continues to occur.



© Nicky Milner

NICKY MILNER

POSTGLACIAL

- ★ Coordinated by the University of York in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102040>

ACCULTURATION, BELONGINGNESS AND IDENTITY FOR MIGRANTS IN GERMANY

EU-funded researchers investigated migrant, host and intergenerational perspectives on psychological and sociocultural adaptation of migrants and on attitudes about integration, feelings of belongingness and group affiliation. Their work included development of a theoretical framework addressing the bidirectional nature of the acculturation process.

The project BELONGINGNESS (Where do I belong? The effects of uncertainty-identity on acculturation outcomes for migrants in Germany) integrated acculturation theory and uncertainty-identity theory to investigate the possible consequences of uncertainty about oneself and belongingness.

Research efforts targeted a better understanding of when and where conflicts and social tensions arise between host members and migrants as well as between generations, and what intervening variables impact on positive outcomes (e.g. social cohesion and harmony). Overall, the aim was to better understand why some migrants maladapt to the host society and choose to identify with a subgroup as a way to reduce uncertainty and oppose the host society.

The first of three project phases explored the meaning of integration in the German context from the perspectives of migrants and majority members. Following this, BELONGINGNESS carried out a large-scale quantitative survey of majority members (Germans) and minority members (migrants in a broader sense). Sample sizes were 603

individuals representing the majority, an ethnic sample of 135 (mixed ethnicities, mainly originating from Turkey, eastern European countries and the Middle East) and a bicultural sample of 241 (similar composition to the ethnic sample, including participants of Turkish, eastern European, Latin American and western European descent).

Studies assessed general feelings of national orientation (assimilation), ethnic orientation (separation), multicultural orientation (integration), and belongingness, feeling secure and feeling connected to Germans (for migrants). Other variables of interest were well-being measures such as flourishing, which speaks to self-perceived success in important life areas (e.g. relationships, self-esteem, optimism and purpose).

Preliminary results indicate a relationship between a multicultural orientation and flourishing for native Germans and migrants as well as Germans with a migration background. One important finding is that the feeling of belonging (over and above multicultural orientation) is a predictor of flourishing and

“The aim was to better understand why some migrants maladapt to the host society and choose to identify with a subgroup.”

sociocultural competence in the bicultural sample and even stronger in the ethnic sample.

The EU continues to face a wide array of challenges with respect to the unabated influx of refugees in recent years. BELONGINGNESS findings contribute to efforts to resolve intercultural conflicts and the mechanism behind hostile attitudes. They can also be employed by host members, migrants and policymakers to work towards social cohesion.

BELONGINGNESS

- ★ Coordinated by Jacobs University Bremen in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105110>



ENERGY

NEW LOW-ENERGY HEATING SYSTEM

Space heating and 'Domestic hot water' (DHW) in residential and commercial buildings are responsible for about 40% of total energy consumption in the EU. Meanwhile, solar thermal energy stands as one of the most promising heat sources available. Although energy efficiency in new buildings is important, the main target is existing buildings, due to the need for new developments and adaptation to existing technologies in order to comply with recent EU directives.

The EU-funded EINSTEIN (Effective integration of seasonal thermal energy storage systems in existing buildings) project has developed, evaluated and demonstrated a low-energy heating installation based on 'Seasonal thermal energy storage' (STES). The system uses solar collectors combined with a heat pump and an isolated water tank to store the heat obtained by STES in summer, for subsequent use in winter.

This approach can reduce energy consumption by up to 70% compared to conventional thermal systems. Research included the development of a new heat pump capable of operating at higher temperatures and suitable for integration into STES systems.

Although heat pump technology is well known, STES systems are still not a mature technology, and the integration between these two systems had not previously been optimised. In addition, an appropriate heat pump and a suitable evaluation tool did not exist, until it was created by the EINSTEIN project.

A software evaluation tool for selecting the most cost-effective retrofitting of a building was developed, together with a decision support tool for selection, preliminary design and evaluation of STES systems in existing buildings.

Design guidelines were drawn up for future owners and users of STES systems. In addition, researchers put together training material and a lessons learned document that summarised the experience gained by the consortium.

Project partners also built and monitored two pilot plants. The first was in Bilbao, Spain at the building level, while the second was in Warsaw, Poland at the district level.

The concepts developed by EINSTEIN were based on the highly innovative adaptation of existing technology. This will enable the development of almost zero-energy buildings in the near future, thereby achieving one of the main objectives of the EU's Energy Performance of Buildings Directive (EPBD).

According to the results obtained from the STES installations' economic and financial feasibility study, this technology would be beneficial for locations in southern Europe, such as Madrid. Based on current prices of natural gas and electricity in this city and, without the need for subsidies, assuming that the selling price of heat coming from the STES installation is the same as that currently paid by customers (who use natural gas boilers), a STES installation with a total annual heat demand of 10 000 MWh (1 000 dwellings) would offer an IRR of 10% and an investment (EUR 6 million) payback time of 10 years.

EINSTEIN

- ★ Coordinated by TecNALIA in Spain.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/102067>
- ★ Project website:
<http://www.einstein-project.eu/>

CABLES THAT CAN STAND THE WET

Most European offshore wind farms are found near the coast in shallow waters, which presents technical difficulties when it comes to using this renewable energy source. However, researchers have improved an underwater cable connection system to solve this problem.

The EU has a binding target of 20% renewable energy consumption in 2020, and offshore wind energy has the greatest potential to help achieve this target. The next-generation wind turbines will have to be located 40km out at sea and at depths of up to 80m.

Submarine cables either run individually across the sea or a subsea hub provides a connection point. From there on, a single, higher-voltage transmission cable runs to the shore, transmitting power. However, cable inspection and maintenance at great depths are difficult. In addition, it is necessary to increase the transmission voltages given that larger conductors are heavier and more expensive.

“The project’s connector will help boost performance and increase reliability of high-voltage submarine power links.”

The EU-funded WETMATE (WETMATE - A 33kV subsea wet-mateable connector for offshore renewable energy) initiative addressed technical cabling challenges associated with wind farms moving to deeper water and farther out at sea.

WETMATE worked to develop a high-integrity 33 kV wet-mateable connector that can withstand high hydrostatic pressures. The researchers designed it to be affordable and cheap to operate.

The project team equipped the cable connector with monitoring features to improve subsea cable detection and allow preventive maintenance. The researchers were therefore able to eliminate routine maintenance at greater depths, presenting a major improvement in power infrastructure management.


Researchers initially examined the balanced detection method to locate ‘partial discharges’ (PDs), which cause current spikes, in the cable. They developed and tested environmental and PD detection circuit sensors. Partners also produced prototype circuit boards to

test energy scavenging, environmental sensing and PD detection.

WETMATE first intended to use optical fibre within the cable to send information about the state of the connector back to the shore. However, the team opted to use an ultrasonic modem between the connector housing and the energy converter at the surface as it is more efficient.

The project’s connector will help boost performance and increase reliability of high-voltage submarine power links. The solution is also supporting the European strategy for sustainable, competitive and secure energy supply.

WETMATE

- ★ Coordinated by Hydro Bond Engineering in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/project/rcn/106010>
- ★  <http://bit.ly/2hJRGGL>



ADVANCED NANOCOMPOSITES FOR ENERGY CONVERSION TECHNOLOGY

'Fuel cells' (FCs), as an efficient conversion technology, can help Europe get passed its energy and environmental challenges. An EU-funded initiative has addressed the various issues restricting the further development of this promising technology.

In recent years, the advancement and subsequent commercialisation and roll-out of FC technology has been hampered by several bottlenecks. To deal with this issue, the NANO-FCSC (Engineering of nanocomposites for a new energy conversion device joining fuel cell and solar cell) project set out to explore a new development route for current FC technology through the use of nanotechnology, particularly advanced nanocomposite materials.

Project partners prepared, characterised and tested nanocomposites for a novel energy conversion technology that combines the principle of FCs and solar cells. They also investigated scientific principles and device mechanisms, including ion and electron transport.

Work began by studying new effective composite materials that can be used for single component fuel cells. For this purpose, industrial-grade rare-earth (LCP)

and perovskite oxide (LSCF) were fabricated and investigated. Project partners investigated and characterised their microstructure, morphology and electrical properties. They modulated various ratios of LCP to LSCF in the composite to achieve balanced ionic and electronic conductivities. This enables FC and solar cell devices to perform better. FCs with an optimum ratio reached the highest open circuit voltage and a maximum power density while also displaying good performance stability. The high performance is a result of the interfacial mechanisms and electrode catalytic effects.

The NANO-FCSC team discovered that the Schottky junction has a significant impact on FCs, particularly device performance. FC devices incorporating the Schottky junction attain high power output. In addition, it offers advantages such as simplicity, a light weight, and low-cost materials and technology.

"FC devices incorporating the Schottky junction attain high power output."

Lastly, scientists designed and developed a novel device that converts hydrogen fuel into electricity while achieving a stable power output.

NANO-FCSC introduced a promising new material, opening up new avenues for FC and innovative energy technologies while accelerating FC commercialisation.

NANO-FCSC

- ★ Coordinated by Aalto University in Finland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107687>

FRESH APPROACH TO SOLAR CELL DESIGN

A low-cost alternative to traditional solar cells has been developed by the EU-funded project HYBRIDSOLAR.

The aim of HYBRIDSOLAR (Morphology and molecular packing in polymer-nanocrystal hybrid solar cells revealed with synchrotron x-ray characterization and other techniques) was to improve the understanding of nontoxic polymer-nanocrystal hybrid solar cells. These devices have the potential to combine the advantages of organic and inorganic materials to produce high-performance, yet light-weight and flexible devices.

Researchers demonstrated the control of molecular packing and morphology in hybrid solar cells, and correlated it with their properties and performance in order to fabricate high-efficiency solar cells. The form factor and morphology of matildite nanoparticles containing silver, bismuth and sulphur (AgBiS₂) developed by researchers and the polymer hole transport layer were controlled by varying processing conditions. These included annealing, solvent variation, the solution concentration and the ligand exchange process.

Although solar-cell efficiencies were below 1% at HYBRIDSOLAR's outset, its efforts have resulted in efficiencies of up to 6.3%. It is believed this represents the highest efficiency of any nontoxic nanoparticle solar cell that is solution processed at low temperatures. Therefore, the main results have been included in a patent application, been published in Nature Photonics and received widespread media coverage. The knowledge gained within HYBRIDSOLAR is of paramount importance to further improving the design of solar cells and achieving commercially relevant efficiencies.

HYBRIDSOLAR

- ★ Coordinated by ICFO in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/185782>



ENVIRONMENT

NEW RESEARCH WARNS OF INCREASED HURRICANE RISK TO THE NORTHEAST UNITED STATES

New research published by the EU-funded HURRICANE project has highlighted how the north eastern coast of the USA could be struck by more frequent and more powerful hurricanes in the future due to shifting weather patterns.

Over the past 450 years, hurricanes have gradually moved northwards from the western Caribbean towards northern North America, according to the research funded through the HURRICANE (Past hurricane activity reconstructed using cave deposits: Have humans increased storm risk?) project, led by the UK's Durham University.

HURRICANE's project team suggest that this change in hurricane trajectories has been caused by the expansion of atmospheric circulation belts driven by increasing carbon dioxide emissions. This is bad news for major cities such as New York and Boston located on the north eastern seaboard, as they could now come under increased threat from future hurricanes and will need to better prepare themselves for their potential impact.

Published in the journal 'Scientific Reports' in November 2016, the study saw researchers reconstruct hurricane rainfall for the western Caribbean dating back over four centuries, by analysing the chemical composition of a stalagmite collected from a cave in southern Belize. They found that the average number of

hurricanes at the Belize site decreased over time. When the hurricane history of Belize was compared with documentary hurricane records from locations such as Florida and Bermuda, this showed that Atlantic (Cape Verde) hurricanes were moving to the north rather than decreasing in total numbers.

Impact of industrialisation

In particular, the researchers found that even though natural warming over the centuries had some impact on shifting hurricane tracks, the research team found that hurricane activity in the western Caribbean decreased markedly in the late nineteenth century. This coincides with a major industrial boom, as the region was rapidly integrated into the growing world economy. This economic growth saw an increasing level of carbon dioxide and sulphate aerosol emissions in the atmosphere.

The research team outlined how initial regional cooling of the Northern Hemisphere due to increased industrial aerosol emissions should have pushed the hurricane tracks southwards following the rapid industrialisation. However, rising amounts

of atmospheric carbon dioxide had overridden this effect by expanding the Hadley cell, a pattern of circulating air in the Earth's tropical belt. This subsequently pushed hurricane tracks further north, away from the Caribbean towards the US north eastern seaboard. Importantly, the research suggests that since the late nineteenth century, manmade emissions have become the main driver behind shifting hurricane tracks, by altering the position of global weather systems.

Sandy sets a precedent

In 2012, Hurricane Sandy struck the Caribbean and much of the eastern US seaboard, continuing as far north as the eastern coastal Canadian provinces. A large number of US states were affected by Sandy, with New York and New Jersey suffering the most. In total, 233 people died as a result of the storm and the damage caused was said to have run into tens of billions of dollars.

Dr Lisa Baldini, the study's lead author, commented: 'Given the devastation caused by Hurricane Sandy, it is important that plans are put in place to protect

ENVIRONMENT

against the effects of similarly destructive storms which could potentially occur more often in the future.'

Co-author Dr James Baldini added: 'Although hurricane tracks have gradually moved northwards away from the western Caribbean, rising sea surface temperatures could promote the development of cyclonic storms within the western Caribbean... however, increased sea surface temperatures also provide extra energy, potentially fuelling larger storms. We therefore need to prepare for the effects of more

frequent landfalls of larger storms along the north east coast of the United States and stronger storms impacting the Caribbean.'

HURRICANE

- ★ Coordinated by the University of Durham in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/93165>

UNDERGROUND CO₂ STORAGE

An EU team has assessed the feasibility of underground 'carbon dioxide' (CO₂) storage as a means of combating climate change. The principle is generally sound: trapped CO₂ does not leak, and capped storage sites have a low risk of failure.

The international community has agreed to constrain global warming to a relatively benign average temperature increase of 2 °C maximum. Ensuring such a result requires various solutions, notably carbon capture and geological storage.

Funded by the EU, the ULTIMATECO₂ (Understanding the long-term fate of geologically stored CO₂) project assessed the long-term effects of CO₂ geological storage. Specifically, the study addressed the evolution of CO₂ plumes, leakage prevention and regional-scale impacts. The research also helped develop uncertainty assessment tools in a bid to boost confidence in the modelling.

The team found that CO₂ injected into a storage site can cause long-term changes. The mechanisms include CO₂ dissolving in water or reacting with rocks to produce minerals.

Modelling of trapping mechanisms in typical storage scenarios suggested that over 50% of CO₂ remains in a supercritical form decades after site closure. However, gas is still contained within the structure. Mineral trapping was limited to sandstone reservoirs used for CO₂ storage. New modelling techniques also showed the importance of basin-scale models for predicting the evolution of CO₂ in terms of pressure impact.

Typical caprock presented a low risk of failure. CO₂ also made a low impact on well integrity, however well history was also a factor in integrity. The team therefore recommended developing geophysical tools to improve the evaluation of abandoned wells, which pose a leakage risk.

Caprocks and wells both showed a tendency to self-repair in the presence of CO₂. In general, predicting leakage

risk is difficult because of the complexity of underground geology. Nevertheless, risks were assessed as low or very low, as was the long-term impact of CO₂ storage.

The ULTIMATECO₂ project's assessment of risks and impact of CO₂ storage confirms the validity of such methods in combating global warming. By using underground storage, the world may be better equipped to reach CO₂ targets.

ULTIMATECO₂

- ★ Coordinated by BRGM in France.
- ★ Funded under FP7-ENERGY.
- ★ <http://cordis.europa.eu/project/rcn/100552>
- ★ Project website: <http://www.ultimateco2.eu/>
- ★  <http://bit.ly/2hKrPFX>



"CO₂ also made a low impact on well integrity, however well history was also a factor in integrity."

LINK FOUND BETWEEN EL NIÑO AND SRI LANKAN DENGUE EPIDEMICS

Researchers have discovered a strong association between El Niño-Southern Oscillation conditions in the Pacific, based on observed weather, and dengue epidemics in Sri Lanka.



The El Niño phenomenon is an irregularly occurring and complex series of climatic changes which has a number of important effects both across the Pacific region and throughout the world. These include the appearance of unusually warm, nutrient-poor water off northern Peru and Ecuador, typically in late December, the reversal of wind patterns across the Pacific, drought in Australasia, and unseasonal heavy rain in South America. Now researchers from the EU-funded DENGUETOOLS (Innovative tools and strategies for surveillance and control of dengue) project have found that El Niño conditions in the Pacific precede exacerbated dengue epidemics six months later in Sri Lanka.

'Dengue is a major public health burden in Sri Lanka, and the Kalutara district is one of the most affected areas,' comments Joacim Rocklöv, co-author of the study and DENGUETOOLS researcher from the Unit for Epidemiology and Global Health at Umeå University. 'So understanding how reoccurring weather patterns drive dengue is vital in controlling and preventing the disease spread.'

In the study, published recently in the 'International Journal of Environmental Research and Public Health', the research team used the Oceanic Niño

Index, which is a measure indicating El Niño activity by sea surface temperature in the Pacific Ocean, along with local weather and epidemiological data in Sri Lanka to quantify data associations. Weekly weather variables and data on dengue notifications, gathered by Prasad Liyanage for the Sri Lankan Ministry of Health (an official DENGUETOOLS consortium member) between 2009 and 2013, were analysed to estimate locally specific and overall relationships between weather and dengue.

Results indicated that there was an increasing risk of dengue with increasing rainfall starting at about 50 mm per week. The strongest association between rainfall and dengue was found around 6 to 10 weeks following rainfalls of more than 300 mm per week, which results in extremely wet conditions and a high chance of flooding. With increasing temperatures of 30 degrees Celsius or higher, the overall relative risk of dengue increased steadily starting from a lag of four weeks. Except for the period 2012-2013 during which a prolonged but flattened dengue epidemic was observed, all the other years displayed distinct annual seasonal peaks of dengue cases from May to September.

Being a tropical illness spread by mosquitoes, increased rainfall and discarded man-made receptacles scattered outside human habitats result in a proliferation of breeding grounds for mosquitoes. The availability of ample breeding sites leads to an increase in the number of mosquitoes. Warm temperatures also further augment dengue transmission dynamics by increasing survival and biting rates, as well as decreasing the extrinsic incubation period of the dengue virus in mosquitoes.

'Looking at weather and dengue incidents over longer periods, we found a similar strong link between how increased rainfall and warmer temperatures resulting from the reoccurring El Niño phenomenon are associated with elevated risks of dengue epidemics,' said Prasad Liyanage. 'In the longer perspective, our data further confirms this association and suggests that dengue fever thrives whenever El Niño visits our island.'

"Results indicated that there was an increasing risk of dengue with increasing rainfall starting at about 50 mm per week."

By finding a link between El Niño and dengue prevalence, the DENGUETOOLS researchers have suggested that their findings can be used to improve predictive surveillance models with lead times of up to six months. This would give health officials more time to increase preparedness and mount control effort responses prior to the epidemics.

DENGUETOOLS

- ★ Coordinated by Umeå University in Sweden.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/100455>

GENE EXPRESSION INDICATES PLANTS ARE ADAPTING TO INCREASED CO₂ LEVELS

Research partly supported through the EU-funded EXPEER project has found that plants are increasingly adapting to increasing atmospheric 'carbon dioxide' (CO₂), which could have important implications for global food security and nature conservation.



The research from the University of Southampton, UK, published recently in the journal 'Global Change Biology', shows that as plants are exposed to elevated CO₂ emissions, gene expression is altered, indicating that changes in gene regulation could be a prominent mechanism underpinning adaptation to elevated CO₂.

Short-term benefits of rising CO₂

With increasing levels of atmospheric CO₂ (emissions grew faster in the 2000s than the 1990s and the concentration of CO₂ reached 400 ppm for the first time in 2013), the short-term impact on plants can be described as relatively positive, as this drives up photosynthesis and plant growth, including crop growth and food production. Recent decades have actually seen the Earth become greener as vegetation growth has been stimulated by CO₂ rises.

However, the long-term impact of higher levels of atmospheric CO₂ on plant life is still a matter of scientific debate. 'Until now, few reports had given us any insight into the long-term impacts of rising CO₂ over multiple generations and none have been undertaken on the molecular signature underpinning such adaptation,' commented lead study author Professor Gail Taylor of the University of Southampton. 'One reason for this is that it's a difficult problem to crack — to find plants that have been exposed to conditions of the future but are available today.'

To investigate this further, the research team used a unique resource — naturally high CO₂ springs where plants have been subjected to more CO₂ over many hundreds of years and multiple plant generations. Taking *plantago lanceolata* plants from a 'spring' site in Bossoleto, Italy, and comparing the molecular signature with the same plants from a nearby 'control' site (at today's CO₂) showed striking differences in the total gene expression (the process by which

specific genes are activated to produce a required protein).

'The study shows that when we take plants from these two places that represent the atmosphere of today with that of the future (out to 2100), and place them together in the same environment, the plants from spring sites were bigger and had a better rate of photosynthesis,' said Prof. Taylor. 'Most importantly, plants from the spring sites had differences in the expression of hundreds of genes.'

Prof. Taylor and her team predict that from their gene expression data planetary greening will continue. 'It won't switch off or become acclimated as CO₂ continues to rise, but some of the extra carbon in future plants is likely to go into secondary chemicals for plant defence. This is associated with more gene expression underpinning plant respiration.'

Impact on stomatal pores

One of the most interesting findings from the research was that stomatal pores on the surface of the leaf (small holes that control the uptake of CO₂ for photosynthesis and the loss of water vapour) increase in number after multi-generation exposure to future CO₂. The team had predicted that pore numbers would decline, in line with past research over geological timescales using fossil plants.

Prof. Taylor added: 'This is a counter-intuitive finding but strongly suggests that stomatal pore numbers increase, since we have identified several key regulators of stomatal numbers that are sensitive to future high levels of CO₂. One of those is SCREAM (SCRM2), which is a member of the "Basic helix-loop-helix" (bHLH) protein family that acts to regulate plant developmental transitions.'

She admits that the full consequences of this developmental change is not yet fully understood but shows that plants will adapt in unpredictable ways to future levels of CO₂ over multiple generations. This is an important question to address, as it is imperative to know how food crops may evolve over future generations as a result of the changing climate, as well as whether planetary greening will continue and the impacts of this for global nature preservation.

As well as being part-funded through the FP7 EXPEER (Distributed Infrastructure for EXPERimentation in Ecosystem Research) project, which concluded in May 2015, the research also received support from the British Council and the UK's National Environment Resource Council (NERC).

EXPEER

- ★ Coordinated by INRA in France.
- ★ Funded under FP7-INFRASTRUCTURES.
- ★ <http://cordis.europa.eu/project/rcn/96968>
- ★ Project website: <http://www.expeeronline.eu/>

AQUATIC RESOURCES

SATELLITES TO MONITOR THE EARTH'S WATER

Researchers have developed fully automated online tools to convert data collected by satellites into global water monitoring systems.

SENTINEL-2 (S2) and -3 (S3) satellites were developed by the European Space Agency (ESA) to monitor climate change impacts on Earth systems such as forests and lakes. By measuring parameters such as sea- and land-surface temperatures, forest coverage and inland water quality, these satellites keep a remote eye on the Earth's health.

INSIGHT (Darwinian Neurodynamics), a ground-breaking EU-funded project led by one of the current pioneers of theoretical evolutionary biology, has achieved a better understanding of exactly how we solve problems, by examining how ideas in our brains could evolve throughout our lives. The findings could have implications for programming problem-solving robotics that think for themselves and advance our knowledge of how human language developed.

The EU-funded GLASS (Global Lakes Sentinel Services) project developed online tools and algorithms to extract information from S2 and S3 satellite images for monitoring global lakes and reservoirs.

While water samples can be analysed in a lab, remote sensing covers a greater global area with high resolution. In addition, the S3 satellite passes over the same geographical area frequently, allowing ecologists and water managers to closely monitor inland waters.

To turn the vast amount of data captured by S2 and S3 into useful information, researchers developed algorithms for water quality. To test these, GLASS collected data from different types of inland water, ranging from clear and blue to green and brown. These lakes either reflect or absorb light, allowing them to be classified based on their optical properties.

Researchers discovered that their algorithms did not suitably describe the large optical variation of all lakes. They therefore developed a pre-classification tool that allows users to select specific algorithms for a lake based on its water type.

To demonstrate their system, researchers measured the optical properties of lakes in Estonia, Italy, the Netherlands, Finland and Sweden. They then developed software packages that allow users to remotely analyse different

types of lakes that need to be managed in different ways. These include green, algae-dense waters, deep, clear lakes, shallow, murky waters and mine tailing ponds.

The project's openly available data, products and results will help users to better understand and manage global water systems. Importantly, GLASS will allow the EU Water Framework Directive (WFD) to use satellite data to improve water quality and provide ecosystem services like drinking water. Based on the use cases, GLASS developed training materials, which will help a new generation of remote sensing experts, ecologists, environmental technicians and GIS experts to work with S2 and S3-OLCI data for water quality monitoring.

GLASS

- ★ Coordinated by Water Insight in the Netherlands.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/106791>
- ★ Project website: <http://www.glass-project.eu/>

THE EFFECT OF WARMING WATERS ON COLD-WATER FISH

EU-funded researchers have studied the genetics behind temperature preferences of fish in Antarctic waters. Their findings will help conservationists protect these species, as climate change warms and alters their environment.



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Climate change is affecting species right around Earth; the Antarctic is no exception. Here, rising temperatures will likely reduce habitats available to cold-water species, among other concerns.

Understanding the genetic basis of temperature dependence in cold-water fish will improve conservation and management plans for these species. Researchers from the EU-funded POLAREXPRESS (Temperature drives evolution: In search of gene expression differences between eurytherm and polar stenotherm fishes) project studied how fish in the Southern Ocean are genetically adapted to their preferred temperature ranges.

The scientists studied three related fish species from the Antarctic. They compared

the genetics of two species that can live only in a narrow temperature range with a third that is less temperature-sensitive.

After keeping the fish at different temperatures, the researchers identified the genes that were more or less active in response to temperature. They then researched the function of the genes they had identified.

POLAREXPRESS also sequenced part of the genome of one of the species and identified markers to study the genetic health of wild populations of these fish.

The results of this project have helped scientists understand the effects of climate change on Antarctic fish species. This understanding will assist in the long-term conservation of marine species in warming oceans.

“After keeping the fish at different temperatures, the researchers identified the genes that were more or less active in response to temperature.”

POLAREXPRESS

- ★ Coordinated by Alfred Wegener Institute for Polar and Marine Research in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/187678>

SUSTAINABLE WASTEWATER TREATMENTS

An EU team has developed a combination of eco-efficient wastewater treatment technologies aimed at the Indian market. The group produced anaerobic and solar treatment systems as well as constructed wetlands.

Wearable robots are programmable body-worn devices, or exoskeletons, that are designed to mechanically interact with the user. Their purpose is to assist or even substitute human motor function for people who have severe difficulty moving or walking.

India is facing a water crisis, particularly concerning untreated wastewater pollution of natural waterways. The situation will only worsen under climate change and increasing population

“The team completed five small and large pilot treatment plants.”

numbers, however new wastewater treatment technologies or practices could mitigate such pressures.

The EU-funded SWINGS (Safeguarding water resources in India with green and sustainable technologies) project was set up to devise the necessary measures. The goals included low-cost water reuse and treatment technologies, including anaerobic digestion and constructed wetlands. Such technologies, to be used in combination, require zero energy and are therefore considered sustainable. The two technologies were to be complemented with low-cost solar disinfection units.

The consortium suffered setbacks due to delays in receiving funds, earmarked for the pilot plants, from the Indian government. The situation required changes to the project's goals and also pushed the initial timeframe back.

However, the project did successfully design, build and implement the anaerobic system, horizontal and vertical constructed wetlands, and solar disinfection systems. The team completed five small and large pilot treatment plants.

The systems were designed to achieve a 'Biochemical oxygen demand' (BOD) of 80-90%, 'Chemical oxygen demand' (COD) of 70-80%, and removal of nitrogen and phosphorous nutrients of 40-60%. The treatment rate may be up to 1 000 litres per hour.

The project work also produced a decision-support system, designed to help with selecting and optimising treatment options, as well as a sustainable pathogen monitoring technique.

SWINGS' results will help India treat much more wastewater than it does at present, improving both the natural environment and human health. India will be a very strong market for the new technologies, with the EU representing a smaller but nonetheless substantial market.

SWINGS

- ★ Coordinated by Aimen in Spain.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/104196>



INDUSTRY

ROBO-MATE: FROM BRAIN MUSCLE GATHERING TO HEAVY WEIGHT LIFTING

© Robo-Mate

Soon, European workers with manual handling tasks could see their jobs becoming a lot more easier. Technology developed under the ROBO-MATE project is set to allow them to lift up to 15 kilograms while making it feel like it was no weight at all.

Despite growing automation in European industry, a lot of tasks still involve manual handling. This comes at a considerable cost — that of workers' health. In Europe alone, 44 million workers suffer from occupational 'musculoskeletal disorders' (MSDs). Not only does this impact their daily life and shorten their careers, but it also costs Europe as much as 3% of its GDP.

If you had to put that problem in the hands of a Hollywood blockbuster scenarist, he'd probably tell you that the answer is crystal clear: if workers are to move ever heavier objects with less effort, that requires an exoskeleton. And as science fiction-esque as it may sound, researchers from 12 European organisations would actually concur.

Together, these organisations — among which the Zurich University of Applied Sciences, IIT, Fraunhofer and Ropardo — initiated the ROBO-MATE project (Intelligent exoskeleton based on human-robot interaction for manipulation of heavy goods in Europe's factories of the future) with one objective in mind: putting together an intelligent, easy-to-manoeuvre, wearable exoskeleton for manual-handling work.

'We had long discussions with end-users and internal brainstorming sessions that helped us come up with and dismiss different concepts,' explains Dr Konrad Stadler, coordinator of the project for Zurich's University of Applied Science. 'In the end, we decided in favour of the concept that fitted best

the requirements of end-users while also being achievable within three years: a modular, light-weight exoskeleton for the handling of goods up to 15 kg.'

A step ahead

The most important word here is 'modular'. Unlike any other industrial exoskeleton concept, Robo-Mate consists of four different modules that can either be combined or used as a stand-alone support technology. These include a trunk module that applies a supportive force to the worker's hips and upper body — reducing compression forces in the lower back by up to 25%; a passive arms module providing a constant lift to the worker's arms to handle constant loads; an active arms module providing a variable lift for pick and place tasks; and a 'Human-machine interface' (HMI) module to help workers interact with the exoskeleton or display assembly instructions.

'There are two unique aspects of Robo-Mate: One is the construction of the passive arm module. Unlike other passive arms, it provides a constant lift no matter where your hands are and without any heavy motors and batteries. The second aspect is our modular concept: We have seen that there is no one-size-fits-all approach to the problem of heavy object handling. By providing different modules, we allow industry to select the one module or the combination of modules that is best to perform a given task,' Dr Stadler explains.

INDUSTRY

Getting there wasn't an easy task. Other exoskeleton concepts had already been running for five or more years when the ROBO-MATE project started, and the team only had three years to beat them. 'The other problem was and still is weight', says Dr Stadler. 'For the exoskeleton to be user-friendly, it has to be lightweight. But current actuation technology that meets requirements in respect of movement speed and support torque results in too heavy and too bulky systems. That was a huge challenge which we overcame with a parallelogram design for both the active and the passive arm modules.'

Turning heads in industry

Judging by media and industry interest around the concept, it is safe to say that the consortium has a winning formula on its hands. The trunk module, passive and active arms have all been tested extensively at Centro Ricerche Fiat, COMPA and INDRA, and the final prototype demonstration that took place in Sibiu, Romania in August 2016 attracted representatives from over a dozen companies. In total, 70 companies have already contacted the consortium to express their interest, and three are currently negotiating with a project partner to rent modules for testing.

'Tests conducted in our laboratories have helped us measure muscle activity and perceived exertion with and without the exoskeleton,' says Dr Stadler. 'Workers also tested the modules in production environments and we measured cycle times of specific tasks and perceived exertion/usability.'

Results from these tests show that the modules can indeed protect workers from injuries while improving efficiency.

Moving further: from industry tests to market

With the project completed at the end of November, core partners are now focusing on commercialisation of their technology. Four of the partners joined forces with an exoskeleton manufacturer and have submitted an application under the Horizon 2020 Fast Track to Innovation (FTI) scheme to bring the trunk module to market, while six companies from the automotive, construction and manufacturing sector will participate in further testing. In the meantime, two other partners are looking into a possible application for another European grant.

'We are also planning a start-up company,' says Dr Stadler. 'All in all, we think that the passive arms module can be commercialised within a year, the active arms in 2-3 years and the trunk module in 3-4 years. But that depends a lot on whether we are successful with our applications for follow-up projects and this start-up company.'

ROBO-MATE

- ★ Coordinated by the Zurich University of Applied Sciences in Switzerland.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/108891>
- ★ Project website: <http://www.robo-mate.eu/>

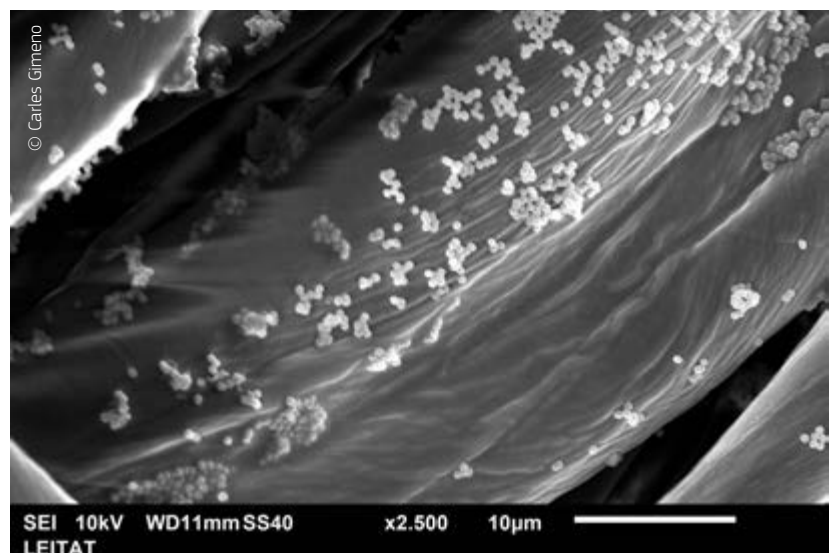
SUSTAINABLE TEXTILES REPEL BITING BUGS

Chemical resistance in insects and other arthropods, as well as stricter legislation of the pesticide market and anthropogenic factors, such as climate change, all demand new technologies for controlling ticks and bedbugs. An EU-funded consortium is therefore developing textile technologies to protect European citizens from attack.

Ticks are carriers of human and animal diseases, which are becoming more prevalent as a result of climate change. Bedbugs are also increasing due to climate change, the increased movement of people and reduced susceptibility to pesticides. Although ticks and bedbugs are found in different environments, they have similar behaviour and can be combated using the same biocides.

The EU-funded BETITEX (Development of sustainable textiles against bugs) project was set up to create textile materials for outdoor clothing and home textile products that contain a biocide to repel or kill ticks and bedbugs. 'The aim of this research is to improve the durability, sustainability and effectiveness of insecticidal and repellent products which are currently on the market,' says BETITEX coordinator Dr Ariadna Detrell.

At present, a repellent spray containing a biocide is the most common way of controlling ticks and bedbugs. However, not all of them comply with Regulation (EU) No 528/2012 of 2012 on using biocidal products and making them available on the market, due to their toxicity and environmental impact.



'One of the main issues surrounding the existing biocides is their toxicity to humans, as vapours can be generated due to the high temperatures achieved during the application procedure on textile materials. This fact needs to be considered when scaling up the process in the textile industry, which is not used to working with such chemicals,' Dr Detrell explains.

Natural, biodegradable or recyclable textile materials used in combination with authorised biocides and eco-friendly textile technologies will help to overcome this challenge. BETITEX has therefore conducted detailed studies of different encapsulation technologies for application on textiles, in order to minimise the toxicity of the treated fabrics.

'Toxicity can be reduced through the encapsulation of the active substance and its controlled release,' Dr Detrell says.

'Different biocides have been studied and embedded using two different technologies: micro- and nano-encapsulation and sol gel. They were then applied to textile materials during the extrusion of polypropylene yarn and also through different textile finishing technologies, such as padding, coating and dyeing,' adds Dr Detrell.

This approach helps to control the repellent or insecticide effect, thereby contributing to a longer lifespan for the biocide. It also leads to greater durability, enabling the effect to be maintained even after the textile has been washed 50 times.

'Although not all the solutions developed have the same effectiveness, the

results are positive' observes Dr Detrell. 'In most prototypes, a 100% mortality rate of ticks and bedbugs was obtained in less than 24 hours. Furthermore, during the project a synergistic effect was achieved, combining specific biocides with specific embedding and application technologies on different fabrics.'

'Another important point to highlight is that the biocides we used are not the ones most commonly found in products that are already on the market, such as outdoor clothing protecting against ticks and mattress covers protecting against bedbugs. In addition, the key results have been obtained not only at the laboratory scale but also at the industrial scale.'

BETITEX will therefore help to limit human exposure to biocides by reducing the need for and use of repellent spray.

It will also offer the possibility of obtaining protective clothing for those venturing into tick-infested areas, while treated household fabrics will ensure that sleepers need not worry about being feasted on by bedbugs in the middle of the night.

BETITEX

- ★ Coordinated by Gremi Tèxtil de Terrassa in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/project/rcn/110634>
- ★ Project website: <http://www.betitex.eu/>
- ★  <http://bit.ly/2iSttGv>

ANTIFOULING PAINT THAT HELPS PROTECT THE ENVIRONMENT

The colonisation of a ship's hull by marine organisms is termed biofouling. So-called hard foulers, such as barnacles, are of particular concern as they can increase drag on a ship, resulting in up to 70% increased fuel consumption.

Current antifouling technologies are based on the release of biocides or on low-adhesion coatings. Biocides such as copper oxide are based on continuous release, which can have long-term ecological effects and therefore cannot be considered as sustainable. Low-adhesion coatings suffer from a lack of mechanical resistance and long-term durability, along with associated high material and maintenance costs.

The LEAF (Low emission antifouling coatings based on the novel discovered post settlement penetration triggered antifouling) project was set up to develop and demonstrate a new antifouling technology that was not based on biocide release or low adhesion. Researchers worked on a new approach in which the antifouling effect occurs when the barnacles establish themselves and start the process of penetrating the paint. The biocide is only needed in low concentrations, and the coating in which it is held can last for years.

Project partners developed new methods for measuring biocide leaching rates and characterising antifouling paint formulations, and established a number of different assays to test biocide efficacy. Field testing of different LEAF formulations was carried out in widely different fouling conditions in the North Atlantic, English Channel, Mediterranean and Brazilian coastal waters. A sustainability assessment of the LEAF coatings was also conducted. This included life cycle analysis comparing traditional copper-based solutions with the system developed by LEAF, as well as ecotoxicology and human safety aspects for LEAF's proposed solution.

The innovative character of LEAF is that it provided significant operational benefits. For example, as it does not rely on the continuous emission of biocide and erosion of the paint, it has a longer service life and extended maintenance cycles. The low amount of biocide required to achieve antifouling efficacy also has environmental benefits. The effectiveness of LEAF, even with water-based paints, will remove the need for solvents and reduce emissions of 'Volatile organic compounds' (VOCs).



The removal of solvents and VOCs will mean safe indoor working conditions during bad weather, thereby enabling European shipyards to compete more effectively. Methods developed through the LEAF project will also help future research into the next generation of environment-friendly antifouling coatings.

LEAF will provide ship and boat owners as well as policymakers with a zero to low-emission solution to the problem of hard fouling. This will mean a reduction in fuel consumption and atmospheric emissions, with no heavy metals accumulating in sediment or the biosphere.

The LEAF concept can also be further developed for other fields of application where fouling is a problem, such as the renewable marine energy and aquaculture sectors.

LEAF

- ★ Coordinated by SP Technical Research Institute of Sweden.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/project/rcn/104634>
- ★ Project website: <http://www.leaf-antifouling.eu/>

NOVEL COATINGS TO REFLECT THE SUN'S HEAT

Heat from human activities can greatly influence climate change, with recent studies linking rising temperatures in cities to the solar absorption that occurs in buildings and homes. EU-funded scientists have developed a novel coating technology with high light reflectance that can help reverse solar absorption and mitigate the urban heat island effect.



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“The features imprinted varied in size and shape, demonstrating the versatility of the process.”

I ncreasing carbon levels have been highly intertwined with rising temperatures in urban areas; however, carbon is not the only culprit. Human activities and building infrastructure are equally or more responsible for heat generation. Solar reflectivity refers to the amount of ‘infrared radiation’ (IR) reflected from a surface; high levels of solar reflectivity translate to higher light reflectance values and better reflection of the Sun’s heat.

Researchers working on the EU-funded SPIRCAM (Towards solution-processable near-IR and IR reflective coatings and mirrors for improved heat and light management) project developed new coatings and photonic structures. They offer better control over light and a significant reduction in the solar heat absorption that influences temperature changes in cities.

Project members developed novel coatings and mirrors based on hybrid organic-inorganic structures that improved heat and light management. This is attributed to their excellent solar reflectance, high transparency in the ultraviolet and visible parts of the spectrum, and tunable index of refraction.

Hybrid materials consisted of a water-soluble polymer, PVP, and an inorganic transition metal oxide (ZnO). This structure can improve reflectance of light in plastic electronic devices or solar reflectance in commercial buildings.

Researchers then employed a simple, yet novel approach for introducing photonic structures into the newly developed hybrid film. By leveraging micro-moulding techniques, they successfully imprinted photonic structures onto the surface of the hybrid film. These micro-patterned surfaces

— with either a periodic or a random structure — proved to efficiently scatter and diffract light of various wavelengths. The features imprinted varied in size and shape, demonstrating the versatility of the process. Altering the surface structure of the hybrid makes it possible to tune the diffraction wavelength to meet the requirements of any optoelectronic device.

In the end, researchers used commercial electrochromic polymers and ionic liquids to control the optical response in the photonic structures. Significant progress was also achieved in producing bilayer structures consisting of PVP-ZnO and electrochromic polymers to explore the optical response.

SPIRCAM’s newly developed hybrids pave the way towards the development of innovative coatings that reflect the Sun’s heat.

SPIRCAM

- ★ Coordinated by the Imperial College of Science, Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186501>

IT AND COMMUNICATION TECHNOLOGY

BUILDING A SUSTAINABLE, INTELLIGENT AND POWER-EFFICIENT CLOUD

EU-funded researchers are combining high-performance computational power with hardware and servers in order to build a more efficient, heterogeneous cloud.

Whether it's sharing files via Dropbox, saving images on Google Drive or placing an order with Amazon, we all use what is commonly referred to as 'the cloud' for our basic computing needs. But did you know the typical cloud server only operates at approximately 20% of its computing capacity? In fact, the cloud is now responsible for nearly 10% of the world's total electricity consumption — meaning the current model of cloud computing is simply not sustainable.

The EU-funded CLOUDLIGHTNING (Self-Organising, Self-Managing Heterogeneous Cloud) project intends to change this by creating a more efficient, sustainable and user-centric cloud. The project is working to develop an intelligent, power-efficient cloud computing infrastructure that will provide energy savings to cloud service providers and simplify access for cloud users. By using heterogeneous

processing resources, the project believes it can increase the cloud's computing capacity from the dismal 20% of today to a more sustainable 80%.

Behind the cloud

It might be hard to understand how cloud computing can be so inefficient. After all, the whole idea of the cloud is that we no longer need to have physical files, data or hardware. However, behind the cloud sit huge, homogeneous data centres comprised of a large number of machines, components and hardware — a model that CLOUDLIGHTNING researchers believe restricts computational processing power and limits what certain cloud computing users are able to do.

As a case in point, take the 'High performance computing' (HPC) used by the technical and scientific community

— a community whose needs are not met by the commoditised nature of today's homogeneous cloud. For example, their use of cloud resources is not always predictable and tends to scale up and down. As today's cloud providers do not offer the ability to configure available resources in a way that can meet these unique needs, cloud computing is simply not being used for HPC.

According to a recently published report by the CLOUDLIGHTNING project, the project team has found that such inflexibility has led HPC users to develop a general sense of distrust in the cloud. In particular, they have concerns about cloud computing's data management capabilities, including the lack of cloud infrastructure capable of meeting the communications and I/O requirements of high-end technical computing.

“The project proposes a novel cloud management and delivery architecture based on the principles of self-organisation and self-management.”

Another problem with the current system is that it encourages cloud providers to over-provision their computing resources as a way of accommodating users’ unpredicted peaks in demand. The downside of this practice, however, is that it results in tens of thousands of cloud servers located in data centres around the world running — and consuming energy — even though they’re not actually being used.

A heterogeneous idea

CLOUDLIGHTNING aims to overcome these barriers to cloud computing by

developing a power-efficient cloud infrastructure that will simplify access to cloud resources. Its proposed solution involves the creation of a heterogeneous cloud system that combines high performance computational power with the power-efficient use of different types of hardware and servers capable of working together. More technically, the project proposes a novel cloud management and delivery architecture based on the principles of self-organisation and self-management, which shifts the deployment and optimisation effort from the consumer to the software stack running on the cloud infrastructure.

The project’s ultimate goal is to address the inefficient use of resources and, consequently, to deliver savings to the cloud provider and the cloud consumer in terms of reduced power consumption and improved service delivery. Although the project is still a work in progress, it has already published use

cases for three application domains — genomics, oil and gas exploration and ray tracing — which will be used to validate the CLOUDLIGHTNING management and delivery models.

The project’s next step after its first promising results is to launch a testbed that runs the CLOUDLIGHTNING software stack. Researchers note that this testbed will gather the instrumentation data that will subsequently serve as the basis for large-scale simulations of self-organised and self-managed hyperscale heterogeneous clouds.

CLOUDLIGHTNING

- ★ Coordinated by University College Cork in Ireland.
- ★ Funded under H2020-ICT.
- ★ <http://cordis.europa.eu/project/rcn/194118>
- ★ Project website: <http://cloudlightning.eu/>

MEMRISTORS PROMISE MORE PRECISE AND AFFORDABLE NEUROPROSTHETICS

In a new paper, researchers from the University of Southampton, UK, and members of the EU-funded RAMP project, have demonstrated how memristors could help aid the development of more precise and affordable neuroprosthetics and bioelectric medicines.

Monitoring neuronal cell activity is fundamental to neuroscience and the development of neuroprosthetics but a persistent problem is the device being able to effectively process the neural data in real-time, which in turn imposes restrictive requirements on bandwidth, energy and computation capacity.

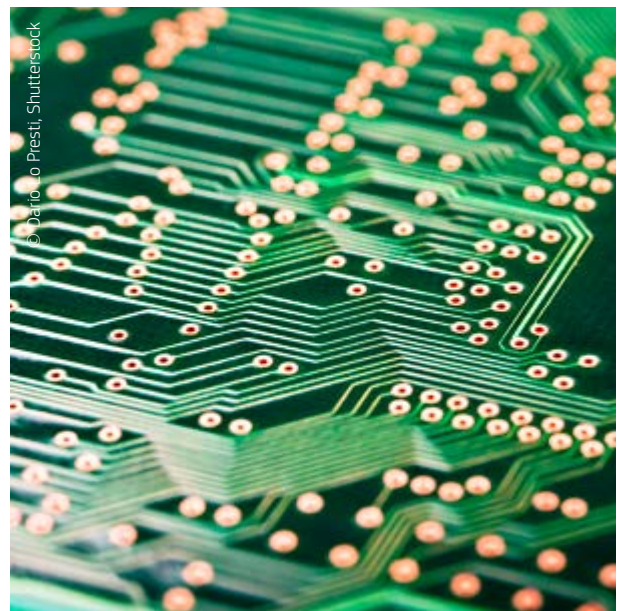
The solution to this problem, according to scientists working as part of the RAMP (Real neurons-nanoelectronics Architecture with Memristive Plasticity) project could lie with the use of memristors. These are electrical components that limit or regulate the flow of electrical current in a circuit and can remember the amount of charge that was flowing through it and retain data, even when the power is turned off. In essence, they perform a role akin to biological synapses and possess the intrinsic ability to simultaneously carry out computational tasks and store information at aggressively downscaled volumes and power dissipation.

Lead author Isha Gupta, a postgraduate research student at Southampton University, commented: ‘Our work can significantly contribute towards further enhancing the understanding of neuroscience, developing neuroprosthetics and bio-electronic medicines by building tools essential for interpreting the big data in a more effective way.’

The research team developed a nanoscale ‘Memristive integrative sensor’ (MIS) into which they fed a series of voltage-time samples, which replicated neuronal electrical activity. By acting like brain synapses, the metal-oxide MIS was reportedly able to encode and compress (up to 200 times) neuronal spiking activity recorded by multi-electrode arrays.

Besides addressing the bandwidth constraints, the researchers claim that this approach is also very power-efficient in that the power needed per recording channel was up to 100 times less when compared to current best practices.

‘We are thrilled that we succeeded in demonstrating that these emerging nanoscale devices, despite being rather simple in architecture, possess ultra-rich dynamics that can be harnessed beyond the obvious memory applications to address the fundamental constraints in bandwidth and



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power that currently prohibit scaling neural interfaces beyond 1 000 recording channels,' said co-author Dr Themis Prodromakis.

The work undertaken by the RAMP team is a highly promising leap forward for addressing a diverse number of diseases and conditions from which the development of sophisticated neuroprosthetics promises to significantly reduce symptoms and increase quality of life for patients. One of the biggest challenges in this field has been to ensure that neuroprosthetics have the 'feel' of being a part of the patient's own body or, for prosthetics located in or on certain parts of the body, are non-invasive.

Through the RAMP consortium, engineers from Southampton were able to link with biologists from the University of

Padova, Italy, and the Max Planck Institute, Germany, using the facilities of the Southampton Nanofabrication Centre. The paper has been published in the journal 'Nature Communications'.

The RAMP project, which received just over EUR 2 million in EU funding, ended in October 2016.

RAMP

- ★ Coordinated by the University of Padova in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/109899>
- ★ Project website: <http://www.rampproject.eu/>

NEW HORIZONS IN VISUAL PRESENTATION



institutions, local training and education at each project partner host site, and training through research initiatives.

Science and technology is one area that could particularly benefit from DIVA. Another is 3D data processing, for example in reconstruction of architectural structures.

Project research in interactive visualisation and display systems has already led to many publications. DIVA's progress and results have also been published on the project website. In parallel, the project team was active through conferences, workshops, lab visits for students and summer schools.

Overall, the project has helped overcome barriers related to large-scale interactive 3D visualisation and display systems. It built a team of experts who have advanced the field and bolstered European competitiveness in this respect. The results generated from this project will contribute to many core technologies of the future.

Advances in 3D modelling and interactive visualisation promise to support many applications in the future, from computed tomography scanning and architecture through to high-tech entertainment.

In today's high-tech world, data visualisation has become very important for deciphering the massive amount of information around us, supporting fields from science right through to entertainment. The EU-funded DIVA (Data intensive visualisation and analysis) project trained field experts to tackle challenges in visual presentation. Bringing together early-stage scientific researchers, the project worked on developing new methodologies in data-driven science and technology applications. In partnership with various renowned industry names, it integrated relevant

training and research projects on topics such as data acquisition and knowledge discovery. Key study subjects included data compression, visual data processing, feature extraction, multi-scale modelling, interactive rendering, display systems, human-computer interaction and visual perception.

In line with its objectives, DIVA successfully embarked its researchers on intensive training activities, including three multi-day summer schools over three years and four workshops. Project achievements also included fellow exchanges between the partner

DIVA

- ★ Coordinated by the University of Zurich in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/102753>

"The project worked on developing new methodologies in data-driven science and technology applications."

BIO-TEXT MINING MAKES ADVANCES

Society is moving from an economy of scarcity in data to an economy of abundance that looks set to change the face of healthcare. In line with these predictions, EU researchers have made significant headway in obtaining contextual information from massive chunks of biomedical data.

Pubmed alone has information on more than 21 million scientific publications with over 2000 new entries being added daily. The BIOLITCONTEXTMINING (Contextual text mining from the biomedical scientific literature) project designed methods based on natural language processing and machine learning to enable scientists to effectively extract and utilise relevant information.

Project researchers advanced the state-of-the-art in bio-text mining with new methods for relation extraction, local and non-local context information extraction and knowledge discovery. For instance, their Interaction Network Ontology (INO) collects and classifies over 800 interaction keywords, and can also cover complex interaction types. INO-based literature mining helps to identify and characterise the interactions among host and Brucella genes. Through a technique for relation and local context information extraction, they can now identify relations among brain regions.

In another key development, researchers devised methods for identifying important non-local context, such as experimental methods used to detect protein-protein interactions from full text articles.

To understand bacterial interaction mechanisms at the molecular level, knowing their natural environment location is vital. Astoundingly, there is currently no comprehensive database carrying this information, despite the abundance of literature on bacteria ecology. Researchers therefore developed ontology-centred methods to obtain bacteria context information, such as their habitat.

To gain access to contextual biomedical information, project members contributed to the development of two web-based systems — IGENET and PHISTO. Along with a knowledge discovery approach that was integrated with IGENET, they successfully identified fever and vaccine associated gene interaction networks in a case study. Significant progress was also made

with regard to methodologies for analysis of gene-gene interaction and drug-target interaction prediction.

The novel BIOLITCONTEXTMINING text mining tools will help advance several biomedical areas, including experimental biology, bioinformatics and systems biology. Project outcomes have led to publications in eight peer-reviewed journals as well as six peer-reviewed conference and workshop papers, with some journal papers currently under review.

BIOLITCONTEXTMINING

- ★ Coordinated by Boğaziçi University in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/102596>
- ★ Project website: <http://www.cmpe.boun.edu.tr/~ozgur/projects/biocontext.html>



“Their Interaction Network Ontology (INO) collects and classifies over 800 interaction keywords, and can also cover complex interaction types.”

Virus

Worm

Adware

Trojan
Horse

Spyware

Rootkit

Ransom
ware

SECURITY

A PROACTIVE APPROACH TO ENSURING LONG-TERM CYBERSECURITY

To address the evolving cybersecurity threat, the EU-funded SHARCS and PQCRYPTO projects are developing the security paradigms, architectures and software needed to ensure our ICT systems are secure and trustworthy.

In today's connected world, more and more of our day-to-day activities are dependent on cybersecurity. From banking to online shopping, telemedicine, mobile communication, cloud computing and the Internet of Things — society continues to put an increasing amount of sensitive and private information online.

With the always evolving threat of hacking, it is essential that the public and private sectors take a proactive approach to cybersecurity. To help accomplish this, two EU-funded projects, SHARCS (Secure Hardware-Software Architectures for Robust Computing Systems) and PQCRYPTO (Post-quantum cryptography for long-term security), are working to develop new security paradigms, architectures and software to ensure our ICT systems are secure and trustworthy.

Updated encryption methods needed

Today, most of our online information is protected via public-key algorithms

(RSA), discrete-logarithms in finite fields or elliptic curves. In practice, these systems typically provide enough variation to ensure the security of our online communications. But as society moves towards the use of large, quantum computers, the viability of these systems will become obsolete.

Flip Feng Shui demonstrates vulnerabilities

To put the severity of this threat into perspective, project-affiliated hacking experts used a new, non-software bug-based attack technique to alter the memory of cloud-hosted virtual machines. The technique, called 'Flip feng shui' (FFS), lets the attacker rent a virtual machine on the same host as the victim, allowing them to crack the virtual machine's keys or install malware without being noticed. With this attack, not only can the hacker view and leak data, they can also modify it by using a hardware glitch. As a result, the server can be ordered to install malicious and unwanted software and allow logins by unauthorised users.

In one FFS attack, researchers gained access to the host's virtual machines by weakening OpenSSH public keys with just one bit. In another attack, researchers adjusted the settings of the software management application APT by making minor changes to the URL where an APT downloads software. From here, the server could install malware that was presented as a software update.

"Project-affiliated hacking experts used a new, non-software bug-based attack technique to alter the memory of cloud-hosted virtual machines."

Mitigating tomorrow's threats today

Clearly, more work needs to be done to ensure the security of our online information. In just this one test, researchers

SECURITY

disproved the common belief that hardware bit flips have limited practical power. Armed with FFS primitives, researchers were able to mount a devastatingly powerful end-to-end attack — even in the complete absence of software vulnerabilities.

To mitigate threats such as FFS and others, there is an ongoing need for new testing methods, hardware certification and adaptations of software needs. For these reasons, the SHARCS project is designing, building and

demonstrating secure-by-design applications and services capable of achieving end-to-end security for users. At the same time, the PQCRYPTO project is working on cryptographic systems that are secure not only for today's needs, but also against the long-term attacks presented by quantum computers. Together, these projects will provide a portfolio of high-security systems capable of answering the evolving cybersecurity needs of mobile devices, cloud computing and the Internet of Things.

SHARCS / PQCRYPTO

- ★ Coordinated by Hellas in Greece / Eindhoven University of Technology in the Netherlands.
- ★ Funded under H2020-ICT.
- ★ <http://cordis.europa.eu/project/rcn/194217>
- ★ <http://cordis.europa.eu/project/rcn/194347>
- ★ SHARCS website: <http://sharcs-project.eu/>
- ★ PQCRYPTO website: <https://pqcrypto.eu.org/>

EU RESEARCHERS RAISE CONCERNS OVER PILOT FATIGUE

A new study released by the EU-funded FUTURE SKY SAFETY project has reported that half of airline pilots believe that fatigue is not taken seriously by airlines, raising questions about safety within the European aviation industry.



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The study conducted by consortium members the London School of Economics (LSE) and Eurocontrol, and in collaboration with the European Cockpit Association, is the first large-scale survey of pilots' perceptions of safety within the industry. Overall, European aviation remains an ultra-safe industry with an impressive safety record, with a low frequency of accidents and near-misses. As a result, 'safety culture', defined by the report as 'safety-related norms, values, and practices shared by groups managing risk in an organisation' has become a cornerstone of Europe's effective safety management system.

Worrying results

However, the report, which saw the participation of 7 239 pilots (14% of Europe's total commercial pilot population), raises some important questions with regards to pilots' perceptions of aviation safety. In particular, 51% of pilots surveyed reported that fatigue is not taken seriously by their airline and that 28% of pilots felt that they had insufficient numbers of staff to carry out their work safely. Even more noteworthy, less than 20% of the pilots surveyed felt that their airline cares about their personal wellbeing.

Overall though the results highlighted that perceptions of safety culture are generally positive amongst pilots. The vast majority did not feel that they have to take risks that make them feel uncomfortable about safety, and they indicated a high degree of confidence in their colleagues. Consequently, the results show that the biggest concern appears to be fatigue and understaffing and that many believe they are being pushed too far by their demanding schedules.

The survey also revealed significant differences in the pilots' assessment of safety culture depending on different factors

such as the type of airlines they work for or the type of contracts under which they operate. Pilots working under atypical contracts or for low cost and cargo airlines have more negative perceptions of safety culture than their colleagues working under more secure forms of employment and for network carrier airlines.

Recommendations for future action

Following thorough analysis of the survey results, the project researchers recommended three courses of action that should be pursued by the aviation industry in response to the findings. First, to identify the causes and potential solutions in the areas of safety culture within European aviation that were less

positively perceived by pilots, such as fatigue and management's commitment to safety. Secondly, to begin systematically measuring and exploring safety culture in commercial aviation companies as is done in other safety critical industries, such as oil and gas. Finally, the researchers urge the industry to consider opportunities for inter-organisational learning on safety culture (e.g. sharing best practice amongst organisations).

'Pilots, airlines and regulators need to begin a dialogue to understand what these results mean for industry,' commented co-author Dr Tom Reader. 'This will help to address the concerns raised by pilots and help identify what could be changed to maintain the positive safety

culture within the industry, whilst ensuring European aviation remains competitive.'

His colleague and fellow co-author, Dr Anam Parand, also said: 'Whilst our study doesn't show any cause and effect between fatigue and accidents, the potential for fatigued pilots to impact on safety is definitely a concern and that should be addressed. There have been a few accidents where one of the primary causes was implied to be that of fatigue.'

FUTURE SKY SAFETY

- ★ Coordinated by NLR in the Netherlands.
- ★ Funded under H2020-MG.
- ★ <http://cordis.europa.eu/project/rcn/193734>
- ★ Project website: <http://www.futuresky.eu/projects/safety>

ARCHITECTURE, TOOLS AND MECHANISMS FOR SECURE CLOUD COMPUTING AND ITS USE IN CRITICAL APPLICATIONS

A set of security tools, mechanisms and recommendations has been developed under techno-legal guidance to make cloud computing transparent, safer and more resilient when used in critical infrastructures and applications.

Cloud computing is facilitating knowledge exchange, new services and access to information in unprecedented ways, but this comes with security risks and challenges. The EU-funded SECCRIT (Secure cloud computing for critical infrastructure IT) project has investigated cloud-computing technologies and associated risks that affect critical infrastructure in a bid to strengthen cloud security and add resilience.

Bringing together expert institutions and organisations from Austria, Finland, Germany, Greece, Italy, Spain and the UK, the project worked on several research pillars to advance security and resilience in critical infrastructures and applications.

At the outset, the team developed a vulnerability catalogue as input for a novel risk assessment methodology, in doing so furthering risk assessment tools and contributing to European standardisation in the field. It worked on policy specification, decision and enforcement for secure data handling in the cloud, as well as a resilience framework including anomaly-detection-as-a-service.

Another important project objective was to develop tools for audit trails and root cause analysis, which involved new open-source software prototypes. The team also devised a cloud assurance profile evaluation method with proof-of-concept scripts.

The software components and tools were enhanced with security guidelines that support critical infrastructure stakeholders in using the cloud, as well as techno-legal guidance with recommendations on relevant technical and legal issues. Fulfilling the legal requirements from the very beginning of this project was a major focus, as the developed systems needed to be legally compliant for use in practice. Therefore, SECCRIT adopted a privacy-by-design approach to developing legally compliant systems.

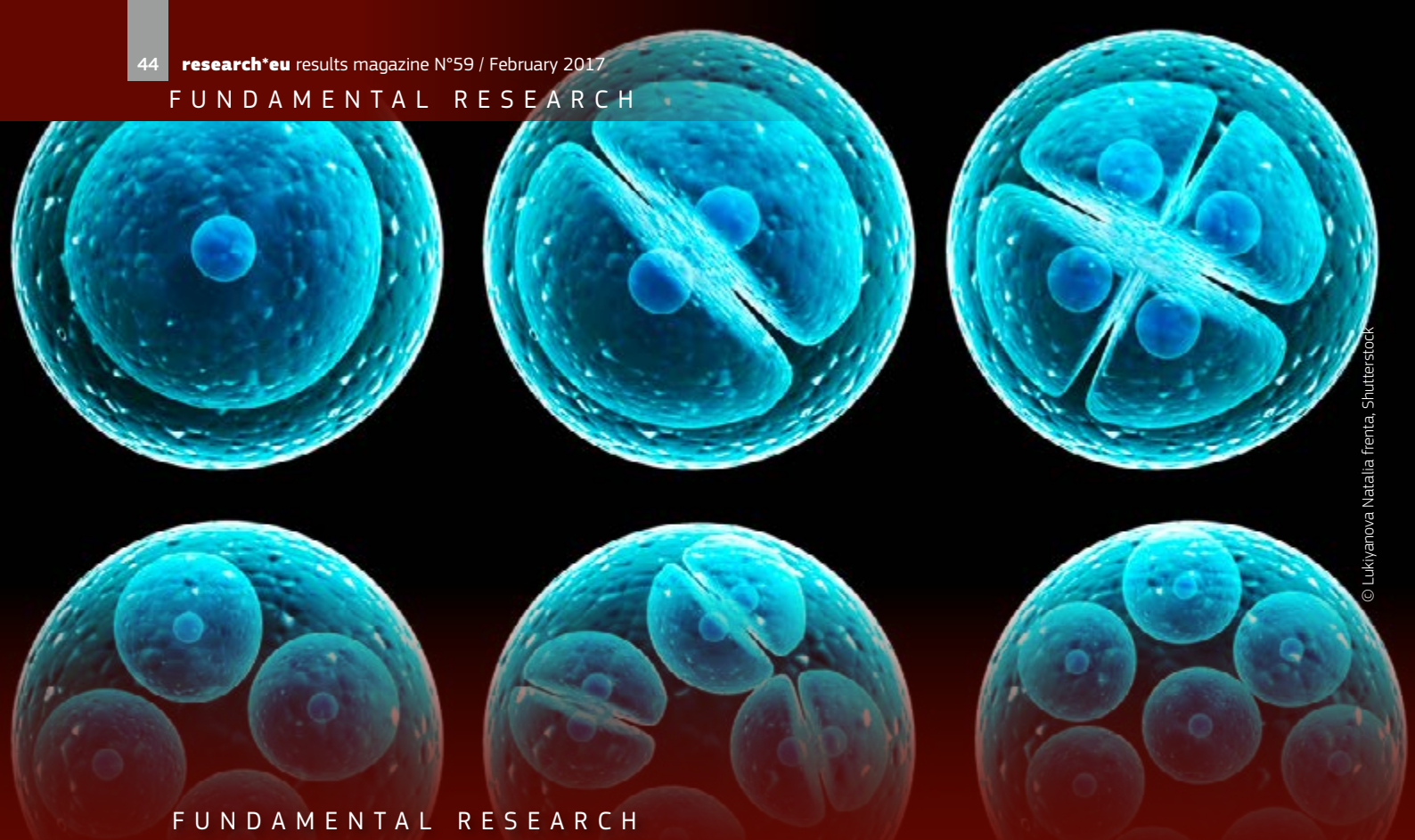


Beyond developing and testing the above tools and mechanisms, the project team produced 38 peer-reviewed scientific papers, in addition to organising four user workshops and a seminar on cloud security. The results have also contributed to student theses, lectures and follow-up projects, with plans for future commercialisation of the software tools.

Keeping the cloud secure and resilient for critical-infrastructure users will mean uninterrupted productivity and efficiency in business and industry. It will also indirectly help to promote a better standard of living for Europeans.

SECCRIT

- ★ Coordinated by AIT in Austria.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/106660>
- ★ Project website: <https://www.seccrit.eu/>
- ★ <http://bit.ly/2iL9TA4>



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FUNDAMENTAL RESEARCH

BIOCHEMICAL INSIGHT INTO CELL DIVISION

Since their discovery decades ago, we know that cells divide. However, there remain questions regarding the biochemical mechanism of cell division.

Cell division is an essential biological process that requires the concerted action of many regulators. The last step known as cytokinesis involves the equal sorting of cellular components between the daughter cells, and membrane ingression and closure. Both processes rely heavily on membrane components and properties, with membrane transport being required to relieve cortical tension during the physical separation of cells. However, the precise mechanism of membrane rearrangement remains unknown.

The primary objective of the EU-funded CHEMMEM (A chemical approach to understanding the role of membranes and membrane transport in cell division) project was to investigate the role of membrane lipids in cell division. Using mass spectrometry, they analysed the lipidome changes in dividing cells and found that only certain lipids with specific side chains accumulated at the division site.

Atomic force microscopy helped researchers analyse the mechanical properties of lipids in dividing cells and identify the lipid biosynthetic enzymes involved in division. Functional insight indicated that, during cell division, membrane lipids

had structural roles and were also involved in signal transmission. Transport of lipids and proteins in the division machinery occurred through membrane trafficking.

Intriguingly, scientists discovered that the G-protein coupled dopamine receptor D3 regulated endocytic sorting and that the clinically used drug Prazosin served as an inhibitor of endocytic sorting and cytokinesis. Although the precise mechanism warrants further investigation, the finding underscores the complexity of cell division.

Collectively, the findings of the CHEMMEM study enhanced our understanding of cell division and unveiled a new role for membrane lipids. This information will help scientists comprehend how cell division is deregulated in diseases such as cancer and drive the development of novel interventions.

CHEMMEM

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/102937>

HOW TO BUILD A PLANT

Plants are able to survive many external threats through their structure and chemistry, but there is a knowledge gap regarding the synthesis of the plant hormone auxin. Researchers have recently employed systems analysis to close this gap.

Plants have evolved developmental flexibility over time, allowing them to shape their body and metabolism to survive often hostile environments. One of these responses is to control the shape of the plant through the auxin phytohormone.

Over recent decades, researchers' understanding of auxin action and signalling has greatly improved. By contrast, the synthesis of auxin is still not fully defined in terms of the reactions and enzymes involved.

The EU-funded SYSBIOAUX (A systems biology approach to disclose auxin synthesis in plants) initiative set out to find the pathways by which auxin is synthesised in plants. The researchers used a systems biology approach on the model plant *Arabidopsis thaliana*.



SYSBIOAUX studied the cross-talk between individual pathways that are thought to create auxin and regulate it in plants. The researchers used genomics, transcriptomics and metabolomics on the *Arabidopsis thaliana* model plant to understand this process.

The project team was able to gain some insight into the genetic control of auxin synthesis. After further transcriptomic and metabolic studies, they created a model of a network of reactions that produces auxin.

SYSBIOAUX was able to find a connection between auxin synthesis and plant stress responses, closing a long-standing gap in our knowledge of how plants grow.

“SYSBIOAUX was able to find a connection between auxin synthesis and plant stress responses.”

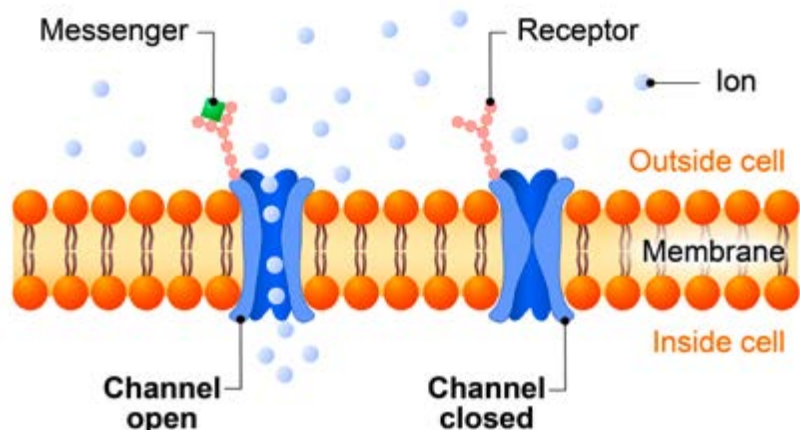
SYSBIOAUX

- ★ Coordinated by the Technical University of Madrid in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/102480>

THE TECHNOLOGICAL POTENTIAL OF ION CHANNELS

Understanding how cells respond to environmental cues represents a major challenge. European researchers have focused on how we could manipulate these responses at the molecular level in order to treat disease.

Ligand-gated ion channels' (LGIC) are specialised receptors that, in response to certain stimuli, form a transmembrane pore and allow the migration of ions between the extra- and intra-cellular space. Research over the years has resulted in the extensive characterisation of LGIC function, especially in relation to neural signalling. In contrast, there is limited information on large families of 'microbial LGICs' (m-LGICs) from a genetic and functional point of view.



To exploit the technological potential of m-LGICs, the EU-funded MIC-SN (Microbial ion channels for synthetic neurobiology) project performed systematic characterisation of their diversity. The long-term goal was to utilise them as biotechnology tools for controlling biological signals or as targets of new antimicrobial agents.

From a biotechnological perspective, m-LGICs proved unsuitable for use in mammalian cells. However, researchers successfully achieved the functional

expression of the *Arabidopsis thaliana* plant LGIC in human cells. This receptor exhibited all the desired properties that would allow for controlling mammalian nerve cells with orthogonal biomolecules.

Since aberrant LGIC signalling of nerve cells can result in prominent dysfunctions, orthogonal manipulation of neuronal electrical signals could be used to treat neurological diseases such as epilepsy. In addition, LGICs could open the door to new agents that target microbes threatening health and agriculture.

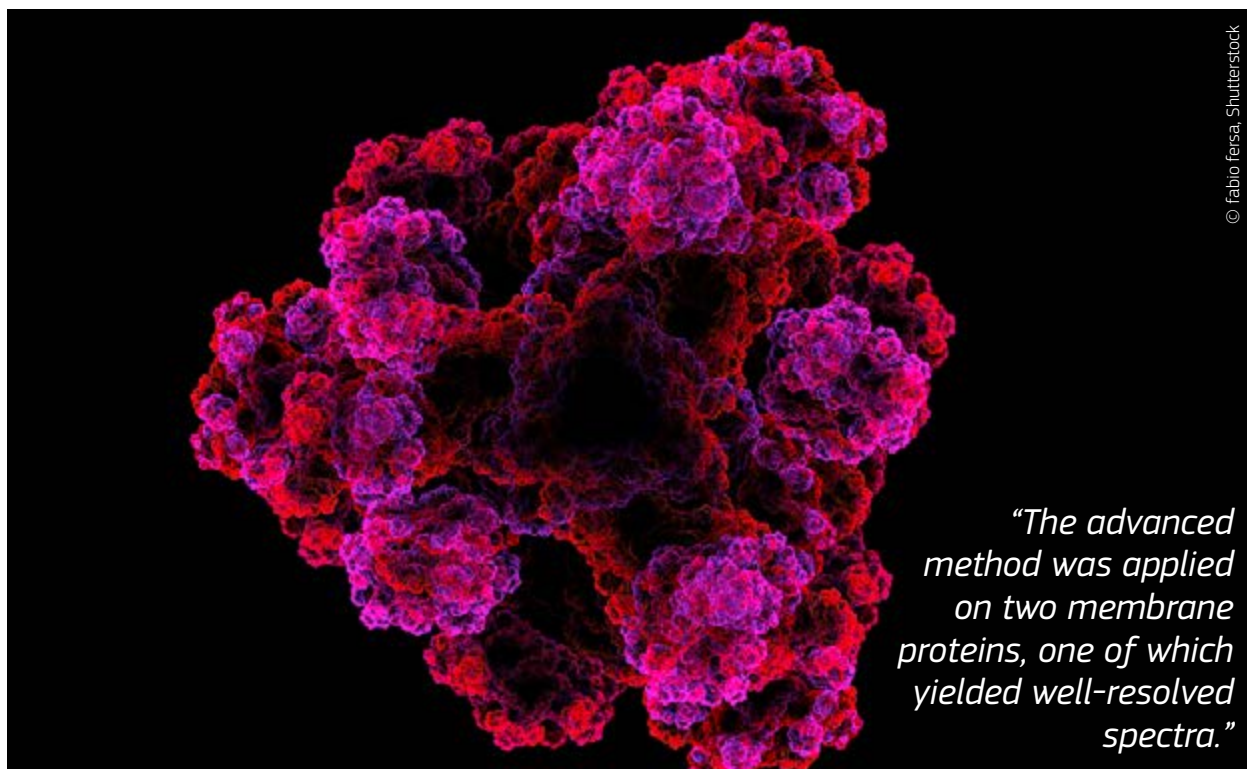
*“Researchers successfully achieved the functional expression of the *Arabidopsis thaliana* plant LGIC in human cells.”*

MIC-SN

- ★ Coordinated by the Institute of Science and Technology Austria.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/102591>

NOVEL METHODOLOGY UNVEILS MEMBRANE PROTEIN STRUCTURE

Determining protein structure is a prerequisite for understanding its function. European researchers have developed a novel spectroscopy technique for elucidating the structure of membrane proteins.



“The advanced method was applied on two membrane proteins, one of which yielded well-resolved spectra.”

Proteins are the major constituent of all living cells and play a central role in many important biological processes. Proteins located in the cell membrane are vital for mediating the entry and exit of molecules across membranes for signalling and cell adhesion. Despite their importance, there is no 3D structure information on all membrane proteins due to the difficulty in obtaining crystal structures.

The EU-funded MEM-MAS (Structure and dynamics of metal ion transporters using solid-state nuclear magnetic resonance at high field and fast magic angle spinning) project set out to develop a ‘Nuclear magnetic resonance’ (NMR) spectroscopy methodology in a bid to determine the structure of membrane proteins. The consortium managed to overcome existing bottlenecks in NMR-based structure determination and improve sensitivity and reliability, while maintaining spectral resolution.

The advanced method was applied on two membrane proteins, one of which yielded well-resolved spectra. The development of

new pulse sequences accelerated the time-consuming step of resonance assignment. Alongside the application of new instrumentation, it also allowed magic angle sample spinning. This proved particularly suitable for larger proteins with less structural homogeneity, such as the viral nucleocapsid protein.

Overall, the MEM-MAS project results are expected to revolutionise the field of structure determination by solid state NMR. Greater throughput elucidation of membrane protein structure will improve our knowledge of their function and aid in the development of new treatments for human diseases.

MEM-MAS

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186118>

EVENTS

MARCH

02

Barcelona, SPAIN

CONFERENCE

GRAPHENE FLAGSHIP WORKSHOP AT MOBILE WORLD CONGRESS

The Graphene Flagship, which receives funding from the Horizon 2020 GRAPHENECORE1 project, will be hosting a workshop at the annual Mobile World Congress that will take place in Barcelona, Spain, on 2 March 2017.

The workshop, entitled 'From Datacom to IoT, Enabled by Graphene 2017', will offer knowledge on how graphene can empower the development of information and communication technology as well as a networking platform for industry and academia.

The workshop will provide an overview on cutting edge research performed by the Graphene Flagship and the opportunity to showcase successful implementations of graphene products by key industries. More specifically, participants will learn about graphene possibilities in wireless and optical communication; wearables and flexible displays; Internet of things; and sensor systems.

For further information, please visit:
<http://graphene-flagship.eu/from-datacom-to-iot-enabled-by-graphene-2017>

MARCH

07►08

Gorica, SLOVENIA

CONFERENCE

BEWATER FINAL CONFERENCE

The EU-funded BEWATER project will host its final conference in Nova Gorica, Slovenia, from 7 to 8 March 2017.

The conference, entitled 'The River Basin Adaptation Conference', will be dedicated to sharing experiences on science-society interactions as developed within the BEWATER project and other initiatives. The conference day will include keynote speeches, presentations and interactive sessions on best practices on how to adapt river basin management to climate change, while involving society.

The River Basin Adaptation Conference will be a practice-oriented conference with a strong science base, with the aim to share experiences and identify best-practices on science-society interactions for river basin management and climate change adaptation.

There will also be a field trip on the second day of the conference.

For further information, please visit:
<http://bewaterproject.eu/events/river-basin-adaptation-conference/description>

MARCH

14►16

Meise, BELGIUM

MEETING

EU BON FINAL MEETING

The EU-funded EU BON project will be hosting its final meeting in Brussels and Meise, Belgium, from 14 to 16 March 2017.

The final meeting of the project will first take place at the Royal Belgian Institute of Natural Sciences on 14 March and will then move to Bouchout Castle, Meise, BE, for the 15 and 16 March.

The three day meeting will include a number of sessions and policy workshops on the new tools developed during the project, as well as discussions on lessons learnt throughout the project and how to advance the EU BON business plan. There will also be two dinners organised by the project to take place in local restaurants on 15 and 16 March.

For further information, please visit:
http://symposium.eubon.eu/final_meeting_2017

EVENTS

For more forthcoming events:
<http://cordis.europa.eu/events>

MAR.

28►30

Stockholm, SWEDEN

CONFERENCE

ERIFORE AT NWBC 2017

The EU-funded ERIFORE project will be presented at the 7th Nordic Wood Biorefinery Conference (NWBC 2017) that will take place in Stockholm, Sweden, from 28 to 30 March 2017.

NWBC is the leading event where research and industry meet to discuss recent wood-based biorefinery developments. The conference will cover new research results and industrial experience related to biorefining based on wood and/or on pulp mills:

- Biorefinery systems and processes
- Biorefinery products: chemicals, materials and fuels
- Economic and sustainability issues

The two-year ERIFORE project, which is developing a European roadmap for new models of research infrastructure collaborations in forest-based bioeconomy, will be presented on the final day of the conference (30 March).

For further information, please visit:
<http://www.innventia.com/nwbc2017>

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