News

No. 78

gmv INNOVATING SOLUTIONS

2021, all hail railway transport

INTERVIEW
Ramón Azuara
Deputy General Manager of Spain's national railway operator Renfe

INTELLIGENT TRANSPORTATION SYSTEMS

INNOVATIVE SOLUTIONS FOR TRANSPORTATION

At GMV we believe that behind every need, behind every problem, there is a challenge and an opportunity to innovate. GMV offers the customer the best solution, fully adapted to their own requirements and including all the necessary support.

GMV is a leading company in the design, development and deployment of Intelligent Transportation Systems (ITS) for the railway sector, offering integrated turnkey solutions and its own products for Fleet Management (***SAE-R***®), Ticketing and on-board systems (***PA & Intercomm***, CCTV, PIS).

With more than 400 clients in 35 countries on 4 continents, from Kuala Lumpur, Los Angeles, Tel Aviv, Jerusalem and Sydney to Madrid or Barcelona, our clients endorse GMV as a world leader in the design and implementation of Intelligent Transportation Systems.

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Letter from the president

Freight trains can stretch out to a length of nearly 1 km with dozens of wagons pulled by a single locomotive. This impressive pulling power explains the fascination exerted by locomotives and trains ever since the first steam trains began to revolutionize overland transport. The 19th century saw the construction of the first electric locomotives and also the first trams were built to meet big cities' increasing need of mass transit options. Nowadays, a growing awareness of pollution and climate change has given a new boost to railway transport, and many cities are running flagship tramlines as well as subway networks and local commuter trains.

Today's trains compete as a means of transport against the car and plane. For middle distance journeys, door-to-door travel often turns out to be faster with the high-speed train than flying. Spain's high speed train AVE already circulates at speeds of up to 300 kph, while the world's quickest experimental trains are nudging speeds of 600 kph. The train is also the safest and least-polluting means of transport, given a sufficient level of ridership. This is where GMV's solutions for intelligent railway transport come into their own. We work to help train- and tram-operators streamline their services and boost the attractiveness and safety of journeys, for the railway to mark the path towards a swifter, more flexible and more sustainable mobility.

Mónica Martínez

No. 78

Published
GMV

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Magazine No. 78. Second quarter of 2021

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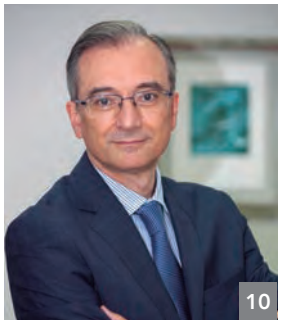
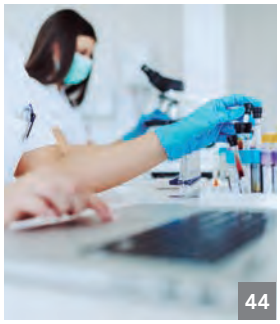




2021, all hail railway transport

The European Year of the Rail kicked off on 1 January 2021, a European Commission initiative to bring out the benefits of the railway as a safe, smart and sustainable means of transport. As well as stressing its benefits for people, the economy and the climate, however, the European Year of the Rail will also be looking at the remaining challenges to creating a single, borderless European railway.

Throughout this year various national and European railway activities will be organized to encourage its use by both the public at large and businesses, thus contributing to the European Green Deal's aim of becoming climate neutral by 2050.

29 March saw the official inauguration of European Year of the Rail 2021, a ceremony organized by the European Commission and the Portuguese presidency of the Council of the European Union.

Transport generates 25% of greenhouse gas emissions, but the railway is accountable for only 0.4% of these emissions in the European Union. Railway's CO_2 emissions per passenger are up to five times lower than the private vehicle's and up to seven times lower than the aircraft's. Much of the network has by now been electrified so the railway is the only means of transport that has slashed its emissions since 1990, highlighting its key role in sustainable tourism. Accident figures are very low too; it is in fact the safest overland transport. According to the European Commission, railway transport in Europe is on a continually upwards trend, growing by an average 1.7% p.a. since 2005.

Encouraging railway transport, therefore, is high on the agenda of all member states, including Spain, which has the boon of being able to work with the Recovery and Resilience Fund over the next 3 years. This fund has been set up by the European Union to help member states climb out of the COVID-19 slump; it represents a fine chance for the states themselves and companies within them to drive growth and improvement in various ambits, including sustainable mobility, where the railway, as already noted, is in a league of its own.

The Secretary General for Infrastructure, Sergio Vázquez Torrón, argues that now is the right time to tackle the second, CO_2-reducing modernization process, encouraging modal transfer policies within the railway and driving the digital transformation of Spain's transport system.

Organizations like the Railway Infrastructure Administration (*Administración de Infraestructuras Ferroviarias*: ADIF) boast a bulging project portfolio worth 14 billion euros in all, so it is optimistic about these already mature developments receiving funds from the European Recovery and Resilience Plan.

MAFEX, Spain's Railway Association, represents the Spanish railway industry, pooling 94 firms that account between them for 82% of Spain's railway exports. This association, of which GMV forms part, is determined to make railway transport, both passengers and freight, the backbone of national transport policies, encouraging its wider takeup and international development. To this end MAFEX has pinpointed diverse project lines and actions its partners can contribute to, representing a great chance too for the development of intelligent transportation systems (ITSs), with GMV featuring in this endeavor. These projects deal with such subjects as connectivity, communications systems, fare payments, sustainable and competitive energy, integrated platforms to help in decision making and planning (preventive and predictive maintenance), operations management and groundbreaking services, among others.

According to IP&T Center, the future development of the railway industry and railway traffic management is most likely to be based on more automated ITSs interconnected on a major railway network that taps into new technology to cut lifecycle costs. This will call for a digital transformation of the railway industry as a whole.

This is backed up by the "Diagnostic Study of New Transport Technology, its Implementation and Demand", conducted by Spain's Public Works Ministry (Ministerio de Fomento), which argues that the keys to improving the passenger service, drawing on the new technology trends, lie in all the following: ITSs that enhance the service for the occasional passenger, intermodality, onboard infotainment, ridership counting systems and bang-up-to-date fare payment systems.

Railway ITSs can be broken down into those dealing with critical services (safe train movement) and the fleet-management systems dealing with the non-critical side, where GMV's experience and expertise lie.

ITSs for critical services are based on rolling out dedicated, high-availability communication networks to facilitate communication between the driver and command post while also connecting up onboard and trackside safety systems. These systems include signaling infrastructure, such as Announcement of Signals and Automatic Braking (Anuncio de Señales y Frenado Automático: ASFA), the European Rail Traffic Management System ERTMS), Control and Regulation Centers (CRC) or Centralized Traffic Centers (CTC).

The noncritical-service ITSs are now going from strength to strength, in two main ways. Firstly, improving passenger experience, a top priority nowadays of all operators, and secondly making it easier and more efficient for the operator to run the railway. In the words of Ramón Azuara, Renfe's deputy operations manager, the rollout of the onboard communications platform, supplied by GMV on over 1500 trains of its fleet, is a crucial and ambitious project in which Renfe and GMV have always worked closely together. It is also one of the key components of ITS technology of noncritical systems in a major operator.

Non-critical operational services usually take in all systems that are useful to the operator and passenger, with diverse applications such as:

- ✓ Voice communications and messaging between drivers and the railway operator's control center.
- ✓ Direct PA from the control center to passengers.
- ✓ Direct intercom from onboard passengers to the operator's control center.

- ✓ Real-time viewing of footage from the train's passenger compartment.
- ✓ Downloading of recordings to the control center.
- ✓ Generation of alarms and reporting them to the control center.

- ✓ Remote diagnosis of train equipment.
- ✓ Passenger infotainment systems.
- ✓ Intercom and PA systems.
- ✓ Passenger information systems in station foyers and on platforms.
- ✓ Tracking, dispatch and regulation systems in the control center.
- ✓ Other non-critical safety systems such as exit-signal alert devices (the Spanish DASS system) or speed limit warnings.

To this set of ITSs must be added ticketing systems, especially station access control by means of ticket and smartcard validation, onboard validation (particularly on trams) ticket-vending machines onboard trains and in stations. The ticketing systems, drawing on the experience built up and lessons learned during the COVID 19-driven public transport crisis, are bound to benefit greatly from the European transformation and resilience aid schemes.

One of the top priorities is to cut out cash payments, digitalizing the fare-entitlement purchase and validation process. In built-up areas this boils down into EMV- and QR-enabled fare payment systems, allowing cashless cell-phone payment. In this urban environment, both on tram and metro, Account Based Ticketing (ABT) is likely to come into its own, allowing passengers to get on the train without previously having bought a ticket, sure in the knowledge of being charged the most advantageous fare for the journey made.

GMV has produced many notable inhouse developments within the abovementioned railway ITSs, boasting a portfolio of such notable customers as Spain's national operator Renfe, Morocco's national operator Office National des Chemins de Fer (ONCF) and Philippine National Railways (PNR), metro operators like Metro de Barcelona and Metro de Santiago de Chile plus rolling stock manufacturers such as Alstom, Talgo and CAF, all with important national and international projects in hand.

The short- and mid-term future of these systems will involve the progressive takeup of new services facilitated by improvements in mobile communications and internet services, with multimodal mobility systems drawing on Mobility as a Service (MaaS) applications and communication and infotainment systems for passengers with the future rollout of 5G networks.

In sum, the future railway strategy has two main thrusts: firstly, what has come to be called the "Connected Train", in which digital-communication breakthroughs, especially ITS-based, can solve railway-safety operational problems, meet passenger's connectivity demand and monitor operational parameters. And secondly, ITS-based sustainable train mobility, which is due to make a major contribution to the European Green Deal's goal of a 90% reduction in emissions by 2050.

Ramón Azuara

Deputy General Manager of Spain's national railway operator Renfe

Ramón Azuara Sánchez is currently the Deputy General Manager of Spain's national railway operator Renfe. He graduated in economics and business administration from Universidad Autónoma de Madrid, within the specialty of financing. He joined Renfe in 1983 and has worked there ever since.

During his long Renfe career he has held many posts of responsibility, including General Manager of Renfe Passengers; Information Systems and Procurement Manager; Station Innovation and Projects Manager; Planning and Commercial Manager and Customer Manager, all within Renfe's passenger business.

In his current post he is responsible for conceiving and developing new business lines and new products to boost the business and profitability of group companies and also enhance their efficiency by coordinating activities and finding synergies.

In recent years there has been an ongoing mobility revolution. How would you rate Renfe's performance here and the changes that have been brought about?

We are now witnessing a paradigm shift in the concept of private transport. Society is now increasingly beginning to seek a response to its mobility needs without having to own the means of transport concerned. Use is now outgunning ownership. This trend has engendered share transport businesses with companies like BlaBlaCar and customer-centered mobility options like the hiring of cars, bicycles, e-scooters/segways, etc, charged per minute of use.

This trend might at first sight seem to be at loggerheads with collective transport. I would argue that, in general, it is favorable, providing additional last-mile alternatives are handled properly to make sure they're complementary to long- and medium-haul public transport rather than competitive.

We at Renfe have been working for some years in the integration of other means of transport to offer passengers an origin-to-destination overview and increase their traveling options. The high-speed services, for example, have been synched with international flights, bus- and ship-lines, while also streamlining connections with other railway services.

To cement this policy we are now working on an inhouse mobility-integrating platform to offer customers what has come to be known as "mobility as a service" (MaaS). We have called this transport-integrating platform "Renfe as a service" (RaaS), offering our customers the best door-to-door, single-ticket mobility solution. We believe RaaS will mark an intermodal before-and-after in Spain.

What are the latest trends at Europe level to enhance the management, safety and quality of railway transport services?

The European railway market is undergoing a huge transformation, driven by the deregulation of passenger traffic. This liberalization, effective since last December, has been conceived as an open access model in which any eligible operator can seek access to any European infrastructure. Obligatory public services, for their part, will have to be put out to public tender as from December 2023.

To ensure an effective, competition-driven, smoothly managed and top-quality European market, it is vital to unify safety systems. This is being done under the European Rail Traffic Management System (ERTMS), which seeks Europe-wide railway line interoperability. It is a very time-consuming and costly endeavor, however, so the national safety systems will have to live alongside the interoperable system for some time yet.

As regards service quality and management, all European railway operators are working to harness the benefits of new technology, endeavoring to apply it not only in the companies' internal management systems but also, and above all, in customer attention procedures, giving them better information and new services.

Sustainability is now the buzz word in the transport sector and is especially to the fore in a low-carbon means of transport like the railway. What is Renfe's sustainability strategy?

The railway is the least polluting form of collective transport. This gives railway operators an edge over the rest. But we don't stop there;

in Renfe we're carrying out various sustainability-favoring projects as one of the main thrusts of our strategic plan. These include eco-driving systems and innovation projects for the use of new, less polluting train fuel to replace diesel, such as liquefied natural gas (LNG) or hydrogen.

A clear example of this ongoing commitment is our recent shutdown of the purchase of rolling stock for the commuting and regional train services because the tenders received for non-electrified lines were diesel- rather than new-fuel-based. This decision falls into line with the national and European bid for clean, renewable energy. Our sights are therefore set on hydrogen as the zero-pollution fuel.

We are also working on a project to set up solar power farms for generation of our own renewable energy. This ambitious project blends the two goals of more sustainability and lower costs.

The pandemic of this last year has hit all sectors hard but especially public transport. How has Renfe risen to this challenge and how does it see the post-COVID future?

The passenger transport sector has indeed been one of the hardest hit by the pandemic due to the lockdown travelling constraints. When the national lockdown was declared in March 2020, with the obligation for everyone to stay at home except for essential workers, long-haul railway journeys plunged by a historic 99% and the local commuter service by 95%. Such a swingeing fall was unprecedented and obviously had a grave knock-on effect on Renfe's results.

Our guiding light in tackling this crisis has been our overriding sense of public service, guaranteeing at all times a skeleton service despite the huge cost of keeping this up under the circumstances. We centered our efforts on guaranteeing proper sanitizing to make sure the service was safe, stepping up onboard cleansing and ventilation.

In Renfe we're carrying out various sustainability-favoring projects as one of the main thrusts of our strategic plan

We see the post-COVID future as a different scene to the one we knew before. Factors like teleworking, online meetings are going to change the demand for our services and probably reduce it, so we need to adapt ourselves to this new situation. But there will be offsetting business opportunities too. Teleworking, after all, is likely to encourage a move away from the major cities to smaller locations farther afield. While the short-haul business might well fall, therefore, medium- and long-haul are likely to rise. Academic commuting is also likely to change; universities are now tending to combine online and onsite learning. We also foresee a higher concern for sanitizing. There will inevitably be a dip in business too due to the pandemic-engendered economic downturn. We have modeled the possible behavior of demand to suit these trends and will continue to adapt ourselves as fleet-footedly as possible to any ongoing changes in the scenario from here on.

Technology is playing an ever-increasing role in mobility. How do you at Renfe see the future of mobility with the application of communication technology, IoT and Big Data?

The fourth industrial revolution or Industry 4.0 is transforming society at dizzying speed on the strength of new technology like Big Data and IoT.

Big Data, for example, now means a previously unthinkable amount of information can be processed in the form of both structured and unstructured data. One of the boons of this new information handling capacity is better customer management; the vastly increased information trawl enables us to fine tune client profiles. This will help us bring both the transport service itself and passenger information more into line with customer needs, while also tweaking prices and add-on services to suit. This technology, able to correlate such a huge amount of variables and information, will also help to improve demand forecasting.

IoT and the new telecommunications technologies are now being increasingly taken up to keep track of the state of the train and station's various systems and components. This will be conducive to better maintenance of these items and hence higher efficiency and service quality.

In general this new technology has now been taken up to a greater or lesser degree across our whole business, although there is certainly still room for future improvement. In fact, so quick is this technological trend that there is a danger of missing out on new improvement opportunities, especially in organizations as big as Renfe. For this very reason we see a better option in the innovation capability and fleet-footedness of small firms, which can carry out more specialized technology projects and solve business challenges in a shorter time. We have structured this collaboration through our TRENLAB innovation hub and startup nursery, which studies and selects candidate innovation projects of potential interest for the market as a whole and Renfe itself. After four project calls we are delighted with the results.

The purpose of initiatives of this type is twofold: firstly, to speed up the company's digital transformation and, secondly, keep up with the innovation train. We combine these initiatives with bigger technology implementation projects of more market-mature ideas.

2021 has been declared as European Year of Rail, which is expected to showcase the sector's worth. How does Renfe see this initiative and how does it plan to participate this year?

The European Year of Rail is a great chance to get across to society the sheer importance of railways as a

sustainable, smart and safe means of transport. It is indeed a fine shop window for the sector.

Various railway activities will be put on during the year to encourage railway use and contribute towards the European Green Deal goal of becoming climate neutral by 2050. Among these activities Renfe is participating in conferences and debates on this matter while also attending national and international congresses and tradefairs.

Probably the most headline-grabbing action we will be participating in this year is the European Commission's Connecting Europe Express running from Lisbon to Ljubljana.
All these initiatives will help bring home to the public at large the railway's environmental benefits and put it forward as the best and smartest transport choice. Countries like France are now taking measures to ban domestic flights where the railway offers a service taking less than 2 ½ hours. Spain has recently presented its national long-term strategy called "Spain 2050", mooting similar, railway-boosting measures.

The allocation to Spain of a large chunk of the Next Generation EU (NGEU) fund represents a great chance for all economic sectors. What particular improvement opportunities do you see for the railway and public transport?
The NGEU fund allocation proffers a huge opportunity not only to recover pre-pandemic activity levels but also to build a more solid and sustainable production scheme. Spain's Recovery, Transformation and Resilience Plan (*plan de recuperación, transformación y resiliencia*) aims to support transformation projects to help decarbonize and digitalize the transport- and building-sectors in favor of a more sustainable economic growth model.

The extraordinary allocation of over 13 billion euros for sustainable mobility projects is a great boost to the sector, especially in digitalization and innovation projects. Within railway services this aid centers on the local commuting lines, the most heavily used, and the freight service. Encouragement of railway freight transport is without doubt one of the most important thrusts of sustainable development. Structural

measures need to be taken in order to increase railway's small market share in comparison with road transport. This overall goal will be favored by the support facilities for purchasing new rolling stock and investing in interoperability and digitalization.

Renfe has expressed lively interest in a great number of projects and we are now keenly awaiting the upcoming calls and tenders. In all these projects we're open to collaboration with private companies.

Collaboration between Renfe and GMV goes back a long way, boasting a long history of technological improvements to meet users' transport needs. The roster of projects includes the onboard communication platform, Spain's Exit Signal Warning Device system (*Dispositivo de Alerta ante Señales de Salida*: DASS) and the satellite-based warning system on Renfe's fleet. Which aspects of this joint work would you take as the most significant?

Renfe and GMV indeed have a long track record of collaboration, pride of place going to the onboard communications system, which has been fitted in Renfe's whole fleet, including high-speed, local, medium-haul and freight locomotives. This adds up to over 1500 trains and locomotives, an eye-catching figure that bears out the scale and ambition of this project.

But the project was also fiendishly complex with a huge number of systems to be integrated. This has inevitably been time-consuming and the project has been longwinded with some overruns, but both parties have bent over backwards to overcome the difficulties and have managed to do so with notable success.

The boons of this project are several. The telemetry of our train's systems can now be accessed remotely,

> The NGEU fund allocation proffers a huge opportunity not only to recover pre-pandemic activity levels but also to build a more solid and sustainable production scheme

obtaining the geo-location in real time and comparing each train's actual and programmed running. Online information can be sent through the PA system and inside television screens, while footage can be received from inside the train. Many other applications represent a great leap forward in management prowess. Proper handling of all this information will enable us to enhance service quality and slash running costs.

GMV hands over a radio-aid ground inspection system to Saudi Arabia

GMV hands over to SANS, Saudi Arabia's air navigation services provider, an ***Emil*** system for ground inspection of Instrument Landing Systems (ILS) and VHF Omnidirectional Range (VOR), radio navigation aids that allow aircraft to land and fly on route, respectively

Annex 10 of the International Civil Aviation Organization (ICAO) recommends the periodic measurement of radio navigation aids by means of both ground- and flight-inspection campaigns, as specified in document 8071 (Flight inspection manual for radio navigation aids).

Emil is an automatic system developed by GMV for ground inspection of Instrument Landing System (ILS) and VHF Omnidirectional Range (VOR), radio navigation aids that allow aircraft to land and fly on route, respectively. ***Emil*** also enhances the certainty of ground inspection readings, ensuring the radio aids work properly.

Diverse international airports, including Barcelona's El Prat, have already taken up ***Emil***, slashing their radio aid calibration costs.

In autumn 2021 GMV is to hand over to SANS, Saudi Arabia's air navigation services provider, a complete radio navigation aid ground inspection system: VOR, ILS tracker and ILS path, to be set up in one of Saudi Arabia's main airports.

The system to be delivered by GMV to SANS comprises real time ***Emil*** processing and post-process result analysis software. This software calculates all the essential radio-aid checking parameters specified in ICAO's 8071 document. It will additionally provide the raw measurements for a detailed analysis in the event of any anomalies. This software is an upgrade of the system developed by GMV for Spain's air navigation services provider, ENAIRE, to automate and speed up its ground inspection procedures. The ***Emil*** software thus draws on GMV's experience and caters for all radio aid maintenance needs.

The system also includes a 2000 Kg trailer with swivel platform and 22-m mast. This component is vital for path signal ground inspection, which calls for a precise measurement above the height of 20 m. Path inspection also needs precision down to 5cm in the vertical position of the measuring antenna, obtained from an industrial wire sensor.

The system comprises too a vehicle-mounted 4-m mast for ground inspection of the VOR and tracking signal. With radio aids of this type it is necessary to know down to a precision of 25 cm the horizontal plane measuring position, obtained by means of a multi-constellation RTK GNSS.

Last but not least the system includes ILS/VOR EVSG1000 signal analyzing equipment made by R&S, which is the parameter-measuring benchmark for these radio aids.

The system to be provided by GMV to the Saudi operator will enable automation of its inspection tasks, enhancing the flexibility of measuring campaigns and facilitating ILS path measurement.

GMV investigates the impact of aeronautic GNSS receiver interference

Together with Switzerland's air navigation services provider, Skyguide, GMV has recently presented the results of the first work package of the GNSS Receiver Interference Testing (GRIT) project carried out for Eurocontrol.

This one-year project will study the effect of different types of GNSS signal vulnerabilities on a certified aeronautical GNSS receiver. These effects include deliberate or unintentional interference directed at aviation; the collateral results of other attacks, such as Personal Privacy Devices (PPDs); ionospheric effects (e.g. scintillation); multipath effects, etc.

The knowledge obtained about the effects of each one of these vulnerabilities will enable now threat detection algorithms to be defined and new mitigation techniques as well, for possible implementation in the new generation of receivers.

Another aim is to improve definition of the compulsory tests of new receivers under RTCA/EUROCAE standards to demonstrate resilience to these vulnerabilities as part of the type approval process.

For this study a simulation platform was designed and developed. The GNSS signals it emitted were then subjected to various vulnerabilities (especially interference with different signal forms and potency levels) and it was fed from different certified aeronautical receivers (CMA-3024, CMA-5024, GPS-4000S), which represent between them the typical equipment of a fleet of aircraft currently operating in Europe.

The simulation platform's advanced design enabled these receivers to be put through their paces not only in static but also dynamic conditions, i.e., throughout any aircraft's flight phase trajectories.

GMV passes on its experience in artificial intelligence applied to aeronautics

From February to April four of the seven scheduled FLY AI webinars were held, a series of online seminars organized by EUROCONTROL on behalf of the European Aviation High Level Group on Artificial Intelligence. The idea was to demystify and bring out the potential of artificial intelligence (AI) to transform European aviation, helping to speed up AI takeup in aviation sectors.

GMV, one of Europe's leading companies in applying artificial intelligence to critical aeronautics systems, took part in two of these webinars: "Research and Innovation in AI for Aviation" and "EASA AI Trustworthiness Guidance".

In the former Ricardo Sáenz, defense and security programs manager, presented the main defense R&D initiatives, highlighting the cooperation programs of the European Defense Agency (EDA), the European Commission's PADR and EDIDP initiatives, and the future FCAS fighter project. The webinar also dealt with the main technical challenges to be met by defense AID, in both manned and unmanned systems.

In the latter Eugenio Sillero, head of defense and security projects, presented the first results of the SAFETERM project as well as an approximation of the workflow to bring it into line with future certification requirements of AI-based aeronautical systems. In this project GMV is looking into the use of artificial intelligence to allow an unmanned aircraft to decide on its own where to land in the event of any emergency, minimizing the risk to people.

Enter SATNUS Technologies SL, to develop new technology for unmanned vehicles of the European FCAS

GMV, SENER Aeroespacial and TECNOBIT-GRUPO OESIA have set up, in coordination with the Spanish MoD, the company SATNUS Technologies, S.L. to coordinate all activities of the remote carriers technology pillar, led in Spain by the 3 companies in a consortium.

The setting up of SATNUS Technologies, S.L. reaffirms the commitment of GMV, SENER Aeroespacial and TECNOBIT- GRUPO OESÍA to FCAS, through the Next Generation Weapon System (NGWS). The 3 companies thus set out to drive national participation in this important remote carriers technology pillar, bringing out the capability of Spanish engineering and the full potential of Spain's industry.

This pillar focuses on the development of new technologies and assessment of new UAV concepts, opening the door for development of disruptive technology affording benefits to Spain's industrial technological base as a whole. It will have a particularly beneficial knock-on effect on research technology centers due to the dual military-civil nature of many of the pillar's research initiatives.

The three companies pool a wide range of technological expertise in the areas of aeronautics, space, defense and security, bringing this experience to bear on major international and Spanish MoD programs. Within the remote carriers pillar the three companies are coordinating the industrial team and Spanish technological team designated by the Directorate General of Armaments and Material (Dirección General de Armamento y Material).

The creation of SATNUS Technologies S.L. coincides with the recent announcement by the Spanish MoD of the agreement reached by the three participating countries (Germany, Spain and France) to tackle the next phase of the European FCAS defense program. Under this agreement Spain's industry will have an equivalent weight to that of Germany and France, representing an unprecedented participation and effort in Europe's aerospace industry.

GMV rounds out its participation in the FCAS program with direct participation in other FCAS technology pillars, inputting technological developments in activities where it has already proved its mettle as a worldwide benchmark, such as avionics, navigation and artificial intelligence.

GMV features at GNC 2021 & ICATT 2021

GMV was present at the 11th International ESA Conference on Guidance, Navigation & Control System (GNC 2021), held virtually from 21 to 25 June jointly with the International Conference on Astrodynamics Tools and Techniques (ICATT).

The conference, targeted mainly at international participants of the aerospace industry, equipment manufacturers and space agencies, represents a great chance for promoting guidance, navigation and control (GNC) activities, getting to know new clients and encouraging cooperation looking ahead to the future.

GMV is European number-one in GNC systems and a pioneer at world level in exploration missions to both planets and asteroids. European projects primed by GMV in this area include HERA, AIM, Marco POLO, Neoshield2, SYSNOVA-BEAST and Rosetta.

In keeping with this leadership, GMV featured prominently at the conference, presenting a total of 9 papers. These ran through some of the projects GMV is currently working on, like HERA, for planetary defense; HERACLES, a robotic moon mission that will mark out the path to follow for future planetary exploration; and Mars Sample Return, a Martian exploration mission. Other GNC projects looked at included space robotics, SST for object detection or ADR for active debris removal, like GUIBEAR, RACE or COMRADE.

GMV supplies the ground segment of Hispasat's new generation of satellites

The awarded contract was won on the strength of GMV's vast experience in supplying systems of this type based on GMV's inhouse line of operational products

"Amazonas Nexus will strengthen Hispasat's position in the booming air- and sea-mobility markets and will also help to close Latin America's digital gap. Agreements reached for supply of its ground segment builds on our tried-and-tested business relationship with GMV, with whom we have been working successfully for three decades now".

Miguel Ángel Panduro
Hispasat's CEO

"This new contract will forge even closer bonds between GMV and Hispasat, a relationship now dating back to 1991. We're delighted to see Hispasat turning once more to GMV's experience for the control of its new generation of satellites, including new areas of collaboration".

Jorge Potti
GMV's general manager of Space

GMV has signed a series of ground-segment supply contracts for Hispasat's Amazonas Nexus satellite, which will replace Amazonas 2 in the orbital position 61º West and enhance its forerunner's capabilities. The contract as a whole includes supply of the control center and flight dynamics system, a new ground station in Río de Janeiro for the Amazonas Nexus satellite, a new satellite tracking system and sundry ground equipment, plus a new control and management system for all Hispasat's ground stations.

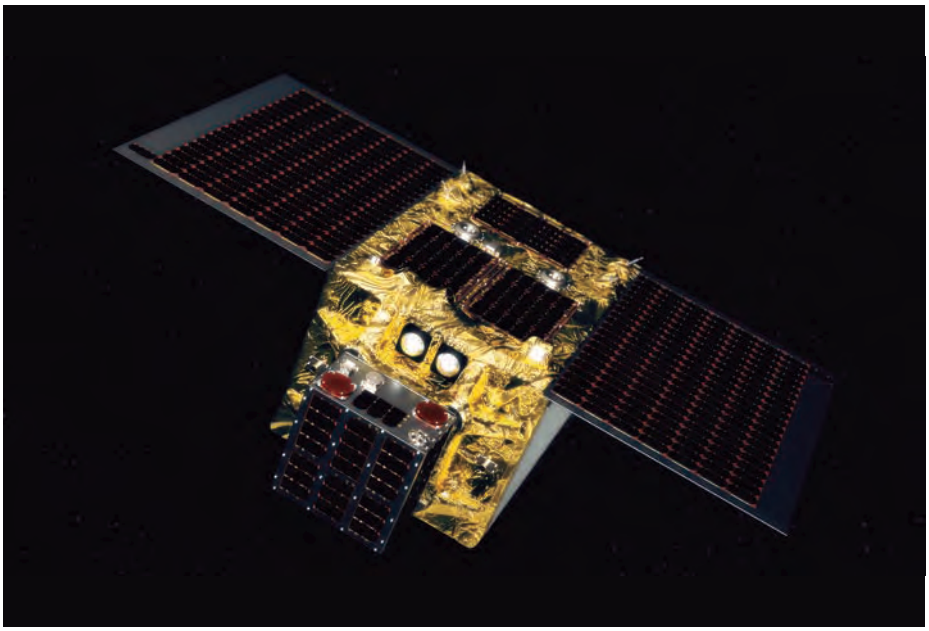
Amazonas Nexus ushers in a new generation of Hispasat satellites and will open up new markets and win new clients, providing high-capability air- and sea-transport mobility services, among others. It will continue to cater for Hispasat's current Amazonas 2 clients. The new upgraded satellite will give coverage to the whole American continent plus the north and south Atlantic corridors (areas of busy air- and sea-traffic) and Greenland, providing state-of-the-art Ku-band telecommunication services. It also includes Ka band capability to streamline gateway-satellite communications. This will multiply the total onboard capability available for commercial use while also fine-tuning capability unit cost in comparison with traditional satellites.

The recently awarded contract was won on the strength of GMV's vast experience in supplying systems of this type based on GMV's inhouse line of operational products. Pride of place here goes to the real-time telemetry and telecommand processing product ***Hifly*** and the flight dynamics system ***FocusSuite***. Other GMV products will also be supplied, like ***Magnet*** for management and control of ground stations.

As well as setting up a new ground station, the contract also takes in new control centers in Arganda del Rey, Tres Cantos, Maspalomas and Río de Janeiro to cater for a new network of timing and frequency reference generating equipment plus integration of new baseband equipment.

Hispasat, one of GMV's marquee clients, is already using a GMV-supplied control center and flight-dynamics system for controlling its existing fleet (Amazonas 2, 3, 5 and Hispasat 30W-5, 30W-6, 36W-1 and 74W-1).

Successful launch of the ELSA-d mission



On 22 March Elsa-d (End-of- Life Service by Astroscale) was successfully launched atop a Soyuz rocket from Baikonur cosmodrome in Kazakhstan.

ELSA-d is a service-demonstration mission for end-of-life services. The mission comprises two satellites, an active, controlled spacecraft called "Servicer", which rendezvous, docks or captures, and another spacecraft or simulated space debris satellite called the "Client". The Servicer is equipped with optical sensing instruments for rendezvous operations and a capture mechanism, while the Client is fitted with a magnetic docking plate to facilitate identification, rendezvous and capture procedures.

Within the mission's ground segment GMV has provided the In-orbit Servicing Control Centre at Satellite Applications Catapult with the mission planning system and flight dynamics system, based on its inhouse solutions ***Flexplan*** and ***Focussuite***.

Elsa-d's aim is to demonstrate the Servicer's capacity to approach and capture end-of-life satellites. Once the Client has been captured, the Servicer will shift it into a safe parking orbit or launch it into the atmosphere to burn it up. This will avoid the buildup of space debris from end-of-life space missions.

If the demonstration mission is successful, Astroscale will offer commercial and institutional operators these debris capture services for their spacecraft, reusing the ground segment developed for the demonstration mission. This will present the opportunity for ***Flexplan*** and ***FocusSuite*** to be part of Astroscale's future space debris capture missions.

Validation of the FDS for Inmarsat's I-6 F1 and I-6 F2 satellites

GMV has developed and now validated ***FocusSuite***, the world's most advanced and widely used flight dynamics system, for the sixth generation of Inmarsat satellites (I-6).

This system boasts important technological and cybersecurity advances. A new web interface, for example, has been developed to modernize and improve the user experience. GMV has also created a new highly versatile computational system capable of controlling not only geostationary missions such as I-6 F1 and F2, but also other types of missions ranging from low- and medium-orbit to high and very eccentric orbits. ***FocusSuite***, moreover, can be configured not only to control a conventional satellite fleet but also major constellations. All these upgrades have been designed to comply with the strictest cybersecurity standards, minimizing IT security risks and vulnerabilities.

The Inmarsat-6 satellites, developed by Airbus Defence and Space, are based on a variant of the Eurostar platform's E3000 Mk2, using electric propulsion and steerable thrusters both in the launch and early orbit phases and in nominal operations.

Inmarsat PLC, a telecommunications-satellite company based in London, provides worldwide mobile services by means of thirteen geostationary telecommunications satellites. I-6 F1 and I-6 F2, the two satellites of this mission, scheduled for launch in 2020 and 2021 respectively, aim to improve Global Xpress services in L and Ka bands.

The I-6 mission will endow Inmarsat with a whole new generation of 5G capabilities, providing worldwide mobile communications services. In this context of new technological challenges, Inmarsat has turned to GMV and its advanced flight dynamics system ***FocusSuite*** for improving and personalizing its satellite operations with the highest possible degree of reliability, safety and automation.

GMV supplies operations centre for the new generation of Yahsat satellites

GMV provides the United Arab Emirates company Yahsat with the control center and flight dynamics system of its sixth satellite, Thuraya 4 NGS, a state-of-the-art L band system

GMV, the world's number one supplier of satellite control systems, has signed a new contract with the UAE-based Al Yah Satellite Communications Company (Yahsat) to supply the control centre and flight dynamics system for the operator's sixth satellite - Thuraya 4 NGS, a next generation L-band system slated for operations in 2024.

Thuraya 4-NGS will lead the continued advancement of Yahsat's mobile satcom business through its subsidiary — Thuraya— in core markets. It will enable next generation mobility solutions with higher capabilities and flexibility, while increasing capacity and coverage across Europe, Africa, Central Asia and the Middle East.

Yahsat is one of GMV's flagship clients. It is now using the company's flight dynamics systems and mission planning system, rolled out by GMV for the control of all the satellites of the Al Yah family (Al Yah 1, 2 and 3).

The recently awarded contract has been won on the strength of GMV's wealth of experience in providing systems of this type, grafting them on to the existing product line. Pride of place here goes to the real-time telemetry and telecommand processing system ***Hifly*** and the flight dynamics system ***FocusSuite***. The contract also takes in the provision of other inhouse GMV fleet-control products like ***Flyplan***, dealing with operations planning and automation. GMV will also see to the deployment and integration of the center, as well as system maintenance and operator training.

GMV makes headway in groundbreaking passive satellite tracking techniques

In the second half of 2020 GMV carried out a project for the Spanish Industrial Technology Development Center (*Centro para el Desarrollo Tecnológico Industrial*: CDTI). The idea of the project was to analyze passive satellite tracking techniques to gauge their applicability to GEO space surveillance and tracking systems and especially the Spanish Space Surveillance and Tracking System (S3T) under the umbrella of the European Space Surveillance and Tracking System (EUSST).

This technique means that satellites emitting an active communication signal can now be tracked. This active signal is simultaneously received by a suitably deployed network of receiving antenna, making it possible to determine with great precision and in near real time the emitting satellite's orbit while also detecting and estimating its maneuvers.

Under this EUSST-consortium H2020-funded project, GMV has carried out a feasibility study for CDTI and has specified and designed this system for providing S3T with data to enhance the in-orbit collision avoidance services currently rendered by S3T's Operating Center (S3TOC) for dozens of European operators and several hundred satellites. GMV has also developed for CDTI a prototype that simulates the whole system and its data-processing chain.

Due to the interest of this technique for space surveillance applications, in which GMV is European leader, and to keep this activity going into the future, GMV initiated in 2021 the development of an inhouse passive satellite tracking system called ***Focusear***. This system will provide data and services not only for space surveillance systems but also to support orbit determination activities. The first tests of this system are now being conducted on GMV's Tres Cantos site in Madrid. Additional antennae will be deployed in other GMV offices in Spain (Seville, Valladolid and Barcelona) to provide an operational service.

This project has received funding from the European Union's innovation and research program H2020 under the contract GA No. 785257

GMV re-elected to the vice-presidency of TEDAE's Space Committee

On 7 May the General Assembly of the Spanish Association of Technological Defense, Security, Aeronautics and Space Companies (*Asociación Española de Empresas Tecnológicas de Defensa, Seguridad, Aeronáutica y Espacio*: TEDAE) was held to renew, pursuant to its standing orders, the governing board as well as the vice-presidencies of the committees of aeronautics, defense and space. GMV was elected to run the Space sector, an executive post held by GMV's space manager Jorge Potti since 2016, while Manuel Pérez, GMV's defense and security manager, was elected as member of TEDAE's governing board.

The governing board (*Junta Directiva*) is TEDAE's collegiate management body acting under the aegis of the general assembly. It is made up by TEDAE's president; the sector vice-presidents; a minimum of fourteen (14) members, which must be associated firms; and TEDAE's secretary. For the next three years (2021-2024) the board will be made up by: Aciturri Aeronáutica, Aernnova Aerospace, Airbus, Escribano Mechanical and Engineering, Eropavia España, Centum Solutions, Santa Bárbara Sistemas, GMV, Indra Sistemas, ITP Sistemas, ITP Aero, Navantia, Saes and Tecnobit.

TEDAE comprises 90 Spanish space-, aeronautics-, defense- and security-firms. According to 2019 figures, these companies' aggregate turnover adds up to 13.04 billion euros; they export 71% of their products and services, account for 1% of Spain's gross domestic product, generate 57,600 highly-skilled jobs and plow back 9% of their earnings into R&D.

GMV to upgrade the GSSAC Mission System for German Space Agency at DLR

The project, forming part of EU SST's data processing activities under the mandate of the German Space Agency, aims to upgrade the mission system of the German Space Situational Awareness Centre (GSSAC)

GMV, European industrial leader in Space Situational Awareness (SSA) and Space Surveillance and Tracking (SST), has been awarded by a new contract by the German Space Agency at DLR for maintenance and upgrade of the Mission System of the German Space Situational Awareness Centre (GSSAC), located in Uedem, Germany.

In order to foster the development of an SST capability in Europe, the EU established in 2014 (through decision No. 541/2014/EU of the European Parliament and of the Council of 16 April 2014) a Framework for Space Surveillance and Tracking Support. The aim of this Support Framework is to develop an independent SSA/SST capability in Europe by EU SST. Since then, the incipient national SST capabilities in the countries within the so-called EU SST consortium (Germany, France, UK, Italy and Spain since 2016 and also Poland, Romania and Portugal since 2019, the UK left the consortium in 2021 post Brexit) have been federated in a coordinated manner; EU SatCen acts as front desk for the SST services provided by the EU SST consortium.

This new project is part of data processing activities within EU SST under German Space Agency's responsibility. Its main objective is to maintain and upgrade the GSSAC Mission System in order to meet future requirements of an advanced framework regarding performance and scalability, based on GMV's experience and capabilities in the field.

Both German (Munich and Darmstadt) and Spanish (Madrid) branches of GMV will be involved in the activity, working with teams located in Darmstadt and Madrid. GMV leads EU SST contracts in 5 countries (Spain, France, Germany, Poland and Romania) and counts on additional capabilities and contracts in the UK in the SST domain.

GMV presents the results of the BEWATS project

On 28 May a meeting was held to present the results of the Beach Waste Tracking System (BEWATS) project, which is looking for effective beach-litter cleaning mechanisms, doing so by applying current and tide models to predict waste origin and end points; it is also using satellite images to detect plastic marine litter. GMV is taking part in BEWATS in collaboration with Vigo University and the Mathematical Sciences Institute (ICMAT) of Spain's Higher Council for Scientific Research (*Consejo Superior de Investigaciones Científicas*: CSIC).

The project has centered on Galicia, in the Rias of Vigo and Pontevedra, including the National Park of the Atlantic Islands of Galicia. Four experiments were held in which GMV has applied and successfully validated its groundbreaking earth-observation-data analysis and processing method. The validation procedure involved "targets" of different sizes and types of plastic set up along the coast by the research group of Vigo University's AtlantTIC Center. GMV's satellite-image processing algorithm was able to pinpoint, classify and quantify possible marine litter. To do so GMV used images taken from the Sentinel-2 satellites (with a spatial resolution of between 10 and 20 meters) provided by Copernicus Open Access, combined with machine learning techniques drawing from dynamic marine models.

During the meeting Vigo University's I-MARK group presented the results of the SWOT analysis (strengths, weakness, opportunities and threats) and the market study on the possible commercial application of the developed technology, which threw up very promising results for potential clients of the public sector.

Those present included the Spanish Marine Litter Association (*Asociación Española de Basuras Marinas*), the Zero Waste Association (*Asociación Vertidos Cero*), the Irish Centre for High-End Computing (ICHEC), CETMAR, the Balearic Island Coastal Observing and Forecasting System (SOCIB), Universidad Politécnica de Valencia (UPV) and the Spanish Oceanographic Institute (*Instituto Español de Oceanografía*).

BEWATS has been funded by the Programa Pleamar of the Biodiversity Foundation (*Fundación Biodiversidad*) of Spain's Ministry for the Ecological Transition and Demographic Challenge (*Ministerio para la Transición Ecológica y el Reto Demográfico*).

Use and application of satellite data to fend off climate change

On 22 April, Earth Day, GMV held the webinar "Earth Day 2021. How Satellite information supports restoring our damaged earth".

GMV has a long track record of service provision under the earth observation program Copernicus and is also participating in important environmental, emergency and security projects.

GMV talked about various projects in which it has been involved, analyzing key issues such as the support of sustainable forestry and of countries' pursuit of the sustainable development goals and their efforts in the monitoring of extreme hydrological events or the detection of plastic litter in the sea.

FirEURisk kicks off, a project to improve the management of forest fires

FirEURisk is a Horizon 2020 project designed to develop, test, and disseminate an integrated and science-based strategy for wildfire risk management in Europe

Wildfires are a major risk to forests, affecting the ecological balance and health. The COVID-19 pandemic has prevented winter biomass clearance, while as heavy snowfalls have added tons of dead litter to the understory, increasing the danger of fire ignition in the next wildfire season.

In this regard, the Horizon-2020 FirEURisk project was launched last April 1st, geared to develop, test, and disseminate an Integrated and Science-Based Strategy for wildfire risk management in Europe. It focuses on developing strategies for fire risk assessment, reduction, and adaptation to future fire regimes.

The Portuguese Association for the Development of Industrial Aerodynamics (ADAI) leads a multidisciplinary consortium of 39 partner institutions from 19 countries, that seeks a paradigmatic shift on wildfire management, developing appropriate solutions and services, and gaining knowledge to address the open challenges linked to current and predicted wildfire conditions in Europe in the coming decades.

GMV leads the assessment of cascading effects from fires such as soil erosion and landslides from bare and fragile soils, ecosystem degradation, flooding, and air pollution; and intertwined effects with other risks such as windstorms, drought, biotic disturbances, and forest mortality.

GMV also coordinates the demonstration of products developed at local scales in 5 regional Pilot Sites across Europe, which will showcase the scalability of the proposed solutions.

The expected results of the project aim at reducing the negative effects associated with fires such as human casualties (morbidity and mortality), loss of wildlife, cultural and economic losses, and social disruption because of major infrastructure damage and deterioration of natural capital.

Results will be produced during 4 years with a budget of 10 million euros. FirEURisk is funded by the European Commission's H2020 framework program under grant agreement number 101003890.

MED-GOLD Living Lab 2021

After the first MED-GOLD Living Lab held back in 2020, the second was held from 27 May to 24 June. Falling under the umbrella European Project MED-GOLD, the event is aimed at early career scientists and professionals in the areas of climate science, agriculture, business strategy, social sciences and communication.

This year it presented the latest methodologies for coproduction of climate service prototypes with end users.

MED-GOLD, a European-Union, Horizon-2020 (H2020) initiative, is run by a consortium that includes GMV. MED-GOLD's aim is to show climate information's added value for agriculture, especially as an aid in decision-making; it encourages the creation of adapted and highly specialized services based on seasonal, decennial or even longer term climate forecasts, taking into account the present and future environmental context.

Throughout the four weeks online speakers dealt with different disciplines involved in the development and implementation of climate services in the farming sector.

Participants were able to work in multidisciplinary teams mentored by MED-GOLD scientists to learn about the concepts and methodologies employed to develop climate services and familiarize themselves with climate data and available tools through the Copernicus Climate Data Store (CDS) and the MED-GOLD project.

GMV develops the BIOMASS operational simulator

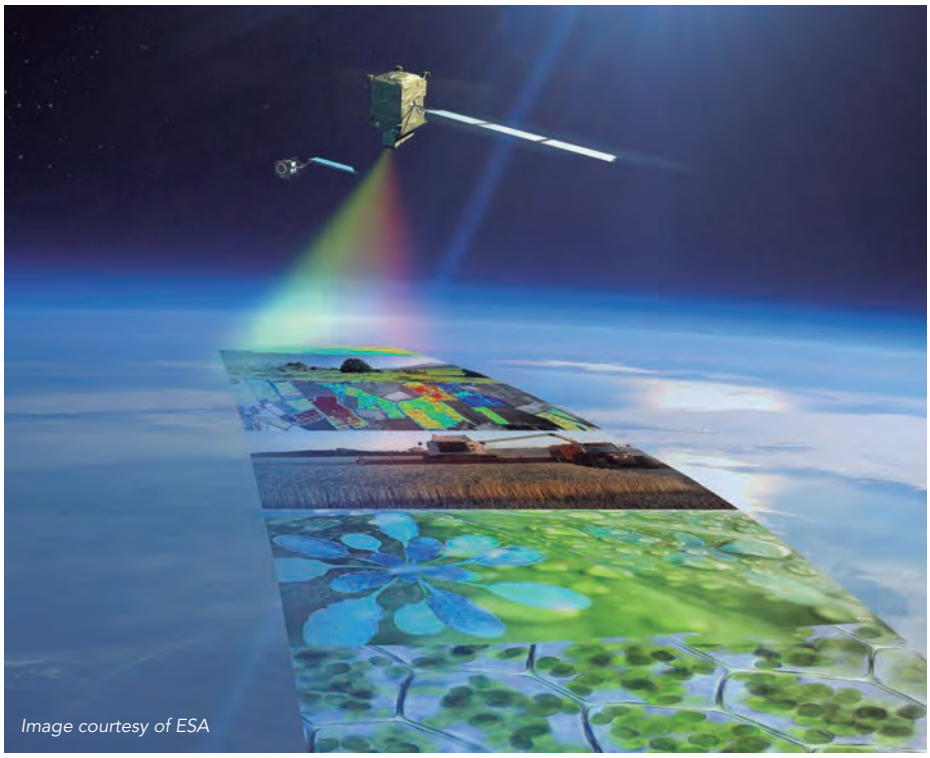


Image courtesy of ESA

ESA's European Space Operations Centre (ESOC) has recently awarded GMV the contract for development of BIOSIM, the operational simulator of the BIOMASS´Earth Explorer mission.

ESA's Earth Explorer missions provide crucial insights for a better understanding of our planet. The Explorers are research missions designed to address key scientific challenges, focusing on the atmosphere, biosphere, hydrosphere, cryosphere to ascertain the interactions between these components and the impact of human activities on the Earth's processes.

BIOMASS, the 7th ESA Earth Explore mission, aims to reduce uncertainty about the worldwide spatial distribution and dynamics of forest biomass in order to improve current assessments and future projections of the global carbon cycle. The scientific objectives of the BIOMASS mission will address a fundamental gap in our understanding about the status and dynamics of Earth forests.

BIOSIM simulator will be used by ESA for mission control system and facilities testing, as well as for validation of the ground segment and of the operational (nominal and contingency) procedures, as well as for the training of operations staff.

BIOSIM technology is based on the ESA SIMULUS infrastructure. It includes the ESA LEON3 emulator where the satellite's actual OBSW is executed. Functional models of all the S/C components, and the Ground Stations Network are then implemented on top of this infrastructure.

GMV is one of ESOC's main Operational Simulator providers, particularly in the Earth Observation Program. The list of simulators already developed by GMV for ESOC includes Sentinel-1 A/B/C/D, Sentinel-5p, Earth Care, and now BIOMASS.

BIOMASS, with an operational lifetime 5 years, is scheduled for launching in 2023 from Kourou, using a Vega launcher.

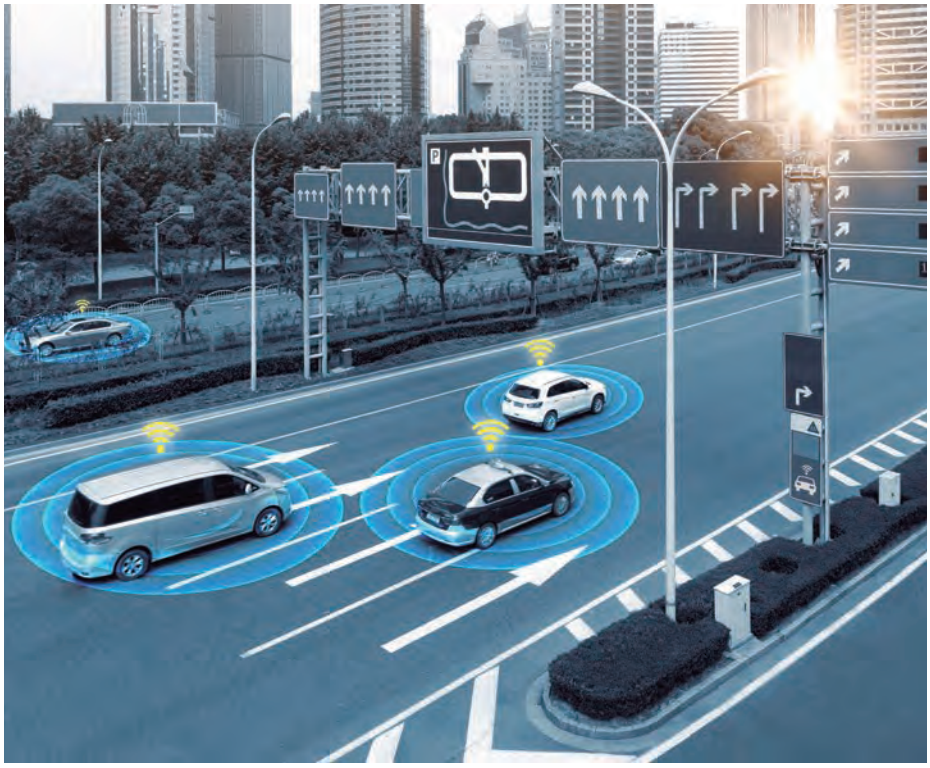
GMV at the core of the Galileo High Accuracy Service

GMV has been awarded by the European Union Agency for the Space Programme (EUSPA) with the contract for the implementation of the Galileo High Accuracy Data Generator (HADG), which will be the facility in charge of generating the high-accuracy corrections data to enable the provision of the Galileo High Accuracy Initial Service (HAS).

The purpose of the HADG is to ensure the continuous provision of HAS data with a proper rate, accuracy, availability, continuity and latency. The data will encompass orbit and clock corrections, biases, quality indicators and service parameters.

The HADG contract addresses a key infrastructure development in under the Galileo program. The Galileo HAS, after all, together with the Open Service Authentication (OSNMA) and the Commercial Authentication Service (CAS), is one of Galileo's standout services, setting it apart from other GNSSs like GPS or GLONASS.

GMV, as leader of the project will be responsible for core project activities such as the provision of the algorithms for the computation of the high-accuracy corrections, which



rely on GMV's ***MagicPPP*** SW suite for Precise Point Positioning.

The project has now reached the system qualification phase, involving the necessary validation activities ahead of the initial declaration of the coming into service of HAS, scheduled for 2022. This will be a significant Galileo milestone, ushering in a new era for advanced GNSS in Europe.

GMV's leading role of in the Galileo High-Accuracy Service is the culmination of a long race and the result of R&D investment made by GMV in pursuit of cutting-edge GNSS high-accuracy solutions. GMV presented the first version of ***MagicGNSS*** in 2008, and it is now the core element selected to leverage Galileo HAS to the most advanced position within the public GNSS systems.

GMV joins Women in Aerospace Europe

GMV has recently joined Women in Aerospace Europe (WIA-E) as a corporate member. WIA-E, founded by Simonetta Di Pippo and Claudia Kessler in 2009, is a not-for-profit that is dedicated to increasing the leadership capabilities and visibility of women in the aerospace community.

By now it has become the sector's flagship professional association, brokering initiatives to whip up interest in this sector, especially among the new generations. GMV supports this association together with other members like ESA, ASI, EUMETSAT, CNES, GSA and DLR.

The association pursues its goals through local groups distributed throughout Europe's cities. These groups lever WIA-E's actions, helping its members to take an active onsite part in networking and training activities and conferences, etc.

In March a local WIA group was set up in Madrid, on the strength of an initiative driven by nearly 50 representatives, both men and women, from diverse space companies and institutions, including GMV, CDTI, INTA, Isdefe and TEDAE.

The Madrid local group's remit takes in the promotion of space-based applications and services such as help in fighting climate change, improving emergency response, boosting security, advancing communications and optimizing transport. It will be paying special attention to education and the promotion of STEM careers.

Blastoff of a new ISS expedition

On 23 April Crew-2 Dragon, the second operational mission of NASA's commercial crew program and the 65th long term expedition to the ISS, blasted off for the International Space Station. (ISS).

Supporting ESA and DLR, GMV forms part of the Columbus Control Center, working in the Flight Control, Ground Control and Ground System teams. It is also working in the Training team of the European Astronauts Center and in the Mission coordination team of Houston's Mission Control Center. About 20 colleagues are involved in this ESA mission

ISS construction work began in 1998. This project would not have been possible without international collaboration; the EU in particular contributed with crucial engineering work, especially on the Columbus module, a scientific-research module attached since 2008 to Harmony.

As well as taking part in the Columbus preparation phase, GMV also had a hand in the design, development and integration of the control center of the German Space Agency (DLR) in Oberpfaffenhofen. In 2008 it joined the ground- and flight-operations teams, supporting the day-to-day monitoring and the configuration of the Columbus module it-self.

GMV develops a new maritime Galileo receiver

Vessel Bridge. Photo: Meyer Werft

Under the Advanced Shipborne Galileo Receiver Double Frequency (ASGARD) project the technology multinational GMV is collaborating with the defence and security company Saab, to develop a new civil, legislation-compliant, Galileo-signal-using maritime receiver. Co-funded by EUSPA (former GSA), ASGARD aims to boost Galileo take up in maritime transport by developing shipborne e-GNSS (European GNSS) data-processing receivers.

In the transport sector as a whole a growing number of regulations enforce GNSS use. Maritime transport is no exception; it is now bound to fit a Positioning, Navigation and Timing (PNT) system that is interoperable in any part of the world. PNT systems are now an obligation in many maritime activities; countries are therefore bound to provide this service for the community and maritime traffic, as a navigation aid in keeping with international recommendations and regulations. Satellite navigation can therefore boost the efficiency, safety and optimization of maritime transport. Galileo and EGNOS, the European Union satellite systems, are making priceless inputs here, with applications taking in all the following: port operations and navigation, localization of spills, improved control of maritime traffic, localization of catastrophes, maritime rescue, ship tracking, improved logistics, ship port approaches, automation and more efficient port dredging.

The development of shipborne multi-system radio-navigation receivers (MSR) is now taking a new approach, aiming to provide resilient PNT to improve safety and navigation efficiency. The MSR covers all the shipborne navigation systems and equipment that apply or provide PNT and associated integrity and state information. It calls for support of at least two independent radio-navigation systems; this offers a chance to encourage the use and take-up of e-GNSS (both Galileo and EGNOS) in maritime equipment.

In this context GMV and Saab will be developing a double frequency multi-constellation maritime receiver navigation system (capable of receiving signals simultaneously from Galileo and other satellite positioning systems) complying with European and international legislation, with the unique ability to provide an additional layer of system safety using Galileo's Open Service-Network Message Authentication (OS-NMA). Galileo OS-NMA provides digital signatures of the Galileo Open Service Navigation Messages. It gives the mean for Galileo OS-MNA capable receivers to verify Galileo navigation data received is coming from a Galileo satellite and has not been falsified/spoofed. This verification method provides the Galileo constellation with strong protection, turning it into a more secure and solid GNSS.

The new maritime receiver represents a new generation of GMV's Galileo receivers and will be integrated into a Saab navigation system in a format that is already well known by the maritime industry. The receiver will be tested according to the requirements of the European Maritime Equipment Directive for GNSS receivers. It will additionally be exposed to sophisticated spoofing tests, before being put through a shipborne field test campaign. In addition to coordinating the project GMV will also be responsible for the analysis and consolidation of ASGARD equipment requirements for maritime navigation and its design, implementation and validation.

This action has received funding from the European Union under grant GSA/GRANT/02/2019/ASGARD

GMV supplies Galileo Second Generation Radio Frequency Constellation Simulator

The main objective of this project is to develop a radio-frequency constellation simulator to support engineering and experimentation of Galileo second generation's Open Service and Public Regulated Service

GMV was selected by the European Space Agency (ESA) as a supplier of Galileo Second Generation Radio Frequency Constellation Simulator. This is the largest contract signed by GMV in Portugal and results from a continuous investment in the simulation strategic line, as well as activities to study the Galileo signals and their evolutions.

The main objective of this activity is to develop a Radio Frequency Constellation Simulator to support Galileo Second Generation Engineering and Experimentation activities in the Open Service and the Public Regulated Service domain. The main objectives of the Galileo Second Generation are to phase in new services, improve existing services and boost system robustness and security while also cutting both operating- and maintenance-costs, all with the prime purpose of cementing Galileo's position as one the future's top GNSSs.

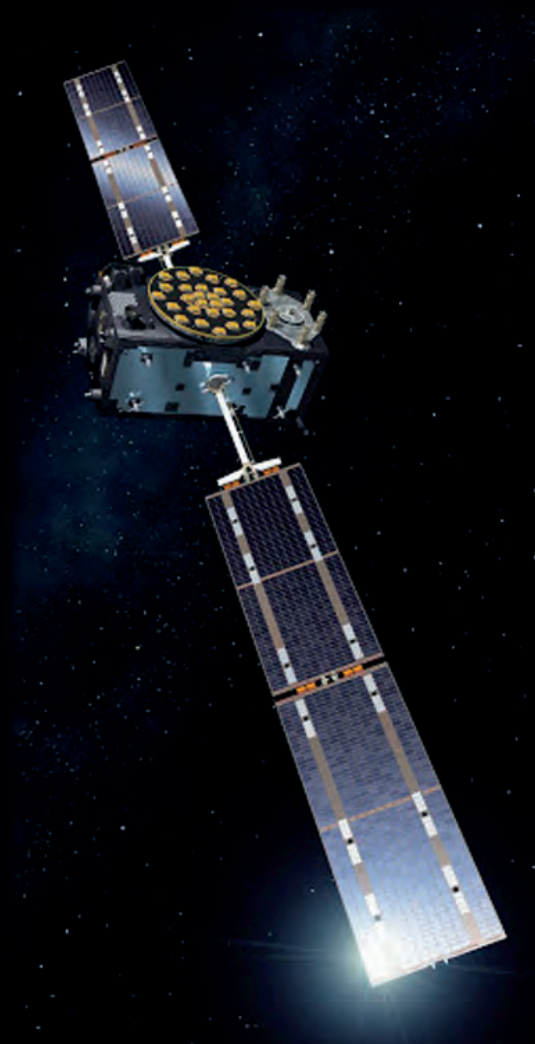
In the G2G RFCS contract, GMV teams in Portugal and Spain together with its key partners Orolia and TECNOBIT are developing a constellation simulator covering both Galileo generations and Galileo Open Service and Public Regulated Service. The RFCS will simulate the progressive deployment of the G2G with its new signals and will be a key element to support the development of Galileo 2nd Generation infrastructure and for the testing of experimental user receivers.

In addition to the simulation of the constellation and radio frequency signals emitted by the satellites, the RFCS will cover many user characteristics such as dynamic behaviour, signal impairments such as multipath and interference but also solution hybridization (e.g. inertial sensors) and signal distortions.

The RFCS is designed to guarantee flexibility, configurability, modularity, scalability as well as segregation of Need-To-Know information. For this purpose, the RFCS is built with COTS products and follows a Software Design Radio approach.

This activity is highly linked with other PRS activities within GMV, identified as strategic for the maintenance of the European leadership position of GMV in the Galileo program. The Galileo Public Regulated Service (PRS) is an encrypted navigation service for governmental authorized users and sensitive applications that require high continuity.

This activity reinforces GMV strategic objective of becoming a worldwide supplier of Signal Simulator products for the current GNSS and for the future Galileo 2nd Generation.



ESA has received funds as funding body under the European Union's Horizon 2020 research and innovation programme

The ADE robotics project carries out the final field tests

Coordinated by GMV, the Autonomous DEcision Making in very long traverses (ADE) project is dedicated to autonomous robotic decision-making, targeting specifically surface robot planetary missions performing very long traverses in unknown environments

After nearly two years of work Bremen in Germany hosted from 18 March to 16 April the final tests of the ADE (Autonomous DEcision Making in very long traverses) space robotics project from 15th of March to 16th of April, rescheduled from the initially-intended venue of Fuerteventura due to COVID-19 travel constraints.

ADE falls within the Strategic Research Cluster (SRC) in space robotics technology, coordinated by the H2020 PERASPERA project. Its remit is to develop and test a planetary rover system with very long traverse capabilities by independently taking the decisions required to progress, reduce

risks and seize opportunities of data collection.

Coordinated by GMV and run with the collaboration of 13 partners from all over Europe, ADE is dedicated to autonomous robotic decision-making, targeting specifically surface robot planetary missions performing very long traverses in unknown environments. ADE draws on the ERGO (European Robotics Goal-Oriented Autonomous Controller) autonomy system developed under GMV leadership in the first SRC phase.

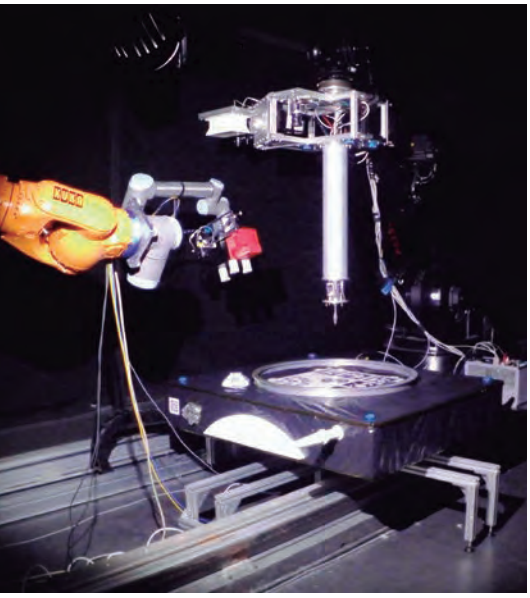
The robotics platform used for field testing the project's technology was the SherpaTT rover developed and provided by the Robotics Innovation Center of the German Research Center for Artificial Intelligence (DFKI). SherpaTT is a desert veteran that has already carried out simulated space missions in the Utah desert (USA) and Morocco under the GMV-led ERGO project, in 2016 and 2018, respectively.

For 5 weeks the robotic technology was put through its paces, testing navigation autonomy using the perception and localization cameras, sample-collection and -depositing with the robotic arm, automatic goal-oriented mission planning (travel to a fixed point, carry a sample from one point to another, move on to an image-taking point), plus the possibility of ad hoc scientific target recognition as the opportunity arises.

ADE came through the tests with flying colors, pulling off a long and totally autonomous traverse of almost 500m with the rover SherpaTT in a record time of less than three hours.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821988

EROSS tests validate the on-orbit servicing technology



Last April the testing campaign to validate the H2020 EROSS project´s technologies was conducted in GMV´s ***Platform art***© robotic testbed.

The objective of European Robotic Orbital Support Services (EROSS) is to demonstrate European solutions for the Servicer and the Serviced LEO/GEO satellites, enabling a large range of efficient and safe orbital support services. The project assesses and demonstrates the capability of the on-orbit servicing spacecraft to perform rendezvous, capture, berthing and manipulation of a collaborative client satellite provisioned for servicing operations including refueling and payload transfer/replacement. This project is developing and merging the building blocks of the previous Operational Grants from 1 to 6 of the Strategic Research Clusters on Space Robotics within the Horizon 2020 programme, three of them led by GMV from 2016 to 2019.

Thales Alenia Space, as project coordinator, is leading the mission and system designs within the overall GNC architecture and its validation on robotic testbeds. In the EROSS project, GMV is supporting the integration of the building blocks from previous Operational Grants, i.e. ESROCOS (OG1) and ERGO (OG2). In particular GMV is inputting the design of the satellite guidance function for rendezvous, capture, docking and servicing operations and supporting Thales Alenia Space in France in the GNC and Autonomy validation. GMV is also providing support for inclusion of the ESA ASSIST refueling interface device within the EROSS demonstration.

Moreover, GMV's ***Platform-art***© is the proposed test facility for the overall EROSS demonstration.

The validation result was excellent and highlighted the efforts over the last 2 years, through the Covid outbreak and the countless technical challenges.

The ***Platform art***© facility enabled us to step up the technology readiness level of EROSS software and hardware elements in a space-representative scenario for on-orbit servicing operations based on visual navigation, promoting the autonomous activation of the different phases to accomplish the mission. During late May and early June, additional testing activities are planned in NTUA, PIAP and TASF facilities to demonstrate the capabilities of on-orbit servicing technologies developed in EROSS.

The EROSS H2020 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821904

Robotics and autonomous systems for smart process and resource management

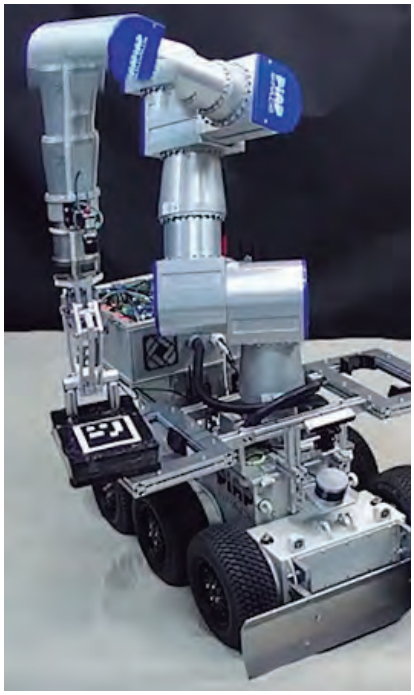
Innovation is the surest path towards a stronger industry based on a rock-solid Industry 5.0. GMV, always an innovation powerhouse, has been working with technology to drive the digital transformation and sustainability, focusing on the development of hi-tech projects in three major areas: automation, digitalization and cybersecurity.

Under the title "Unmanned Systems in the Naval and Offshore Sector", Navantia Training Centre (NTC) hosted a hybrid online/onsite technical convention organized by Cádiz's Naval Maritime Cluster jointly with CATEC and with the collaboration of Cadiz Provincial Council, to debate robotics applications in the naval and offshore sector. Miguel Hormigo, Industry Manager of GMV's Secure e-Solutions sector, gave a paper on GMV's various AGV and digitalization solutions for Industry 4.0.

Hormigo's paper brought out exponential technology's potential for transforming certain business models and solving the different problems by means of human-machine integration: operational efficiency, new products and services, economy of results (intelligence), autonomy, etc. In the automation section he also put forward examples of Autonomous Mobile Robots (AMR) and Automatic Guided Vehicles (AGV) specially designed to improve the performance of material distribution and processes, both indoors and outdoors.

The robotic project PRO-ACT is completed

In late April, after 27 action-packed months, the PRO-ACT (Planetary RObots Deployed for Assembly and Construction Tasks) project was brought to completion.



PIAP-Space (Veles)

DFKI (Mantis)

Kicking off back in 2019, PRO-ACT was one of the 5 projects selected for European-Commission funding in the second phase of the H2020 space robotics Strategic Research Cluster (SRC). Drawing on its wealth of experience in space robotics, GMV featured prominently in PRO-ACT, led by SpaceApps and carried out by a 10-member consortium.

PRO-ACT's main remit was to design, develop and validate applications to facilitate and support the preparation of future manned missions to other planets. Another of PRO-ACT's goals was to address the problem of setting up a precursor lunar base by assembling an in-situ resource utilization (ISRU) system, doing so with the aid of cooperatively acting mobile robots.

PRO-ACT used all the common building blocks (OG1-5) developed during the first phase of the program, pride of place going to the European Robotic Goal-oriented Autonomous Controller (ERGO) and the European Space Robot Control Operating System (ESROCOS); the two GMV-led building blocks in the cluster's first phase.

GMV also led the definition, design and implementation of the multi-robot architecture related to planning, execution, coordination and monitoring, while participating too in the development of other support systems (communications, control center and ground monitoring), in the integration of common building blocks developed in the first phase plus testing and demonstration activities and bringing results to wider notice.

Due to the Europe-wide COVID lockdown restrictions the final project demo was mainly carried out remotely, adjusting each one of the initially scheduled sites to two different testing areas (in Germany and Poland), commanded from GMV's multi-robot control stations in Spain to check that PRO-ACT's Cooperative and multi-robot framework worked properly.

After this test the final project acceptance was held remotely on 26 May, with the presence of members of the European Commission (EC) and European Space Agency (ESA) together with PRO-ACT's other consortium members. This was considered to be a resounding success; both the EC and ESA congratulated the consortium for its effort and fleet-footedness in coping with the COVID lockdown constraints.

5th ASTI Robotics Challenge

The grand finale of the 5th ASTI Robotics Challenge, Spain's top educational robotics competition, was held on 5 June. The aim of this challenge, organized by *Fundación ASTI*, is to encourage STEM talent, especially in the field of mobile collaborative robotics.

A total of 24 teams competing in two categories vied with each other onsite in this final knock-out round, held in Burgos's Human Evolution Museum. Their mission was to design and build a mobile robot capable of coping with each challenge posed by the R&D team of ASTI Mobile Robotics.

GMV is supporting this initiative as in previous years, as part of its ongoing pledge to nurture budding science- and technology-talent. Mariella Graziano, GMV's executive manager of robotics and flight systems development and strategy, sat on the jury.

Initiatives of this type challenge youngsters to test their mettle and pit their wits in various areas of performance. As well as learning technology-, programming- and robotics-skills, they also develop team-working and project-management expertise plus entrepreneurial, innovative and creative prowess.

Cloud intelligence as decision-making and distributed-simulation support

Following on from the prototype, EDA has awarded GMV two new developments based on both concepts

In 2019 the European Defence Agency (EDA) awarded to GMV and UPM's IPTC Research Center the 4-year CLAUDIA contract for developing a dedicated Modular Software Analysis platform (SWAN), to research into the possibilities of supporting the analysis and assessment of military scenarios, focusing on those related to Hybrid Warfare, through an extensive analysis and processing of the various data involved. This platform will be using technologies such as cloud computing and storage, artificial intelligence (AI) plus other Big Data management tools, seeking to meet the needs of Defense Forces that operate in dynamic, mobility-requiring environments with high threat levels.

The first contract involved development of the SWAN platform, centering on information sources at cloud-hosted strategic level. This initial contract was brought to a successful completion and various demos were held to showcase SWAN capabilities for member states under EDA's Information CapTech and Simulation Captech initiatives. Following on from this prototype, in 2021 EDA has awarded two new developments under this framework contract based on the tactical cloud and distributed simulation concepts.

Firstly, the SWAN platform will be extended to the tactical level and an analysis will be made of the pros and cons, looking at such features as edge computing availability, lower latency, etc. In pursuit of this aim it is planned to deploy the new developments in a commercial tactical cloud device with sights set on a dismounted soldier system as final user.

A new capability will also be tagged on so that SWAN can tap into information from distributed simulators. The idea is to make up for the lack of available data in hybrid warfare environments. As well as completing the proof of concept, an agent based modeling (ABM) simulator will be implemented.

GMV presents to the army its developments in unmanned ground vehicles

GMV was one of the ten firms selected to give a paper in Workshop 11 on unmanned ground vehicles (UGVs), an event held on 7 and 8 June by the Spanish army and the Directorate General of Armaments and Material (*Dirección General de Armamento y Material*: DGAM) under the Force 2035 project.

José Luis Delgado, Head of GMV's Defense and Security Section, presented the European Commission's European Defence Industrial Development Programme (EDIDP) project called Integrated Modular Unmanned Ground System (iMUGS), in which GMV has been participating as part of a consortium of European firms. iMUGS's aim is to develop a valid scalable architecture applicable to both manned and unmanned vehicles, capable of catering for many different types of soldier-support missions, working in manual, autonomous or swarming mode. Under this project GMV is leading the command and control and interoperability work, so Delgado also talked about the main features of the command post being developed. To wind up he also presented GMV's FOXIZIRC robot, designed to dry-run navigation and autonomy technologies.

Held online, the event forms part of the Spanish MoD's initiatives to encourage the development of robotics and autonomous ground systems, prime among them being DGAM's recently launched *Escorpión* project. Some of the developments presented in the workshop have already been tested by the army and others will be put through their paces in the coming months.

GMV makes headway in the design of the SENDA navigation system for the F-110 frigates

GMV continues to make progress in the design of the SENDA system under the contract signed between GMV and Navantia for development and supply of five SENDA systems and backup components for the future F-110 frigates to be delivered to the Spanish navy as from 2027.

The SENDA system has come through its second design milestone with flying colors, focusing on the handover of part of the technical design documentation agreed with Navantia, continuing the roadmap for production and delivery to Navantia of the first equipment for its verification and integration in Navantia's testing lab.

The current design phase will continue until the first technical milestone, when the rest of the technical design documentation required by Navantia will be handed over. In the interim GMV continues to work with DGAM and Navantia to phase the latest GNSS technology into SENDA and signal distribution to the rest of the vessel's systems.

The SENDA navigation system is GMVs' advanced naval navigation and timing solution. It incorporates multi-constellation (GPS, Galileo) satellite navigation technology compatible with both civil and military signals, plus DGNSS corrections. SENDA also hybrids own satellite navigation data (GNSS) with data received from external sensors, such as inertial navigation systems (INS), pitometer logs, etc, and includes state-of-the-art algorithms to provide robust navigation in contested GNSS scenarios.

SENDA rounds out GMV's range of military navigation products and makes GMV today's flagship Spanish firm for navigation systems, boasting tried and tested experience in the aeronautics-, ground- and naval-sectors with platforms for the RPAS ATLANTE, the 8x8 vehicle Dragon and the F-110 frigates.

GMV and INTA sign an agreement for carrying out scientific research projects

On 18 May Spain's National Aerospace Technology Institute *(Instituto Nacional de Técnica Aeroespacial*: INTA) and GMV signed a scientific research collaboration agreement.

Published in Spain's official new-law journal, the BOE, of Wednesday 9 June 2021, and signed by the head of INTA, Lieutenant General Jose María Salom, and GMV's CEO, Jesús B. Serrano, the agreement sets out to encourage navigation and defense cooperation, INTA and GMV both mutually benefiting from each other's laboratories and developments.

The agreement also aims to lay down the overarching collaboration conditions, the fine detail then to be decided in every specific contract signed by INTA and GMV as each individual project is tackled. This will help to forge even closer bonds of cooperation between government institutions and industry, to the general benefit of the country as a whole.

The possible collaboration areas defined in the agreement include command and control systems, ICT security, cyberdefense mechanisms and lab testing of any groundbreaking industrial systems of common interest as they crop up in the near future. Prominent here will be the first- and second-channel tests and evaluations and their applications in systems used for defense purposes.

The agreement comprises a confidentiality commitment, both parties binding themselves to publish their joint activities always by mutual consent. They will also be backed up by a monitoring committee to oversee and direct all activities under this agreement.

GMV upgrades SASEMAR's operational management information systems

For yet another year Spain's Maritime Safety and Rescue Society (*Sociedad de Salvamento y Seguridad Marítima*: SASEMAR) entrusts to GMV maintenance of the operations management and information system (*Sistema de Información para la Gestión de Operaciones*: SIGO).

This GMV-developed system, up and running since 2004, has been conceived as a global solution for handling all the information on any emergency occurring in each SASEMAR center, facilitating centralized data access to optimize recourse use (personnel and rescue units). It also studies possible trajectories both of spills and ships or persons disappeared on the high seas, drawing on parameters such as: weather data (wind and currents), local geography (tide movements) or data on the main features of the vessels involved or the people in the water, such as clothes or utensils. This will make rescue operations quicker and ensure resources are better organized. All this information will be accessible from SASEMAR's various coordination centers.

The improved features of this new contract include all the following: integration of SIGO with other SASEMAR platforms such as OCEANO for obtaining information from notification and radio warning of Maritime Safety Information (*Información de Seguridad Marítima*: ISM); better reporting; a new team management module for the fight against pollution; and connection with the Spanish Navy's Maritime Action and Surveillance and Operations Center (*Centro de Operaciones y Vigilancia de Acción Marítima*: COVAM), favoring the exchange of information and collaboration between both maritime authorities.

Upgrading and application of new ISR interoperability features and technology

■ Following on from its development of a suite of JISR SAPIIEM tools under the Interoperability of Joint ISR Systems (*Interoperabilidad de Sistemas ISR Conjuntos*: ISIC) for the Spanish MoD, GMV has recently signed a new contract with the MoD's Subdirectorate General of Plans, Technology and Innovation (*Subdirección General de Planes, Tecnologías e Innovación*: PLATIN).

The remit of this contract is to provide C4ISR software development and research services. This involves three main actions: firstly R&D into changes necessary in SAPIIEM to bring it into line with the upcoming changes in NATO's standards and interfaces, plus incorporation of new types of information sources and AI-based automation improvements. Secondly, the holding of experiments to coincide with exercises, tests or awareness-raising events to check technical interoperability with allied systems and get feedback from the new developments. Thirdly, technical support to continue participating in standardization of national developments under NATO.

Work began back in December 2020 and is due to run until November 2022, with the aim of obtaining new ISR functions in SAPIIEM systems to be validated at operational level and standardization proposals to ensure interoperability with allied countries.

Industry and Academia COU conference

Just as on the previous two occasions, GMV took part in the 3rd Industry and Academia COU conference, held online by the Spanish Security Community of Users (*CoU España*) of the Security Technology Center (*Centro Tecnológico de Seguridad*) of the Spanish Home Ministry.

The conference set out to give representatives from industry and academia a stage to present their expertise, ideas and projects directly to potential final users among the CoU working groups ahead of the research and aid calls launched every year by the European Commission.

This year' conference took its cue from the new European Horizon working program. GMV's participation in this conference stems largely from one of the main matters dealt with: "Border Management & Drones-Antidrones". In the corresponding session on 22 April, GMV presented the technological capabilities of command and control systems, adapted to ensure efficient information exchange with, for instance, EUROSUR, MARSUR and CISE environments of data fusion services and integration of the services provided by surface and subsurface drones.

This technology can also integrate drone management and allocation for border surveillance, both land and sea. Notably too, all have been implemented and deployed in Horizon 2020 projects like ANDROMEDA and PADR projects like OCEAN2020. They have also been taken up by the Single European Sky ATM Research (SESAR) for demonstrating U-Space services for Unmanned Traffic Management (UTM). GMV's input here is the ***Dronelocus***® tracking service, which enables positioning data from different drone sensors to be processed and recorded.

Talos, GMV's inhouse command and control system developed for the Spanish MoD paves the way for Spanish integration in ASCA

From 25 April to 22 May the Spanish army took part in the Dynamic Front (DVIDS) multinational exercise led by the United States in Europe, designed to improve the allied countries' ability to deliver long-range firing capabilities.

During these exercises the Spanish army's Campaign Rocket-Launcher Artillery Regiment (*Regimiento de Artillería Lanzacohetes de Campaña*: RALCA) No. 63 validated the ***Talos*** fire support command and control system for its integration in the ASCA (Artillery Systems Cooperation Activities) community.

Developed since 2010 for the Spanish army's Directorate General of Armaments and Material (*Dirección General de Armamento y Material*: DGAM), ***Talos*** is GMV's C4I system for the planning, management and execution of military operations at tactical level, allowing integration of various combat functions (command, firing, intelligence, logistics and communications) in the same mission. In terms of the firing function it allows for all-in management of the fire support cycle. The latest upgrade also implements the ASCA protocol that allows its integration with the fire support systems of allied nations belonging to ASCA group (USA, France, Germany, Denmark, Italy, the Netherlands, Norway, Turkey, Great Britain).

To be eligible for membership of the ASCA program a country has to show that its national command and control system and national operational rules (NIOP) are compatible with the ASCA interface.

The command and control system certification process is conducted by interconnecting the candidate's national system with the system of an ASCA member country. This member country sponsors the candidate national throughout this process. Spain's sponsor is the United States. ***Talos*** came to this exercise with the implementation of the ASCA protocol already validated with the artillery systems of two ASCA countries, following the procedures laid down by the standard: with the US's (Advanced Field Artillery Tactical Data System: AFATDS) and the UK's Fire Control Battlefield Information System Application (FC-BISA).

As a preliminary phase to Spain's full ASCA membership, and in order to build up to operational capability, the exercises included integration of a Spanish Artillery Battery in a US army group to carry out real firing actions using ***Talos*** with its ASCA capability.

The exercises, supported remotely by GMV as national Spanish representation, were a resounding success and rubberstamp Spain's full ASCA membership.

Photo: Pfc. Denice Lopez

GMV joins forces with SENER and Escribano to break into the missile market

On 10 May GMV, SENER Aeroespacial and Escribano signed a collaboration agreement for working jointly on the development and promotion of solutions in the field of missiles and other high-performance guided munitions, doing so under SMS initiative.

The three companies' combined expertise will produce a key industrial player in the missile sector in response to the needs of the Spanish MoD and armed forces, representing national interests in international cooperation projects.

This agreement boosts national industry's capability of taking on national and international missile programs on an equal footing with the rest. The idea is to help boost missile efficiency and maximize the economic, industrial and technological return on the necessary public spending to obtain and maintain costly missile systems during their long lifecycles. This initiative strengthens Spain's industrial defense fabric by reducing fragmentation and encouraging technological specialization in a key industrial sector.

GMV provides BICES with an X-Domain solution

GMV, in collaboration with AUTEK Ingeniería, is to provide an X Domain solution for exchanging Intelligence, Surveillance and Reconnaissance (ISR) products through the Battlefield Information Collection and Exploitation Systems (BICES).

This contract responds to the need of NATO members and other allied countries' (e.g., Sweden or Finland) for exchanging intelligence information between them. GMV currently provides the ISR exchange solution through the ***CSD Sierra*** systems (based on the standard STANAG 4559 Ed.4) hosted in BICES Group Executive (BGX) in Brussels, acting as connection node with the CSD systems provided by other countries.

AUTEK's PSTcsd solution, developed under a contract with the MoD's Subdirectorate General of Plans, Technology and Innovation (*Subdirección General de Planes, Tecnologías e Innovación*: PLATIN), inputs a CSD product exchanging capacity through two physically separated networks with a different level of security. This solution is also accredited for exchanging classified information up to secret level.

With the combination of PSTcsd with ***CSD Sierra***, Spanish industry is contributing a secure, groundbreaking solution for exchanging intelligence information between different domains, not currently catered for in BICES. This contract also paves the way for other countries to introduce this capacity in order to unite networks of different information domains.

Opinion

Strengthening security-enhancing awareness-raising programs

During this pandemic we've seen the number of cyberattacks soar. This suggests that technology-driven cybersecurity is no panacea. There are many possible reasons for this. One of the most convincing is that human beings, usually the weak link, are blithely unaware of the risks and are ignorant too of the required behavior in any digital environment.

The human factor is crucial in cybersecurity. The robustness of any cybersecurity program has to strike the right balance between people, processes and tools. In recent years more attention has been paid to this human factor of cybersecurity, especially where the use of the security technology has failed to protect companies from cyberattacks.

A change of mindset is needed in regard to users, allowing and encouraging them to take on more responsibility for security rather than viewing them as passive, security-receiving objects. Awareness-raising campaigns then need to be adapted to suit people's perception of the risk. These users need to be capable of understanding and applying the advice and keen to do so; the latter calls for changes in attitudes and intentions rather than fear as a crude deterrent.

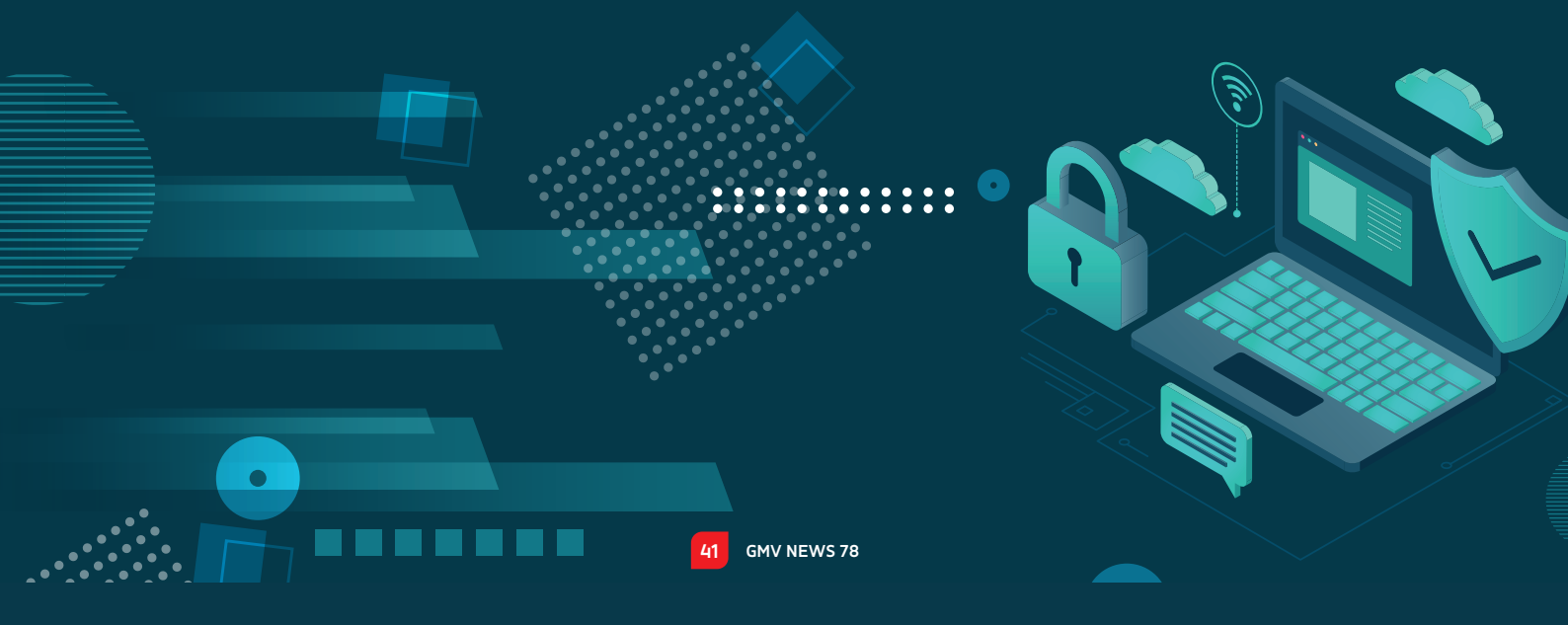
The main aim of cybersecurity awareness-raising campaigns should be to encourage the adoption of safe behavior. People learn from examples; when they see that others in the organization back its security awareness-raising program, they will too. This involvement in security awareness-raising has to be across the board.

Furthermore, most cybersecurity awareness-raising programs have a theoretical approach. It would now be beneficial for users to experience lifelike cybernetic incidents, just like a fire drill.

One of the objectives and plans for this year of 2021 should be to build a cybersecurity culture and awareness based on individual responsibility, confidence, communication and cooperation. Users should now be encouraged to take an active role to ensure proper awareness and responsible behavior.

Carlos Alfonso Castañeda
Business Developer Partner LATAM
GMV's Secure e-Solutions sector

> "The main aim of cybersecurity awareness-raising campaigns should be to encourage the adoption of safe behavior"



Cybersecurity, inoculation for secure tourism

At the end of April GMV took part in H&T Innova, the hospitality innovation tradeshow organized by Malaga Tradefaire and Congress Hall (*Palacio de Ferias y Congresos*). This is one of southern Europe's flagship hospitality and tourism events, looking at how innovation is a crucial lever in tourism's recovery, especially after being so hard hit by the COVID-19 pandemic.

Joan Antoni Malonda, Tourism Business Developer of GMV's Secure e-Solutions sector, gave a paper entitled "Cybersecurity, inoculation for secure tourism", tabling the importance of technology in ensuring trustworthy hotels and a better client experience.

We are now facing a new scenario. Tourists have become digitalized and use diverse apps not only to prepare the trip but during the stay itself (QR code apps, information access apps, touchless apps). The tourism apps market is booming, bringing the importance of cybersecurity to the fore.

Joan Antoni Malonda's paper stressed the importance of a vulnerability analysis, pentesting, etc, to guarantee a safe use of these apps. He also looked at the Wi-Fis available to clients. These are now taken for granted in hospitality venues but we need to make sure they're secure. Due heed has to be paid to the negative image given to clients if they suffer any information theft or unauthorized email access after using the hospitality Wi-Fi.

1st STIC Conference Colombia Chapter

On 16 and 17 March the 1st STIC Conference Colombia Chapter was held, organized by the National Cryptology Center (*Centro Criptológico Nacional*: CCN), under the aegis of the National Intelligence Center of Spain (*Centro Nacional de Inteligencia de España*), and the National Cybersecurity Institute (*Instituto Nacional de Ciberseguridad*: INCIBE), dependent on the State Secretariat of Digitalization and Artificial Intelligence.

Held under the banner theme of "Cybersecurity, the commitment that unites us", the conference is being supported by GMV together with other major cybersecurity companies, seeking worldwide security collaboration and information exchange.

Opinion

Rollout of LoRaWAN technology for global and cybersecure connectivity

When taking on any IoT project, it is vital to ask ourselves first a series of questions to ensure the best choice of our technology platform: what type of measures will I be able to carry out and how often? How long will the device's battery last? What scope will the transmitted signal have? How much data can I send? Is my platform a shared public platform or a private one? Just as important, however, is to run through a cybersecurity box-ticking exercise too in order to ensure the best project performance in both setting-up and running phases: "Is the data I'm sending secure? How prone is it to third-party interception? Is it possible for the legitimate device to be overridden by a malicious one sending false information? Is data transmission between the IoT platform and the data-computation platform secure?

Here is where the Long Range Wide Area Network (LoRaWAN) comes into it own, as a secure, wireless connectivity solution. Its design-up objective is to provide both reliability and security in data transmission, whether in the device-IoT signal or from the IoT platform to the data processing and computation platform.

LoRaWAN's end-to-end security is one of its main development features. This security has to be all embracing and across the board, establishing the need for all the following: an obligatory data encryption and authentication process; the use of AES-128-based cryptography levels to establish network and application sessions; device identification mechanisms based on control of frames sent and device re-authentication as need be.

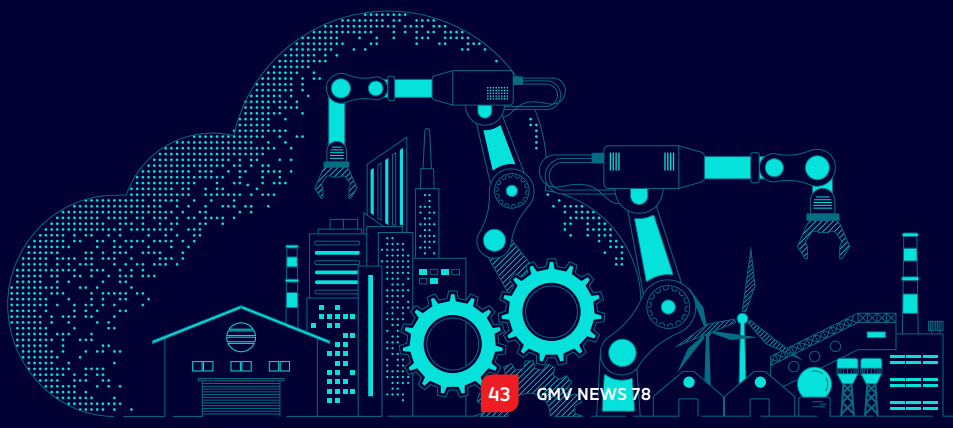
We at GMV boast experience in the following success stories:

- **Rollout of LoRaWAN network for traceability and control of personal location in open spaces**: a LoRaWAN system was set up capable of recording the location of persons and objects by means of a GPS-enabled device, setting up links of up to 8 km in wooded areas by using omnidirectional antennae.

- **Rollout of LoRaWAN network in an industrial production line**: setting up of a LoRaWAN network together with a LoRaWAN network server designed to control an industrial production line with battery-fed devices with an average life of more than 5 years. The system flags up system-behavior anomalies by means of integration with the factory's monitoring systems.

Javier Hidalgo Sáez
Industry Solutions Architect
GMV's Secure e-Solutions sector

"Design-up, end-to-end security is one of LoRaWAN's main development characteristics"



GMV creates the technological biomedical data platform under eTRANSAFE

This is the world's only drug-safety-assessment biomedical data system

Drug development, as in other R&D endeavors, brings together the work and results of several stakeholders to produce between them substantial benefits. Up to now big Pharma has been loath to share their information on the toxicity of thousands of compounds as gleaned from animal testing. Most of this data remained backed up in private silos without any possibility of pooling it. eTRANSAFE has turned this situation around, developing a technological biomedical data platform for exchanging preclinical and clinical data from diverse sources and then integrating and mining it for all its worth. The overall idea is to produce more efficient drug safety evaluation tests, replacing some of the animal testing with retrospective analysis techniques drawing on all the evidence built up by the pharmaceutical industry.

GMV, responsible for control and coordination, is one of the project partners seeking to improve drug safety. As Ferrán Sanz points out, academic coordinator of eTRANSAFE and director of the Biomedical IT Program of the Hospital del Mar Medical Research Institute (Institut Hospital del Mar d'Investigacions Mèdiques) and Universidad Pompeu Fabra "GMV is playing a key role in developing the IT system to manage, mine and analyze all the shared data".

Adrián Rodrigo, GMV's Business Solutions for Smart Health manager, explains that "working from data governance techniques the project is striving to organize and share all the available information of pharmaceutical firms to generate a critical mass of biomedical data that can then tap into big data technology and computational methods capable of drawing conclusions from all the information that would otherwise have gone unprocessed". He goes on "the idea is to make data combination possible for joint analysis, applying all data confidentiality methods within a secure platform".

Big Data to boost safety

Drug safety assessment is a knowledge-intensive process that demands advancement in data handling methods and tools for facilitating data sharing, mining, analysis and predictive modeling. This calls for the integration of information of different types and from different sources (e.g. publicly available biomedical knowledge, proprietary preclinical and clinical data, etc).

As pointed out by François Pognan, Novartis Pharma's executive manager of biochemical safety, and Thomas Steger-Hartmann, head of investigational toxicology and vicepresident of Bayer AG, "In initial clinical trials the safety of new candidate drugs is extrapolated from preclinical data taken from animal experiments. These extrapolations are based solely on data generated for the particular project concerned. A systematic, global analysis of safety forecasting, trawling all data recorded over time, has never been made.

There is therefore little to go on when trying to ascertain how far and how often an effect observed in an animal can be extrapolated to humans".

Hence the importance of this public-private collaboration project coordinated by the Institut Hospital del Mar d'Investigacions Mèdiques and funded by the EU and the European Federation of Pharmaceutical Industries and Associations. Besides GMV, other Spanish project partners are the Universidad Pompeu Fabra and Synapse Research Management Partners SL, leading between them 4 of the 10 work packages. The industrial coordinators are the pharma companies Novartis and Bayer AG.

Teleophthalmology during a pandemic

With the outbreak of the COVID-19 crisis, GMV offered healthcare authorities its remote healthcare platform, ***Antari Professional Care***, to provide ubiquitous service to the increased number of patients. The prevailing reality has affected medical appointments for patients with diseases other than this virus. The initiatives promoted to alleviate this impact include the launch by GMV's partner, e-Health Vision. The company's teleophthalmology platform "My Vision 360", based on ***Antari***, helped reduce the pressure on health centers during the months of lockdown, with the collaboration of 250 opticians, the Jimenez Díaz Foundation and GMV, which offered its remote healthcare platform ***Antari*** free of charge.

My Vision 360, based on ***Antari***, was also used during the first wave of the pandemic to monitor certain cardiovascular processes in patients hospitalized in the Jiménez Díaz Foundation as a result of infection with the Coronavirus SARS-CoV-2.

GMV shares the goal established by the United Nations in SDG 3: To ensure healthy lives and promote well-being for all at all ages. To achieve that, it offers healthcare professionals digital healthcare solutions and services developed in collaboration with hospitals, health research institutes, universities, pharmaceutical laboratories and patients.

GMV showcases its pharmacological research range at Inforsalud

With a paper called "Research networks using federated systems" Inmaculada Pérez Garro, Digital Health Manager of GMV's Secure e-Solutions sector, and José Carlos Baquero, Artificial Intelligence and Big Data manager of GMV´s Secure e-Solutions sector, took part in the 24th National Health IT Congress (*Congreso Nacional de Informática de la Salud: Inforsalud*).

Pérez Garro's paper focused on GMV's technological model in major pharmacological research projects, in a technological session moderated by Eladio Linares Morcillo, Director of Health Service Information Systems of the region of Castilla La Mancha.

GMV continues as technological leader in the new phase of the HARMONY project

This phase plans to work with about 30,000 data items harmonized and anonymized by GMV, which, as technological leader, is applying advanced analytical techniques and Big Data tools, abiding at all times by health information security and privacy legislation

The HARMONY Alliance, in its second phase under the name "HARMONY plus" has widened the trawl of patients with hematological malignancies from more than 15 European countries. As pointed out by Dr. Hernández Rivas, specialist from the Hematology Service of the University Hospital of Salamanca and coordinator of the HARMONY consortium, the project at first did not take in all hematological illnesses but now it is working with data from all types of hematological malignancies because "we need more in-depth data with more genomic information, probably not from all illnesses because not all of them have the same development of genomic knowledge, but in some of them it would be crucial to bring together DNA sequencing data with RNA-Seq data or methylation".

As the project leaders explain, the hope Is to work with 30,000 data items harmonized and anonymized by GMV, which, as technological leader, is applying advanced analytical techniques and Big Data tools, abiding at all times by health information security and privacy legislation. Dr. Guillermo Sanz, head of the Clinical Hematological Section of University Hospital La Fe de Valencia and co-coordinator of the Harmony consortium, takes it on: "health data calls for the strictest security standards as laid down by the European Union".

Data quality is supervised by the Data Quality Supervision Committee, which lays down the necessary data-assessment criteria to make sure it passes the screening process and turns out to be useful for research purposes. "Once a cooperative group decides to enter HARMONY and sends its data, we have systems for displaying out-of-range variables, the number of blank variables and final assessment of the effort. Cost matrices can bring out important variables to suit the particular project concerned in each case", stresses the Hospital La Fe hematologist.

In this new stage the project aims to progress beyond European borders.

Another object is the creation of historical control arms. Hematological illnesses are very diverse; some of them call for monitoring longer than 15 years. "In myeloma we are now achieving this in an average of 10 years, making it a singular series", explains Dr. Hernández Rivas. This challenge would impinge on new drug access. Dr. Sanz goes on: "if we can get EMA to accept tests of this type in the coming years, this would enable us to conduct new-drug studies of a single branch, which could then be compared to the standard. This would bring new drugs on stream quicker".

GMV to set up Barcelona tramline's new fleet management system

One of the main project principles will be to achieve interoperability with new systems that will include, both at onboard level and in the control center, the development of an API for publishing significant fleet management information, based on the Advanced Message Queuing Protocol (AMQP)

Alstom has contracted GMV to renew the fleet management system of the Trambaix and Trambesòs tramlines, running in the metropolitan area of Barcelona.

The new system will take in the installation of unified central subsystems to enable joint management of the two tramlines, plus fitting of the system in all rolling stock running on the tramlines, comprising 41 Alstom Citadis 302 trams.

The architecture at onboard level will be deployed over an Ethernet backbone with inclusion of a GMV control unit in each cab, human machine interface (HMI) for the driver plus an audio matrix for control of peripherals and interface with the existing TETRA radio.

The project scope will include a new development for overspeed control in the various trams of the line, tripping visual and sound alarms for the driver. Onboard interfaces with all the following will also be maintained: the train's various onboard systems, the train control and monitoring system (TCMS) for receiving technical alarms and state reports, the passenger information and PA system for sending information, the TETRA radio, Wi-Fi communications in tram garages, ticketing and points control.

To ensure communication redundancy and a broader bandwidth, the new system will allow cell-phone communications through an LTE modem and its associated antenna.

The control center will be fitted with a redundant virtualized server system to unify management of both lines, including interfaces with the driver and timetabling system, with the tram-stop passenger information panels and the track-train communications system TETRA. A new interface will also be developed with the traffic control centers to establish traffic light superiority at crossings; important train-running information will also be published: time of passing certain points; location; early or late running and simple or multiple operation mode, among others.

One of the main project principles will be to achieve interoperability with new systems that will include both at onboard level and in the control center the development of an API for publishing significant fleet management information, based on the Advanced Message Queuing Protocol (AMQP).

GMV to supply the train CCTV system for the Danish firm DSB

GMV is to supply the CCTV system for the eight new Intercity trains, based on a Talgo 230 chassis. This model, to run at a top speed of 200 kph from the Danish capital Copenhagen to the German city of Hamburg, will have a passenger capacity of over 440.

The CCTV to be supplied is totally digital, comprising two state-of-the-art recording devices per train, two onboard display terminals and 71 digital cameras.

Each recording device will be able to deal with half the cameras, storing the footage for later download and display by authorized personnel. This includes all necessary mechanisms to guarantee data confidentiality, applying the most suitable cybersecurity techniques for this purpose.

To top up this system the supply also includes a control-center video display and management tool based on web technology. Authorized users will thus be able to view recorded contents while also accessing in real time the images of any train camera. This system permits permanent supervision of everything happening on board. All this will be accessible from Google Cloud.

Additionally, at onboard level the onboard personnel will be able to supervise everything happening on the train by means of touchscreens. These monitoring stations enable authorized users to view any onboard camera or a mosaic ensemble of several at once. Any alarm events will also be displayed, the closest camera being trained on the event concerned.

ITS Upgrading of Transporte Urbano de Gijón

GMV has won two projects under the final client of the Municipal Urban Transport Company of Gijón (*Empresa Municipal de Transportes Urbanos de Gijón*: EMTUSA).

The first, awarded by EMTUSA, involves renewal of the onboard ticketing system by replacing the current ticket vending machines (also supplied by GMV) by state-of-the-art RMDT100 and DTD100 machines for an 82-vehicle fleet.

These machines, apart from the currently contracting ticketing function, will also be able to take on the function of an onboard fleet management system later plus onboard passenger information system, DVR for recording video-surveillance footage and, lastly, an eco-driving function.

The new system is managed by the current back office and will maintain the contactless card system of Gijón and the Asturias Transport Consortium (*Consorcio de Transportes de Asturias*). A hardware capacity will then be tagged on for EMV enablement or smartphone emulations plus management of QR-code transport entitlements scanned from paper or screen.

The second project awarded to GMV by T-Systems but also with the final client of EMTUSA involves the phasing in of two new functions:

- The headway management system to be fitted on 38 buses will streamline vehicle frequency along the whole line. An onboard tablet will show the driver the headway between the foregoing and following vehicles on the same line.
- The ridership counting system when passengers board and leave the buses, to be fitted on 62 vehicles. The ridership counting sensor information will be crucial for calculating vehicle occupancy.

GMV will effect the supply in the coming months; the whole system is scheduled to come on line within 2021.

CAF contracts GMV for supplying the onboard systems of new Renfe trains

For these train models GMV will be supplying three of the systems, the passenger information system, the communications platform and Exit Signal Warning Device (*Dispositivo de Alerta ante Señales de Salida*: DASS)

The train manufacturer CAF has contracted from GMV several onboard systems for the 37 new trains awarded as the first batch by the national operator Renfe. These will be incorporated into the metric gauge fleet, formerly the Narrow Gauge Railway (*Ferrocarriles de Vía Estrecha*: FEVE), which currently runs trains in the regions of Asturias, Cantabria, Basque Country, Galicia, Castilla y León, Murcia and on line C-9 of Madrid.

These new trains, running at a top speed of 100 kph, will comprise two or three cars to suit demand. Additionally, five of the trains will be hybrid, hitching onto the overhead power lines where available to run electrically and thus reduce emissions.

For these model trains GMV will be supplying three of the systems, the passenger information system, the communications platform and Exit Signal Warning Device (*Dispositivo de Alerta ante Señales de Salida*: DASS).

The passenger information system will manage uniformly for all batch models the text information to be shown in the front- and side-information-screens plus the content of the inside monitors fitted throughout the cars, also supplied by GMV. These screens will show line and destination information, next stop, connections with other lines and any other service information. The inside monitors will also screen videos of general interest or ads. This visual information will be synched with the corresponding acoustic emission by the train PA.

The second system, the onboard communications system, already fitted on the rest of Renfe's fleet, will allow control center operators to check the position of each train, communicate live with the driver and passengers, view incidents in real time and receive varied information from several of the onboard systems to which the platform is connected. It will therefore now be possible to take the right action at any moment to make sure the service is always kept running properly.

Lastly, the DASS, already up and running in Catalunya, will top up track signaling safety and head off any exit signal overruns, stopping any train from starting up from any stop until the driver has previously confirmed the state of the exit signal pertaining to him or her.

FGV awards to GMV a contract for developing timetabling software

GMV has won the contract for developing passenger service planning software by Valencia Regional Railway (*Ferrocarrils de la Generalitat Valenciana*: FGV), a public corporation in charge of running the Metrovalencia transport in Valencia city plus the TRAM service in the city of Alicante.

Metrovalencia pools metro and tram transport of Valencia city, its metropolitan area and hinterland, with 133 stations distributed over 156 kilometers.

Alicante's TRAM Metropolitano, for its part, caters for Alicante city's transport network plus that of its metropolitan area and the Costa Blanca axis to Denia, with five lines up and running and 71 stations straddling 13 wards.

The new timetabling app plans, defines and manages the train's timetables and driver rosters to suit. This data is distributed to various systems such as the traffic control centers, the fleet management system, the passenger information system and FGV's enterprise resource planning (ERP) system. It also produces diverse train- and driver-centered service planning reports.

The tool supplied for this purpose, based on GMV's inhouse railway fleet management system ***(SAE-R®)***, sets out to streamline FGV's current operations and its response capacity to any unforeseen events calling for service tweaks.

Fine-tuning Interbus's ITS systems to cater for fare payments with EMV bankcards

Interbus is taking an important step towards cashless operations, tweaking the fleet's onboard systems to operate with the 167-bus fleet of Madrid Regional Transport Consortium (*Consorcio Regional de Transportes de Madrid*: CRTM).

To do so it has contracted from GMV the pertinent equipment that allows for the future phasing in of EMV-enabled or cellphone-emulation fare payment.

The final solution can be broken down into two main phases: firstly, under this present contract, unhitching the current electronic ticketing machines (ETM), supplied by GMV back in 2010, from the client-level fleet-management equipment for communications with the control center.

This involves the fitting of a new onboard modem allowing for direct LAN connection between the ETM and control center while maintaining ongoing RS232 communications for keeping up fleet-management and ticket-vending functions. This will avoid backlogs and delays when sending bulky files via de serial port and allow direct control of this equipment through the LAN connection, providing the EMV card reader with a direct internet outlet for sending transactions to the payment gateway.

The second phase, to be contracted later, will consist of the supply, integration and installation of bankcard-enabled validation equipment.

Inauguration of Cascais's new urban transport service

In late May buses of the operator Grupo Ruiz made the epoch-making maiden voyage in the Portuguese city of Cascáis, heralding the start of service operation.

Those present at the inauguration ceremony included Carlos Carreiras and Miguel Pinto, president and vicepresident of the Cascais Chamber of Commerce; Gregorio Ruiz and Alberto Egido, president and general manager of Grupo Ruiz; representatives of the busmakers and a broad representation of the company's new personnel. During the inauguration and the first moments of operation Álvaro García, Senior Project Manager guaranteed the perfect operation of GMV's ITS, and was warmly received at the event.

Grupo Ruiz was awarded this concession in late April of last year; the new service, with a fleet of 79 buses and 17 minibuses, has boosted local travel options, with new lines and state-of-the-art buses incorporating the transport-management and passenger-safety-information systems contracted from GMV in October 2020:

- The fleet management system provides vehicle positioning information and communication with drivers, allowing services to be tweaked to suit. Door-mounted ridership counters tell operators vehicle occupancy levels at all times.

- Inside the vehicle a 21" TFT screen and LED panel and the PA system keep passengers up to speed with the run and next stop. The control center, moreover, feeds information into the whole set of bus-stop information panels, giving ETAs and vehicle passing times.

- The vehicles are fitted with security cameras and store this information in due accordance with Spain's data protection law while passing on live footage to the control center as need be. The project also includes the fitting of an emergency eCall system, enabling the buses to set up a connection with the 112 emergency call attention center if any potential accident is detected or at driver request, enabling the emergency services to react immediately.

GMV renews the CRTM maintenance contract for Avanza and ALSA

■ In early 2021 GMV renewed the maintenance contract with the two major operators Grupo Avanza and Grupo ALSA.

In the case of Avanza the contract is based on all-in maintenance of the onboard ticketing and fleet-management systems for the 522-bus fleet, in total, of Larrea, Llorente, Interurbanos and Etasa-Alacuber. This renewal is based on first- and second-level corrective maintenance, equipment repair on GMV's site and a 7x24 on-call service for critical hardware and software problems.

As for ALSA the maintenance contract is based on the correction of hardware faults on GMV's site and ticketing software faults on the 423-bus fleets of Nex Continental, Santo Domingo, ALSA Metropolitana and Irubus.

Corrective maintenance work on both fleets is logged daily on the maintenance web by operators or GMV technicians. Additionally, GMV's project head manages and monitors this work until complete solution and closure, thereby ensuring compliance with the contracted service level agreement (SLA).

All the sales data of ALSA and Avanza's ticketing systems plus the vehicles' positioning data of Avanza's fleet management system are recorded by a central server to generate quality reports that are presented by the operator to the Madrid Transport Consortium (*Consorcio de Transportes de Madrid*). These show punctuality and service performance, onboard sales, validations and partial payments between zones, etc.

Realtime bike rack sensor occupancy data

■ Riding a bike to or from the bus can greatly improve a traveler's access to areas that may not be well-served by transit. Many agencies have installed bike racks on the front of their vehicles, but it's not guaranteed that a space on the rack will be available.

GMV Syncromatics, has collaborated with DASH in Los Angeles to introduce realtime bike rack sensor occupancy data in our dispatch software.

Dispatchers will now understand how many bike spaces are available on vehicles throughout their system at that moment. And in the near future, bike rack occupancy data will also be accessible via historical reports.

This update provides planning and policy decision makers with the information they need to ensure their systems best accommodate first and last-mile connections. From reevaluating bikes onboard policies to planning for route expansion in areas with high bike + bus ridership, bike rack sensor occupancy data will bring benefits for transit planners and operators alike.

We're excited about the future benefits for riders, too, as we look to make this information available over the next year through our custom rider app and third-party applications. If a rider sees the arriving bus has a full bike rack and they have some flexibility in their departure time, they may choose to wait for the next bus or they may choose to use another travel mode.

Similar to our passenger crowding tools and data, we're hopeful that realtime bike rack sensors can play a role in restoring confidence in transit and promoting alternatives to driving.

This new feature can be yet another tool transit practitioners use to strengthen first and last-mile connections and improve the transit rider's experience.

Launch of ERASMO, the European autonomous-driving project

GMV is leading technical project direction and coordinating hardware and software positioning tasks. It is also supplying the high-precision GNSS-based algorithms and the positioning-integrity algorithms for the autonomous connected vehicle

Vehicle positioning systems are constantly evolving to meet the strictest autonomous driving needs. Estimations need to be increasingly precise with guaranteed levels of integrity and safety and technology needs to keep up with the pace. GNSS technology is playing a key role in autonomous driving, but camera-based positioning and V2X connectivity are also essential for safer, more efficient driving with fewer accidents.

The three-year Enhanced Receiver for AutonomouS MObility (ERASMO) project is being co-funded by the EU Agency for the Space Programme (EUSPA), taking its cue from the former European GNSS Agency (GSA). It aims to tap into the services offered by Europe's satellite navigation system, Galileo, and camera-based positioning to contribute towards autonomous driving system including a V2X communications interface (5G) designed to allow cooperative information exchange between vehicles and their surroundings. It will also improve system performance, speed and latency to give it an edge over all other market competitors.

ERASMO is being led by the company Nextium in collaboration with partners from the whole of Europe who boast between them a vast range of critical road-transport applications: GMV, Renault, Université de Technologie de Compiègne (UTC), Artisense, Septentrio and VVA.

GMV holds responsibility for technical project direction, coordinating positioning-application hardware and software tasks and the combination of information between the various sensors.

GMV is supplying too the GNSS-based high-precision algorithms as well as the algorithms combining information from different sensors to provide the connected autonomous vehicle's required positioning integrity.

GMV is leader in cooperative transport systems (based on ITS-G5 or 5G). It is also responsible for defining the positioning use of the car's V2X-based C-ITS services and exploring 5G's communications and advanced positioning possibilities. GMV, last but not least, is providing the communications software in charge of uniting all system components in a synchronized and robust way.

GMV integrates Portugal's NAP information into SATELISE

As part of the SATELISE pilot scheme on the toll roads of *Norte Litoral* (A28) and *Via do Infante* (A22), GMV is to integrate information from the Portuguese traffic authority's National Access Point (NAP) to pass on relevant information to the user's toll-payment smartphone app.

NAPs play a crucial role in Europe's mobility data exchange procedures. A NAP is a web-based portal handling data concerning all the following: safe and secure truck parking areas (SSTP), real time traffic information (RTTI), safety related transport information (SRTI) and multimodal travel information (MMTIS), dealing with all modes like train, bus, metro, cycling etc.

The project will develop a web-based interface to allow the NAP to be quizzed periodically from the SATELISE backend. Available information is coded in DATEX II format, a European standard governing traffic-data exchange between European traffic management centers. The DATEX network currently consists of 50 to 60 operational nodes organized in various types of networks and nodes. Most of these nodes are used for exchanging data at national level though some also cater for international exchange.

The traffic information will be sent to the smartphone whenever SATELISE consults the server about events in the area where the vehicle is running.

Users will receive information as text messages and predefined event images, by means of an information window if the app is open and in the foreground or as a system notification if the app is in the background or the telephone is blocked or the screen turned off.

The behavior of the app's "text-to-speech" function will also be checked out as an alternative for users to receive traffic information in a safe and non-distracting way.

GMV gives a connected-vehicle session in the ASEPA course

The previous four Autonomous and Connected Vehicle Specialization Courses have been so warmly received that many partners and sympathizers have been keenly advocating the holding of a fifth course, online this time to ride the current pandemic-engendered telematic boom, and the University Automobile Research Institute (Instituto Universitario de Investigación del Automóvil: INSIA-UPM) duly stepped up to the plate.

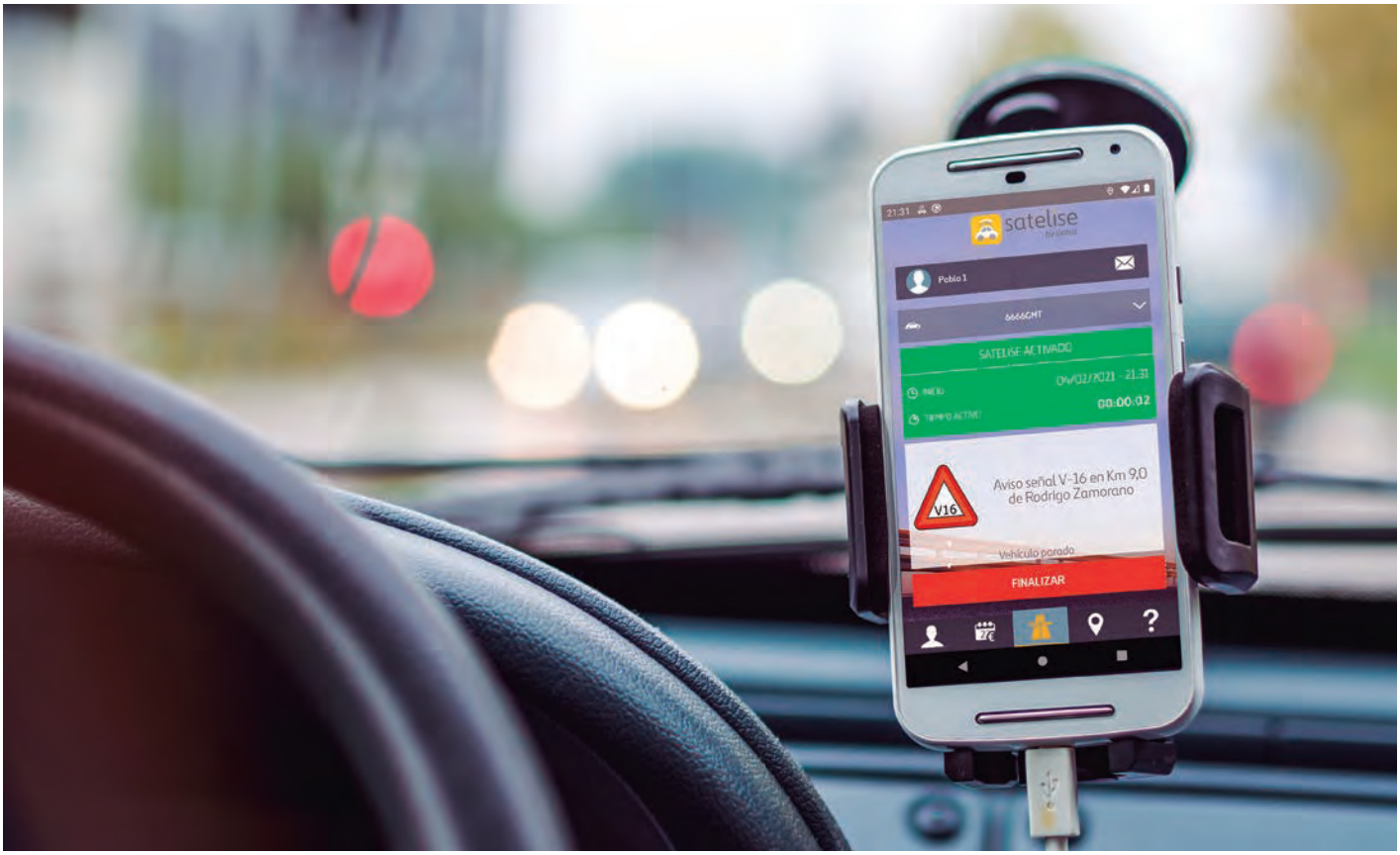
This was a two-module course, one dealing with the autonomous vehicle and the other with the connected vehicle.

From mid-May to late-June the course, held this year in online mode, was given by ten experts in these future specialties, not only researchers and academics but also representatives of the main firms and the foremost autonomous- and connected-vehicle brands.

As in previous courses GMV gave one of the sessions, presenting various vehicle-communication applications. This session gave details on a wide range of connected vehicle services, where GMV is inputting its vast experience.

The 2021 course will be harnessing the advantages of an online format to facilitate participation by Spanish and Ibero-American automotive professionals and colleagues.

SATELISE in the C-Roads testing phase



An update of the SATELISE app has been deployed in AUTEMA (the toll road running from Terrasa to Manresa) in the C-Roads testing phase.

The SATELISE app has been updated to integrate and validate C-ITS services on a smartphone by means of mobile communications as an alternative to V2X communications (ITS-G5) integrated in the vehicle's on board units (OBUs).

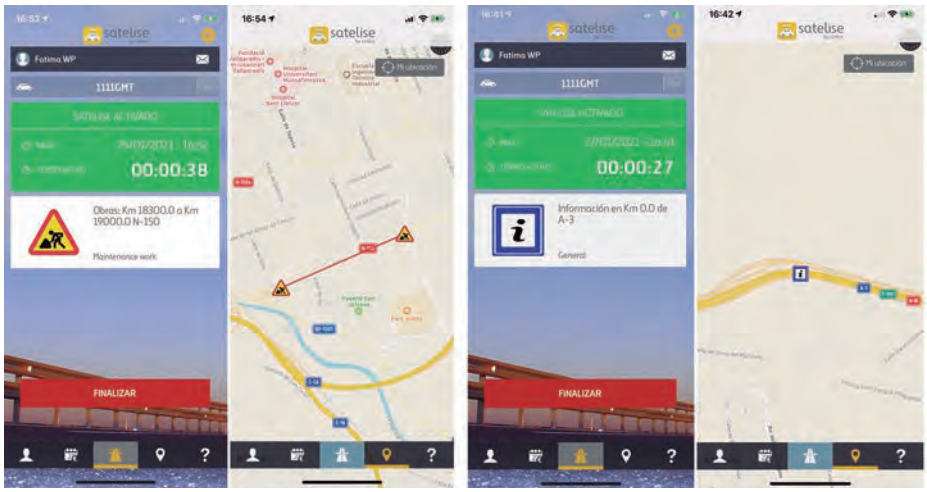
The SATELISE platform for these pilot tests is connected not only to the DGT 3.0 platform and the DGT's NAP but also Catalunya's traffic information service (Servei Català de Trànsit: SCT), whose point of access has a DATEX-II-format web interface that enables the app's traffic information to be updated every 5 minutes.

This update will provide SATELISE users with C-ITS services giving information on traffic, roadworks, hold-ups, accidents and other road warnings pertaining to the vehicle's current position and in the handheld itself, without having to install additional apps or sign up for any new service.

The pilot scheme, currently in final testing phase, will enable the performance of the various traffic information platforms to be studied while also checking that the information services are suitable for distribution to the public.

To validate the C-Roads use cases, various KPIs and function parameters have been defined in the application. This allows for study of the traffic-efficiency and safety impact areas and user response to the various events that may occur and any traffic information received on the app.

Finally, the deployed C-ITS services will be able to ascertain how far available information is conducive to safer, more efficient driving.



GMV holds a webinar on using the smartphone to manage low-emission zones

In mid June GMV put on a webinar under the title "The smartphone as a tool for managing low-emission zones" guided by Carlos Barredo and Pablo Rivas from GMV's automotive sector.

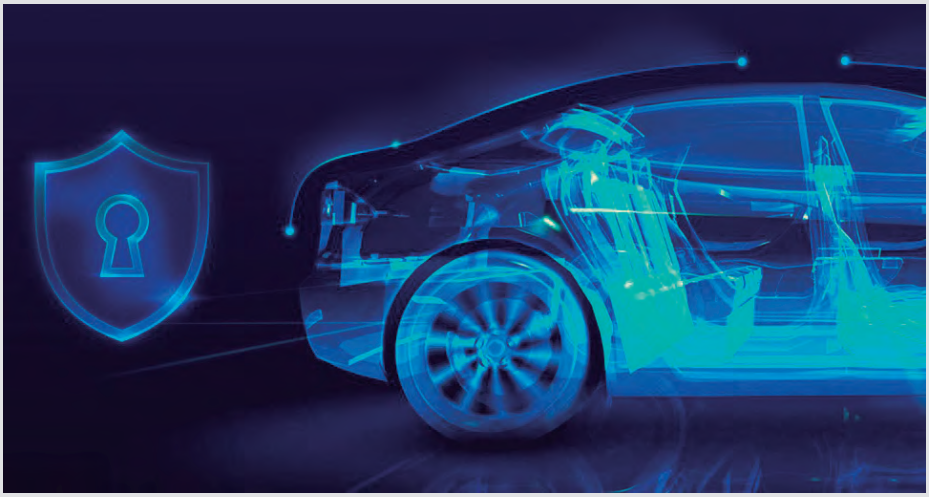
The recently passed law 7 of 20 May 2021 on the climate change and energy transition (*Ley de cambio climático y transición energética*) governs the low emission zones for cities of over 50,000 inhabitants. In the webinar GMV presented a smartphone- and GNSS-based system architecture for running these zones.

This iOS- and Android-enabled app gives drivers information on the city's low-emission zones and the eligibility requisites for entering them.

Connection with the government website, likewise developed by GMV, will allow a knock-on connection through the mobile app with drivers. They will thus receive any relevant information on these zones from the local councils running the service.

The webinar showcased GMV's trailblazing automotive and satnav technology, after which the audience had the chance to ask any questions about any aspect of concern to them.

GMV participates in Universidad Rey Juan Carlos's summer course on vehicle cybersecurity



In late June GMV participated in the "Vehicle Cybersecurity Conference", organized by Madrid's Universidad Rey Juan Carlos.

Marco Donadio, GMV's Automotive Business Development and Cybersecurity Project Head, gave a paper under the title "Attacks, technology and threats in the connected and autonomous vehicle".

Today's state-of-the-art vehicles are incorporating different inhouse connectivity and computation functions. Outward vehicle connectivity is a must for safety, comfort and passenger entertainment. Unfortunately, there is then a direct relation between the number of self-driving functions brought into each manufacturer's range and the attack risk posed by these outward connections.

Marco's introduction brought out the importance of vehicle cybersecurity and ran through today's systems, the latest trends and the possible future effect of new technology like 5G, autonomous cars and big data, among other factors.

He then moved on to practical examples of the various types of vehicle vulnerabilities as brought out in GMV's Car Hacking laboratory.

He wound up by explaining how these vulnerabilities might be mitigated, starting with secure software development and then applying risk analysis and pentesting techniques, where GMV has been leader for some years now.

Cooperative STREETS pilot underway

Road mobility is not only about buses, cars or trucks getting from point A to point B; it's a whole lot more. Urban road mobility faces several challenges, such as traffic flow, complexity of the road network, pedestrian safety or different traffic priorities.

Accidents lead to severe congestion, cutting a major artery of a city in just a few minutes, impacting hundreds or thousands of people's lives.

Any accident will always effect not only those directly involved but also everyone else around them: everyone pays with time lost. Factor in too the added congestion and pollution caused by any accident.

Neither does the story stop there. Accidents also affect emergency services, putting other people's lives at risk where rapid response is of the utmost importance. And the snowball effect can go on and on, just because someone was distracted while driving.

Under the C-STREETS project, co-funded by CINEA through the Connecting Europe Facility (CEF), GMV is working to improve road safety by setting up a new line of built-up-area mobility solutions.

These solutions encompass a set of services currently being piloted across

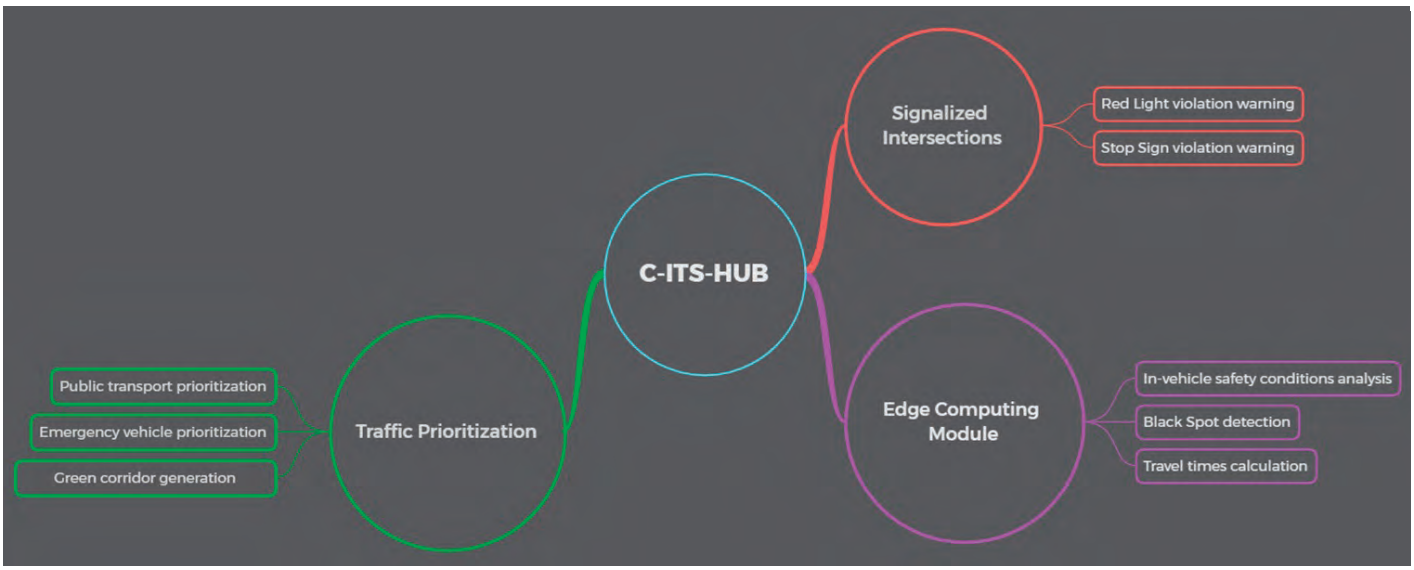
Europe on all countries participating in the C-ROADS platform, taking advantage of ETSI G5 technology. This technology is what enables car-to-car and car-to-infrastructure communication.

The services under development by GMV include calculation of travel times, identification of blackspots, in-vehicle safety condition analysis, and traffic prioritization and signalized intersections.

Taken together, these services will ensure better traffic awareness and efficiency. The Intersection monitoring and traffic prioritization will also enhance safety, as drivers will get early warning of potential traffic violations, or any incoming emergency vehicles.

These services will function under the same platform —the C-ITS Mobility HUB— the main goal of which is to provide road operators with a real-time infrastructure overview and help them take the necessary decisions to optimize the traffic and safety of the cities they are responsible for.

The developments currently underway are scheduled to finish by mid-2022 and are expected to be piloted in Lisbon until the end of 2023.



Hannover Messe, the engine of industrial transformation

For the first time the world's biggest industrial tradefair, Hannover Messe, has been held totally online, this year under the banner theme of innovation, inspiration, interaction.

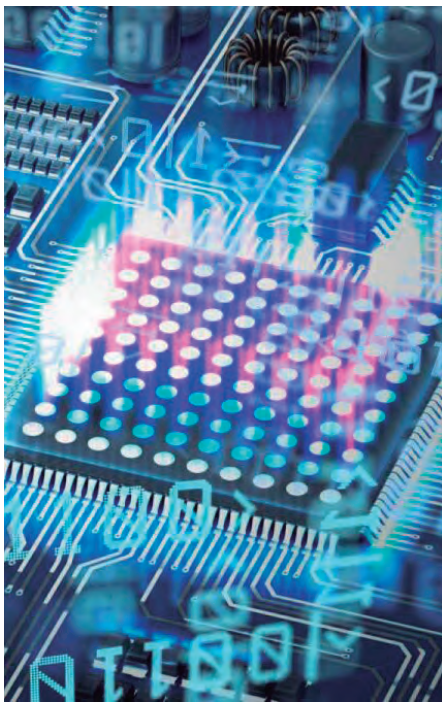
GMV, one of the tradefair's sponsors, showcased its automation-, digitalization- and cybersecurity-services and solutions. GMV rises masterfully to the challenges posed in these three great technological areas to make sure Spain's industry is competitive worldwide with sustainable and efficient industrial processes throughout its whole value chain.

Many industries around the world are reinventing themselves to bring themselves into line with the coronavirus-pandemic situation, relying increasingly on green and digital technology to keep up with market changes. This is the right time to make workplaces more inclusive, building more resilient supply chains and switching to more sustainable forms of production.

Digitalization and automation come into their own here, but without ever losing sight of the importance of working in a 100% secure environment.

Advances in robotics AI, for example, are streamlining the man-machine interface to boost the value of labor power, empowering workers and boosting resilience.

GMV joins the European Quantum Industry Consortium



With the aim of boosting the quality and competitiveness of Europe's quantum industry, GMV has joined the European Quantum Industry Consortium (QuIC), Europe's biggest quantum-industry organization. QuIC, founded at the behest of the European Commission, defends, advocates, promotes, and fosters the common interests of the European Quantum Industry towards all Quantum Technology stakeholders.

QuiC now has over 100 members, representing between them major corporations, SMEs, research and academic centers and associations, all of them European and all working in quantum technology. QuiC was born to develop a strong European Quantum Technology ecosystem to match similar initiatives in the USA (QED-C) and Canada (QIC).

GMV broadens its portfolio of AI solutions for Legaltech with the collaboration of Atomian

Lawyers, public prosecutors and debt-recovery firms need to process hundreds of judicial notifications on a daily basis. The manual processing is very costly and cumbersome; it is also error prone and hence inefficient.

GMV and Atomian therefore put their heads together to offer the legal sector a solution for automating the detection and extraction of information from judicial notifications, such as court data, procedures and parties, number of court orders, procedure heading, classification of content, appeals or key dates. Atomian's technology, crucially, works not with labels but rather cognitive computing that can understand the text like a person, extract key generic features with great precision as well as transcriptions and conclusions drawn from the body of the text.

The product can also produce a summary and encode events. This summary indicates the objective of the notification on the basis of its literal extract plus verbalization of fields taken from the procedure heading and the classification of the content.

This automated reading and extraction of the key information of judicial notifications slashes costs and time while cutting out human error too.

GMV joins in the eCitySevilla project to develop a digital and sustainable city

GMV is bringing its digitalization, robotics and electric-vehicle expertise to this 100% sustainable future city project

The eCitySevilla project is a public-private collaboration initiative led by the Regional Council of Andalusia (Junta de Andalucía), Seville City Council (Ayuntamiento de Sevilla), the Cartuja Technology and Science Park (*Parque Científico y Tecnológico Cartuja*: PCT Cartuja) and Endesa, GMV recently joining in to bring its technological experience and expertise to the table.

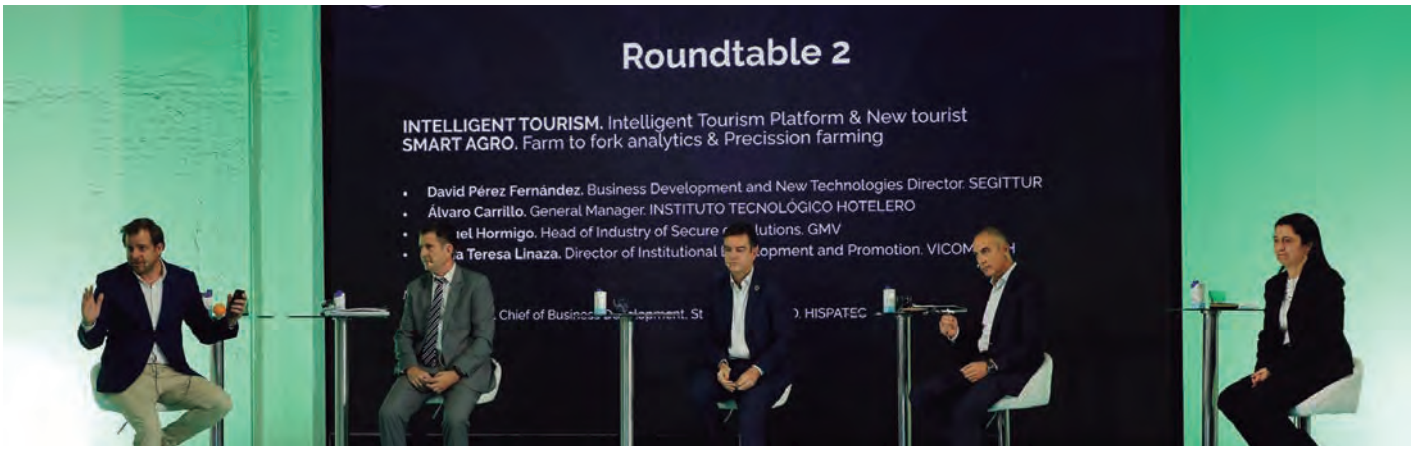
The project plans to develop in PCT Cartuja a digital, open-ecosystem, low-carbon and sustainable city model, bringing forward to 2025 the energy and climate aims originally set for 2050. eCitySevilla is a smart community that seeks to boost the efficiency of traditional networks and services on the strength of advanced digital technology to the benefit of people and firms trading in PCT Cartuja.

Digitalization is the very heart and kernel of this aim of turning PCT Cartuja into a worldwide sustainability beacon and model of energy transitions. GMV will be involved in the Digitalization working group, which aims to use advanced technology that makes a better use of resources and cuts emissions, paying special heed to the UN's Sustainable Development Goals (SDGs), The idea is to help government authorities at all levels to be more responsive to peoples' needs and drive sustainable development in the transition towards a circular economy.

GMV is also bringing its expertise to the Sustainable Mobility working group, working from the premise that future mobility will be electric, interconnected and shared; its key input here is its robotics and autonomous vehicle experience. The initial target is to make Seville a low-carbon city and renew the environment using clean vehicles, such as the electric, driverless shuttles capable of adapting routes to suit passenger destinations by using artificial intelligence.

GMV, in short, is putting its shoulder behind this ambitious project of a future 100% sustainable city driven by the participation of citizens, companies and government authorities, who between them can design and implement a Science and Technology Park of worldwide renown.

Digital, talent-based platforms to favor the farming industry



■ Recovery funds, like Next Generation EU, are going to favor various endeavors, including technology-driven farming. Farming is Spain's biggest employer and money earner but it needs an injection of automation and digitalization to favor farming across the board: bigger crops, streamlined production, higher quality levels, product personalization and traceability, early detection of farming risks, pest- and illness-onset forecasting, reduction of fertilizers' environmental impact, among others.

In the 4th "Artificial Intelligence Summit 2021" of Spain's Association of Electronics, Digital Contents and ICT Companies (*Asociación de Empresas de Electrónica, Tecnologías de la Información, Telecomunicaciones y Contenidos Digitales*; AMETIC), Miguel Hormigo, Industry Manager of GMV's Secure e-Solutions sector, took part in the debate on the key factors in the present and future of the farming and tourism sectors. He stressed the importance of finding out the final user's needs and providing suppliers with real capabilities. He signaled four mainstays of GMV's work: data governance, the function and application of the algorithm, the value chain and interaction.

The closing address was given by the Secretary of State for Digitalization and Artificial Intelligence, Carme Artigas, who argued that "AI is a huge opportunity for generating new business models, boosting efficiency, building the data economy and quality jobs".

BIDS21, how to share confidential and private data of space projects

■ Artificial intelligence is now coming into its own in space projects, where the solution is just as important as the data quality. The current potential of machine learning means it can now complement or even, in some cases, replace classic methods for solving such tasks as signal processing or anomaly detection. Moreover, the greater the amount of data available, the better the performance, so it is now routine for several organizations to collaborate in a common solution. This can spring privacy problems, however, and it is not always possible for the data to be shared among different parties.

In the Big Data from Space 2021 (BIDS21) event Juan Miguel Auñón, Data Scientist of GMV's Secure e-Solutions sector, presented a brand-new solution to this problem: ***uTile PET*** (Privacy Enchancing-Technologies) for the collaborative development of AI algorithms without jeopardizing the privacy of any party involved. He put forward as an example secure k-means, a clustering algorithm allowing organizations to collaborate in a common good, safeguarding privacy along the way.

uTile PET is GMV's inhouse solution for harnessing confidential and private data in order to improve analytical models and machine-learning algorithms while complying at all times with organizational requirements, safeguarding data privacy and abiding by all privacy legislation. ***uTile*** strikes the right balance between data privacy and usability, using advanced cryptographic methods to keep data encrypted while all necessary calculations are carried out. It thus ensures organizations' sensitive data is never exposed or shunted between departments, organizations or countries.

Aiming at sustainable industry

GMV takes part in a meeting organized by the German Chamber of Commerce for Spain to debate the sustainable development goals (SDGs)

In late March the German Chamber of Commerce for Spain (Deutsche Handelskammer für Spanien: AHK) held the online event "Agenda 2030: Towards sustainable reindustrialization in Europe". GMV participated in this discussion panel together with other companies trading on the Spanish and German markets, to talk about the Sustainable Development Goals (SDGs), especially those impinging directly on the industrial scene.

GMV's president, Mónica Martínez Walter, shared a panel with Miguel Fernández, from Merck España; Miguel Ángel López, from Siemens, and Kirsten Raapke, from TÜV Rheinland Spain. AHK's CEO, Walther von Plettenberg, moderated the session focused on specific green and sustainable-industry goals: SDG 9 (Industry, innovation and infrastructure), SDG 12 (Responsible production and consumption) and SDG 13 (Climate action).

The event brought out the importance of a resilient industry based on innovation and sustainability, capable of coping with crises like the one we have suffered in 2020. The European Commission has been working hard since 2010 on industrial policies targeted towards this field. But the figures still show that industry's contribution to GDP on a Europe-wide level is lagging behind EC's goal. Spain, indeed, has recorded a growth, albeit modest. As a strategy for strengthening the business fabric, the speakers stressed the increase in R&D outlay and society's growing interest in new technology, among other measures.

One of the key factors in achieving an innovative, inclusive and sustainable industry (SDG 9) is digitalization, which translates into higher productivity, energy efficiency and a saving in resources. Along this line Mónica Martínez emphasized technology as the main driving force behind business growth. GMV, always firmly committed to research, development and innovation, is currently involved in many R&D projects, especially at Europe level and is working on a good number of SDG-related projects too. Its roster of activities include space technology, robotics, planetary defense, earth observation, climate services for farming, modernization of forestry, aircraft control systems, maritime safety, border security, human-migration management, green and smart cities, cybersecurity, healthcare and telemedicine, Big Data and artificial intelligence.

The event closed with a networking session in which attendees could mingle with speakers to ask questions and express their concerns.

This is the first of a series of three encounters to be held as prelude to the 5th Hispano-German Business Encounter, scheduled for late October.

GMV inspiring female talent

Right from the word go GMV has always been a keen supporter of educational initiatives as one of the prime drivers of development and social transformation. These initiatives range from chats and activities with primary-school pupils to mentoring sessions with university students, always with the overarching aim of nurturing their scientific-technological skills in the various educational stages.

On 11 May, for instance, GMV held a virtual workshop to look at how a product is introduced into the market. Organized by GMV in collaboration with the foundation Asti Talent & Technology, the workshop, as part of its STEM Talent Girl program, targeted third- and fourth-year secondary pupils and baccalaureate students.

Working from the real case of the ***DTD100*** fleet-management and ticketing system developed by colleagues of GMV's Intelligent Transportation Systems (ITS) sector, the workshop ran through the various stages from design, tendering procedure, software- and hardware-development, system architecture definition and the service-maintenance phase to final implementation.

This activity forms part of the fifth STEM Talent Girl, which held its closing ceremony for the school year 2020/2021 on 20 May in Boecillo Technology Park (Valladolid). By means of this program Fundación Asti and the collaborating organizations aim to empower the new generations of female talent.

GMV has been collaborating with the ASTI Foundation, based in the Castilla y León region, since 2017. Under this program GMV colleagues give chats, master classes and individual tutorials to pass on their own experience and, above all, their passion for technology, emphasizing the great number of career outlets.

STEM Talent Girl Conference

On 16 June GMV took part in the online STEM Talent Girl Conference, organized by Castilla y León Televisión and the Regional Ministry of Family Matters and Equal Opportunities (Consejería de Familia e Igualdad de Oportunidades) of the Regional Authority (Junta) of Castilla y León.

Sara Gutiérrez, manager of GMV's automotive business unit, took part in the panel discussion on Technology Transfer in the Business World.

She stressed the need to give a higher profile to women with successful science and technology careers to serve as a role model. Firms like GMV, Sara, went on, are always looking for people with Science, Technology, Engineering and Mathematics (STEM) skills.

Firms are therefore duty bound, she argued, to encourage the taking up of STEM careers by girls and young women. In the not too distant future many more STEM-skilled professionals will be needed, and we at GMV are keen to take them on regardless of their gender.

With this aim in mind GMV participates actively in initiatives like this one, designed to steer girls towards scientific-technological careers.

The wellbeing of its staff, one of GMV's overriding concerns

GMV sets in motion its Wellbeing scheme with the aim of ensuring its staff's wellbeing in all aspects of their lives

Talent, fruit of its teams' endeavors and responsiveness, is one of GMV's calling cards. It is therefore determined to guarantee the best working conditions and workplace climate. But it doesn't stop there; it also takes a lively interest in the much broader picture of its staff's physical, mental and emotional wellbeing.

The UN's Sustainable Development Goal (SDG) 3 "Good Health and Wellbeing" sets out to ensure healthy lives and promote well-being for all at all ages as a sine qua non of sustainable development. This program is broken down into four main targets: physical and emotional wellbeing, social wellbeing, wellbeing and health (especially in these times of pandemic) and financial wellbeing.

The aim of GMV's wellbeing scheme is to bring out the importance of looking after yourself personally with the close-by help of team GMV's various corporate activities.

Our colleagues David Merino and Miguel Recio explain below their experience of taking part in these hallmark GMV initiatives to encourage a healthy lifestyle and a good environment.

Physical and Emotional Wellbeing

David Merino

Head of GMV's Maritime Defense and Security Surveillance section

When I was asked to talk here about physical wellbeing I accepted in a heartbeat, especially when the request itself was so flattering.

The truth is I was always the sort of kid who got involved in the typical football and basketball teams with my schoolmates; any proposed sporting activity, in fact, was fine with me. But I didn't really start to run regularly until my great GMV friend Fernando passed on the bug. We would go out at midday. At first I went out each time with a heavy heart but we egged each other on and the reward was certainly worth the effort. It was like kick-starting the day anew, a recharging of the batteries that saw me through the afternoon at full throttle.

We began to sign up for fun runs and we set up a group of runners of all ages and abilities. GMV helped out by brokering all our races. A real luxury, without a doubt.

Everyone who knows me knows I love competition so you can imagine what the intercompany Olympics means to me. It gets me out to run a few extra kilometers for a couple of weeks. The GMV team even stood once on the top of the podium.

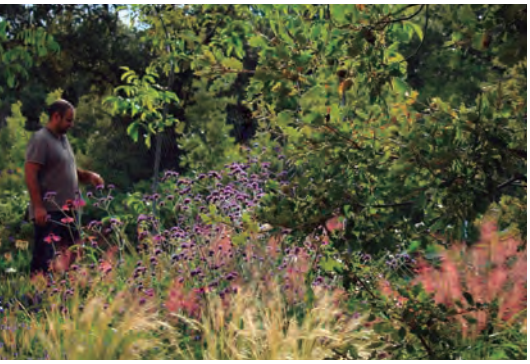
I believe that sporting activities of this type are a huge leg-up for the working teams, helping us to get to know each other outside the workplace too. The act of setting up the teams, settling on race strategy and working towards a common goal is a massive boost to group camaraderie.

One of the things I've always liked most about GMV is its support of sport in a number of ways, ranging from building dressing rooms to financing sporting activities like the football league, basketball, volleyball, the Gympass program, the intercompany Olympics, company runs, sailing, etc. Many options for all tastes, which I urge you to try out if you haven't done so yet.

Social Wellbeing

Miguel Recio

Head of the software development division of GMV's Secure e-Solutions sector



I've always dabbled in gardening since my childhood years, thanks to my dad, but my real landscape-gardening hobby took off when my wife and I bought a house plot in Segovia and we then had to design a garden.

The creation of this garden, genning up from books, visiting other peoples' gardens and writing a blog were all an enriching learning process in which I came to know many fascinating people. Mixing with professional and amateur landscape gardeners is crucial because I've always understood it as an intrinsically sociable process above all. A garden, after all, is a place to create and enjoy with your loved ones and there will always be a mind-broadening input of ideas from your own particular set.

I therefore jumped at the chance of taking part in a "Brown Bag", a company initiative where employees enjoy a laid-back snack-break encounter and swap notes with colleagues on various themes and issues. My own experience was really rewarding, enabling me to bring some GMV colleagues into my circle of gardening friends.

GMV is a company with a very powerful culture and philosophy, where camaraderie and group feeling are mainstays. Finding out about the hobbies and interests of the people I work with everyday helps to knit together this culture into an even tighter fabric.

I would encourage anyone who enjoys a hobby to take part in activities of this type; they're sure to find out that some of the people they work alongside every day share this same interest. If you don't dare run a "Brown Bag" yourself, I'd recommend you at least to keep up to speed with the ones being held. You're sure to find out that, as well as great professionals, you're also surrounded by people with a very rich cultural life.

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