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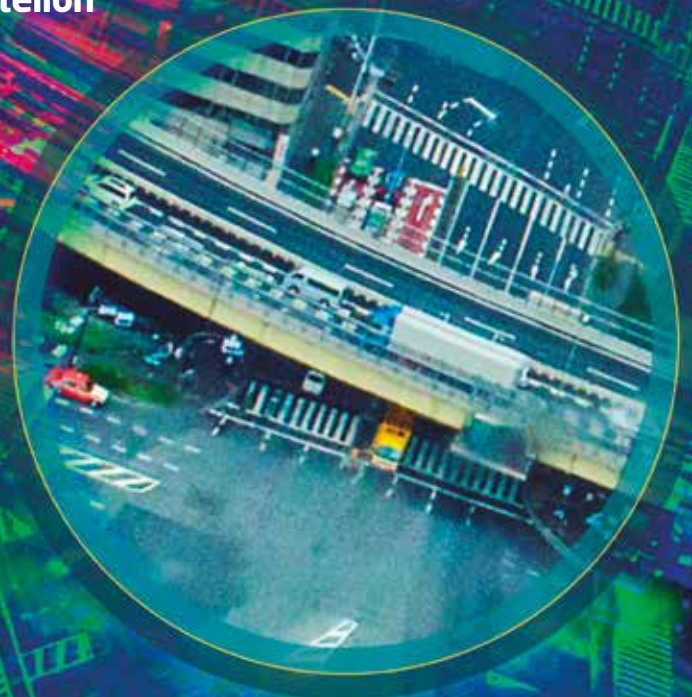
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DEC20 | MAR21

IT Cybersecurity and transport

+ ARTICLES

ERTMS: All aboard!
AIXM in Abu Dhabi's airports
Guadalajara-Colima highway in Mexico
La Sagrera, the station of stations
Southern railway access to the port of Castellón
Reconditioned trains for Kenia
Station remodelling in Extremadura
2030 Agenda / CSR: Sustainable mobility
Brand Spain: The kingdom of castles
Ineco team: Safety and health



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EDITORIAL

A setting for protection and entrepreneurship

We end 2020 focused on the two key pillars of our work, now more important than ever with the COVID-19 pandemic: cybersecurity, the key to protecting knowledge; and entrepreneurship, which is essential to make progress and improve the quality of life of the community as a whole.

In helping improve the cybersecurity of organisations, we have had to develop measures and action plans to resolve incidents on rail networks, satellite navigation systems and critical infrastructure. In an increasingly digital world, ensuring security is as crucial as in the physical world: both worlds converge in ground-breaking projects such as ERTMS, the subject of an article focused on our most recent work for the EU with on-board systems for trains and the European Galileo satellite system, where we have now been involved for ten years.

Contributing to improved transport safety has made us resilient entrepreneurs, capable of recognising failure and providing solutions. That has been one of our main aims as the Supervising Agent of the Guadalajara-Colima highway in Mexico, a strategic route on which the latest data show a marked improvement in the accident rate. The inspection and servicing of the former Renfe trains that will provide regional services in Nairobi and the digital systems developed to improve aircraft information at Abu Dhabi airport are further examples of our work to improve safety.

Our entrepreneurial drive and passion make us adaptable and give us the capacity to carry out projects within Spain aimed at creating more sustainable, appealing and efficient transport. Examples include the new La Sagrera station, in Barcelona, a megaproject led by Ineco based on multimodality that will radically change transport in the city; and improvements to stations in Extremadura and in freight access to the port of Castellón.

And to conclude with entrepreneurship, with an eye on sustainability, we now share with our readers an overview and the specific steps taken by the company around Agenda 2030 and the Sustainable Development Goals, one of the foundations of our Strategic Plan and a shared project that has involved every department and every person in our organisation.



“We have come to the end of 2020, a year in which our priority has been to ensure the safety and well-being of every team at Ineco, focused on the two essential pillars of our work: cybersecurity and entrepreneurship”

CARMEN LIBRERO
President of Ineco

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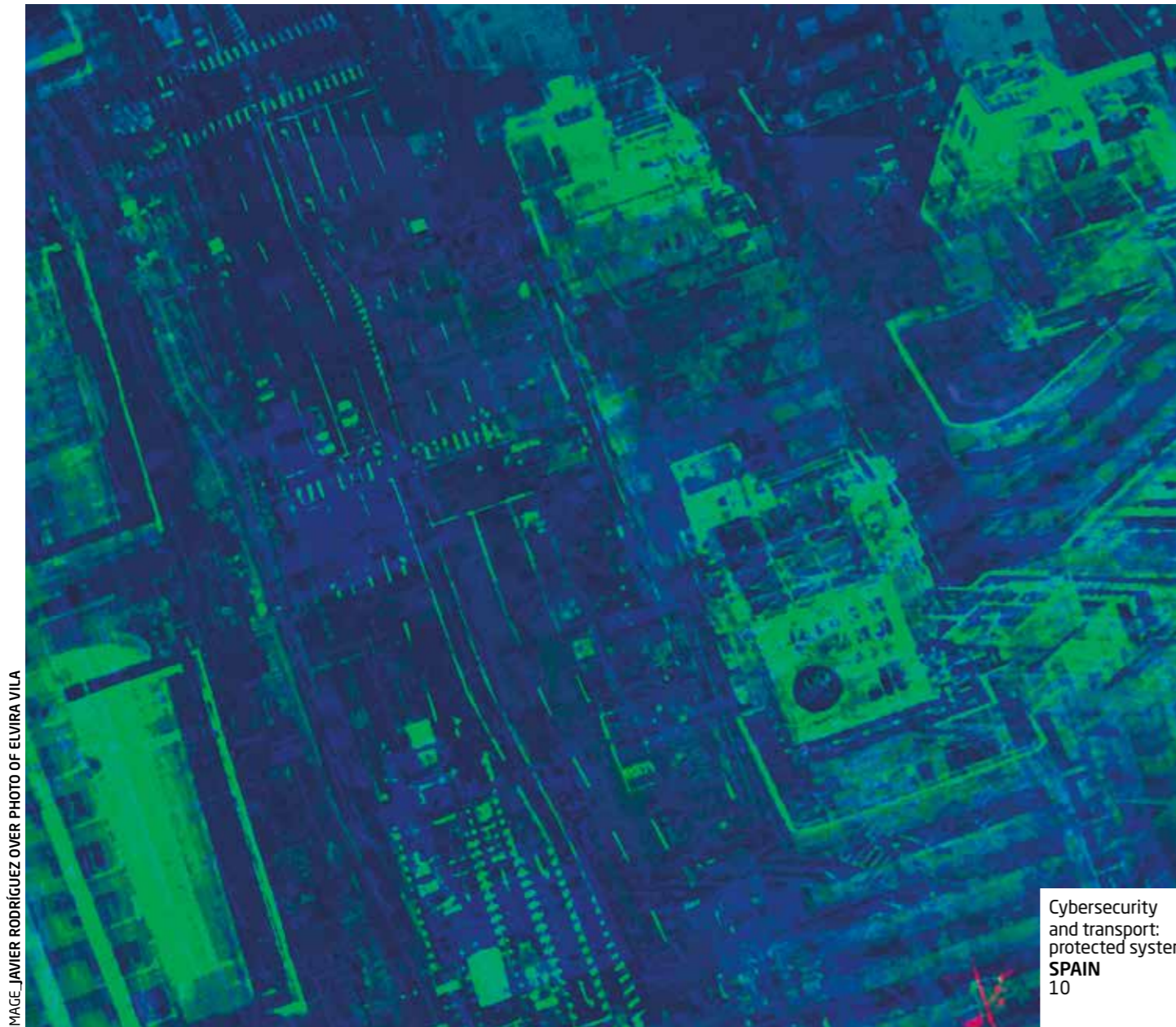


IMAGE JAVIER RODRÍGUEZ OVER PHOTO OF ELVIRA VILA

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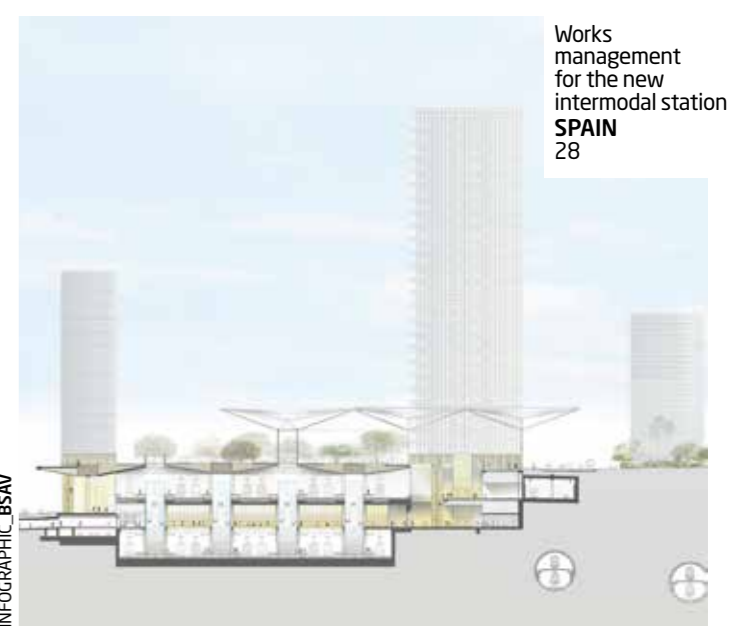
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ISSUE 70 COVER
CYBERSECURITY AND TRANSPORT: PROTECTED SYSTEMS.
IMAGE_JAVIER RODRÍGUEZ OVER PHOTO OF ELVIRA VILA

PHOTO: MINISTRY OF TRANSPORT AND COMMUNICATIONS OF PERU



PERU



PHOTO: CORPAC

WORK RESUMES ON THE EXPANSION OF THE AIRPORT IN LIMA

The expansion of Lima's Jorge Chavez airport, which Ineco began supervising with its partner CESEL in 2014 for OSITRAN (Public Transport Infrastructure Investment Oversight Board), has been reactivated. Airside earthmoving started in December 2019 (photo, left) and May saw the awarding of the works for the

new control tower that will stand at 65 metres and is already well advanced (photo, right). In August, the works began on the 3,480 metre second runway. According to the airport's concession holder, Lima Airport Partners (LAP), both projects will be operational towards the end of 2022.

STUDY FOR A NEW AERODROME IN THE AMAZON JUNGLE

In consortium with Peruvian consultancy HOB, Ineco has been awarded the contract to prepare a pre-investment study for the creation of a new aerodrome in the Barranca District in the Loreto department of the Peruvian Amazon.

The study will define the options in terms of location and size. Its scope will include an analysis of traffic demand; an analysis of the airspace and flight procedures; the orientation of the airfield; technical, economic, social and environmental issues; and, engineering with respect to the profile and cost of the project.

Ineco will be responsible for the work related to aviation, while HOB Consultores will handle the aspects of the project related to the location, data collection and fieldwork.

PHOTOS: MITMA



SPAIN

OPENING OF THE ZAMORA-PEDRALBA AVE LINE IN GALICIA

On 26 October, the Minister for Transport, Mobility and Urban Agenda officially opened the high-speed line in Galicia between Zamora and Pedralba de la Pradería, leaving only one leg to complete the line. The new railway, 110 kilometres long and with 14 viaducts and 9 tunnels, is outfitted with level 2 ERTMS and has been built for speeds of 300 km/h.

Ineco has been heavily involved in work on the line. It is currently the works and environmental manager for

several sites on the last unfinished section, between Pedralba and Ourense (see IT67). At 101 kilometres long, and with 32 viaducts and 31 tunnels, Transport Minister Abalos declared that "this is one of the most complicated stretches of high-speed railway in Spain and Europe".

The official opening was also attended by the Minister of Work and Social Economy, Yolanda Díaz, and the Presidents of Adif and Renfe, Isabel Pardo de Vera and Isaías Táboas, along with other leading figures.

UNITED KINGDOM

HS2, THE 'BACKBONE' OF THE NEW UK TRANSPORT NETWORK

Ineco was involved in the assessment of the integration of the Birmingham to Leeds eastern leg of HS2 with other rail projects in the region, carried out by the UK's National Infrastructure Commission (NIC) at the request of the Government. The report for that assessment concluded that investments in the North and the Midlands should be given higher priority since they offer significant improvements in capacity, connectivity and reductions of greenhouse gas emissions from the mid-2030s.

Having commissioned an independent review of the entire high-speed rail project, in February 2020, Prime Minister Boris Johnson confirmed the

need for, and the importance of, HS2 as the new 'backbone' of the country's transport network, while at the same time announcing a new rail plan for the North and the Midlands.

Meanwhile, in September, work officially started on Phase 1, which is expected to generate 22,000 jobs in the United Kingdom over the coming years.

Ineco has been working with AECOM and Capita on the preliminary design of the civil works and environmental impact studies for Lot 2 of Phase 2B of the Birmingham-Leeds leg since 2017. In 2012, Ineco started work with Capita on Phase 1, London to Birmingham.

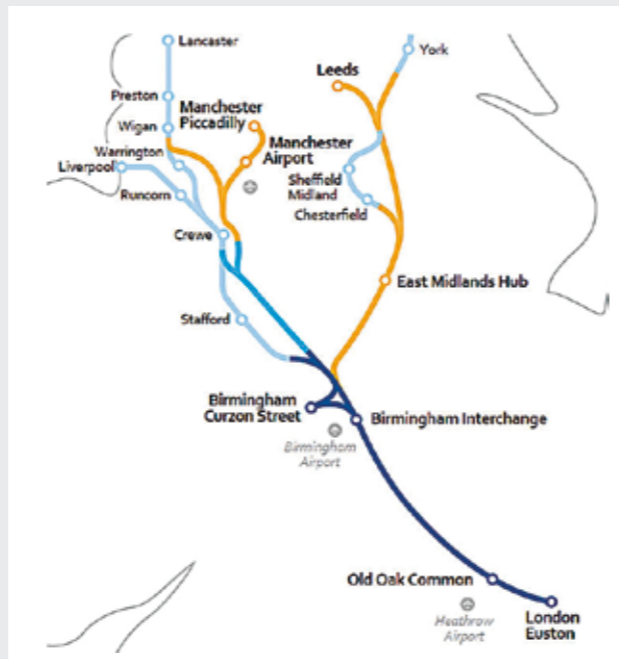


IMAGE: HS2 LTD.

EUROPE

RAILGAP, HIGH-PRECISION TRAIN LOCATION

Ineco is a member of the international consortium awarded the RAILGAP (Railway Ground truth and digital MAP) project, part of the Horizon 2020 Programme of the European Global Navigation Satellite Systems Agency (GSA). CEDEX (Spanish Centre for Studies and Experimentation of Public Works) and the manager of Spain's railway infrastructure, Adif, are also members of the consortium, led by Rete Ferroviaria Italiana (RFI).

RAILGAP will collect massive quantities of data from commercial trains. Its focus will be to develop innovative high-precision tools to collect basic route data and digital mapping for railway lines with unprecedented accuracy. The project, which started in Autumn 2020, will allow reduced energy consumption by ERTMS and command and control systems, increasing their economic and environmental efficiency.

KUWAIT



PHOTO: INECO

THE INECO TEAM GOES INTO ACTION AT KUWAIT AIRPORT

The deployment of Ineco's integrated project management team to take operational readiness activation and transfer (ORAT) for the expansion of Kuwait International Airport (KIA) has begun. In the picture, from left to right, the

first arrivals in October, engineers Ángel Toro, Stephen Manjai and Samuel Machín.

The expansion includes a new 700,000 m² terminal building, extensions to both runways and a new control tower.

INTERNATIONAL
EXPODRÓNICA 2020 AND DACUS EUROPEAN PROJECT

The drone industry continues to grow year after year, and Ineco is active in different fields related to the industry, principally in regulatory issues and air traffic. Ineco experts, Víctor Gordo from CNS/ATM Systems and Javier Carvajal from the *Smart Products* department (in the picture, during their presentation), gave a presentation on smart cities and drones at Expodrónica 2020, which was held virtually in September.



Elsewhere, Ineco is involved in DACUS (Demand and Capacity Optimisation in U-space), which aims to develop a service-oriented demand and capacity balancing process for drone traffic management, integrating tools with predictions based on Artificial Intelligence.

Ineco will develop a dynamic capacity model based on collision risk in this proposal led by CRIDA and ENAIRE, with EUROCONTROL, BR&T Europe, ISA, JEPP, Darmstadt Technical University (TUDA), SSG, Toulouse Metropole and AHA (Netgen-ehf) completing the consortium.

EUROPE
TENERIFE LIGHT METRO, A MODEL OF PUBLIC-PRIVATE COLLABORATION FOR THE UNITED NATIONS

The United Nations Economic Committee for Europe (UNECE) published its case study on Line 1 of Tenerife Light Metro in September. The studies are provided to Governments as models of best public-private collaboration practices to achieve the United Nations' Sustainable Development Goals (SDG).

The case study was prepared by IESE PPP for Cities (Specialist Center on PPP in Smart and Sustainable Cities), with the collaboration of Ineco, and it highlights where the project met the SDGs such as: use of clean energy, improvements to public infrastructure, commitment to sustainable cities, the fight against climate change and collaboration between the public and private sectors.

Ineco was a shareholder and was involved from the beginning in the planning and construction of the two lines of Tenerife Light Metro, opened in 2007 and 2009.



SOUTH SUDAN
THE REFURBISHMENT OF THE MATERNITY UNIT AT BOR HOSPITAL IS COMPLETE

Ineco's 2019 professional volunteer project for the refurbishment of the Maternity and Paediatric Wards at Bor Hospital in South Sudan has come to a successful conclusion. The project, in collaboration with the NGO Doctors of the World, involved the design and construction of a drainage and water-supply system. The company also donated an ultrasound machine to the hospital, which treats more than 15,000 patients.



THE PALMA CONTROL TOWER LAUNCHES ITS VOICE COMMUNICATIONS SYSTEM

Ineco supported Enaire in the roll-out and commissioning of the new voice communications system for the control tower at Palma de Mallorca airport (in the picture), completed in June.

The new dual system, that ensures communication between air traffic controllers

and pilots, uses digital Voice over Internet Protocol (VoIP) technology to manage air traffic. It provides features that allow integration of services with the REDAN data network, improve interoperability of systems and the availability of services in the event of an incident.

EUROPE
AGREEMENT BETWEEN INECO, ISDEFE AND INTA FOR THE EUROPEAN SPACE PROGRAMME

Ineco, INTA and Isdefe have signed an agreement to jointly pursue projects of mutual interest in the opportunities generated by the European Union's new Space Regulation. The memorandum cements the collaboration of the three public bodies that began in 2019.

RAILWAY PROJECTS FOR THE RAIL NETWORK OF THE PORT OF SAGUNTO



cargo terminal and a vehicle terminal, both electrified, and security and communications facilities.

In April, Adif also awarded the works for the new freight rail access, whose project was also designed by the company in 2019; three branches totalling 5.6 kilometres, for 750 metre trains to connect Sagunto with the Mediterranean and Cantabrian-Mediterranean Corridors.

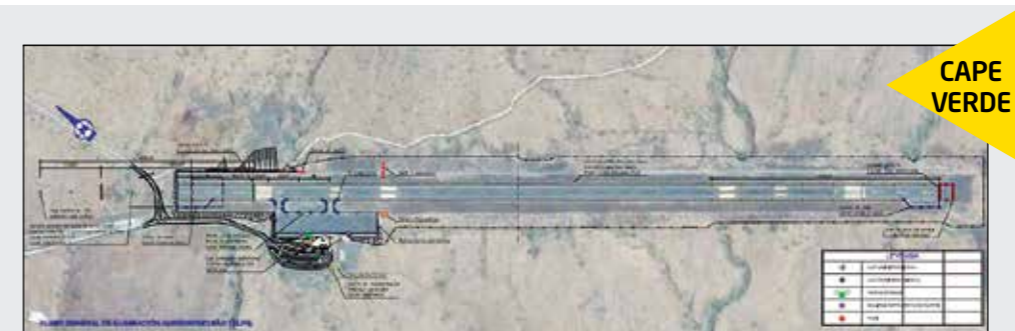
Sagunto is the major steel port in Spain and also handles considerable volumes of gas, vehicles, containers and bulk solid cargo.

The Port Authority of Valencia has commissioned Ineco to map the internal rail network and sidings for the project of the Port of Sagunto, which includes a new general

SPAIN
INECO WILL DESIGN THE PROJECT FOR THE REMODELLING OF MADRID'S PALACIO DE CONGRESOS

The Spanish Institute of Tourism (Turespaña) has commissioned Ineco to design the project for the remodelling and expansion of Madrid's Palacio de Congresos, on the Paseo de la Castellana. The project will include an evaluation of the state of conservation of its most famous feature, the Joan Miró mural on its façade.

The Palacio de Congresos was opened in 1970 but has been closed since December 2012, when a technical report determined that it did not comply with safety regulations. Once remodelled, the 40,000 m² building will house the new headquarters of the World Tourism Organisation, which has been based in Madrid since 1975.



General plan of the lighting for São Felipe aerodrome.

MORE AVIATION STUDIES FOR THE AIRPORTS OF CAPE VERDE

ASA (Aerportos e Segurança Aérea), manager of the airports in Cape Verde, has once again commissioned Ineco to review procedures and operational policies at São Felipe aerodrome on the island of Fogo. Ineco will prepare a review of obstacles and safety in relation to the introduction of night operations and instrument flight conditions, and draft in-

strument flight procedures. In addition, in 2019 the company also carried out a study for the installation of an ILS (Instrument Landing System) at São Vicente airport. These recent projects join the long list of projects carried out by Ineco to improve and expand the airport network in the country since 2003 (see *ITRANSPORTE* 7, 50 and 61).

URUGUAY
THIRD CONTRACT FOR THE REVIEW OF THE PASO DE LOS TOROS PROJECT



Plant to manufacture sleepers for the works.

Ineco has signed a third contract with the Uruguay Rail Corporation to provide advisory services in signalling and telecommunications for the review of the Central Railway project, known as Paso de los Toros. The new contract, like the two previous ones, is the result of the agreement signed in 2017 between the Spanish Ministry of Transport (MITMA) and its Uruguayan counterpart (MTO). The project consists of the construction and maintenance of 273 kilometres of railway between the port of Montevideo and the city of Paso de los Toros, applying the highest European safety standards.

Cybersecurity and transport: protected systems

In a world that is increasingly dependent on technology and internet communication, cyberattacks are the newest –and greatest– threat. In the case of transport systems, anticipating and taking preventive measures against the potential impacts of an attack on the security and continuity of a service are a priority.

By Ineco's experts and engineers: **Esteban Dauksis**, Information Technologies; **Ángel G^a Luengo**, Railway Signalling and ERTMS; **Luis Manuel Lozano**, CNS-ATM Systems; **César Pérez**, Land Security and Civil Defence; and **Alberto Rodríguez**, Galileo System

Information technology has permeated every area and every aspect of our lives. Society as a whole has made such large strides in digitisation in recent years that now practically every area of activity is assisted –or even governed– by an information system.

On public transport, fewer and fewer people have printed tickets; the popularisation of internet access has taken us from the almost romantic image of the information superhighway to a situation where being connected is all but compulsory: anyone who lacks a mobile phone cannot share in the benefits brought by digitisation. Law 11/2007 on remote public access to government services has reduced the need to deal with paperwork face-to-face to a minimum. The universal, ubiquitous access to the internet, which has enabled globalisation and purchasing from outlets in the other countries, has also given rise to new risks and threats. Connecting to the internet opens up the possibility of anybody, from any continent, being able to come through our virtual front door and interact with our physical machine.

And if that is happening to individuals, the need to ensure digital security is even more pressing for businesses and organisations, particularly in sectors classified as critical, such as transport. The definition of cybersecurity is simple: it is the application of the idea of physical security to the virtual realm, created by computers. Security breaches, like accidents, cannot always be prevented but a clear plan and strategy can enable us to create the required capacity and prepare ourselves.

Ineco is working on different fronts and in different sectors and support systems for rail and air transport networks to create methods, strategies and internal policies, including training. As part of that work, we are preparing measures and action plans to resolve incidents on railway networks, satellite navigation systems and critical infrastructure. It's a matter of helping organisations to be more cybersecure, in the broadest sense of the word, both in the physical world and in the digital world, helping them to anticipate problems; to develop cybersecurity habits and cultures; to protect themselves; to critically review themselves and to make the changes required for them to remain focused on meeting their goals.

THE NEW RISKS OF DIGITISATION

In 2008, it was reported that a 14-year-old Polish boy had generated chaos and caused four trams derail in the city of Lodz. The tools he used: a manipulated TV remote control, time and determination. In September 2016, experts at the USA's Department of Homeland Security tested the vulnerability of a Boeing 757 on the ground. They were able to access

INECO IS WORKING IN SECTORS AND SUPPORT SYSTEMS FOR TRANSPORT NETWORKS TO CREATE METHODS, STRATEGIES AND INTERNAL POLICIES, INCLUDING TRAINING

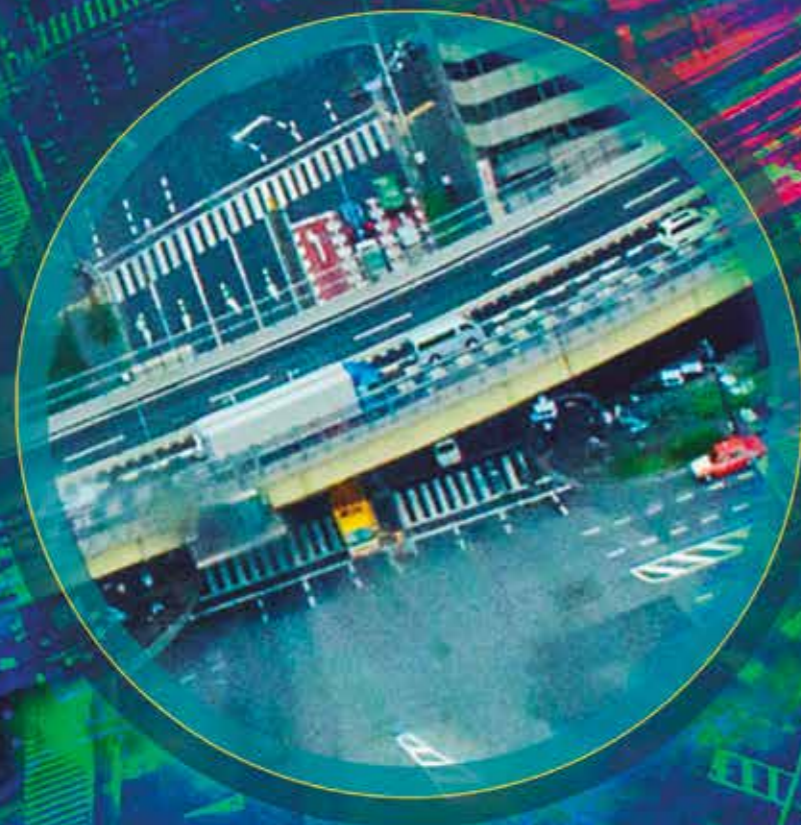
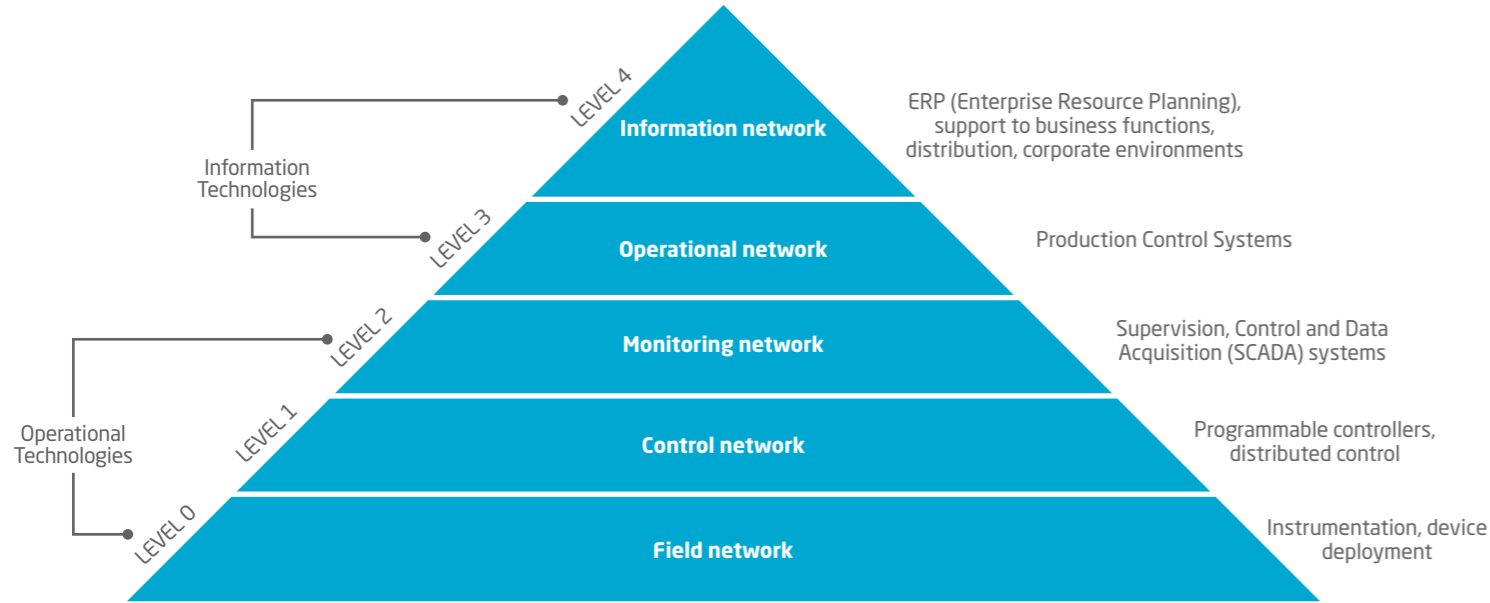


IMAGE: JAVIER RODRÍGUEZ OVER PHOTO OF ELVIRA VILA

CYBERSECURITY IT (INFORMATION TECHNOLOGY) AND OT (OPERATIONAL TECHNOLOGY)



The figure shows a classic structure for the elements of an industrial/transport network, split into OT and IT. The boundary between the two is normally established at the higher levels of corporate systems. However, the current trend is towards rapid convergence at every level, thanks to the growing prevalence of IIoT (Industrial Internet of Things) items in field networks, the management of sensor alarms via mobile devices, etc.

the plane's systems using radio waves. Fortunately, transport systems as a whole dedicate enormous efforts to technology and procedures at all phases of development and operation to protect themselves against such failures, whether intentional or not.

The Spanish Government's Department of National Security recently published a percentage breakdown of the strategic sectors most affected by cyberattacks in 2019: transport was the sector most affected, with 37% of incidents, far above the 23.87% suffered by the finance-tax sector and the 23.77% in water infrastructure.

The consequences of a cyberattack on essential services such as energy, water, hospitals, and transport are not limited to monetary losses, harmed reputation and breaches of confidentiality, but also include harm to people and the environment. The industrial environment (Operational Technologies or OT) in which support systems for those essential services are installed have specific features that set them apart both in terms of the typical security measures in traditional computer environments (Information Technologies or IT) and in terms of the possible consequences.

CYBERSECURITY FOR CRITICAL INFRASTRUCTURE

In today's society, certain services are essential to the continuity of basic functions: health, security, social and economic well-being, and the smooth operation

of government institutions, which are referred to as 'essential services'. The infrastructure that supports the operation of those services is known as 'critical infrastructure', meaning that there is no alternative. The operators of essential services and critical infrastructure, public as well as private, are required by the EU's NIS directive to report all cyberincidents to their corresponding Computer Emergency Response Team (CERT), which in Spain is INCIBE-CERT for private sector operators and CNN-CERT for public sector operators.

For that reason, the State Secretariat for Security (SES) created the Office of Cybernetic Coordination (OCC) which is responsible for technical coordination and communication with those Spanish reference CERTs. The OCC's move to place it directly under the SES last August (it was originally part of the National Centre for the Protection of Critical Infrastructure) demonstrates the ever-growing importance of cybersecurity within the National Security Strategy.

Given all of this, it is apparent that the capacity of critical infrastructure to maintain service continuity in the face of any malicious attack is absolutely essential. That capacity – resilience – has been a cornerstone of the protection of critical infrastructure from the beginning and has become one of the core principles of the National Security Strategy. To achieve resilience, it is essential to have a holistic, panoramic vision that creates a security culture.

Consequently, and in order to ensure that operators comply with the requirements to adequately protect critical infrastructure, the National Centre for the Protection of Critical Infrastructure (CNPIC), working with Ineco and Leet Security, is undertaking the creation of a certification scheme for the protection of essential infrastructure and services that will give visibility of security maturity in every part of an organisation. The scheme will have advantages both for government, providing an agile and effective tool for monitoring the security of critical infrastructure and its operators, and for operators themselves, who will be able to use certification to evidence compliance with their obligations under the Protection of Critical Infrastructure (PIC) Law and have a tool to understand and improve their level of security.

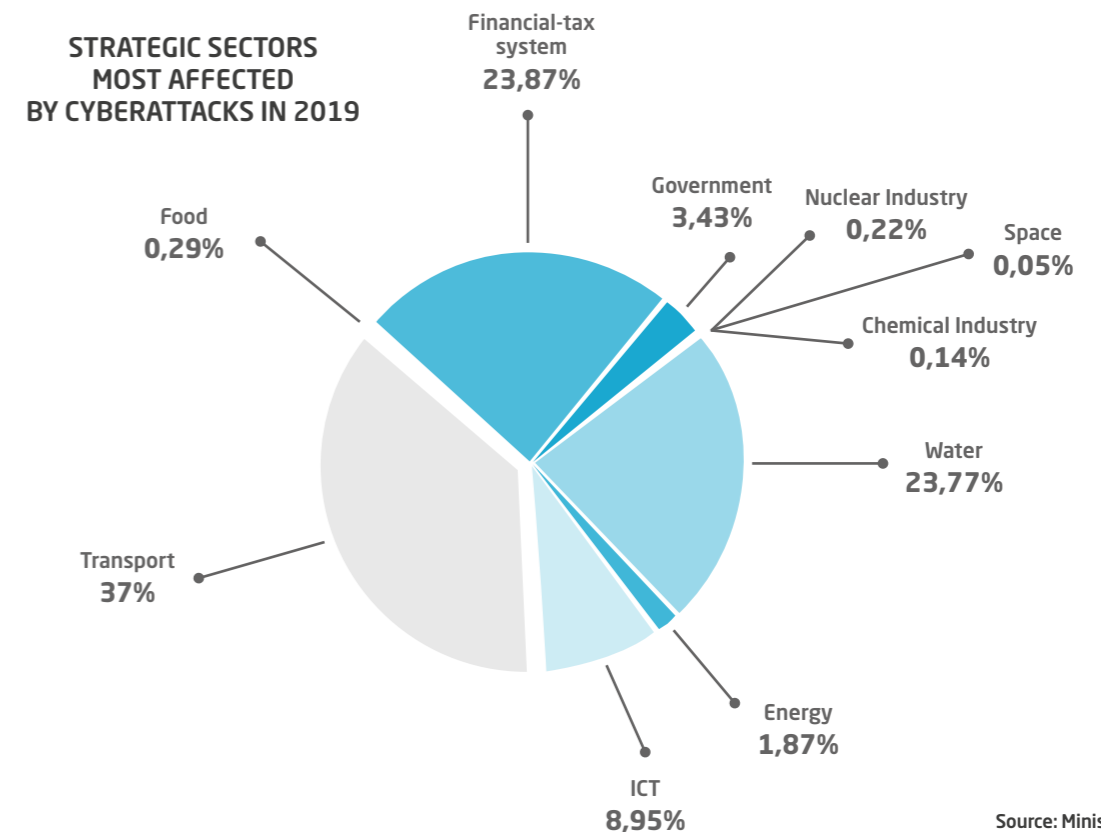
CYBERPROTECTION MEASURES IN THE RAIL INDUSTRY

One of the objectives and successes of the rail industry since the beginning has been safety and security, using the tools available at different times. Today, the use of new technology assets that extend the capacity and performance of systems generates a new need: protection against cyberattack. The principal objective is to prevent harm to people, which translates in seeking to avoid situations involving risk of collision, derailment, etc.

THE NATIONAL CENTRE FOR THE PROTECTION OF CRITICAL INFRASTRUCTURE (CNPIC), WORKING WITH INECO AND LEET SECURITY, IS PROMOTING THE PROTECTION OF ESSENTIAL INFRASTRUCTURE AND SERVICES

The safety systems on a railway network include signalling that makes for efficient, safe use of the network. The system as a whole works on the basis that if a given problem arises, the safety level will go up. The highest level is 'All trains stopped', which is actually one of the goals of a cyberattack: loss of availability.

The implementation of cyberprotection measures in the rail industry has some unique features: technology with very long life cycles (up to 25 years), a feeling of being protected as a result of using their own network infrastructure, and highly specific technology and protocols. The deployment of devices across tracks, stations, control centres, trains, etc. makes for highly distributed infrastructure. Digitisation is increasing the risk of cyberattack



Source: Ministry of Home Affairs

through the deployment of IoT devices across the infrastructure, the extension of the attack surface area through interconnection with external systems, greater public information and online sales.

For example, some of the protective measures in ERTMS (European Rail Traffic Management System): the Level 2 of this European standard for automatic train protection is based on continuous mobile communication between a train and its control centre (GSM-R, Global System for Mobile Communications-Railway). Communications are encrypted to ensure the integrity of transmissions, because this is how the train gives real-time information about its position and receives instructions as to up to how far it can run and at what speed, depending on the state of the line and other traffic.

Addressing the cyberprotection of this system requires a holistic analysis, taking into account the level of security of the technology used (GSM, encryption algorithms), the maturity of linked processes (keys distribution) and the skill level of the people involved (possible attackers, motivations, knowledge required, benefits, opportunities to act). Some public results from a general review of the system showed that the greatest risk is posed by attacks launched from within the network, by highly skilled staff against elements of the national railway implementation, not covered by the standard, related to the management of encryption keys and the interface with control centres. It was also noted that the use of the GSM-R (2.5G) communication network creates vulnerabilities that have already been in next-generation networks.

INECO LEADS THE ACTIVITIES OF THE SERVICE CENTRE FOR USERS OF THE GALILEO PROGRAMME, WHICH PROVIDES SERVICES WORLDWIDE

The trend towards digitisation in the industry will lead to greater efficiency and service quality, but also increased cybersecurity risks. Railway network support systems are massively adopting technology change. Communications networks have gone from using proprietary protocols over dedicated links to interconnected networks with open protocols. Mechanical and electrical components have given way to electronic components and the early stages of the deployment of the Industrial Internet of Things. Maintenance processes are already being carried out automatically and remotely. All of this brings new risks.

Several challenges face the rail industry, which of great importance because it is a critical infrastructure. A factor in its favour is its well-established

culture of the importance of personal safety, reflected in the implementation of the certification procedures mandated by AESF (State Agency for Rail Safety). But there is still a ways to go: establishing a rail CERT for coordination at the national and European levels, moving towards implementation of standards based on best practices and, more generally, raising awareness of the risks generated by cyberattacks.

THE COMPLEXITY OF AIR AND SATELLITE NAVIGATION

Air navigation is becoming increasingly dependent on technology, principally ATM/CNS systems. The notion of CNS encompasses air communications, radio navigation aids systems and surveillance radar. ATM systems, on the other hand, are the systems that support air traffic control operations.

Because of these dependencies, cybersecurity in this area is exceptionally important and shares the features common to all OT (Operational Technologies) environments. The enormous complexity and high degree of interrelation of these systems are particularly noteworthy, with multiple information sources, stakeholders and components in communication with each other, which creates a very large attack surface. In operation, the most important things are operational security, integrity and availability. Confidentiality is less critical. Air navigation is also characterised by being based on legacy systems with a high replacement or update cost because they are loaded on a large number of aircraft. As a result, migration is slow and countermeasures have to be compatible with those legacy systems. Another characteristic specific to air navigation is that attacks can be made not just against data, but can also be electromagnetic (jamming, spoofing).

Nevertheless, the importance of cybersecurity in air navigation is also due to the potential impact of a logical security breach, potentially triggering events that endanger the safety of an aircraft or affect continuity of service, and have other important effects (financial loss, reputation harm, etc.). The trend in air navigation is towards greater interconnection, the use of open standards, the growing use of general purpose market products and a move towards remote management. Those factors, together with the fact that cyberattacks are becoming increasingly sophisticated, lead to greater vulnerability. As EASA concluded in the Bucharest Declaration (2016), the concern is that the aviation system is insufficiently protected against cyber-threats, and there is an urgent need to develop a holistic response. The main organisations involved, such as ICAO, are already taking action.

The sector is also facing new challenges that will no doubt put cybersecurity at the heart of its further development, such as the concept of the smart



PHOTO: GSA

EUROPEAN GALILEO SYSTEM: CYBER-PROTECTED SATELLITE NAVIGATION. Galileo is classified as an essential service because it is used in many areas that are critical to public safety such as transport, business applications (agriculture, topography, etc.), location services, finance, energy, telecommunications, and others. As such, its protection, in which Ineco is playing an active role, is absolutely essential.

airport, using the Internet of Things and SCADA (Supervisory Control and Data Acquisition) systems in airports and navigation; the implementation of SWIM (System Wide Information Management) with consequent greater interconnectedness; the proliferation of drones, and remote control towers.

Galileo, the European Global Navigation Satellite System (GNSS) is classified as an essential service because it provides PVT information (Position, Velocity and Time) for use in areas that are critical to public safety such as transport (aviation, maritime transport, self-driving vehicles, etc.) and in essential services such as business applications (agriculture, topography, etc.), unregulated applications (LBS or Location Based Services, IoT, etc.), finance, energy, telecommunications, and others. Consequently, given the critical nature of GNSS and its importance, it is essential to protect the system and implement security measures at various levels, such as accreditation of infrastructure and equipment for the handling of classified information and the implementation of cybersecurity measures in both ground-based systems and information systems on the satellites to protect information and communication.

In the case of satellite navigation, the protection of navigation signals sent by users is fundamental. Currently, the two biggest threats are jamming and spoofing. Jamming consists in the emission of RF (radio frequency) signals that are stronger than and

otherwise similar to the target signal with the aim of blocking that signal, making receivers unable to determine their position using the satellite signal. Spoofing, on the other hand, consists of generating signals that are analogous to those produced by GNSS systems and stronger than the GNSS system signals, with the aim of making the receiver tune to the false signal instead of the real one and thus receive altered location information, misleading it as to its true position.

Measures to counter these threats focus on different aspects of the user's environment (antenna and receiver) and of the GNSS itself. For antennas, a controlled radiation pattern and adaptive beamforming, among others. For the receiver: multi-frequency (E1, E5 and E6), multi-constellation (GPS, Galileo, GLONASS, BEIDOU), hybridisation, monitoring of signal metrics, etc. For the system itself, the use of more robust modulations (MBOC, AltBOC), multi-frequency, PNT (Position, Navigation and Time) resilience, and authentication against spoofing. PNT resilience and authentication are two of the most important measures in the Galileo environment. PNT resilience is the convergence of GNSS with other technologies to improve reliability, performance and security. Authentication allows users to be sure that the signals they are using are being received from Galileo satellites rather than from any other source. Authentication is achieved by using public and private key encryption. ■



PHOTO: ADIF

All aboard!

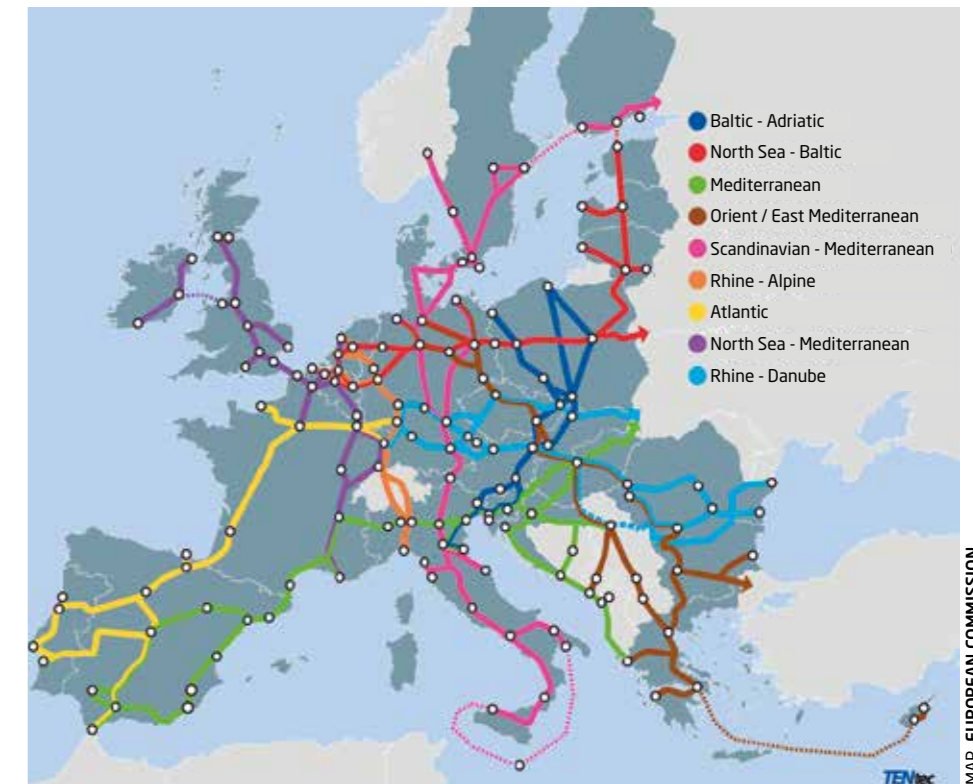
Working for the European Commission, Ineco analysed strategies for deploying on-board ERTMS equipment on three major continental networks. On-board systems are a part of the roll-out of the overall system that make the technical, operational and economic efficiency of signalling and control systems in Europe possible.

By **Silvia Domínguez**, telecommunications engineer,
Lucía Blanco and **Alfonso Lorenzo**, industrial engineers

Across the Member States of the European Union there are more than 20 national rail signalling and control systems, called 'Class B systems' by the Commission. For long-distance railway transport, this means that whenever a train crosses from one country to another, the locomotive, driver and even the whole train may have to be changed. The solution is a common system that allows trains to operate with the same rail "language" on every network, something called 'interoperability'. In 1989, this principle led to the birth of ERTMS (European Rail Traffic Management System) with the support of the European Commission for its implementation as the sole system.

On behalf of the European Commission, during the period 2014-2021 Ineco has been coordinating the implementation of the system along nine European rail corridors, totalling 51,000 kilometres. It is a huge and complex industrial project that involves national and European rail regulators, operators, infrastructure managers, manufacturers, stakeholders along the corridors, and others, and requires the monitoring of ground-based and on-board systems.

A specific study on on-board systems was carried out by the consulting firm PWC and Ineco and submitted to the European Commission in October by Ineco. The starting point is that widespread implementation of ERTMS is key to achieving the goal of railway interoperability that will make it possible to create a "single European railway area"



PRINCIPAL NETWORK OF MAJOR EUROPEAN CORRIDORS

On behalf of the European Commission over the period 2014-2021, Ineco has been coordinating the implementation of the ERTMS system along nine European rail corridors, totalling 51,000 kilometres.

MAP: EUROPEAN COMMISSION

similar to the "single European sky" for air transport. But adapting the infrastructure is not on its own enough; train fleets also have to be adapted to make the system efficient.

In April 2020, 12% (6,120 km) of European corridors were working with ETCS and 63% with GSM-R. Of the 15,682

kilometres due to come into service in 2023 under the European deployment plan for ERTMS, 5,906 kilometres (38%) have been contracted and 78% of what was planned to have been achieved by the end of 2019 has been completed. Almost all of the high-speed networks in Italy and Spain are monitored and



PHOTO_ALSTOM

WHAT IS A ERTMS?

ERTMS (European Rail Traffic Management System), and its control and protection subsystem, ETCS (European Train Control System), is an Automatic Train Protection (ATP) system that provides a high level of safety.

It consists of the exchange of information between trains and infrastructure and is based on on-board signalling and continuous speed monitoring. It can be deployed on different levels of application, which differ in the way that the

information is transmitted: burst transmission from track to train for Level 1 and continuous two-way transmission in Levels 2 and 3.

It is made up of two basic subsystems, one on-board and the other trackside, that are connected via interoperable channels. The on-board ETCS equipment is the European Vital Computer (EVC) and the trackside ETCS equipment is essentially the groups of Eurobalises and LEU (Lineside Electronic

Unit), associated with Level 1 communications, and the Radio Block Centre (RBC), associated with Level 2.

ERTMS can also make use of GSM-R (Global System for Mobile Communications-Railway), which allows data and voice transmission between the driver and control centre.

The implementation of ERTMS brings with it different improvements in railway operations, such as interoperability of

different types of train in different infrastructures and increased safety and capacity. This capacity is calculated based on the number of trains with established characteristics that can travel on a railway line or network during a certain period of time. In addition, the benefit of ERTMS in railway digitisation programmes has been demonstrated through its deployment in the modernisation processes of numerous railway networks at international level.

protected by ERTMS. The system allows trains in commercial service to run at speeds of up to 350 km/h. Extensive parts of the networks in the Netherlands, Czechia and Belgium, as well as Switzerland outside the EU, have been outfitted. ETCS is also used to control freight trains arriving at Europe's biggest port, Rotterdam. Europe's longest tunnel under the Alps, the St. Gotthard tunnel in Switzerland, 57 kilometres long, has Level 2 ERTMS. The system has also been in service for a number of years in commuter services, such as those in Madrid (see IT46).

The report found that, despite this progress, there is still much work to be done to achieve sufficient implementation of ERTMS to deliver a truly interoperable rail network: implementation continues to be patchy and most Member States have chosen not to do it now, but rather in the long term. And while there are rail companies, operators and manufacturers that have chosen to outfit their fleets with ERTMS, the report notes that, in most cases, this is only done when required due to the characteristics of the network, because of the technical, financial and economic risks that must be assumed. Fewer than 4,000 trains have been equipped with the system in Europe. Over the last five years, approximately 5,000 new vehicles have been acquired in Europe. However, only 900 of those new vehicles are equipped with ERTMS. The lack of equipped vehicles consequently stops rail infrastructure operators from de-

ERTMS-EQUIPPED TRAINS WILL BE KEY TO THE CONTINUED OPERATION OF INTERNATIONAL FREIGHT ROUTES

rieving the maximum benefit from the ERTMS system that has already been deployed.

The principal aim of the study is therefore to assess the impact of further trackside deployment of ERTMS on operators, mainly for international freight transport. In particular, the study assesses the efficiency of the installation of ERTMS to significantly expand the routes available to locomotives, and efficiency in terms of the simplification of signalling equipment in vehicles.

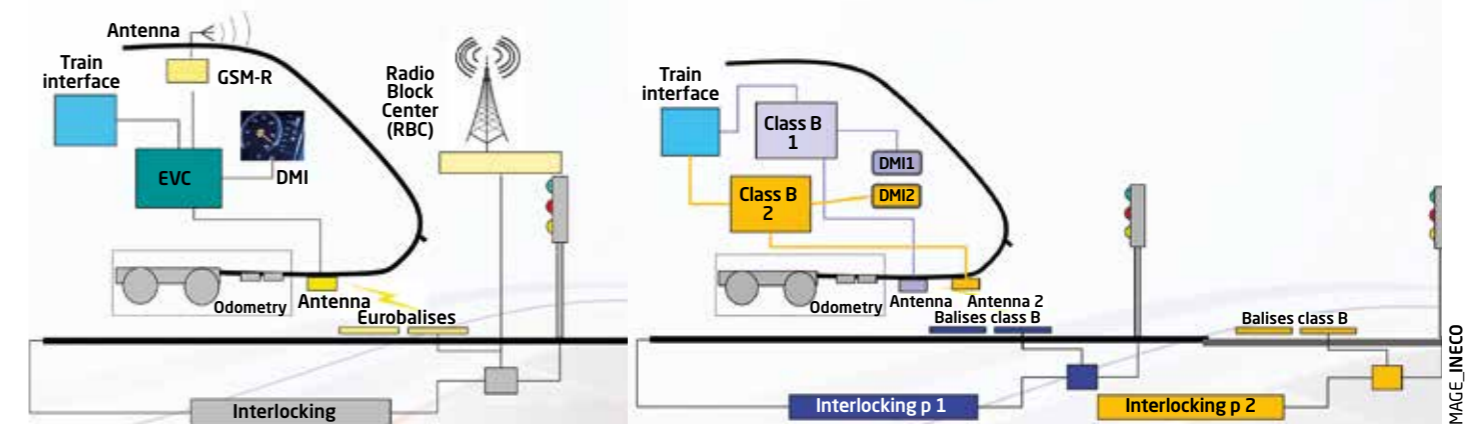
To do that, three major European networks with high volumes of international freight traffic and extensive ERTMS installation were selected: Network 1, made up of the Netherlands, Belgium, Luxembourg, western Germany, eastern France, Switzerland and north-western Italy; Network 2, made up of north-eastern Italy, Austria, western Hungary, Slovenia and southern Germany; and Network 3, which encompasses north-eastern Germany, Poland, Czechia, Slovakia, Hungary and Austria (Vienna node only).

PRINCIPAL CONCLUSIONS

From the point of view of ERTMS implementation, the report confirms that over the next few years, significant use of ERTMS in rail operations will be achieved. In Network 1, the number of kilometres not equipped with ERTMS will fall from 70% in 2020 to just 15% in 2025.

From the point of view of infrastructure managers, the report recommends that national deployment strategies include the considerations that would enable them to prioritise specific sections. That prioritisation would have an enormous impact on European freight operators. For example, in 2025 a locomotive equipped with ERTMS alone will be able to cover the distance between the port of Rotterdam and northern Italy, more than 1,000 kilometres, if ERTMS deployment on just 75 kilometres of the route can be sped up.

From the point of view of rail companies, the report confirms that over the next few years, ERTMS could substitute Class B systems in the fleet, rather than being an additional system. In addition, to cover international freight transport, the report concludes that all new locomotives should be equipped with ERTMS and recommends consideration of ERTMS installation in the existing fleet. ERTMS-equipped trains will be key to the continued operation of international freight routes. The issue of connectivity is common to the three networks assessed, albeit to varying degrees. The lack of ERTMS-equipped loco-



Comparison of full ERTMS structure and Class B systems.

IMAGE_INECO

motives would lead to the loss of 100% of the international routes in Network 2 by 2030, 86% on Network 1 and 50% on Network 3.

Although there are good reasons to support strategies for on-board implementation of ERTMS, a transition period with one or two Class B systems alongside ERTMS is inevitable. Based on its analysis of international traffic as well as the deployment and the characteristics of the system, the report concludes that there is no single Class B system that can be considered the most effective one to work alongside ERTMS on the whole European fleet. It is clear that each operator needs its own individual strategy, depending mainly on the country it is based in.

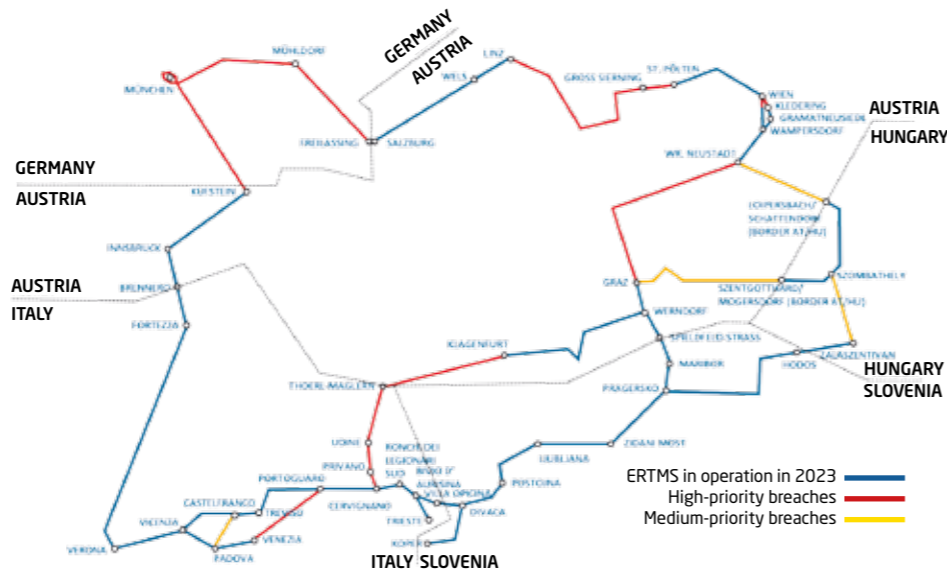
To implement those strategies, they need to be supported by technical analyses of the principal risks that the deployment of ERTMS poses to the fleet. The report focuses on a review of national technical rules and the interface between ERTMS and Class B.

ACCELERATED, COORDINATED DEPLOYMENT OF ERTMS CAN GENERATE DIRECT BENEFITS ON ALL THE NETWORKS STUDIED

The main recommendations to mitigate the risks posed by those aspects of the systems to deployment include:

- Encourage the use and stability of existing Class B products when different providers have relevant solutions. This allows effort and resources to be concentrated on the deployment of ERTMS, creating efficiencies across Europe, rather than on further developing Class B. Also, further development of Class B using the standard interface (or STM) does not guarantee ready connectivity with ERTMS systems.

- To grow international traffic, dual-standard solutions should not be al-



For the purposes of the study, three major European networks with high volumes of international freight traffic and extensive installation of ERTMS were selected. In the images, two maps of Network 2 and 3; this last encompasses north-eastern Germany, Poland, Czechia, Slovakia, Hungary and Austria (Vienna node only). MAPS_INECO

lowed for Class B if there is no available alternative.

- Broaden transparency requirements in information concerning national technical rules for all parties involved, including the Member States and infrastructure managers, as well as providers and rail companies. This would enable Europe-wide mechanisms to be updated and improved to avoid the adoption of unexpected national rules that could have significant effects on interoperability in international transport.

The report contains a review of different scenarios for each of the selected networks, to assess the potential financial effects of alternative ERTMS implementation strategies on infrastructure managers and international rail freight businesses. This analysis, comparing cumulative long-term (2020-2055) cash flows in three possible scenarios, confirms that coordinated and accelerated deployment of ERTMS could bring direct benefits –for infrastructure managers and for rail companies– in each of the three networks in the study. ■



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Digital aeronautical information for Abu Dhabi

In 2018, Ineco developed a consultancy project on the implementation of the AIXM international standard on aeronautical information exchange in the airports of Abu Dhabi. This model is based on a common language and protocols in digital format for aeronautical information services in different countries.

By **Ignacio Alejandro**, aeronautical engineer, **Fernando Carrillo**, computer technical engineer and **Jaime García**, telecommunications engineer

Aeronautical information publication (AIP) is the package of data originating from multiple sources that makes air navigation possible. For example, pilots can know which part of the air space they can use (the airway, similar to a road on the ground), what obstacles there are, whether they are following the correct route (radio aids), whether they are going to encounter fog or wind (meteorological information), if there are other aircraft and where they are, etc. The Aeronautical Information Services (AIS) in each country gather, verify and disseminate all of this information.

AIXM is a digital model that is being implemented at airports worldwide. It establishes a common language and system among the different Aeronautical Information Services in each country. Not just to codify aeronautical information but also to manage, distribute and verify the information and provide traceability from source to publication.

In 2018, the government airport manager, ADAC (Abu Dhabi Airports Company) commissioned Ineco to research the process to implement AIXM services at its airports and the impact on its existing systems. The analysis also identified what would need to be done under ATM (air traffic management) requirements and to address the ADAC environment, but also to identify the gaps in its existing systems.

Ineco had worked previously in the emirate: from 2014 to 2019 it worked with Aena Internacional on operational readiness and transition (ORAT) for the new MTC (Midfield Terminal Complex) at Abu

Dhabi International Airport. Similarly, from 2015 to 2019 Ineco worked in collaboration with PMDC as project manager on the expansion of Fujairha Airport, also for ADAC.

AIXM IS A FILE FORMAT FOR MODELLING AND EXCHANGE OF AERONAUTICAL INFORMATION IN DIGITAL FORMAT FOR GLOBAL USE

THE INECO STUDY

To assess the implementation of AIXM in Abu Dhabi's airports, we started by reviewing data management based on the current situation. We identified the different sources of information and determined what process was being used for the communication with the Emirates civil aviation authority (GCAA) for each AIRAC (Aeronautical Information Regulation and Control) cycle, (an aeronautical information system that shows operational changes to facilities, services and procedures, published every 28 days) for permanent changes; and notification of temporary changes or NOTAM.

Various processes were also reviewed, such as the preflight information service, flight planning, management of NOTAM information, the collection and publication of aeronautical information from Abu Dhabi's airports, etc.

The next task was to test the implementation of AIXM, which incorporates a definition of the data chain, including data originators and aeronautical information itself, commercial providers and end users. That definition introduced two key concepts for aeronautical information: timeliness and quality, on which the efficiency of the process depends to a large extent. Key performance indicators (KPI) were also set, measured at the time and projected following implementation of the model.

Subsequently, a number of scenarios for AIXM implementation within ADAC were defined and a transition plan was developed. For the scenarios, various lines of communication were reviewed and analysed: between ADAC/AIS and Civil Aviation, between the airports and ADAC, between ADAC and air traffic control, and others. Having determined that continuity of the client's business during the change was essential, functionality, maintainability and safety indicators were established, based on the ISO/IEC 25000 standard.

With the aim of selecting the best option for each line of communication, Ineco prepared a questionnaire for stakeholders. Based on the answers to the questionnaire, we fine-tuned and selected a final scenario for each line of communication. The final step consisted in drawing up the technical and operational specifications for ADAC to launch a bidding process for the installation and commissioning of a fully AIXM-compatible system. We also drew up a human resources plan and listed the suppliers of the tools in the model. ■



New MTC terminal at Abu Dhabi International Airport.



Ineco and ADAC teams after the project kick-off meeting in February 2018.



PHOTOS: ADAC

Controllers at Abu Dhabi International Airport, on the right, the control tower, 110 metres tall and opened in 2011.



PHOTO: GERT MEWES (FLICKR)

WHAT IS AIXM?

Until the early 2000s, aeronautical information documents (NOTAM, Notice to Airmen or notice to pilots, flight paths, etc.) were produced on paper or in PDF format, although they were distributed electronically via different processes and systems in each country. In 1996, the European Organisation for the Safety of Air Navigation, Eurocontrol, started work on a standard for a European database. In 2001 it began to draw up a specification for the publication and exchange of AIP in electronic format. It later joined with the Federal Aviation Agency (FAA) and the US National Geospatial-Intelligence Agency (NGA), and the project was opened up to the participation of other countries and international industries, with a new version in 2005. The following year, the World Congress on AIS was held in Madrid and work started on the roadmap to move from paper documents to the new model.

There are currently 55 organisations from around the world working on the development of AIXM, including Eurocontrol, the International Civil Aviation Organisation (ICAO), the FAA, air navigation service providers, airlines, software developers and other bodies.

How to manage 35,000 vehicles a day

The change in the management model promoted by Banobras has led to significant improvements to this Mexican highway. With a total of 148 kilometres and the highest standards of quality and service, the management data reveal an increase in capacity, enhanced revenue monitoring and a notable improvement in road safety.

By Miguel Blanco and Marino Insúa, civil engineers



WORKS SUPERVISION
The new Acatlán junction, one of the works being supervised by Ineco.

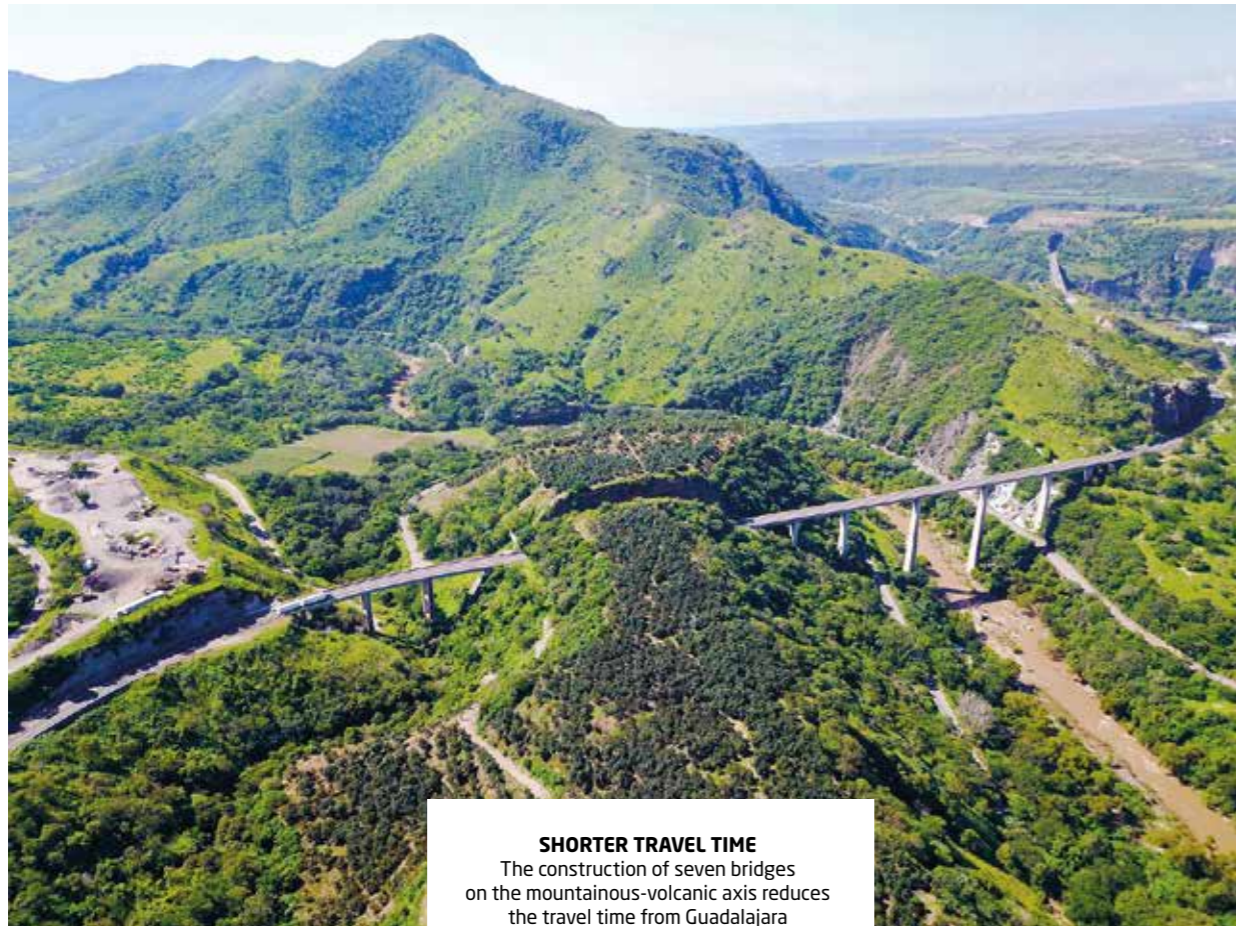
The completion of work on the last section of the Guadalajara-Colima highway modernisation marks a new milestone in a project whose comprehensive supervision has been carried out by Ineco since 2011, a task which includes its management, monitoring, supervision, maintenance and renovation through 2025. The improvements to the new operating model which Banobras, the National Bank for Public Works and Services, began to apply for the first time on this highway, and subsequently on others throughout the country, are ensuring that the service provided achieves a high level of satisfaction among users and a reduction in the number of accidents.

The extension of this highway, with a capacity of more than 35,000 vehicle transits per day, is a major step forward for the economic development of the region. Built in 1983, it is part of the important Manzanillo-Tampico road axis, a strategic commercial route. Its 148 kilometres facilitate the connection with Manzanillo, the main port of the Mexican Pacific coast, from which more than 75% of the goods leave by road.



INECO'S MULTIDISCIPLINARY TEAM
The company currently has a multidisciplinary team of more than 24 people between Guadalajara and Mexico City, in addition to support staff. Ineco is also the majority shareholder of the Mexican company Inecomex, with which it is collaborating on this project as well as on all the work carried out in Mexico.

PHOTOS: INECO/INECOMEX



SHORTER TRAVEL TIME
The construction of seven bridges on the mountainous-volcanic axis reduces the travel time from Guadalajara to Manzanillo by 40 minutes. The infrastructure has been recognised throughout the continent, both for its size and topographical characteristics, as well as for its enormous socio-economic impact on the region. In the photo, the Atenquique bridges I and II, in the state of Jalisco.

ADMINISTRATION AND SUPERVISION FOR 14 YEARS

Ineco heads a group of Mexican and Spanish companies and will complete nine years as the Supervising Administrator Agent (AAS) on the Guadalajara-Colima highway in 2020. These works are part of the contract that Banobras awarded to the Spanish company in 2011, with a duration of 14 years. Banobras is the Federal government's financial institution for financing infrastructure, including private sector participation.

The contract includes support for the contracting of the maintenance-rehabilitation agents and the operator of the section; the monitoring and control of the operation and maintenance work carried out by these agents; the management of the expansion, modernisation and major maintenance work carried out since 2011; the review of the projects and topographical control; as well as different supervisory works.

KEY POINTS FOR IMPROVEMENT

1. More bridges, tollbooths and lanes. Since the start of the contract in 2011, Ineco has participated in the supervision of the modernisation work on the highway section, with an investment by Banobras of more than 6 billion Mexican pesos. The work includes the modernisation and construction of new junctions, the extension of the section from 2 to 4 lanes over more than 56 kilometres, the construction of new tollbooths and the extension of up to 6 lanes in the end section.

2. A new quality-based model. The Guadalajara-Colima highway was one of the first test sections for the implementation of this new operating model. Ineco, as an administrator, participated in the definition of the performance indicators. This ensures that the highway is operated in

accordance with quality standards. The highway's activity is monitored 24 hours a day, 365 days a year in order to detect incidents, provide support during accidents and evaluate and report on the status of the road network.

3. More control, more vehicles, more revenue. The opening of new tollbooths and the installation of modern toll monitoring systems have allowed a greater control over capacity and revenue, which has led to a reduction in revenue losses and an increase in the highway's overall revenue by an annual average of 6%. According to the Mexican government, a total capacity of 14.2 million was recorded from 1 January to 31 December 2019. It is worth noting that within the first three years, with the implementation of the new model, revenues from electronic media increased from 134,121 dollars in 2014 to more than 5.2 million dollars (116 million Mexican pesos) in 2017. Thanks to traffic counting and classification systems,

TOLLBOOTH AND VEHICLE CONTROL



24-HOUR CUSTOMER SERVICE



IMPROVED ROAD SAFETY



MORE BRIDGES, TOLLBOOTHS AND LANES



PHOTOS: INECO/INECOMEX

in addition to the smart management systems associated with ITS (Intelligent Transport Systems), it is possible to know the number of vehicles currently traveling at any given point. This enables the AAS and Banobras to plan the highway efficiently in the long term and to guarantee optimum conditions for the installed elements.

4. A modern electronic toll system. Mexico's road network is one of the busiest in the world, requiring the development an electronic toll system to accurately monitor revenue and record all transactions electronically. This system, promoted by Banobras, makes it possible to eliminate the use of cash, which translates into safer and more efficient collection.

5. Improved road safety. In order to reduce accidents on the highway and to detect accident accumulation zones, road safety inspections are carried out every two years. In order to guarantee free-flow and safe traffic and a better knowledge of

the condition of the road, risks are analysed and evaluated and improvements are proposed by analysing and identifying the elements that can be improved. The highway has multiple ITS systems such as traffic cameras, SOS posts, variable information signs, weather data collection, etc.

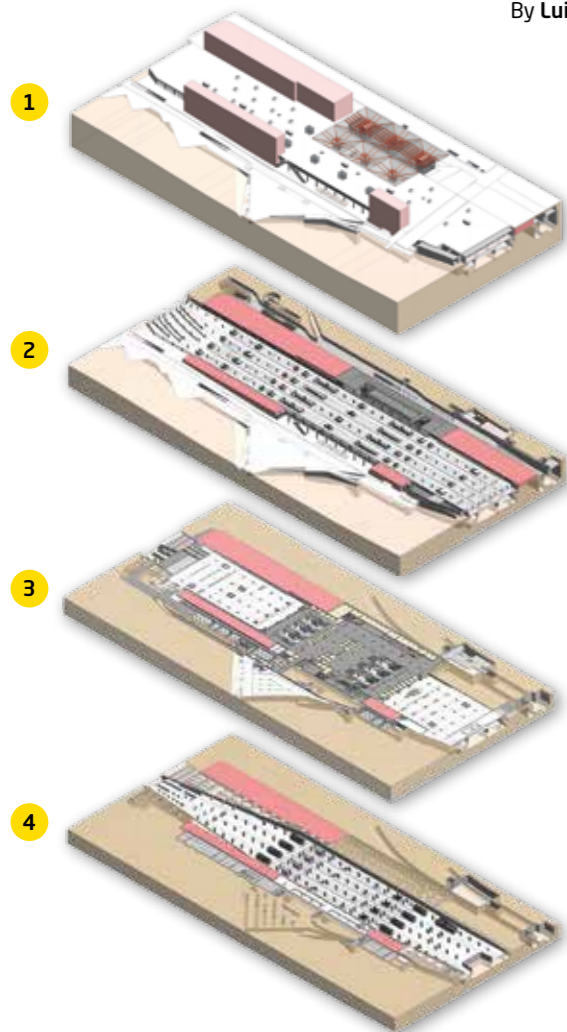
6. 24-hour service for users. The highway offers 24-hour customer service year round, as well as suggestion boxes, information panels and communication centres. In addition, online resources such as email, social networks and the operator's website have been made available to customers. The AAS, as part of its highway surveillance service, ensures the correct state of the public services installed on the highway section. A new management system has also been implemented to protect information and minimise information loss. In the past, no such computerised backup was available and there was a heavy reliance on physical reports. ■



La Sagrera, the station of stations

A new gateway is being built in Barcelona, La Sagrera station, and this gateway will serve not only those entering and leaving the city, but will also introduce more efficient, attractive and sustainable mobility, based on multimodality.

By Luis Ubalde, PhD in civil engineering



DESIGN OF THE NEW LA SAGRERA INTERMODAL STATION

- 1. View of the roof.
- 2. Platforms for high-speed services.
- 3. Floor of the general hall.
- 4. Platforms for Rodalies de Catalunya and regional train services.

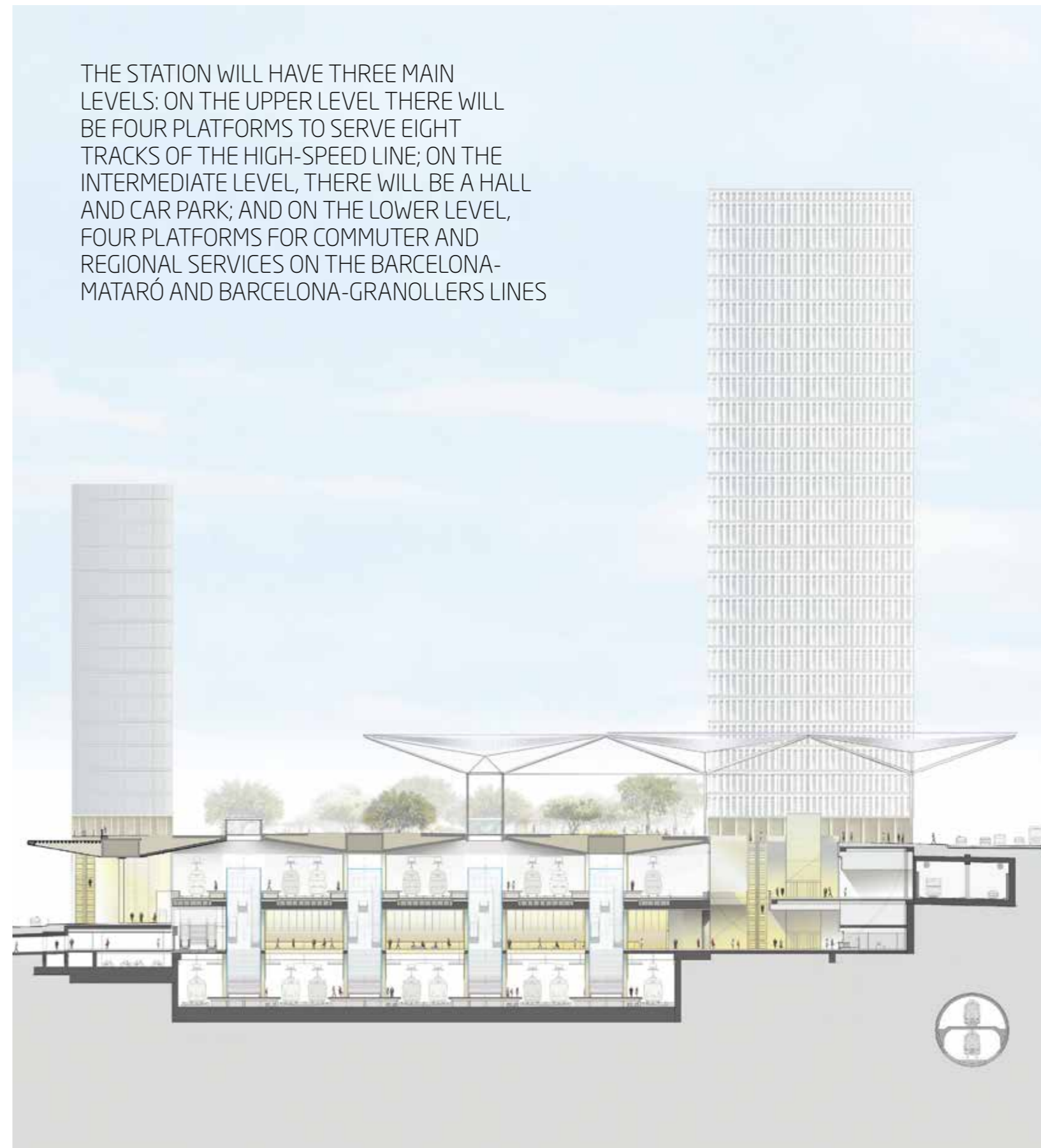
The railway, in its endeavour to facilitate public transportation, has been opening new stations in cities in order to connect them to the world. Since the days of coal, travellers arriving at stations have discovered the atmosphere of a place through the introduction provided by the platforms, marquees, halls and restaurants of the major stations. This is how it was and still is: the entrance to a great station is also the entrance to the city, making it the duty of stations to bid travellers a friendly welcome and farewell, offering convenience and positive memories that enhance the reputation of the location.

A great station cannot be separate from the urban fabric that surrounds it. A station is a city, as are its entrances and its railway yard, which have a decisive impact on the character of the neighbourhood to which it belongs and on the layout of the roads.

A great railway station is also the main node that must make possible, in an orderly and efficient way, the routes that enable the mobility of the population. The need to travel must be satisfied by making an effort to minimise the external costs that transport entails, seeking formulas that are increasingly conscious of respecting the environment. The successful combination of different modes of transport in a single journey, taking advantage of the strengths of each one, has made multimodality a solution to be taken into account by regional planners, and it is in the design of large stations that this concept is of key importance.

Main node, city and gateway. The new La Sagrera intermodal station, located in a neighbourhood in Barcelona bearing the same name, aspires to all these objectives. This aspiration is fully justified

THE STATION WILL HAVE THREE MAIN LEVELS: ON THE UPPER LEVEL THERE WILL BE FOUR PLATFORMS TO SERVE EIGHT TRACKS OF THE HIGH-SPEED LINE; ON THE INTERMEDIATE LEVEL, THERE WILL BE A HALL AND CAR PARK; AND ON THE LOWER LEVEL, FOUR PLATFORMS FOR COMMUTER AND REGIONAL SERVICES ON THE BARCELONA-MATARÓ AND BARCELONA-GRANOLLERS LINES



IMAGES: ADIF ALTA VELOCIDAD (PAGE 28) AND BSAV (PAGE 29)

Ineco is managing all the works at the new La Sagrera station. These images show different views of the work on the structure and of the accesses to La Sagrera station throughout 2020.



PHOTOS: LUIS UBALDE

by the need to complement the existing node of Sants station and by the vocation to finish building a part of the city of Barcelona that over time had become a border separating two neighbourhoods: La Sagrera and Sant Martí de Provençals.

Sants station node, in operation since the 1970s, was adapted in 2008 to host Barcelona's high-speed services. The station, which had 12 tracks with platforms, was expanded to 14 tracks, leaving 8 in Iberian gauge for conventional services and 6 in international gauge for high-speed services. There is no escaping the fact that practically all the commuter and regional service lines pass through this station, which is connected to two underground lines and is centrally located in the city, almost equidistant from the two arteries that cross Barcelona: Gran Via and Diagonal.

The conversion of long-distance intercity services, as well as some regional services, into high-speed services has gradually taken up the capacity offered by Sants station for this type of service. The Madrid-Barcelona high-speed corridor, which went into operation in 2008, was joined by the connection with France in 2013 and the link with the Mediterranean Corridor in 2020, generating a notable increase in demand for the use of the six international-gauge tracks at this station, as well as its associated workshop in the Can Tunis area.

MAIN NODE,
CITY AND GATEWAY.
THE NEW INTERMODAL
STATION OF LA SAGRERA,
LOCATED IN THE BARCELONA
NEIGHBOURHOOD OF THE
SAME NAME, ASPIRES
TO ALL THIS

Certainly, the possibilities offered by powerful infrastructure such as the Madrid-Barcelona-French border high-speed line invite us to think about future growth. The fight against climate change calls for the promotion of railways in the internal relations between the Member States of the European Union, especially on those corridors where the railway

guarantees reliable service that takes less than three hours between city centres, thereby making it possible to only use aviation for longer connections to take advantage of its strengths. Initiatives in the high-speed rail sector have been developed to respond to this situation, ranging from the use of higher capacity trains (dual-composition trains or double-decker units, for example) to low-cost services or, in another sense, preferential services with open tickets that emulate those offered by some airlines; all of these initiatives will strengthen the amortisation and *raison d'être* of the infrastructure built in recent decades. Be that as it may, anticipating that demand for mobility will not slow down (on the contrary, it seems that it will continue to grow, once the ravages of the pandemic have been overcome), the high-speed services that will reach Barcelona in the coming years are going to need a greater number of tracks on which to hold trains, on which to park them (during off-peak hours and after business hours), and on which to maintain and repair them.

In addition to these circumstances, the process of railway liberalisation already that is under way, sponsored by the European Union, should be added to the list in order to create a more efficient system capable of achieving the best possible transport supply. The high-speed infrastructure must be prepared for a multi-operator scenario, where tracks with platforms and auxiliary track and workshop

facilities are no longer used by a single incumbent operator, but must be shared or distributed among different railway operators.

All of this makes it absolutely essential for Barcelona to have a new station and parking tracks for high-speed services. It is, in short, the fundamental purpose of La Sagrera station. Its location is not as central as that of Sants station, but it will not be at a disadvantage. On the contrary, both stations will complement each other: if Sants station, due to its central position in the urban fabric of Barcelona, will play a key role for users of high-speed services who live in a large part of the city and its nearby metropolitan area, La Sagrera station, given its good connections to the highway network, will provide an advantage for those coming from the metropolitan region and beyond.

In addition to the six international-gauge tracks currently housed at Sants station, eight tracks with their four respective platforms will be added in La Sagrera station. The station building will contain, in addition to the commercial platform area, a technical train management area equipped with ten parking tracks with their corresponding technical platforms (apart from the two general passing tracks) where preparatory operations can be carried out for a new service for those trains that have La Sagrera as their station of origin. This involves cleaning operations, emptying WCs and supplying them with bactericidal

THE FIGHT AGAINST
CLIMATE CHANGE AND
THE LIBERALISATION OF
THE RAILWAYS, AMONG
OTHER CIRCUMSTANCES,
MAKE IT NECESSARY FOR
BARCELONA TO HAVE A NEW
HIGH-SPEED STATION

liquid and water, changing the position of the seats and replenishing food supplies. These operations, which in part are being carried out in the existing stations on the commercial platforms themselves, will have two completely separate spaces in La Sagrera, increasing operational capacity and safety. Considering that the platforms for high-speed services must allow trains of up to 400 metres in length to be parked, a building is being built in La Sagrera that is almost a kilometre long, which includes the commercial platform area, the technical platform area and an intermediate space where the track devices that connect the parking tracks with the sidings are located.

The track layout was designed so that the station serves both trains that use La Sagrera as an



PHOTO_LUIS_UBALDE

In the image, the two lines of the Rodalies network running through La Sagrera. The left-hand image is the line from Barcelona to Mataró, in an intermediate phase of its transfer to the interior of the structure of the future station.

THIS NEW URBAN AREA WILL HAVE A PARTICULARLY ENVIRONMENTALLY SENSITIVE DESIGN THAT OPTIMISES ENERGY EFFICIENCY AND SUPPLY AND WASTE MANAGEMENT

intermediate station and those coming from south of Barcelona that end their journeys at this station. To do this, it was decided that the general tracks would be the ones outside the station's train yard, leaving the sidings in the central area, so that train rotation can take place without any shear stress at the station's head. Excluding the general tracks, the remaining six tracks of the commercial platform area are related to the parking tracks of the technical train management area as follows: each pair of parking tracks is assigned three siding tracks, leaving one extra parking track.

In addition to the two areas described (commercial platform area and technical train management

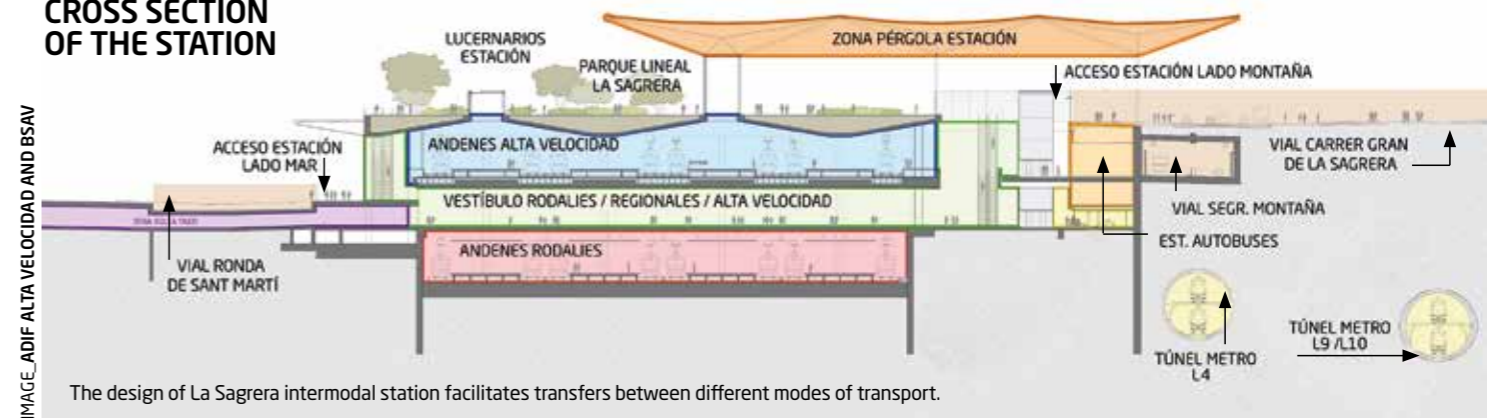
area) there is a third area, which, though not connected to the previous areas, is very close to them. This is a workshop area with reception and working tracks equipped with pits, directly connected to the tracks in the technical train management area, without having to occupy the main track to go from one area to another.

The intermodal nature of La Sagrera node makes this facility a station of stations. In fact, in addition to everything that has been said about high-speed services, there is also a section devoted to commuter and regional train services on two lines of the conventional network: the line from Barcelona to Mataró and the line from Barcelona to Granollers, which continues to Girona and Portbou. In addition, the station is complemented by an underground intercity bus station and the connection with two lines of the Barcelona underground network (lines L4 and L9/L10). All of this is organised into a structure formed by three main levels: on the lower level of the station, the tracks of the conventional network (four tracks of the Barcelona-Mataró line and four tracks of the Barcelona-Granollers line with their respective platforms); on the intermediate level, the station hall (with a part for commuter users; another part for high-speed users) and on both sides of the hall, a parking area for cars; and lastly, on the upper level, the international-gauge tracks and their platforms for high-speed services.

Currently, the execution of the works is at the point where, having completed the curtain walls that surround the lower level of the station, the floor slab (2.5 metres thick) and having finished the first slab, the line from Barcelona to Mataró has been put into service inside the station structure and its accesses. Of course, trains have not yet started to pick up and drop off passengers, but merely passing through the heart of the future station undoubtedly represents a major milestone. Subsequently, a similar procedure will be followed for the line from Barcelona to Granollers, and lastly, the high-speed line will move from its current provisional alignment to its definitive location inside the station.

The work on La Sagrera station goes beyond what has been described here: its scope goes as far as constructing a piece of Barcelona. The station is also a part of the city. It is located on a railway corridor along which three railway lines run, which will no longer be above ground and will be covered by a city park. With its 40 hectares, this will be the largest urban park in the city, running above the train tracks over a distance of 3.7 kilometres. Its construction is associated with the urban development of the old railway area of La Sagrera, which, from the generation of 1.25 million m² of buildable roof, will mean the creation of housing for 25,000 inhabitants

CROSS SECTION OF THE STATION



THE EVOLUTION OF THE WORK ON THE SAGRERA INTERMODAL STATION IN PICTURES



PHOTOS_ADIF ALTA VELOCIDAD

1. Former freight terminal of La Sagrera (2007). 2. Construction of the provisional alignment (2008). 3. Beginning of construction of the logistics area (2013). 4. Beginning of the excavation between screens (2012). 5. Beginning of construction of the floor slab (2018). 6. Close up of the assembly of the floor slab (2018). 7. Completed sewer section of the Rambla Prim (2018).

at the end of the whole process (more than 40%, will be protected housing), as well as generating some 30,000 jobs throughout the area.

This new urban area will have a particularly environmentally sensitive design that optimises energy efficiency and supply and waste management. In this respect, groundwater will be used for the irrigation system for the landscaped areas and the sewer tanks of the tertiary buildings; there are also plans to implement a centralised air-conditioning system, which will use the waste heat from an existing incineration plant in cold weather and will provide

cooling by using sea water; the buildings will have pneumatic waste collection and will be connected to a state-of-the-art telecommunications network, all in accordance with the criteria of a truly smart city.

As a result of all this, a new gateway is being built in Barcelona, La Sagrera station, and this gateway will serve not only those who enter and leave the city, but also introduce more efficient, attractive and sustainable form of mobility, based on multimodality. Given the urgency of the situation, we cannot falter in our fight against climate change: this work is a step in the right direction. ■

More freight trains for the port of Castellón

SOUTH BASIN

The port of Castellón is located in the Grao de Castellón area, about four kilometres from the city centre. The expansion and consequent increase in freight traffic at the south basin led to the decision to promote a new railway access through this area.

The new southern access to the port of Castellón will modernise and increase rail freight traffic and connect the port to the Mediterranean Corridor. The project is designed by Ineco and will replace the northern access that runs through the city centre in precarious conditions with 19 level crossings.

By **Sonia Blanes, Elisa Bueno** and **Íñigo Ortega**, civil engineers

With a single-track and mixed type branch line, mostly electrified, the new 8.3-kilometre long southern railway access is part of the activities performed by MITMA (Ministry of Transport, Mobility and Urban Agenda) to promote rail freight transport in Spain. Until now, the port facilities and railway network had been connected by a non-electrified single-track branch, which starts at the Las Palmas stop, north of Castellón station. This 6.8-kilometre branch runs through urban areas and has 19 level crossings, reducing its operational effectiveness.

Ineco's project aims to connect the port of Castellón to the El Serrallo industrial estate and to the Mediterranean Corridor. Three types of track are used: on ballast in land sections; embedded slab track in the tunnel section between walls and in the pergola area under CV-183; and interlaced track in the inside the port.

The port of Castellón is located in the Grao de Castellón area, approximately four kilometres from the city centre. The expansion and consequent increase in freight traffic in the south basin led to the decision to develop a new railway access through this area.

THE NEW RAILWAY ACCESS ADDRESSES THE INCREASE IN FREIGHT TRAFFIC CAUSED BY THE EXPANSION OF THE SOUTH BASIN. THE PORT OF CASTELLÓN IS LOCATED IN ONE OF THE REGION'S ECONOMIC ACTIVITY

The Port Authority awarded Ineco the drafting of the project to develop this infrastructure, which is vital for the port's competitiveness and growth. The company had previously drawn up the projects for the inland network (phase one of the south basin rail network and connecting rail bridge between the south and north basins).

ONE NETWORK, TWO GAUGES

In Spain, the Iberian gauge, measuring 1,668mm, is the most widespread. This has historically been incompatible with other European networks, which use the international gauge of 1,435mm. Although the decision to implement the Iberian gauge is believed to have been to provide protection against a possible French invasion, this difference actually stems from a study conducted in 1844. This study stated that complex Spanish geography needed wider tracks so that the trains could cross the valleys and mountains of the entire peninsula without complications.

Most Spanish tracks still use the Iberian gauge, except for the AVE high-speed lines, adapted to European standards; the Mediterranean Corridor is being adapted to allow international gauge traffic.



The port of Castellón represents about 5% of the freight traffic of all mainland ports in Spain.

THE NEW BRANCH WILL ALLOW MORE RAIL TRAFFIC, OFFERING A MORE COMPETITIVE AND SUSTAINABLE TRANSPORT ALTERNATIVE

PHOTO: PORTCASTELLO

THE MEDITERRANEAN CORRIDOR, A KEY FOR TOURISM

The Mediterranean Corridor is a double high-speed railway line that runs from the French border to Algieras and connects cities like Barcelona, Valencia, Alicante, Murcia and Malaga, as well as the rest of Europe. This infrastructure is one of the most important railway axes in Spain and will allow people to reach their destinations faster by reducing travel times by almost half, which represents a boost to the economy, tourism and employment. Its link to the Trans-European Transport Network will enable it to connect the continent from north to south in order to make railway more competitive compared to other means of transport.

The work is accompanied by a series of activities relating to noise pollution in the project completion and operating phases. These measures include carrying out an annual measurement study during the first three years, as well as an acoustic and vibration study and the installation of noise barriers in various sections.

THE PORT OF CASTELLÓN

The port of Castellón is located in a very busy area of the region and is one of the drivers of economic growth and employment in the city. It is the ninth largest of Spain's 46 general-use ports and fourth in terms of solid bulk. In recent years the port of Castellón has improved its infrastructure by modernising machinery and different facilities at the quays. Beside the port is the El Serrallo industrial estate, with large companies from the petrochemical and energy sectors, and one of the largest industrial centres in the Valencia Region. ■



Map showing the location of the port and area of operation.

The project includes the construction of a new electrical traction substation to meet the operational needs of the new rail access. It will be housed in a prefabricated building with concrete panels and will supply power for traction, signalling and communications.

In addition to the construction of the new single-track railway platform, the assembly of the superstructure and catenary, and the new substation, the project also includes other associated works such as: the construction of underpasses and overpasses, drainage works, replacement of easements, building demolitions, civil protection facilities and quality controls.



Ineco's projects cover the actions for the development of the new southern branch to the port of Castellón, and include the platform and superstructure of a single 8,295-metre long general track and five interoperable mixed-gauge switches, with a total of 6,230 metres of electrified track, and one electric substation. In addition, four underpasses, two overpasses, a cut-and-cover tunnel between walls, a pergola and two structures on the Barranco de Fraga channel to support a bypass, and a railway viaduct will also be built.



Transfer of units sent by ship from the port of Barcelona.

PHOTO ICEX-KENYA

A new life in Nairobi for Mallorca's trains

Renfe has contracted Ineco to provide the inspection and commissioning of the first five CAF diesel trains that will serve the commuter network of the Kenyan capital. The units, which were sent from Mallorca, have been assessed and prepared to provide service for another 25 years.

By José Ramón Armenteros, Middle East, Asia and Africa representative

In 2012, Nairobi, the capital of Kenya and one of Africa's major cities, reopened its railways after a century, with its first commuter line connecting the capital to the Syokimau neighbourhood in the south, which saw the construction of the first new railway station in 80 years. It was the first step to giving the city and its suburbs an accessible, efficient mass public transport system that will help to reduce congestion. Growth of the population –some four million people in 2019– has stimulated the use of private vehicles and the city's popular minibuses, known as 'matatus', which operate as shared taxis.

For this reason, work is underway for the Development of Commuter Rail Master Plan for the

Nairobi Metropolitan Region, and aims to make rail the alternative mode of transport for the 13 million people that the World Bank, which is supporting the project, estimates will live the city by 2030 (increasing to 22 million in 2045). By then, it is expected there will be a total of six commuter lines, with 163 kilometres of track, 53 stations and 1.4 million daily passengers.

The first actions recommended by the Master Plan include the purchase of rolling stock, improvements and outfitting of the existing workshop, works to improve the condition of stations and renovate the track, and obtaining technical support for the inspection, commissioning and operation of the new trains.

This final task is the one undertaken by Ineco for Renfe, which worked with its Kenyan counterpart –Kenya Railways– and the overall authority for Nairobi's commuter network, NAMATA (Nairobi Metropolitan Area Transport Authority), on the acquisition of rolling stock in Spain, also including the supply of spare parts and staff training. With the support of Spain's Ministry of Commerce and Industry (via ICEX) and Ministry of Transport, Mobility and the Urban Agenda, Kenya signed a contract in 2019 with SFM (Mallorca Rail Services) for the purchase of 11 diesel twin units and one trailer. Specifically, the units are Series 6100 units manufactured by Construcciones y Auxiliar de Ferrocarriles (CAF) in the period 1994-2003, of which the first batch of five units has already been shipped to Kenya.

The units, which were withdrawn from service by SFM following the completion of the electrification of its network, have been reconditioned to extend their useful life by at least 25 years. Ineco carried out the pre-shipping inspection of the units, which departed from the port of Barcelona. Inspection included verification of the list of spare parts requested by Kenya Railways for maintenance of the fleet and checking the condition of the spare parts; inspection and recording the results of static and on-track tests carried out by SFM; visual and documentary review of the units and the reconfiguration of the Automatic Train Stop system (ATS) to factory settings, following the static and on-track tests.

CAF's Series 6100 trains are equipped with two Cummins NTA-855-A diesel engines, one at each end, compressed air brakes and double doors on both sides. They can reach a top speed of 110 km/h. They measure 15.5 metres in length, 3.7 metres high and 2.5 metres wide and have a maximum capacity of 252 passengers: 156 standing and 96 seated. They have space for bicycles and door-closing warning alarms. A total of 52 were manufactured. They first entered service on the rail network in Mallorca in June 1995.

They were retired progressively as the network was electrified and ran on the island for the last time in May 2019. In 2015, SFM sold 12 units to the French railways. In their new home in Kenya, the units will cover various routes from Nairobi to Syokimau, Embakasi, Thika, Kikuyu and Kitengela. ■



PHOTO OLAF TAUSCH / WIKIPEDIA

PHOTO_SETHAPHOPES / WIKIPEDIA

Above, a 6100 train at the station in Manacor, Mallorca 2012. On the right, interior of the trains.

EXPERTS IN ROLLING STOCK

Reconditioning is an option that allows many railway operators to upgrade their fleets with quality rolling stock at a lower cost and more quickly than with new vehicles, because trains are manufactured upon request using components from many manufacturers and to each customer's specification. Hence the need for different adaptations to ready them for alternative uses, in addition to the usual tests before commissioning, which require the supervision of expert technicians.

Ineco has over 20 years' experience in Spain and abroad in the supervision and validation of more than 1,500 trains of every type, both new and reconditioned. The reconditioned trains it has worked on include the 49 NS74 Alstom trains manufactured in the 1970s for the metro in Santiago de Chile; and the three TD 2000 series locomotives manufactured in Spain in 2006 by Ingeteam, when they were no longer required by Basque operator Euskotren, they were purchased by Ecuador to outfit the new line between Durán and Quito.



PHOTO PIXABAY



On the left, congestion in central Nairobi; on the right, the station at Syokimau.

PHOTO KENYA RAILWAYS

BADAJOS STATION

Recreation of a night view of the renovation: outside, a pedestrian square is created to enhance the building. On the façade, the openings along the bottom are outlined with metal frames, with metal slats covering the upper part. A new shelter covers the entrance.



More light and space in four stations of Extremadura

The stations of Plasencia, Cáceres, Mérida and Badajoz, built at the end of the 19th century, are being renovated for the arrival of the high-speed train, following the remodelling that Ineco designed for Adif Alta Velocidad.

By Carlos Albaladejo and Félix Expósito, architects, and Maximiano Moreno and Agustín Tejedor, project managers

The arrival of high-speed rail (see *ITRANSPORTE* 69) requires the adaptation of the passenger buildings in the four main stations of the Autonomous Community of Extremadura: Plasencia, Cáceres, Mérida and Badajoz, to the needs of the new railway service. Ineco, in addition to directing the work on the four stations and working on the track renovation, has drafted the remodelling projects for Adif Alta Velocidad, the Spanish railway infrastructure administrator, which include the buildings, entrances and the surrounding area, as well as the platforms, shelters and underpasses.

All of the works follow general guidelines with the common objectives of improving the sustainability and accessibility of the facilities. Outside, the main works consist of the creation of plazas in front of each station, in which the pedestrian is given centre stage. On the façades, the installation or renovation of shelters will highlight the entrance doors. The aim is to improve the integration of the stations into the urban fabric.

In the interior, the general concept is to gain more natural light, for which suspended ceilings are eliminated, increasing the height in the halls and opening

up the spaces. The use of sustainable materials, improved air-conditioning efficiency and the installation of LED lighting are all part of the project. Furthermore, all of the spaces are totally accessible, and include technologies such as Wi-Fi, electric vehicle charging areas and personalised information points.

In order to carry out these works, it has been necessary to make the service compatible with the works, which is why personnel have been moved to provisional modules so that they can continue to provide service, and the works have been carefully designed to guarantee passenger comfort at all times. ■



BADAJOS STATION A NEW URBAN SPACE

- It was opened in 1866 and initially had a façade topped by a pediment with a skylight, decorative elements widely used at the time. These were later replaced by a rectangular screen façade with 24 openings and a shelter. The housing for railway personnel that began to be built around the station became what is today the neighbourhood of San Fernando. The station has two platforms.
- The works reorganise the exterior space, where pedestrian traffic predominates, while inside the passenger building the spaces are being completely remodelled. A large plaza will be created in front of the building as a space for relaxation and enjoyment, integrating it into the neighbourhood, respecting the symmetrical composition and enhancing the building as a scenic backdrop for Avenida Carolina

Coronado. On the main façade, the openings in the lower band are strengthened by metal frames in the form of lanterns and there is a lattice of metal slats above. These match existing slats in the central body of the entrance and their orientation changes, giving movement to the arrangement.

- A new shelter will be installed outside to cover the entrance. The interior remodelling is centred on the central body, which houses the hall and main entrances, and the eastern body, which contains various auxiliary facilities. A double height hall is created with an open and naturally lit waiting area, enhancing the central character of the space. The underpass and platforms are also being remodelled.



CÁCERES STATION

A RENOVATION THAT RESPECTS THE 'SKIN' OF THE BUILDING: ALUMINIUM AND GLASS

- The existing station dates from 1963 and replaced the original one, inaugurated by King Alfonso XII in 1881, which was demolished. The new building was designed longitudinally, with a symmetrical façade formed by a central body and two lateral bodies with towers at both ends. The main entrance is protected by a large semi-circular shelter. Inside, the waiting room is decorated with a ceramic mural by the artist José Luis Sánchez, dedicated to the conquest of America, and the platform façade has a stained glass window with railway motifs (tracks, turnouts and signals).
- The station has two platforms with three operational tracks for passengers and an underpass equipped with lifts.
- The work includes urban operations to 'create the city' and works on the passenger building that highlight the value of this architectural piece. The conversion of the public space in front of the passenger building into a large square connects the station to the rest of the urban fabric. The arrangement opens the passenger building up to the city, making it part of the architectural scene of Cáceres. Pedestrians, cyclists and public transport (taxis and buses) will converge in this new urban space.
- The integration of the passenger building is achieved renovating the building's 'skin', while respecting its dimensions and construction. It is made up of a lightweight set of horizontal aluminium slats, which will shape the structural bays of the building, giving movement to the façade and breaking up the flatness of the existing building. A new car parking area will be created, which will be detached from the façade of the passenger building, giving the complex space and clean lines.
- In the interior spaces intended for travellers (hall, toilets and underpass), the finishes will be renovated and the sunlight and ventilation conditions will be improved. All this is accompanied by new facilities that improve the energy efficiency and comfort of the station.
- In the platform area, the shelter will be renovated with new waterproofing, and the underpass between platforms will be resurfaced and given new flooring, as well as new glass railings combined with stainless steel.



EXPERTS IN RAILWAY CONSTRUCTION

Ineco has extensive experience in the construction and renovation of all types of railway stations and in adapting them to high speed.

Since the end of the 1980s and the commissioning of the first Madrid-Seville line in 1992, and as the network has expanded, the company has worked on drafting projects and providing management and technical assistance in different works in more than twenty high-speed stations throughout Spain, such as Atocha and Chamartín in Madrid (1992 and 2009); Santa Justa, in Seville (1992); Sants and La Sagrera, in Barcelona (2008, currently); Lleida (2003); Zaragoza-Delicias or María Zambrano, in Malaga; A Coruña, Santiago and Vigo and another nine stations in the Galician Atlantic Axis (2002-2015); Toledo (2005), Valladolid (2007), etc.

More recently, it has carried out the projects and work management of the high-speed stations of Antequera, Loja and Granada (2019). We also participated in other new construction projects, such as those in Vigo-Guixar (2011), Puente Genil and Antequera-Santa Ana (2007) and Camp de Tarragona (2006). The company is currently working on the adaptation of the stations in Abando, in Bilbao, to the high-speed rail system and on the new intermodal station in Ourense.



PLASENCIA STATION OPENING UP SPACES WHILE PRESERVING THE BUILDING'S IDENTITY

► The station was opened in 1893, as part of the 'Ruta de la Plata' line to Astorga, which is now closed. The passenger building, in a simple and sober style, has a central body of two floors with three linteled openings each, and two side annexes. The roof is a gabled tile roof with the original support structure from 1893, which has been preserved with energy improvements in the insulation. It is located outside the town centre, south of the Jerte River. It has two platforms (one is a service platform), with three tracks and several more that are no longer in use, a freight dock (which will house the cafeteria space) and a building formerly used for railway residences.

► The project is mainly focused on development, entrances and buildings. A new station square will be created, with road access and parking adjacent to the station buildings, separate from the development area and façades of the buildings. The cargo building attached to the station, which will house the future cafeteria, will be refurbished,

creating a transition space between it and the passenger building, which will be marked with a new shelter, as well as the taxi stand and the main entrance to the station.

► In the passenger building, all of the interior spaces are being renovated by extending the hall to the current cafeteria area (which is being moved to the renovated building); new restrooms are being built, and a double height main space is being created by demolishing the first floor, which gives a greater sense of space and light. The works include structural reinforcement, remodelling of the installations and improvement of the building roofs, conserving the support structures of the roofs (riveted wood and steel), to preserve the buildings' original character. During the construction phase, materials that have added value due to their special historical characteristics, will be reused, such as part of the original tiles, which will be restored and reused for the roofs. In the interior, the furniture and lamps are being updated with more modern designs.



MÉRIDA STATION RESTORING HARMONY

► This is the largest station in the Extremadura network in terms of size and passenger traffic, and several lines converge here. It was opened in 1864 and is very close to the historic centre of the city. As with the previous buildings, the passenger building is arranged with a central body with two floors plus side buildings. It has more than 10 tracks and a cargo area.

► In the solution designed for the Mérida station, special attention has been given to harmonising the spaces that make up the complex in order to recover the spatial quality that has been lost over time. In

terms of development, a new well-defined access plaza space will be created while respecting the retaining wall structures. This will create a homogeneous space in which the pedestrian area is differentiated from the roadway, creating transition spaces that frame the large backdrop of the passenger building's façade. This same idea was adopted inside, with the hall as an articulating element and a new corporate style. This hall has been designed as a dominant space, incorporating passenger services and the commercial area. The edges of the existing platforms will be adapted to allow passenger access to the new trains. The underpass will also be completely renovated.



THE STATIONS OF EXTREMADURA, YESTERDAY AND TODAY

The four original stations were opened between 1864 and 1893, and from an architectural point of view they have the characteristics of the period: simple lines and a functional design typical of 19th century industrial buildings. The regulations at that time established general guidelines for the different existing railway companies to maintain a certain aesthetic continuity in their facilities. It was recommended that stations located in rural areas be simple constructions that fit in with the surroundings, with decorative elements reserved for urban stations. All of them share a common feature: the passenger building as the main construction, plus other annexed facilities, which include locomotive and wagon depots, workshops, warehouses, docks, scales or watering (water supply to steam locomotives), such as the one at Cáceres station. There used to be a house for the Station Manager and sometimes also for the railway staff, as in Mérida and Plasencia, and in some cases these gave rise to entire neighbourhoods, such as San Fernando in Badajoz.

As for the passenger buildings, these are symmetrical constructions, with one or two floors, with the main façade in a central body that is higher and more prominent than the rest, with annexes on both sides, and gabled roofs, as in the case of the Merida station. The walls were usually made of stone, painted white



or light colours, and the door and window openings, corners and ledges were framed in ochre, brown or blue-grey.

WORKS IN PLASENCIA. The works include the restoration and reuse of some original materials, such as wood, rivets and part of the roof tiles. In the picture, the station's shaded walkway.

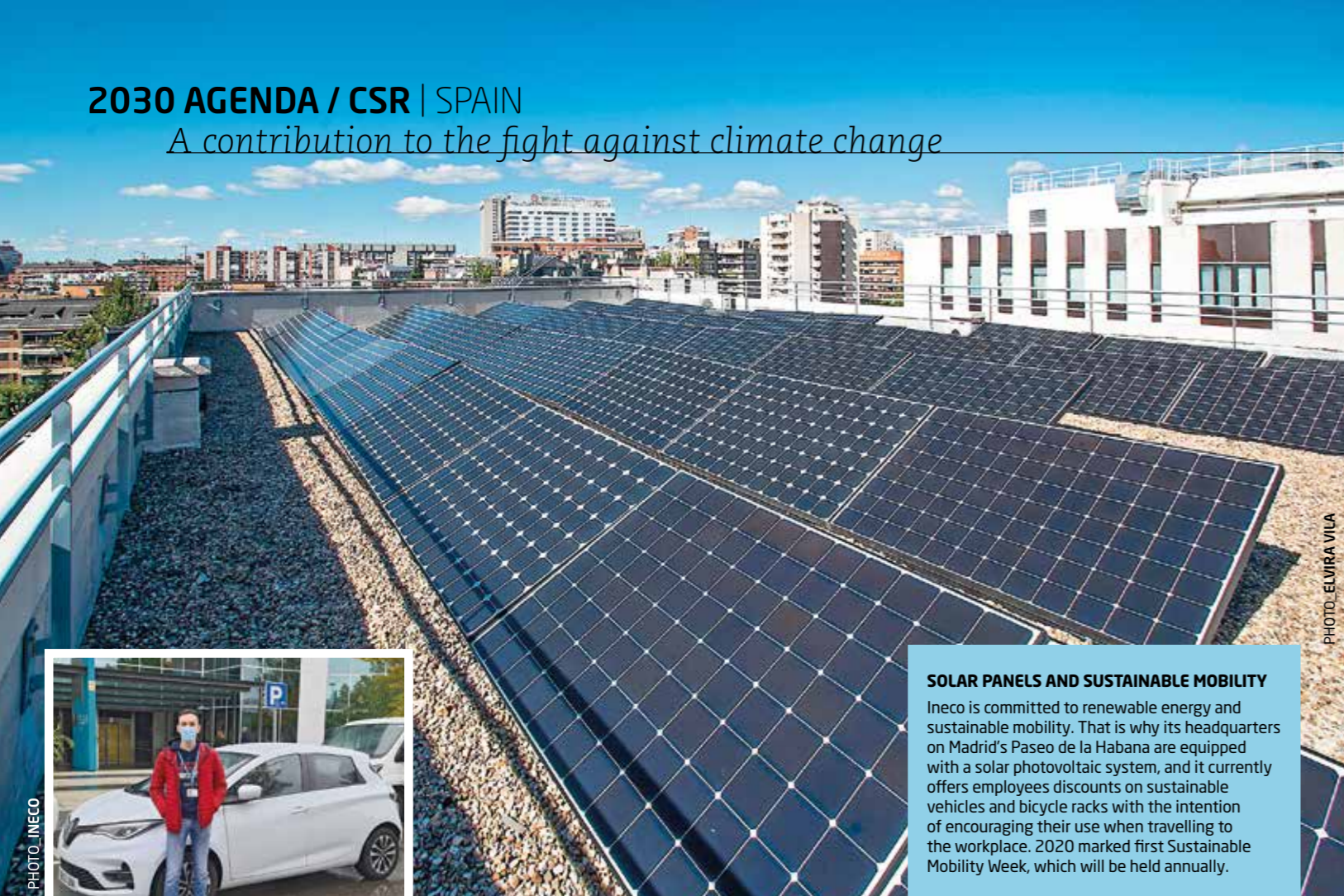


PHOTO: ELVIRA VILA

SOLAR PANELS AND SUSTAINABLE MOBILITY

Ineco is committed to renewable energy and sustainable mobility. That is why its headquarters on Madrid's Paseo de la Habana are equipped with a solar photovoltaic system, and it currently offers employees discounts on sustainable vehicles and bicycle racks with the intention of encouraging their use when travelling to the workplace. 2020 marked first Sustainable Mobility Week, which will be held annually.



Marcos Moreno, one of the winners of a weekend with an all-electric Renault ZOE in Ineco's Sustainable Mobility Week competition.

For a healthy, sustainable environment

Sustainability and protection of the environment are at the heart of Ineco's business. Ineco has intensified its fight against climate change and has made sustainable development one of the foundations of its Atenea Strategic Plan 2019-2022.

By **Sofía Lombardo**, chemical engineer and **Bertrán Visedo**, BA Hons in Environmental Studies

Achieving a sustainable environment is one of the most important global challenges. Ineco puts that challenge at the heart of its business, with its customers and staff, as well as with society in general. The company has extensive experience preparing strategic plans and other plans such as urban mobility plans, applying a global perspective and focusing on

key aspects such as safety, resilience, equitable access, intermodality and efficiency. The Company's contribution to the fight against climate change has strengthened in recent years. It has taken part in projects such as Adif's Fight Against Climate Change Plan, Aena's Climate Change Strategy and projects in railway energy supply and energy certification for buildings.

Some of the more important projects carried out to improve quality of life of society include strategic noise mapping, investigation of atmospheric and hydrological pollution and acting as technical management on civil engineering projects. It has also made an important contribution to the design of inclusive infrastructure and implementation of many projects involving public participation.



PHOTO: INECO

Those actions respond to the growing concern within public authorities and the wider community regarding sustainability, in line with the Spanish Sustainable Mobility Strategy (EEMS) of the Ministry of Transport, Mobility and the Urban Agenda, which provides a country-wide framework to foster a low-carbon, lower-energy economic model, following principles of social justice and fair distribution of wealth.

STAFF INVOLVEMENT

In this context, Ineco encourages its staff to care for the environment and be socially responsible, in line with the



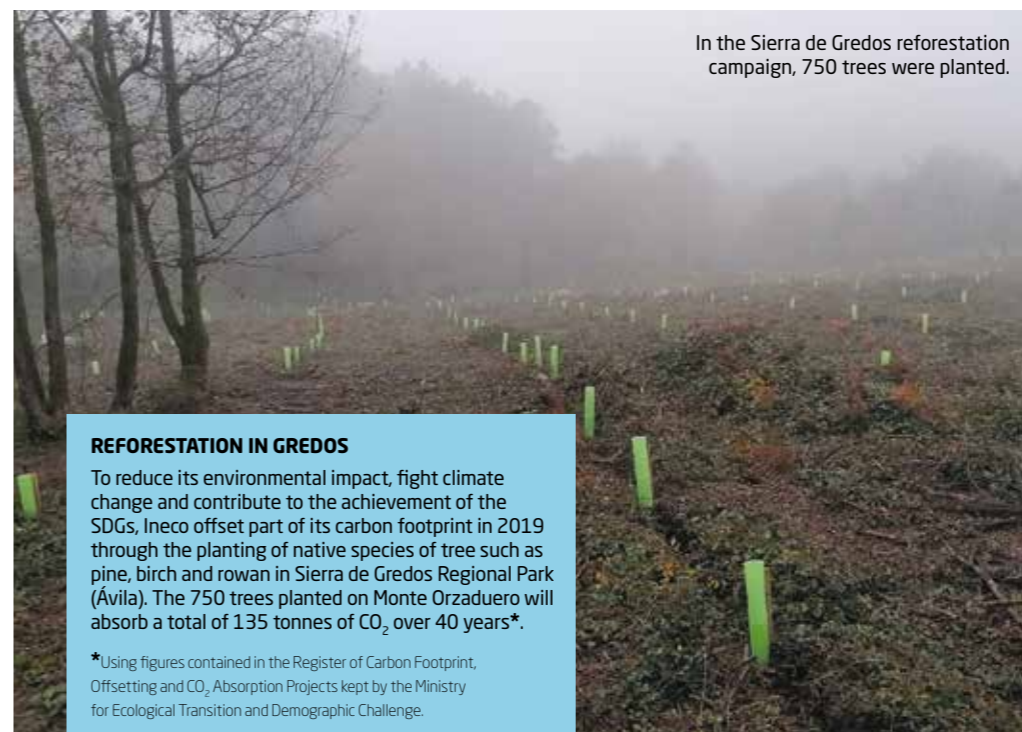
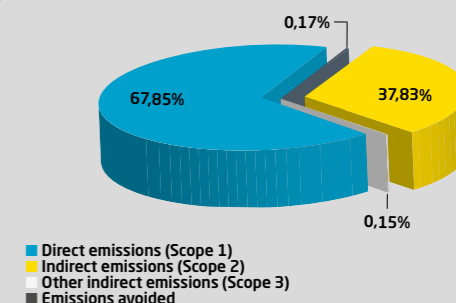
PHOTO: ELVIRA VILA

Each year Ineco awards the Environment Prize to the most pro-environment project in the company. Above, 2019's winning team, Agustín Roldán, Mirela Vladovic and Mirian Pinilla, with Deputy Director Bertrán Visedo. Left, campaign to reduce the use of plastic cups.

INECO'S ENVIRONMENTAL IMPACT

In 2019, the company's carbon footprint dropped to a total of 9,355 tonnes of CO₂ equivalents. That represents a reduction in our carbon footprint from 3.27 tonnes of CO₂ equivalents per employee in 2018 to 2.47 tonnes per employee in 2019, and a reduction against turnover from 34.77 tonnes to 30.71 tonnes of CO₂ equivalents per euro of turnover.

Ineco's Carbon Footprint (tCO₂ eq)



In the Sierra de Gredos reforestation campaign, 750 trees were planted.

REFORESTATION IN GREDOS

To reduce its environmental impact, fight climate change and contribute to the achievement of the SDGs, Ineco offset part of its carbon footprint in 2019 through the planting of native species of tree such as pine, birch and rowan in Sierra de Gredos Regional Park (Ávila). The 750 trees planted on Monte Orzaduro will absorb a total of 135 tonnes of CO₂ over 40 years*.

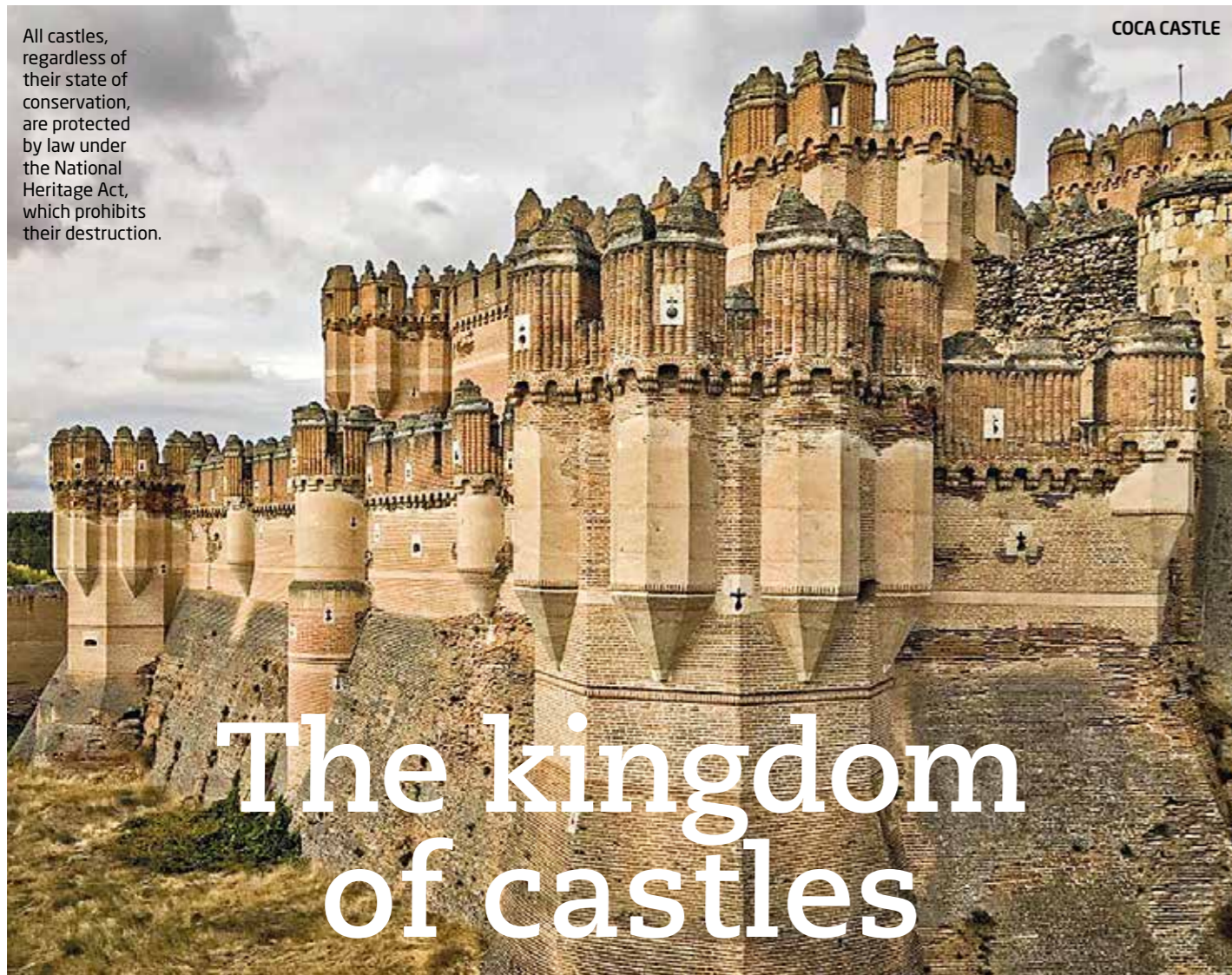
*Using figures contained in the Register of Carbon Footprint, Offsetting and CO₂ Absorption Projects kept by the Ministry for Ecological Transition and Demographic Challenge.

PHOTO: SUSTAINABLE WOODLAND SPAIN

values and principles that govern the United Nations Global Compact, which it joined in 2008. One example of this are the activities that have taken place over recent years, such as the annual celebration of Environment Week to commemorate World Environment Day, on June 5, including workshops, roundtables, volunteering, competitions and other activities, all based on the themes chosen each year by the UN.

Ineco also offers the Environment Prize, an annual award for the most pro-environment project in the company. Winners in recent years include: the installation of brake-energy converter-regenerators at several substations on the conventional rail network (2017), raffling of unneeded IT equipment among the staff (2018), and the creation of the 'digital twin' (A-76 Highway) to modernise the environmental management of infrastructure (2019). ■

All castles, regardless of their state of conservation, are protected by law under the National Heritage Act, which prohibits their destruction.



COCA CASTLE

The kingdom of castles

PHOTO: ANDRÉS M. QUESADA / WIKIPEDIA

The history of Spain is written in its almost 20,000 fortifications, with an estimated 2,600 genuine mediaeval castles, built between the eighth and the sixteenth centuries.

By **ITRANSPORTE**

In the meantime, the Moors also built their own palaces, such as the Alcazar in Seville (tenth century) and the eleventh-century Aljaferia in Zaragoza. Some of the most notable fortifications include the alcazabas or walled citadels, for both residential and defensive purposes, and built inside towns, such as those of Almería, Mérida, Tarifa, Bada-

joz, Málaga and Calatrava la Vieja (in Ciudad Real).

In a mediaeval context, with a largely rural, feudal society with still emergent monarchies, castles, often built on the sites of old Roman forts, were refuges for nobles and peasants during long sieges. The emergence of artillery at the start of the fifteenth century completely transformed military tactics and strategy. Castles lost their original purpose.

The most characteristic architectural features of a mediaeval castle are: an elevated site, a walled enclosure with bailey, lodgings, stables, cisterns and other out-buildings; and the Tribute Tower, absent from Moorish forts. A beautiful example is La Mota Castle, in Valladolid, standing 40 metres high, or the Moorish Burgalimar Castle, in Baños de la Encina (Jaén), with additions by the Christians after the

capture of the castle at the beginning of the thirteenth century.

Spanish castles usually also had a moat (Coca Castle, Segovia); metal-reinforced gates, portcullises, barbicans or outer walls, and drawbridges. Walls and towers had battlements for archers and other defensive features such as machicolations (projections from the

top of the walls to give an advantage to defenders).

These buildings were so important that one of the old Christian kingdoms, the Crown of Castille, was named after them, as are today's autonomous regions of Castilla y Leon and Castilla-La Mancha and the city and province of Castellón. The names of many of today's towns and

villages incorporate 'castillo' (castle) or a word related in some way to castles –like torre (tower), torreón (dungeon/tower), etc.– or their Arabic equivalents: alcala, alcazar, alcocer, etc. The case is similar with the surname Castillo, which is number 44 of the 100 most common according to the Spanish National Statistical Institute.

Unlike many castles in central Europe, owned by feudal lords, castles in mediaeval Spain tended to be owned by the Monarchy and were governed by a warden appointed by the king. From the fifteenth and sixteenth centuries, monarchs entrusted the defence of castles to noble families (Manzanares el Real, Madrid) or to military orders, like the Knights of St John (Peñarroya in Argamasilla de Alba, Ciudad Real; Consuegra, in Toledo) and the Knights Templar (Ponferrada Castle, in León) who also built Peñíscola Castle in Castellón. ■

GENUINE CASTLES...

There are two main features that distinguish a genuine mediaeval castle from other large houses or palaces, according to experts: their military purpose, determining design and location, and that they were originally built between the eighth and the sixteenth centuries. That is how they are defined by the Association for the Restoration of the Castles of Aragon (ARCA) which considers that, from the Renaissance on, many buildings should be called "forts" or palaces, but not strictly castles. What is certain is that, according to the register kept by the Spanish Association of the Friends of Castles and in the absence of official figures, there are currently some 20,000 buildings of one type or another in every possible state of conservation. Of those, it is estimated that about 2,600 are mediaeval castles. Among those that best preserve their original structures are the castles of Gormaz, in Soria, in Moorish style, with the longest outer wall in Europe; Consuegra, in Toledo, in the Romanesque style (twelfth century) and Manzanares el Real, in Madrid, started in the fifteenth century.



LOARRE CASTLE

PHOTO: ARAGON TOURISM



PARADOR AT CARDONA

PHOTO: PARADORES



BELMONTE CASTLE



ALCÁZAR IN SEGOVIA

PHOTO: WIKIPEDIA



GORMAZ CASTLE

PHOTO: WIKIPEDIA



TEMPLAR CASTLE IN PONFERRADA

PHOTO: PONFERRADA TOURISM



MANZANARES EL REAL CASTLE

PHOTO: WIKIPEDIA



BURGALIMAR CASTLE

PHOTO: WIKIPEDIA

...AND NOT SO GENUINE

The fascination sparked by mediaeval castles is reflected in some contemporary constructions (or reconstructions) that imitate them. In the nineteenth century, Romanticism made the Middle Ages fashionable. That led to the building of the castles of Bendinat at Calviá (Mallorca), in the Neo-Gothic style, and the castle at Lachar in Granada. Even more modern are the castles of San José de Valderas at Alcorcón (Madrid), from the beginning of the twentieth century, and the castle of Cebolleros in Burgos, constructed by hand by a private individual starting at the end of 1978, in a similar way to the cathedral of Mejorada del Campo in Madrid. Others are the product of reconstructions of real castles that were carried out without historic rigour or with the addition of architectural and decorative features from other periods, countries and styles, with variable aesthetic results (castles of Butrón in Gatica, Vizcaya; and Olite in Navarre and others).

When the goal is your well-being

The main objective of the work of Ineco's Management, Labour Relations and Safety Department is to ensure the health and safety of everybody who works for the company.



Ineco's Health and Safety team at the entrance to the company's headquarters in Madrid.

PHOTO_ELVIRA VILA

“The health crisis is forcing us to adapt continuously to the new reality in each of the countries in which we operate”

LUIS JANEIRO, Deputy Director of Administration, Labour Relations and Safety at Ineco

The health crisis has tested the entire company, especially those responsible for health and safety, who have had to ensure that workplaces and work-related travel are COVID-safe, putting appropriate measures in place wherever Ineco operates. To prevent the infection and the spread of SARS-CoV-2, escalation and de-escalation scenarios have been established in each country and, above all, for different client needs.

The team is made up of experts in occupational health and safety, as it relates to Safety at Work, Industrial Hygiene, Ergonomics and Psycho-Sociology

and Occupational Health. Over these last few months the team has implemented a number of workplace protocols and measures that, thanks to the cooperation of all staff, have been successful in keeping the level of the disease below 2.4% of the workforce.

To manage the return to in-person work, Ineco has developed a strategic consulting solution based on technology and data exploitation, through BIM tools, to define safety distances in workstations, common areas or traffic areas. GIS is also being used to monitor movements in real time, among others. ■

KEYS TO THE FIGHT AGAINST COVID-19

- 1 DISPLAYS, POSTERS, SIGNS, SANITISING GEL DISPENSERS, THERMAL CAMERAS, ETC.
- 2 COORDINATING BUSINESS ACTIVITY WITH CLIENTS ON 5 CONTINENTS.
- 3 MORE THAN 2,800 SEROLOGICAL TESTS IN SPAIN AND WORLDWIDE.
- 4 19,000 GLOVES AND 75,173 MASKS FOR THE WHOLE WORKFORCE.
- 5 MORE THAN 3,400 TRAINING COURSES ON COVID-19.
- 6 MORE THAN 3,000 COVID-19 ENQUIRIES ANSWERED.
- 7 IMPLEMENTATION OF A MEDICAL ATTENTION SERVICE.



Help us to take care of you on your journey

Aena's airports have implemented all the safety measures against COVID-19. But don't forget that your cooperation is crucial.

Make sure you check out all the information at [infocovidena.es](https://www.infocovidena.es) before you fly.



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