

UAS Activities In Spain



Herewith following the reader will find an overview of the Spanish companies and organizations involved with UAS research and development and their UAS-related activities.

Aernnova is a global aerostructures company assuming the integral management of large aircraft sections. Aeronnova also provides the market with engineering services, composite and metallic parts, as well as repair and product support services. Based on its expertise in aircraft structures, Aeronnova has established UAS development as one of its strategic lines of business, extending its capabilities to multidisciplinary optimization of aircraft design, flight mechanics, control systems and flight platform integration.

Relevant activities in 2007 included the development of a UAS for forest fire-fighting and aerial surveillance applications (Flightech), and contributions to the Spanish national standard for UAS certification. Aeronnova is also a member of ATLANTIDA consortium, contributing to aircraft performance model tasks and flight platform integration for air traffic management experiments with UAS. Other Aeronnova R&D projects cover design of a mini-autogyro UAS. www.aeronnova.com

The **Aerospace Research and Technology Centre** (CTAE) has been involved in UAS since 2006. The kick-off project in this field was a feasibility study on the use of UAS for civilian applications focused on: (1) worldwide operational legislation and certification; (2) technical requirements for applications; and (3) business plan targeted at the Spanish market. The CTAE modus operandi uses internal research projects to acquire and spin-in knowledge as well as to study and evaluate advanced concepts in UAS. CTAE also works closely with industrial partners either by spinning off its expertise and consolidating it in a tangible and possible product commercialisation; or by collaborating together from the beginning in specific (sub)system implementation.

Reference projects in 2008 include: (1) lightweight and precise positioning platform for indoor and outdoor environments using GPS and wireless technologies; (2) integration of GPS with EGNOS; (3) decentralised and collaborative UAVs mission planning and control; and (4) integration of sensors for autonomous vertical take-off and landing.

CTAE envisages future R&T efforts and capabilities in autonomy (teleoperations/telerobotics) concepts, mission operations, planning and scheduling of tasks and activities, decentralised and cooperative control, localisation and navigation technologies, human-machine interfaces including advanced visualisation devices, as well as certifications and legal aspects regarding the use of these platforms in civilian scenarios. www.ctae.org

In 2007, **Aerovision** completed the development of the FULMAR-LAND 2.0, with a new fully automatic recovering system, based on the AP04 autopilot and a ground-based deployable net recovery system. This UAS is a newer version of the FULMAR-LAND 1.0, completed by Aerovision in 2006. Aerovision will provide this system to be used in

the ATLANTIDA project between 2008 and 2010. The ATLANTIDA project will use the FULMAR system to test the ATM developments made by an Spanish consortium of 18 companies directed by Boeing R&T Centre Europe, and funded by the Spanish administration under the umbrella of the CENIT research program.

In the first half of the year 2008, Aerovision will manufacture two prototypes of the FULMAR-SEA system. This system will use an aircraft with the ability of landing on the open sea. The prototypes will be tested between June and October 2008 along the Basque coast of Spain. The FULMAR-SEA is a UAS designed and developed by Aerovision and it will be used by the fishing companies to detect the tuna fish during 2009. www.aerovision-uav.com

«The activity of the Aerial Robotics Group at **AIN** (Asociacion de la Industria Navarra) focuses on the development of robotics applications based on autonomous helicopter platforms. For this purpose, AIN has developed, in the last years, full capabilities in systems integration, including flight control, communications and payload systems into different available mechanics. This approach allows the adaptation of the whole system to the application requirements. Currently AIN operates three kind of systems with different useful payloads up to 5 kg (small), 10 kg (medium) and more than 20 kg (big) ranging from 20 to 80 kg maximum take-off weight.

In accordance with this philosophy, after previous work years in flight control systems, in 2003 REE (responsible for the transmission network and for operation of the Spanish electricity system) and AIN signed a contract for the development of PELICANO project concerning an aerial robotic system for power line inspection, which proved successful. In 2007 a second phase of this project was started which includes the integration of a 4 axis gyro-stabilized electro-optical system as well as additional navigation capabilities for the operation in the power line environment. According to the work programme the new prototype will be tested in third quarter of 2008. Furthermore the group is involved in the MICROVISION Project, under the umbrella of the Eureka programme, carried out by the Spanish consortium made up of Aurensis, Geovirtual and Catalonia Institute of Geomatics, concerning the development of a system for the generation of high quality, spatially referenced geo-information at an affordable cost. The system shall allow for a frequent and flexible operation, thus enabling the access of new user communities to this type of information. Finally the group is involved, in collaborating with other research organizations, in the development of obstacle avoidance systems by optical means.» www.ain.es

Airview was founded in 2003 in order to provide aerial platforms to the UAS industry and research centres. Airview designs, manufactures and operates a comprehensive range of aerial vehicles under 150kg MTOW, conceived as flexible platforms for different payloads. From 2003 to 2006, Airview developed the AV-01 family and AV-02 according to the needs of the projects in which it was involved.



AV01 - Airview, Spain

In order to automate several functions of its UAS, Airview develops onboard equipment and payload interfaces, as well as its own ground station applications.

In 2007, Airview took part with Argongra (GIS supplier) in a joint project to generate automated algorithms to recreate aerial information gathered from UA. This project was partially founded by Madrid Regional Government. Within the scope of this project, the AV-03 vehicle was added to Airview's product family in order to provide the increased payload capacity and range required by the project. Airview's website: www.airview.com.es

The **AITIIP Foundation** is a technological center with 50 high qualified employees and its own technologies and productive facilities. The most relevant work regarding unmanned aircraft is its participation in PLATINO programme, especially in HADA project. The participation in this project has been focused on the use of design and manufacturing of unique components such as wings, fuselage, wing opening mechanisms and control surfaces, which have been applied in the demonstration activities with the COLIBRI prototype. The development of these components has been possible with an integral application of the newest technologies like rapid prototyping, high speed machining of foams FC covered.

The AITIIP Foundation is specialized in processing technologies and their optimization, tooling industry, systems integration and innovation in productive technologies and rapid manufacturing, leading industrial subsectors in Spain like plastics converters, tooling industry (moulds and dies), rapid manufacturing and inverse engineering, covering the entire value chain to achieve goals in product development. www.aitiip.com

ARIES Ingeniería y Sistemas is one of the pioneering and leading companies in Spain in the field of UAS since the company started its collaboration on INTA's SIVA UAS programme in 1997. ARIES developed the launcher for SIVA



Aries Ingeniería y Sistemas Spain

programme and has specialised in the design and manufacture of UAS launchers, having developed since then a family of them based on different technologies: the RO-01 conventional pneumatic launcher, the RO-02 bungee launcher, the NIHEL nitrogen launcher, the LAE high energy pneumatic launcher and some other launchers for undisclosed clients.

Additionally, ARIES developed a Universal Transportable UAS Engine Test Facility for INTA and is still working on a derivative of a helicopter radar-based Obstacle Awareness System capable of providing a tactical UAS with autonomous sense and avoid capabilities. The UAS-related activities deployed by ARIES during 2007 can be summarised as follows:

- High Energy Launcher: This is a partially supported Spanish MoD research demonstrator for a universal UAS pneumatic launcher able to launch up to 400Kg at 70m/s with an acceleration peak below 12g. The launcher is currently undergoing validation and characterisation test at the INTA facilities.
- Assessment of Technology Needs for UCAV: This EDA research project was lead by Alenia Aeronautica with a consortium of companies from Italy, Spain, Portugal, Netherlands and Norway. The objective of the project was to identify the peculiarities of UCAV and the implications on technologies for a system due to fly in the 2018 timeframe. ARIES contributed in the field of launchers, on-board auxiliary power units and was responsible for the training.
- PASI: This is the first operational tactical UAS programme for the Spanish Army. It was undertaken by a consortium consisting of Indra and EADS CASA, with IAI MALAT and ARIES as subcontractors. ARIES was responsible for the overall engineering of the programme. Additionally, two new Tactical Control Stations were developed to interface the PASI system with the Spanish Army tactical network. Finally, ARIES participated in the provision of services as maintenance support and in the training of the military operators.

Finally, in the beginning of 2008 ARIES created the Unmanned Solutions Department in a pioneering business initiative focused on the provision of services with UAS for civil markets (i.e. agriculture, customs & coast guard, environment protection, industry & flight services, police & civil security, etc). www.aries.com.es

Aries Complex¹ (which together with ARESA and ACTA form the ARIES Group¹) is leading, together with I.N.T.A., the consortium of the Platino programme for the development of the HADA UAS. Aries Complex is providing the industrial vision of the project, while INTA is the technological leader. HADA stands for "Helicopter ADaptative Aircraft" and it is a development project that expects to have a flying prototype in 2011. The consortium consists of an important number of companies, technological centres and universities throughout Spain. More information regarding HADA is provided further in this publication. www.ariescomplex.com

¹ Neither Aries Complex, nor Aries Group, is related to Aries Ingeniería y Sistemas.

Besides conventional aviation, the provision of operational support to upcoming airspace uses, such as in unmanned or personal air transportation, represents a major challenge that the future ATM is faced with. In its way ahead towards Trajectory-Based Operations (TBO), the future ATM paradigm is expected to heavily rely on advanced automation tools that will facilitate a strategic and collaborative trajectory management approach, ultimately enabled by a net-centric,

service-oriented system architecture. In that regard, UAS settle on the boundary of automation of aerial vehicles' operations and, because of that, their integration in ATM is often perceived as a chief problem among the many ones that the future ATM solution shall be required to address. But, those same flight platforms that are pushing ATM into harder trouble also bring about a unique and affordable opportunity to facilitate its solution, and this is precisely the idea behind the ATLANTIDA initiative. With a budget of €28.9M (partially funded by the Spanish Ministry of Industry through its Center for Technological and Industrial Development, CDTI) and a duration of 3,5 years, the ATLANTIDA project will tackle the scientific and technological challenges that need to be overcome for the introduction of high levels of automation in the management of complex airspace. ATLANTIDA (acronym of «Aplicación de Tecnologías Líder a Aeronaves No Tripuladas para la Investigación y el Desarrollo en ATM» – Application of Leading Technologies to UAS for the Research and Development of ATM) aims at exploring an approach to automated air traffic management that may seamlessly apply to any scenario of operation of air vehicles, including conventional manned aircraft, civil/military UAS applications and the futuristic Personal Transportation System. To that aim, advanced high-fidelity simulations will be conducted along with flight trials using UAVs to enable developing and evaluating innovative net-centric trajectory-oriented concepts and technologies. **Boeing Research and Technology Europe (BR&TE)** leads the ATLANTIDA consortium, which encompasses 18 partners among major Spanish aerospace and IT companies (Indra, Atos Origin, TCP, GMV, Altran, TTI, Aernnova, INSA, Aertec, Indisys, Integrasys, Aerovision, MDU, Isdefe, Catón, Iberia & Qualitas), and top-notch technical universities. www.boeing.com



CATUAV is a privately owned small company dedicated to UAVs. Since 2003 its main goal is to develop its own UAV technology and provide customers with services and technical solutions. The main facilities are located in a small airfield 40 km north of Barcelona, near the village of Moia. CAT UAV cooperated with INDRA in the development of a small video-surveillance UAS called Atmos-2 and is now working in two new projects: Atmos-3 and Furos. Both are small UAVs, Furos under 11 kg total weight and Atmos-3 under 2 kg. The company has also designed a two place control center that looks like a flight simulator and it's used to monitor and control UAs. This control center is trailerable by any car to move it easily where needed. CATUAV has also recently developed a small near infrared digital camera and a special processing software to obtain low cost, high resolution NDVI aerial images. For additional information see: www.catuav.com

CTA is a research centre that was established as a non-profit entity in 1998. Since the beginning, the priority for CTA has been to develop technologies of interest for the aerospace sector. With a main part of activity dedicated to development and certification tests, CTA runs yearly R+T projects with a total value of 1,5 Million Euro. Since 2003, CTA has defined avionics as an strategic research area for the centre. Currently ongoing projects in this area concern systems for both UAS and structural health monitoring equipment. Directly involved in UAS Research and Technology projects at a national level with INTA (Platino project) and Boeing Research and Technology Europe (ATLANTIDA project), one of the main activities in research is to advance clear and established procedures for the certification of UAS in order to start the introduction in non-segregated airspace. Another regional project named as HEGATEK, established CTA as the leader of a research group with the Basque Engineering University (UPV) and a Virtual Engineering research centre (EUVE) for the development and manufacture of a fully autonomous VTOL UAS. The different phases include the programming and validation of a flight control system and a flight navigation system, implementing the results on a 5 kg piston engine-powered helicopter.

The Centre for the Development of Industrial Technology (CDTI) is a Spanish public organisation that plays a decisive role in the promotion of innovation and technology development in Spain, since its creation in 1977. The mission of CDTI is to help Spanish companies to improve their technological level by providing funding for research and development projects, the management and promotion of their participation in international technological co-operation programmes, and facilitating technology transfer. CDTI also encourages and assists in the creation, development and consolidation of technology-based enterprises in Spain.

CDTI is entitled with the management of the programmes to support Aeronautical R&D. In this field, CDTI has prepared a Strategic Plan to optimise the Government's policies during the next eight-year period. The Plan implements several policies in order to support instruments aimed at increasing the Spanish aeronautics turnover from now to 2016. Within the main goals of this Plan, developments and support of infrastructures in the field of UAS rank highest. www.cdti.es

EADS is a driver of innovation and technology in the aerospace and defence industry. Through its Defence & Security Division (DS), EADS develops integrated system solutions in the UAS field that meet present and future customer's needs. Major focus today is on the development of combined military air systems related to ISTAR capabilities. DS in Spain is committed to important research and development activities comprising the whole UAS spectrum, including the URAV and UCAV segment. DS Spain participates in the tri-national programme known as Advanced UAV, leading both the communications system and the ground segment. It has competences in the areas of airframe design & analysis, general systems, sense and avoid and Electronic Support Measures (ESM). DS Spain is also the representative in the European project Neuron, a UCAV technology demonstrator. It has the lead in the ground segment together with significant contributions to data link management, airframe design & manufacturing.

Investigations are conducted to prove the feasibility of advanced wide-band link technologies both for LOS (Line of Sight) and SATCOM applications. In the field of

communications, DS Spain is a major player for the development of Link 16 in Europe and this experience has been incorporated in several UAS projects.

The company has developed advanced architectures aiming at certifiable ground control stations, including simultaneous multi-vehicle C2 and dynamic re-planning. They are tested in various EADS platforms. As an example, successful results have been proved during the flight test campaign of the UAS technology demonstrator in Spain in 2007.

It is also present in the tactical UAS segment through both, its own system ATLANTE and, the first tactical UAS for the Spanish Armed Forces called PASI, which is developed together with Indra.

In summary, DS Spain offers a complete portfolio of mission systems and solutions for the UAS programmes: platforms, multi-mission ground stations, multi-source data fusion systems, command and control systems for strategic, operative and tactical levels, communication networks and intelligence systems. www.eads.es

GMV is a privately owned technological business group with an international presence. GMV offers its solutions, services and products in: Aeronautics, Banking and Finances, Space, Defence, Health, Security, Transportation, Telecommunications, and Information Technology for Public Administration and large corporations.

GMV is the company responsible for SISCAR, which (in Spanish initials), stands for «Joint System for Precision Approach and Recovery/Landing of Aircraft». This system provides information, control, precision approach and automatic landing/recovery for military aircraft and, where applicable, civil aircraft from fixed sites on airbases, aerodromes and ships, in any weather conditions, day or night. The system is interoperable with other systems of allied nations and civil aviation systems. GMV is currently working on SISCAR technologies oriented to provide UAS ATOL capabilities. GMV participates in the ATLANTIDA program. GMV responsibilities consists on the development of the navigation subsystem to be installed on the UAVs and also the ground deployment of a navigation augmentation system in order to ensure the required performances. In addition, GMV will develop prototypes for the ATFCM which will balance demand and capacity during the aerial operations planning phase, and the operations Centre (UOC) which computes and monitors optimum 4D trajectories. In the context of UAS, GMV is also responsible for the design and development of a two ISTAR information systems (SEISMO). The system is composed by an information exploitation centre and a scenario generation module for training purposes. The contract also includes providing support to the Spanish MoD in the MAJIC program (mainly in SOSTAR-X, TCAR, AGS and A-UAV). www.gmv.es

Indra Sistemas S.A. is a leading Spanish IT and Defence Systems company with extensive experience in Airborne Equipment, Simulation and Automatic Test, Command and Control, Satellite Navigation, Communications, Air Traffic Control and Air Traffic Management, Integrated Logistic Support, Sensors, Missiles and ISTAR systems. Examples of current UAS-related activities are the following:

- Indra is the national leading supplier of airborne radars, participating in relevant multinational projects (NATO AGS, SOSTAR-X, Advanced-UAV SAR/MTI), and developing national airborne SAR/MTI radars capable to be placed on board different types of UAS (e.g. HORUS

for MALE and Ku-SAR for tactical UAS). Indra offers a wide range of EO/IR sensors for Defence & Security applications, and is currently developing the Multi-purpose Multi-role Platform (MMP), an advanced 4 axis gyro-stabilized optronic platform with sensor interchange capability, specially designed for tactical UAS.

- Indra is also developing an IFF Transponder for UAS, based on existing equipments for manned aircrafts. The extensive portfolio of Indra in on-board Electronic Warfare systems constitutes a basis for new UAS-oriented products.
- In the field of Sense&Avoid Indra is developing a low cost system for Tactical-UAS, and it is involved in an international consortium for the development of a technological demonstrator for large size UAS.
- Based on our previous experience in communication systems (e.g. MIDS-JTRS, TERSO, SATCOMs...), Indra is developing a family of UAS-applicable Data Links (e.g. Ku and C Band DL for Tactical-UAS, SATCOM DL) based on Spread Spectrum modulation and Software Defined Radio Technologies.
- Indra is working in the improvement of the architecture, usability and interoperability of UAS Ground Stations for different applications and programmes. In particular, Indra has developed a multiplatform interoperable Mission Station for data exploitation and visualization that has been integrated on MAJIC programme. Indra is also developing a generic mission control segment for Payload Control and EO/IR images exploitation.
- In 2008 the Spanish Army has deployed its first operational Tactical UAS in Afghanistan. The system, called PASI, and based on the Searcher II platform of IAI-Malat, Israel, has been delivered by a consortium comprising Indra and EADS CASA, with IAI MALAT and Aries as subcontractors. www.indra.es

The **Institute of Geomatics (IG)** is a public for non-profit organisation that does research and education in the area of geomatics. (Geomatics is the art, science and technology of dealing with geo-referenced information; from acquisition, orientation, interpretation, to storage and dissemination).

The IG is involved in a number of initiatives to use UAS as platforms for photogrammetry and remote sensing (P&RS). Besides the currently accepted two paradigms of geo-information data acquisition (aircraft and satellites), the IG is promoting the adoption of UAS-based P&RS as the third data acquisition paradigm. In this context, the IG specialises in sensor integration, robust navigation and precise sensor orientation and calibration.

The IG is currently involved in the uVISION project, «A new concept for the acquisition, processing and representation of geoinformation». uVISION is a Brazilian-Spanish cooperation project that, in Spain, is lead by the company AURENSIS. The other participants are AIN (manufacturer of UAS), GeoNumerics and GeoVirtual. In uVISION, the IG is responsible for the HW integration of the remote-sensing and trajectory determination payload (medium-format high-resolution camera, INS/GPS-based robust navigation and orientation system), for sensor orientation and calibration and for precise «a posteriori» position-velocity-attitude determination from the INS/GPS and other ancillary navigation sensors data.

Ingeniería de Sistemas para la Defensa de España, SA (ISDEFE) is a non-profit company owned by the Spanish Ministry of Defence that participates in the field of UAS R&D, either in Spanish projects (PLATINO, ATLANTIDA) or European projects (SOFIA, INOUI) under the EC FP6

Research Framework Programme.

The PLATINO project deals with the development of a morphing VTOL unmanned aircraft (HADA) that during the cruise phase is capable to fly as a fixed wing aircraft. It is complemented by developments giving HADA the capability of landing automatically and see, sense and avoid.

ATLANTIDA project is trying to get a higher level of automation in the ATM environment through the Business Trajectories concept developed by SESAR. Using UAS within the project will validate this concept.

ISDEFE is leading the SOFIA FP6 project, which is developing a Flight Reconfiguration Function (FRF) for manned aircraft in case the authorised pilots have been neutralised. This system has a strong relationship with the field of UAS since the FRF would give the UAS the capability of autonomously re-planning and safely landing the UAS, avoiding obstacles, weather and other aircrafts. The INOUI FP6 project is studying the integration of UAS in the non-segregated airspace in the future European ATM environment as being defined by SESAR. This establishes a relationship between SESAR and UAS.

In all these projects ISDEFE performs work in UAS technologies, UAS certification, integration in ATM and airports, and safety assessment. ISDEFE also supports the Spanish Armies in the purchase, deployment and operation of UAS. www.isdefe.es

Ingeniería y Servicios Aeroespaciales, SA (INSA) is a ground segment engineering aerospace company belonging to the National Institute of Aerospace Technique (INTA).

Since the '90s and under contract to INTA contract, INSA has developed the ground control system (GCS) of the SIVA programme, a pioneer tactic UAS programme. INSA was responsible for the GCS overall design and implementation, including data link, UAS command and payload control, mission planning, payload data exploitation, etc. Another product developed by INSA is the portable remote video terminal, which permits the direct reception of the SIVA payload data, independently from the GCS.

When the SIVA units were transferred to the Spanish Army as UAS training systems, INSA was responsible for the specialist training of the armed forces, including training courses for pilots, maintenance and exploitation. INSA also supported INTA in the definition and implementation of system upgrades, both for the SIVA system (for instance in the satellite relay) and for the other UAS of the INTA range, such as MILANO (a strategic UAS), ALO (Observation Light Aircraft) and DIANA (aerial target system).

INSA is taking part in the ATLANTIDA project led by Boeing Research and Technology Europe, looking after meteorological models for trajectory prediction, the ground meteorological station and the simulation interface for air traffic control systems. Additionally, INSA is leading, together with ISDEFE, the development of the so-called SANCHO project (blimp system for surveillance, communications relay and navigation systems). The final objective of SANCHO is the implementation of medium to high altitude unmanned aerostatic systems with a view to improve current observation and communication systems, as well as to fly navigation payloads contributing to augmenting or certifying space navigation systems. Currently, the development team is working with commercial blimps where the conventional remote piloted systems are being replaced by autonomous systems, while specific payloads are being defined, integrated and

flight tested. www.insa.es

Instituto Nacional de Técnica Aeroespacial (I.N.T.A.), the Spanish national aerospace research Institute, has been pioneering UAS research and development in Spain for more than 18 years now. It developed the SIVA (Sistema Integrado de vigilancia aérea) tactical UAS consisting of aircraft, control station and launching and retrieval systems. SIVA has been transferred to the Spanish Army, which is using it routinely for troop training. I.N.T.A. has also developed the small short range ALO (Avión Ligero de Observación) UAS for «over-the-hill» missions designated ALO. I.N.T.A. has also developed the Alba small aerial target for short range artillery and SAM training (now in production), and is developing the Diana medium-sized turbojet aerial target land-based and naval missile defence training.

I.N.T.A. has two new UAS systems under development: MILANO and HADA. MILANO is an extended range, long endurance fixed wing UAS, while HADA is a «Morphing» aircraft capable of VTOL and high efficiency cruise flight (see further in this publication). I.N.T.A. also gives technical support to Spanish industry and cooperates with other research institutions and universities. www.inta.es



SAVL - Oberon Space, Spain

Oberon Space, a company supported by the CDTI (Center for Technological and Industrial Development), is involved with the design and flight-testing of a small unmanned demonstrator aircraft that flies using the power emitted by a laser. The aircraft named SAVL is intended to have day and night flight capabilities, recharging its batteries when passing over a laser power source. This power source will not only carry the energy, but also the pulsed information. The system will be composed of a wide set of small lasers, spread out in such a way that all its rays will converge into a space region. The unmanned aircraft will have special solar cells to efficiently convert the laser ray into electricity.

In order to make the aircraft totally autonomous, a low-cost autopilot has been developed. The autopilot is composed of an inertial measurement unit (INS), pressure and GPS sensors. The INS was totally developed by Oberon Space, using MEMS technologies, and is very compact (2.3x2.0x1.6 cm). The system can be used for a wide range of applications (surveillance, traffic control, coastal monitoring, aerial photography, etc), with the advantage that it can fly continuously without requiring to land to refuel. www.oberon-space.com

PiLDo Labs is a reference in the validation of systems for aviation and has been developing several GNSS based applications with promising impact, as Approach Procedures with Vertical Guidance (APV) being the first company to test these procedures in small and medium-sized airports in the Catalonia area., Air Traffic

Management (ATM) based applications based on GNSS, Environmental studies based on satellite data, etc. These technologies are being adapted for their use in UAS, together with the development of advanced mission control and flight control on-ground systems based on EGNOS and GALILEO Safety-of-Life services. These systems allow the estimation of unmanned aircraft position with highly reliable safety margins, permitting an accurate and safe navigation.

SENER Ingeniería y Sistemas, S.A. is a leading engineering, consultancy and systems integration company that has become an international benchmark in the Aerospace, Civil and Architecture, Energy and Process and Marine Engineering fields. In the UAS area, SENER has recently taken part in two projects for the European Union, both of them within an international consortium: in the MAVDEM (Mini Aerial Vehicle DEMonstrator) project, SENER is in charge of the design and development, as well as all the integration and testing activities, of a technology demonstrator prototype, with special focus in the concept design, the guidance, navigation and control system (GNC) engineering and several flying tests. This unmanned aircraft will be a portable vehicle of 1.5 kg weight and 50 cm long. SENER has also participated in a study on the use of UAS in border surveillance activities (BSUAV), which is part of the Preparatory Action in the field of Security Research for the VII Framework Program of the European Union. The purpose of this supporting activity is to present a structured analysis of the potential contribution of UAS to peacetime security on European borders. The study will include five steps: interviews to the final users; synthesis in the form of generic situations, the requirements on UAS able to handle these situations, the definition of realistic UAS systems, and the presentation of those results to the final users. Finally, SENER has also contributed to the UCAV project for the 'Scenario Definition and Mission Analysis' and the 'Consolidation of UCAV Main Characteristics and Technological Considerations', where SENER has lead the: 'Sub-system Analysis' that divides the UCAV system in functional systems and subsystems. SENER has developed the subsystems health management system, communication system (aircraft), vehicle management system, launch and recovery, ILS (integrated logistic support), communication system (ground) and sensor payload (RADAR/SAR), as well as all the activities related to the coordination of the different partners, and the leadership of the work package.

In 2008, SENER Ingeniería y Sistemas, S.A. and General Atomics Aeronautical Systems, Inc. (GAASI), a leading manufacturer of unmanned aircraft systems (UAS) and tactical reconnaissance radars, have signed a teaming agreement that promotes the use of the Predator® UAS series to support Spain's airborne surveillance and reconnaissance requirements. SENER Ingeniería y Sistemas, S.A. is part of SENER Grupo de Ingeniería, S.A., an engineering group with more than 4,500 employees and an annual turnover of 791M€ www.sener.es

SISTEPLANT, a Spanish engineering company was founded in 1984, and has its head-offices in northern and branches in Spain and other countries. The company, with +100 staff and 30% of RDI over sales, is mainly involved with the aerospace and defence sector around the improvement of industrial operations in aircraft manufacturing and assembly, and MRO. The company is proprietor of the advanced artificial intelligence-based software PRISMA3, and is developing with INTA (National

Institute of Aerospace) an onboard-box, called SIMAP, connected to the flight-control-system, and aimed at the smart real-time detection of maintenance preventive actions. The SIMAP has been specifically developed for medium-large UAS, and will be tested in the HADA mixed rotor aircraft platform developed by Aries-Complex and INTA. www.sisteplant.com

Spanish Civil Aviation Authority (DGAC) has been involved in UAS rulemaking and industry development since 2006, when Spanish public organisation CDTI (Centre for the Development of Industrial Technology) established contact with the DGAC Certification Department to show the emerging interest from industry in introduce UAS for commercial applications.

FlighTech Systems, with the Technical Certification support of the DOA AERNNOVA, is the first Spanish company that has presented DGAC its UAS project «ALTEA». FlightTech maintains a fluid collaboration with DGAC, which is elaborating a Certification Specifications document for small UAV Systems, the document will cover unmaned vehicles with a maximum take-off weight between 20 Kg. and 150 Kg. (additional limitations are specified in the draft also). From DGAC point of view, it is very useful for both parts that industry and DGAC work in parallel in innovative areas like UAS development. The final goal is to create an Airworthiness Code in concordance with the directive lines drawn by EASA NPA 16-2005 for UAS heavier than 150 Kg. The creation of this code will be coordinated with European NAAs and international organizations to achieve the implementation of UAS operation in national air space in the next years.

DGAC is also participating in the last international initiatives regarding UAS like AAGRLU (Aviation Authority Group on Regulation of Light UAS) and it is our intention to take part in the different Work Groups created in Europe to establish a common regulatory background for small UAS.

TCP Sistemas e Ingeniería, S.L. (TCP) is a Spanish independent company founded in 1993, counting around 400 high-qualified employees and active in the field of Software Engineering and Consultancy with a specialised division for the Aerospace market. TCP is leading different projects for UAS, in the frame of its R&D UAS-Lab, whose main objective is to develop the most advanced flight control systems, ground monitoring and control techniques and testing solutions for UAS. The main purpose of the first project in this area, named SISCANT and successfully completed in December 2005, was the design and implementation of reusable adaptative flight control systems able to face subsystem failures, adverse and degraded flight conditions and autonomously adapt to environmental changes. SISCANT II, started in December 2005, has the objective to build a new flight control and navigation functionalities (i.e. trajectory optimisation, flight in extremely adverse conditions, use of Virtual Reality for operations) based on the results of SISCANT, including on top a very robust controller. Plataforma-UAV, successfully completed in October 2007, was the study, design and implementation of a development platform dedicated to providing an improved FCS of UAS. SOARV-UAV, started in January 2007, has the objective to develop a new system for UAS Ground Station supporting the air operation based in virtual reality. All projects have been realized in partnership with Universidad Politecnica of Madrid.

UAS-Lab has generated several test flights near Madrid, achieving a high testing level and a mature team of experts

in fields as diverse as real-time environments and embedded software, flight-path optimisation, flight control system design, teleoperated ground systems, virtual reality techniques, safety-critical implementations and hardware managed security systems. Finally, TCP is a major player in ATLANTIDA, a large project aimed at studying, design, develop and testing innovative ATM concepts through the use of a UAS testing fleet. www.tcpsi.com

The Advanced Control Systems (SAC) group is part of the **Technical University of Catalonia** (UPC). It has more than 20 researchers dedicated to the analysis, design and implementation of identification, modelling, control and fault tolerant systems for different engineering applications: active acoustic noise control, process and industrial control, fuel cells, robotics, water cycle control, wind turbine generation, and UAVs. In particular it has been working in unmanned helicopters for the last 3 years with the objective of incrementing the autonomous behaviour of these vehicles by exploiting recent identification and control techniques and adding artificial vision devices.

This group also leads a project at UPC which concentrates the UAV technological developments, both in airplanes and helicopters, with the participation of other groups: ICARUS (operations), IRI»VIS (artificial vision) and the Geomatic Institute-IdG (navigation). The three general objectives of this project are: (1) Develop state of the art technology; (2) *know how* transfer to industrial partners, and (3) promote internal relations among groups inside UPC in this area. Specifically the idea is to increment the autonomous behaviour of UAVs in order to satisfy more sophisticated missions, e.g. landing in a mobile base (ship), obstacle avoidance or visual control among groups of UAVs. It is intended as a means of developing civil applications in many areas, e.g. forest fire detection, high voltage cable inspection, etc. These applications would be jointly developed with interested industrial partners. www.upc.edu

The Intelligent Communications and Avionics for Robust Unmanned aerial Systems (ICARUS) Research Group is located at the **Technical University of Catalonia** (UPC). The group is focused on the development of systems that enable the effective and efficient operation of UAS within a civil application framework (see www.icarus.es). Three research directions are currently addressed in order to implement a «Mission Control Computer» concept: (1) developing new avionics for the intelligent control of the UAV's mission and its payload; (2) strategies and methodologies for developing mission oriented flight plans; and (3) architectures and UAS procedures for the safe integration of UAS into non-segregated civil airspace. ICARUS aims at developing technological solutions that improve UAS applicability and flexibility. As application scenario, a UAV architecture is being developed for the detection, control and analysis of wild land forest fires. Information obtained by the aerial platform together with its analysis could be shared with fire brigades on the ground will allow taking the strategic decisions to optimize actions against the fire, thus reducing damage to the environment, costs, and improving the security of the overall operations. This development is being implemented in close collaboration with the GRAF (Forest Activities Reinforcement Group) of the Bombers de la Generalitat de Catalunya, as well as with the US FS to guarantee the practical applicability of the system within the limitations imposed by the management complexity of a large forest fire. www.upc.edu

UAV Navigation is a leading company in UAS and manned aircraft avionics. UAV Navigation's AP04 family of autopilots is currently being used in UAS all over the world, from mini and micros to tactical, both fixed wing and helicopters. World leading projects, from twin-engine high subsonic jet target drones in the US, to leading edge man portable electric UAS with auto tracking and camera-guidance capabilities in Israel, all benefit from using UAV Navigation's line of avionics. Additionally, UAV Navigation's ground control station systems allow simultaneous control of multiple heterogeneous UAS (including mixed fixed-wing and heli), both on field applications and on C4 installations. Completing the line of unmanned products, the company's hardware-in-the-loop simulators allow full mission training, including simulated video generation capabilities.

Three years after its market launch the Rotary Wing AP04H Autopilot has proven itself as reliable mature product.

We are very grateful to the Spanish UAS Community for their continuous interest in UAV Navigation products, which in the last four years has resulted in 90% of Spanish UAS projects using the AP04 autopilot.

On manned aircraft, the company's systems are used in extreme applications such as the telemetry of the RedBull Air Race, where attitude, position and velocity have to be calculated during 10G+ aerobatics. These demanding applications have allowed UAV Navigation to develop the only Electronic Flight Information System (EFIS) in the experimental aviation market capable of correctly operating during extreme dynamics. This EFIS system operates as both, onboard cockpit instrumentation, and as a full training/debriefing system when used in combination with UAV Navigation's line of virtual-reality flight reproduction and analysis tools. www.uavnavigation.com

The Applied Artificial Intelligence Group at **Universidad Carlos III de Madrid** has, among its interest research areas, data fusion, intelligent systems, multiagent systems, fuzzy logic, evolutionary computation, operations planning/routing, etc. They apply these lines to the design of complex perception systems such as surveillance systems, air traffic control, visual sensor networks and navigation systems.

In the field of UAS, the development of autonomous systems deals with unexpected events, and the importance of the ability of adaptation to the changes. The two main requirements are the capacity of controllers to respond to unexpected events and the ability to perceive changes in the environment, maintaining a reliable representation of the surroundings.

The first problem is related with the area of control, and can be improved by modelling the actions of the agent on the environment. In this line, the research in machine learning, neural networks, evolutionary techniques, planning, etc., may improve the reaction to expected behaviors. The second problem, perception, is generally achieved through sensor fusion, an essential aspect of modern systems using complementary sensors. In the case of UAS, a case of interest is the integration of complementary sensors such as inertial sensors onboard (autonomous, with high rate to capture fast vehicle dynamics) with external sources such as radio navigation sensors (with no degeneracy due to time drift). UAS applications are more conditioned due to the limited set of inexpensive and light sensors on board. So, robustness is required to isolate faults and keep useable levels of performance to guarantee autonomous operation.

The fusion methods usually require a complex modeling and tuning process to automatically regulate its performance and avoid problematic conditions, especially

to meet robustness requirements. Several artificial intelligence techniques can be applied to these goals, including uncertainty modeling, machine learning, heuristic search and global optimization. www.uc3m.es



The Computer Vision Group at the **Universidad Politécnica Madrid** is an active application oriented R&D group in the field of UAS since 1997. Since then this group has been developing several governmental R&D projects jointly with some private founded projects, in which the main focus has been to introduce computer vision within the UAS. In these projects computer vision is not only used for detecting visual targets, recognizing them and tracking them, but the extracted visual information is also used for guiding and controlling the UAS fights themselves accordingly to external visual references. In November 2007, the CV-UPM group co-organized with INTA the first national UAS conference (Innovation in UAS'07) in Madrid. The Group is currently in charge of developing the project «Computer Vision for UAS: navigation, cooperation, tracking and inspection», it has three fully operative, vision based UAS and it is closely cooperating with the Spanish industry for exploiting the results in industrial systems. www.upm.es

The Dynamic Systems Research Group at the **Universidad Politécnica Madrid** has been working since its foundation to provide solutions to the main problems relative to the use of the UAS at civil use. When completed, the Spanish companies will have at its disposal the appropriate technology to compete under the same conditions as the rest of the aeronautical companies, at both European and International level. For that reason, the research team does not limit itself to theoretical research, but also works with key sectors of the aeronautical industry to put into practice the technological advances they have achieved. It collaborates with BR&TE, TCPSI, UAVNavigation, and Prointec amongst others. The main developments are:

- ATLANTIDA (CENIT 2007-2010 Project):
- KUAV -2 Flight platform for Boeing R&T Europe
 - Automatic Flight Control System for TCPSI
- SOAR-UAV (Project founded by the CAM 2007 – 2008):
- Flight Operations Support System, based in virtual reality, for UAS SISCANT (PROFIT Project 2004 – 2005):
 - Development and Certification of Advance Control Systems for Unmanned Airplanes
- SISCANT II (PROFIT Project 2005 – 2007):
- Flight Control System for Unmanned Airplanes UAV – PLATFORM (Project subsidized by CAM 2006 – 2007):
 - Developmental Support Platform for UAVs Flight Control Systems. www.upm.es

The Microwaves and Radar Group at the **Universidad Politécnica Madrid** is a very active research team in the field of microwave circuits and systems development, and it is specialized in radar systems. The group addresses all the fields related with radar, including system integration and signal processing. The GMR has more than 25 years

experience in designing microwaves and radar sensors and has collaborated with the main companies and public organizations of this industrial sector in Spain and Europe (Indra, Alcatel-Alenia, I.N.T.A., ESA, EADS, etc). In the last years the group has focused on high resolution SAR and ISAR radar systems, mainly in the millimeterwave bands. At present, the group is involved in the development of a miniaturized imaging radar in the 34GHz band, with a bandwidth in excess of 1 GHz and resolution of 15x15cm. The system is portable and has a low consumption, in order to be suitable as a UAS payload. An experimental system has already been «flown» using a ground-based platform (a car) running along a road that is slightly elevated above a surrounding landscape, and high resolution images have been demonstrated. The system incorporates a movement error compensation technique completely based on signal processing, so no inertial navigation system is required. Ranges beyond 2 km have also been demonstrated with the prototype. The group also maintains some activity in passive microwave imaging in the 35 GHz and 94 GHz band. www.upm.es



The GRVC group, lead by Prof. A. Ollero at AICIA-**University of Seville** has a strong activity in Unmanned Aircraft Systems. This group, with more than 30 engineers, including 10 PhDs, has been involved in 7 UAS projects with European and Spanish funds in 2007. The GRVC group is the coordinator of the AWARE project (European Commission 6th Framework Programme) on the integration of UAS and wireless sensor and actuator networks. The current results of the AWARE project include the joint transportation of a load by means of three autonomous helicopters, which is the first time that has been demonstrated.

During 2007 the group improved the previously developed prototypes of the HERO autonomous helicopter and developed two new autonomous fixed wing UAS. This year the group is working on technologies for autonomous landing on moving platforms (SAHAB project), positioning and navigation using computer vision (AEROSENS project), UAS teleoperation, and multi-UAS networking and coordination (AWARE and AEROSENS projects). Furthermore, in 2007, the GRVC group started participation in the ATLANTIDA project lead by Boeing Research and Technology Europe on the automation of air traffic control and the experimentation by means of multiple UAS, and in the HADA project lead by INTA. In 2007 the GRVC group also developed UAS applications for terrain mapping (AEROSENS) and visual and infrared detection of fires (AWARE project).

The group also worked on the monitoring of flora and fauna in natural environments (SADCOM project) and in Disaster Management/Civil Security applications (AWARE and ROBAUCO). www.iis-seville.org