

GLOBAL SOLUTIONS FOR THE SPACE MARKET
BEYOND LIMITS



EU-Japan, 9-11 March 2015

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gmv[®]
INNOVATING SOLUTIONS

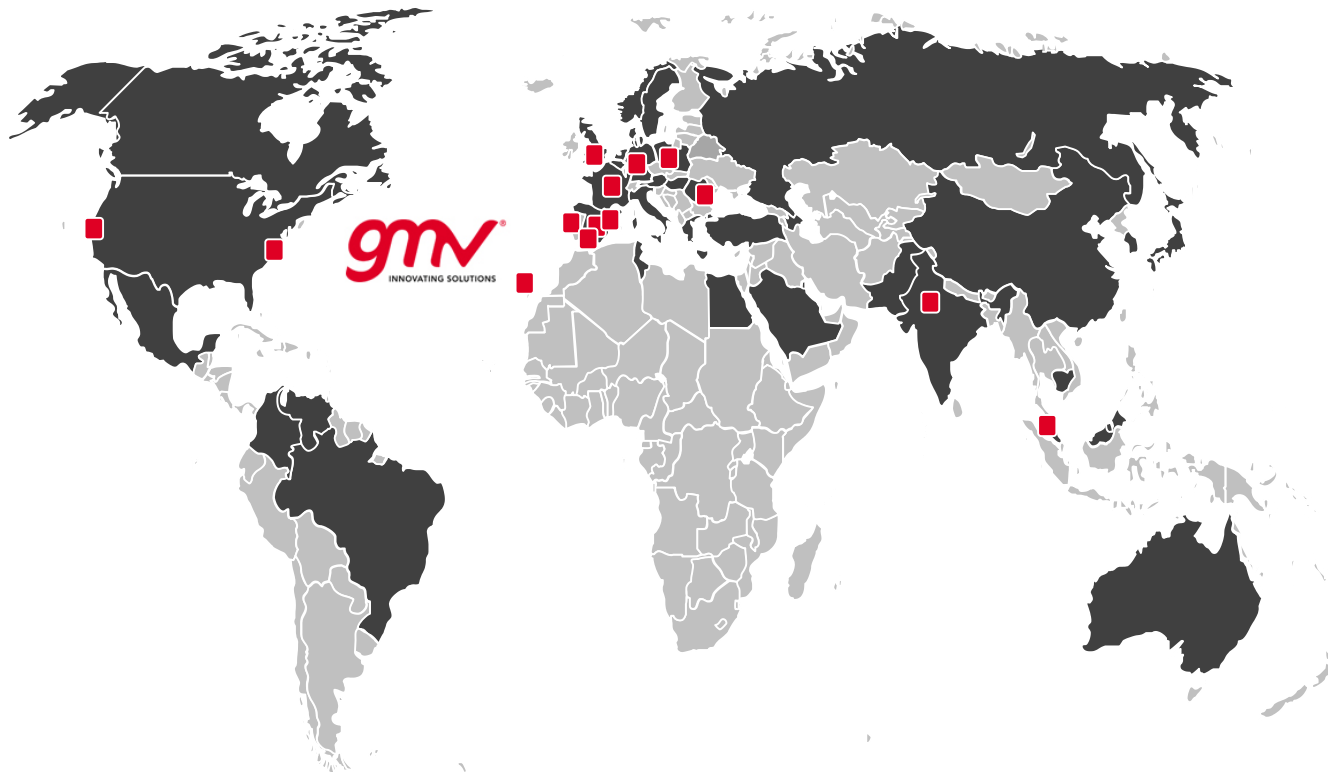
GMV

INTRODUCTION



WHAT IS GMV TODAY

A **high technology multinational** conglomerate, **founded in 1984**, with presence in Spain, United Kingdom, USA, Portugal, Germany, Poland, India, Romania, Malaysia, France and Colombia. GMV technology is deployed in **5 continents**



€ **115M€**
(total revenue)
80M€
(space-related)

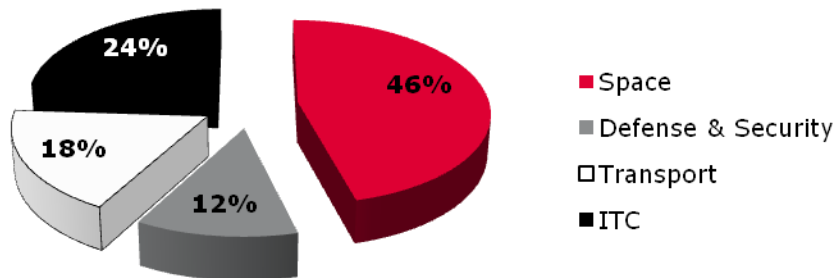
 Over **1.100**
employees
worldwide

CMMI
Level 5

WHAT WE DO

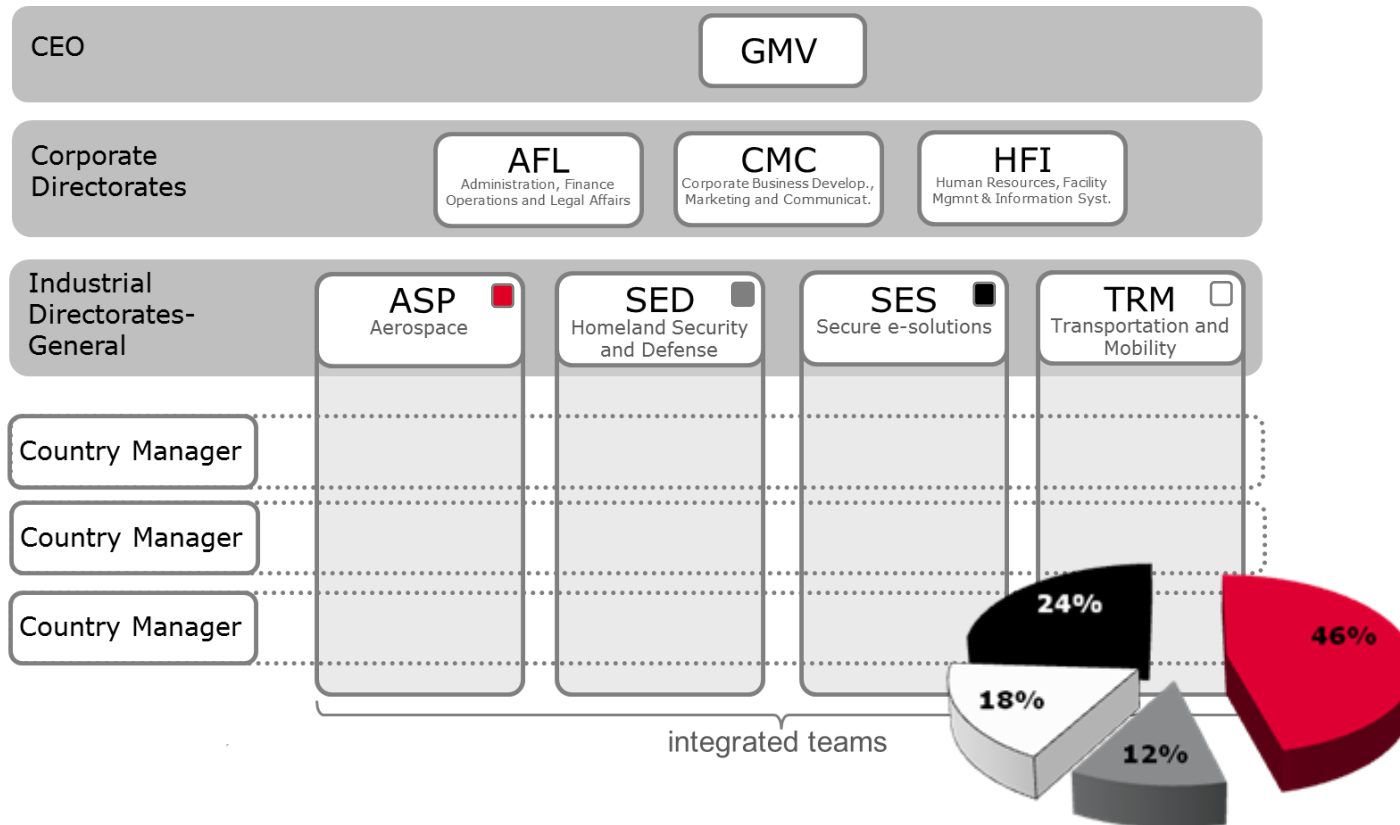
GMV provides engineering, expert support services and turn-key IT systems and solutions for these markets

- Aeronautics
- Space
- Defense
- Security
- Healthcare
- Transportation
- IT & Telecommunications



GMV ORGANIZATION

International organization based on **4 industrial general-directorates** and **3 corporate directorates**
Integrated operations of the 12 GMV firms



OUR PROPOSAL

GMV goes beyond customer requirements, exploring their actual needs, willing to find out new solutions. This lets us offer the right response, sometimes unique and always trustworthy.

- **Innovation capability**

- Product dev for cost/schedule improvement
 - Application of state-of-the-art-technologies

- **Technological Leadership**

- over 50 papers/year in specialized conferences

- **Quality**

- CMMI-5 certified

- **Competitiveness**

- 60% success rate in GMV proposals

- **Customer focus**

- 85% recurrent customer contracts
 - 70% increase in number of customers 05/10

- **Response capability**

- 24x7 services

- **Flexibility**

- Part of our corporate culture



COMMITMENT TO QUALITY

GMV's commitment with customer, excellence, innovation and continuous improvement extends to its Quality management procedures.

GMV is aware that Quality is not only a certificate but the result of the commitment of all its personnel with every day work.

GMV's subsidiaries have the appropriate Quality certificates for their activity sector and area of specialization.

GMV Aerospace and Defence S.A.

- CMMI Level 5
- ISO 9001: 2000
- UNE-EN 9100:2003
- AQAP 160 & 2110
- ISO 14001: 2004

GMV Soluciones Globales Internet S.A.

- ISO 9001:2000
- ISO 27001:2005
- UNE 71502:2004
- ISO 14001: 2004

GMV Sistemas S.A.

- ISO 9001:2000
- UNE-EN ISO 9001:2000.

Skysoft Portugal

- ISO 9001: 2000.
- UNE-EN 9100:2003 (in progress)



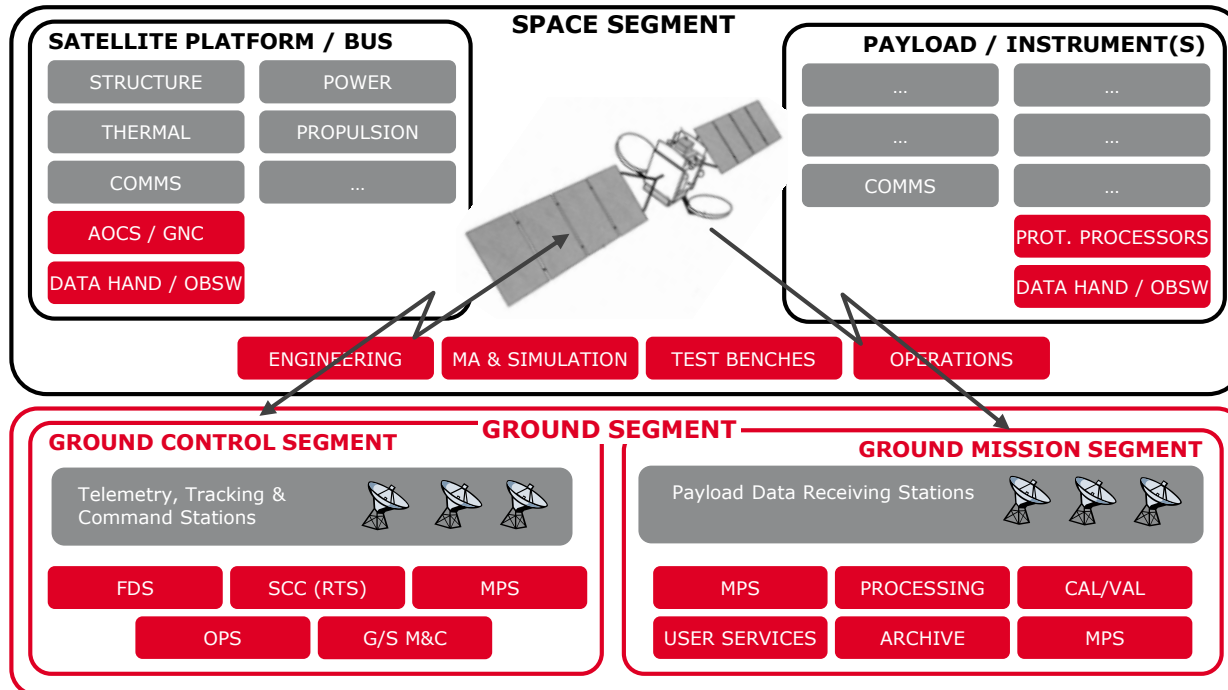
GMV IN THE

SPACE MARKET



GMV IN SPACE

- Active in **space segment, ground segment** (control and mission/payload segments), **operations** and **space applications** (transport, defense & security, environment, etc.)
- A cumulative number of almost **300 satellites** supported by GMV (all domains)



Included in
SpaceNews' Top 50 Space
Manufacturing Industries

GMV OFFER IN SPACE: 5 PILLARS

• FLIGHT SEGMENT

- Mission Analysis and Systems Engineering
- Guidance, Navigation and Control (GNC) Systems
- Robotics and Autonomy
- Mission and Satellite Simulators
- On-board Software and Test Benches

NAVIGATION

- Engineering and algorithms of navigation systems
- Large navigation processing and generation systems
- Precise positioning augmentation
- GNSS tools

GROUND CONTROL SEGMENT

- Design and integration
- Satellite control centers
- Flight Dynamics Systems
- Ground Station monitoring and control systems
- Mission Planning Systems
- Operations

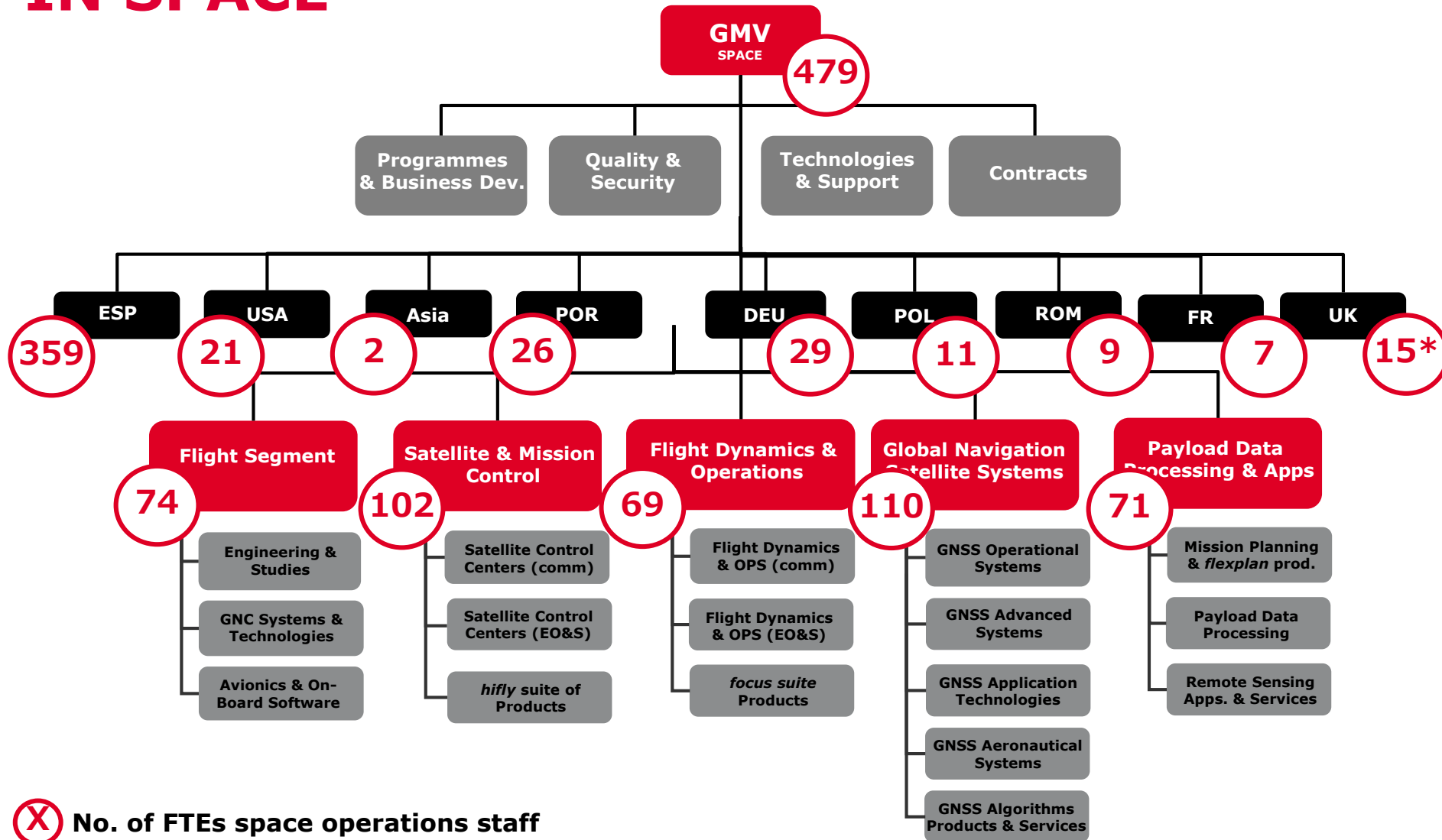
PAYLOAD DATA GROUND SEGMENT

- Design and integration
- Earth observation payload data processing systems
- Science Operation Centers
- Telecommunication payload management systems
- Mission Planning and Scheduling

USER SEGMENT AND APPLICATIONS

- Remote sensing applications
- Satellite navigation applications

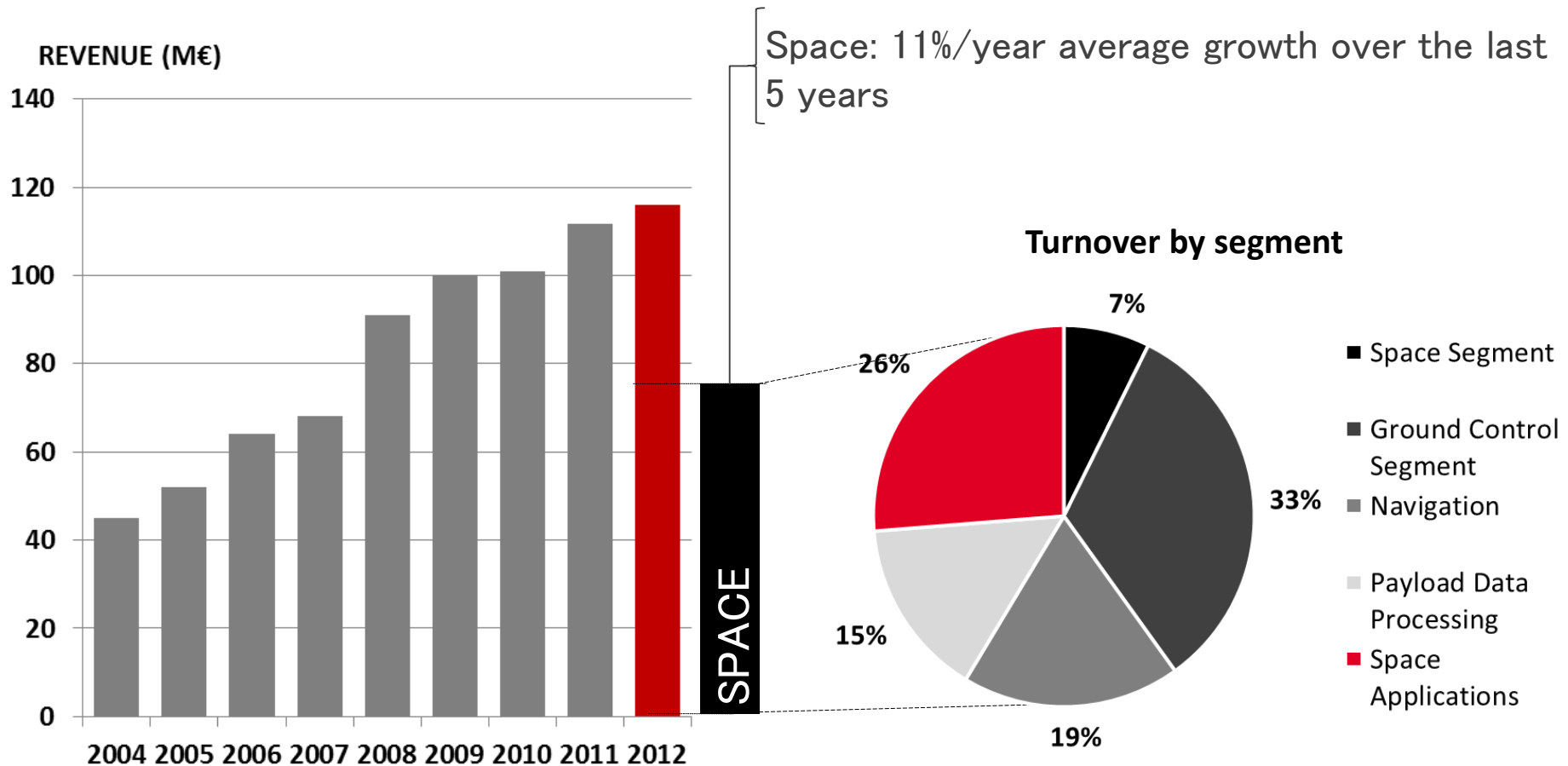
INTEGRATED OPERATIONS TEAM OF GMV IN SPACE



X No. of FTEs space operations staff
* By 2015

GMV TODAY: FIGURES

The result of a multinational conglomerate diversified in various industries.



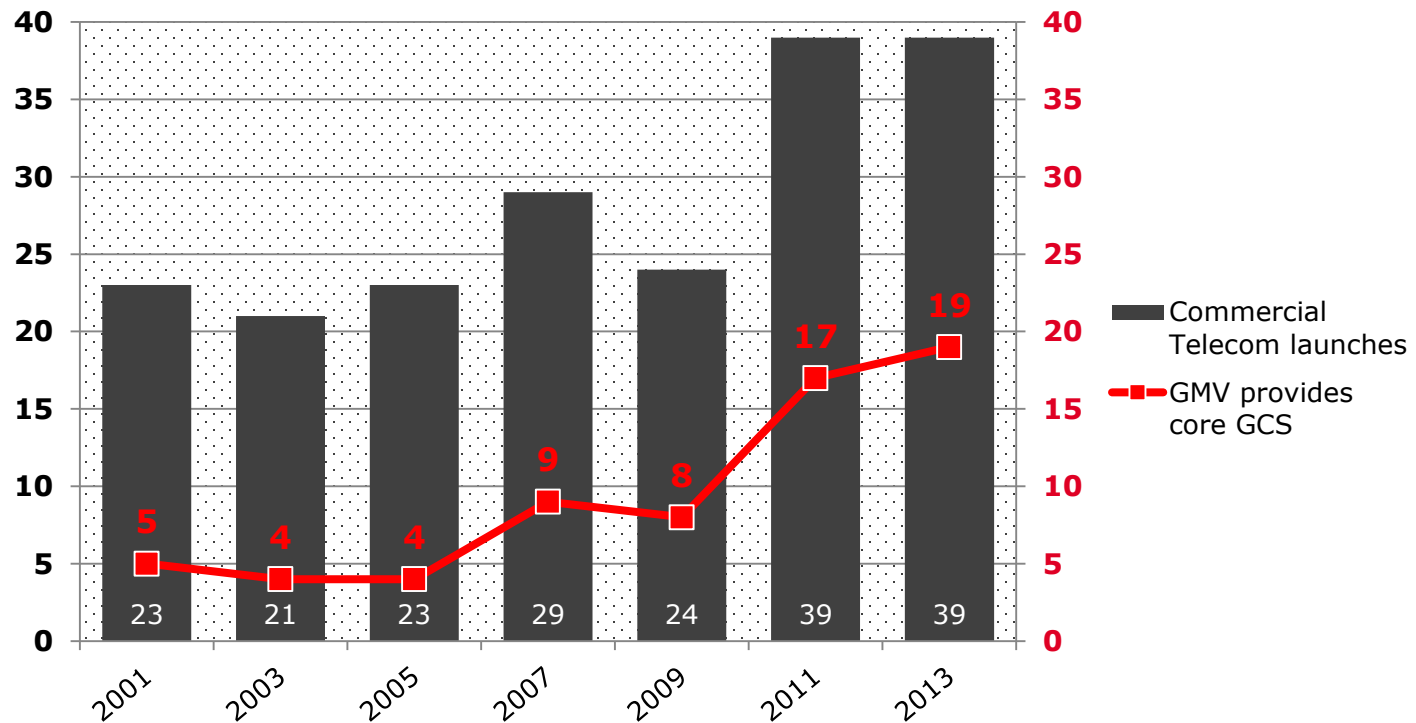
GLOBAL REACH, GLOBAL OFFERING

- Wide range of **competences**: consultancy, project management, systems engineering, development, AIV, operations, training, maintenance.
- Solution that best suits our customer needs:
 - **Custom made systems** (ad hoc development for specific needs & requirements; flexible approach; agile methodology)
 - **Product based solutions** (based on GMV's wide portfolio of operationally proven COTS, reduced risks, shorter delivery times, customization services, benefits from user community)
 - **Service based solutions** (support customer decision processes, customer operations and customer business model)
- Key supplier in most space market segments:
 - Commercial **telecommunications** missions,
 - **Earth observation**,
 - Global **Navigation** Satellite missions,
 - **Scientific** missions,
 - Space **Transportation & Exploration**,
 - **Technology Demonstration** and **Applications**

#1 WORLDWIDE

INDEPENDENT GCS SUPPLIER TO COMMERCIAL TELECOM OPERATORS

- Around 50% of all launched commercial telecom satellite, based on GMV technology to support GCS operations



OUR PORTFOLIO OF MAIN CUSTOMERS

INSTITUTIONAL CUSTOMERS: SPACE AGENCIES



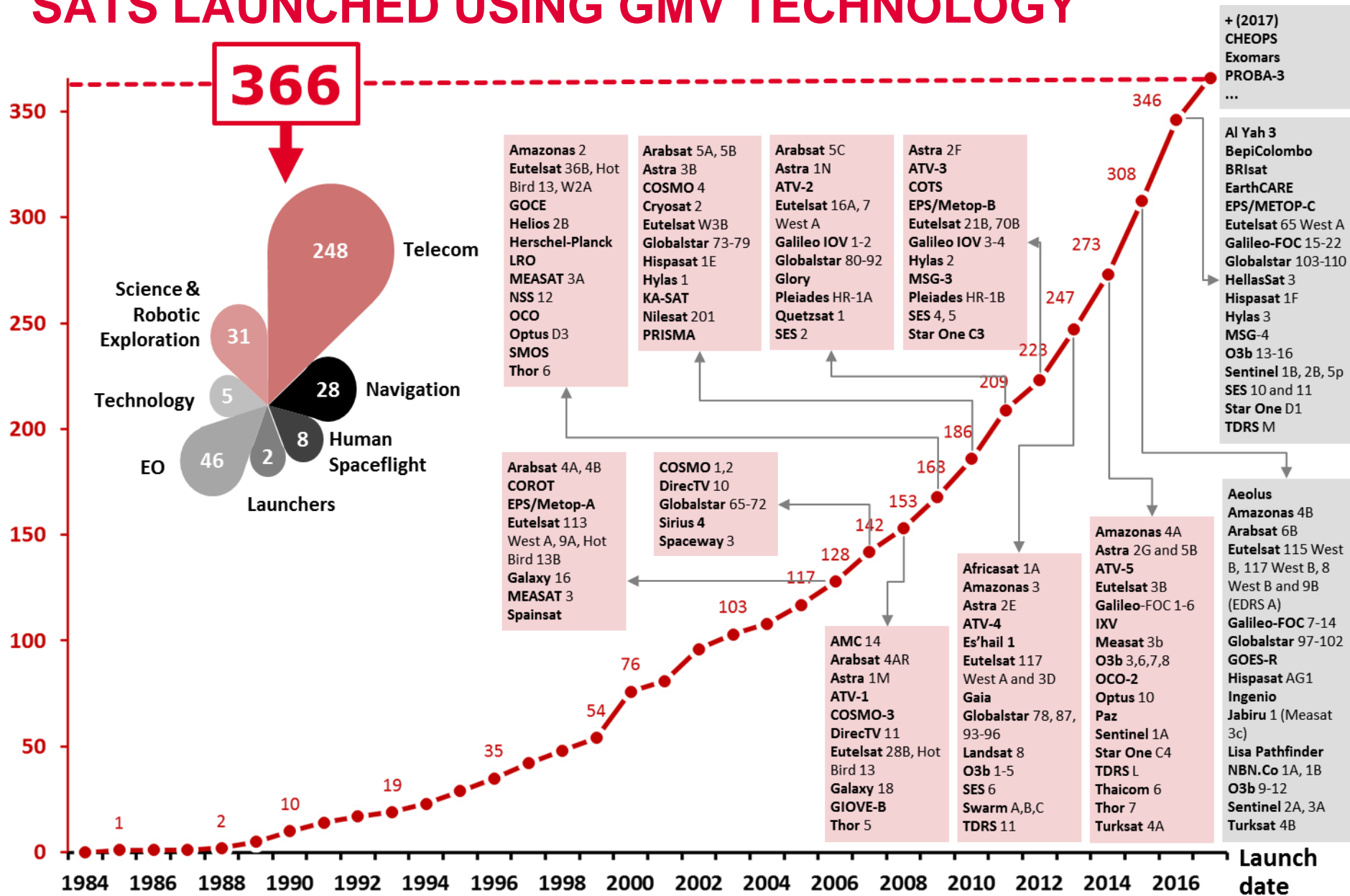
TELECOM SATELLITE OPERATORS



SATELLITE MANUFACTURERS / SYSTEM INTEGRATORS



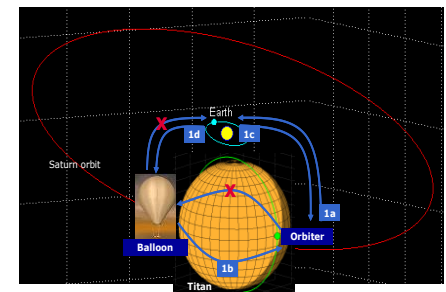
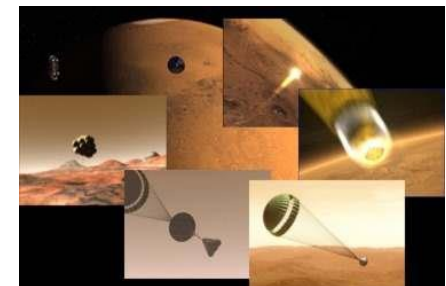
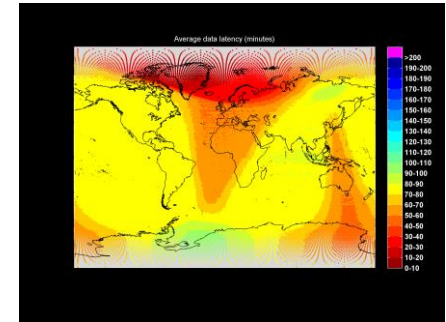
SATS LAUNCHED USING GMV TECHNOLOGY



GMV EXPERIENCE AND CAPABILITIES IN **SPACE SEGMENT**

GMV IN SPACE SEGMENT [OVERVIEW]

- GMV offer in space segment:
 - **Mission analysis**
 - **GNC**
 - **Simulation**
 - **Robotics**
 - **On-board Software** design and development.
 - **Avionics** (Real-time Validation and Verification) and **Test Benches**.
 - **Instrument prototype processors** (included in this presentation together with the data processing facilities)
- Working with satellite primes/system integrators
- Able to develop/integrate complete subsystems
- Support to science/scientists.
- Strong technology background



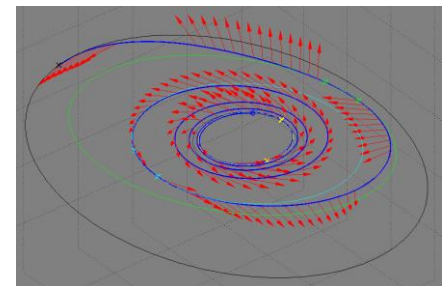
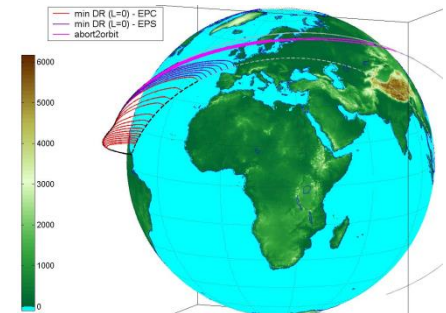
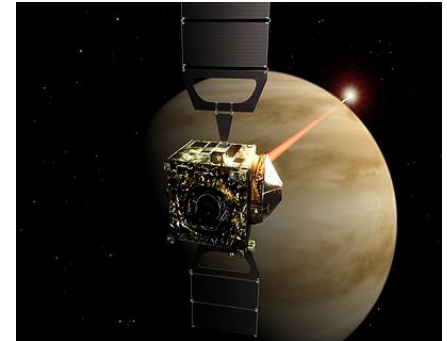
GMV IN MISSION ANALYSIS, SIMULATION & SYSTEM ENGINEERING

■ Mission Analysis

- GMV is active in the field since its creation in 1985
- Recognized by ESA as Centre of Excellence in Orbital Mechanics since 1989
- Strong experience in all types of missions (telecom, EO, science & exploration)
 - E.g. Bepi-Colombo, Venus Express, Missions to NEOs, Huygens, Exomars, SMART-1, SMART-2, Marco Polo, JGO (Jupiter, Ganymede Orbiter), Next-Moon (Lunar Lander), CryoSat, Spectra, GOCE, WALES, SEOSAT/INGENIO, SESAT

■ Support to **system engineering**

- Support to system level activities, including studies such as Trajectory design (earth observation, interplanetary, low-thrust, etc.), Orbital evolution analysis and orbit selection, Navigation and guidance, Ground segment and Data access and analysis



GMV IN GNC

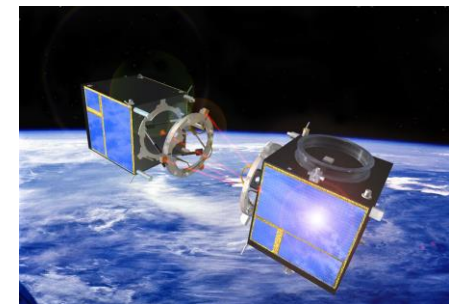
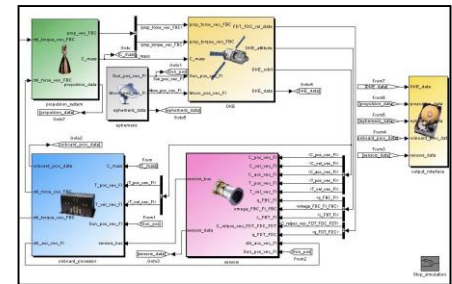
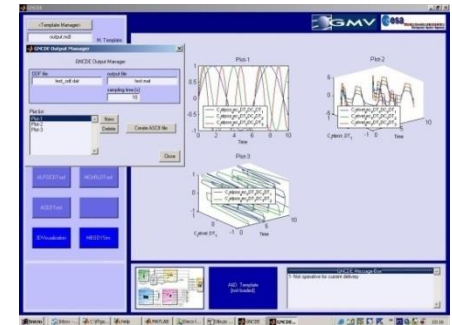
[CAPABILITIES]

■ GNC core activities

- Design, Implementation, Verification and Validation of complete subsystem (including algorithms).

■ GNC related activities

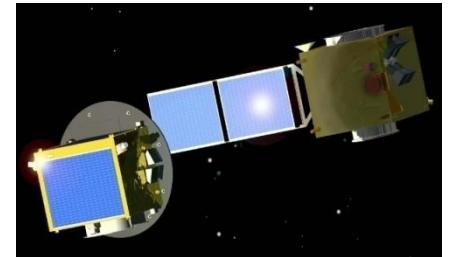
- Functional simulators for performance evaluations
- GNC development environment
- Overall integration of the simulators
- Generation of autcoded software
- Real-Time and Dynamic **test benches** design, set-up and implementation
- Real-Time and dynamic
- Development of GNC **design software tools**
- Contribution to the development of **advanced sensors** (v.g., RF FF sensor)



GMV IN GNC

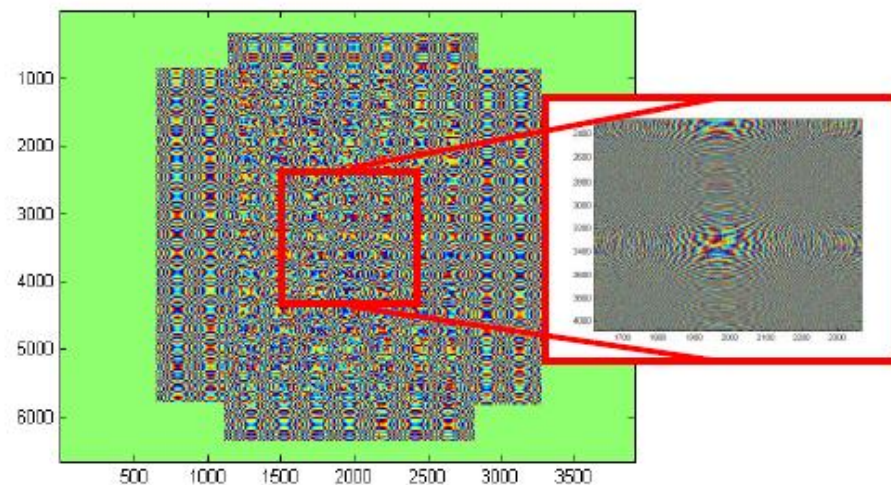
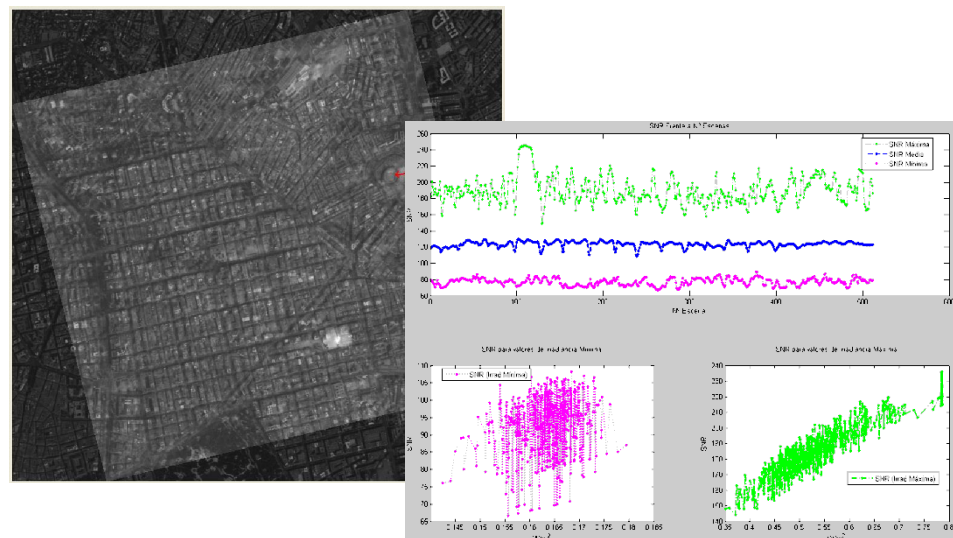
[KEY REFERENCES]

- **PROBA-3** Formation Flying System
- RF Navigation system for **PRISMA**
- **Autonomous** RDV GNC Test Facility
- ESA NEXT Lunar Lander mission: with insitu science and mobility, demonstrating soft precision landing with hazard avoidance at the Moon South Pole, in preparation of MSR and future exploration missions.
- **Precision Landing** GNC Test Facility
- **IXV** (Intermediate eXperimental Vehicle) is a technology platform that tackles the basic European needs for re-entry from LEO
- **gncde**: generic environment for design and performance evaluation of GNC systems



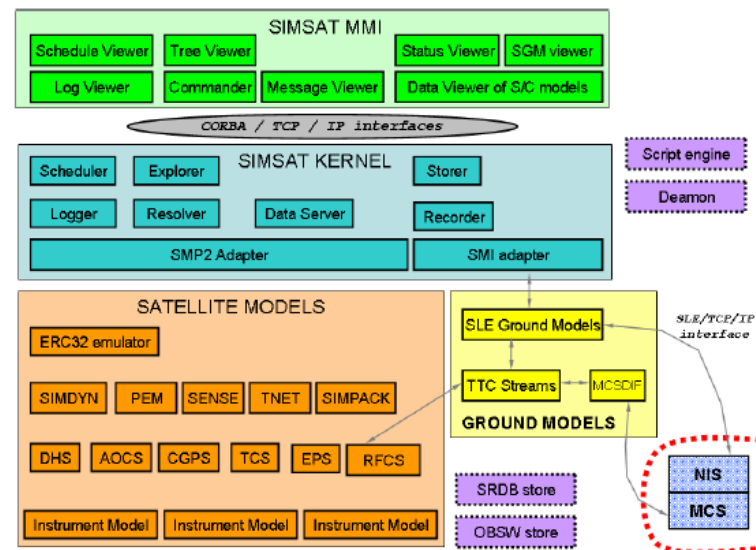
GMV IN S/S SIMULATION

- EIPS-SEOSAT. E2E Simulator of SEOSAT mission,
 - Simulation of scene conditions.
 - Orbit and attitude simulation.
 - Atmosphere simulation.
 - Instrument simulation
 - Raw data formatting
- SIMSAR. Contribution to INTA E2E Simulator of PAZ mission
 - Orbit and attitude simulation.
 - Propagation of radar pulse and echo in the atmosphere
 - Scene simulation
 - Generation of raw data.
- Aeolus Satellite Simulator



GMV IN S/S SIMULATION

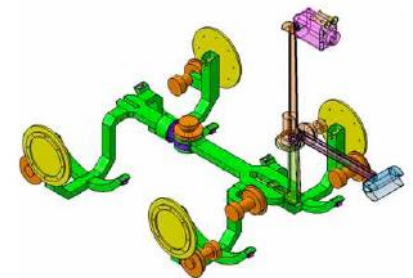
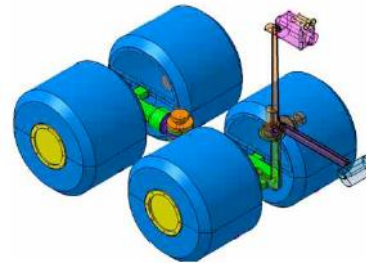
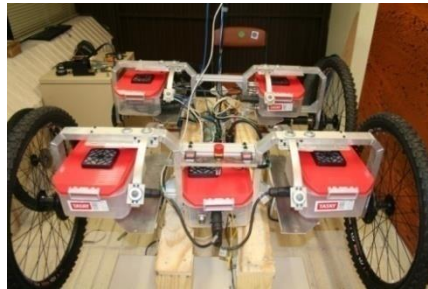
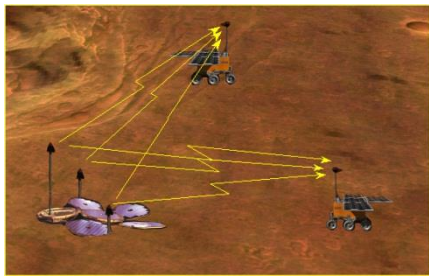
- Satellite Simulator based on SIMSAT infrastructure from ESA-ESOC
 - Aeolus Satellite Simulator
 - Sentinel 1 Satellite Simulator
 - Ingenio/Seosat Satellite Simulator
- SIMSAT is able to host a spacecraft and ground segment simulation, providing a complete running simulation. SIMSAT:
 - Provision of a graphical user interface
 - Scheduling of simulation models
 - Message / Event / Fault logging
 - Visualisation of model data
 - User control of the simulation via commands and scripts
 - Saving and restoring the simulation state (breakpointing)



GMV IN ROBOTICS

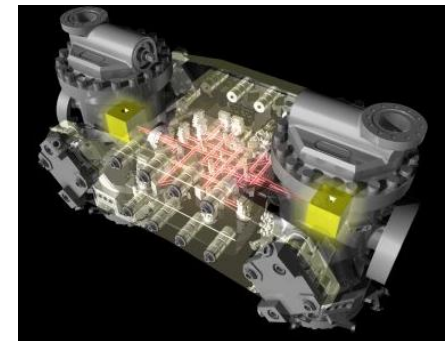
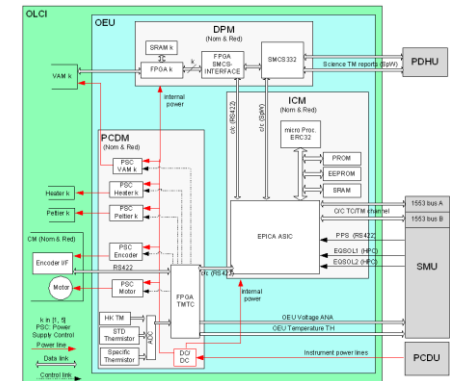
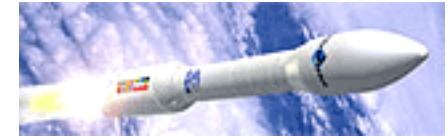
[KEY REFERENCES]

- EGP-ROVER: Eurobot Ground Prototype Rover Platform (prime, GNC, AIV)
- PRoVIScout: EU Frame Program
- MOONHOUND (Robotics Lab) - Lunar Challenge (UPM) with GMV sponsorship
- RF-WIPE: RF Wireless for Planetary Exploration



GMV IN ON-BOARD SW

- Independent SW verification
 - **VEGA ISV**: V&V of OBSW components of the VEGA launcher, newest member of Arienne Space launchers
- Instrument on-board SW:
 - **Sentinel 3 OLCI ICM SW** (Instrument Control Module)
 - **Lisa Technology Package (LTP) Application Software** (ASW) for the Data Management Unit (DMU).
- Future ESA OBSW Generic architecture
- AOCS/GNC:
 - **PROBA-3 GNC OBSW**
 - **IXV OBSW**



GMV IN ROBOTICS

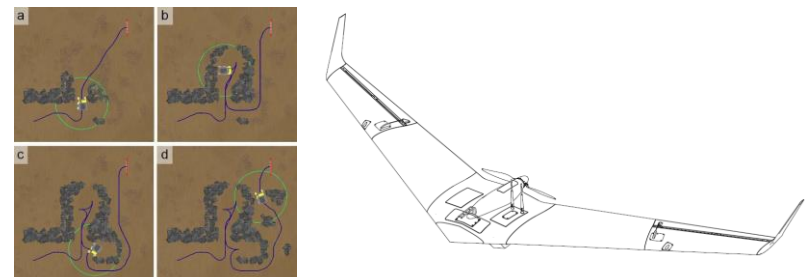
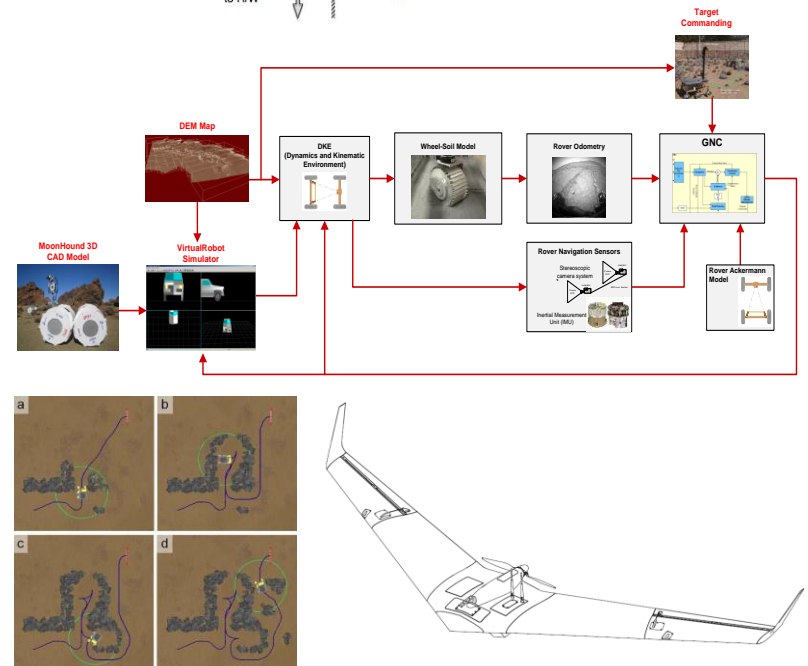
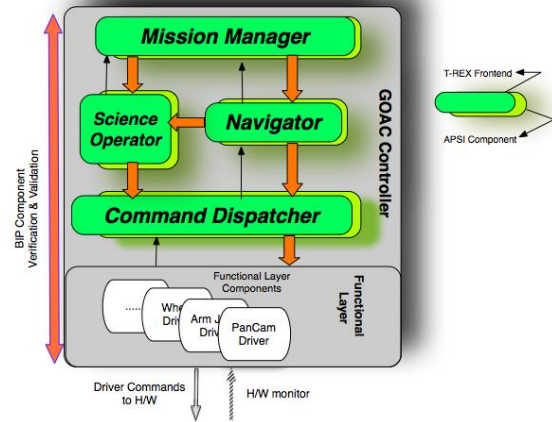
[TECHNOLOGY]

■ GOAC: Autonomous Controller

- Space segment autonomy (control of the future autonomous space robots), including a proof-of-concept demonstrator of an autonomous controller for space robotics (Exomars/EGP).

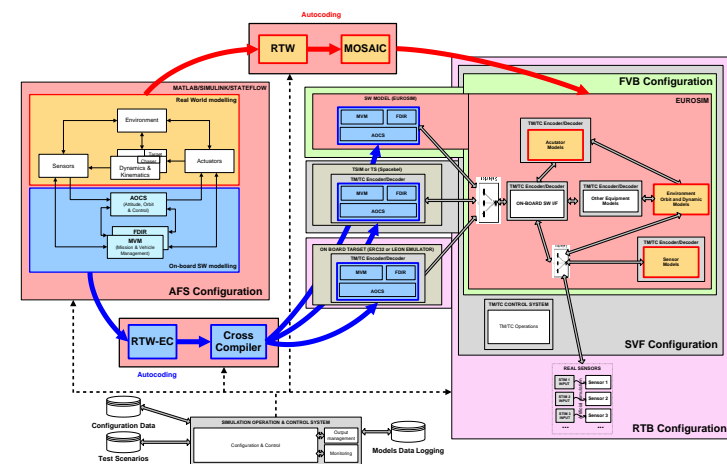
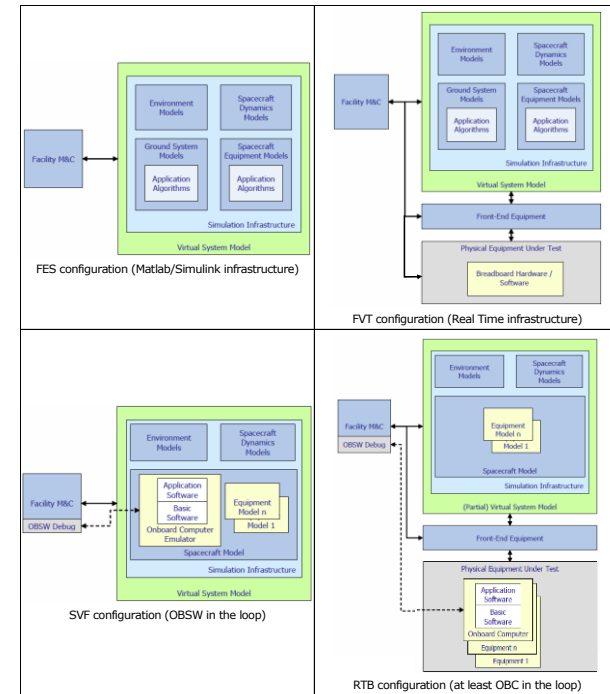
■ RobMPC: Robust Controller

- MPCSoft Tool: Develop a MPC framework (design methodology, chain tool, algorithms library, study cases, standard test elements) for the development, validation and verification of embedded MPC controller for space applications.
 - Robust Model Predictive Control
 - Planetary exploration rover
 - UAV



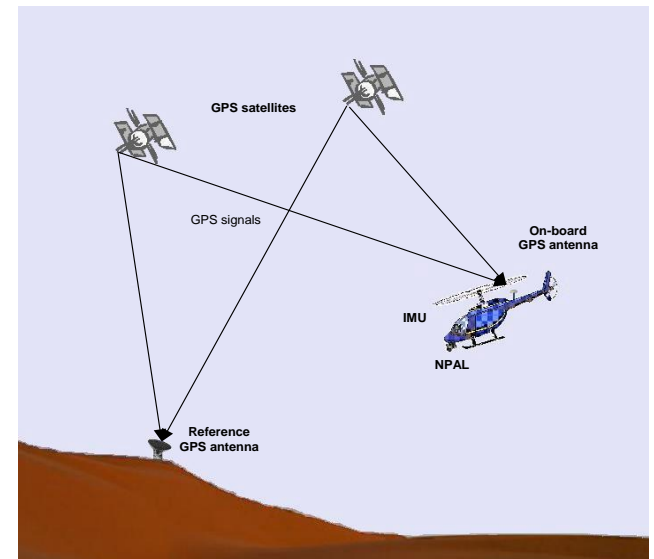
GMV IN AVIONICS & REAL TIME V&V

- **ATB-FESE:** Avionics Test Bench (ATB) FES Enhancement
- **ATB-RAC:** ATB Requirements and Architecture Consolidation
 - Full ATB requirements and architecture (FES: Functional Engineering Simulator, FVT: Functional Verification Test environment, SVF: SW Validation Facility AND RTB: Real Time Test Bench (HW-in-the-Loop))
 - Configuration automation through the use of a database → SDB prototype
 - Automatic instantiation process
- **ATB-E2E :** End-to-End ATB
 - SDB full development
 - Libraries and SDB population
 - Instantiation exercise



GMV IN TEST BENCHES/ON GROUND TEST

- **PLATFORM:** Dynamics Test Bench Rvd, FF and robotics applications.
 - Real-time system with CPU emulators.
 - Closed loop and scaled scenarios.
- **IBDM Tests**
 - Support to test and validate the International Berthing and Docking Mechanism.
 - Beta tester.
- **PLTF:** Platform Landing Test Facility
 - GMV in charge of the landing platform precise trajectory determination, for the verification and validation of the NPAL payload testing flight (GPS+IMU)
 - Platform PVA detailed design.

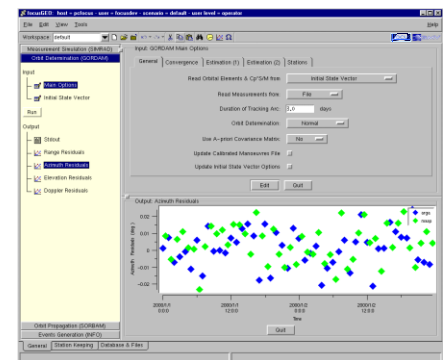
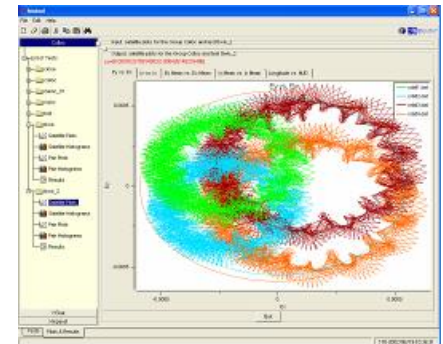


GMV EXPERIENCE AND CAPABILITIES IN **GROUND SEGMENT**



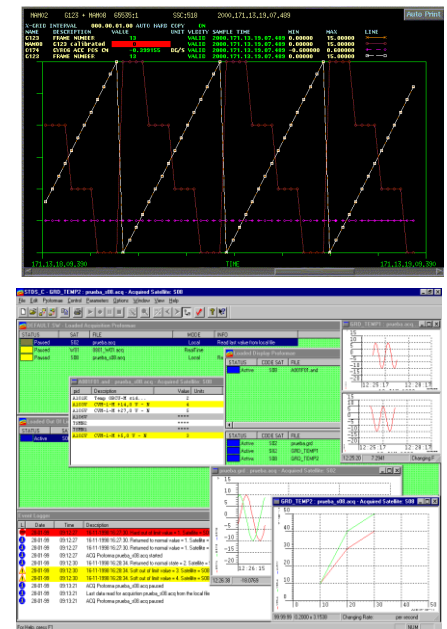
GMV IN GROUND CONTROL SEGMENT [OVERVIEW]

- GMV offer in ground control segment:
 - **GCS Studies and Design**
 - **GCS core facilities:**
 - **Satellite Control Center (Real-Time System)**
 - **Flight Dynamics**
 - **Mission Planning**
 - **G/S Monitoring and Control**
 - **GCS Integration and Validation**
 - **Operations support**
- Working with space agencies, satellite operators and satellite primes/system integrators



GMV IN GROUND CONTROL SYSTEMS

- GMV is a **world-class supplier** of Ground Control Systems to a large number of satellite operators
- Ground control systems **integrator**
- Advanced **truly multi-mission solutions** covering the GCS core (MCS, FDS, MPS) based on mature product lines: *hifly*[®]/SCOS-2000 *focusSuite* and *flexplan*
- Strong experience in **consolidating operations** and deep knowledge of this market segment: GMV experience spans over **22 years** providing GCS technology to support operations. GMV GCS solutions selected to support operations of **150 satellites** worldwide
- **Independent supplier** with intimate knowledge of satellite platforms from all major satellite manufacturers



GCS: OUR BUSINESS MODEL

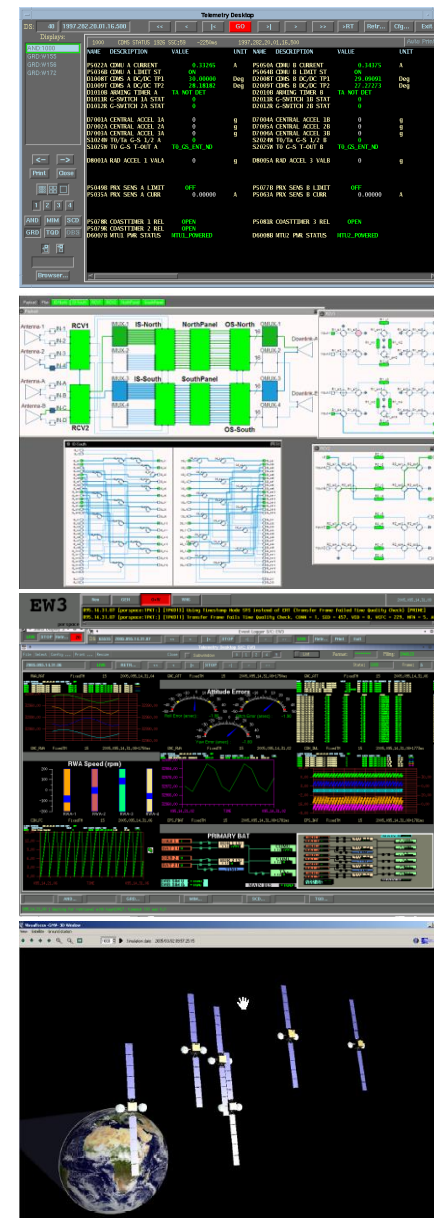
Multi-mission solutions based on innovative and mature products:

- 100% flight proven, strong heritage
- Multimission-multiplatform ready
- Modern SW technologies / HMI
- Open architecture
 - API → SOA
 - Expandable / scalable
- 3rd party SW & HW free
- Extensive support of standards
 - CCSDS, XTCE, SLE, ...
- Automation, operations consolidation
- ITAR free



GCS FOR TELECOM [MAIN REFERENCES]

- **Eutelsat's** NEO (New Open Satellite Control System) and Eutelsat's multi-mission flight dynamics, based on our *hifly*[®] and *focusSuite* product lines. Complete heterogeneous Eutelsat fleet of more than 23 spacecraft of 7 designs with demanding automation and collocation
- Provider to **SES** of satellite control centres for A1M, A2B, A3B, Queztsat and NSS12
- Consolidation of **Hispasat's** multi-mission ground control systems based on our product line
- Flight dynamics provider for the complete **Globalstar and O3B** constellation
- Satellite payload configuration and management based on our *smart rings* product contracted by **Lockheed Martin** for **SES Americom's** AMC-14 and **SES Sirius'** Sirius 4
- Ground segment for **StarOne, Arabsat, Nilesat, Azersat, Thaicom, NBN and Optus**



GCS FOR EO & SCIENCE

[MAIN REFERENCES]

- **ESA frame contracts:** MA, FDS, NAV, GFC8, OD8
- **ENVISAT:** Mission Control Facility, Reference Operation Plan Generation Tool, Flight Dynamics
- **EPS/METOP:** Mission Planning, Flight Dynamics
- **SMOS:** payload control systems (PLPC)
- **CRYOSAT/GOCE/SWARM** Mission Control Systems
- **INGENIO and PAZ:** Spanish Space program
- **OCO and GLORY:** flight dynamics
- **LDCM** (Landsat Data Continuity Mission) mission planning, archiving and TM extraction
- **LRO** (Lunar Reconnaissance Orbiter) mission planning
- **XMM-Newton:** Mission Control Facility, Flight Dynamics
- **WSO** Ground Control Segment
- **ATV** flight dynamics



GMV IN GROUND MISSION SEGMENT

[OVERVIEW]

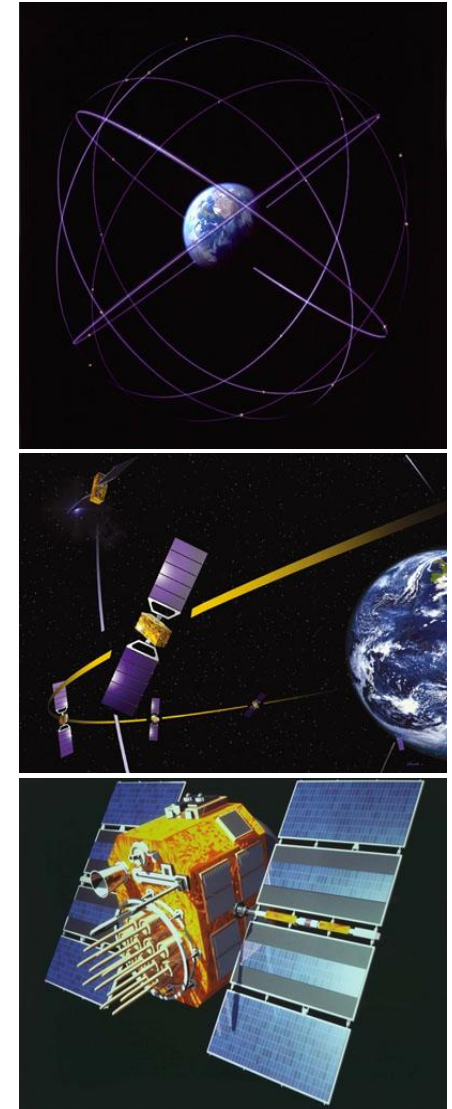
- Impressive track record of GMV providing Ground Segments to Support Mission Operations
- A leading supplier of operational systems for a large variety of missions (Earth Observation, Science, Navigation and Defence)

EO	Science	Navigation	Defence
ENVISAT	ISO	EGNOS	Helios I
METOP/EPS	XMM	GIOVE-B	Helios II
SMOS	LRO	Galileo IOV	MUSIS Phase A
SWARM	GAIA	GAGAN	SEISMO
LANDSAT	HP		
ALOS	WSO		
MSG	COROT		
MTG-Phase A	EXOMARS		

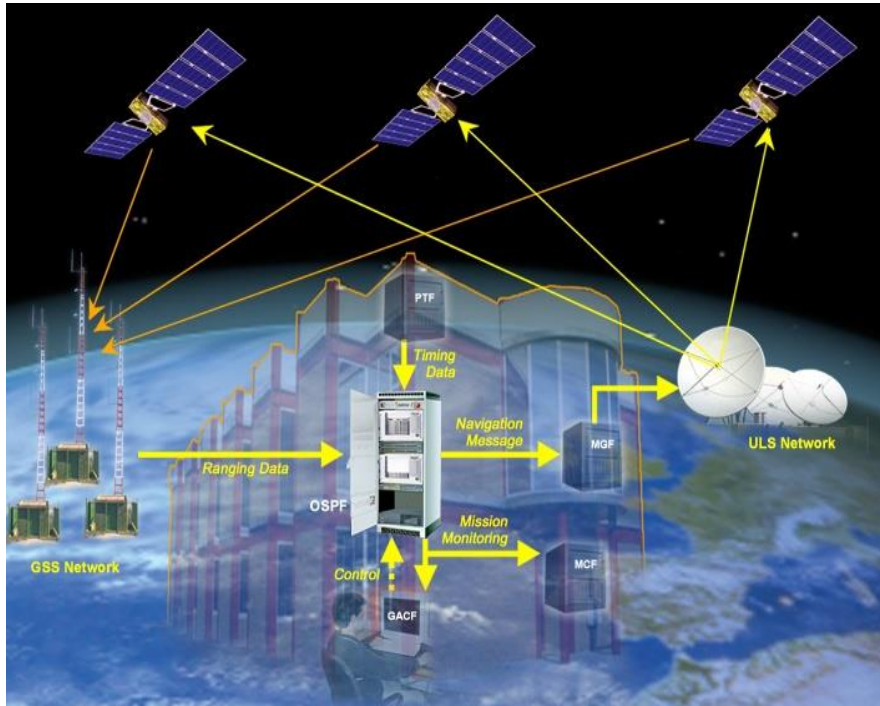
GMS FOR NAVIGATION

GNSS systems

- One of the largest GNSS engineering teams in Europe (>100)
- Key role in the development of European GNSS strategy
- Strong participation in the Galileo program
 - #3 in Galileo infrastructure by revenue share
 - #2 in Galileo applications (GJU) by revenue share
- Pioneering work:
 - Development and experimental demonstration of GPS attitude determination (1989)
 - validation of 1st European space qualified GPS receiver (1991)
 - GPS and GLONASS integrity monitoring (1991)
 - ... etc



GMS FOR NAVIGATION: OUR OFFER



- Applications
- GNSS Experimentation
- System Design and System Engineering
- Simulation Tools
- Navigation and Integrity Algorithms
- Turn-key critical subsystems development
- Constellation Design & Control
- Flight Dynamics
- Critical SW development

GMS FOR NAVIGATION

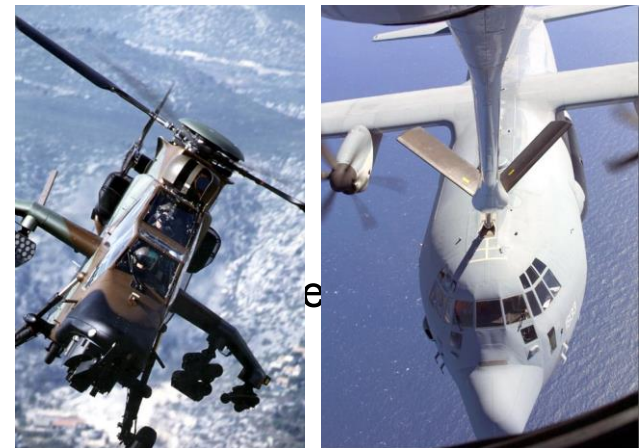
[MAIN REFERENCES]

- Strong contribution to **EGNOS**, including:
 - Early Test System
 - EGNOS System Test Bed CPF
 - EGNOS End to End Simulator
 - Central Processing Facility Processing Set
 - Application Specific Qualification facility
- Outstanding contribution to **Galileo**, including:
 - Orbit Synchronization Processing Facility, OSPF
 - Integrity Processing Facility, IPF
 - Service Product Facility, SPF
 - Mission Network Equipment SW, MNE
 - Flight Dynamics Facility, FDF
 - As GaIn/GSS partner GMV is also playing an active role in activities such as System, GMS and GCS
 - GIOVE-B Satellite Control Centre and Flight Dynamics System



GMS FOR NAVIGATION [OPERATIONAL SYSTEMS]

- GNSS offer includes operational SW development
- CMMI-5 certified
- Experience includes DO-178B up to level B
- References in GNSS:
 - EGNOS CPF-PS: 146 kLOC level C
 - Galileo OSPF: 235 kLOC level C
 - Galileo IPF: 130 kLOC level B
- Experience in a variety of HW platforms, OS (Vxworks, Lynxworks) and languages (C, Ada)
- Extensive RAM and Safety engineering



GMS FOR NAVIGATION [TOOLS AND R&D]

■ Commercial *magicGNSS* suite:

- *magicODTS*: Precise orbit determination and time synchronization
- *magicPPP*: Precise Point Positioning for High Precision Markets
- *magicSBAS*: SBAS demonstrator
- *magicIONO*: Under development

■ Other tools:

- GNSS Service Volume simulation (Polaris)
- GPS/SBAS End to End Simulation (EETES)
- Constellation design (Elcano)
- Performance assessment (ASQF, Teresa, Eclayr)
- GBAS toolkit (MARS3)

■ Strong policy on R&D on Navigation Infrastructure

magic
GNSS



<i>polaris</i>	<i>eetes</i>
<i>teresa</i>	<i>elcano</i>
<i>eclayr</i>	<i>armhade</i>
<i>mars3</i>	<i>asqf</i>

GMS FOR EO & SCIENCE

■ Processing facilities

(MERIS IPF (L0, L1, L2), MetOp/GOME-2 (L0, L1), MetOp/GRAS (L0, L1), OPPP (L2), MOS (L2), SAFNWC/MSG, SMOS L0, L1, L2, L3 and L4, SWARM L1b, SEOSAT/INGENIO GPP)

■ Systematic Product Quality Control

(GOME-2 PQE, EUMETSAT SAF Nowcasting, MSG MPEF PQM, SMOS SPQC)

■ Mission Planning

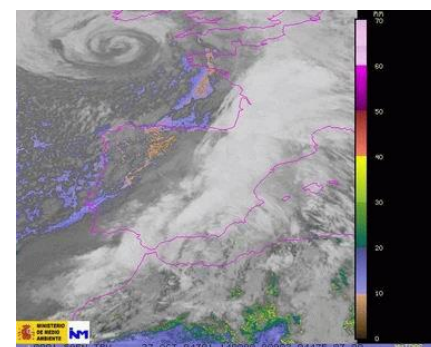
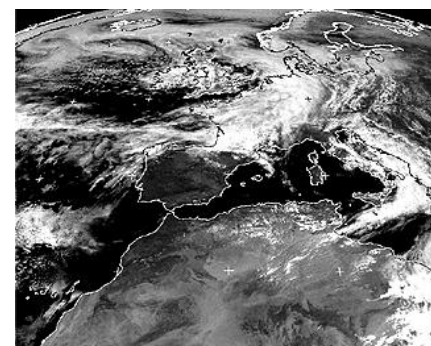
(Envisat MCF, Metop MPF, SMOS SPGF, Ingenio, Paz, LRO, LDCM, On-line Short Term Science Planning Repository, Helios II CSO)

■ Monitoring and Calibration Facilities

(GOME-2 SPA, MSG MPEF)

■ Monitoring and Control

(EUMETSAT SAF Nowcasting; MSGACIN: Spanish Meteorological Operational Processing Chain; SMOS Specific Monitoring Functions)



GMS FOR EO & SCIENCE

- **Interactive Analysis Tools**
(GOME-2 SIOV, GRAS SIOV, SMOS Global Mapping Tool, SMOS Land Cover Tool, SMOS Comparator Tools, SCoT)
- **Local Archive and Catalogue**
(CREPAD; ODISSEO (MMMC))
- **Ground Mission Segment Definition and Integration**
 - Spanish ENVISAT E-PAC
 - HELIOS II Ground Segment
 - ALOS AIT
 - COROT CM
 - WSO G/S
 - EXOMARS ROCC
- **Support to ESAC, Eumetsat and AEMET**



GMS FOR EO & SCIENCE

[MAIN REFERENCES]

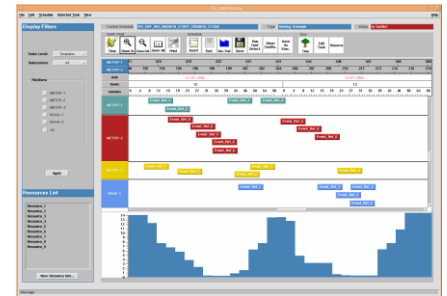
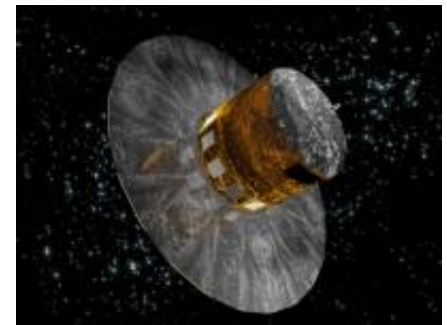
- **CREPAD**, MultiMission Centre of Acquisition, Process, Archiving and Delivery of Earth Observ. Data
- **ALOS**, Complete user chain validation
- **AEMET**, Maintenance of the Operational Chain
- Envisat, Spanish Node (**E-PAC**) Integration
- **Helios-2**, CSO: Operational Coordination and Supervision
- **ExoMars** Rover Operation Control Centre (ROCC)
- **XMM** SOC Science Operations System
- **COROT** Mission Center
- World Space Observatory - UltraViolet (**WSO-UV**) Science Operations System



GMS FOR EO & SCIENCE

[MAIN REFERENCES]

- **SMOS**, planning, processing facilities and reference facility
- **EPS/METOP**: GOME-2 Processor Prototype (0-1b), GOME-2 in-orbit validation, product quality evaluation, sensor performance assessment, GRAS Processor prototype and operational processor (0-1b), in-orbit validation tools and on-site consultancy support
- **MUSIS**, Phase A Image Chain, Catalogue and Portal Access
- **Gaia** data access and analysis study
- **MTG** Ground Segment Phase A Study
- **LDCM** mission planning, archiving and TM extraction
- **LRO** mission planning



GMV IN THE SPACE MARKET

APPLICATIONS



GMV IN SPACE APPLICATIONS

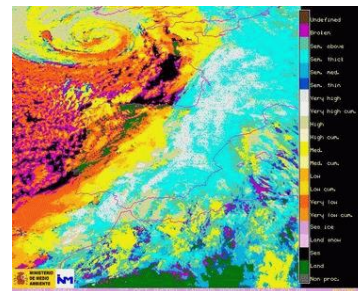
[OVERVIEW]

■ GNSS APPLICATIONS:

- Fleet management systems
- Intelligent traffic and road tolling systems
- Precision agriculture systems
- Personal security applications
- Homeland security applications
- Military applications

■ EO APPLICATIONS:

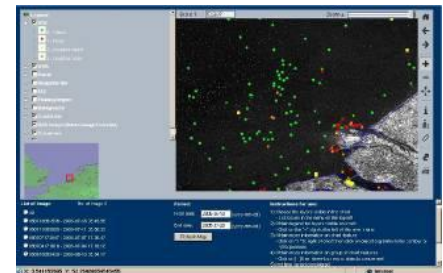
- Market development studies
- User segment and services in:
 - Security
 - Maritime
 - Fire monitoring
 - Forest monitoring
 - Atmosphere
 - Flooding
 - Energy
 - Meteorology



EO USER SEGMENT AND SERVICES

[KEY REFERENCES]

- Involved in GMES program with projects in:
 - GMES-EC FP 6: WIN (wide information network), PREVIEW (Prevention, Information & Early Warning to support management of risks), OSIRIS, LIMES (Land/Sea Integrated Monitoring for European Security)
 - ESA GSE: MARISS (Maritime Security System), MARCOAST (Marine and Coastal Environment), Forest Monitoring, RESPOND (Humanitarian aid), PROMOTE (Protocol Monitoring - Atmosphere)
 - Participation in DUE: Globaerosol
- Contribution to ESRIN service support element
- Local user services: Eumetsat SAF nowcasting helpdesk and CREPAD
- Contribution to Spanish Helios exploit. Center



GNSS APPLICATIONS

[KEY REFERENCE]

- GMV is very active in GNSS applications
- Fleet management systems: our flagship, #1 supplier in Spanish market (>6.500 vehicles)
- Build upon our deep knowledge of
 - GNSS technology through our involvement in numerous GNSS development programs
 - Complementary technologies required
 - System integration
 - Proc. algorithms (Estimation, Guid., Control, Optim...)
 - SW development (RT, CR, GUIs, GIS, DB, IP...)
 - HW development
 - Key markets and how applications add real value to users. More than 11 years of experience and nearly 150 GNSS applications contracts for final users in the markets of:
 - terrestrial, aerial and maritime transportation
 - telecommunications and e-business
 - defense and security





Thank you
Celestino Gomez-Cid
cgomez@gmv.com

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INNOVATING SOLUTIONS