GROUND SYSTEMS ARCHITECTURES WORKSHOP – GSAW 2009

WHY DOES IT TAKE SO LONG TO DEPLOY **NEW TECHNOLOGIES** IN **GROUND SEGMENT** DATA SYSTEMS?

GMV'S EXPERIENCE

INNOVATING SOLUTIONS

OVERVIEW

1. What is ***Technology***?
2. The problem: deploying new technologies in Ground Systems
3. GMV's technology development approach in Ground Systems
4. GMV's cross sectorial technology development strategies
5. Lessons learned

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WHAT IS *TECHNOLOGY?*

WHAT IS TECHNOLOGY?

- Webster's Dictionary: *"The practical **application** of **knowledge**, especially in a particular area"*

- Encyclopedia Britannica: *"**Application** of **scientific knowledge** to the practical aims of **human** life"*

- Ursula Franklin ("The Real World of Technology"): *"The **way we do things** around here"*

- In the **Ground Segment domain** and given the scope of GMV's activities we will understand *technology* as any combination of:

  Custom application software, COTS software, middleware, programming languages, operating systems, hardware, development methods, standards, protocols, operational procedures, data formats, paradigms, ...

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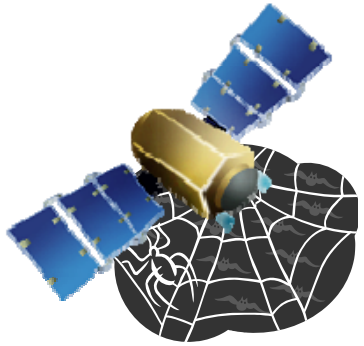
THE PROBLEM: DEPLOYING NEW TECHNOLOGIES IN GROUND SYSTEMS

GROUND SYSTEMS TECHNOLOGY (1)

- We like to think we work in **high-tech**…, but:
  - How much Fortran 77 or Ada 83 source code is included in your system?
  - When was the last time you were checking ebay® for legacy HW replacements?



- This is a **risky business**. A problem can have a huge impact on the mission.
  - Nobody wants to be the first operator that uses a new product or a new technology: Flight-proven is a key quality

- The truth is, Ground Systems is not always the best environment for the development of new technologies. Usually, only **proven technologies** are applied.

GROUND SYSTEMS TECHNOLOGY (2)

- Many **barriers** prevent quick deployment of new technologies
  - **Long missions** (e.g. typical GEO is 15 years). Cost/benefit ratio of upgrading to new technologies after some time not necessarily favorable, so the operator is stuck with the original technology.
    - Total cost of ownership needs to be considered
  - The number of potential deployments of a new technology is small (small customer base). **Return on investment** may be small (or negative).

  - Operators are **reluctant to lose features** in transition to a new system. *I want everything I have plus a lot more…*
  - Large **variability** of requirements across missions.
    - What works well for one may fail for the next
    - Scalability issues (e.g. single satellite vs constellations)
    - Difficult to create a 'generic' technology that will suit all
  - **ITAR** may limit or restrict the potential market of a new technology developed in the US

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GMV's TECHNOLOGY DEVELOPMENT APPROACH IN GROUND SYSTEMS

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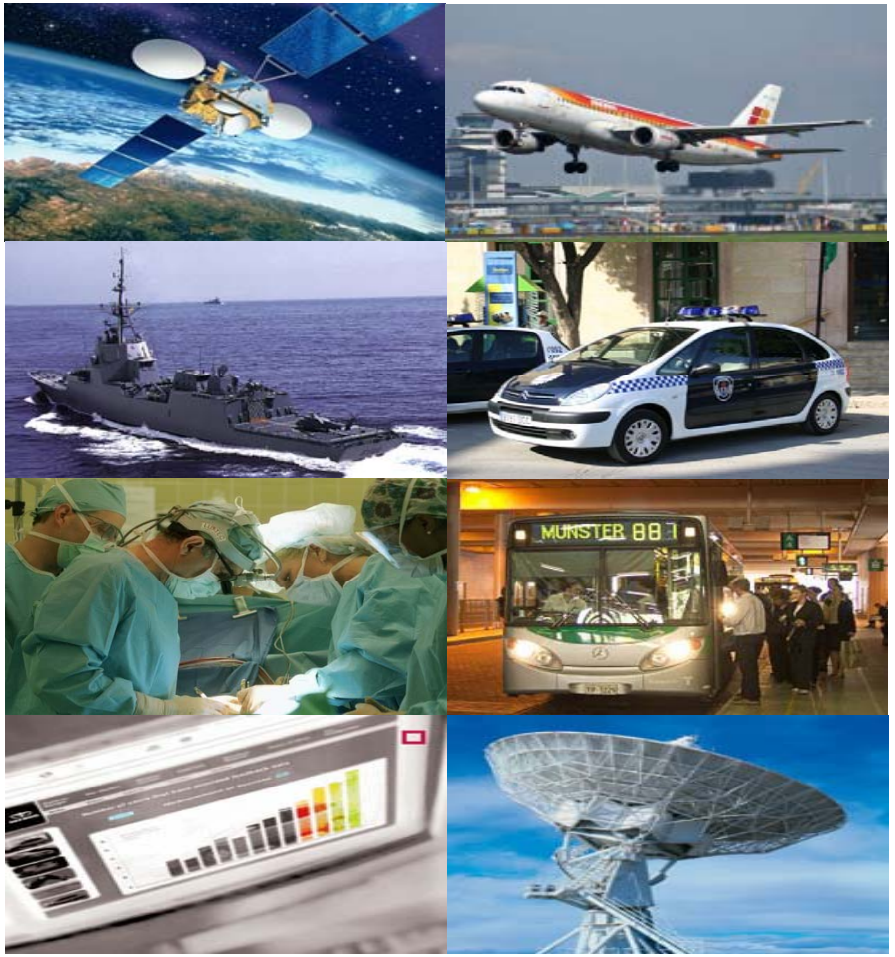
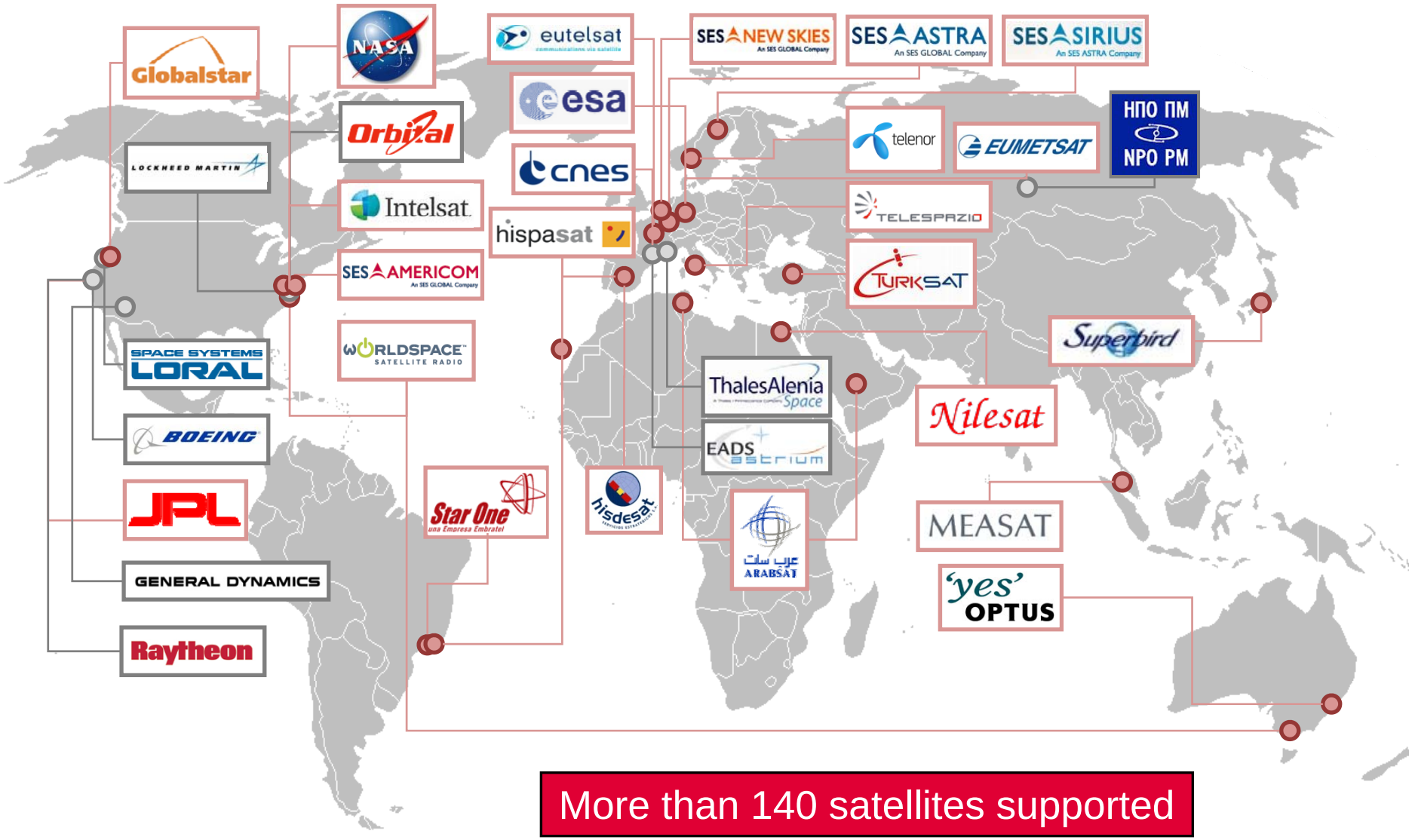
GMV BACKGROUND

- GMV is a privately-owned **multi-national** established in 1984
- **Offices** in USA (Rockville, MD), Spain (HQ), France, Germany, Portugal. Over 1,000 employees.
- Company origins and largest business area is **space**
- One of the largest space Ground System suppliers in the world
- Engineering services and turn-key IT systems and solutions for
  - space
  - aeronautics
  - defense
  - security
  - Healthcare
  - transportation
  - IT & telecommunications

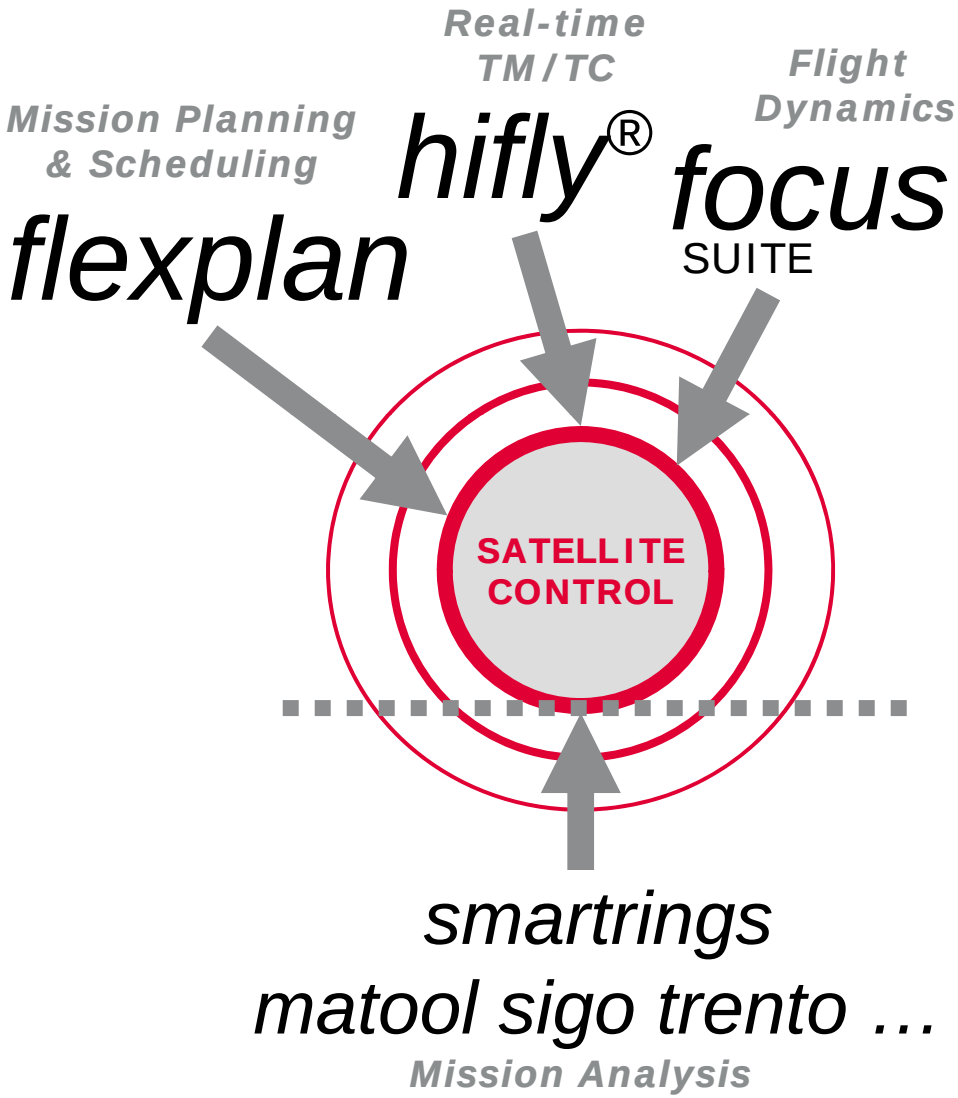


MAIN CUSTOMERS IN GROUND SYSTEMS



More than 140 satellites supported

BUSINESS MODEL: PRODUCT LINES

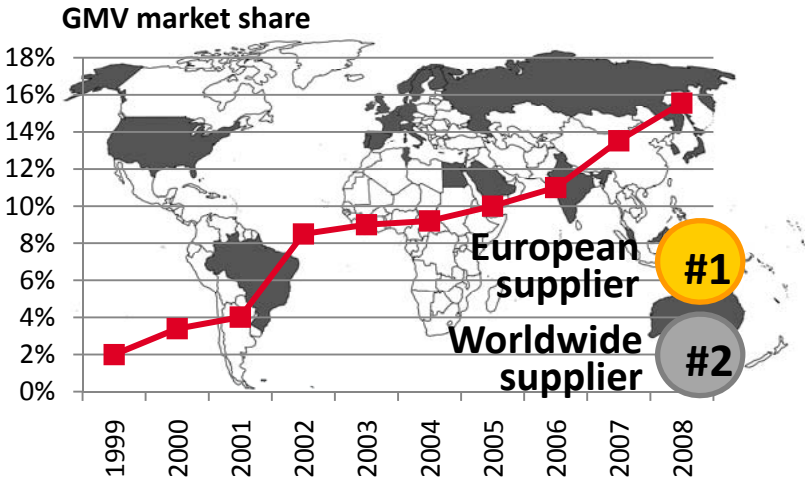


Business model strongly supported by innovative and mature **product lines** …

- 100% flight proven
- Strong heritage
- Multi-mission
- Modern SW technologies
- Extensive support of standards
  - CCSDS, XTCE, SLE
- Advanced GUI
- Open architecture
  - API => SOA
- HW vendor independence
- Expandable and Scalable
- Automation

TECHNOLOGY GOALS AND STRATEGY

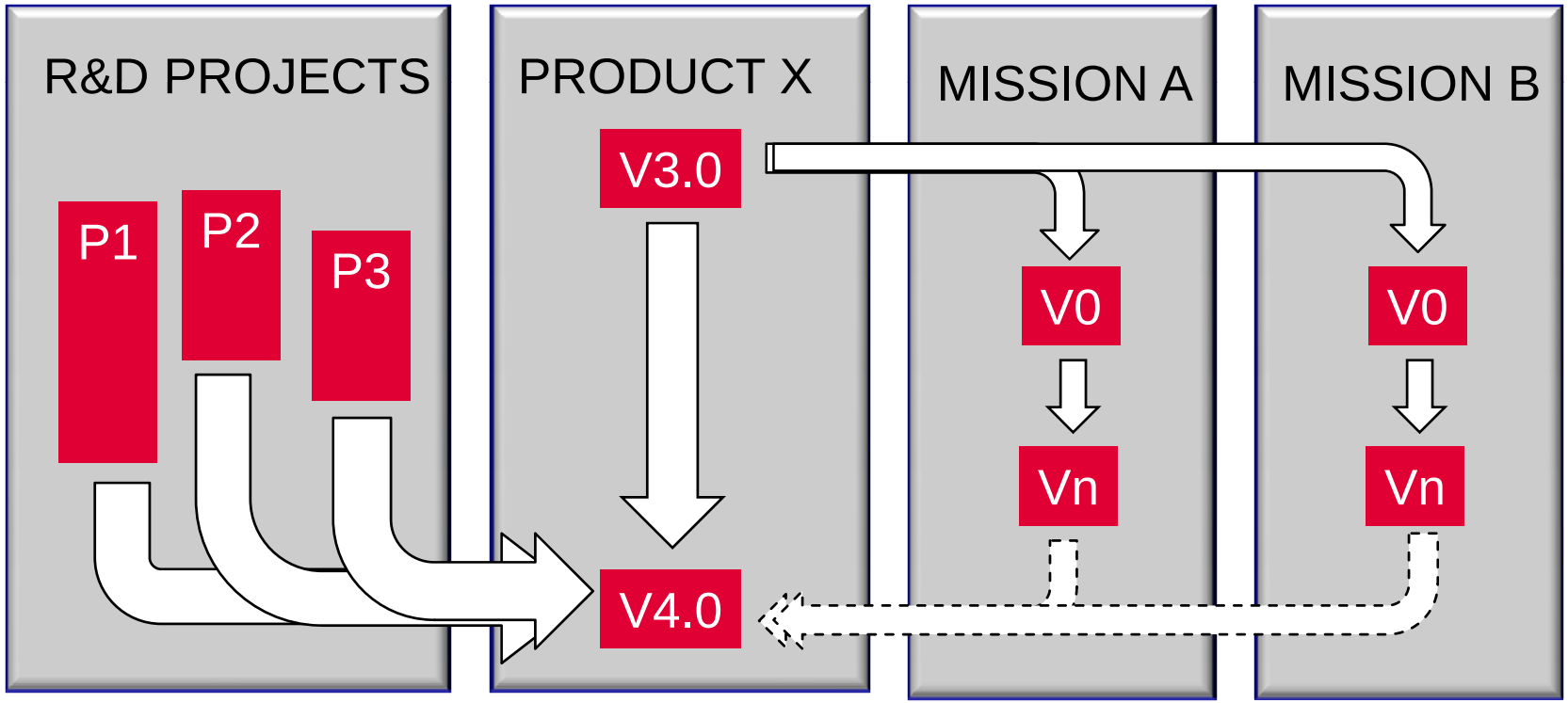
- Our final **goal**: to be the #1 global supplier of ground systems
- Having the **best technology** will help only if it has the **right price**.
- Being a **global** supplier is key to have a wide customer base that justifies investments in new technologies
- Technology development is **channeled through product lines**.
  - Products are used by a wide, global, customer base
    - E.g. ***flexplan*** is used simultaneously by NASA, ESA and a joint EUMETSAT/NOAA mission



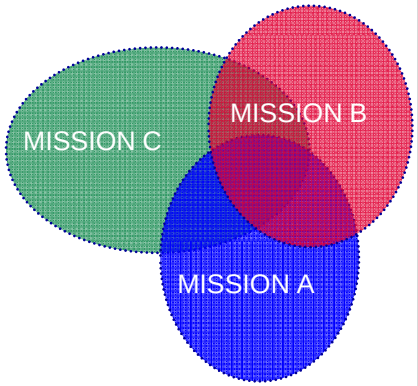
- **12%** of our revenue is **reinvested in research & development** (R&D)
- Active **collaboration with space agencies and universities** in R&D programs

R&D, PRODUCT LINES AND MISSIONS

- Evolution of technology is **gradual** and is managed within the product line, in line with the long-term **"road map"**
- Many enhancements come from **internal R&D efforts**
- Deployments for different **missions** provide customer feedback and new SW components, some of them are fed back to products



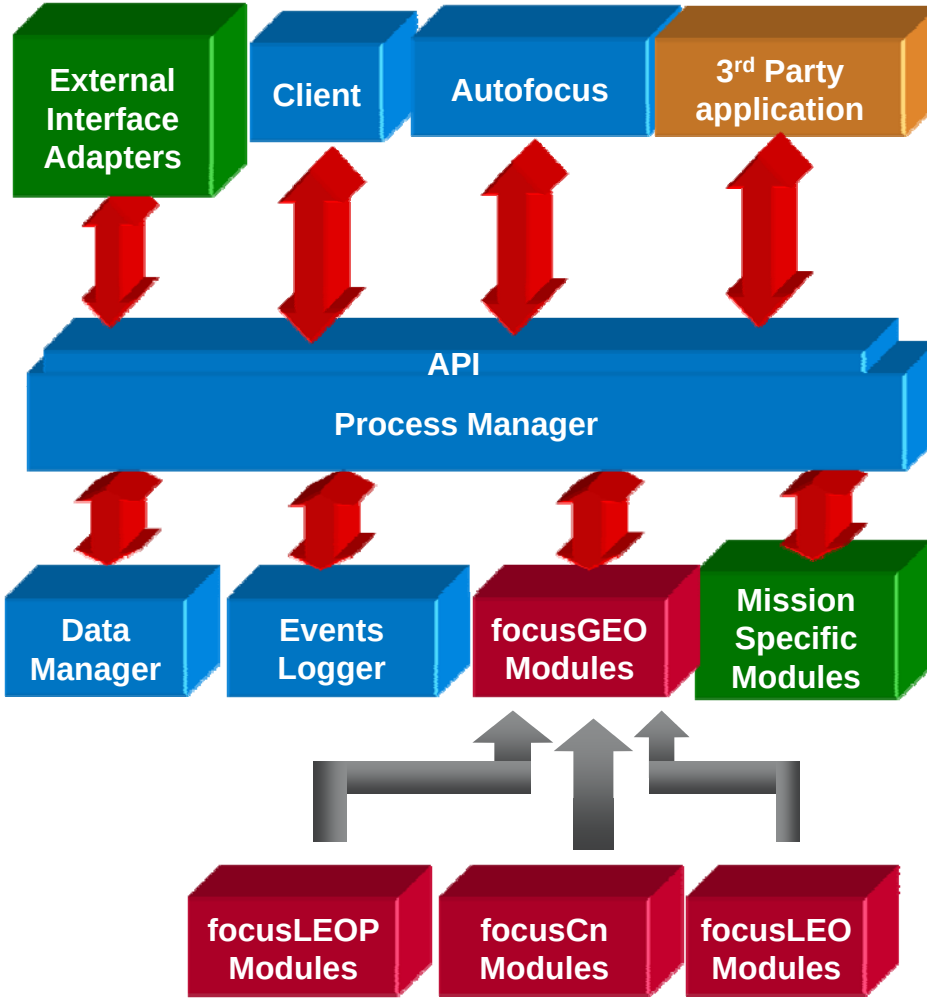
FRAMEWORK STRATEGY



The wide variability of the requirements in different space missions has led GMV to avoid a rigid product-based strategy

Instead we have used a **framework** strategy for each product line:

- **Reference architecture** (scalable)
- Suite of **configurable components**, some optional
- Open architecture, powerful **API**
- This approach **reduces risk and cost** in the development of new systems



INCORPORATING EXTERNAL TECHNOLOGY

GMV has successfully incorporated **technology from other parties** in some of its product lines. Some examples:

- esa
  - **Flight dynamics:** NAPEOS within ***focusSuite***
  - **Satellite Control Systems:** SCOS-2000 within ***hifly***
- NASA
  - **Mission Planning:** CLIPS within ***flexplan***, in progress
  - Messaging: **GMSEC**
- **Open source**: Multiple examples:
  - MySQL
  - Eclipse RCP

Significant investment needed to:

- Add support for certain types of missions (e.g. commercial GEOs)
- Add capabilities to make the products competitive in the global market
- Add support for new standards (e.g. XTCE, SLE)

OTHER ELEMENTS

- Two instrumental elements of the technology development process at GMV are:

- **Quality Management System**:
  - ISO9001 & CMMI Level 3 certified, moving towards CMMI Level 5.
  - Essential to guarantee correct development process, stability of the products, repeatability, continuous improvement

- **Knowledge Management System:**
  - Technology map
  - Internal consulting
  - Corporate intranet
  - Powerful tools for project management and information search
  - Aggressive training program
  - Active participation in conferences

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GMV's CROSS-SECTORIAL TECHNOLOGY DEVELOPMENT STRATEGIES

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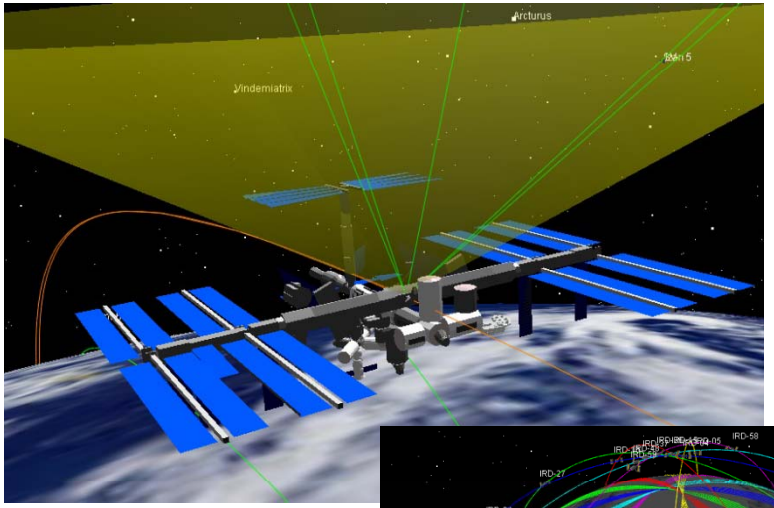
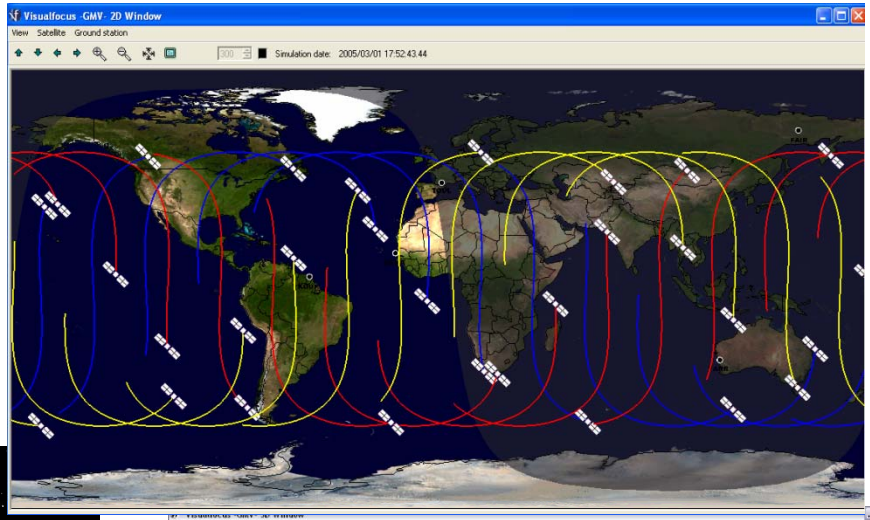
CROSS-SECTORIAL TECHNOLOGY DEVELOPMENT STRATEGIES

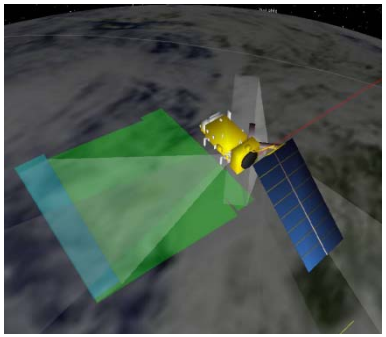
- Multiple opportunities for technology transfers across different domains where GMV works **in the space business**:
  - Mission Analysis & Systems Engineering
  - Operational Systems: Mission Planning, TM/TC, Flight Dynamics, Data Processing, ...
  - GNSS
- But also many opportunities to transfer technology **to/from other areas**: Defense, Transportation, Information Technologies, Security, Healthcare, ...
- This has proven to be **very beneficial**.
- Some **strategies** to promote cross-sectorial technology transfers:
  - Share Quality Management & Knowledge Management Systems
  - Identify actively commonalities in requirements and opportunities for internal reuse of frameworks & components
  - Promote internal transfers of personnel

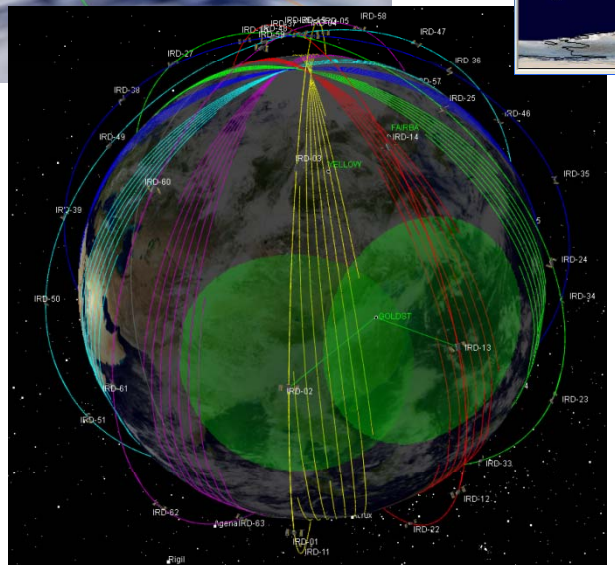
CROSS-SECTORIAL TRANSFER: CASE 1

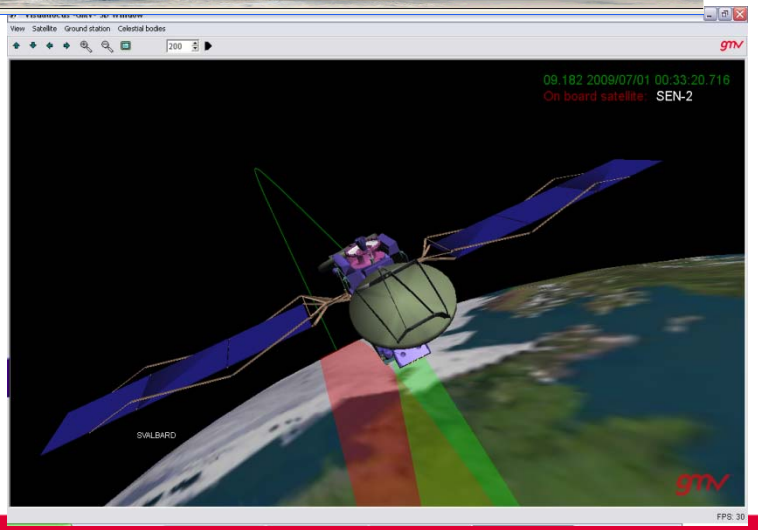
From ***visualfocus***: 2D/3D space mission visualization…





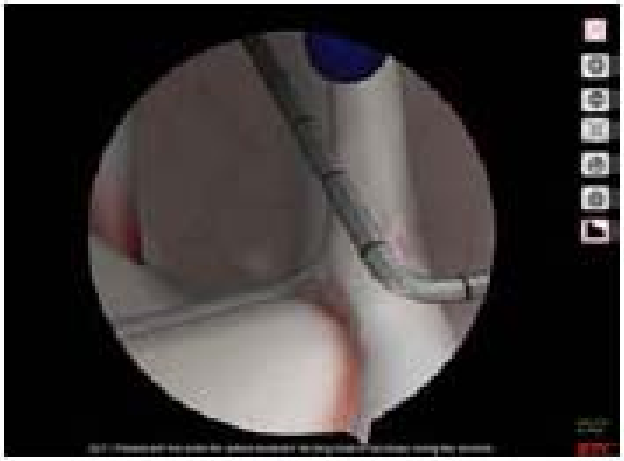


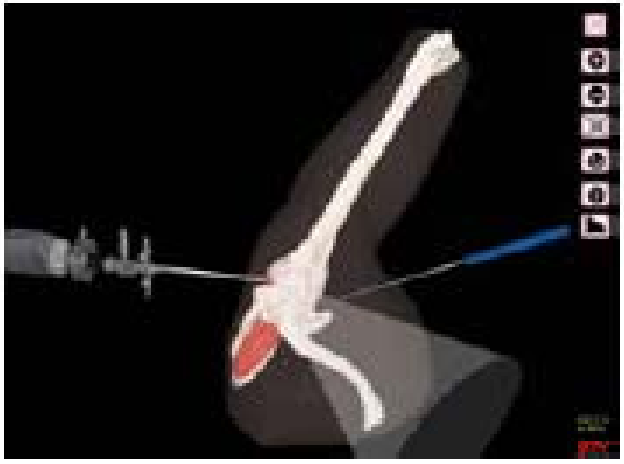




CROSS-SECTORIAL TRANSFER: CASE 1:

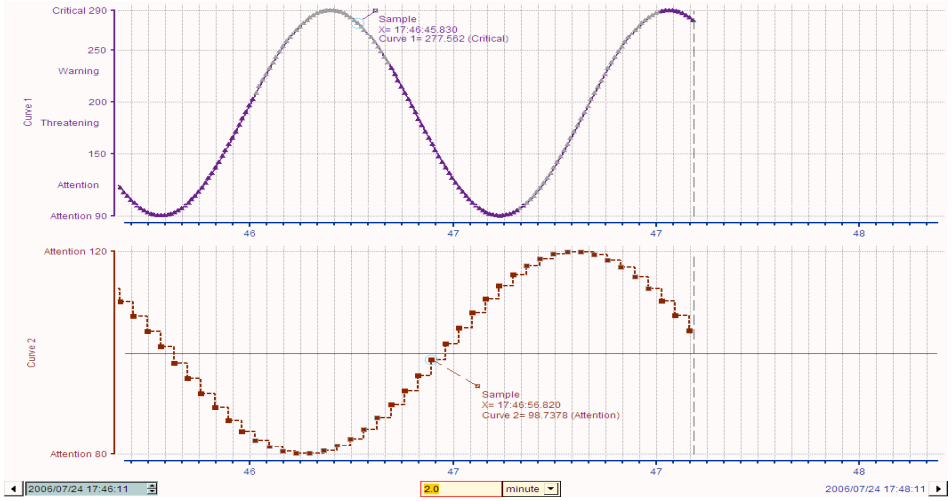
… to ***insight***: Virtual reality simulator for minimally invasive arthroscopic surgery training

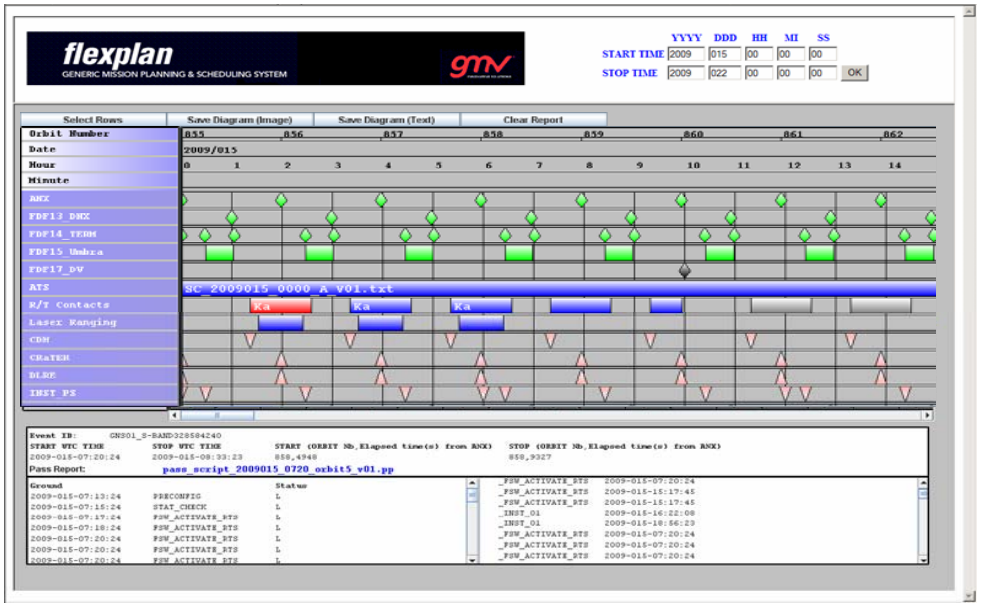




CROSS-SECTORIAL TRANSFER: CASE 2:

- Advanced **Java** applications and **web-based interfaces** were first used in the mid 90s in our **Internet & Security** division (GMV SGI)
- The know-how that was developed has been very valuable to add new web interfaces to some of our **satellite control** products:
  - ***hifly*** Web TM (TM/TC)
  - ***flexplan*** Activity Plan (Mission Planning & Scheduling)





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LESSONS LEARNED

A FEW LESSONS LEARNED

- Having a wide, **global customer base** has made our technology much richer.
- **Feedback** received from customers around the world **is priceless**
- Being active in very different areas (many not related to space) has helped us to identify **opportunities** for technology transfers & **synergies**
- **Cost** to turn a technology demonstrator into a product is significant and usually higher than expected. Accurate cost / benefit analysis of an investment in technology is hard to complete.
- **Developing new technologies jointly with operators** (end users) is always the best path for success
- **Open frameworks** work, rigid products don't.

Thank you

Gonzalo Garcia

VP of Operations, USA

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