ESA Technology R&D Programmes

Lino de Faveri
Space Technology Research Manager
SER-SSO

Engelberg, March 5th 2007

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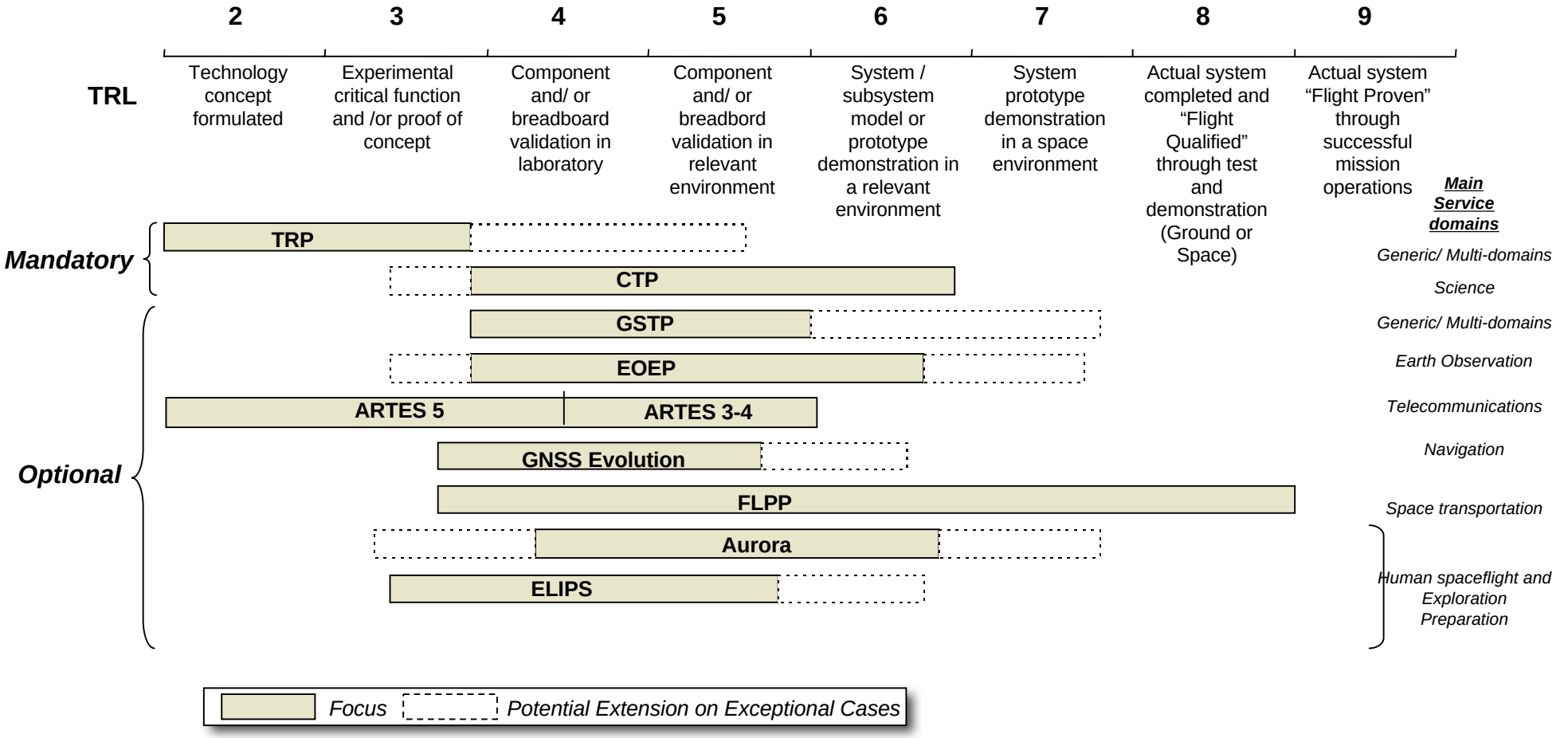
ESA R&D Technology Objectives

- Ensure effective technological preparation of Europe's future space programmes
- Support European industry to reinforce its worldwide competitiveness
- Provide opportunities for forward-looking, innovative technology developments

ESA Technology R&D programmes

Technology Programmes versus Technology Readiness Levels (TRLs)



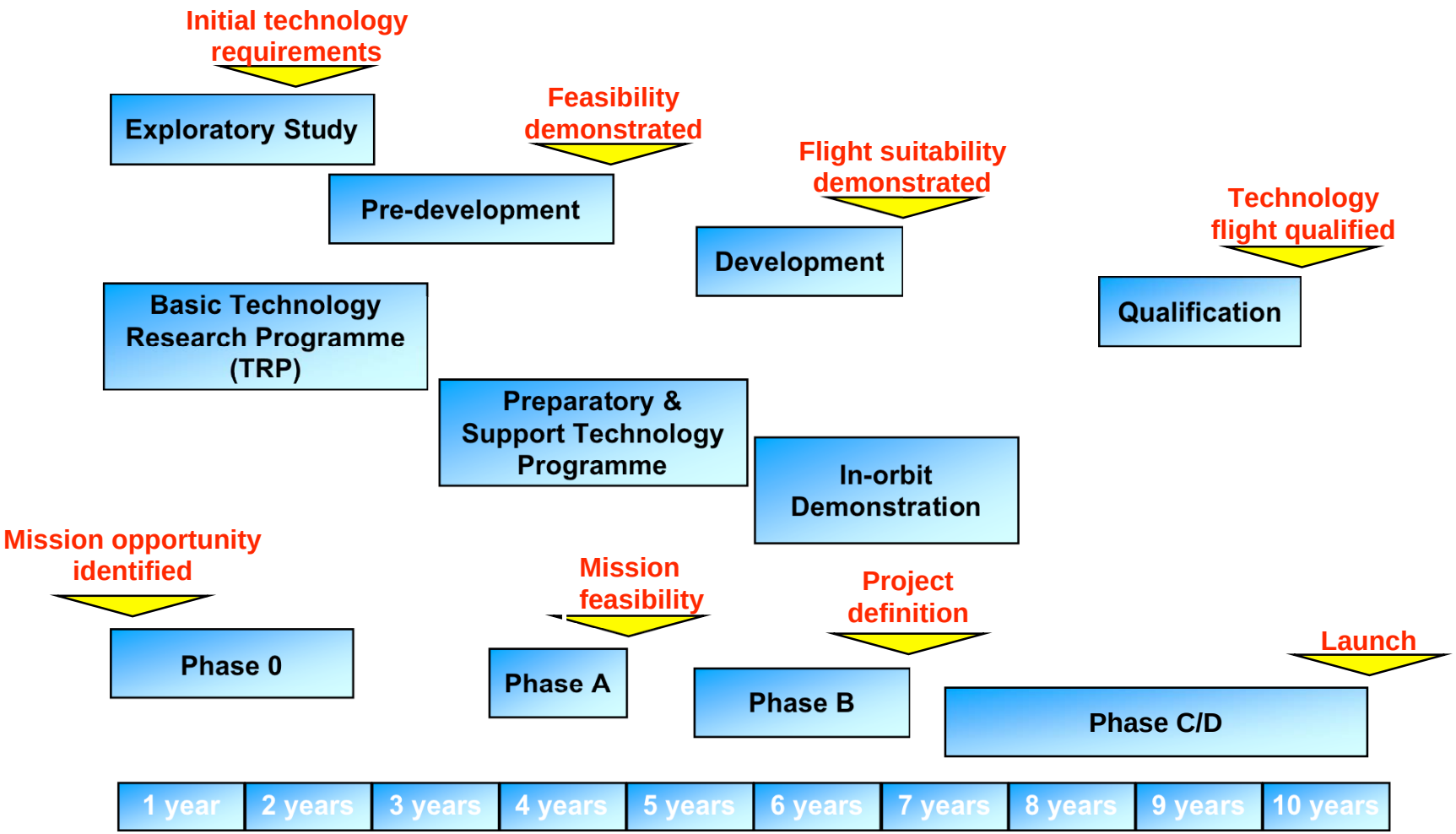
Basic Technology Research Programme (TRP)

- Part of ESA Mandatory Programmes
- Covering all technology disciplines & applications
- Assess innovative/prospective technologies
- Providing the R&D nucleus for most future ESA developments
- Enable ESA space missions by demonstrating the feasibility of technologies
- Based on three-year Workplans, with yearly updates
- About 45 M€ in commitments per Year

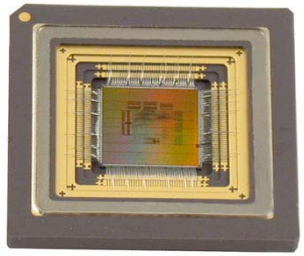
General Support Technology Programme (GSTP)

- Optional Programme - Each member state decides:
  => The amount of its participation
  => The technological activities to support
- Covering general purpose technology developments
- Aim at pre-development of identified technologies required by future space projects
- Bridges the gap to User programmes by developing generic/cross-cutting technologies
- Three-year cycle with regular updates
- Regular AOs are part of GSTP
- About 50 Meuro in commitments per Year

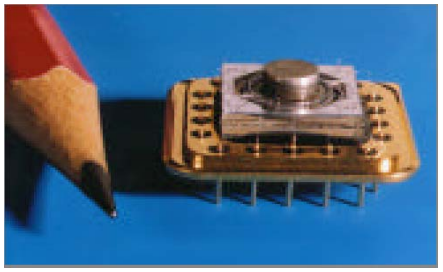
ESA Technology Development Cycle



What is NewPro ? **NewPro is conceived as technology programme to address new needs and emerging applications, seeking shared funding with the EU:**



⇒ EUROPEAN NON DEPENDENCE

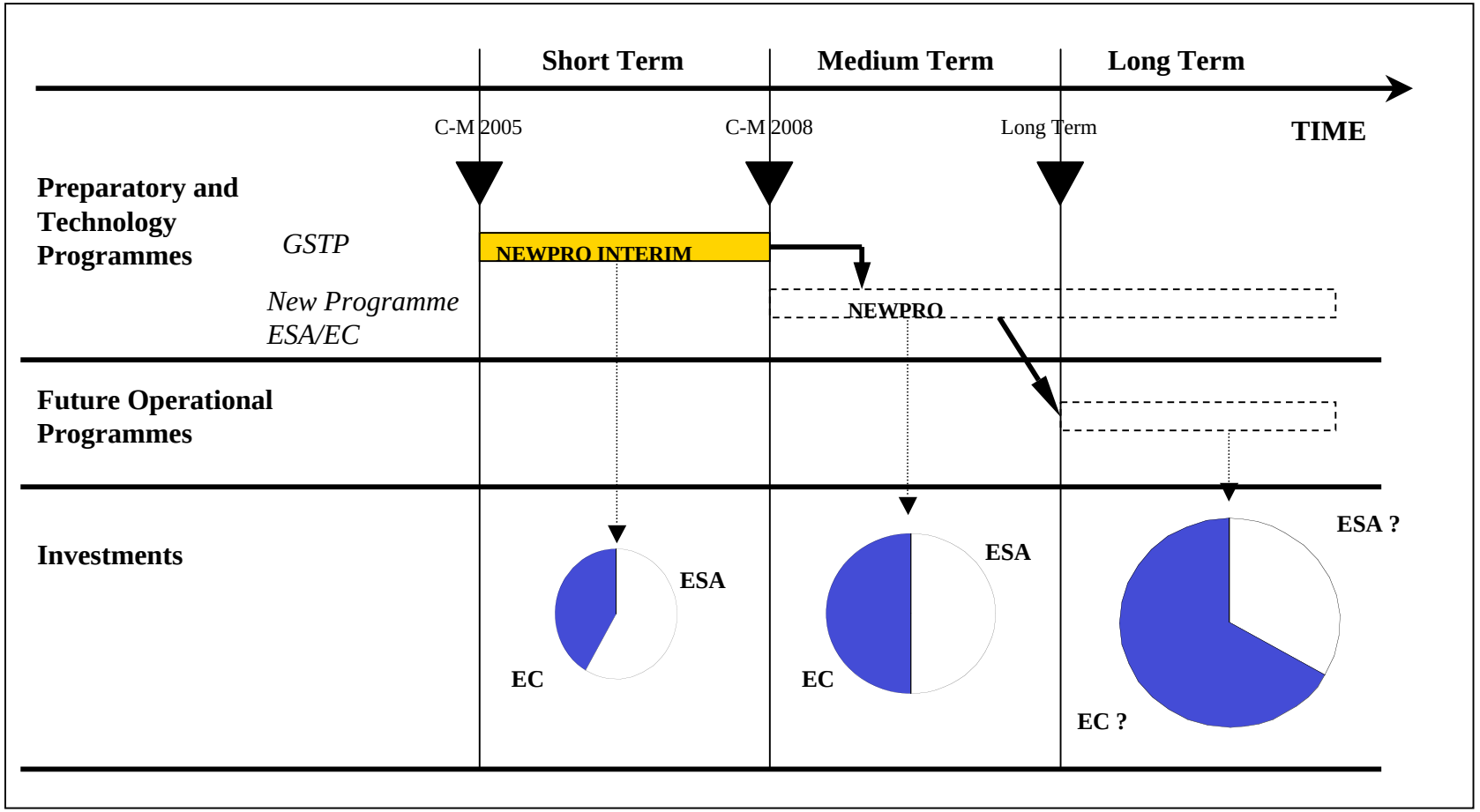


⇒ MULTIPLE-USE TECHNOLOGIES

⇒ SECURITY FOR CITIZENS

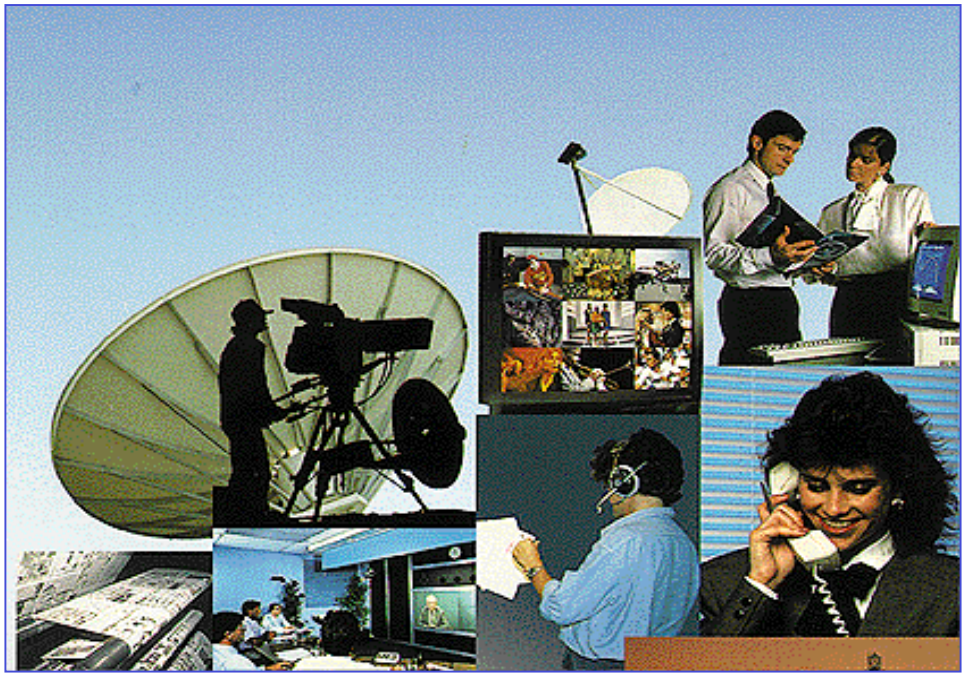
An interim period in the GSTP to define the shape of the new programme and set-up the programme mechanisms, including the cooperation with the EC

NewPro: A full programme preceded by a 3 year interim phase:



Telecommunication: a commercial success

- Telecommunications Satellites represent the largest worldwide commercial space market.



ARTES Programme Organisation

- ARTES (Advanced Research in Telecommunications Systems) program constitutes the backbone of the telecommunications activities of ESA.
- ARTES is a highly flexible program that allows the implementation of R&D activities with different degrees of technical and commercial maturity
- ARTES is structured into elements, which represent the legal and financial frames of the program

ARTES Programme elements

Element	Objective	Timeframe	ESA Funding	Participation Modus
ARTES 1	Strategy	Long-term	100%	ITT
ARTES 3	Multimedia, satcom system elements, new systems	Short-term	Up to 50%	ITT
ARTES 4	ESA/Industry Partnership	Short-term	Up to 50%	Continuously open ITT
ARTES 5	Technology	Long-term	100%	ITT
ARTES 8	Alphabus and Alphasat	Mid-term	50% to 100%	ITT
ARTES 11	Small GEO Platform and Mission	Mid-term	50% to 100%	ITT

ARTES 1

- Objective: perform mission, system and general configuration studies to prepare medium and long-term programme
- Funding level: about 5 M€ per Year, fully funded (100%)
- Yearly workplan based on “Call for Ideas”
  - Workplan is published on the Telecom web site (http://telecom.esa.int)

ARTES 3

- Objectives:

  Promote Multimedia applications and systems
- ARTES 3 is divided in 4 Programme Lines:
  - Line 1: Development of the Multimedia Market (Applications/Services)
  - Line 2: Development of Satcom System Elements (Equipment & Products)
  - Line 3: Pioneering Novel Systems
  - Line 4: Advanced Mobile Systems
- Funding level: about 35 M€ per Year, co-funded activities (50%)
- Process of participation: via ITT (Lines 1&2) and continuous Open Call for Proposals (Lines 3&4)
- Lines 1 and 2 have a yearly workplan

ARTES 4

- Objective: Research, develop & demonstrate state of the art technologies and services with clear applications potential
- Flexible Industry driven Programme Element
- Funding level about 35 M€ per Year, up to 50%
  - Strategic Plan / Business Plan,
  - Products ready for the market

ARTES 5

- Objective: prepare the long-term technological basis for European and Canadian industry in the area of satellite communication
- Funding level: about 22 M€ per Year, fully funded (100%)
- Yearly workplan based on “Call for Ideas”
  - Workplan is published on the Telecom web site (http://telecom.esa.int)
- The ITTs contain firm SOW and technical specifications

ARTES-8 Large Platform Programme

- **The Large Platform program is an initiative of Alcatel Alenia Space (F) and Astrium (F) strongly supported by France**
- **Two sub-elements:**
  - Sub-element 1: Platform development
    - Pre-developments
    - AlphaBus development
  - Sub-element 2: Mission implementation
    - Announcement of Opportunity -> Selection of payloads -> Phase A
      -> Final selection of partner (Inmarsat / Eutelsat) -> Phase B/C/D/E
    - Development of payloads and ground segment
    - Assembly, integration and test of AlphaSat
    - Launch and operation
- Global ESA commitments about 550 - 600 M€

ARTES-11 Small Satellite Programme

- **The Small Satellite program is an initiative of OHB (D) and strongly supported by Germany (Oerlikon Space in the Core industrial team)**
- **Two sub-elements:**
  - Sub-element 1:
    - Pre-developments
    - Small Satellite bus development
    - Manufacturing and test of protoflight model of the bus
  - Sub-element 2:
    - Small Satellite Mission development
    - Selection of payloads
    - Manufacturing, assembly, test, and launch
- Global ESA commitments about 110 M€

SCIENCE & EO specific Technology Programmes

Core Technology Programme (CTP)

- Part of ESA Mandatory Programmes
- Ensure effective preparation of ESA's future scientific missions by
  - Early development of critical technologies
  - And following initial technology developments (TRP) by developing engineering models, tested in relevant environment
- About 20 M€ in commitments per Year

Earth Observation Envelope Programme (EOEP)

- ESA Optional Rolling forward programme (5-Year periods)
- EOEP is the backbone to implement ESA's living planet strategy includes research-oriented earth-explorer missions
- Technology development includes sensors technologies and algorithms in several areas such as
  - Ultra-violet to microwave sensors to probe the earth atmosphere
  - Long wavelength radars in P- & L- band to penetrate Earth vegetation and soil
  - Radar C-X in Ku band for surface sensing
  - Optical super-/hyper-spectral sensors to map the earth surface status and composition
  - Laser and microwave altimeters, gravity gradiometers and magnetometers
- About 12 M€ in commitments per Year

Future Launchers Preparatory Programmes & AURORA

Future Launchers Preparatory Programme (FLPP)

- FLPP Programme is structured in successive overlapping periods
- Developing technological and industrial capabilities to improve exiting launcher technologies, next generation after ARIANE, or for the Next Generation Launcher (NGL)
- Preparation of the down-selection of reusable launch vehicle (RLV), system concepts, etc.
- Identification of possible evolutions to reduce the cost of current expandable launch vehicle (ELV), etc.
- About 25 M€ in commitments per Year (phase 1), 70 M€ up to 160 M€ per Year for phase 2 (2010)

AURORA (Science exploration)

- AURORA Programme aims to pave the way for human exploration to the moon and mars
- Near and medium term robotic exploration missions (including human exploration)
- Range of technologies such as
  - Soft-precision landing, autonomous navigation & autonomous rendevous, capture/docking
  - Bio-sealing and monitoring technologies , life support and recycling systems
  - Planetary protection aspects & long-term habitability module design
  - Power and propulsion systems
  - Radiation protection, health monitoring, countermeasures against microgravity effects
- About 6 M€ in commitments per Year

Swiss Priorities of space technology policy

Priority A : Intelligent, light and very accurate mecanisms and structures, integrating micro- (nano-) technologies and advanced materials

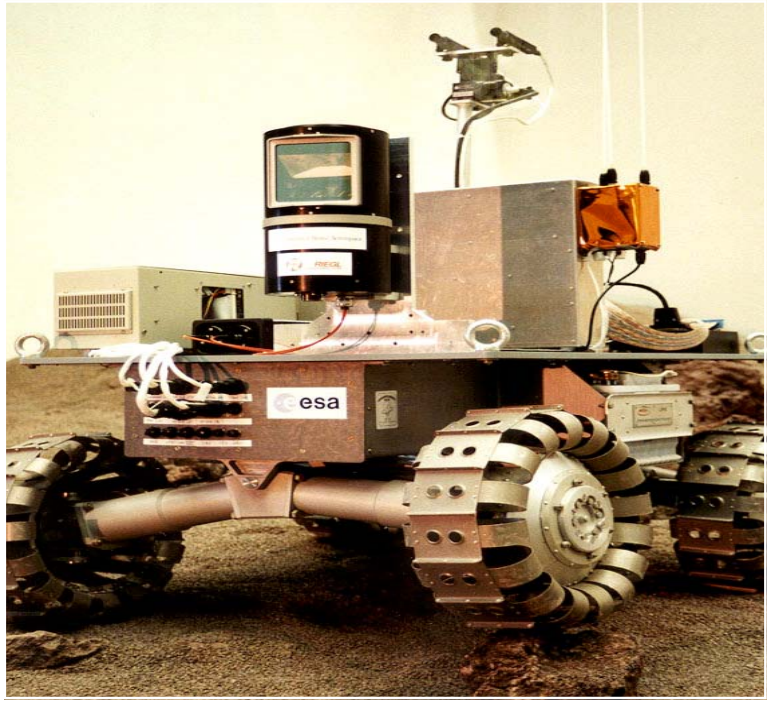
Priority B : Time & Frequency (atomic clocks)

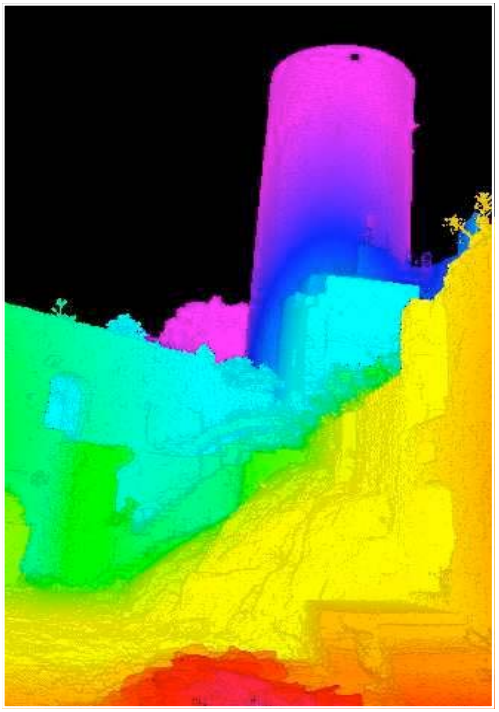
Priority C : Electro-optical data transmission and measurement systems (laser, optic fibers)

Priority D : Miniaturised technologies for space instruments, primarily in scientific and EO missions

Priority E : New technologies for applications financed by the users in the areas of Earth Observation, satellite navigation and telecommunications

Laser Camera on a Robot





7 m — 50 m

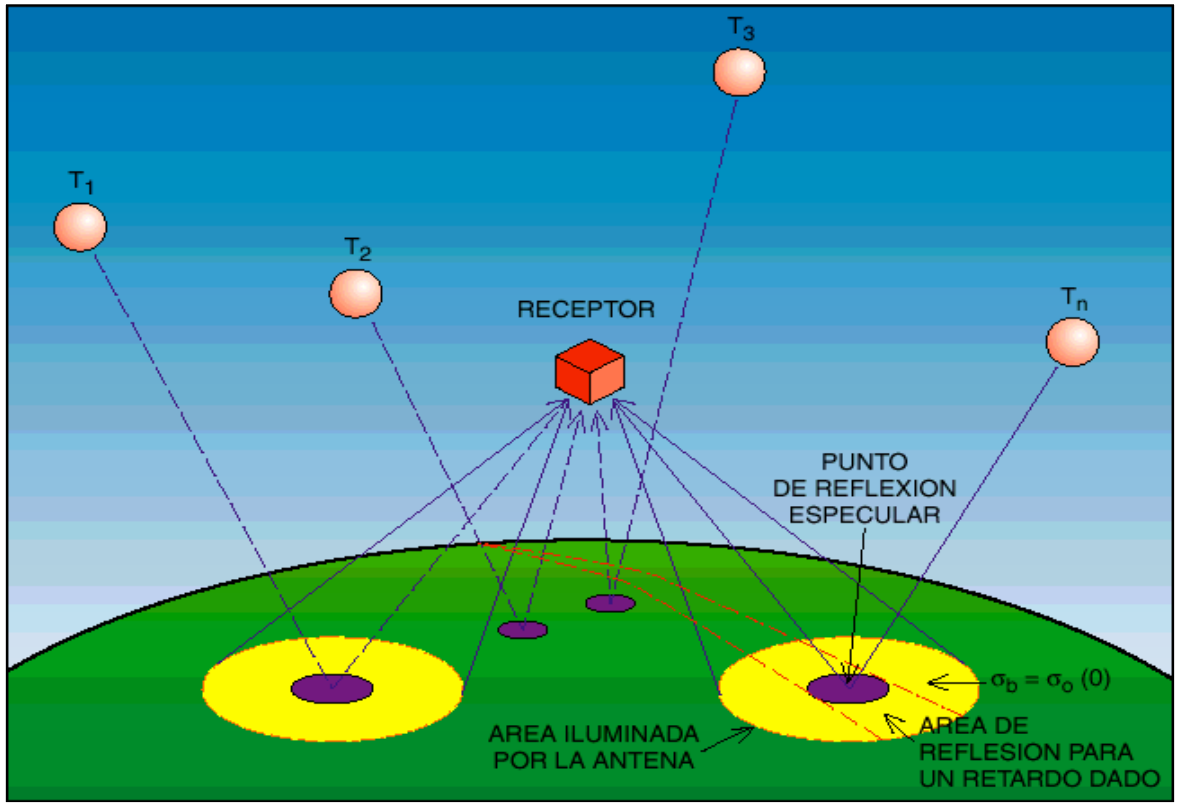
Objective: Increase range of Laser Camera (TRP developed) from 200m to 1200 m

Objective:

Passive Reflectometry & Interferometry System (PARIS)

Objective:

Demonstrate feasibility of new EO sensor based on PARIS concept.



Primary Application:

Mesoscale ocean altimetry

Underlying Principle:

The system performs ocean altimetry by combining direct and ocean reflected signals from opportunity sources such as GPS and GNSS.

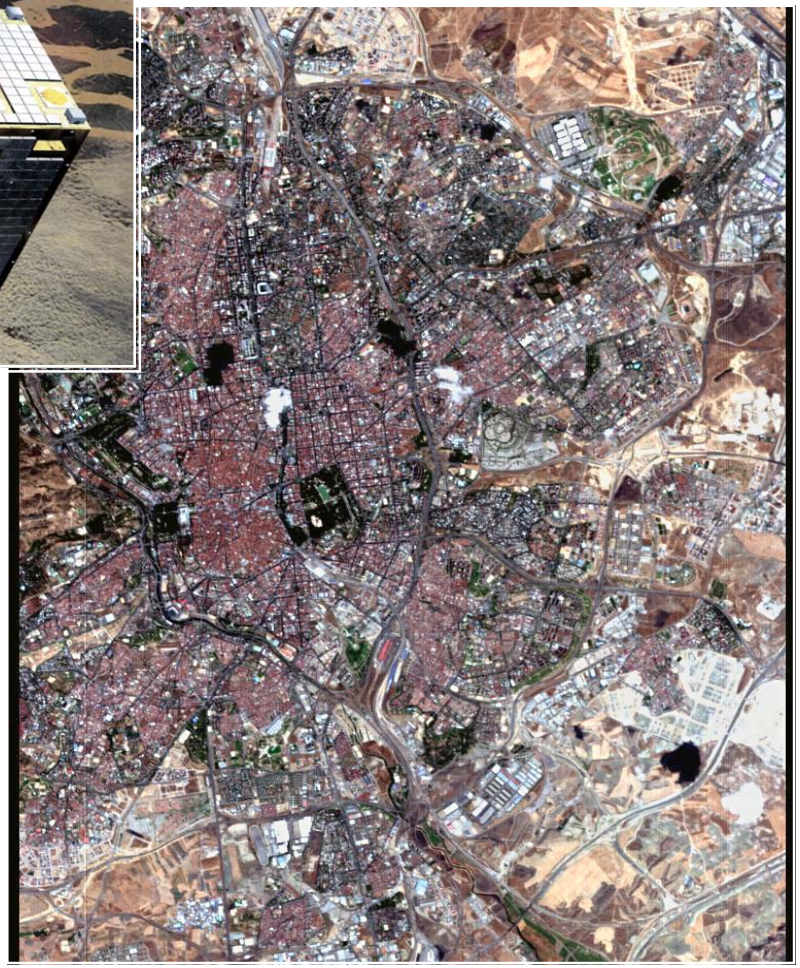
GSTP: PRoject for On-board Autonomy (PROBA)

Main Objective:

To demonstrate on-board autonomy potential

...but also:

S/W for O/B mission planning, navigation , failure detection
Autonomous Star-Tracker
ECR-32 based main computer
DSP 21020, GPS receiver
GaAs Solar Cells (CISE)
Compact High Resolution Imaging Spectrometer (CHRIS)
Standard Radiation Environment Monitor (SREM), DEBrie in Orbit Evaluator



PROBA 3, History and Objectives

PROBA 3 history

Interest in formation flying demonstration has been expressed in the frame of the PROBA 2 CFI by several delegations and industry.

Two preliminary industrial studies for a FF demonstration mission have been performed by ESA in 2004. Both studies confirmed the feasibility and interest of such mission. Both studies designed a mission without a payload.

Following the completion of these studies, ESA looked for potential payload. At the same time, CNES issued an “appel a idees” for FF missions. ESA and CNES planned to cooperate for a possible demonstration mission and agreed that the best payload which “might” be compatible with a demonstration mission was a coronagraph.

ESA completed an internal Phase 0 for a demonstration mission with a coronagraph payload.

Ministerial and IPC end 2005 confirmed the interest and decision was taken to go ahead with Phase 1 (Phase A/B and technology pre-developments in the GTSP)

2008 decision to go ahead with the final implementation will be taken.

PROBA 3 objectives

PROBA 3 is a technology development and demonstration mission. Its goal is to prepare future ambitious missions

The demonstration mission does not replace the user mission

It does not need to be in exactly the same orbit environment

The objectives derived from the goal are:

The development to TRL-8 / TRL-9 of technology required for satellite formation flying (FF)

The development to beta version / SW release of tools / facilities

Utilisation of advanced design, development and verification techniques

This is to be achieved by

Deploying two satellites with the appropriate FF system and a “strawman” P/L

The selected “strawman payload” is the sun coronagraph, selected for its simplicity as instrument, but its demanding requirements in terms of FF.

PROBA 3 mission objectives

The mission requirements are therefore of two classes:

Requirements associated to the formation flying, the development of the technology, the tools and facilities and utilisation of the techniques

Requirements associated to the sun-coronagraph mission / payload**.**

The FF mission requirements are established with the future user programmes:

Space science, Earth Observation, Exploration, Surveillance …

An inter-directorate group is set-up to identify the user requirements domain and derive FF mission requirements on PROBA-3

The requirements associated to the mission will be established by a Science Advisory Group (SAG) convened with support from ESA's Space Science Directorate

The intention is to progress also in the utilisation of advanced techniques for System Engineering and Software Development and AIV.

PROBA 3 technology objectives

- **In-flight demonstration and validation of FF technologies, currently under development in Europe, in preparation for future European scientific and applicative missions:**
  - **Metrology systems** (RF Metrology, Optical Metrology);
  - **Actuators** (High precision propulsion systems);
  - **Inter Satellite Communication Links** (ISL);
  - **FF System architectures** (Centralised, Decentralised);
  - **FF GNC design**;
  - **Structure (??)**
  - **Typical FF manoeuvres**;
  - **Validation of engineering tools, simulators, test beds**;
  - **End to end command & control and operations**.
- **Consolidation of the engineering approach required by a FF mission including new verification and validation techniques**
- **The challenge is also at system level:**
  - First FF mission,
  - Upgrade of small spacecraft platform to include FF functionalities.