

APPENDIX 1 to AO/1-6052/09/NL/CBI

REFERENCE DOCUMENTATION

ESA Programmes with Czech participation

1. The European Space Agency (ESA)

The European Space Agency, created in 1975 as result of the fusion of the satellite and launchers organisations ESRO and ELDO, works as an intergovernmental organisation with the mission to provide and promote the exploitation of space science, space research and technology development and the deployment of space applications. The activities of the Agency are financed via its eighteen Member States (Luxembourg and Greece joined ESA in 2005 and the Czech Republic at the end of 2008) and Canada as associate Member State. ESA activities are also financed by third parties for specific programmes, e.g. EUMETSAT.

Government of the Agency is done through the ESA Council and its Committees on Industrial Policy (IPC), Science (SPC), Administration and Finance (AFC) and International Relations (IRC). Further to these Committees, ad-hoc Programme or Participant's Boards steer ESA's activities in different ESA optional programmes (JCB-Joint Communication Board, PB-Earth Observation, PB-Launchers, PB-Human Spaceflight, Microgravity and Exploration and PB-Navigation).

1.1 Space Technology - Background

The ESA Ministerial Council meeting held in Berlin in 2005 approved programmes and activities amounting to nearly 8.1 € billion for the period 2006 -2010. The approximately 3 € billion ESA's budget for 2008 is split into 10 major lines either under the ESA Mandatory Programme and the optional Programmes. Launcher activities account for 21% of ESA's budget, Human Space Flight (including the European participation to ISS) and microgravity for another 11%, Navigation (including Galileo) for 11%, Telecommunications 9%, and Earth Observation for 13% of the Agency budget. Please note that all the following figures summarising the ESA's budget and activity lines, do not yet include the participation of the Czech Republic. The Technology activity line covers only GSTP and PRODEX in Figure 1.

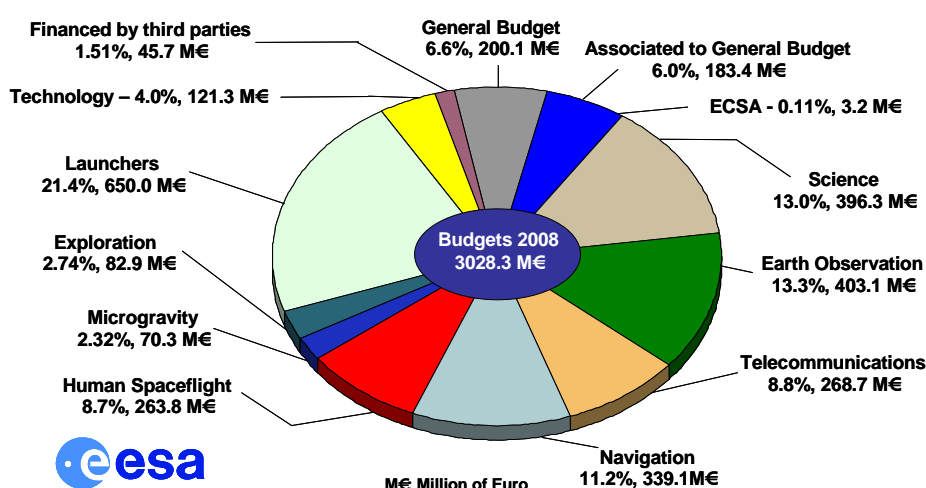


Figure 1 - Major ESA activity lines for 2008 (Czech Republic not yet included) – Source: ESA¹

¹ESA budgets for 2008, including appropriations carried forward

Income from member and other states for 2008 is depicted in Figure 2. It amounts to €2.4 billion. There is furthermore income from member states from previous years in the order of 350 M€ and other income of approximately 260 M€, totalling 3 028.3 M€.

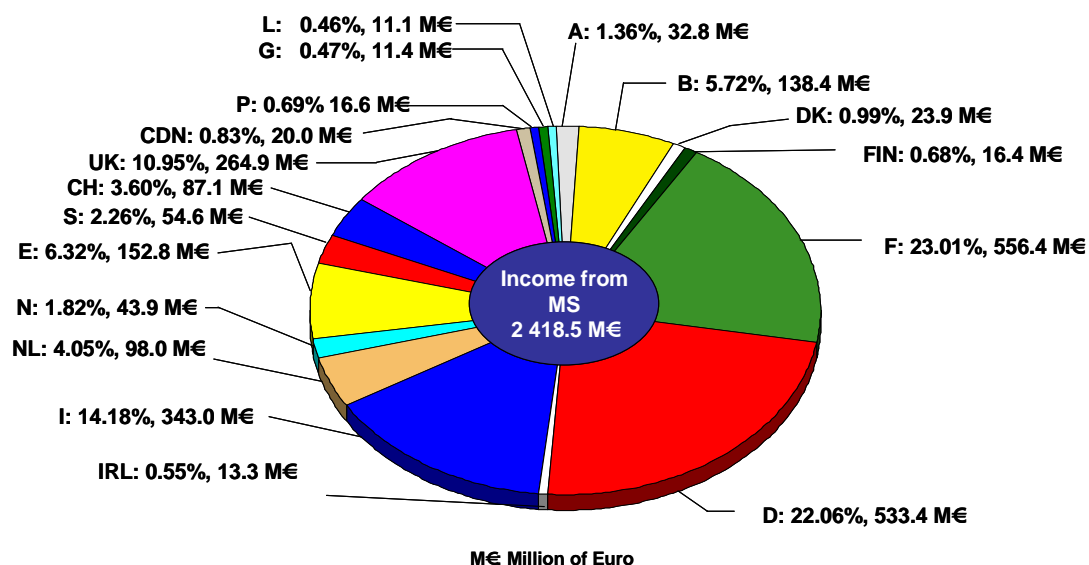


Figure 2 - Member States contribution to ESA budget for 2008 (Czech Republic not yet included)

Income from Member States consists of two components, the mandatory contributions, which are calculated based on the countries GDP, and the contributions to optional programmes, where each country decides on its own, how much money it allocates to a programme, see Figure 3.

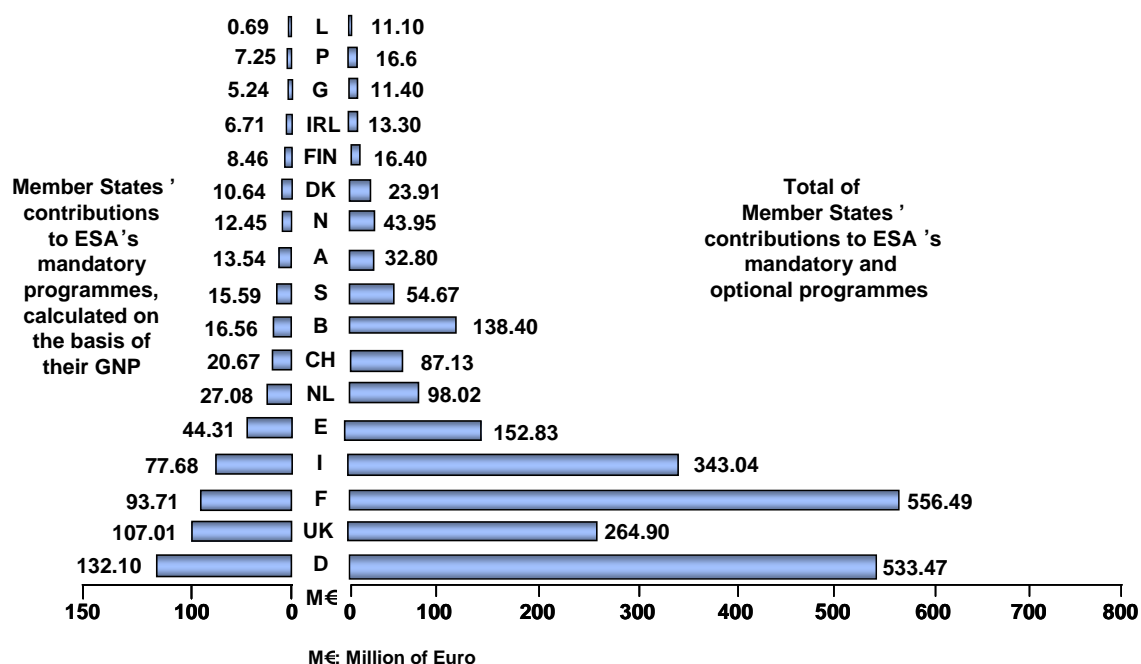


Figure 3 - Member States contribution to ESA budget for 2008, divided in mandatory and total contributions (Czech Republic not yet included)

The Agency's technology activities are implemented through several ESA preparatory Programmes, either of thematic (Telecommunications, Launchers, Earth Observation, Human Spaceflight, Science, Exploration, etc) or horizontal nature. The Technology Research Programme (TRP), the General Studies Technology Programme (GSTP), the Future Launchers Preparatory Programme (FLPP) and the Telecom/ARTES

programmes account for about three quarters of all technology R&D conducted in ESA (see Figure 4).

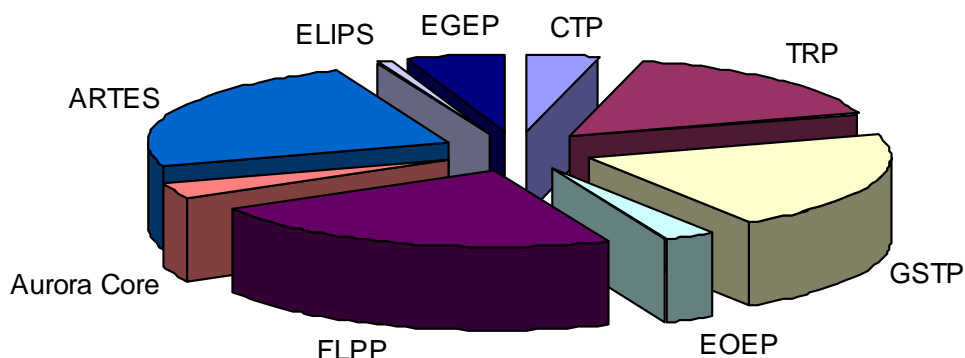


Figure 4 – Technology R&D component of ESA Programmes (2008 budget), in the order of €250 million (Czech Republic not yet included)

The success of ESA programmes relies on timely and mature technology development.

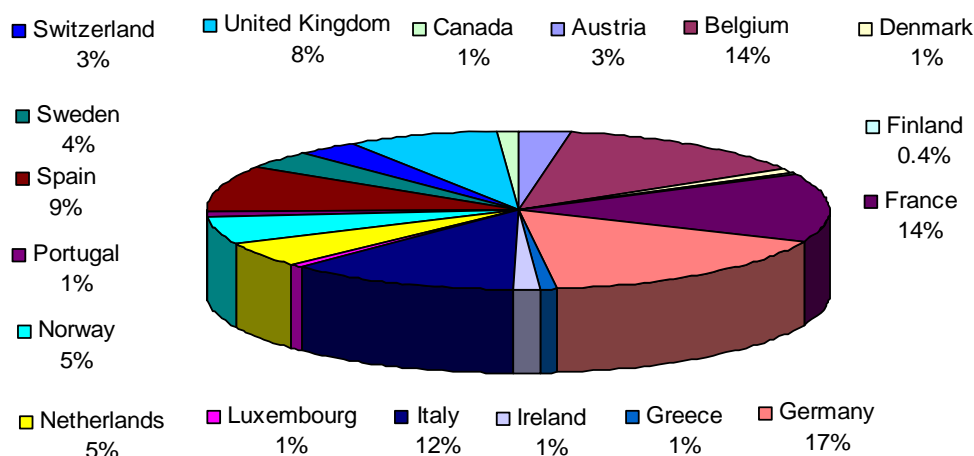


Figure 5 – Internal Estimation of Contribution (2008 budget) to Technology R&D component of ESA Programmes (Czech Republic not yet included)

1.2 Summary of all Optional ESA Programmes with Czech Participation

Beginning from 2009, the Czech Republic financially contributes and thus, it is a participating state in 13 ESA optional programmes.

Earth Observation

The **Earth Observation Envelope Programme (EOEP-3)** makes it possible to develop future missions concepts and instruments and to prepare *Earth Explorer* and *Earth Watch* missions. The programme includes sensors technologies and algorithms development in several areas as well as development of multi-mission ground segment for operating satellites and accession to data. The programme supports the

scientific and service community in the use of Earth Observation data (Czech Participation: ~ 2.6 M€).

GMES Space Component (GSC) programme will be a further major step towards full operational European EO system. Segment 2 will span the period 2009-2018, overlapping with the on-going segment 1 (2006-2013) initiated in C/M 05. It includes in particular the development of two units of the *Sentinel 4* instrument (to be embarked on MTG), and a *Sentinel 5 Precursor* satellite, as well as the development activities of the *Sentinel-1*, -2 and -3 B satellites. Satellite system development is co-funded by and elaborated in close consultation with the EU. It is designed to meet user requirements for a range of operational services, including Emergency Response, Land Monitoring, Marine and Atmospheric Composition (Czech Participation: ~ 1.7 M€)

Meteosat Third Generation (MTG) will comprise two different satellites and will enhance the accuracy of forecasts. The initial two prototype satellites will be developed with a fixed contribution by EUMETSAT. ESA will then procure an additional four recurrent satellites on behalf of EUMETSAT (Czech Participation: ~ 2.2 M€).

Telecommunication and Integrated Applications

ARTES Programme provides support for the R&D improving the competitiveness of the European space industry through the development of innovative satellite communications technology. ARTES 1 constitutes the preparatory element of the Telecommunications programme; it is the basis for the definition of the strategy of ESA in this domain. **ARTES 3-4** are designed to allow the generic developments of technology, equipments and systems for industry's target markets and to allow updates and improvements to existing products (Czech Participation: ~ 1.7 M€)

Iris (ARTES 10, Phase 1.2) Programme will achieve the development of a modern communication standard enabling aircraft to communicate seamlessly on a worldwide scale via satellites, using low cost and low complexity user terminals. The first part of the programme (till 2011) will include the test and validation infrastructure, the ground segment, the interface with the overall Air Traffic Management system, and safety analysis (Czech Participation: ~ 4 M€).

The Integrated Applications Promotion (IAP) (**ARTES 20, Phase 1**) Programme will foster the use of integrated space technologies, alone or in combination with a variety of terrestrial systems. The programme is based on two elements: Basic activities (raising the level of awareness of the potential users, identification of potential new services and preparation of new projects for demonstration) and Demonstration activities (projects that will lead to preoperational services) (Czech Participation: ~ 0.17 M€)

Navigation

European GNSS Evolution Programme (EGEP) includes R&D activities composed of system definition and support studies, technology R&D, test-beds and system predevelopments and accompaniment activities. Candidate critical technologies will be developed, with the aim to provide by 2011 a second generation EGNOS payload on board a geostationary satellite (Czech Participation: ~ 0.48 M€)

Improving Knowledge

The **ELIPS Programme Period 3 (ELIPS-3)** proposes extensive and optimised use of the European resources and capabilities available on the ISS, complemented by autonomous European mission platforms for performing gravity- or radiation-related research. The programme will provide focused fundamental research in Life and Physical Sciences in Space; applied research (diagnostics and novel treatments for age-related diseases, etc.); technology demonstrations in aerospace, energy, automotive and biotechnology; research for Exploration (crew health, exobiology research); education and outreach (Czech Participation: ~ 2.7 M€).

The purpose of **Scientific Experiment Development Programme (PRODEX)** is to provide funding for the development of scientific instruments or experiments proposed by institutions in the participating States for use in the context of the scientific space programmes and missions of the Agency or of its Member States and participation of institutions in the execution of national scientific space programmes or missions which have been considered by the Agency as meeting the overall objectives of its own programmes (Czech Participation: ~ 0.5 M€).

Space Transportation

The **Future Launchers Preparatory Programme (FLPP, period 2 step 2)** is developing technological and industrial capabilities to improve launcher technologies. The specific tasks include next generation launcher concepts, technology development and verification for new technologies (high thrust engine, solid propulsion, cryogenic technologies, storable propulsion), and the system integration of several re-entry technologies (Czech Participation: ~ 0.5 M€).

The **European Transportation and Human Exploration Preparatory Activities Programme (ETHE)** includes the definition of a new transportation system providing cargo return capabilities (based on ATV), the definition of a Moon Lander along with technological development for enabling human exploration (e.g. life support systems). In addition, studies on the post-ISS infrastructure in LEO will support the decision process on the extension of the ISS lifetime in 2010 (Czech Participation: ~ 0.19 M€).

Generic technology development

The **General Support Technology Programme (GSTP 5)** covers general purpose technology developments. It aims at pre-development of identified technologies required by future space projects. It bridges the gap to specific programmes/missions by developing generic/cross-cutting technologies (Czech Participation: ~ 3.2 M€).

2. Technology Readiness Levels - The Process Boundaries

ESA has adopted the Technology Readiness Level (TRL) scale as a way to measure the maturity of a technology. It has now become a well-established standard.

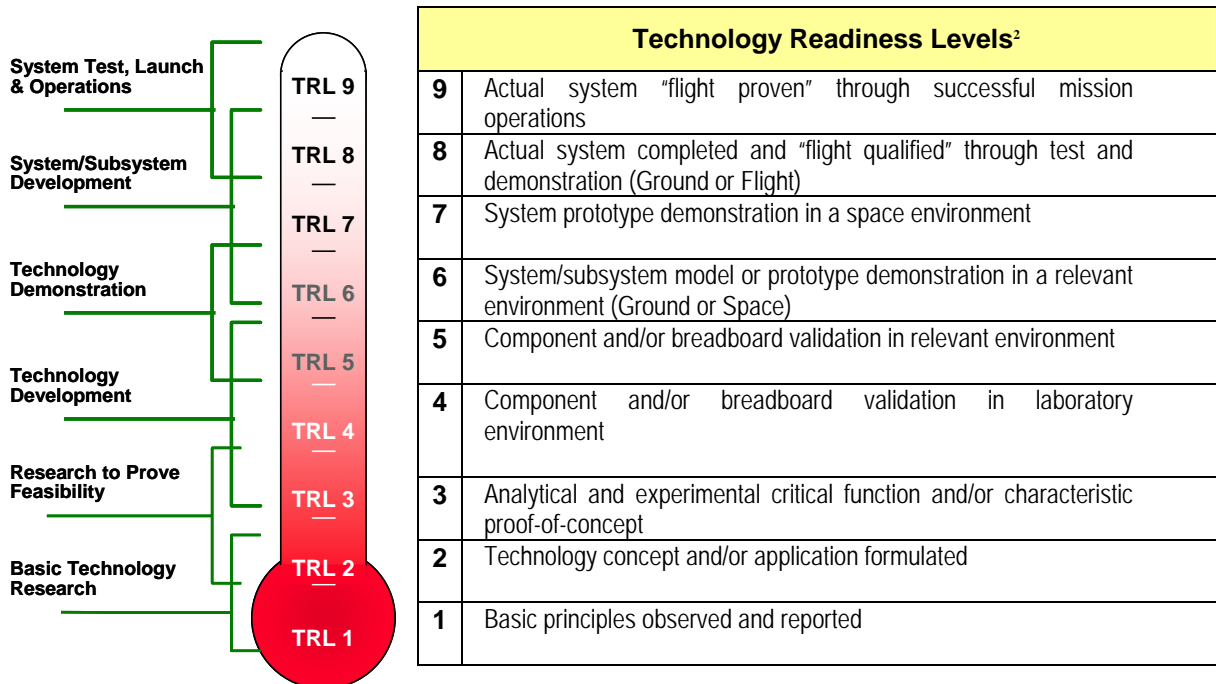


Figure 6 – Technology Readiness Levels adopted in ESA since 2005

Regarding the maturity status of software the same number of TRL are indicatively used. A short description using software engineering terms is shown in Figure 7.

TRL	Software Maturity
9	Live Product
8	General Product
7	Early Adopter Version
6	Product Release
5	BETA Version
4	ALPHA Version
3	Prototype
2	Algorithm
1	Mathematical Formulation

Figure 7 – Technology Readiness Levels using software engineering terms

Figure 8 gives an indicative correspondence between commonly used engineering terms and TRL levels:

² ref. *Technology Readiness Levels - A White Paper* April 6, 1995, John C. Mankins, Advanced Concepts Office, Office of Space Access and Technology, NASA)

TRL	Commonly Used Engineering Terms
9	Mission Operations. Flight Qualified Hardware/Software
8	Theoretical First Unit. Flight Unit. Flight Spare.
7	System Demonstration.
6	High-Fidelity Laboratory Prototype. Engineering Qualification Model. Subsystem model. Development Model. System Model.
5	High-Fidelity Breadboard. Brassboard. Engineering Breadboard. Function-Oriented Model.
4	Component. Breadboard.
3	Laboratory Experiments.
2	Systems Analyses. Pre-Phase-A Studies.
1	Scientific Research.

Figure 8 – Technology Readiness Levels and associated Common Engineering Terms.

3. ESA Programmes with a strong technology R&D component

Technology is developed in ESA under several corporate (TRP, GSTP) and domain specific programmes (EOEP, CTP, etc). Some are mandatory (TRP, CTP), the rest are optional. Only TRP address all service and technology domains. GSTP addresses all domains but telecommunications. Technology programmes in ESA address different stages of development/maturity, as illustrated in Figure 9, where programmes are shown against the TRL scale (see section2.)

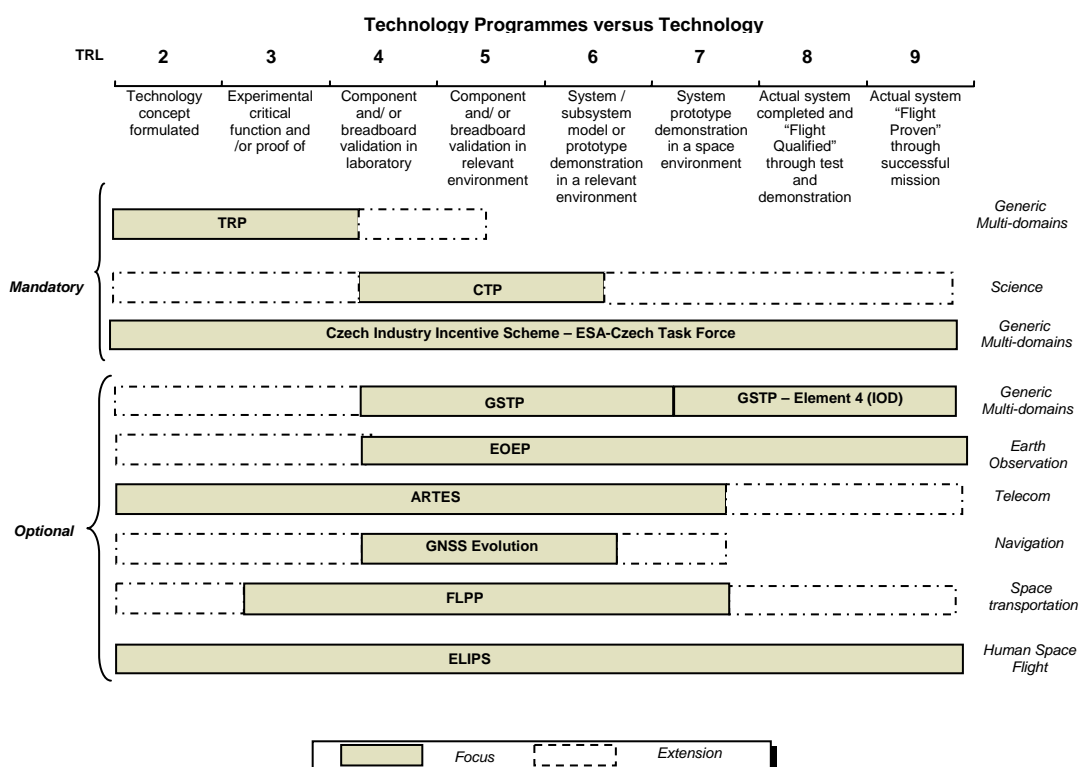


Figure 9 - ESA technology programmes and TRL levels

The main goal of the technology programmes of ESA is to support technology development up to TRL level 5/6 however, depending on the specific technology programme there might be needs of development up to a more mature stage (e.g. flight qualification or in orbit demonstration). In order to achieve the required TRL on

technologies there is the need of continuity among existing and future technology programmes.

For some technologies and techniques and some new applications, it is deemed necessary to complete the development cycle going up to TRL 8/9, i.e. in orbit demonstration, as proposed for the next cycle of the GSTP programme (GSTP-5). In-orbit experiments are important for the development and demonstration of technology, especially of disruptive spin-in technology, spacecraft operation techniques, research and operational techniques and associated technologies. Also new practices, techniques and tools for design, development, and verification and mission operations need to be exercised in smaller yet representative missions.

The Czech Industry Incentive Scheme is part of the mandatory programme and funds the transitional measures to facilitate and optimise the accession of Czech Republic to ESA's Convention. In this Scheme the ESA-Czech Republic Task Force may recommend activities for implementation. All TRLs are in principle possible under the Scheme however, due to its nature, special emphasis is dedicated to achieving tangible targets within the time horizon of the transitional measures. This AO is funded under this Scheme.

The remainder of this section provides background information on Programmes in ESA with strong technology research content and subscribed by the Czech Republic.

3.1 Basic Technology Research Programme (TRP)

Objective: The **Basic Technology Research Programme** is the only ESA technology programme supporting all of ESA's fields of activity, providing the technological nucleus for most future developments. As such, it represents the backbone of ESA's innovative efforts. Innovation Triangle Initiative (ITI), supporting spin-in, is part of TRP.

Process

Call / ITT: Continuously throughout the year on EMITS

Cycle: 3 Year Work Plan with yearly procurement plans / Open AO for ITI/Spin-in

Rules and Regulations

Procurement: **Mandatory programme**, Open Competitive (DN possible)

Funding: ~ 43 M€(2009) annual, 100%, typical funding per activity 300kEuro

Int. Property: Remains with contractor, ESA gets license for ESA purposes

Confidentiality: Public Executive Summary, Final Report available to ESA MS

Call Restriction: ESA Member States

TRL Targeted: 3

The Basic Technology Research Programme (TRP) is part of ESA's basic activities and an essential tool for the Agency to prepare future programmes.

The TRP performs an enabling function reducing the inherent risk of missions by demonstrating the feasibility of technology before flight programmes are decided. Its activities cover all present and future applications such as Space Science, Earth Observation, Space Transportation, Human Spaceflight, and Exploration, Telecommunications and Navigation. Moreover, it supports the development of advanced basic technologies of interest to all applications (e.g. in the field of components, software, power generation, satellite propulsion, etc.).

TRP is the only ESA technology programme supporting all of ESA's fields of activity, providing the technological nucleus for most future developments. It includes the Innovative Triangle Initiative programme ITI.

Once the technological feasibility has been proven, other ESA programmes, further in the chain (see Figure 9), mature the technology through pre-developments, either for ESA projects (CTP, EOEP) or for targeting commercial markets (ARTES, GSTP). In both cases, the intention is to have the technology at the right maturity level.

The target for the TRP in the period 2008 to 2010 is to allocate at least one third of the effort to Generic Technologies, applicable to several missions and to basic technology, not immediately mission driven, aiming at disruptive innovation in view of the future missions. It is a recognised reality that TRP does not have the resources to cover all Service Domains in a sufficient manner. This applies in particular to Space Transportation, Telecommunication and Navigation and is largely the result of accommodating new service domains – or new fields within existing domains – and new technology domains through budget re-allocations within the stable TRP budget.

Priority in the TRP work plan preparation were indicated for:

- **Earth Observation** – Technology developments for the next Earth Explorer Core missions, the post-EPS missions and candidate missions, for which further technology preparations have been recommended;
- **Science** – Developments for the Cosmic Vision Plan (2015-2025) and in particular the so-called Large Missions (Xeus and Laplace/Tandem) and preparation of mission concepts

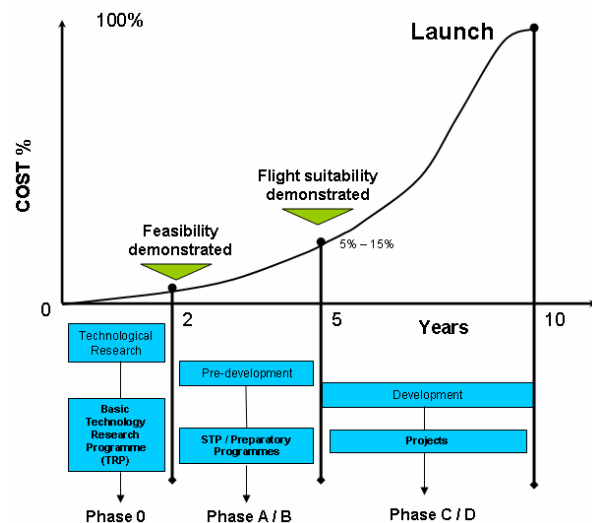


Figure 10 - Positioning of TRP in the supply chain

- recommend by the Space Science Advisory Committee (SSAC);
- **Human Space Flight and Exploration** – Robotic Assistance Technologies, Life & Physical Sciences, Human Exploration Technologies and Autonomous Robotic exploration;
- **Space Transportation (and Planetary entry)** – Launcher oriented Technologies, Human Space Flight oriented Technologies and Generic Space Transportation Technologies;
- **Telecommunication** - Mobile interactive services, fixed services, direct broadcast service, interactive broadband services, data relay and security services;
- **Navigation** – EGNOS evolution, Galileo evolution and Enabling Technologies and Techniques for GNSS Evolution applications;
- **Generic technologies** – They complement the application driven Technologies, by taking care of technologies common to two or more application domains, e.g. platform technologies, ground segment technologies, payload technologies. Furthermore, a sound strategy for technology can not look only at the immediate needs, i.e. the candidate missions, but must look beyond and realise the potential of technology for gradual and disruptive innovation as the way to increase performance and affordability of European space systems and the competitiveness of European Space Industry.

During 2007 it became clear that in order to deal with the increasing complexity and system impact of technology developments, a multi-domain approach was needed, where requirements and plans are created in a multi-disciplinary fashion. Therefore, four multi-domain themes were established considering the priorities and resources available in TRP:

- **Improving the way we deliver and operate space systems:** Developing technologies, techniques and tools that significantly contribute to reduce time and cost of developing and operating space missions.
- **Disruption by evolution:** Technology that implies significant spacecraft evolution in spacecraft avionics: IP in space, Plug-&Play style avionics, software and software reuse, spacecraft management (FDIR, command and control), AOCS, data integrity.
- **Disruptive Technologies:** Developing disruptive technologies that transform the way space systems are designed. Within this initiative, it is intended to put micro-system and nanotechnology (MNT) activities within a system context, and pursue them through a "System-of-Microsystems" approach.
- **Electronic Components:** Focus is on securing development/evaluation of standard components, evaluation and radiation testing. Advanced components e.g. GaN, ASICS, ADC/DAC requiring significant investment have to be addressed in GSTP-5.

This approach shall also enable a more homogenous outcome and ease the transfer of results to projects.

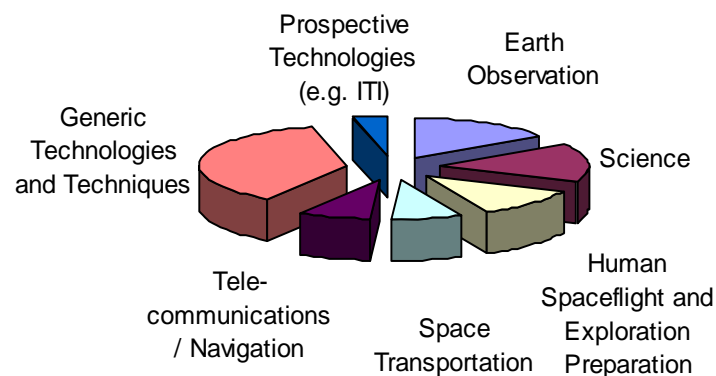


Figure 11 - Distribution of intended budget per theme for the TRP 2008-2010 Work Plan

A particular initiative in TRP is the so called "StarTiger" for fast concurrent prototyping of advanced technology, usually by spinning-in technology available for ground applications. The first call was issued in 2002. The second call was open in 2008. It is the intention to hold periodic calls for two exercises per year.

3.2 Promoting Innovation: Innovation Triangle Initiative (ITI)

Objective: The objective of ITI is to create a dynamic environment where innovations can be easily validated, developed and put to use in industry, thus contributing to a more competitive European Space Industry. ITI aims specifically at absolute novelty or novelty in space. Preference is given to non-space technologies used to address space problems. The main characteristics of ITI are:

- 1) Continuous call for ideas with a standing TEB, meeting periodically
- 2) Proposals are submitted on-line using templates in the WEB site <https://iti.esa.int/>
- 3) Short "time to contract"
 - simple templates for the proposal submission
 - standard, predefined contract (Fast Track procedure)
- 4) Three types of contract:
 - A-Proof of concept (for INVENTORS): fast validation of new ideas and demonstration of its advantages (<= 50 KEURO)
 - B- Demonstration of Feasibility and Use (for DEVELOPERS): component and/or breadboard development validation in the laboratory or in a relevant environment (<= 150KEURO)
 - C- Technology Adoption (for CUSTOMERS): testing of a prototype built taking into account technical and operational constraints imposed by the final targeted application (50% co-funded)

Procurement: Mandatory programme, Open Competitive (DN possible)

TRL Targeted: from 2 to 3 (for Type A/B) and to 5 (for Type C)

Funding rule: 100% for types A and B; 50% for type C

Total yearly budget (08): 1.5 M€(covering Type A and B, only); For Type C: contracts 50% cofunded, ESA funds up to 1 M€per activity (with support from National Delegation).

Call for proposals: Continuously throughout the year using the web site <http://iti.esa.int/>

Cycle: Yearly ITT on EMITS

Key dates: Proposals are evaluated periodically 3 to 4 times per year

One of the roles of ESA is to support the introduction of breakthrough innovations and technologies in the space environment. This is the aim of the ESA *Innovation Triangle Initiative (ITI)*, whose specific goal is to explore technologies or processes that have the potential for significant innovation in the space sector.

The ITI was launched on March 2004 and it is currently funded by TRP for Type A and B activities and by GSTP for Type C activities. Since then, it has supported the identification, validation and development of disruptive space technologies based on new ideas or concepts.

From 2004 to mid 2008, 381 proposals have been submitted by the industry and evaluated. From these the evaluation board retained 96 proposals for funding, for a total of €8.1 million. The projects selected cover a wide range of technologies for spacecraft and missions, in areas such as mechanical systems, structures, materials and processes, instrumentation, optics, computer systems, software, automation and robotics, propulsion, etc.

ITI is based on the concept that a close collaboration between three different types of entities (the inventor, the developer and the customer) is an important factor for the rapid and successful introduction of technology innovations in industry. Industrial participation in ITI requires very low investment in preparing, submitting and managing R&D proposals. Furthermore, the initiative is characterised by:

- accepting unsolicited proposals;
- being wide in scope and not constrained to any specific technical domain;
- being open during all year;
- funding decisions taken in a short time.

As a result of these characteristics, ITI is clearly a good opportunity for entities with little experience in working with ESA and thus it is used as a mechanism to support Technology Spin-In.

3.3 General Support Technology Programme (GSTP)

Objective: The General Support Technology Programme prepares ESA programmes to support European Industry's worldwide competitiveness and non-dependence, implementing the European Harmonised Roadmaps. GSTP funded activities aim at the pre-development/development and - if needed - the qualification of technologies required by future space projects.

Participating States need to notify the Agency of any activities they wish to support prior to an invitation to tender being issued

Process

Call / ITT: Continuously throughout the year on EMITS following approval and support confirmation by Participating States.

Cycle: 5 years (GSTP5) with regular updates through the year

Rules and Regulations

Procurement: Optional programme, GEO Return of 1, competitive (non-competitive tenders are possible)

Funding(08): 55 M€annual, 100% (up to 50 % in non-competitive tenders), typical funding per activity 600kEuro

Int. Property: Remains with contractor, ESA gets license for ESA purposes

Confidentiality: Public Executive Summary, Final Report available to the ESA MS

Call Restriction: ESA MS

TRL Targeted: 6 (and above)

The General Support Technology Programme (GSTP) declaration and implementation bridges the gap to user programmes, developing generic/cross-cutting technologies, elements for scientific payloads and instruments, selected technology transfer activities as well as in-orbit technology demonstration projects.

For its 5th period starting in January 2009, GSTP has been revised so as to organize the programme in 4 elements. This also responds to the Resolution of the Council at Ministerial level held in Berlin in 2005 that invited the ESA Director General to propose a new programme. The objective of such a programme will be addressed by GSTP with its new structure.

Element 1: General Activities (Core): Covers the standard GSTP activities in all Service Domains except Telecommunications. It supports user programmes and industry complementary to TRP and domain specific programmes and contributes to the product policy, also avoiding product obsolescence. This element includes a permanently open Call for Proposals. Such proposals shall be implemented through non-competitive tenders covering:

- close-to-market developments
- technology transfer
- strategic developments for industry support
- new ideas.

The Announcement of Opportunity (AO) in Element 1 has among other objectives, the implementation of ITI class C activities

Element 2: Building Blocks and Components (BB&C) to high TRL: This Element is new and aims at systematically achieving high TRL, 5-6; for building blocks and components so that they may become part of a catalogue of products. The European Component Initiative (ECI) activities, endorsed in the context of the ESCC, shall be considered as part of the Element 2.

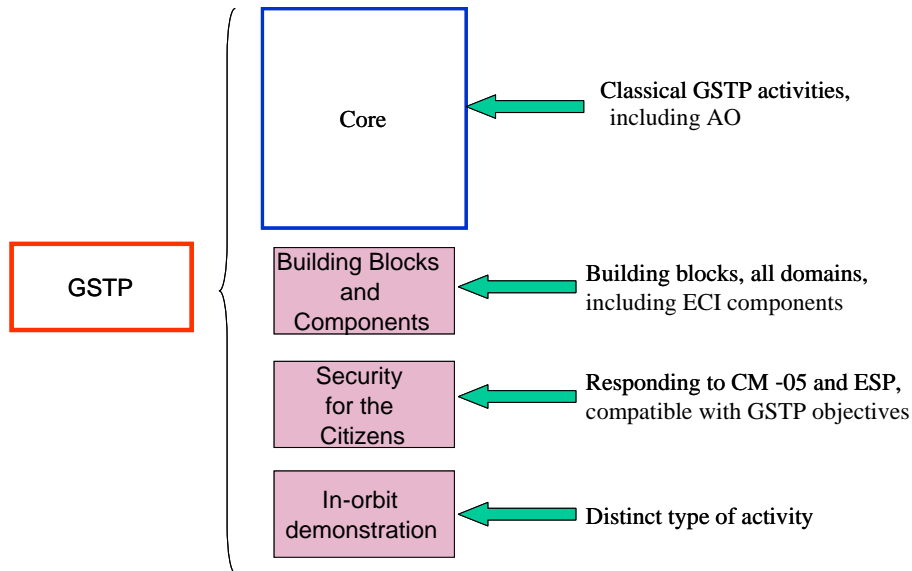


Figure 12 GSTP-5 Structure

Element 3: Security for the Citizens: As Element 2 but for Security, including also Space Situational Awareness.

Element 4: In-Orbit demonstration: devoted to in-orbit demonstration and will include:

- The demonstration of technologies, in particular innovative technologies and specially when flight heritage is strongly desired;
- The demonstration of research techniques, e.g. GNSS reflectometry, and associated technologies;
- The demonstration of operational monitoring techniques, e.g. frequency monitoring; and associated technologies;
- The demonstration of spacecraft operations techniques, e.g. formation flying, and associated technologies;
- The characterisation of the space and spacecraft environment;
- The demonstration of new approaches, techniques and tools for system development, AIV and mission operations;

Well-known ESA's technology in-orbit demonstration projects, initiated in GSTP-3 and GSTP-4, are shown as examples in the following. GSTP-5 will enforce that subject and provide a suitable framework for low-cost in-orbit demonstration of technologies

PROBA-2

Proba-2 is the second in ESA's series of small, low-cost satellites that are being used to validate new spacecraft technologies while also carrying scientific instruments. The launch is planned for 2009 on a Rockot launcher as secondary passenger of ESA SMOS mission.

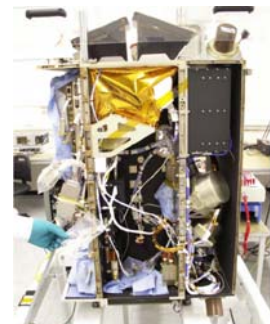


Figure 13 - Proba- 2 spacecraft shortly before the payload integration.

PROBA-3 (Formation Flying)

Proba-3 is conceived as a project for the development of Formation Flying Technologies up to Technology Readiness Level 9, i.e. including in-orbit demonstration. It aims at providing sufficient confidence to future operational missions on these techniques and technologies. Phase B of Proba-3 has been initiated in 2008. Subject to a successful completion of technology developments, Phase C/D/E1 is planned for initiation in 2009/10, to allow for a mission in the 2012/13 timeframe.

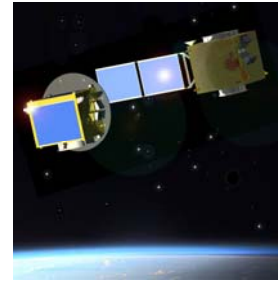


Figure 14 - Proba-3 (artist's impression)

PROBA-V

PROBA-V is a mission based on an advanced Proba platform carrying a multi-spectral instrument capable of providing enhanced data continuity to the Vegetation mission carried out by SPOT-4 and SPOT-5. It is based on the "Lightsat" approach proposed by ESA for its in-orbit demonstration strategy. The mission shall address, amongst technology demonstration, key applications in the domains such as:



Figure 15 - Proba-V (artist's impression)

- land use, land cover and its changes
- vegetation behaviour in response to strong meteorological events
- disaster management.

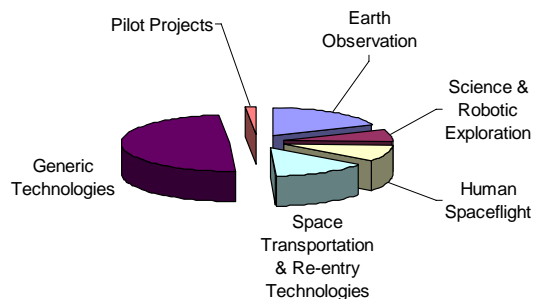
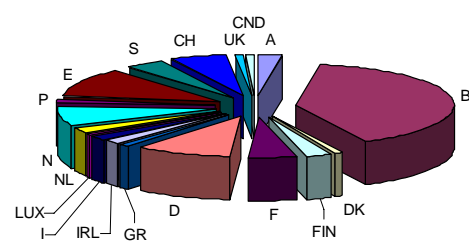


Figure 16 – (a) Distribution of GSTP-4 Work Plan by themes (excluding NewPro and Formation Flying) up to June 2008



(b) Distribution of Member States contribution to GSTP 4 up to June 2008

3.4 Science Core Technology Programme (CTP)

Objective: The main objective of the Science Technology Programme is to ensure an effective preparation of ESA's future scientific missions by the early development of critical technologies. The demonstration of the feasibility of these critical technologies is an essential prerequisite to enable implementation of the planned missions at an acceptable level of risk in terms of cost and schedule. Initial technology developments, leading to an experimental feasibility verification of critical functions or to a validation at breadboard level in laboratory environment, are pursued with funding of ESA's Basic Technological Research Programme (TRP).

TRL Targeted: from 4 to 5
Procurement policy: Open competitive (Direct negotiation possible)
Funding rule: 100%
Total yearly budget after 08: 10 M€
Invitation to tender: Continuously throughout the year on EMITS
Cycle: Work plan 2008-2011

The Core Technology Programme is strongly coordinated with TRP and aims at reaching higher level of technology maturity by developing engineering models, tested in the relevant environment, before the start of the definition phase of a scientific project. These activities, including the adaptation of mature technologies to specific mission requirements, continue as necessary, in parallel with the project definition phase activities, to avoid having the corresponding technology procurements on the critical path of the satellite development phase.

The CTP activities cover platform and payload technologies under ESA responsibility.

3.5 Earth Observation Envelope Programme (EOEP)

Objective: The Earth Observation Envelope Programme, EOEP, is an optional rolling forward programme approved in periods of five years. EOEP missions are defined with the user communities, with the scientific community for the Earth Explorer missions and the operational user communities for Earth Watch missions. EOEP is the backbone for implementing ESA's Living Planet Strategy.

TRL Targeted: from 2 to 9 (depending on own resources and TRP)
Procurement policy: Open competitive
Funding rule: 100%
Estimated budget for technology (EOEP-3): 21 M€(for 2008-2010)
Invitation to tender: Continuously throughout the year

The Earth Observation Envelope Programme, EOEP, includes a Development and Exploitation Component that allows for the preparation of the two classes of Earth Observation missions, the research-oriented **Earth Explorer** missions (core and opportunity) and the operational service-oriented **Earth Watch** missions.

The **Earth Watch** missions are driven by operational user communities and implemented with partners that could take responsibility for service continuity. Essential to Earth Watch is the concept of guaranteed provision of services in the long- term. The missions under development include meteorological missions for Eumetsat, such as the Meteosat Third Generation geostationary satellite and the low-Earth orbiting PostEPS satellite(s), as well as the satellites dedicated to Global Monitoring for Environment and Security (GMES), namely the Sentinel-1, -2 and -3. The Sentinel-4 and -5, devoted to atmospheric composition and air quality, are assumed to be realised as payloads on the satellites for Eumetsat. A precursor for

Sentinel 5 is foreseen. Technology pre-development is supported mainly by two lines of EOEP:

- EOPA: Earth Observation Preparatory Activities
- IPD: Instrument Pre-Development

3.6 Telecommunications Programme (TELECOM/ARTES)

The ESA Telecommunications Programme is designed to maintain and develop a competitive state-of-the-art satellite telecommunications industry in Europe and Canada through improvement of the technological basis and through implementation of satellite telecommunication systems. This is achieved by promoting the innovation, development and implementation of all elements of satellite communication systems including demonstration of complete systems. The scope of the activities of the ESA's Telecommunications Programme is reflected in the **Telecommunications Long Term Plan**. This programme is developed along three major axes:

- Telecommunications Systems Equipment and Technology
- Telecommunications Applications
- Telecommunications Missions.

The programme is complemented with a comprehensive set of preparatory activities that analyse the evolution of the Market, study the feasibility of new missions, evaluate the evolution of Technology and support the standardisation effort on different services.

The satellite telecommunication domain is fundamentally dominated by the demand of the commercial Telecommunications market. However, the increasing demand of the institutional/public sector for satellite telecommunication systems is of strategic importance. To maintain the competitiveness of European industry in this market segment, the Telecommunications programme incorporates lines of action addressing the preparation of industry to be able to respond timely to these needs with adequate products, services and applications and to ensure a strong knowledge base.

In the coming years, it is expected that the satellite telecommunication services will, to a large extent, be a continuation of today's services with the addition of some new services. The services are:

- Fixed, direct Broadcast and Interactive Broadband Satellite Services
- Mobile Broadcast Services
- Mobile Interactive Services
- Institutional and Data Relay Services.

The Telecom Programme is organised into Programme Lines where a strategic lead in research and development will provide most benefit. Input from many sources is analysed in order to decide where this focus should be. The Telecom Programme Lines are the following:

- Preparatory: Constitutes the strategy component of ESA Telecommunications programme lines. It identifies and evaluates opportunities, future systems and concepts within the space and terrestrial telecommunications markets
- Systems, Equipment and Technology: This programme line focuses on the consolidation of new system concepts and the development of advanced equipment, subsystems, satellite payloads, user terminals and gateways. It also addresses the development of technology for

each element of the telecommunication system and for each type of service.

- Applications: The programme line supports innovative applications and solution projects. Innovative applications are applications at a modest scale that have not yet been developed, while solution projects are larger and involve the setting up of fully functional systems characterised by service requirements defined by the end users.
- Missions:
 - Large Platform Mission: Involves the development of the large European telecommunications platform and payload based on state-of-the-art equipment from world-class suppliers. Indeed, a spin-off benefit of the mission is that it will unite European industrial prime contractors and suppliers around a common objective - meeting the future needs of telecom operators.
 - Opportunity Mission: This line is to support new initiatives in setting up new satellite telecommunication systems including the possibility of embarking innovative technology and small payloads on commercial satellites.
 - Small GEO Satellites: This programme line supports the development of a small GEO platform for various applications ranging from technology driven multimedia systems, to small traditional payloads to explore new markets.

The telecommunications programme is organised along several lines of the ARTES programme. Concerning technology the main lines were ARTES 3-4 and 5. As from 2009 these lines were restructured to better suit the user needs and funding schemes. ARTES 3 and 4 were merged into ARTES 3-4, and ARTES 5 was split in 5.1 and 5.2 as presented in Figure 17 (Note that the Czech Republic does not subscribe to ARTES 5).

New initiatives such as ARTES-10 IRIS (and EDRS not subscribed by the Czech Republic) are now part of ARTES targeting space-based contributions to the Single European Sky Air Traffic Management Research (SESAR) and a data relay system for Europe respectively. An initiative on Integrated Applications which develops services based on the synergetic exploitation of space systems and techniques (ARTES-20 IAP subscribed by the Czech Republic) has also been adopted in ARTES.

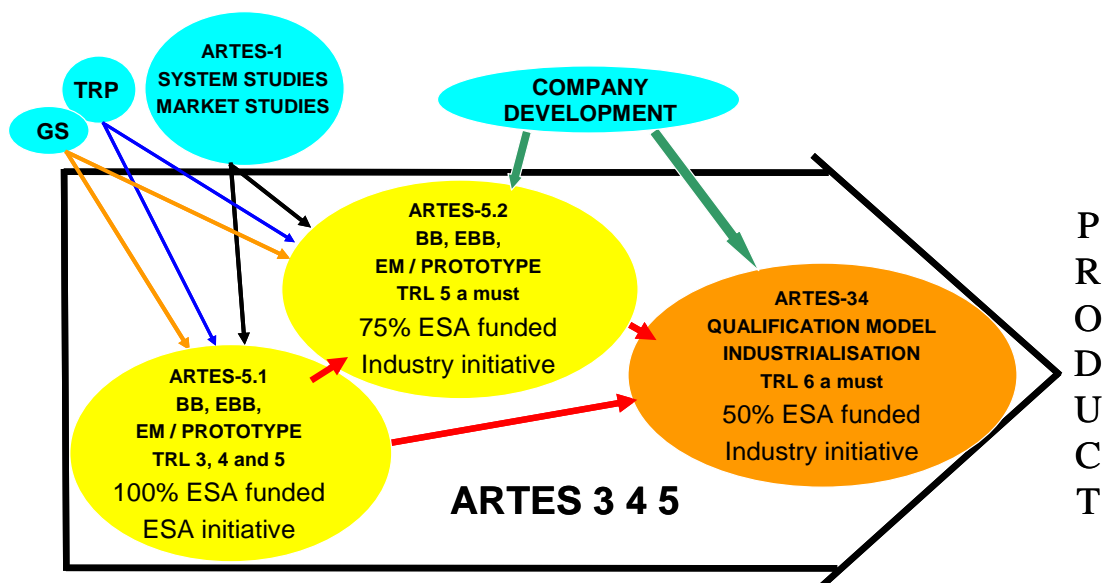


Figure 17 - Product Development Cycle in proposed ARTES elements

ARTES 3-4: ESA Telecom - Products

Objective: Support the development of products for satellite telecommunications to improve the competitive position of the industry.

Proposals particularities:

- Strong emphasis on Strategic Plan / Business Plan
- Products ready for the market
- Proposal with letter of support from delegation

Process

Call / ITT: Continuously throughout the year on EMITS following approval and support confirmation by Participating States.

Cycle: Continuous proposal submission from industry – no detailed workplan

Rules and Regulations

Procurement: Optional programme, GEO Return, Direct Negotiation

Funding: 50%, funding per activity (typically between 0.5 and 3 MEuro)

Int. Property: Remains with contractor, ESA gets license for ESA purposes (certain restrictions on sub licencing)

Confidentiality: Public Executive Summary, Final Report restricted to financing Member State

Call Restriction: ESA Member States

TRL Targeted: 6

3.7 European GNSS Evolution Programme (EGEP)

Objective: The objectives of the **European GNSS Evolution Programme** are to undertake technology research, development and verification related to GNSS and to accompany the introduction of GNSS operational systems, with a view to support the maintenance of the scientific, technical and industrial expertise necessary for Europe, bring the industrial know-how at par internationally, sustain European competitiveness and innovation capabilities and prepare for evolutions and upgrades of the European GNSS Infrastructures EGNOS and Galileo.
In addition, the programme contributes to the consolidation of the technical expertise of ESA, in its role of Design Authority and procurement agent for the European GNSS programmes.

TRL Targeted: from 2 to 7

Procurement policy: Competitive

Funding rule: 100%

Total financial envelope: 75 M€/ 3 years (2009-2011)

Invitation to tender: Continuously throughout the year on EMITS, beginning few months after programme approval.

The programme covers the preparation of the evolutions of EGNOS and Galileo through activities ranging from system definition studies up to system preliminary design reviews, technology development activities, implementation of evolution test-beds and complementary accompaniment activities.

The activities of the programme are grouped as follows:

- System Definition, Preliminary Design and Support Studies, which will allow assessing the feasibility of candidate system evolutions or upgrades, consolidating the system definition of a future European GNSS Infrastructure and establishing a system evolution roadmap answering to the needs of the mission evolutions identified by the EC. When feasibility and potential interest of candidate system evolutions are confirmed in concert with the EC, preliminary design will be undertaken to consolidate the requirements and associated implementation plans of the related upgrades in the operational part of the European GNSS Infrastructure and to be submitted to the EC for further implementation decision.
- Technology R&D activities, which will bring to the adequate level of maturity the candidate space and ground segment technologies needed for evolutions of the European GNSS.
- Evolutions Test-beds, which will be developed and implemented to verify and demonstrate new capabilities for the consolidation of system definitions of candidate system evolutions and mitigate the risks in system developments. The test-beds will vary in complexity and for each of them a number of measurement and demonstration campaigns will be organised in close relation with the relevant user communities and related activities of the EC.
- Accompaniment activities, which will complement the activities above and include among others: studies on applications to provide feedback to the evolutions of the systems, general GNSS monitoring, support to standardisation activities and interface with the scientific community.
- Sustenance of ESA internal expertise at system level in the field of GNSS, which will allow the Agency to act as the Design Authority of the GNSS Infrastructures EGNOS and Galileo.

The activities undertaken by the Agency will be defined in close cooperation with the EC, and in association with the operators, the technological, scientific and user communities. In particular, system requirement drivers behind the evolutions of EGNOS and Galileo will be based on the mission related activities led by the EC and on the operational feedback acquired by the operators of the GNSS Infrastructures. Special attention will be devoted to the coordination with the FP7 activities.

3.8 Experimental Life and Physical Science Programme (ELIPS)

Objective: The ELIPS programme is intended to prepare for and implement research on the International Space Station, and other experiment platforms like Ground-based facilities, Sounding Rockets and unmanned orbital vehicles, in fundamental, applied and exploration-related Life and Physical sciences. ELIPS will be the essential programme to ensure that the European investments in the development and exploitation of the ISS will lead to best science and application results, and serves as scientific preparation for future Exploration endeavours. ELIPS promotes global cooperation, international peer review of research proposals and European coordination in terms of facility development and resource utilization.

TRL Targeted: from 1 to 9

Procurement policy: Competitive

Total financial envelope: 395 M€/ 4 years

Estimated Budget Share for Technology Development: ~ 5 %

The objective of programme is to achieve scientific results in the area of Life and Physical Science and applications, as part of the International Space Station ISS exploitation, as well as the scientific preparation of future Exploration endeavours. ELIPS offers also experimentation on other carriers, e.g. ground-based (space analogue or simulation) facilities, sounding rockets and unmanned orbital elements, for the execution of the experiments. A limited part of the budget envelope is dedicated to related technology development.

3.9 Future Launchers Preparatory Programme (FLPP)

Objective: The **Future Launchers Preparatory Programme** aims at preparing the technical and programmatic inputs for the short/medium-term decisions on the evolution of the European launcher sector through activities on expendable launch systems, and at developing technological and industrial capabilities needed for the Next Generation Launcher (NGL) for the long term, fostering innovative technologies that may benefit the current European expendable launchers. The programme will support Industry and participating Member States in the decision on launchers evolution.

It consists of two financial sub-envelopes:

1. System, Demonstrators and Technology activities (SDT)
2. Intermediate eXperimental Vehicle for re-entry activities (IXV)

TRL Targeted: from 2 to 8

Procurement policy: Direct negotiation at Prime level, open competition at subcontractor level

Funding rule: 100%

Total financial envelope: 200 M€/ 4 years (2009-2012)

Call for proposals: N/A

FLPP work is mainly guided by the objectives of improvement of reliability, flexibility and availability of launch service together with the reduction of its recurrent cost. The FLPP is structured in successive overlapping periods:

- 2004-2006 (Period-1) Studies of reusable launch vehicle (RLV) system concepts driving technology developments, preparation of experimental vehicle concepts; identification of possible evolutions to reduce the cost of current expendable launch vehicles (ELV).
- 2006-2009 (Period-2 Step 1) System studies on new ELV launchers based on mature technologies, and comparative studies on possible NGL concepts, including RLV and ELV configurations with a progressive down-selection. Technology activities covering propulsion, cryogenic upper stage, re-entry, materials and structures, focussing on validation by demonstrators supporting vehicle system concepts. Phase C/D of the Intermediate eXperimental Vehicle (IXV) is also started.
- 2009-2012 (Period-2 Step 2) Completion of the system activities, started with FLPP-1 and FLPP-2 Step-1, in particular on down-selected NGL concepts, on the basis of requirements to be progressively consolidated, taking also into account possible exploration requirements. Completion of phase D of the Intermediate eXperimental Vehicle (IXV). Progress, through ground demonstrators and in-flight experiments, in the technology development and verification for promising and enabling technologies, in particular for High Thrust Engine and Cryogenic Upper Stage Technologies.
- 2012-2015 (Period 3) Finalisation of system studies, flight of the IXV, conduction of integrated engine demonstrator tests and completion of technology developments up to TRL 6, so as to be in a position to give a final recommendation for Europe's Next Generation Launcher

concept, including finalisation of mission requirements, and to enter an NGL development with a commitment by industry on launcher development / recurrent costs and on performance.

Member States approved in 2004 the initiation of Period-1 of the new programme, through the subscription of two sub-envelopes with an overall financial envelope of M€ 39.3 million (e.c.2006) covering Period-1: (1) the Early Activities sub-envelope and (2) the Complementary Technology Developments sub-envelope.

FLPP Period-2 Step 1 activities were decided at the Ministerial Council end-2005 in Berlin. The subscribed financial envelope is M€ 312.6 (e.c.2006).

FLPP Period 2 Step 2 was approved at the 2008 Council at Ministerial level, including two sub-envelopes: (1) System Demonstrators and Technology activities (subscribed by the Czech Republic), (2) Intermediate eXperimental Vehicle for re-entry.