Horizon 2020 Space: towards a programme structure

1. Introduction

Space is one of the fastest growing sectors of the European economy and applications of space are playing an increasingly central role in our society. The effective budget for space research and innovation is expected to increase from approximately 100 M€/year in FP7 (excluding space infrastructure) to 240 M€/year in Horizon 2020. Consultations with space industry and the research community show that there is a need to strengthen the Union level support to space research and innovation activities in order to underpin the growing relevance of the space sector, in line with Article 189 of the TFEU. The planning of the space activities under Horizon 2020 needs to be coordinated with the activities of the member states: the national programmes and activities organised through ESA.

2. Objectives and priorities of Horizon 2020 Space

The overall objective of Space under Horizon 2020 is to prepare for an increasingly pivotal role of space technology in modern society, and to reap the benefits of operational European space infrastructure through European level research and innovation actions. The specific objectives, to which activities funded under Horizon 2020 should contribute, are outlined in the Horizon 2020 Specific Programme:

A) Enable **competitiveness, non-dependence, and innovation** of the European space sector (both industry and research community).

B) Enabling **advances in space technologies**.

C) Enabling **exploitation of space data**.

D) Enable **European RTD in support of international space partnerships**.

Priority should be given to those areas of research and innovation which contribute most to the specific objectives outlined. Annex I details these different areas to be addressed and the contributions made to the respective objectives, under the following headlines:

1) Technology development, in particular out prospective, high risk/high reward space technology research, in-orbit demonstration of new technologies, codevelopment, or spin-in and spin-out between space and non-space technology development;

2) Exploitation of Space data;

3) Research in support of international space partnerships.

3. POTENTIAL STRUCTURE OF SPACE UNDER HORIZON 2020

Consultations of the space community, as well as discussions in Council and Parliament, indicate that **bottom-up, open calls for proposals should remain an important element of Horizon 2020 space**. At the same time there is **also a need for agendadriven lines of space technology development** in the form of sub-programmes. Such multi-annual sub-programmes are key to raise the effectiveness of the Framework Programme and to

- achieve more complex long term goals in space technology development,
- ensure the link between and the progression from early-stage projects into next stage projects,
- prepare for next generation European space programmes,
- strengthen the European position in (future) international partnerships in space exploration,
- allow scientists and engineers to train in the full cycle of space development.

To keep such sub-programmes in the domain of innovative concepts and exploratory testing, the objective should be set in terms of challenging demonstration (potentially inorbit) of new technologies or concepts, and not in terms of operational or scientific mission objectives.

In the special case of sub-programmes in navigation and Earth observation, where technology development is needed in preparation for next generations of Union programmes Galileo and GMES, the approach may be more mission targeted, and could therefore be envisaged to be analogous to ESA mission enabling RTD programmes.

The above objectives and priorities lead to a number of building blocks for Space under Horizon 2020:

a. **Calls for proposals for collaborative projects resulting from annual work programmes.** Similar in approach to Strengthening Space Foundations in FP7, but potentially including a more bottom-up, non-prescriptive element, inspired by Future Emerging Technologies (FET) in the FP7 ICT theme to capture nonconventional visionary RTD.

b. **Strategic Research Clusters (SRC).** For a limited number of themes a multiannual programmatic approach is needed, implemented through a linked set of projects, to achieve a critical mass in the global context and to reach long term goals set for those themes. This approach aligns with the overall Strategic

Programming for Horizon 2020 and the new possibility to develop Multi-annual Work Programmes. As a first orientation, a list of potential topics to be tacked in the form of such SRCs is provided further down in this document. For each of those SRCs a challenging objective to be achieved by 2023 latest, which has the potential to be game changing in the space sector, should be defined. In many cases these objectives are likely to be the demonstration of ground-breaking concepts and technologies on-ground, or in space. A roadmap shall be developed for each SRC, defining a set of projects, and also outlining the best suited programmatic or 'system' approach.

Figure 1 Schematic structure of Horizon 2020 Space

Budget

As a basis for discussions, the following scenario is presented indicatively. A suitable budget split could be 50% for calls based on annual work programmes, and 50% for the agenda-driven part. With the current budget that would mean 700 M€ for the subprogrammes for 7 years. This would allow for 7 thematic sub-programmes of ~100 M€ each in total, with tens of projects each, thereby mobilising enough critical mass to reach a politically appropriate long term goal, i.e. of sufficient complexity and justifiable in an EU Research Framework context.

List of potential SRC Topics

To stimulate further discussions of scenarios, the following topics could be considered for elaboration in a clustered approach.

- **EU Flagship SRC Topics**
  - RTD towards next generation navigation systems
  - RTD towards next generation earth observation systems
- **SSA**
  - Debris mitigation and removal
  - Near Earth Object observation & collision mitigation
- **Space Exploration**
  - Robotic technologies (e.g. including sample handling, vision related concepts, autonomy, interaction between robotic elements, tele-operations)
  - Innovative mission concepts (e.g. cubesat, lander networks)
  - RTD enabling future human exploration (e.g. habitats, life support systems)
- **Cross-cutting**
  - Electric propulsion
  - Highly integrated remote sensing instruments
  - Electronic components
  - Access to space, next generation launcher technologies
  - Access to low Earth-orbit, sub-orbital flight

4. Implementation aspects of Strategic Research Clusters.

The essential elements of each SRC are the agenda-driven nature and the link between different projects, such that the individual projects work in synergy towards the goal specified for that particular theme (Figure 2). To coordinate the various projects, and to provide the system approach required in such a sub-programme, one of the projects, the System Support Activity, should be active for the full duration and will be tasked with developing the roadmap and ensuring that the results from each project are fed into the subsequent projects and eventually into the demonstration project.

Due to the risky nature of research activities, it is however not excluded that SRCs could be merged with others, if duplications or synergies are identified or even stopped at a given stage in the process, if it becomes evident that the long-term objectives cannot be achieved.

Projects in each sub-programme will be Horizon 2020 projects (following standard Rules for Participation), for which calls for proposals/invitation to tender are issued by the European Commission, following the recommendation of the roadmap developed for that particular SRC.

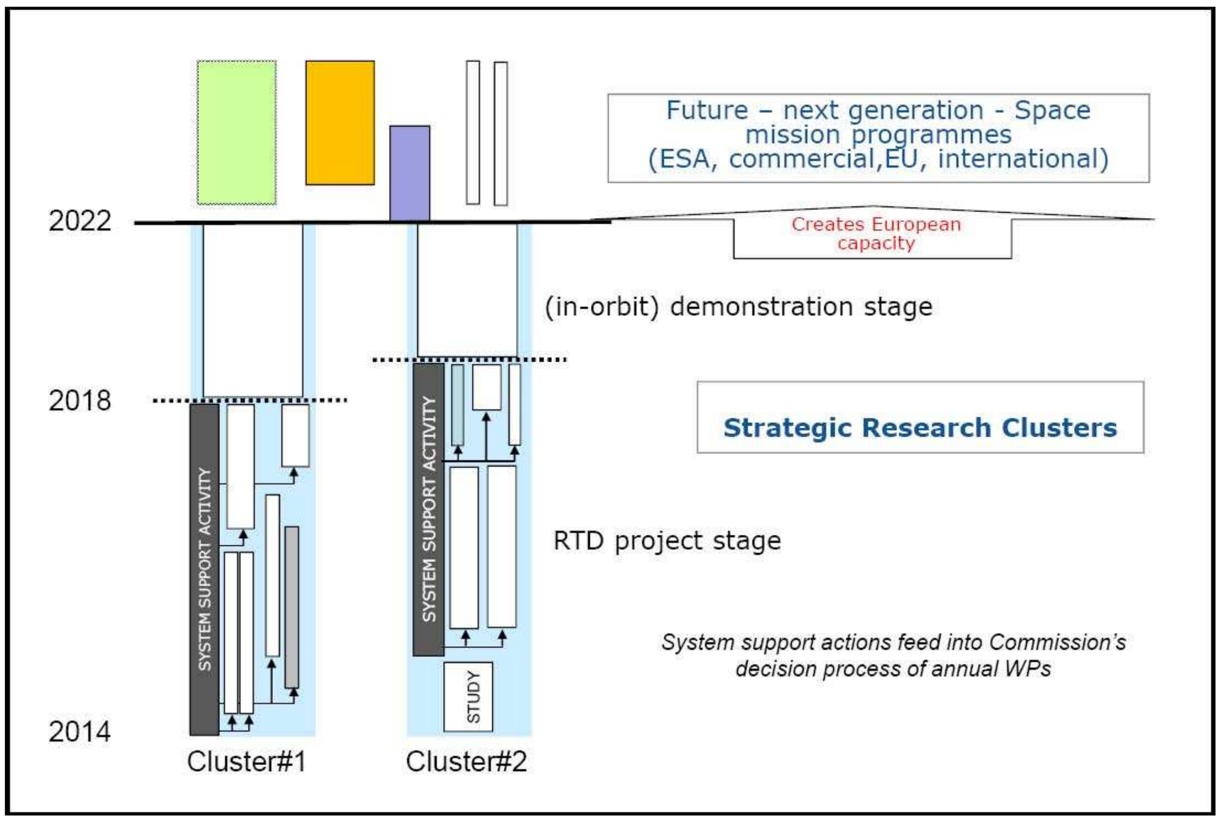

Figure 2 Schematic diagram illustrating the concept of Strategic Research Clusters, consisting of several linked projects.

Two stages can be distinguished: the research and technology development stage, and the demonstration stage. The demonstration stage may in some cases consist of an in-orbit demonstration. The SRCs prepare the ground for ESA, national, EU, or international mission programmes, and equally for commercial missions (e.g. in SatCom, or in entrepreneurial space activities). This implies that Horizon 2020 technology SRC activities target technologies which will be implemented in missions beyond 2020.

In general, the use of grants within the clusters is favoured to be the default implementation mode. Deviations involving other mechanisms could be considered where specific advantages, such as higher leverage can be clearly identified. Mechanisms investigated for their suitability and effectiveness with respect to different SRC topics are:

- Procurement
- Contractual PPPs
- Indirect management
- Reinforced cooperation of Member States.

It should also not be excluded that different funding programmes (national level, ESA) could contribute to the individual projects running in conjunction within a cluster.

ANNEX I

OBJECTIVES AND PRIORITIES OF HORIZON 2020 SPACE

1. TECHNOLOGY DEVELOPMENT (OBJECTIVES A AND B)

In the area of space technology development (Specific objective A and B) the European funding landscape is governed by three actors: Member States, ESA (acting on behalf of its member states), and the Union through FP7. National space RTD programmes vary greatly from country to country in size and scope, and typically may include scientific instrument development, experiments on the ISS, analysis of scientific data from space missions, exploitation of Galileo and GMES services, and technology development for future ESA or national missions. ESA technology development programmes (8% of the total ESA budget) target mission enabling technologies in preparation for ESA missions through procurement contracts, and are therefore focussed on the intermediate Technology Readiness Levels (TRL 4 and 5)[*]. Highest TRL levels are achieved in the actual ESA mission programmes. Consultations[†, ‡] and impact assessment analysis for Horizon 2020 identified a number of gaps in the support to **space technology development and innovation** in Europe.

1) Insufficient opportunities to carry out **prospective, high risk/high reward space technology research**. Today, in the context of ESA/EU missions with a scientific (e.g. astronomy) or service (i.e. Galileo) objective, the acceptable risk has to be limited due to the required operational reliability. This limits the use of innovative technologies and concepts. To achieve major step changes in technological capabilities, and to maintain the competitive edge in the long run (20 years or more) a prior complementary step is required where a high risk, even the risk of failure, is still acceptable. Such disruptive technology research is best achieved in dedicated projects where the private (industry, SMEs) and public sector (universities, technology institutes, national space agencies) can collaborate, also across national borders.

2) **In-orbit demonstration of new technologies** is extremely important for space industry to achieve the stage where components and sub-systems are space qualified. Innovative technologies can subsequently be introduced in commercial or ESA missions with an acceptable risk. This is a crucial step to global competitiveness and non-dependence because it enhances the introduction space components and systems which are of a game changing nature, hitherto not used

* ESA, European Space technology Master Plan, 2011. For reference, TRL2 means the technology concept, TRL4 means the technology validation in the laboratory, TRL9 means flight proven in actual operations.

† FP8 Space Hearing, December 2010, http://ec.europa.eu/enterprise/policies/space/research/hearing_fp8_en.htm

‡ Horizon 2020 public consultations, http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=publicconsultation

in space, and also of second-source components developed for European nondependence reasons.

3) **Co-development, or spin-in and spin-out between space and non-space technology development**. In a number of areas, such as robotics or sustainable use of resources, technology in the space and non-space sector (natural resource industry, or security and defence) is developed along parallel routes, but with limited interaction because of different sources of RTD support. In addition, opportunities for application of space technologies in the terrestrial domain, and the other way around, exist, but are insufficiently pursued. In particular spin-in
(i.e. use of non-space technologies in space programmes) research is needed to reach space qualification of existing technologies in the terrestrial domain, making space more cost effective.

2. EXPLOITATION OF SPACE DATA (OBJECTIVE C)

This area shall support projects and activities aiming at maximising the return from space missions, covering all types of space data and signals, from publicly financed research and analysis to the development of commercial applications. The focus is on the use of data from European missions, including for instance from ISS, ESA science, exploration and Earth Observation missions, and operational missions such as GMES and Galileo. Where appropriate, this may include the use of data from non-European missions (e.g. NASA science missions), often with European instruments on board.

Three types of actions are envisaged:

1) Improving **framework conditions and infrastructure** by cross-national activities which allow users to more efficiently collaborate and access, process and disseminate products based on space data. This will include support to higher-level archives, development of ICT tools for processing and dissemination, calibration and validation activities, and standardisation activities.

2) Support to researchers who generate **scientific results by analysing space data and signals**. Space data is used in very diverse scientific communities, including astronomy, Earth and planetary sciences, climate research, solar weather, astrobiology, and life sciences. This research includes further development of remote sensing methods, analysis of experimental data, research using robotic interfaces, and terrestrial analysis of samples from space.

3) Innovation actions to support the development of **space-derived downstream applications** with commercial or societal relevance. While many mature application domains are covered by the Societal Challenges under Horizon 2020, the space part of Horizon 2020 will support innovative downstream applications in emerging areas where space-derived applications can play a role in the future.

3. RESEARCH IN SUPPORT OF INTERNATIONAL SPACE PARTNERSHIPS (OBJECTIVE D)

Space is one of the research areas where international collaboration is often prevalent. The International Space Station is a prime example for decades of hands-on collaboration between some European countries, the Unites States, Russia, Japan and Canada. But scientific and robotic exploration missions also have an strong international character, with joint missions such as Cassini-Huygens (NASA/ESA) and European instruments on US, Indian or Japanese missions and vice versa. ExoMars, the ESA robotic exploration mission planned for 2018, is likely to be a collaborative project with Russia. It is of strategic importance to Europe to be a relevant and credible partner in such international partnerships and to influence the direction of global space endeavors.

European researchers and industry need to achieve a critical mass and cutting edge expertise in specific domains relevant to such future partnerships. **The actions of Horizon 2020 aim to support European researchers and industry to achieve an excellent starting position for participating in international partnerships and to maintain their participation to the scientific processes and networks concerned.**[§]

[§] While the participation of international partners in H2020 projects is possible in this area, it has to be underlined international partners are not mandatory in these projects.

Currently a number of international coordination mechanisms and partnerships with varying scope are active, or on the horizon:

Earth observation

The **Committee on Earth Observation Satellites (CEOS)** coordinates civil Earth observation missions and programmes. The global coordination of downstream Earth observation activities is carried out by GEOSS, the Global Earth Observation System of Systems. GMES is the European contribution to GEOSS.

Space exploration

The global mechanism for coordination on a technical level for both human and robotic exploration is the **International Space Exploration Coordination Group**, which analyses several international scenarios comprising robotic and manned elements, and further provides a level of coordination of preparatory activities. ESA and many European Space Agencies are part of this group. On a political level the European Commission instigated the High-level International Space Exploration Platform, with a first common declaration after the Lucca Conference in 2011[**].

Space exploration has two elements:

1) **Robotic exploration of the solar system** is regarded as one of the areas where international partnerships are likely to develop in the next years. With ExoMars ESA is taking the first steps in robotic exploration, and is currently seeking the bilateral collaboration with Russia after a failed attempt at collaboration with the US. One of the major global objectives for the next decade is a Mars Sample Return mission, but the Moon and asteroids are equally targets for robotic exploration. Robotic exploration is well suited to a modular, or network type of international collaboration (e.g. a lunar robotic village), rather than single major infrastructure.

2) **Human space flight** pioneered the actual operational international partnership in the form of the ISS, active until 2020. The European contribution to the ISS is managed by an optional ESA programme and national contributions from

[**] The Lucca declaration text.
http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=7040

participating ESA member states. Several ESA member states, for example the UK, have always refrained from participating in human space exploration programmes. Equally, non-ESA Member States of the EU, and most associated states of the EU do not have access through the ESA ISS programme.

Space Situational Awareness

The characterisation of the space environment and its effects on activities in space or on Earth is becoming increasingly important. This includes space weather, man-made or natural space debris, and Near Earth Objects (NEO), asteroids which orbit in the vicinity and might collide with Earth. The global character of the threats to the Earth and in-space assets requires a global approach, or at least international coordination of activities. The defence angle of SSA makes international collaboration a sensitive, but necessary issue. International collaboration is not yet globally coordinated, and is dominated by bi-lateral agreements. The development of an operational SSA service is not within the scope of Horizon 2020, but research activities related to creating the situational awareness are.