SOCIO-ECONOMIC IMPACT ASSESSMENT OF SELECTED ESA TELECOMMUNICATION PARTNERSHIP PROJECTS

BY EUROCONSULT FOR THE EUROPEAN SPACE AGENCY
IN PARTNERSHIP WITH TECHNOPOLIS AND OXFORD ECONOMICS

Executive Summary

May 2019

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1. Introduction

1.1 THE STUDY

In the context of preparing the next ESA Council at Ministerial Level to be held in November 2019 in Seville, the study provides an assessment of the socio-economic impacts either enabled or expected to be enabled by the implementation of a selection of ARTES Partnership Projects, as well as the benefit brought by the Partnership Project scheme.

The scope of the study is a selection of eleven telecommunication space, ground and system partnership activities. These missions are introduced in the table below.

TABLE 1: SELECTED ARTES PARTNERSHIP PROJECTS

PROJECT	CONTRACT YEAR	KEY PARTNERS	OBJECTIVE
ALPHASAT	2007	Airbus FR, TAS FR, Inmarsat	In-orbit validation of the high-power Alphabus platform with L-band payload for Inmarsat and flight opportunities for four advanced technology demonstration payloads
SGEO / HISPASAT 36W-1	2008	OHB, Hispasat	In-orbit validation of the SmallGEO platform with a regenerative payload offering more flexibility for Hispasat
ELECTRA	2013	OHB, SES	In-orbit validation of a full electric propulsion telecommunications satellite of three tonnes by SES that uses the SGEO platform
EDRS	2011	Airbus CIS	New service developed by Airbus using optical ISL on GEO satellites in order to relay the data captured by non-GEO platforms
SPACEBUS NEO	2014	TAS FR	Under the Neosat programme, development of the systems and subsystems for two new European GEO satellite platforms with 30% cost reduction vs. existing Spacebus and Eurostar platforms
EUROSTAR NEO	2014	Airbus FR	
QUANTUM	2015	Airbus UK, Eutelsat	In-orbit validation of a flexible and scalable payload with SDR for Eutelsat loaded on a new small satellite platform
IRIS	2014	Inmarsat	Development of a new satellite-based air-ground communication system for Air Traffic Management (ATM) in partnership with Inmarsat
ECO	2016	Newtec, Avanti	Provision of Wi-Fi hotspots to low-income users in sub-Saharan Africa with Hylas-3 and 4 of Avanti
INDIGO	2015	Newtec, Intelsat	Development of an innovative ground segment (Newtec Dialog modems) to maximise the Intelsat Epic HTS satellites new capabilities
ICE*	2014	Inmarsat	Definition of innovative technologies and approaches to improve the communication capabilities and market reach of Inmarsat's current and future generation of Ka-band and L-band satellite systems and associated services

* ICE Phase 1 was added to the scope of the study following ESA request

1.2 SOCIO-ECONOMIC INDICATOR FRAMEWORK

The table below summarises the economic, technological, strategic and societal indicators which were captured in this study. While the assessment and results of the study do not include the whole of the industry involved in each of the selected Partnership Project, key stakeholders have been considered, including the primes, operators and main subcontractors, accounting in the range of 75-80% of the total ESA funding for the given project.

TABLE 2: LIST OF IMPACT INDICATORS

IMPACT CATEGORY	IMPACT INDICATORS	DESCRIPTION
ECONOMIC	Additional sales Increased product portfolio Signed long-term partnerships	Business opportunities for the project's partners in terms of the total value of sales generated from the project (excl. ESA contract value), new products/services developed and signed LTA
	Jobs maintained Jobs created for the project Jobs created for additional business	Jobs supported by the execution of the projects and the expected additional business
	Gross Value-Added (GVA)	Economic activity supported by the project and the expected additional business
	Government revenues	Taxes (income tax, corporation tax and social security)
TECHNOLOGICAL AND INNOVATION	Technical expertise	Enhancement of the staff's skills and knowledge
	IOD/IOV TRL progression	Technological advancements enabled by the project
	Spin-in Spin-off	Technology transfers enabled by the project
	Increased efficiency	Improvement of internal processes and operations enabled by the project
	Intellectual Property	Filing of new patents
	Technological leadership	Acquisition of a leading position in a given technological area
STRATEGIC	Market share Access to new geographical markets Access to new vertical markets Cost competitiveness International collaborations First mover advantage Brand visibility	Improvement of the industry competitiveness enabled by the project
	European non-dependence	Development of European critical capabilities enabled by the project
SOCIETAL	Scientific knowledge	Publications, citations generated by the project

	Societal value creation	Key social and environmental issues on which the projects have a positive contribution

Societal impacts have been assessed for the projects which have a significant positive contribution to social challenges such as Iris for aviation safety, ECO for the digital divide and access to information or EDRS for supporting safety applications such as emergency services.

1.3 STAKHOLDER CONSULTATION

Critical information was collected through: i) desk data collection and information provided by ESA with the agreement of the projects' partners; ii) an extensive consultation with stakeholders including:

- ESA mission Project Managers;
- Representatives from Member States involved in the projects;
- Key industrial partners, which include the industrial primes, the operators and a selection of sub-contractors involved in the projects.

The consultation process included both an online survey and interviews. The figure below summarises the approach and as well as the participation rates of both steps of data collection.

Thanks to this participation rate there were no data gaps identified in any of the projects considered. The details of the consultation participation are presented in annex of the present report.

FIGURE 1: STAKEHOLDER CONSULTATION

2. Context of the ARTES Partnership Projects

The 1992 ESA Ministerial Council endorsed a long-term plan for combining the Advanced Systems and Technology Programme (ASTP) and the Payload and Spacecraft Development and Experimentation (PSDE) programme in creating ARTES with the following objectives:

- Maintain and improve the capability and competitiveness of the industry of participating countries in the world satellite communications market;
- Contribute to the resolution of problems that affect the European Institutions and the European society at large.

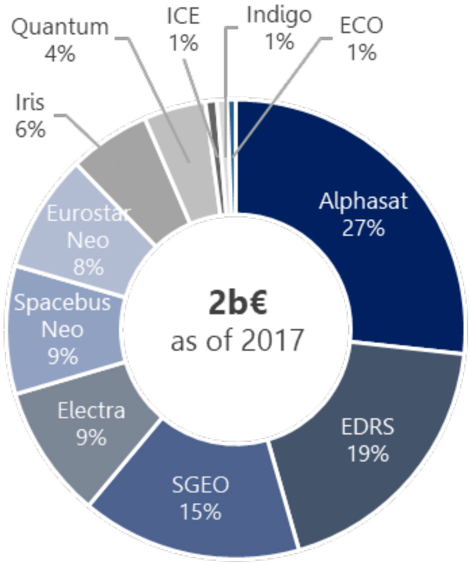
ARTES transforms research and development (R&D) investment into commercial products and services in the worldwide markets. It provides a combination of Generic Envelope Programme elements and Specific Mission/System orientated Programme elements.

2.1 PARTNERSHIP PROJECTS

The Telecommunications and Integrated Applications Directorate (TIA) is ESA's central point for both the design and implementation of the Telecommunication Partnership Projects with the European satcom players. Since Alphasat was kicked-off in 2007, ESA has or is planning to invest about €2 billion in the eleven missions which form the subject of the present study (estimated commitments as of 2017 including both industrial and internal costs).

While the common overarching goal is to support the competitiveness of the European industry on the satcom market, the projects have differences in their contractual scheme. Electra, Quantum, Indigo or ECO are industry-initiated, in which operators and primes come up with innovative products and systems in need of technology developments and commercial flight opportunity (for space systems) before entering the market. The Neosat contracts were signed with the two European primes, with subsequent involvement of operators for the first flights of their respective platforms. Finally, EDRS or Iris are contracts signed with the two operators, in view of a full end-to-end service development (for data relay and Air Traffic Management respectively).

FIGURE 2: ESA INVESTMENT IN THE SELECTED TELECOM PARTNERSHIPS



Source: ESA Note: Investment is Member States' commitments, in mixed economic conditions.

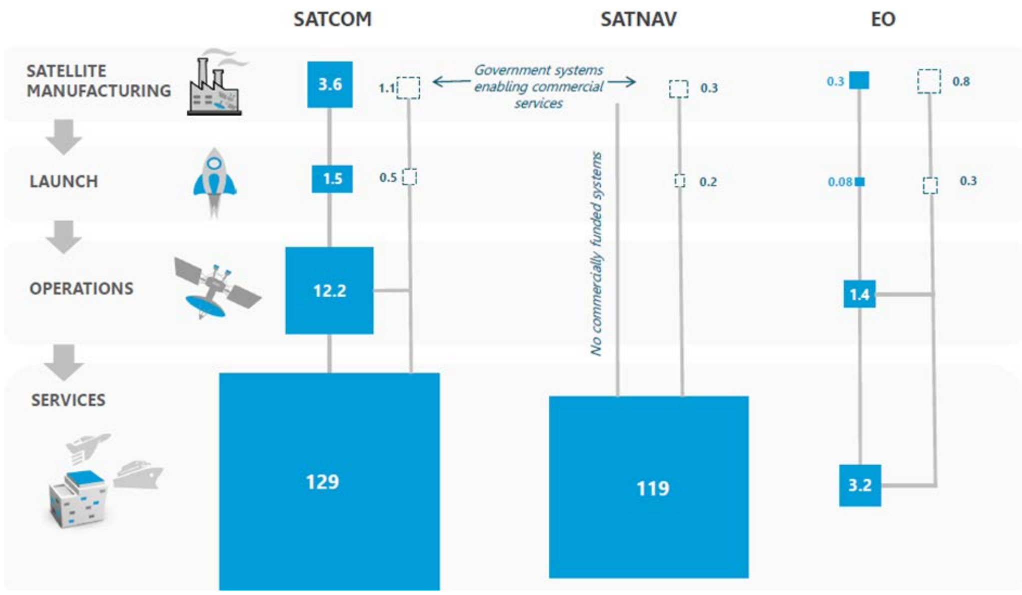
2.2 ECONOMIC CONTEXT

ESA signed the partnership project for Alphasat ten years ago when the satellite communications market was more profitable than today. Many changes have taken place over the past ten years at the four levels of the value chain for commercial satellite communications. The economic and business changes are reviewed below at each level of the value chain.

GEO comsat orders are lower nowadays as satellites are much more capable in terms of Gbps capacity pursuant to market adoption of HTS technology during the decade. With HTS payload technology, satellite productivity has increased tremendously with respect to cost increase. In order to deliver on time, on price and on quality and to maintain their profitability in an increasingly competitive market, the satellite manufacturers target cost reduction and production efficiency through new state of the art production facilities with automation and additive manufacturing, more standardization of satellite hardware and corporate reorganization to maximize synergies in design and production. Over the decade, the comsat manufacturing industry also turned to constellation production with the second generation of Iridium and the first generation of O3b plus the design of the first mega constellation of small satellites for OneWeb. The economies of scale specific to the constellations is currently modifying profoundly satellite design, production and testing with potential benefits for the GEO comsat industry.

Satellite operators are currently adapting to the transformational changes in progress in their markets, i.e. the telecommunications and broadcasting sectors. Most of them have adopted HTS technology as it provides them with more bandwidth at a lower cost per bit for telecom traffic. Indeed, the multiplication of dedicated HTS satellites and of hybrid satellites (combining an HTS payload with a widebeam payload) associated with continuously increasing spectrum efficiency have significantly increase the capacity in GEO and MEO orbit from 0.35 Tbps in 2008 to 2 Tbps in 2017. The surge in HTS capacity reflects the shift in satellite services from broadcasting/video to telecommunications where satellite systems are increasingly used to connect remote areas to the cellular and IP backbones and to provide broadband Internet access to large populations. Over the past ten years, the revenues of the operators have not increased commensurately with the demand for commercial bandwidth. Overcapacity in several regions combined with the strong competition of always more pervasive and capable terrestrial networks has lowered bandwidth price in many markets. In order to safeguard their profit margins, the commercial satellite operators turn to their satellite and launch vendors for always more CAPEX efficient satellite systems.

FIGURE 3: THE COMMERCIAL VALUE CHAIN FOR SATCOM, SATNAV AND EO, 2017



Source: Euroconsult, Satellite Value Chain report, 2018 Edition. Manufacturing and launch revenues estimated from the value of the satellites and launches of the year. Operations and services revenues based on companies' data.

The ground segment market (including user terminals) is going through significant expansion in terms of both capabilities and demand. 2018 has entailed a point of inflexion in the ground segment industry with the preparation of the OneWeb ground network and the launch of additional HTS systems. After some years of market consolidation in the teleport industry for satcom applications, the number of ground sites is tending to stabilize in mature markets and is expected to grow from 2019 driven by new installations in emerging regions. The market on ground segment for satcom applications, is estimated at $221 million, while the satcom user terminals market is valued at $1.9 billion.

Most of the downstream revenues in satellite communications ($129 billion in 2017) are still generated by broadcasting services (85%) that have been the "cash cow" of the commercial geostationary satellite industry for decades. However, the satcom sector is currently experiencing profound transformations with a shift from video and broadcasting to communications services that include:

- Consumer broadband access to the Internet by satellite;
- Enterprise networks using virtual private communications networks over satellite;
- Communications with mobile terminals in the air (aircraft), at sea (vessels) and on the ground;
- Government communications (fixed, on-the-move and on-the-pause).

Each of these telecom markets has specific requirements with respect to satellite connectivity. Low satellite bandwidth and user terminal prices are critical success factors for business growth outside the niche markets where satellite is the only connectivity solution, such as in-flight communications. Future growth in satellite communications services for governments, businesses and consumers is conditional to the availability of more CAPEX efficient satellite systems, i.e. large capacity HTS and adequate user terminals.

2.3 STRATEGIC CONTEXT

The communications satellite market is important for the European space industry as it represents about one quarter of its total consolidated sales of €8.24 billion in 2016[1]. This proportion reflects the large market shares held by the European industry for GEO satellite manufacturing (almost 30% of the world market in the past five years according to Euroconsult[2]). Arianespace is also dominant for launching communications satellites for satellite operators worldwide (48% of the world market in the past five years).

Beyond this economic importance, the communications satellite market is highly qualitative with the European satellite industry now technically on par with the American industry that remains dominant with two prominent manufacturers (Boeing and Maxar). In recent large competitions for highly capable GEO comsat (Inmarsat-F6, GX-5, SES-17, Konnect VHTS), Airbus and Thales Alenia Space proved they can compete with US companies on price and quality. In the satellite propulsion domain, Safran Aircraft Engines and ArianeGroup develop new thrusters that will be used by Boeing for the electric orbit raising (EOR) of the GEO comsat it integrates. With new electric thrusters becoming available, extremely capable satellites (1 Tbps) at less than 6.5 tons of mass will be launched.

The competitiveness of the European GEO comsat industry has been permitted by the technology development support it receives from the European Governments that compensate for the lack of a

[1] *Facts & Figures,* Eurospace, 2017

[2] About 35% when non -GEO comsat are included (O3b and Iridium Next) according to Euroconsult's estimate

large institutional market like in the USA. However, the European industry still lags behind the American industry for space electronic components in terms of price, maturity and/or performance. The gap is primarily due again to lower volume and to lesser institutional support for development and qualification programmes of space-graded components.

The European satellite industry dominates in the constellation domain with the responsibility for the first generation of O3b and of OneWeb. This domination was challenged recently with the order of the second generation of O3b (named mPower) to Boeing. In addition to a highly capable payload for the constellation, Boeing innovated by accepting to pay penalties for late delivery.

The dominance of the world GEO comsat market by the European and American industries has been challenged in the past ten years by the Chinese industry that traded GEO communications satellite system delivered in-orbit for access to natural resources in countries such as Nigeria, Bolivia and Venezuela. Based on that initial experience with captive markets, the Chinese industry has succeeded recently to contract with countries that were previously clients of the Western satellite industry (i.e. Thailand, Indonesia). Not only China increasingly competes internationally for satellite systems, but it also becomes independent from European suppliers for critical payload equipment such as amplifiers.

In addition, the ground segment sector is experiencing accelerated changes, with a continuous stream of innovation transforming the supply of satellite connectivity and associated services. An emblematic example is the development of satellite mega constellations projects which radically change the way ground segment is traditionally conceived. The combination of technology innovation and new competitive dynamics is in turn transforming business models and the relationships between industry players with growing trends towards vertical integration, consolidation and partnerships between historical players and new entrants.

2.4 TECHNOLOGICAL CONTEXT

Communication satellites are built for long but finite lifetimes. Given the large capital invested in sending a satellite into orbit, the industry works continuously to adapt its products to the needs of the its clients, the commercial and government operators, through incremental and disruptive technology changes such as HTS and electric propulsion.

Technology advances in both satellite and ground segments are driven by the needs for more throughput capabilities for given spectrum rights; more flexibility in coverage, power and spectrum allocation; more security of the transmission links. They are discussed in the table below.

TABLE 3: OVERVIEW OF RECENT TECHNICAL ADVANCEMENTS IN THE SATCOM INDUSTRY

SPACE SEGMENT	
HIGH THROUGHPUT SATELLITE	Satellites with high-throughput payloads permitted by multiple spot beams with high-frequency reuse are a major innovation of the Western satellite industry. High Throughput Satellites (HTS) operating in Ka and Ku-bands allow to significantly reduce cost-per-bit for a same amount of spectrum (in comparison to widebeam satellites). Research focuses on increasing the number of beams, reducing their diameter and increasing their flexibility (beyond steerable beams).
DVB-S2X	Since 2004, DVB-S2X is the new DVB-S2 modulation standard (X for extension of DVB-S2) to significantly reduce bandwidth for video backhauling and distribution, IP trunking, cellular backhauling, broadband VSAT and government satellite networks. According to Newtec, it increases the satellite link up to 50% for professional applications.
ELECTRIC PROPULSION	Electric orbit raising is a game changer for the comsat industry as it allows either to significantly reduce launch mass (at same payload performance than a chemically-propelled satellite) or to significantly increase payload capability (large all electric satellites). Research

	focuses on higher performance thrusters in order to reduce the transfer time.
PAYLOAD IMPROVEMENT	More capable digital signal processors (for capacity flexibility, anti-jamming, beam to beam connectivity), solid-sate signal amplification at higher power for higher frequencies, phased array antenna, software-defined radio
IN-ORBIT SERVICE	Development of commercial services starting with life extension for GEO comsat by providing them with station-keeping and de-orbiting. IOS uses different designs (all electric small satellites, large satellite with propellant transfer, space tug).
COTS SMALL GEO	New designs emerge for low cost all digital small GEO comsat through the use of COTS components and less testing/redundancy for reduced lifetime (8 years). The 2-ton all electric satellites would be launched stacked.
GROUND SEGMENT	
NEW USER TERMINALS	New designs in development for electronically-steerable phased array antennas with flat panels to provide on-the-move broadband connectivity and residential broadband access by satellite, whatever the satellite systems are in GEO, MEO or LEO.
MODEMS	Introduction of advanced modulation and coding ("modcod") techniques in satellite modems. Examples include tighter filter rolloffs and adaptive pre-correction for signal transmission, which increase the bandwidth achievable in a channel (thus increasing the scope of the application) or reduce the amount of analog spectrum needed for a given data rate (thus reducing the cost).
HYBRID NETWORKS	Development of hybrid networks combining satellite and terrestrial connectivity, with the widespread introduction of Internet Protocol (IP)-based services and of optical communications. Satellite terminals for IOT ad M2M have to adapt for dual-mode connectivity.
SPECTRUM SHARING TECHNIQUES	Development of 'cognitive satellite communication systems' (CoRaSat), which use spectrum sharing techniques (spectrum sensing, interference modelling, beamforming, interference alignment, cognitive beamhopping) to enhance spectral efficiency and automatically detect and respond to impairments in the transmission channel[3].

[3] Such impairments include Satellite Interference (ASI), Adjacent Channel Interference (ACI) and rain fade, among other.

3. Socio-economic impact assessment

3.1 CONSOLIDATED ECONOMIC IMPACTS

The eleven ARTES Partnership Projects are estimated to generate a total of **€25 billion of Gross Value-added** (the Projects' contribution to GDP) and **€8 billion of government revenues** (taxes) over the full period of analysis (2007-2032) and in the economies of ESA 22 Member States, plus Canada and Slovenia.

The figures below show both the breakdown of total investment, GVA and taxes by project. The total investment considering both public (ESA, and Member States' investment through the national programme) and private (from the primes, operators and subcontractors) funding accounts for a total of €4 billion[4].

[4] The private investment includes both eligible and non-eligible co-funding from the industrial partners. The eligible co-funding is split according to the information provided by ESA and the non-eligible co-funding is allocated to the country of the entity which invested.

FIGURE 4: TOTAL INVESTMENT BY PROJECT

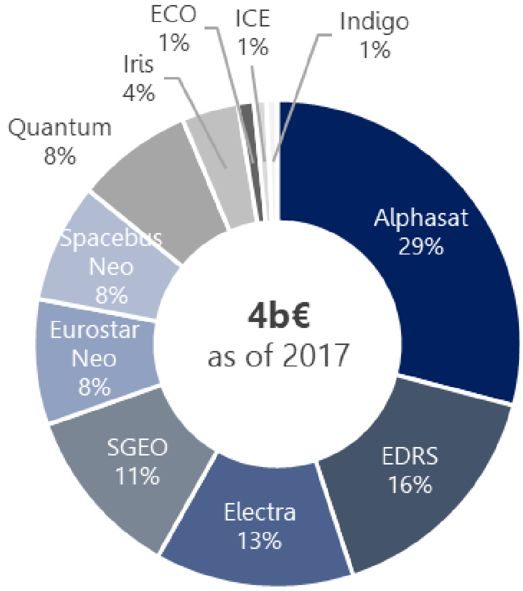


FIGURE 5: TOTAL INVESTMENT BY COUNTRY

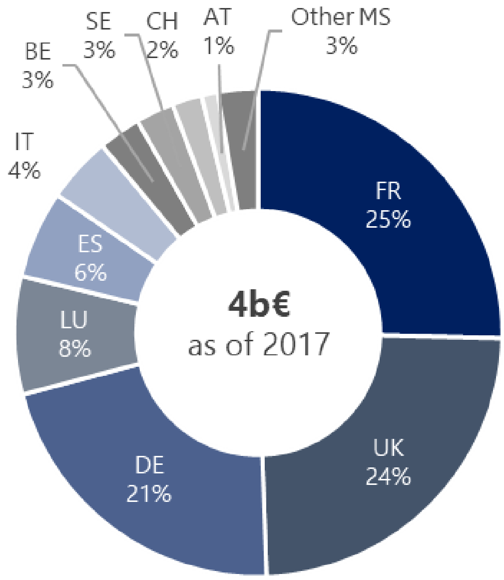


FIGURE 6: TOTAL GVA BY PROJECT

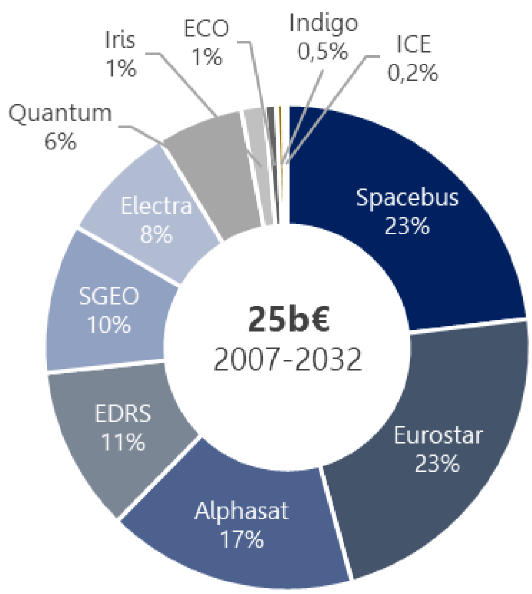
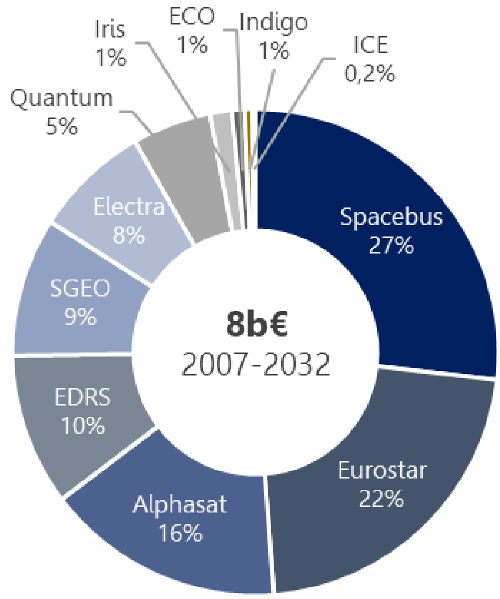


FIGURE 7: TOTAL TAXES BY PROJECT



Source: Collected from consultation, Euroconsult estimates

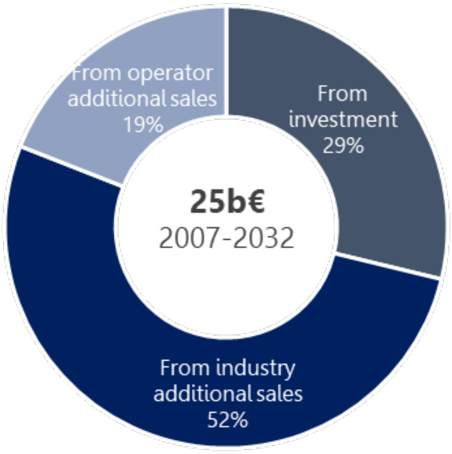
As illustrated in the figure below, the total GVA is estimated to be generated from:

- The investment from ESA, Member States and industry, from which **€7 billion** of GVA are estimated to be generated, representing about one-third of the total GVA (29%);
- The additional sales[5] expected and forecasted by the industrial primes and selected subcontractors, from which **€13 billion** of GVA is estimated to be generated, representing more than half of the total GVA (52%); and
- The additional sales[6] expected and forecasted by the operators, from which **€5 billion** of GVA are estimated to be generated, representing about 20% of the total GVA.

In terms of country distribution, UK, France and Germany account for respectively **31%**, **26%** and **19%** of the total estimated GVA.

[5] Excluding the ESA contracts value
[6] Ibid.

FIGURE 8: TOTAL GVA BY SOURCE



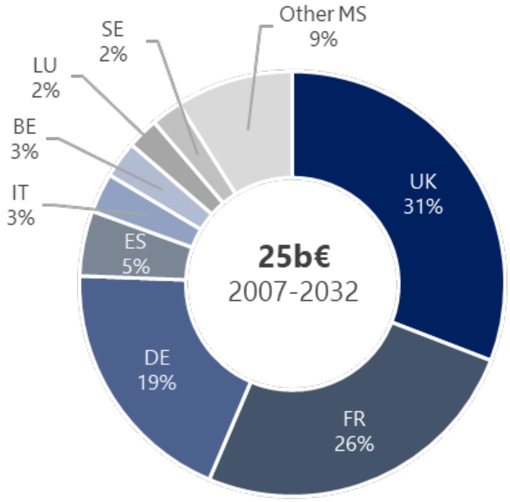


FIGURE 9: TOTAL GVA BY COUNTRY

We have estimated the additional sales generated thanks to the eleven Partnership Projects at a total of **€13.5 billion** for the companies which were consulted. About 44% are generated or expected to be generated by the satellite manufacturers (the primes), 29% from the satellite operators, and the remaining 27% estimated to be generated by the selected subcontractors.

We estimate a total of about **4,600 man-years** supported by the projects, based on the companies' declaration, of which almost 95% by industry (primes and subcontractors) and 5% from the operators.

FIGURE 10: TOTAL ADDITIONAL SALES BY TYPE OF PARTNER

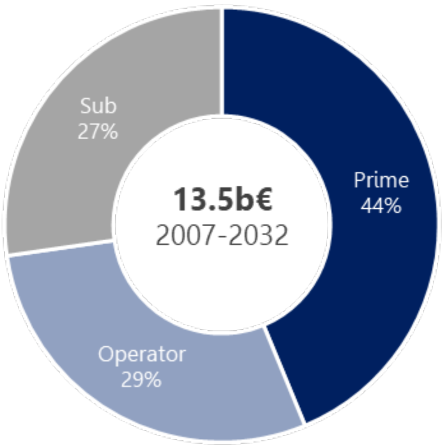
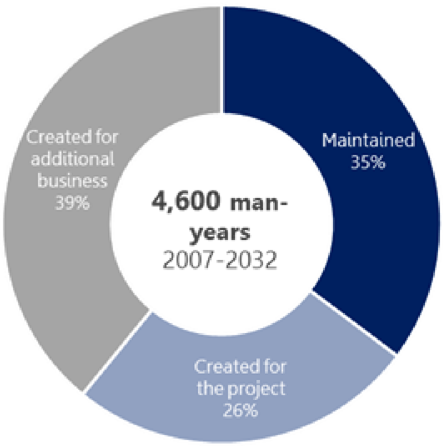


FIGURE 11: TOTAL EMPLOYMENT BY SOURCE



Source: Collected from consultation, Euroconsult estimates

3.2 SUMMARY OF IMPACTS

3.2.1 Key drivers to participate in ARTES Partnership Projects

The charts below present the level of expectations of the main partner companies across a number of key factors to participate in ARTES Partnership projects.

FIGURE 12: SCORING OF EXPECTATIONS FROM INTERVIEWED PARTNERS

Source: Collected from consultation
Note: Scoring of key driving factors from 0 to 3 by all the interviewed partners

While motivations can vary significantly from one project to another and between the partners' role in the projects (prime manufacturers, operators, subcontractors…), the driving factors where stakeholders converge (**technology and product development** and **market opportunities)** reflect well the key objective of the ARTES projects which is to develop new product lines to support the competitiveness of the European industry on the satellite communication market. **Access to additional funding** represents the other key driver for most participants who see ESA as an essential partner to co-fund technologies or products which would be otherwise difficult, if not impossible, to finance.

Five other factors can be of importance case-by-case, depending on the nature of the projects. For instance, **commercial flight opportunities** would be a top driver for the seven space Partnership Projects and insignificant for ground or systems ones. Similarly, **strategic partnerships** will score generally high for subcontractors/SMEs who see in the project an opportunity to develop business relationships in a commercial-like context with other European companies including prime manufacturers and operators.

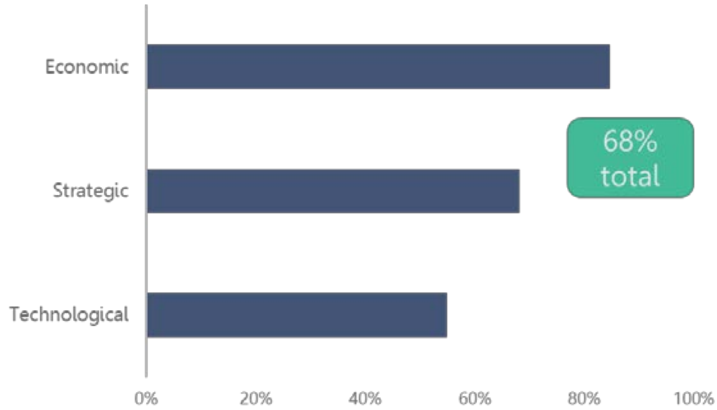
Finally, **service development** ranks low amongst driving factor as it is relevant for specific stakeholders only, i.e. operators essentially. However, it remains an essential component of ARTES Partnership Projects as satellite operators, who are critical partners for these projects, highly regard this element.

3.2.2 Overview of ARTES Partnership Projects Impact

Key partners were asked to score 22 benefit indicators[7] for the eleven ARTES Partnership Projects. For each indicator, a score of 1 has been applied when the company positively reports or expects a benefit, and a score of 0 when no benefit is reported or anticipated. The chart below provides the consolidated view of ESA ARTES Partnership Projects socio-economic impact across all indicators, for all missions and all stakeholders. Scoring results have been normalized in percentage to allow consolidation and comparison.

FIGURE 13: CONSOLIDATED SOCIO-ECONOMIC IMPACT PROFILE
SCORES FOR ALL STAKEHOLDERS ACROSS ALL THE SELECTED PROJECTS

[7] Of the 26 indicators introduced in the socio-economic indicator framework, the GVA, government revenues, scientific knowledge and societal value creation were not scored by the stakeholders.



Source: Collected from consultation

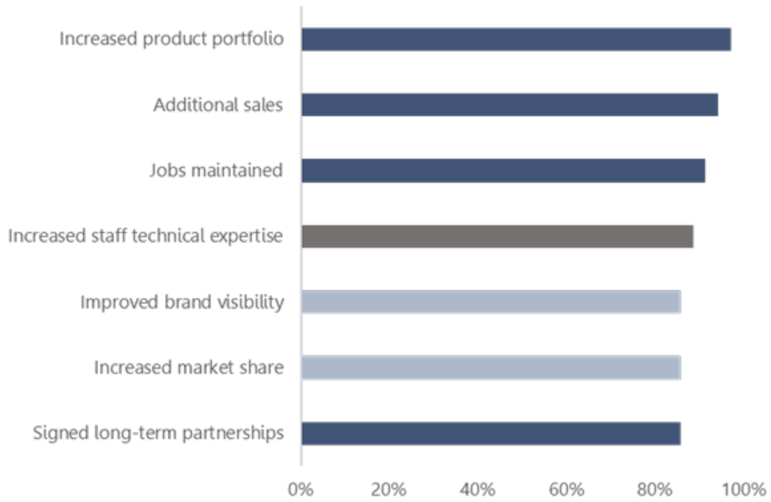
Results given in % of maximum possible total score from participants to the consultation

Economic benefits rank first with a high score of 85%, illustrating that the vast majority of stakeholders reports or anticipates economic benefits from their participation to the missions. This is aligned with the objectives of the ESA ARTES Partnership Projects and with the expectations from these stakeholders when joining the missions. Key drivers for economic benefits include revenue generation, increase of product portfolio and job maintenance. Obviously, the situation of stakeholders varies from one mission to another depending on their commercial outcomes. The top five Partnership Projects in terms of economic benefits (over 90%) are Spacebus Neo, Electra, Indigo, SGEO and EDRS. Alphasat records the lowest score with 58% as the project was marked by strong commercial challenges.

Strategic benefits rank second with a score 68%. In particular, companies report four key enabling effects from Partnership Projects with regard to their market and competitive positioning: increase market share, brand visibility, better cost competitiveness and the ability to address new market segments. Lowest benefit levels are related to first mover advantage (because respondents are often already established market players) and expanding to new geographical markets (as this is not an objective for most of the projects). Perception of strategic benefits vary a lot from one mission to another. Two missions have generated highest strategic benefits to their participants, Eurostar Neo and Eco. For these two missions, strategic benefits rank ahead of economic ones.

Technological benefits rank third with a score of 55%. This apparent lower benefit level can look first surprising, considering that the ESA ARTES Programme, including the Partnership Projects, have for key objective to support R&D in satcom-related technologies, products and solutions. In fact, this score masks important differences between indicators. Companies report very high benefits on essential domains (improved technical expertise and TRL progression, ones of the strongest benefit areas amongst all indicators) while others that are less essential show more limited impacts (such as spin-in/off). The top four Partnership Projects in terms of technical benefits are Quantum, Eco, Spacebus Neo and Ice (60% to 70%).

FIGURE 14: TOP IMPACT INDICATORS ACROSS PROJECTS AND STAKEHOLDERS



Results given in % of maximum possible total score from participants to the consultation

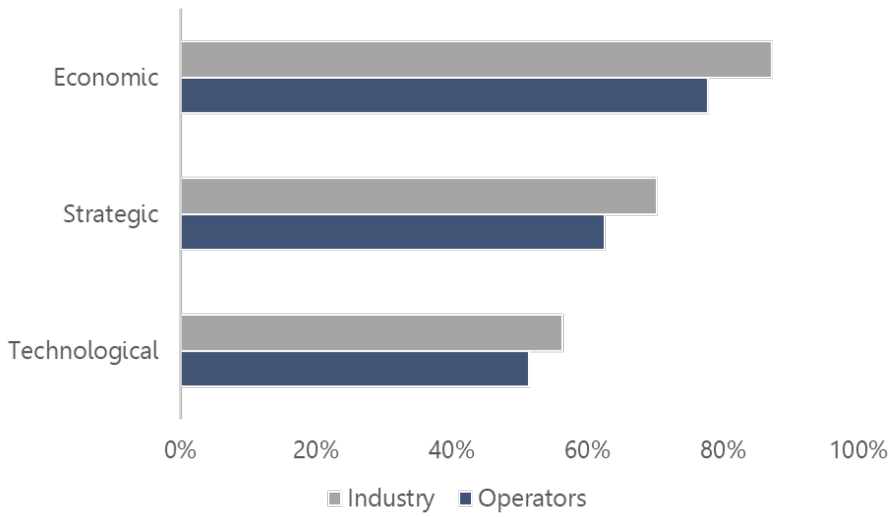
Legend: Economic impacts; Strategic impacts; Technological and innovation impacts

Overall, there is a convergence in the ranking of benefits provided by stakeholders. However, industry partners (prime manufacturers and subcontractors) report slightly higher benefits than operators from their participation to Partnership Projects.

Amongst industry partners, prime manufacturers are those benefitting the most from the projects with a benefit score of 72% compared to 68% for subcontractors. This is logical considering their central role in the projects in terms of definition, execution and subsequent activities. Subcontractors are involved in more specific activities which lead to similarly specific benefit generation. Worth to be noted, technical benefits are where the gap between primes and subcontractors is the most important.

Regarding satellite operators, benefits are specific case by case, according to the projects. Highest benefits are observed when the operator was embarked in the early stage of the mission to maximize the synergies between the technologies/solutions developed and the business case of the operator's mission.

FIGURE 15: IMPACT BY STAKEHOLDER TYPE



Results given in % of maximum possible total score from participants to the consultation

4. Conclusions

4.1 FULFILMENT OF EXPECTATIONS

The consolidated level of expectations achieved at the time of the consultation (summer 2018) across all the interviewed partners and all missions is quite high, with expectations met above 70% for all key driving factors. The hierarchy of expectations met from top to bottom (in the figure below) highlights the socio-economic impact capacity of the Partnership Projects over time, from knowledge generation (staff technical expertise and development of critical capabilities) achieved at the early stage of the missions, to commercial flight and market opportunities which naturally occur at the end of the project lifecycle.

FIGURE 16: FULFILMENT OF PARTNERS' EXPECTATIONS

Source: Collected from consultation

Note: Scoring of key driving factors by all interviewed partners as % of maximum score

The top three expectations are highlighted with a blue shaded line.

Fulfilment of primary drivers to join Partnership Projects vary case by case.

Market opportunities, the second most important driver, rank the lowest among all results with a 70% of fulfilment score across all the interviewed partners and eleven missions Above all, this low score highlights the challenging market conditions associated to the missions, and more generally in the Satcom market currently, or simply the long(er) lead time to fulfil the business case for most innovative services or products developed.

On the contrary, **access to additional funding** shows very high fulfilment along with **doing business with ESA** and **knowledge increase**. Industry scores on these three drivers highlight the fulfilment of ESA's role through the ARTES Partnership Projects in enabling the development of European critical competences and de-risking the projects' partners investment.

Technology and product development is part of the three factors identified by industry as the key drivers for improving their competitiveness on the satcom market, along with cost savings/process efficiency and strategic partnerships. These factors have consolidated scores from 80% to 87% across all missions, demonstrating the capacity of the ARTES Partnership scheme to support industry in achieving competitive leaps. The improvement of competitiveness on the side of the operators is achieved through service development, with expectations fulfilled at a level of 77%.

Finally, the slightly lower score of **commercial flight opportunity**, yet with expectations met at 76% across the primes, operators and subcontractors, reflects the status of a number of missions at the time of the consultation, at which the first flight had not occurred yet (e.g. for the Quantum platform) or was not defined yet (e.g. the signature of the two satcom satellites for the first flight of Eurostar NEO which happened in November).

4.2 LESSONS LEARNED

Risks are intrinsic to the particular scheme of Partnership Projects and ensuring successful risk sharing is a key component of the projects' success. In 50% of cases, partners consider that risks have been anticipated and well managed.

Two risk categories dominate:

- **Programmatic risks** have been underestimated for 80% of the missions (nine over 11) which is essentially related to the difficulty to align a commercial-driven mission with the specific constraints associated to ESA programmes. Typical examples include the impact of dealing with an industry consortium which contains less experienced contractors embarked in the mission. The mission prime is often the most exposed to programmatic risks with important consequences, notably at financial level.
- **Market risks** are also seen often underestimated (the case in six missions), which can be related to an inadequate anticipation of market evolutions or a shortfall in the strategy to address the market. This is viewed as a major issue considering that Partnership Projects aim at supporting market opportunities for industry partners. it shall be noted that this is the risk area where ESA exercises limited influence.

While Partnership Projects embark inherent technical risks, they are considered very well anticipated (only two projects where this was an issue) thanks to the experience of industry partners in related technologies, and the presence of ESA in the mission who provides supports with its own experts.

Financial risks are often a consequence of the other three (e.g. a delay in the project leading to additional costs). They are reported in a minority of cases. Member States report most of concerns regarding financial risks, considering the budget envelop they may commit in a single mission. More flexibility in the mission development would be welcomed to limit these risks, like for instance preliminary validation of the mission (and the associated business model) before the project is fully committed.

FIGURE 17: NUMBER OF MISSIONS WITH UNDERESTIMATED RISKS

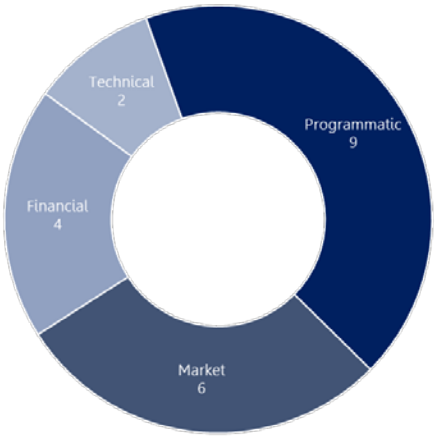
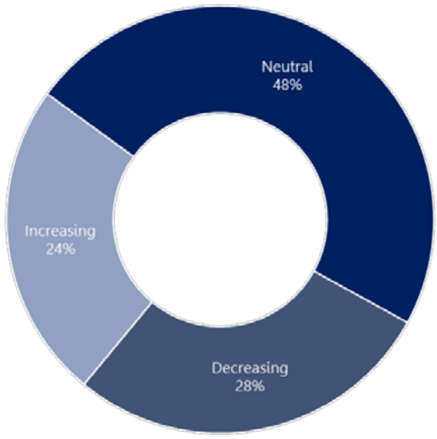


FIGURE 18: IMPACT OF PARTNERSHIP PROJECTS SCHEME ON RISKS



Partnership Projects do not increase the risk profile of the mission: in 76% of the cases, they either have no impact or even de-risk the mission. Typical positive impacts of the Partnership scheme include a greater risk sharing as ESA and its partners would not be in position to cover all risks alone. Partnership Projects also put more pressure on partners than a traditional ESA mission and encourage trade-offs to reach solutions and focus on technological development while taking into consideration commercial constraints of the mission.

In some cases, however, this scheme may increase mission's risks. This is typically related to the programmatic aspects of the mission and the difficulty to accommodate ESA processes and constraints which are not always agile enough for a commercial-like environment. In addition, in most cases Partnership Projects rely on the cooperation between three partners (ESA, the prime manufacturer and the operator) but balancing those interests can prove challenging.

4.3 TAKEAWAYS

The following high-level takeaways can be drawn from the assessment of Partnership Projects:

- ARTES Partnership Projects have generated **strong economic benefits**. This is aligned with the rationale of the projects and with the expectations from stakeholders when joining the missions.
- Overall, stakeholders report **very high benefits on most critical economic, technologic and strategic factors**. Lowest impacts are reported on areas of lower importance.
- Partnership Projects enable **greater risk sharing** and positive trade-offs between technological development and commercial constraints of the mission.
- Stakeholders' key **recommendations** for better efficiency: ESA processes shall be **more agile** for a commercial-like environment, and participating stakeholders must **align their interests** at the start of the mission.
- The analysis by mission has shown that **benefit generation has improved over time** as ESA and its partners got more experience and were able to take into account lessons learned from one project to another.