

IAC-15-B5.2.2

INTEGRATED APPLICATIONS FOR THE EXPLOITATION OF SPACE SOLUTIONS TO RESPOND TO LOCAL, NATIONAL AND GLOBAL NEEDS: AN OVERVIEW ON THE ITALIAN PERSPECTIVE FROM THE ASI ACTIVITIES DRIVEN IN THE ARTES APPLICATIONS ENVIRONMENT.

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The Italian experience of Integrated Application activities as driven by the Italian Space Agency (ASI) in the ARTES (Advanced Research in Telecommunications Systems) Programme of the European Space Agency (ESA) environment is here discussed. The aim of ARTES is to transform research and development investment into successful commercial product. It also responds to the strategic goal of ASI of development of technologies in space telecommunications, both in its space and terrestrial elements, including the technologies for integrating space resources with the new generation of terrestrial networks. Since 2008 ASI supports projects within the ARTES Applications Programme (ARTES 3-4 Satcom Applications and ARTES 20 Integrated Applications Promotion) which is dedicated to the development, implementation and validation of a wide range of innovative applications and services. In the last years, ASI has selected and financially supported the Italian Applications projects, covering a wide range of domains, like disaster/crisis monitoring and management, energy, food security, space situational awareness, transportation, health. They capitalize on the synergies between different data sources to provide the right information, in the right place, at the right time to the right user in a cost-effective manner. A relevant part of the activities are supported by ASI - Industries/SMEs/academia, in a public-private partnership in a cost effective way. Following the ARTES project development guidelines, the innovation and sustainability of the solutions reached so far show a very high level of positive socio-economic impacts. The paper will provide an assessment of the key aspects that affect the outcomes of these applications projects and suggest a methodology to be taken into account to maximize the chance of successes.

I. INTRODUCTION

Since 2008 ASI supports the Advanced Research on Telecommunication Satellite Systems (ARTES) Programme, an Optional Programme of ESA, conceived to *enable European and Canadian industry to explore, through research and development (R&D) activities, innovative concepts to produce leading-edge Satcom products and services*[1]: it responds to some of the ASI strategic goals[2] to *develop technologies in space telecommunications, both in its space and terrestrial element but also to maintain and strengthen scientific knowledge through the development and the launch of key scientific instruments and analysis of the data they provide*. The objectives of the ARTES Applications Programme are to enhance the competitiveness on Research Development and Innovation of Satcom services and to support the economy growth, contributing to the resolution of problems that affect the European Institutions and the European society in general. This ESA Programme aims to integrate the existing space infrastructure establishing partnership between different size enterprises with a different background, research institutes/universities to fit customer's necessities with sustainable services. The ARTES Applications projects are thought to involve directly stakeholders or potential final users in the creation of these services, perfectly designed on their requirements, then establishing new markets of services better addressed to meet the real user needs. This new philosophy to develop successful products attracts inevitably the investors' interests, supporting the economic growth, stimulating scientific research and technological innovation and encouraging space investments/new Missions, promoting a local-national-global culture of awareness and involvement in space.

II. THE ASI-INDUSTRIAL/SME/ACADEMIA SYNERGIES CAPITALIZATION

The availability of the extraordinary amount of information/data/functions currently obtained by the principal space assets of Satcom, SatEO, Satnav, by decades of public-private investments opens new scenarios on the opportunity to develop services for a large reward in terms of benefits for citizen and society. The commitments to develop Satcom services and Integrated Applications between space and ground assets can stimulate the inception and the growth of new markets. ARTES initiatives are part of this context working as a positive economic driver to trigger the socio-economic recovery with a role on creation of new market opportunities and determining a technical-cultural change in the solution approach for emerging needs of civil societies. At national level, ARTES Applications activities, by settling/stimulating strong interactions among all the actors, represent an opportunity for ASI to create synergies between its institutional role and space economic players (industry-SME-academia). Relevant in this sense is the fact that ASI, Industries, SMEs and Research Institutes/Universities support them in a public-private partnership (with an economic commitment of 50%) in a cost effective way. The wide range of domains of the Italian ARTES Applications projects is a first way to capitalize on the synergies among these different actors, to obtain as much is possible services integrating data sources to provide the right information, in the right place, at the right time to the right user in a cost-effective manner.

ASI is also interested to promote the Integrated Applications among economic actors, traditionally not involved in the space economy, helping to overcome the initial difficulties in their insertion in this sector: the opening Integrate Applications market is potentially huge and its dimensions are strictly linked to the bringers of original, innovative and disruptive solutions. The partial independency from the degree of industrial development in specific Regions on the National territory is a strong point. Italian Regions historically disadvantaged in terms of industrial activities and penalized in the socio-economic aspects have through the Space Integrated Applications and Satcom services the same opportunities to develop their economy than others Regions. Some successful ideas of Integrated Applications have as main users typically these Regions, with projects for services enabling to better preserve and economically valorize their territory: this is the right direction to elaborate new models of economic development with a low environmental impact. Italy, with its extremely fragile environment, is very sensitive to these solutions. The developed services benefit Italian citizens as well as institutional users, while providing new opportunities for businesses spanning the spectrum from startups.

ASI at the present time is working to set an Italian Ambassador Platform to assure a stronger interaction with National economic-industrial actors.

III. ITALIAN ARTES APPLICATION PROJECTS

The ARTES 20 and ARTES 3-4 Applications Elements are part of ARTES Application Programme, they are focused on the development, implementation and validation of a wide range of innovative applications and services.

ARTES 20 is dedicated to the Integrated Applications and it is also called ARTES Integrated Applications Promotion (IAP) programme, involving at least two space assets among Satcom, SatEO and Satnav, together with other ground assets to develop sustainable services for the citizen needs.

ARTES 3-4 is an ARTES Element for the development of Satellite Communications products/services applications, generally driven by the industries: its section ARTES 3-4 Applications, also called Satcom Apps, is focused on services.

The applications realized in the above mentioned elements of the ARTES programme are implemented mainly in two phases, a feasibility study and a demonstration project.

The Italian bidder industries/SMEs/academia (or a consortium of them) can submit the outline proposals simultaneously to ASI and ESA which evaluate the project and generally suggest improvement or changes. After a certain number of interactions among bidder-ESA-ASI, depending mainly on the maturity of the project, the proposal converges toward a final form fitting the ASI-ESA requests. These requests are strongly linked to the necessity to design a successful project, maximizing the return of investment, its potentiality exploitation and fitting the strategic interests of ASI.

In about 6 years of activities (2009 to the present time), ASI has selected and financially supported projects covering a wide range of domains, like disaster/crisis monitoring and management, energy, food security, space situational awareness, transportation, health. In Figure 1 is shown the case of ARTES 3-4 Apps projects and in Figure 2 the ARTES 20 projects.

The total number of the Italian projects for ARTES 3-4 Apps is 11 and 24 for ARTES 20. Some ARTES Apps projects are performed only as feasibility study, others only as demonstration projects but for many of them the demonstration project followed the feasibility study. The feasibility studies last 12 months on average and the demonstration projects about 30 months (for both ARTES 3-4 and ARTES 20).

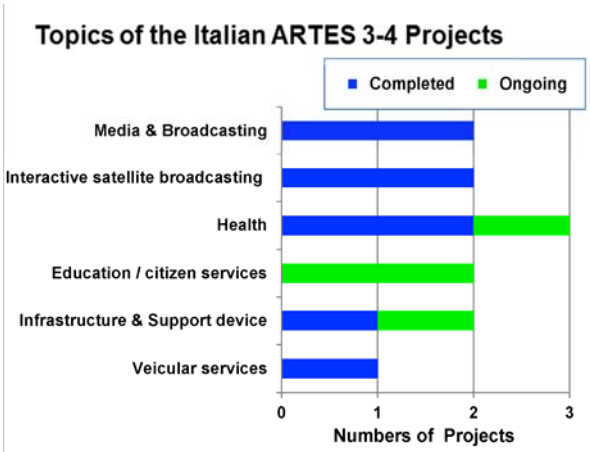

Fig. 1: Numbers of the completed and ongoing Italian ARTES 3-4 Applications projects on specific topics. Many Italian ongoing projects are in the demonstration phase.

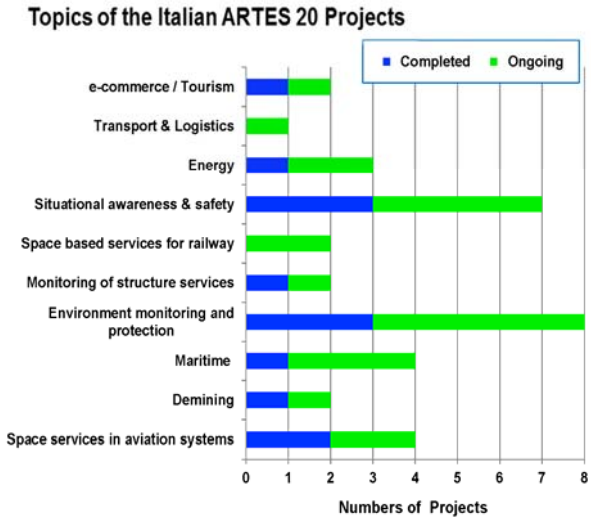

Fig. 2: Numbers of the completed and ongoing Italian ARTES 20 projects on specific topics. Many Italian ongoing projects are in the demonstration phase.

The natural attitude of ARTES Applications to encourage the constitution of consortia, distributing opportunely the work tasks, is confirmed also for the Italian case, registering the predominant presence of consortia among the bidders. Generally an enterprise of large-medium size already involved in the space takes advantage of Research Institutes/University teams and SMEs cooperation. Globally, the Italian case shows for ARTES 20 a total of 53 Companies among industries, SMEs and Research Institutes/Universities, ARTES 3-4 a total of 22.

The Figure 3 shows the distribution in number and kind of the Italian players: for ARTES 3-4 industries are 11 (50%), SMEs are 5 (23%), academia are 6 (26%); for ARTES 20 industries are 29 (54%), SMEs are 18 (34%), academia are 6 (12%).

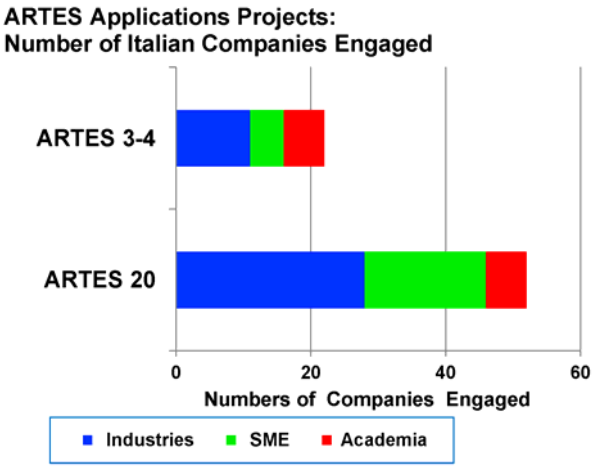

Fig. 3: Number and kind of players of the Italian companies engaged in the ARTES Applications projects.

The Italian projects completed were judged by ESA of quality in line with the average level of the global European experiences[3]. In particular, about the 36% of Italian projects were considered at a level of *commercial services* (fully successful cases), 18% at a level of *operational cases* and 20% as *seed* cases (partially successful cases). Only a percentage of 26% has been considered with *no follow-on*. Even if this statistic is obtained on a limited number of cases, the general trend is very encouraging and it is an incentive to study with attention the key elements driving the project success: ESA-TIA (Telecommunication and Integrated Application) is working on it, obtaining interesting results through the elaboration of conceptual instruments to better drive and potentiate its commitment in the ARTES activities.

IV. INDICATORS OF SOCIO-ECONOMIC IMPACT

To reach the objective to deliver of an operational service supported by a sustainable business model, ESA-TIA developed a methodology for assessing socio-economic benefits, starting from its experience on the

ARTES projects results. Following this methodology they have identified five binary Key Performance Indicators (KPI) strongly influencing to the commercial success; "*they mostly relate to user acceptance, technical quality, motivation of stakeholders and ability to generate revenues during the demonstration phase*" [4]. These guidelines are being used by ESA-TIA to guide and assist on-going projects to forestall the success rates at least as good as those before observed.

Linked to the KPIs are been inferred the Indicators of socio-economic impact, ten indicators to be assessed to each project, these are[5]:

1. ***Revenues*** *(absolute and compared to the ESA co-funding).*
2. ***Exports*** *(proportion of revenue outside the home country and outside the EU).*
3. ***Jobs*** *(created or sustained as a result of the project).*
4. ***Investment leverage*** *(total 3rd party investment in term of equity, debt, grant, public funds or M&A following on from the ARTES project, as compared to the ESA co-founding).*
5. ***Extent of the value chain*** *(number of business relationship including consortium partners, suppliers, distributors etc.).*
6. ***Addressable market size*** *(in terms of potential financial value).*
7. ***Increase in the ratio of R&D spend to revenue*** *(a positive indicator is that both the ratio and revenue increase).*
8. ***Value creation*** *(for the users).*
9. ***Social benefits*** *(quantifiable but non-financial).*
10. ***Innovation impacts*** *(e.g. market disruption and patents).*

These indicators define strong constraints driving to the success and are now used to direct the projects to be compliant with them. The KPIs and the socio-economic indicators are used by ESA during all the project phases: from the proposal project acceptance, during the project evolution, to the service finalization.

ESA-TIA considers the elaboration of KPIs and socio-economic indicators a work in progress, upgrading its statistic continuously on the very large set of the ongoing projects.

At the same time, changing perspective but always based on these results, with the aim to treasure the KPIs and socio-economic indicators lesson, these indicators could be used backwards to individuate criteria to make decisions on proposals which have to begin successful projects: this is the ASI-TIA perspective.

V. CRITERIA TO MAXIMIZE THE CHANCE OF SUCCESS

Application to ARTES 3-4 and ARTES 20 is open to the bidders and there is not a limit at this time in the number of the applicable projects that can be submitted to ASI.

In the ARTES context, the role of ASI is to evaluate the real Italian interest/profitability/strategic value of the submitted projects and, in positive cases, support them. These initial project steps are very dynamic and in this phase the bidders meet ASI to present its project: from the service ideas, the potential users, the presence of stakeholder in the consortia, the project costs, the kind of work and the company/consortium expertises to goal it, etc. This is the phase in which ASI can really promote synergy between its space interests/activities and the interests of the industries/SMEs/academia, better driving the bidders choices and supporting adequately their efforts. The main problem is take the right decision maximizing the chance of success of these projects: it means make a good investment for the Italian System, in economic terms but also in cultural and know-how terms, stimulating the positive energy inside the Italian society.

For this purpose, during the last year, inspired by the ESA-TIA work on the KPIs and socio-economic impact indicators, ASI decided to take advantage of ESA results on the successful cases harmonizing ASI criteria to pre-evaluate the ARTES proposals. Helped by ESA-TIA, ASI developed a methodology taking into account parameters coming directly from the ESA-KPIs and linked to the potentiality of the proposed services to be compliant with the socio-economic impact indicators.

To these parameters are associated opportune weights, studied to obtain an appropriate balance among them, with the aim to have a more detailed process to attribute an evaluation as is possible objective and documented. These new criteria have been defined for ARTES 3-4 Applications and ARTES 20.

The methodology considers first of all the proposals compliance with ARTES 3-4 Applications criteria and ARTES IAP (Integrated Application Promotion) criteria, mandatory criteria representing a Boolean variable **b** [0;1] for which the no-compliance meaning a zero in the final global score, **g**, then, the evaluation methodology considers the following parameters:

1. ***Suitability (Strategic Vision)****:*
   - *1.1.* User benefit.
   - *1.2.* Coherence with ASI strategies.

2. ***Suitability (Technical aspects)****:*
   - *2.1.* Innovation of the service.
   - *2.2.* Cross-fertilization between different disciplines/technologies.

3. ***User/stakeholder Involvement**:*
   - *3.1.* Presence of stakeholder(s)/customer(s)/user(s) within the consortium *(evidence via formal written statement in the proposal)* and their participations specified in terms of assigned projects tasks, technical roles and interests*;*
   - *3.2.* User(s) needs consolidation*.*

4. ***Key Technical Aspects**:*
   - *4.1.* Clarity and completeness of system architecture and supported services*.*
   - 4.2. Technological maturity … *(for FS proposal: " … of the space assets used"; for DM proposal: "… for all key elements").*
   - *4.3.* Consortium expertise and/or experience on the addressed solution and service provision*.*

5. ***Sustainability Potential**:*
   - *5.1.* Market share projection and commercial opportunity for the service*.*
   - *5.2.* Competitive position analysis *(e.g. SWOT).*
   - *5.3.* Adequacy of Financial Planning *(assumptions, indicators).*

6. ***Adequacy of Programmatic Aspects & Costs**:*
   - *6.1.* Adequacy of cost elements and value for money.
   - *6.2.* Adequacy of the implementation approach *(starting point, heritage, development approach, timing).*
   - *6.3.* Partnership and market introduction plan*.*

Appropriate weights, $w_{i,j}$, are defined for each parameter, $p_{i,j}$, depending the case of "feasibility" project or "demonstration" project. The score, $s_{i,j}$, for each $p_{i,j}$, is attributed on a scale from 0 to 4 meaning:
4 = perfect, 3 = good, 2 = medium, 1 = low,
0 = not present, not good or insufficient.

The operative evaluation for each macro parameter p_i is obtained as:

$$r = r_1+r_2+r_3+r_4+r_5+r_5+r_6 = \Sigma_{i,j} \ (p_{i,j} * s_{i,j}) \qquad [1]$$

The global evaluation of the proposal, **g** , is:

$$\mathbf{g} = \mathbf{b} * (r/r_{max}) \qquad [2]$$

where

$$r_{max} = \Sigma_{i,j} \ (w_{i,j} * 4) \qquad [3]$$

correspond to the maximum score, 4, for each parameter, so that $\mathbf{g} \in \Re\{0;1\}$.

For the proposal acceptance its $\mathbf{g} > 0.6$.

This methodology and the definition of parameters and values associated to their weights is considered by ASI a work in progress, anyway the results obtained in about a year are encouraging: its use has allowed a faster and harmonized evaluation process, where all cases can be well documented.

VI. CONCLUSIONS

ASI is implementing in the framework of ARTES Applications Programme a certain number of activities to make System among local-Regional-National-global resources capitalizing synergy through a strong interaction of ASI/industries/SMEs/academia. The well documented positive results obtained in the concluded and ongoing projects in ARTES Applications Programme provided ESA with a large set of information on the successful cases. These information was used by ESA to extract conceptual key elements on the project successful factors and on the socio-economic impacts of the services provided/investment done. ASI treasure these ESA results to better perform its work elaborating, helped by ESA, criteria to pre-evaluate the proposals in a faster and harmonized process, well detailed and documented.

ACKNOWLEDGMENTS

The Authors acknowledge all ESA-TIA team for their kind collaboration, specially they desire to thank Amon Ginati, Head of ESA-TIA, Francesco Feliciani, Head of Commercial Application Demonstration Projects of ESA-TIA, Dietmar Schmitt, Head of ESA Technologies and Products Division, and Antonio Sposito, ASI Advisor for the ARTES Programme for their precious suggestions.

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[2] ASI Strategic Vision 2010-2020, ASI, http://www.asi.it/sites/default/files/ASI_DVS_2010_2020_ENG_0_0.pdf
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[4] Socio-Economic Impact of the ARTES Applications Programmes, pg.5, ESA-TIAA-WP-2014-0362.
[5] Socio-Economic Impact of the ARTES Applications Programmes, pg.8, ESA-TIAA-WP-2014-0362.