ESA STUDY CONTRACT REPORT

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Executive summary

ABSTRACT:

This report concisely describes the findings of the study Finnish technological capacities with regard to ESA opportunities. An analysis of the past and current space technology activities in Finland has been performed to identify structural weaknesses and strengths. Furthermore, a study has been made of the current technology developments in Finland that have led to a list of potential new space technology products that could contribute to the ESA mandatory programmes. Finally, a list of recommendations to improve the Finnish participation to the ESA programmes has been produced.

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ACRONYMS

ALD	Atomic Layer Deposition
ESA	European Space Agency
ESTEC	European Space Research and Technology Centre
GNP	Gross National Product
GSP	General Studies Programme
IR	Infra-red
ITI	Innovative Triangle Initiative
GSTP	General Support Technology Programme
MBO	Management buyout
R&D	Research and Development
SME	Small and Medium-sized Enterprise
SoW	Statement of Work
TN	Technical Note
TRL	Technology Readiness Level
TRP	Technology Research Programme
UV	Ultra-Violet

1. INTRODUCTION

During the last years, the geographical return coefficient of Finland in ESA programmes was below unity on a recurring basis. Thanks to significant efforts, this situation was finally corrected at the moment of the geographical return discontinuation, end 2014.

In the frame of an updated policy instrument called Observatory of Critical Countries, which aims at preventing that such a situation prevails again in the future, with an emphasis on how to develop structural effects and competitiveness, the Agency is engaged in an analysis which will:
- look for potential structural reasons which could lead again to the same difficulties
- analyse future procurements of the Agency to measure the degree to which they would provide sufficient business opportunities to Finnish research institutes or industrial companies, so that Finland reach a proper geographical return coefficient,
- identify, when needed, options and plan of actions, to significantly secure the geographical return coefficient of Finland over time.

An analysis of the on-going development of Finnish technological capacities, with regards to the technology needs of the Agency is required in this context, with the aim of identifying new potential performers, with opportunities of being sustainable industries in space, which could be activated to become new players into space business, to extend the ESA related industrial base of Finland, and

therefore improving/facilitating the geographical return achievement of Finland, and developing commercial business in space and non-space sectors.

The objective of this activity is to analyse the on-going development of Finnish technological capacities, with regards to the ESA technology needs and to provide recommendations.

2. OVERVIEW OF FINDINGS IN WORK PACKAGES 3-5

2.1. Statistics of past activities

The contracts with Finnish companies during the last ten years (from the start of 2006 – to the first quarter of 2016) have been analysed. During this period there were about 172 contracts placed in the frame of the mandatory programmes for an amount of 48.8 M€ and about 279 contracts placed in the frame of optional programmes for an amount of about 82 M€. It can be noted that more than 50% of the contracts were placed with research institutes although they account for only slightly more than 25% of the total value. It can also be noted that Ruag Space Finland Oy collected about a third of the total contract values during this period and the top 4 companies (i.e., RUAG Space Finland Oy, Space Systems Finland, VTT/Millilab Oy, and DA-Design) collected about 3 quarter of the total contract value.

2.2. Analysis of the past and present involvement in ESA technologies

The most active Finnish companies in space industry have their origin already from the time when Finland was not yet a member of ESA, but Finland had co-operation agreement with the Soviet Union.

When Finland joined ESA in 1995, companies turned their activity to ESA and at the same time the activity to East ceased after dissolution of the Soviet Union. Those companies are SSF (Space System Finland), Ruag Space Finland (earlier Patria), DA Design/Space (earlier Ylinen Electronics) and Oxford Instrument (earlier Metorex, Outokumpu). It took rather a long time to turn the activity from nationally funded projects to ESA funded projects and to commercial business.

The current situation in Finland is that all ESA suppliers are small companies. Some are small subsidiaries of big foreign companies. It seems that large companies are reluctant to do space business in Finland even when they have relevant technology. Nokia for instance was strong in RF technology, antennas etc. but never bid in ESA tenders.

A brief analysis of the status of the most active Finnish companies is given below.

RUAG Space Finland Oy was earlier the space department of Patria company. It is now owned by the Swiss space company RUAG. One can expect that its turnover will grow.

Space System Finland Oy (SSF Oy) is growing fast after applying its technology developed in space projects to other industrial applications. The company is also fully competitive in space applications. However, the number of space contracts of the company is slowly growing.

DA-Design Oy is specialized in RF technology. DA-design is one of three companies in Finland capable to bid for primes and ESA contracts regularly. Their business volume is slowly rising.

Harp Technologies Oy is growing in RF technology applications. Harp Technology is also looking contracts outside space business to keep the business volume steady.

Oxford Instruments Analytical (OIA) is interested to work in space programmes. Its business is not dependent on space contracts. OIA's detector technology, however, has strong contribution from earlier space activities. Currently OIA does not have any special space project team.

ASRO - Aboa Space Research Oy has developed technology for particle detection technology.

HS Foils Oy has been founded on the basis of developments in ESA ITI projects. Originally the only product was the ultrathin window for x-rays. The company has now growing industrial markets in windows.

Modulight Oy developed laser technology for satellite communication. Continuous business with ESA, however, was not followed. Modulight's main business is now in laser technology for medical industry.

Iceye Oy develops CubeSat satellites with SAR capability. The company would be willing to work with ESA but up to now ESA does not have a clear policy in small satellites.

Reactor Space Lab Oy is also in CubeSat satellite business. The company plans its main business in the domain of services.

A questionnaire was sent to 42 industries and research institutes. 27 answers were received or collected via interviews. The details are shown in Technical Note 3. A brief summary of the answers is given in this section.

Slow payment of invoice especially by prime contractors is mentioned several times. As a result too much capital is bound in projects.

Overall the profitability in space business is found to be lower than in other industrial sectors.

ESA processes are perceived to be too slow compared to the ones in usual industrial business.

Finnish companies are remotely located with respect to the main contractors and ESA. Companies may therefore have less information than other competitors.

For newcomers bidding process is tough. It is difficult to compete with companies having a lot of experience.

The volume of national space business is very limited. A way around this limitation has been to develop at a very early stage business strategy where space technology is applied also to other industrial markets.

ESA is in general perceived as a very helpful partner, but (new) companies do not have contacts. Tekes should allocate more resources to help contacts between Finnish industry and ESA.

2.3. Analysis of the Finnish national on-going or planned technology developments

Tekes plays an important role in Finland in public funding of technology development to raise competitiveness from national level to international level. There is a permanently open call for industry.

Tekes has a number of on-going technology programmes. None of them is specifically related to space some of them related to wireless data communications, artic seas, and industrial internet are good candidates for technology developments with possible synergy with the space sector.

Finland does not have any space agency and the Ministry has mandated Tekes to co-ordinate space activities in Finland. For space activity there is no special programme but normal R&D support must be used. It seems that in general companies are hardly funded if they cannot indicate other markets than ESA applications.

In Finland the main focus of the space sector is in application of space information for a wide range of use. Aalto University has made excellent work in designing nanosatellites. Based on this experience two companies have been founded. The first of those is Iceye Oy. This company develops nanosatellites equipped with SAR imaging instrument. Iceye got funding from EU and Tekes, and in addition venture capitalist funding from USA. The company has the business idea to sell imaging services directly to customers. Because Iceye is in service business it fulfils Tekes' funding model. Iceye has its business contacts in USA. They do not foresee any collaboration with ESA in their activity.

The second Nanosatellite company is Reaktor Space Lab Oy. This company participates also in ESA R&D project with other Finnish space companies. Reactor Space Lab's business model is also to sell services.

In Aalto University there is very advanced on-going R&D in optoelectronics. photodiodes having almost 100% quantum efficiency from UV to IR may offer plenty of industrial applications and certainly for space applications as well.

Finnish Meteorology Institute (Dr. Pekka Janhunen) has developed a concept of electric sail that was partly funded by ESA TRP programme.

2.4. Potential Finnish Players wrt to the Analysis of the ESA technology plans & future technology priorities

Basically the technical capability of Finnish space companies matches well the ESA plan.

The three biggest space companies in Finland, Space System Finland (SSF), DA-Design and Ruag have of course technology areas which satisfy several ESA needs. These companies plan to pursue business with ESA. SSF is growing well and expanding its "space capability" to other industries. This makes them stronger in space applications. DA-Design has invested in new facilities and their budget numbers seem very positive. Ruag belongs to the Swiss Space Corporation which will support its Finnish operation.

Furthermore, in this study products from 85 Finnish companies potentially needed by ESA programmes have been identified. Out of these companies, 33 had earlier ESA contracts and 52 are potential newcomers.

The most promising new products were cross-checked with ESA experts. This selection is also based on the willingness of those companies to work with ESA. There are presumably much more companies and product that could be available but an exhaustive search was beyond the scope of this contract. The most promising new products are summarised below.

- Tikitin Oy. develops silicon based MEMS oscillators to replace quartz oscillators. ESA is interested in this technology and will publish tender in TRP programme in 2017. Tikitin is intended to bid based on its very good background knowledge in this technology in Europe. However, it has no previous experience of bidding for an ESA contract.

- Diarc Technology Oy has unique proprietary coating technology for various applications. It has already delivered coatings for space applications. Diarc delivers to Patria special coatings for composite frames of solar panels. Promising contacts were established with ESA.

- Advacam Oy has Medipix license and produces imaging radiation sensors including advanced imaging software. Contacts with ESA are established and possible applications in ESA programmes are under discussion.

- Finlitho Oy produces lithographic gratings from UV to X-rays by using e-beam lithography. There are applications in industry, R&D laboratories and maybe in space.

- Minima Processors Oy is specialized in very low power processors. Those could be used in different instruments.

- Reactor Space Oy is involved in CubeSat satellite development and software. Activity in ESA depends on ESA's interest in CubeSat technology.

- HS Foils Oy is an old space company in the domain of X-ray windows and filters, but has plans to expand its activity to optical detectors based ontechnology developed at Aalto University.

- The consortium associating Pixpolar Oy, Summasemi Oy, and Kovilta Oy has advanced imaging sensor technology. This can be used from IR to x-rays. Specialty in this technology is that the image can be read without destroying it. The technology is very good in low light conditions. Also it will be possible to use "black diode" surface structure which could make this sensor superior for UV imaging. ESA financed 3D simulations and the next step is process development.

- The consortium associating Ruag (former Patria), Space System Finland (SSF) and Oxford Instruments Analytical Oy (OIA) had about 15 years ago a space debris detector project. This collaboration could build this kind of detector which is needed for Space Environment analysis and for fulfilling the observation requirements of the ESA space situational awareness programme. The business depends of course on the availability and performance of other detectors.

- Timegate Instruments Oy is commercializing timegated Raman spectroscopy. ESA has already Raman spectrocopy program going on at certain level. This type of method may be interesting for instance in Mars rovers.

- Aalto university R&D group led by prof. Hele Savin has developed "black silicon" coating technology on optical silicon detectors. In a paper published in Nature they have presented that QE of diodes is almost 100% from UV to IR. This will have many applications also in ESA programmes. A spin-off SME company is being set up.

It should also be noted that there is a significant interest at ESA for ALD technology developed by Picosun. This could potentially make it possible to use lead free solder in space applications. Finland has large ALD cluster and has done several projects for ESA.

The financial turnover that may be generated within the next three years by the identified new technologies identified in this study has been found to be commensurate to the yearly averaged Finnish georeturn unbalance which is of about 2 M€.

3. RECOMMENDATIONS

The list of recommendations emerging from this study is summarized as follows.

- An update of the national approach to space technology
  - National space strategy should be updated taking into account the new trends in space business
  - Finland should raise its share in optional programmes to at least GNP level
  - Tekes space staff should be raised to two equivalent full time employees to coordinate space activities
- Increase the exchange of information between ESA and the Finnish industry:
  - Tekes should arrange seminars for companies interested to participate in ESA programmes
  - matchmaking processes should be supported starting e.g. with the new products identified in this study
- Competitiveness of companies in ESA tenders:
  - Finland should invest more in GSTP optional programmes
  - ESA should consider more proof of the principle type contracts for small companies (like ITI)
  - To help the bidding process and competitiveness of companies Tekes should fund the preparation phase of proposals
  - "How to write good proposals" seminars should be arranged by ESA/Tekes
- Enhancement of existing space clusters:
  - VTT/Aalto Micronova
  - ALD cluster & other coating technologies
  - small satellites business
- ESA should be encouraged to develop a strategy related to CubeSat satellite to increase synergy between ESA and national activities.