LEA – A New Chapter in Europe´s Declaration of Non-Dependence in Space

Authored by the HPS – the „M“ in European Space SME

„Technology“ means „knowledge how to solve problems by applying technical solutions“. In the absence of abundant natural resources technology is nothing less than the key to self-determination and liberty as the highest societal value in a free world.

Therefore, the European Commission (EC) dedicates with high priority comprehensive programs to generating independent European intellectual properties in a multitude of crucial economic and social fields, ranging from agriculture, mobility and health to areas like energy, environment, connectivity, safety and security.

Among these, space serves as the crossover- or interdisciplinary technology; today, each and every single technology on earth is supported by and depends on further developments of applications in space.

Under the title of „Horizon 2020“ the EC – backed by ESA´s wealth of experience – has issued Europe´s priorities in the process of reducing dependence from non-European sources for critical key technologies. Among the concrete fields in focus is one that provides the basic technical prerequisite for the two central strategic capabilities of space technologies, namely to observe and to communicate, allowing to gain and to distribute information first hand, sustainable freely and unfiltered.

This special technology in focus here concerns the knowledge how to construct powerful antennas crucial for specific earth observation, environment, telecommunication, safety and defence missions – antennas which are much larger than any launcher´s fairing and therefore technically equipped for automatic self-deployment in space. The name of the project as response to the EC-COMPET-1-2017-tender “Development of Large Deployable Structures for Antennas”: LEA, Large European Antenna.

Still today, all satellites with self-deploying antennas larger than four meter in diameter have to rely on limited non-European resources. The institutional as well as the commercial space market, however, is growing and the demand in certain technologies increases rapidly. It is estimated that in Europe alone the demand for self-deploying antennas at sizes between 5 and 20 meters will reach half a dozen for the next ten years at minimum. Moreover, large deployable antennas (LDA) are one of the key enabling technologies to realizing almost all innovations already at the horizon:

- In the domain of earth observation large deployable reflectors support mainly radiometer and radar instruments. Especially low frequency instruments observing P-band or L-band require large antennas to provide sufficient sensitivity or resolution for the desired products. SweepSAR and Scan-On-Receive radar technology benefits significantly from very large reflector antennas resulting in high resolution wide swath radar instruments throughout the complete frequency spectrum used in space-borne SAR systems. Focusing on Europe, ESA´s Biomass mission using a very large 12 meter reflector is currently in its implementation phase. Several other missions are in definition and study phase like Tandem-L and potential concepts for Sentinel-1 next generation.
- In the domain of satcom/telecommunications large deployable antennas operating up to Ku/Ka-band are becoming key to applications like web broadcasting, TV distribution to cable

hubs, Direct-to-Home (DTH) services, inflight- and ontrain-connectivity, IoT („Internet of Things“), and military applications. Especially telecom satellite service providers using High-Throughput Satellites (HTS) with multi-spot beams and high frequency reuse will benefit.

- In the domain of science missions potential scenarios have been identified for deep space missions and related communication applications. Maintaining communications and data-links from deep space back to earth will require antenna systems with high sensitivity and low frequency bands.

Against this background, for Europe the risk of technological dependence is simply intolerable.

Based on a very high percentage of all necessary developments and pre-developments on subsystem-, assembly- and element-level for more than 10 years mainly under the auspices and funding of the European Space Agency (ESA) the German SME- and partner-companies HPS (High Performance Space Structure Systems GmbH, Munich), LSS (Large Space Structures GmbH, Munich), and HTS (Hoch Technologie Systeme GmbH, Dresden) have succeeded in forming a consortium of 15 European space companies including even all three large system integrators (LSI) to submit the offer for the development of a 6-meter Protoflight Model (PFM), which consists of reflector assembly, arm assembly, all associated joints and mechanisms, supported by electronics and test facilities on ground.

The European Commission (EC) concluded this offer in July 2017 at a peak-level setting 14.5 out of 15 possible points as first project within its call “Technologies for European Non-Dependence and Competitiveness”. Consequently, the EC granted the 5-million-Euro contract on 23rd of October 2017 to the consortium under the administrative coordination of HPS Lda., Porto, the Portuguese subsidiary of HPS Germany. 65% of the budget is allocated to the SME (Small and Midsized Enterprises) of the LEA-team.

The design of the LEA-PFM starts after the selection of a potential European reference mission scenario in January 2018, the acceptance tests of the hardware produced from 2019 on will be finalized by the end of 2020. The PFM will then be offered at no charge in exchange for a free ride up into space on the open market of planned space missions in order to realize the final in-orbit validation. After that, the European as well as the world markets are open for the new technology made in Europe.

The European LEA-Team

Besides Germany and Portugal, Denmark and Sweden, France and Spain are represented through their leading space specialists.

- **Core Team**

The core team consists of two sites of HPS, LSS and HTS:

Within the European group of HPS, whereas the German headquarter initiated the whole LEA-project, HPS-Portugal (www.hps-lda.pt) has the role of the “coordinator” of the consortium and will act with its huge experience in EU-projects as direct interface to the European Commission. HPS-Germany (www.hps-gmbh.com), specialized in high performance antennas, deployable structures and thermal hardware, takes the role of the technical management. Furthermore it is responsible for the investigation of potential reference missions, the design and analysis (RF, mechanical, thermal,

kinematic) of the LEA-subsystem, the development of the deployable arm assembly, the RF-reflecting metal mesh and for the management of the final test campaign of the PFM.

Large Space Structures GmbH (LSS, www.largespace.de), Germany, takes over the role of the deployable reflector assembly technical manager and is responsible for associated design, analysis, manufacturing and testing. The company's key person holds the most profound heritage in the field of large deployable reflectors in Europe, has developed so far more than 15 different kinds of deployable reflectors and had acted as a main manager from Georgian side on a 6m reflector technology development for the MIR space station with successful flight test as early as 1999.

Hoch Technologie Systeme (HTS, www.htsdd.de), Germany, a member of the Swiss RUAG AG, is developing, building and testing the deployable hinges of the LEA deployable arm assembly and is responsible for all hold-down and release mechanisms of the LEA-subsystem. Since more than 20 years HTS specializes in mechanisms and mechanical components for space applications. In close cooperation with companies, universities and research institutes HTS develops innovative ideas, components and products for national and European space programs and industrial applications.

- **Core Team Support**

In regard to legal and patent aspects the whole LEA- team is supported by Weber Steinhaus & Smith (www.weber-steinhaus.com, Germany). Its key person has an extensive command in the field of national and international space law, particularly from a commercial point of view.

Thales Alenia Space (www.thalesaleniaspace.com, Joint Venture between Thales, 66%, and Leonardo, 33%, France) and OHB (www.ohb.de; Germany) are contributing to the review of potential reference missions and take care of accommodation aspects and system-level requirements. Both Large System Integrators have a big overview on current mission demands and the needs from satellite point of view.

- **Hardware Team**

The hardware-team consists of von Hoerner & Sulger (VHS, www. vh-s.de, Germany), Luma Metall (www.luma-metall.com Sweden), Invent (www.invent-gmbh.de, Germany) and HPS Lda. (Portugal):

VHS, specialist for electronics for scientific and commercial space missions is taking responsibility for the design and development of all on-board electrical equipment such as power, control, monitoring of all LEA mechanisms and the harness from LEA electronics to arm and antenna motor units. In addition, the SME delivers the Electrical Ground Support Equipment (EGSE) hardware that functions as interface to LEA electronics.

Luma Metall is providing kilometres of gold-plated Tungsten wire for the mesh development samples and the PFM mesh. Investigations on optimizing the wire specifically for reflector mesh applications will be performed.

As a specialist for manufacturing of composite structures for aerospace applications, INVENT is going to manufacture the several meters long carbon composite booms for the deployable arm. The long years' experience of this SME will lead to a very lightweight and highly accurate product, important for the whole antenna performance in space.

Besides its role as general project coordinator, HPS Lda. will contribute on element-level with its extensive experience in deployable structures, composite materials and processes as well as thermal

hardware: the company will provide highly accurate CFRP-struts with metallic end-fittings for the reflector assembly and all multilayer insulation (MLI) blankets, necessary to protect temperature sensitive components from solar radiation.

- **Service Team**

Indispensable services in the framework of this project are coming from Spain (INTA), Denmark (TICRA), Portugal (INEGI), and Germany (Etamax and Airbus Defence & Space):

INTA (www.inta.es), the National Institute for Aerospace Technology in Spain, is going to provide thermal, vibration, and shock tests for both arm and the reflector on stowed configuration as well as associated tests on component level including PIM and RF reflection losses on sample level. INTA contributes well to the project with its large facilities and related test experience and wants to develop its service area to meeting the requirements for testing large deployable structures.

As the world´s leading supplier of accurate reflector antenna modelling software, TICRA (www.ticra.com, Denmark) will provide radio frequency (RF) simulations of the large reflector antenna performance throughout the LEA-project. The simulations will be based on a detailed RF-model of the LEA reflector and feed geometry of the PFM in the GRASP software. Simulated results will finally be correlated with measured RF-data.

INEGI (www.inegi.up.pt), the Portuguese Institute of Science and Innovation in Mechanical and Industrial Engineering from the University of Porto, will focus on development, design, manufacturing and integration of several ground support equipment (GSE) required for the LEA subsystem evaluation. This includes a zero-g device for reflector and arm deployment, the adaptors for vibration and TVAC testing as well as thermo-elastic distortion (TED) testing GSE.

ETAMAX Space (www.etamax.de) will bring in its software engineering capacities for the development of the EGSE software for testing the deployment of the LEA controlling motors and sensors with different profiles Furthermore, ETAMAX will perform a meteoroid and space debris risk analysis ensuring a higher reliability and survivability of the antenna as support to the design team.

Airbus Defence & Space (www.space.airbus.com) runs the Antenna Test Center in Ottobrunn and will conduct the final RF-performance testing of the LEA PFM. This project will be another application for the newly developed measurement tool for large antennas, moving above a static item under test. Standard RF test equipment collides with boundary conditions of necessary test setups in order to successfully simulate space environment for such large antennas.

The LEA Team is extremely motivated to master the last challenging step before launching a first fully European large deployable antenna into space and is now looking forward to having the kick-off on November 1st, 2017.

For questions, please contact: LEA@hps-gmbh.com or any other company of the consortium (contact addresses can be found on the homepages mentioned above).

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