Excerpt from

Critical Space Technologies

for

European Strategic Non-Dependence

List of Urgent Actions for 2012/2013

Update for the 2015 Call of Horizon 2020

June 2014

This page is intentionally left blank.

CONTENTS

1 Objectives

In 2011, EC, ESA and EDA ran together the process to prepare a list of urgent actions for Critical Space Technologies for European Strategic Non-Dependence for the time-frame of 2012-2013.

The consensus on the List of Urgent Actions 2012/2013 for Critical Space Technologies for European Strategic Non-Dependence has been presented to the respective bodies of EC, ESA and EDA and been finalised in February 2012. The present document is an updated excerpt from that List specifically in the context of the Call 2015 of Horizon 2020 Space. For further information on the process please refer to the full document. In addition the excerpt includes under the headings "Remarks" and "Information on relevant activities (status May 2014)" additional information to reflect developments since the original publication of the List. This row includes where appropriate a programme reference for the activity.

2 European Non-Dependence process in 2011

The 2011 European Non-Dependence Process followed the procedure as defined in the EC-ESA-EDA JTF (Joint Task Force) final report and executed for the first time in 2009. An overview on the overall process can be found in Figure 1.

Figure 1 European Non-Dependence Process in 2011

After the mapping meeting on 8 September 2011, the next stage was the planning of the way ahead in the form of a Roadmap (referred to hereinafter as the *European Non-Dependence Urgent Action List)*:

I. A *Draft European Non-Dependence Urgent Action List* was prepared by the three institutions, based on the information from the Background Document, and information gathered during the mapping meeting. The *Draft European Non-Dependence Urgent Action List* was delivered for review and comments to Member State (MS) Delegations and Industry Representatives on 4 November.

II. Industry (via Eurospace/SME4Space) was invited to present comments on the *Draft European Non-Dependence Urgent Action List* in a dedicated meeting with the EC, ESA and EDA held on 30 November. The updated *Draft European Non-Dependence Urgent Action List*, including Industry agreed comments, was then distributed to MS Delegations on 2 December, in preparation for the Roadmap Meeting.

III. At the Roadmap Meeting held on the 15 December 2011 at ESTEC, the updated *European Non-Dependence Urgent Action List* was presented to the MS Delegations; the aim of the meeting was to arrive at an agreed *European Non-Dependence Urgent Action List*, including implementation recommendations where appropriate. After the Roadmap meeting, the *European Non-Dependence Urgent Action List* was updated to reflect the discussions and agreements of the meeting.

IV. The updated *European Non-Dependence Urgent Action List* was then sent to the MS Delegations for final review and comments. After implementing received comments the *European Non-Dependence Urgent Action List* was finalised in February 2012, to be presented to the respective bodies of EC, ESA and EDA.

V. The final *European Non-Dependence Urgent Action List* was distributed to all European stakeholders.

The *European Non-Dependence Urgent Action List* is implemented in National and European Programmes. Tracking of the status of implementation will be performed yearly by EC, EDA, ESA and reported to EC, ESA and EDA respective bodies.

3 Urgent actions needing implementation in the timeframe of 2015

3.1 U4 - Advanced materials and material technology for combustion chambers

Detailed Action	– Availability of ITAR free materials and coatings for space engines (TRL 6) – Ceramic chamber materials for advanced bi-propellant spacecraft engines (TRL 4)
Target TRL:	See above
Application Domain:	ALL
Remarks	
Information on relevant activities (status May 2014)	***EC*** ***SMARTEES*** *Multifunctional components for agressive enviroments in space applications - Call: FP7-SPACE-2010* ***THOR*** *Innovative thermal management concepts for thermal protection of future space vehicles - Call: FP7-SPACE-2012* ***LIGHT-TPS*** *Super-light TPS, Reusable Space Systems, UHTC composites/coatings, Si/C and C/C materials, Ni/Cr metallic frames, TPS sandwiches - Call: FP7-SPACE-2013* ***ESA*** *Ongoing activities:* • *Investigation of non-ITAR materials and coatings as part of High Thrust Apogee Engine development (MREP)* *Activities under preparation by ESA for 2014/15:* • *Iridium anti-oxidation coatings on niobium based rocket thrusters (ITI, Ref SC. 10000010775)* • *Development of Functionally Graded/Composite Spacecraft Thruster Nozzles (TRP, Ref SC. 10000009320)*

3.2 *U6 – Fiber Optic Gyro (FOG) based inertial measurement unit (IMU)*

Detailed Action	Ensure long term availability of an European cost effective FOG based IMU (with accelerometers)
Target TRL:	≥ 6
Application Domain:	NAV, SCI, EO, Exploration, potential Telecom
Remarks	The target TRL of 6 implies at least the development of an IMU Engineering Model.
Information on relevant activities (status May 2014)	***EC*** ***MERMIG*** *Modular CMOS Photonic Integrated Micro-Gyroscope* *Call: FP7-Space-2012* ***ESA*** *The following activities are running/have been already approved in ESA work programmes:* • ESA T705-032EC Accelerometer for IMU feasibility demonstrator • ESA T905-014EC European IMU breadboard • ESA E905-016EC Accelerometer component to TRL5 • C205-101FT Accelerometer component development ***EDA*** *The following activity is running in EDA work programme:* • PERU (PACKAGING 3D FOR HETEROGENEOUS RUGGED ELECTRONICS) by others MEMS gyrometer for multipurpose mil. applications

3.3 U7 - Power amplification: Travelling Wave Tube (TWT) materials

Detailed Action	Ensure unrestricted access to materials for TWT production
	• ITAR free helix wire material needed.
	• ITAR free dielectric materials:
	  ○ material for helix support rods
	  ○ insulation ceramic for high-power collectors

Target TRL:	≥ 6
Application Domain:	GENERIC
Remarks	To avoid duplications with on-going ESA activities, the proposals to H2020-2015 must be targeted to achieve non-dependence for different materials than the ones under development (see below). If a continuation of these activities is planned, the target TRL must be increased by one or more levels.
Information on relevant activities (status May 2014)	*Ongoing activities by **ESA**:* *- TRP activity (running to be completed in 2014) on new materials for helix support rods (CN 104896)* *- ARTES 5.2. activity has been KO in Dec 2013 (2 years) and addresses insulation ceramics for high power collectors*

3.4 U12 - High Capacity FPGAs

Detailed Action	Validation of a high capacity Rad Hard Reprogrammable Field-Programmable Gate Array (FPGA) of European source and development and validation of software tools This includes in particular validation and FPGA product consolidation activities such as: • FPGA use, debugging and dissemination: FPGA experimentation by first space end-users, migration of space-subsystems to make use of the new FPGA, Intellectual Property (IPs) migration to the new FPGA, dissemination of the FPGA product • Tools: complement the FPGA tools of such a chip with capability to use higher abstraction-level design descriptions than RTL, extensions to recognise specialised optimally-implemented macros, extra testing and benchmarking of the design and programming tools • Critical tests associated to complex packages • Support for ESCC evaluation and qualification tests with a commercial view. The target European Space FPGA shall have a silicon proven architecture with the requirements indicated in the Remarks (please see below)
Target TRL:	7
Application Domain:	ALL
Remarks	The target European Space FPGA shall be part of a family of European FPGAs with at least one version to address the following architecture elements: • 4-input Look-Up Table (LUTs) • Internal memory • Digital Signal Processing hard-macros. • SERDES High Speed Serial Links. • Internal interconnection shall allow fast interconnect and allow a LUT density higher than 1.500 LUT/mm^2 (value for 65 nm technology not including radiation hardening) with a minimum capacity of 25000 LUTs and scalable to capacities higher than 100.000 LUTs in 65 nm technologies (including radiation hardening).

	The following requirements are needed: • The FPGA shall be radiation hardened: ▪ It shall withstand a Total Ionising Dose (TID) up to 300 krad (Si) ▪ It shall be Latch-up immune for Linear Energy Transfer (LET) up-to 80 MeV/mg/cm^2. ▪ The sensitivity to Single Event Upsets (SEUs) shall be such that no additional radiation mitigation techniques should be done by the FPGA designer in the majority of space applications . ▪ The FPGA shall not have Single Event Failure Interrupts (SEFIs) due to radiation effects. • The FPGA devices shall become available in space-qualified packages. • The FPGA product shall include the software tools that execute the typical digital microelectronics flow starting from a Register Transfer Level (RTL) description and system constraints (e.g. timing, capacitive loading) to ultimately generate the bit-stream necessary to program the FPGA with the desired functions. • In order to meet the FPGA capacity and performance requirements, the FPGA shall be implemented in a technology node (minimum feature size of the transistors) of 65 nm or smaller. • The FPGA product shall not be subject to Non-European export restrictions (98 % of the space FPGAs being used today in all European missions are now subject to ITAR export control), and be based as much as possible in European technology. The requirements and characteristics mentioned above are derived after discussions in the framework of CTB / ESCC and other fora with Industry (customers), Vendors (technology suppliers, private funding) and Public Space Organizations and Agencies (institutional funding). Reference documents: “Microelectronics: ASIC and FPGA”. European Space Technology Harmonisation Technical Dossier, Jan-2012
Information on relevant activities (status May 2014)	***ESA*** • ESA TRP contract: 4000108054/13/NL/LvH, “High density European SRAM-based FPGA: first validated prototypes (NG-FPGA)”; IPC reference: T705-301EC; RFQ reference 3-13735/12/NL/LvH • ESA ECI contract: “Reprogrammable FPGA Tools development”; IPC reference EEE13, ESA/IPC(2011)61; ITT reference ESTEC ITT AO/1-7360/12/NL/LvH.

APPENDIX B: Table of Acronyms and Abbreviations

ARTES	Advanced Research In Telecommunication Systems Programme (ESA)
ASIC	Application Specific Integrated Circuit
CTB	Components Technology Board
ESCC	European Space Components Coordination
EO	Earth Observation
ESTEC	European Space Research and Technology Centre (ESA)
EC	European Commission
EDA	European Defence Agency
ESA	European Space Agency
FOG	Fiber Optic Gyro
FPGA	Field Programmable Gate Array
IMU	Inertial Measurement Unit
ITAR	International Traffic in Arms Regulations
JTF	Joint-Task-Force
LUT	Look-Up Table
MREP	Mars Robotic Exploration Preparation Programme (ESA)
MS	Member State
NAV	Satellite Navigation
SCI	Science
TRL	Technology Readiness Level
TRP	Basic Technology Research Programme (ESA)
TWT	Travelling Wave Tube