EUROPEAN NON-DEPENDENCE ON CRITICAL SPACE TECHNOLOGIES:

EC-ESA-EDA LIST OF URGENT ACTIONS FOR 2009

EC-ESA-EDA
Joint Task Force
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INTRODUCTION

An immediate action for the EC-ESA-EDA Joint Task Force (JTF) on Critical Space Technologies for European Strategic Non-Dependence was to produce a first agreed list of urgent activities for critical space technologies for European Non-Dependence for usage in 2009. Considering the time available, the intention was not to prepare a fully comprehensive list that would require a full consultation with all involved parties as proposed for the 2nd semester 2009. The list presented here excludes relevant topics and activities, for which one or more participants proposed to exclude them for 2009, e.g. to avoid the danger of potential overlap with previous activities or parallel calls.

The list is based on the list distributed at the 9th September 2008 event on Critical Space Technologies for European Strategic Non-Dependence. Inputs from industry were received in a dedicated meeting on 27th February 2009. The JTF considering the practices of FP7, agreed on 6th March on the attached list, in particular in view for potential usage in the frame of the FP7-Space Call 3.

DEFINITIONS OF TERMS

In the context of this document, it is important to recall the definitions of "Independence" and of "Non-Dependence", namely:

- "Independence" would imply that all needed space technologies are developed in Europe.
- "Non-dependence" refers to the possibility for Europe to have free, unrestricted access to any required space technology.

The objective of this action is to contribute to ensure European Non-dependence.



TECHNOLOGY REQUIREMENTS FOR URGENT ACTION

The information collected has been processed with the objective of identifying the technology requirements (TRQs) for which urgent R&D actions need to be supported. The results obtained are presented in the table below. In the table the following information is given:

Column 1: ESA Technology Domain
Column 2: Technology Requirement Title
Column 3: Technology Requirement details

CRITICAL ITEM, IMMEDIATE ACTION IS REQUIRED

Technology Domain	Title	Detailed requirement
On-board Data Systems	Core processors for DSP computers	Development of application-specific co-processors: Next Generation DSP, 1 GIPS.
	ASICS (Deep Submicron)	Deep submicron (DSM ASIC): Low power very high performance sub micron technologies for Data path and signal processing applications. Development of rad hard, long life-time libraries for commercial DSM, definition of "platform ASIC architecture" ASIC technology including High Speed Serial Links (as hard macro and standalone chip). Validation and space qualification.
	ASICS (Co-Processors)	Development of application-specific co-processors: CCSDS 122.0-B-1 image compression ASIC.
	Very High performance microprocessors .13/.09 micron tech.	Development of very high performance (32-64 , multicore) general purpose µprocessor with extended floating point capability: 1 gigaflops processing speed to fulfil telecom, science and earth observation requirements

Technology Domain	Title	Detailed requirement
	Very high sped serial interfaces	Development of very high speed (1-10 Gbit/sec) links and networks for components/units interconnections. I/O devices for DSP computer applications: SpaceFiber (CODEC IP, Network terminal, Network bridge and Router ASICs).
	FPGAs	Rad hard Reprogrammable Field-Programmable Gate Array (FPGA) of European source, large gate density (1-2M-ASIC-equivalent gates).
Spacecraft Environment & Effects	Components for coordinated radiation effects flight experiment	Development of key sensors and detectors for radiation effect evaluation. On ground validation and flight of a collection of radiation sensitive technologies and simultaneous monitoring.
Space System Control	Solid state gyroscope technologies	Product development of a FOG Inertial Measurement Unit (IMU) high precision class (bias stability < 0.01 deg/h). Although the technology is available in Europe the actions is needed to replace obsolete components (Pinfet and optical source)
RF Payload Systems	Power amplification: TWT materials	To identify European suppliers for a set of critical TWT materials (ceramics, metals and alloys), to realise an evaluation and qualification programme for the most sensitive ones and to validate the material suitability for TWT applications.
Space Debris	High power VHF and UHF transmission chain and beam control	Radar systems for the future European Space Surveillance System (ESSS) require power levels and antenna designs that differ significantly from all other known military and conventional radar applications. Technologies that satisfy the ESSS requirements on power level and beam control function and accuracy are required for at least the following components of the transmission chain for the VHF and UHF bands: - RF generators - cooling techniques- high-power amplification - radar beam controllers. Existing technologies require adaptation and qualification for the high output power required taking into account limitations as through the warming of the amplifiers and the amplifier technology as such. VHF/UHF antenna beam control and steering concepts need to be developed.

Technology Domain	Title	Detailed requirement
Mechanisms & Tribology	Dry lubricated Harmonic Drives	Development of dry lubricated Harmonic Drives for low temperature (down to cryogenic) applications rotary actuators
	Hold down and release mechanism (Non-explosive Hold-down and release device)	Development of a non explosive Hold-down and release mechanism, light, safe, easy to use, to cover a broad temperature range (4K 450K)
Opto-Electronics	Space-worth solid-state laser sources	This address a set of requirements at component and subsystem level in terms of reliability, lifetime, radiation, efficiency and space operation both under vacuum and pressurized. The key elements addressed are pump diodes and pumping modules, laser crystals and frequency converters, transmissive and reflective optics and coatings, thermal control and control electronics.
	Enhanced performance and space-worth 1-D and 2-D Sensor focal planes operating from X ray to the Infrared	This technology group address all technological requirements related to the development of rad-hard, low-noise, high Q-E, large-format detector arrays for operation from X rays to Infrared. It includes monolithic and hybrid technology for detector and read-out, foundry optimization/spatialization
	Optical Clock Time Referencing System	Development of an Optical Clock demonstrator for ultra-high precision timing referencing applications in Science, Navigation and Earth Observation. It include the engineering design, development and qualification effort for the following subsystems: a) ultra-stable laser source, b) the atomic reference, c) the optical comb clockwork and d) the control/read-out

Technology Domain	Title	Detailed requirement
Structures & Pyrotechnics	Development of Deployable structures	Large deployable structures are needed as backbone and integral part of large radiators, shields and solar arrays. In addition to providing a deployment function, the structure shall provide stability and integrity for the subsystem in question throughout its mission. Aspects related to system design, active control and stability need to be developed further. Due to the complexity of such structures, in particular the deployment and on orbit dynamics, flight demonstrations will be considered.
	Development of pyrotechnic technologies	Pyrotechnics are needed for the many non repeating functions which are crucial to mission success (solar arrays, antennas, boom, valves, etc.). Increasingly demanding missions require enhancements in temperature survivability, lifetime before firing, reduction of undesirable side effects and continued increasing efficiency. This includes the development of new pyrotechnic materials and ignition methods as well as miniaturization. Self energized separation interfaces of all types and their supporting systems are covered by this effort. (life extension, thermal environment extension etc. Thermite devices development. Miniaturisation)
Thermal	Active Cooler for Detector Cooling below 260K	Interplanetary missions (e.g. Bepi Colombo), Mini/Micro satellites for Earth Observation (e.g. IR) or Science, small landers (Exploration)
	Miniaturisation of two-phase thermal control technology	Development/adaptation of two phase heat transfer equipment (heat pipes, single and two phase loops) to smaller scale (mini/micro level) for e.g. direct integration into electronic equipment, thermal control of small space vehicles (e.g.rovers, mini/micro S/C), temperature control of focal planes and laser heads, etc. In view of the gravity dependence of such devices, the development needs to include in orbit demonstration.

Technology Domain	Title	Detailed requirement
Thermal	Enhancement and extension of two-phase thermal control technology	Further improve the performance and optimize current capillary two-phase heat transfer technology (e.g. improvement of wick structures, multi-evaporator designs, etc.), including the extension of the temperature range of two-phase heat transfer devices (e.g. CPL, LHP and conventional heat pipes) to lower (down to cryogenic) and higher temperatures, for e.g. efficient detector cooling, efficient use of radiator area, overall thermal design optimisation. Especially for CPL and LHP, aspects like accommodation/integration and in-situ assembly/filling techniques will need to be covered also. In view of the gravity dependence of such devices, the development needs to include in-orbit demonstration.
	Active Cooler between 10-80K	To achieve the high sensitivity required for many remote sensing applications (infrared) and scientific applications (all wavelength s), cooling of the detectors and sometimes the optic to cryogenic temperatures is required. Long life, low vibration, high efficient and compact coolers, including drive electronics and cryogenic system equipment (e.g. thermal link assemblies), are required, which are capable to directly cool down detectors (30 80K for Earth Observation and Science) integrated inside a dewar or act as a pre cooler (15 20K) for the very low temperature systems (below 1K) typically applied in scientific instruments.
	Smart TPS Technologies	Development of novel TPS based on smart materials and concepts able to adapt their properties (e.g. curvature, thermal conductivity, thermo-optical properties) to the exposed environment and/or providing self-healing capabilities.
	Thermal Control Technologies compatible with new structural materials	Development of new and/or adaptation of existing thermal control materials & technologies i.e. coatings, heat transport tools (heat pipes, single and two phase loop components), doublers, etc. which are compatible (e.g. with respect to CTE, integration) with new structural materials (carbon fibre panels).

Technology Domain	Title	Detailed requirement
EEE Components and quality	Very High performance microprocessors .13/.09 micron tech.	Development of very high performance (32-64 , multicore) µprocessor with extended floating point capability :·1 gigaflops processing speed to fulfil telecom, science and earth observation requirements
	Passive Components	Development, evaluation and characterisation of new materials and production processes for: miniature connectors, AVX TPS series of capacitors, Schurter fuses, and high voltage (100 V) relays.
	High performance computers, 0.18 micron tech.	Development of HP 32 bits µprocessor with extended floating point capability based on the 32 bits LEON sparc architecture:·100 megaflops processing speed·Multi-processing Silicon reconfigurable computers
Materials & Processes	Advanced thermal control materials	Materials used at the outside of a spacecraft are generally multifunctional in that they protect the underlying hardware from different environmental parameters. One of these functions is thermal control. The purpose of this Technology Requirement is to develop materials that have this multifunctionality, but concentrating on the need for a variable, controlled thermo-optical behaviour. In parallel, testing methodologies will have to be developed and validated. The approaches include passive thermal control as well as active thermal control (e.g. implementation of thermotropic, electrochromic properties).
	PCB improvement	All missions need very reliable electronic assemblies and a the amount of data to be handled by this electronic is largely limited by the possibility to populate PCBs, In this Technology Requirement are evaluated the means to increase component density on PCB s. This includes the assemblies possibilities for new components, e.g. Ball Grid Arrays (BGA s), high dissipation packaging technologies. There is an urgent need for replacing the Thermount that is obsolete and soon not anymore available (end 2009)

Appendix A Table of Acronyms

1 D	1 Dimensional
A/D	Analogue/Digital
Ac	EC Associated Countries
ADC	Analogue Digital Converter
AO	Announcement of Opportunity
ARTES	ESA Advanced Research In Telecommunication Systems Programme
ASIC	Application Specific Integrated Circuit
CCSDS	Consultative Committee for Space Data Systems
C-M 08	ESA Council on Ministerial Level 2008
CNES	Centre national d'études spatiales
CPL	Capillary Pumped Loop
CTB	ESCC Components Technology Board
CTE	coefficient of thermal expansion
DAC	Digital Analogue Converter
DLR	Deutsches Zentrum für Luft - und Raumfahrt
DSM	Deep Sub-Micron
DSP	Digital Signal Processor
EC	European Commission
ECI	ESA Electronic Component Initiative
EDA	European Defence Agency
EEE	Electrical, Electronic and. Electromechanical
ESA	European Space Agency

ESCC	European Space Components Coordination
ESP	European Space Policy
ESSS	European Space Surveillance System
ESTER	European Space Technology Requirements Document
FOG	Fiber Optic Gyro
FP7	EC Framework Programme 7
FPGA	Field Programmable Gate Array
GaN	Gallium Nitride
GIPS	Giga Instructions per Second
GMES	Global Monitoring for Environment and Security
GSTP	ESA General Support Technology Programme
HSSL	High Speed Serial Link
I/O	Input/Output
IMU	Inertial Measurement Unit
INCO	EC FP7 International Cooperation countries
IP	Internet Protocol
IPC	ESA Industry Policy Committee
IR	Infrared
ITI	ESA Innovation Triangle Initiative
ITT	ESA Invitation to Tender
JIP	EDA Joint Investment Program
JRC	EC Joint Research Center
JTF	Joint-Task-Force
LHP	Loop Heat Pipe

LNA	Low Noise Amplifier
LO	Local Oscillator
MEMS	Micro-Electro-Mechanical Systems
MMIC	Monolithic Microwave Integrated Circuit
MS	Member States
PC	EC Programme Committee
PCB	Printed Circuit Board
pMS	participating Member States
RAD hard	Radiation hard
RF	Radio-Frequency
S/C	Space Craft
SAG	EC FP7 Space Advisory Committee
SAR	Synthetic Aperture Radar
SD	Service Domain

SiGe	Silicon Germanium
SP	EC FP 7 Specific Programme
SSF	Strengthening Space Foundations
TD	Technology Domain
THAG	ESA Technology Harmonisation Advisory Group
TPS	Thermal Protection Systems
TRL	Technology Readiness Level
TRP	ESA Basic Technology Research Programme
TWT	Travelling Wave Tube
UHF	Ultra High Frequency
VHF	Very High Frequency
WP	Work Programme