European Space Technology Harmonisation

ADCSS 2016

E. Williams, M. Freire

Technology Harmonisation Team
Technology Planning Section (TEC-TP)
Directorate of Technical and Quality Management

european space technology harmonisation

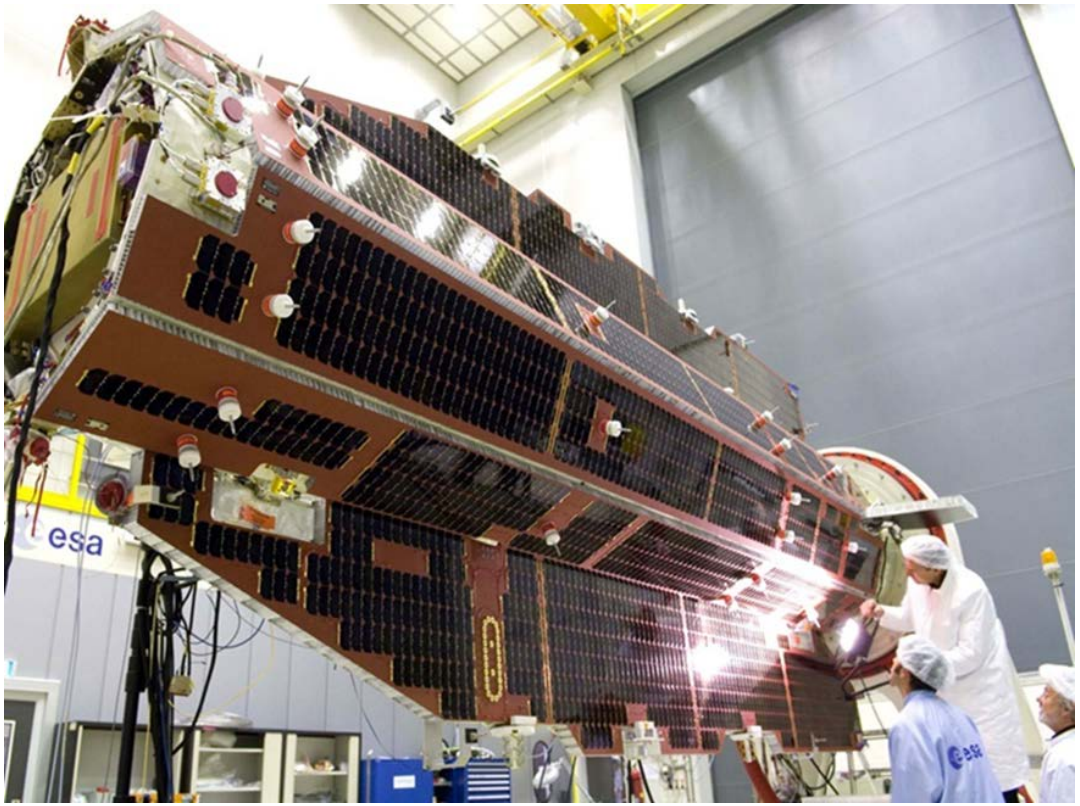
Purpose of ESA

"To provide for and promote, for exclusively peaceful purposes, **cooperation among European states** in **space research** and **technology** and their **space applications.**"

Article 2 of ESA Convention

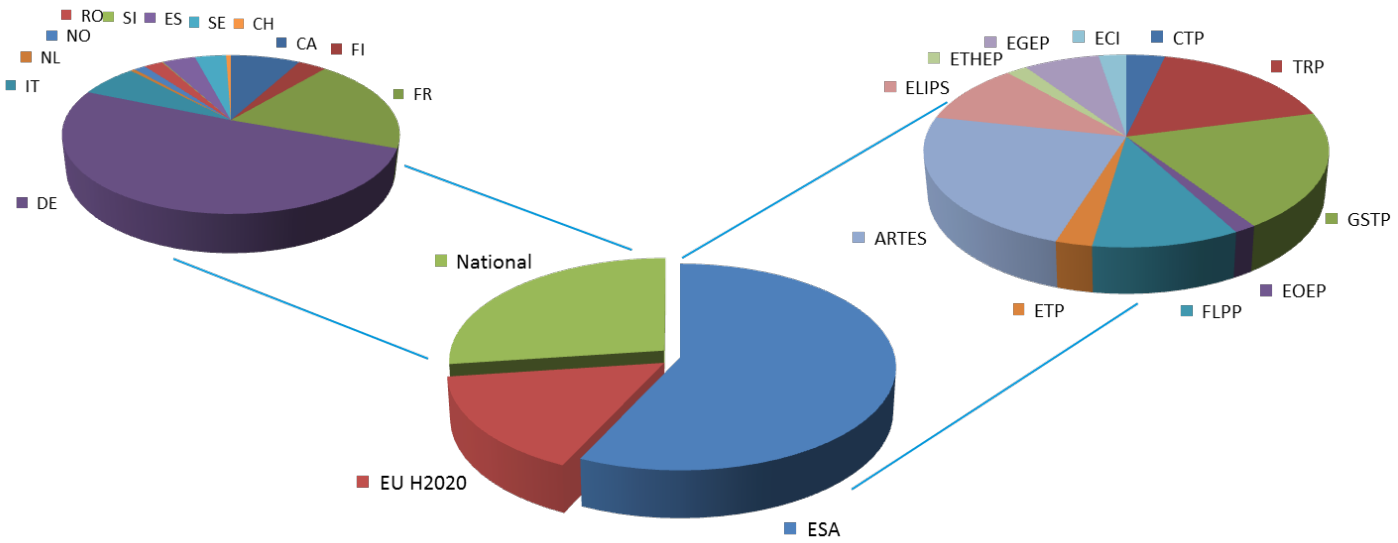
Objectives of Space Technology

1. Enabling the future science and service driven missions, launchers and infrastructure
2. Strengthening the competitiveness of European industry
3. Fostering innovation and technical excellence
4. Assuring non-dependence on critical space technologies



5. Transferring technology from space to non-space applications ('spin-off'), and bringing innovations from outside the space sector to use in the design of new space systems ('spin-in')

Space Technology Budget in Europe

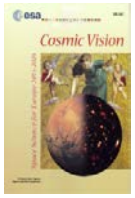


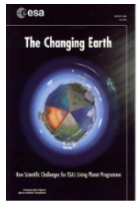
European Space Institutional Technology R&D average yearly budget of over **680M€** (figures from **ESTMP 2016 edition**)

~ 390 M€ ESA funding/year in ESA technology development lines help prepare over **4B€** of investments in missions / launchers / space infrastructures developments and for European industry's competitiveness

From Needs to Roadmaps

Science communities





Operational communities

Copernicus

EUMETSAT

ESOA

National Space Agencies, institutions

Industry

ESA

Aggregation of the technology needs

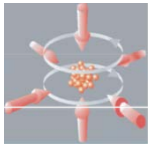
Roadmaps

Coordination of the efforts

- European programmes, National programmes, industry, …
- Capabilities

Variety of Technology Coordination initiatives in Europe – some examples

- Roadmaps across European Programmes for broad set of Technologies
  - **European Space Technology Harmonisation**
- Roadmaps for specific areas across European Programmes
  - European Space Components Coordination (complementary with harmonisation)
  - SAVOIR (input to Harmonisation)
- ESA Service Domain Specific / Programme Specific Technology Roadmaps
  - ESA Science (consistent with harmonisation), EGEP, …
  - ESA roadmaps for Exploration (consistent with harmonisation)
  - H2020 specific SRC PSA projects on H2020 roadmaps
- Other ESA thematic / ESA Cross-cutting initiatives
  - EC-ESA-EDA Non-Dependence Action Lists
  - Future Instrument Technologies (roadmaps through harmonisation)
  - CleanSpace (consistent with harmonisation)
  - Space and Energy (consistent with harmonisation)
- National Agency Technology Roadmaps (input harmonisation via THAG)
- Industry prepared Roadmaps / R&T priorities across Europe
  - Eurospace R&T priorities – reflected in input to Harmonisation via Eurospace

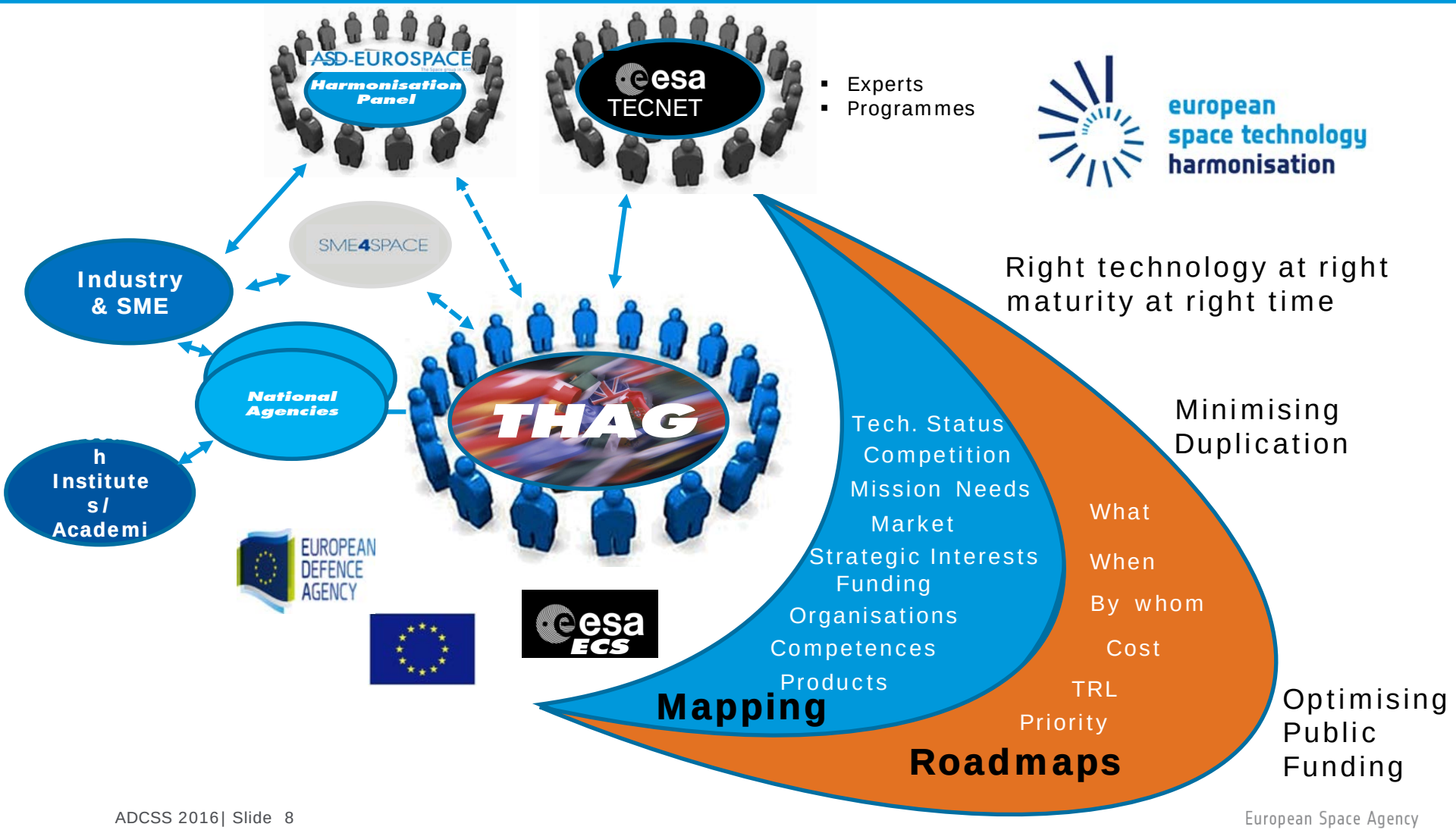


Harmonisation Objectives – since 2001

- "Fill strategic gaps" and "Minimise unnecessary duplications"
- Consolidate European Strategic capabilities
- Achieve a coordinated and committed European Space Technology Policy and Planning
- Contribute to ensuring continuity and coherence between Technology and Industrial Policies

european space technology harmonisation

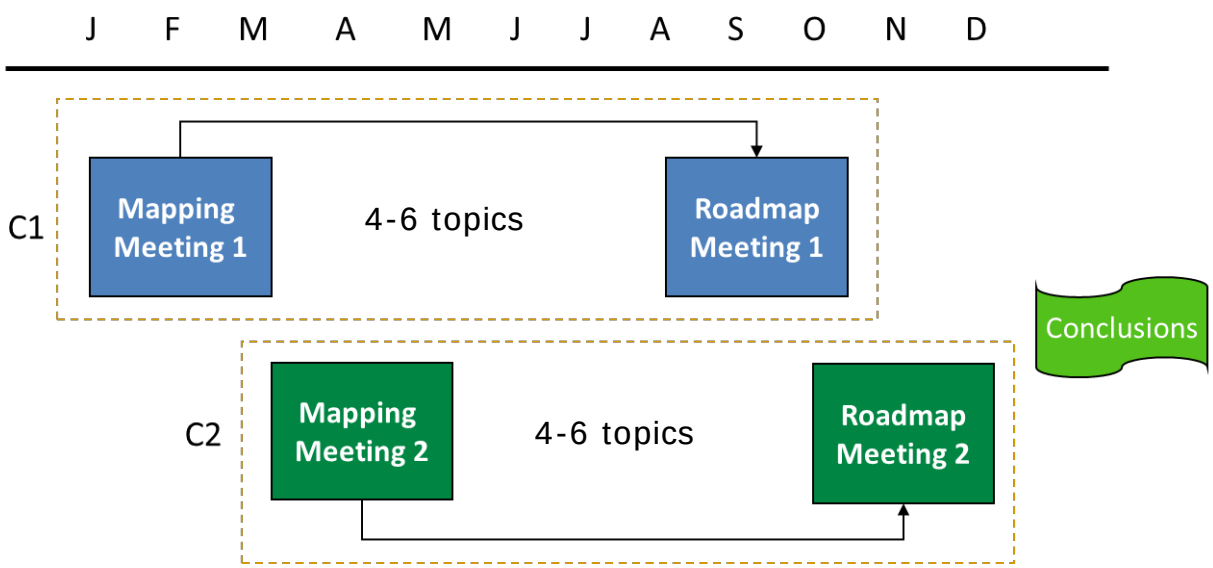
Broad Participation

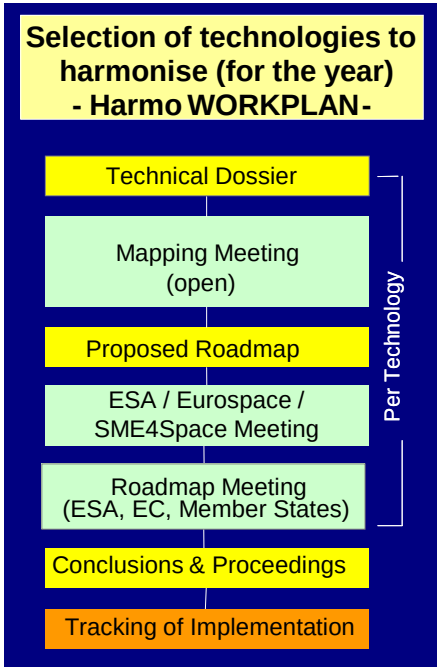


Over 50 Harmonised Technology areas

- ✓Automation and Robotics
- ✓Cryogenics and Focal Plane Cooling
- ✓SAR
- ✓On Board Radio Navigation Receivers
- ✓Thermal SW tools & Space Environment SW I/F
- ✓Aerothermodynamics tools
- ✓Electro-Chemical Energy Storage (Batteries + Fuel Cells)
- ✓Microelectronics – ASIC/FPGA
- ✓Chemical propulsion (Components, Micropropulsion)
- ✓Green Propulsion
- ✓Electrical Motors
- ✓Ground Systems SW (+ functional verification)
- ✓Data Systems and On-Board Computers
- ✓On Board Payload data processing
- ✓On Board Software
- ✓TT&C Transponders and Payload Data Transmitters
- ✓Pyrotechnic Devices
- ✓Two Phase Heat Transport Systems
- ✓Power Management and Distribution
- ✓Inflatable and Deployable structures
- ✓Solar Array Drive Mechanisms
- ✓Upper stage propulsion
- ✓Avionics Embedded Systems
- ✓Optical Communication for space
- ✓System Data Repository
- ✓Microwave Power Breakdown Modelling and Characterisation
- ✓Antenna Reflectors for Telecom
- ✓Technologies for Hold-down, Release and Separation Systems
- ✓Critical Active RF Technologies
- ✓Electric Propulsion Technologies
- ✓Electric Propulsion Pointing Mechanisms
- ✓Solar Cells and Solar Generators
- ✓AOCS Sensors and Actuators
- ✓High Pressure Tanks and Vessels
- ✓Composite Materials
- ✓Space Radiation Environment Models and In-orbit Monitors
- ✓Radiation Test Facilities and Engineering Tools
- ✓Array Antennas
- ✓Lidar Critical Subsystems
- ✓Frequency & Time Generation and Distribution – Space
- ✓Frequency & Time Generation and Distribution – Ground
- ✓Technologies for Optical Remote Passive Instruments – Detectors
- ✓Technologies for Optical Remote Passive Instruments – Structures, Mirrors
- ✓Technologies for Passive mm and sub-mm Wave Instruments
- ✓System Modelling and Simulation Tools
- ✓Technologies for Formation Flying Metrology
- ✓Position Sensors
- ✓Micro-Nano Technologies
- ✓Additive Manufacturing
- ✓Multi-body Dynamic Simulation
- ✓Ground Station Technology

How it works

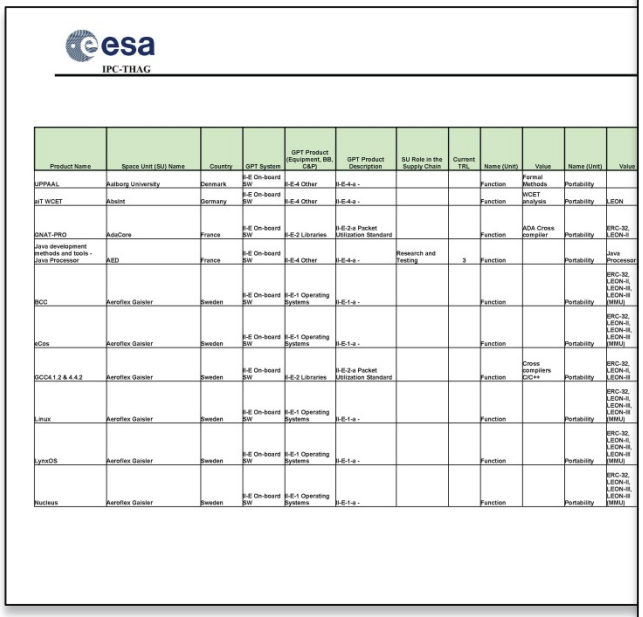




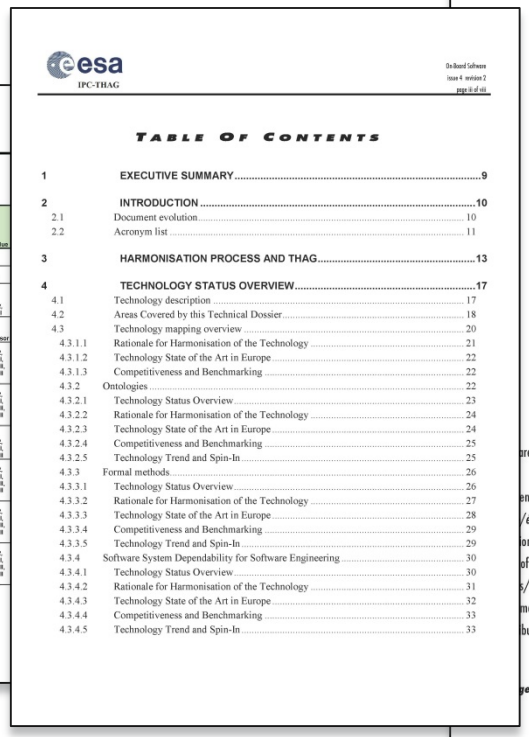
Output of Technology Harmonisation (1/2)

Per Technology addressed:

- Mapping of the situation inside and outside Europe, including identification of critical issues. Technical Dossiers provide a complete overview on technology addressed.


esa IPC-THAG

Product Name	Space Unit (SU) Name	Country	GPT System	GPT Product (Equipment, BB, C&P)	GPT Product Description	SU Role in the Supply Chain	Current TRL	Name (Unit)	Value	Name (Unit)	Value
UPPAAL	Aalborg University	Denmark	II-E On-board SW	II-E-4 Other	II-E-4-a -			Function	Formal Methods	Portability	
aiT WCET	AbsInt	Germany	II-E On-board SW	II-E-4 Other	II-E-4-a -			Function	WCET analysis	Portability	LEON
GNAT-PRO	AdaCore	France	II-E On-board SW	II-E-2 Libraries	II-E-2-e Packet Utilization Standard			Function	ADA Cross compiler	Portability	ERC-32, LEON-II
Java development methods and tools - Java Processor	AED	France	II-E On-board SW	II-E-4 Other	II-E-4-a -	Research and Testing	3	Function		Portability	Java Processor
BCC	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-1 Operating Systems	II-E-1-a -			Function		Portability	ERC-32, LEON-I, LEON-II, LEON-III (MMU)
eCos	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-1 Operating Systems	II-E-1-a -			Function		Portability	ERC-32, LEON-I, LEON-II, LEON-III (MMU)
GCC4.1.2 & 4.4.2	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-2 Libraries	II-E-2-e Packet Utilization Standard			Function	Cross compilers C/C++	Portability	ERC-32, LEON-I, LEON-III
Linux	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-1 Operating Systems	II-E-1-a -			Function		Portability	ERC-32, LEON-I, LEON-II, LEON-III (MMU)
LynxOS	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-1 Operating Systems	II-E-1-a -			Function		Portability	ERC-32, LEON-I, LEON-II, LEON-III (MMU)
Nucleus	Aeroflex Gaisler	Sweden	II-E On-board SW	II-E-1 Operating Systems	II-E-1-a -			Function		Portability	ERC-32, LEON-I, LEON-II, LEON-III (MMU)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On-Board Software
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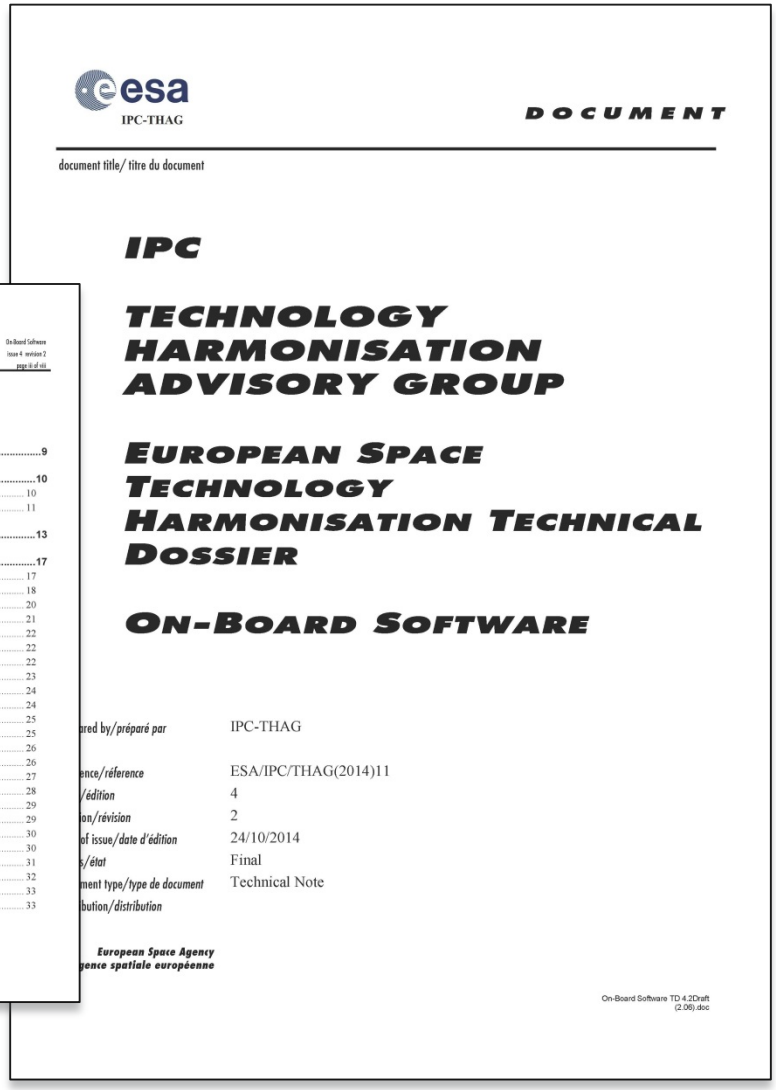
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DOCUMENT

document title/ titre du document

IPC

TECHNOLOGY HARMONISATION ADVISORY GROUP

EUROPEAN SPACE TECHNOLOGY HARMONISATION TECHNICAL DOSSIER

ON-BOARD SOFTWARE

ared by/*préparé par*	IPC-THAG
ence/*réference*	ESA/IPC/THAG(2014)11
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on/*révision*	2
of issue/*date d'édition*	24/10/2014
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bution/*distribution*	

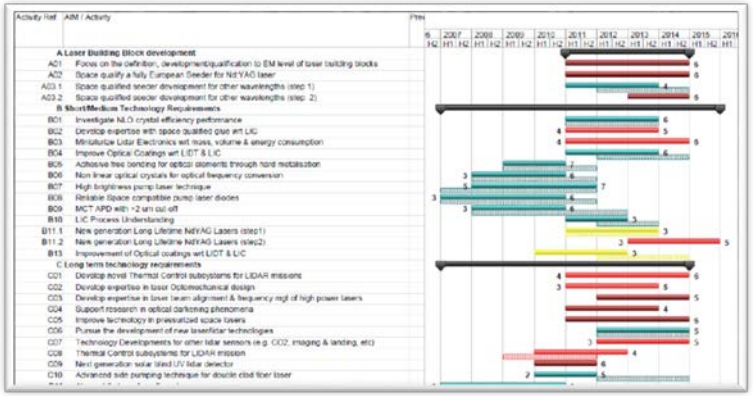
European Space Agency
gence spatiale européenne

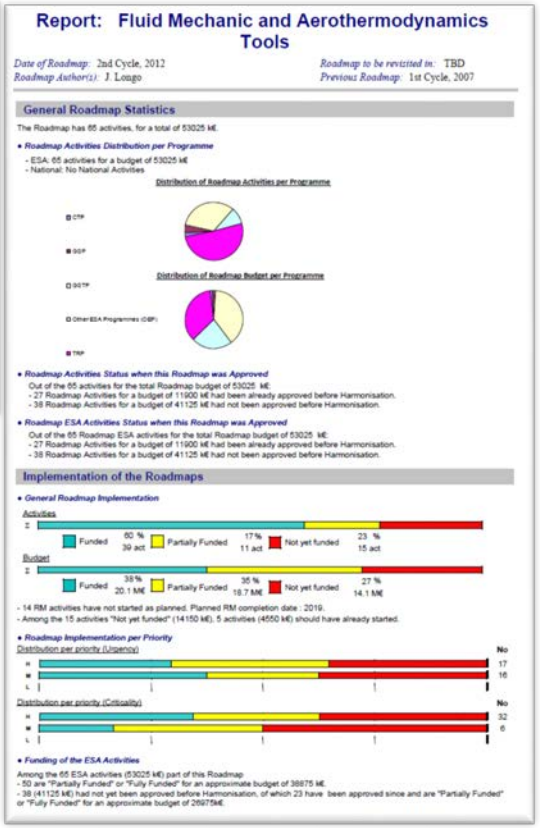
On-Board Software TD 4.2Draft (2.06).doc

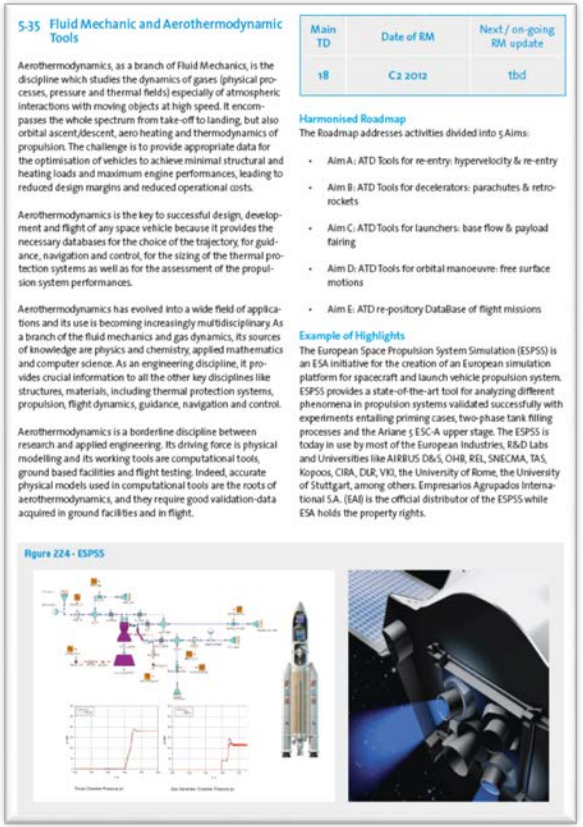
Output of Technology Harmonisation (2/2)

Per Technology addressed:

- **Technology Roadmaps** agreed at European Level with ESA, National Delegations and Industry. Note: Roadmaps are recommendations for decision makers and *not IPC Workplans / Procurement plans.*
- **Recommendations** agreed with ESA, National Delegations and Industry

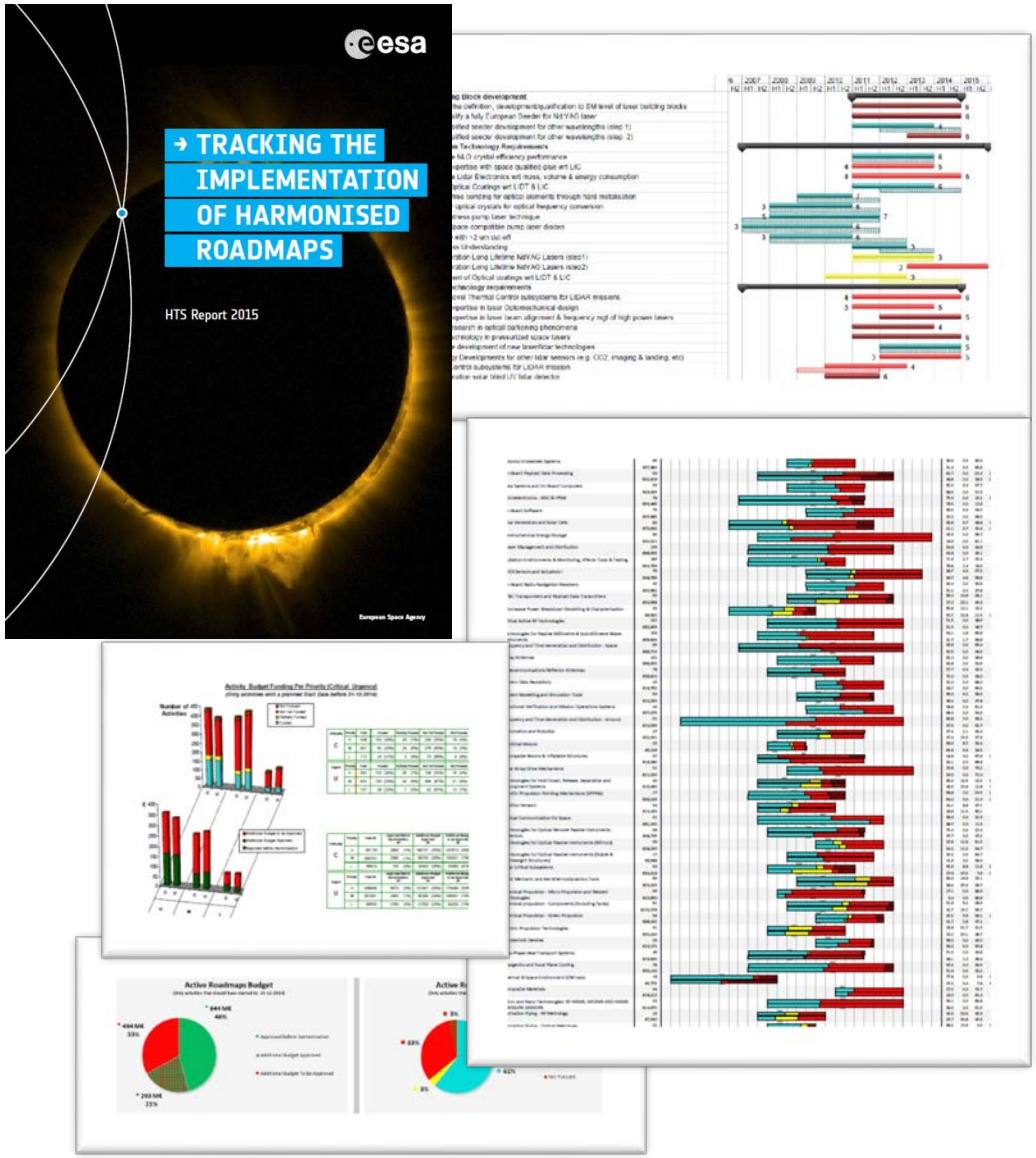






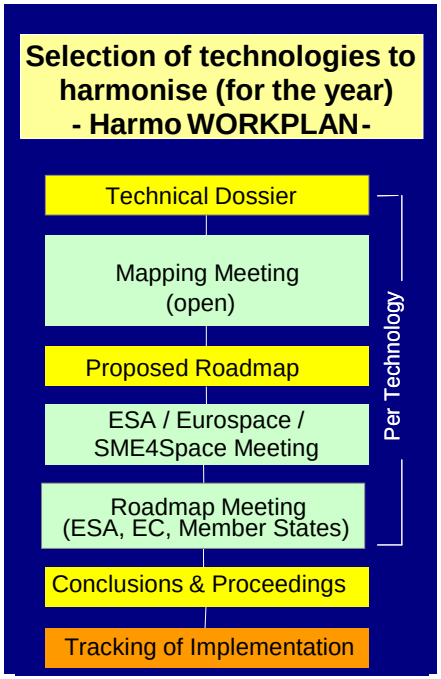
Follow-up / TRACKING Implementation

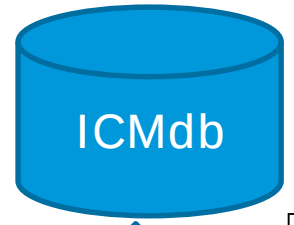
- Yearly Monitoring and Reporting on the **implementation of the agreed Harmonised Roadmaps** in ESA and Member State technology programmes
- Data collected from ESA experts and THAG
- Aggregated statistic and **Key Performance Indicator (KPI) for ESA Council**
- Individual reports for each Harmonised Roadmap

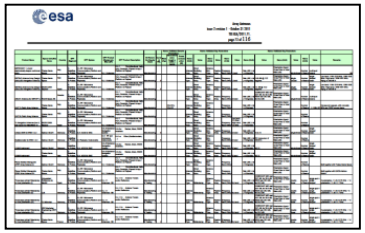


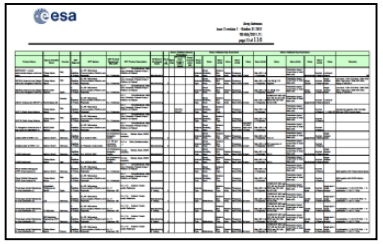
Industry Capability Mapping (ICM) db

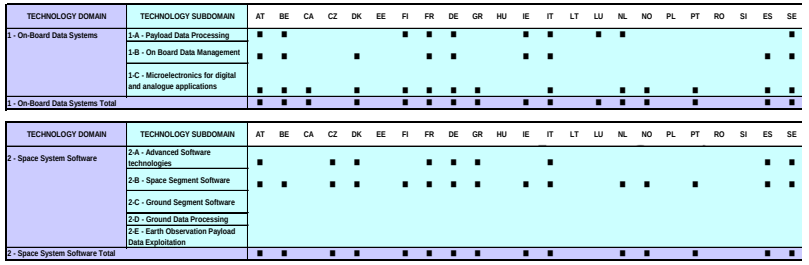
- Through the harmonisation process, information on products and competences of Space Units is reviewed, updated and validated
- Tables of the Technical Dossier concerning European State of the Art are generated by the ICMdb at the beginning of a harmonisation cycle
- The tables are updated through the harmonisation and reintroduced in the database at the end of a harmonisation cycle
- Competence tables generated for ESTMP









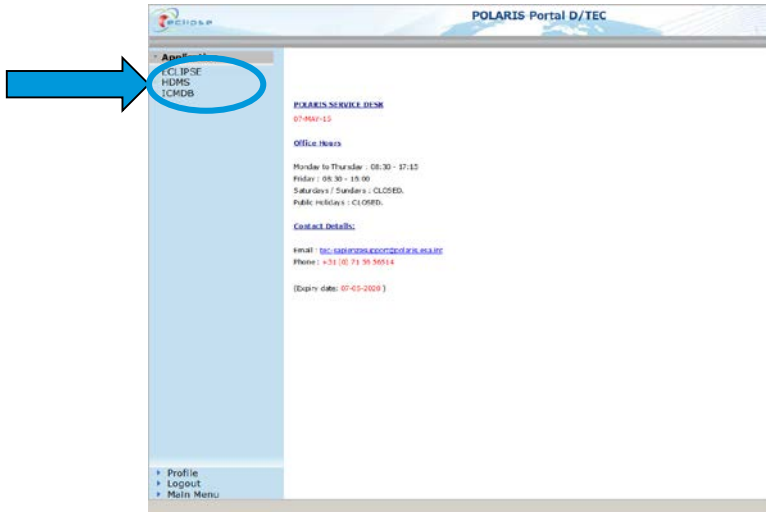


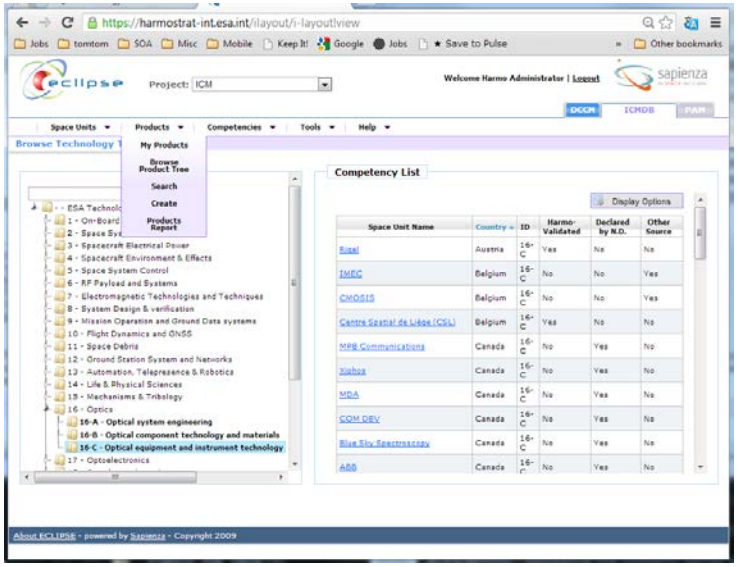
TECHNOLOGY DOMAIN	TECHNOLOGY SUBDOMAIN	AT	BE	CA	CZ	DK	EE	FI	FR	DE	GR	HU	IE	IT	LT	LU	NL	NO	PL	PT	RO	SI	ES	SE
1 - On-Board Data Systems	1-A - Payload Data Processing	■	■					■	■	■			■	■			■							■
	1-B - On Board Data Management	■	■			■			■	■			■	■									■	■
	1-C - Microelectronics for digital and analogue applications	■	■	■		■		■	■	■	■			■			■	■		■			■	■
1 - On-Board Data Systems Total		■	■	■		■		■	■	■	■		■	■		■	■	■		■			■	■

TECHNOLOGY DOMAIN	TECHNOLOGY SUBDOMAIN	AT	BE	CA	CZ	DK	EE	FI	FR	DE	GR	HU	IE	IT	LT	LU	NL	NO	PL	PT	RO	SI	ES	SE
2 - Space System Software	2-A - Advanced Software technologies	■			■	■			■	■	■			■									■	■
	2-B - Space Segment Software	■	■		■	■		■	■	■	■		■	■			■	■		■			■	■
	2-C - Ground Segment Software																							
	2-D - Ground Data Processing																							
	2-E - Earth Observation Payload Data Exploitation																							
2 - Space System Software Total		■	■		■	■		■	■	■	■		■	■			■	■		■			■	■

ICM Database + HDMS Access

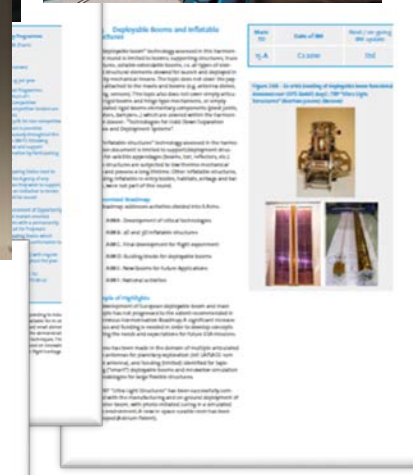
- All Harmonisation documents (TDs, RM, etc) available in the HDMS (Harmonisation Data Management System))
- Both the ICM DB and the HDMS are accessible online through https://harmostrat.esa.int
- Access is available upon request for all European Space Community representatives, ESA Community and THAG Delegates.
- Industry is encouraged to review the ICMdb and suggest updates through the Harmonisation process (via Eurospace, SME4Space and ESA Delegations) or directly to ESA





European Space Technology Master Plan - ESTMP

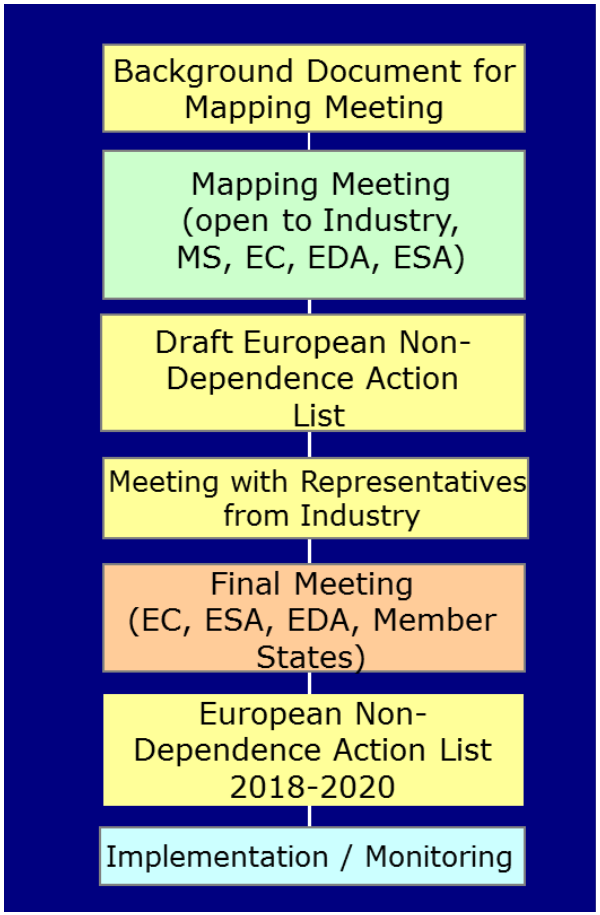
- Since its first publication over 10 years ago, the ESTMP is now a well established document and a true Master Plan for Space Technology development in Europe
- Includes information from ESA, its Member States and European Cooperating States, EC, EDA and other European technology stakeholders
- Provides visibility on the agreed European Roadmaps, their status and the European technology plans that implement them
- It is a shared instrument, resulting from cooperation amongst ESA, its Member States and other European stakeholders
- 2016 edition to be published in November
- Electronic version of the ESTMP can be requested by sending and e-mail to *estmp@esa.int*



Critical Space Technologies for European Strategic Non-Dependence - 2016

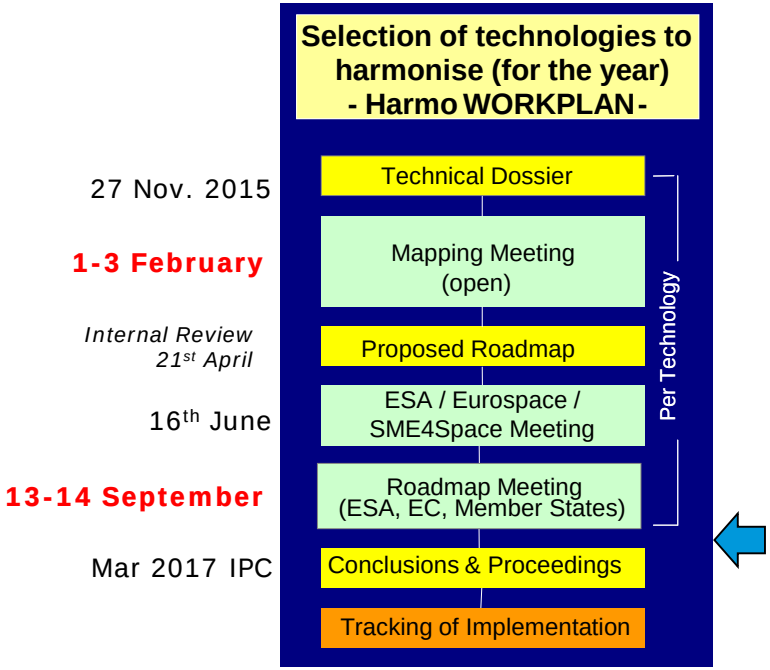
- The Commission-ESA-EDA Joint Task Force (JTF) is running the European Non-dependence process in 2016 with European stakeholders

- The objective is to agree on an updated list of Actions for 2018-2020 timeframe, to be used as an input for the preparation of institutional programmes addressing technology non-dependence



1st Cycle 2016 – Harmonisation of Avionics

Harmonisation Topic
Avionic Embedded Systems
Data Systems and On-Board Computers
On-Board Payload Data Processing
Microelectronics: ASIC and FPGA



- Mapping meetings (1-3 February)
  - 80 participants from 16 countries, European Commission
  - Coordination with CTB
- Roadmap meetings (13-14 September)
  - 4 Roadmaps discussed. Final documentation being prepared

Conclusions

- There is an acknowledged need to coordinate, harmonise and share information to ensure complementarity, promote synergies and avoid unnecessary duplication

- The European Space Technology Harmonisation is an established process, mapping the situation and establishing Harmonised Roadmaps with European stakeholders across the various European Programmes for a broad set of Technologies

- Success of the Harmonisation process depends on an active participation of all stakeholders and your continued support

european space technology harmonisation


esa
THANK YOU
harmo@esa.int