ESA Technology Programmes: TDE & GSTP

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Finnish Space Industry Days,
Helsinki 4th – 5th April 2019

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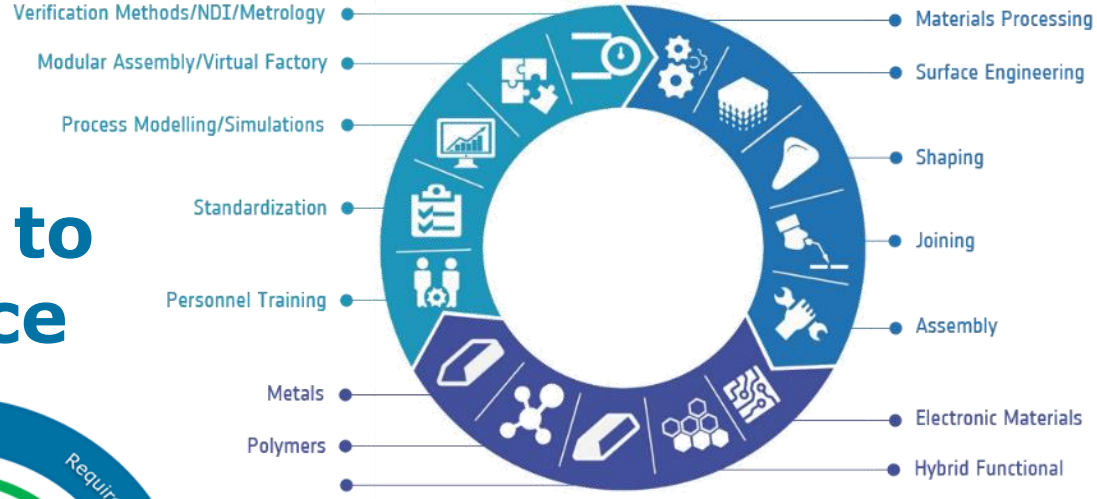
Technology Programmes Objectives

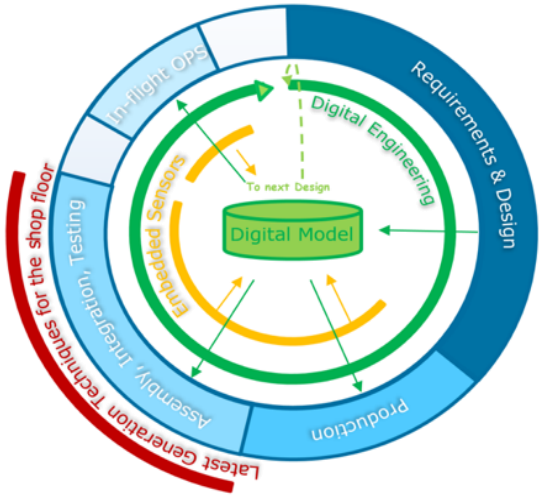
- **Enabling** missions of ESA and national programmes by developing technology
- Fostering **innovation** by creating new products
- Supporting the **competitiveness** of European industry
- Improve European **technological non-dependence** and availability of European sources for **critical technologies**
- Facilitate **spin-in** from outside the space sector

Technology Themes

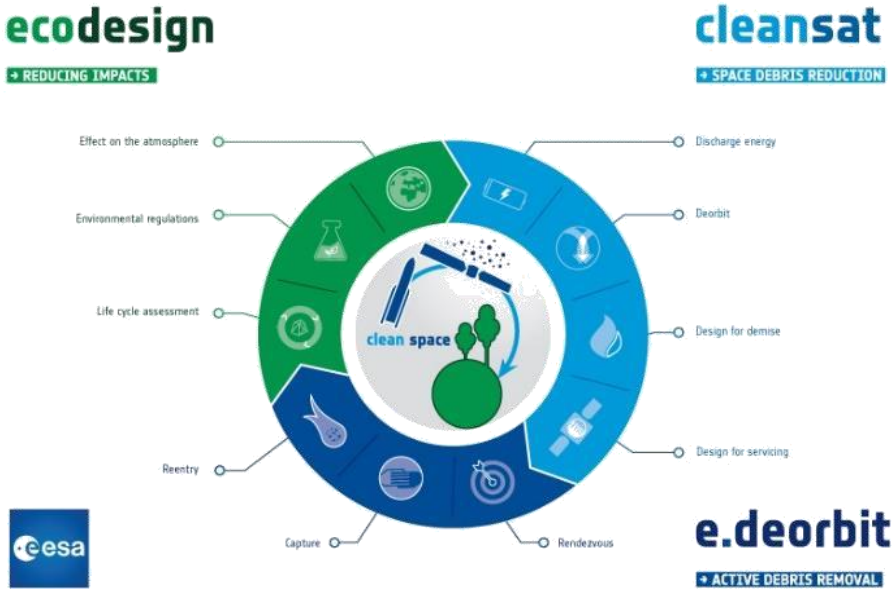
Advanced Manufacturing



Design to Produce

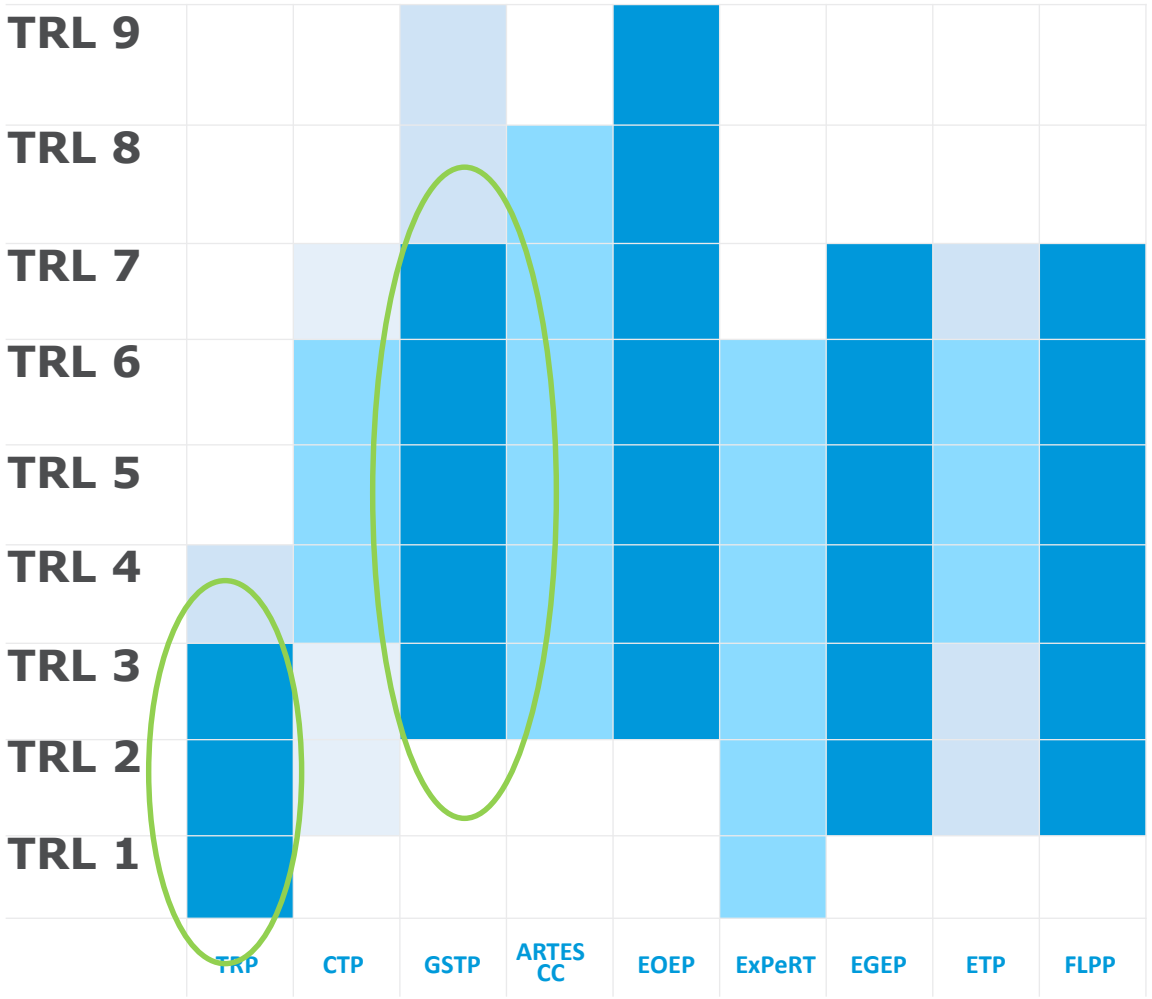


Cleanspace



CyberSecurity

ESA Technology Programmes



Mandatory programmes

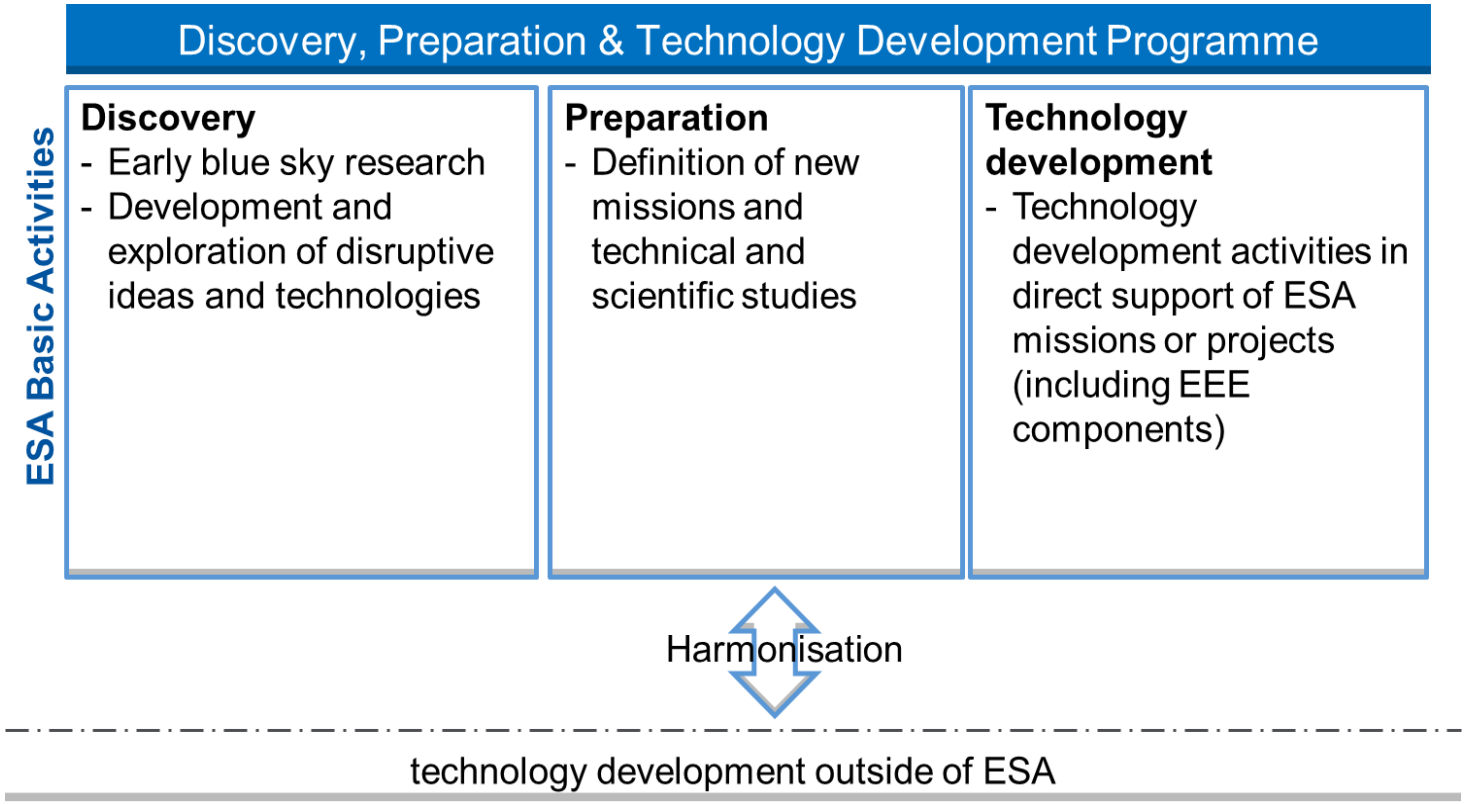
TDE/TRP (Technology Development Element)
CTP (Science Core Technology Programme)

Optional programmes

GSTP (General Support Technology Programme)
ARTES
- ARTES AT (Advanced Technology)
- ARTES C&G (Competitiveness and Growth)

EOEP (Earth Observation Envelope Programme)
SciSpacE (Science in Space Environment)
ExPeRT (Exploration Preparation, Research & Tech)
EGEP (European GNSS Evolution Programme)
FLPP (Future Launchers Preparatory Programme)

Discovery, Preparation & **Technology Development**



Technology Development Element (TDE), formerly TRP

- Covers **all** technology disciplines & applications up to TRL 4
- Based on two-year work plans, with yearly updates
- 50 M€ in industrial contracts per year

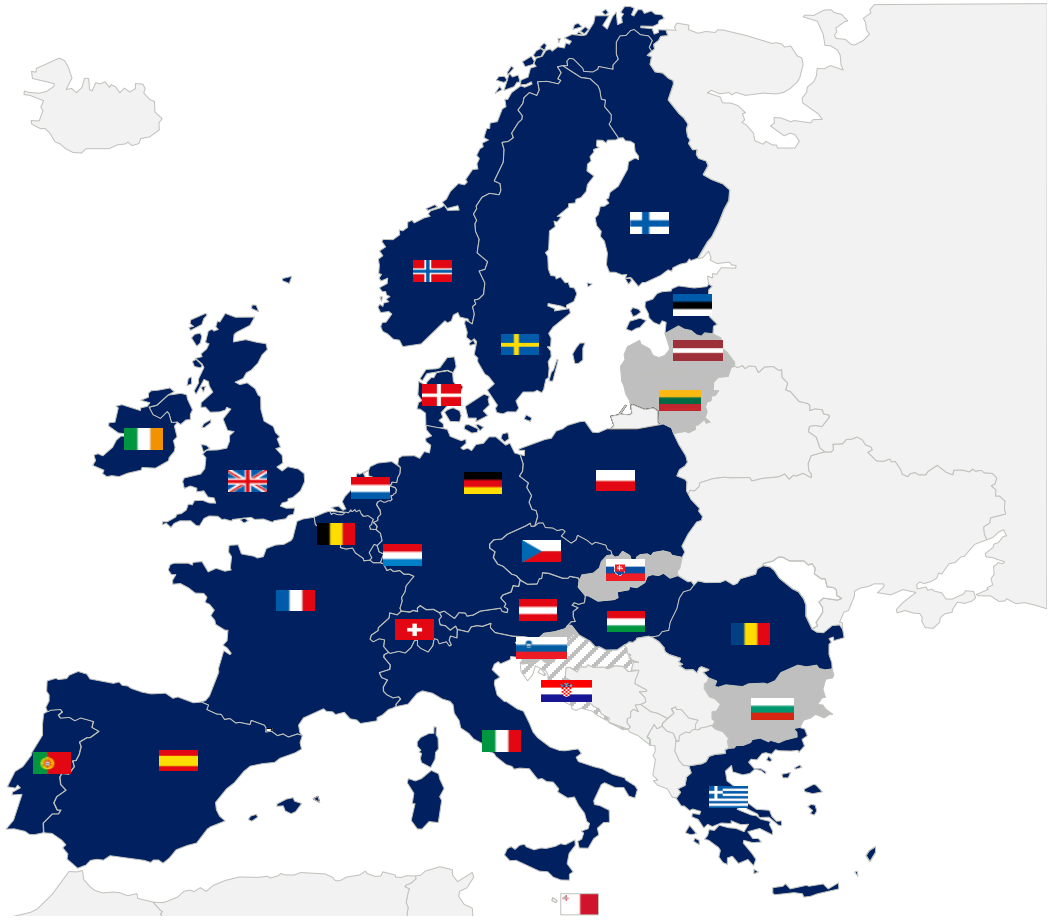
New TDE workplan (2019-2020)

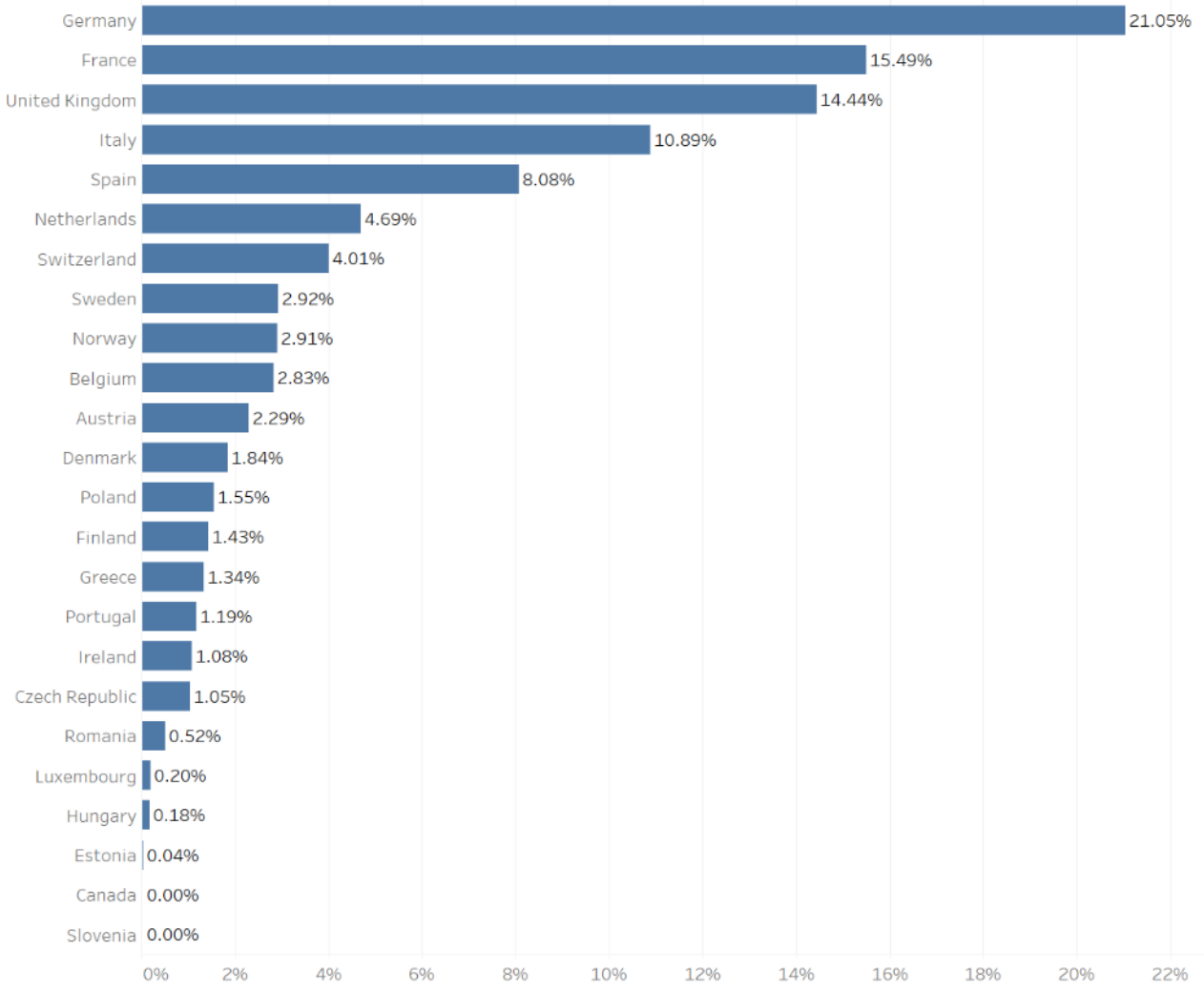
- 197 activities (€78 million)
- Activities presented at the November IPC
- Work plan for 2019 approved by IPC on the 25th of February 2019
- Invitations to tender for each activity are published throughout the year: **see emits.esa.int**

Domain	# of activities	Budget (M€)
Earth observation	28	12
Exploration	35	12
Space transportation	16	6
Telecommunication	12	6
Navigation	12	6
Generic technologies & techniques	94	36
Total TDE 2019-2020	197	78

Countries participating in TDE activities

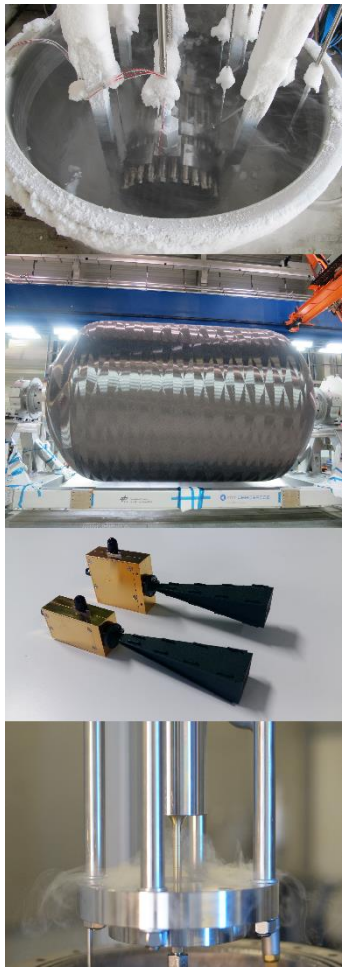
Activities Country Distribution (2013 to 2018)





General Support Technology Programme

- Part of **ESA's Optional Programmes**
- All ESA Members (22) plus Canada and Slovenia are participating.
- Each Participating State decides upon:
  - The amount of its participation.
  - The technological activities to support.
- Covering **all technology disciplines** and applications except Telecommunications
- GSTP subscription since 2013 1,100M€ million / ~ € 100M€ in commitments of activities in 2018.
- **Work plans,** with yearly updates, and multiyear activities / **frameworks** (e.g. de-risk) /**Announcement of Opportunity**



The GSTP ensures the right technology with the right maturity are available at the right time

GSTP 25 YEARS

GSTP EVOLUTION (1993-2020)

PROBA 1 (2001)

ERC32
Goce (2009), Sentinels (from 2014)

Advanced Crew Terminal
Columbus on ISS

Digital Signal Processor (DSP 21020)
ROSETTA (2004-2016)

50.5 M€

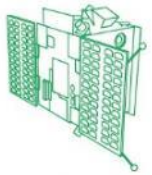
Sloshsat FLEVO (2005)

Leon Processor
Alphasat (2013), Proba-V (2013), Sentinels (from 2014) and BepiColombo (2018)

Launcher Payload Separation System
Ariane 4 and 5

Autocorrelation Spectrometer Chip-Set
SMART (2003)

119.8 M€



PROBA 2 (2009)

Active Pixel Sensor
BepiColombo (2018)

High Performance Green Propulsion

Common Procedure Language (ESSC)

TMA Telescope
Rapid Eye (2008), Proba V (2013)

MELISSA
Regenerative life support systems

EXPERT
European Experimental Re-entry Testbed

242.5 M€

VEGA TVC - Thrust Vector Control (2012)

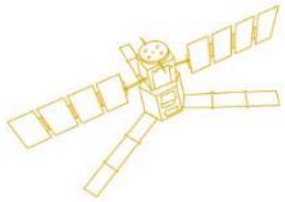
GIOVE Test Receiver
GALILEO

MEMs Rate Sensor
CryoSat 2 2010

GPS POD
Sentinels (from 2014)

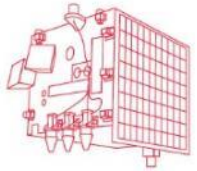
ANITA Gas Monitor (ISS)

SCOC3 System On a Chip



SMOS - MIRAS Instrument (2009)

319.6 M€



PROBA V (2013)

AIS on ISS
Space Based Automatic Identification System Receiver

Hybrid Low Cost Magnetometer
ADM-AEOLUS (2018)

Lightweight APS-based Star Tracker
BepiColombo

Nodding Mechanism on ISS

Nanomaterials Composites
Nanotube skeleton reinforcement

ETP - Energetic Particle Telescope
PROBA V (2013)

296.2 M€

OPS-SAT

GAMIR Receiver
First with Galileo signal

White Thermal Coating
Solar Orbiter (2019)

CHEOPS
Development of the AIT and MOC

IBDM International Berthing and Docking Mechanism
ORION

EGS-CC (2019)
European Ground Systems Common Core

PROBA 3 (2020)

500 M€

GOMX-3 (2015)

GOMX-4 (2018)

Friction Stir Welding Advanced Manufacturing
3D printing, surface engineering, shaping, joining and assembly related activities.

Digital Engineering
Structure optimization, structural efficiency and progressive damage prediction of fit-for-purpose hardware using software tools.

Clean Space
Initiative for reduction of the environmental impact of space activities.

Synergistic Air-Breathing Rocket Engine

Electric Propulsion Alternatives
Micro-colloid Thruster, IFM Nano Thruster

QARMAN CubeSat

Reuse and upgrade of Space Antenna
Azores, Portugal

602 M€

1993 1997 2000 2004 2009 2012 2016 2019

GSTP-1 GSTP-2 GSTP-3 GSTP-4 GSTP-5 GSTP

European Space Agency

GSTP Structure

✓ GSTP, activities are performed under three distinct Elements. The Programme also allows for the creation of dedicated 'Components' by Participating States to cater for larger projects, i.e. small satellites and larger developments.

➔ GSTP Element 1 "Develop"

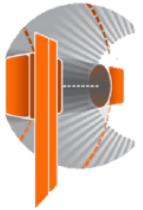
- Dedicated to the development of technologies, building blocks, components and test beds for projects from low TRL to qualification.
- Support the implementation of the technology development targets of ESA and current and future cross-cutting technology themes.

➔ GSTP Element 2 "Make"

- Market driven, industry initiated, co-funded direct negotiation activities
- Strengthen worldwide competitiveness in new and existing markets.
- Develop products in response to gaps in the supply chain e.g. by environmental regulations, migration to new technology and other causes.

➔ GSTP Element 3 "Fly"

- Implements in orbit demonstration of technologies either as products in need of acquiring flight heritage, hosted payload or complete space missions
- Conduct investigations and studies to prepare for future missions
- Fly small missions responding to MS's requests



➔ Precise Formation Flying Component

- Implements the phases C/D/E of the PROBA-3 mission in view of the demonstration of Precise Formation Flying (PFF) technologies and techniques.

GSTP Element 1 "Develop": **Compendia**

- The GSTP E1 Develop Compendium is a **compilation of activity proposals that are considered top priority for ESA**.
- Activity proposals and selection of activities made by representatives of the technical and application domains and internally coordinated.
- It covers all application domains (with the exception of Telecommunication) and specific areas.
- The **objective** of the Compendium is **to trigger discussions among industry and Delegations** of the GSTP Participating States with the aim that the activities are supported and implemented within the GSTP WP.

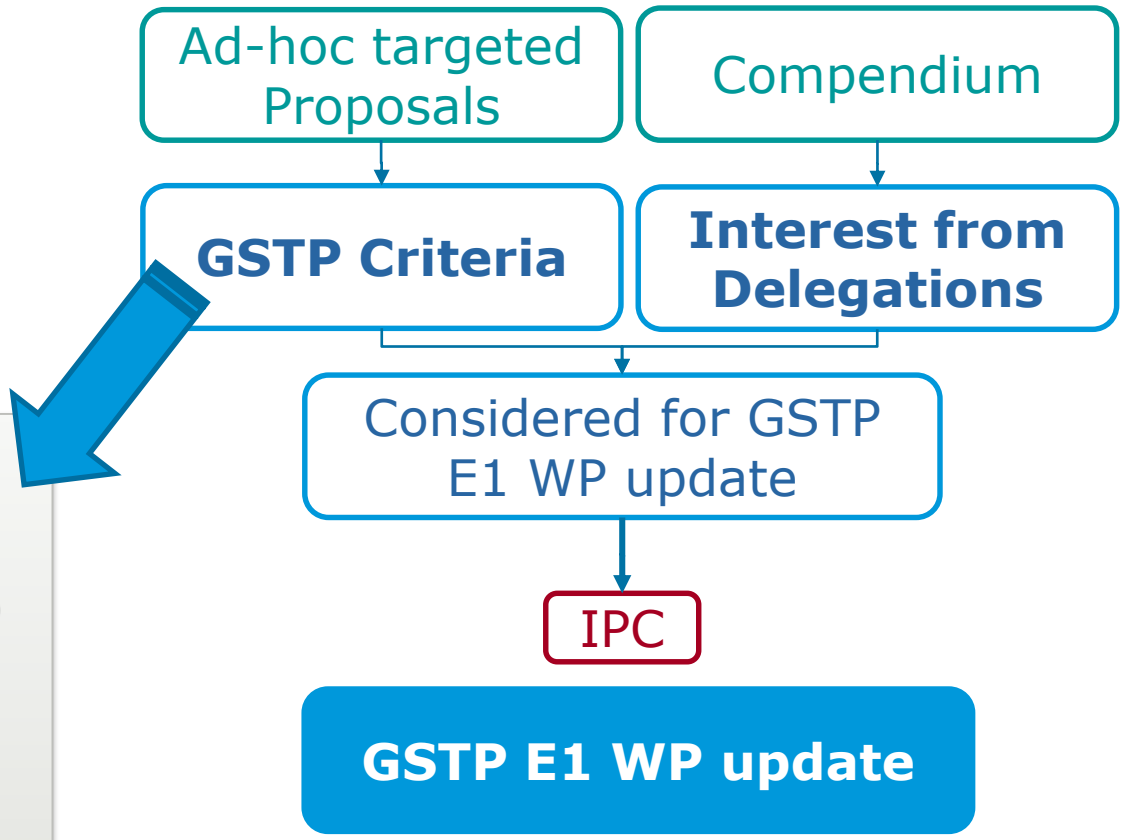
The GSTP E1 "Develop" Compendium of Potential Activities 2017 (ref. ESA-GSTP-TECT-PL-005452), issued in June 2017 includes 143 Activities (~140M€).

GSTP Element 1 Develop: **Work Plan (WP)**

Development of technologies and products from low TRL to qualification Platform, Payload, Ground Segment and Engineering tools
Activities to develop of technologies and products that are ESA driven and/or to develop industrial capabilities in ESA Member States

- Programmatic: TRLs, Application, Consistency of scope /deliverables /TRLs,
- Continuation of previous activities (TRP, GSTP...)
- Innovation? Competitiveness? Enabling mission?
- Industrial sustainability / Capacity Building
- Interest from Delegations + Funds Availability

Proposal GSTP E1 WP update



GSTP Element 1 - Develop: **Frameworks**

- Roughly 10-25 activities approved in GSTP work plan 5 x per year (including activities from the Compendia and ad-hoc proposals.
- **Frameworks introduced to implement specific types of activities faster**

- Frameworks in operation:
  - G61A-036QT, Assessing the use of Advanced Manufacturing to improve and expand space hardware capabilities
  - G617-241TA, Assessments to prepare and de-risk technology developments
  - GT17-136TI, Activities to bridge national technology developments
  - GT17-137TI, Preparation of enabling space technologies/capabilities

GSTP Element 1 - Develop: **Frameworks**

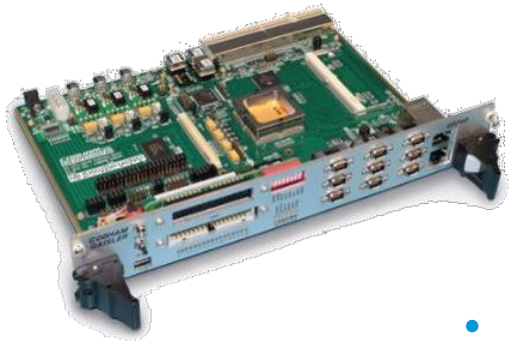
G61A-036QT, Assessing the use of Advanced Manufacturing to improve and expand space hardware capabilities

- Maximum €250K per activity, expected activity duration: 12 months
- It allows entities with a background in space to assess the use of advanced manufacturing to improve their product range and benefit from the expertise and know-how of a recognised applied research organization.
- Tasks:
  - Impact analysis of the use of advanced manufacturing
  - Selection of a few product improvement/expansion opportunities
  - Preliminary design and breadboarding to verify and validate analysis
  - Preparation of a development and qualification plan

9 contracts in 3 Member States, 6 activities under procurement

ESA procurement time: 4 months

GSTP Element 1 - Develop: **Frameworks**



G617-241TA, Assessments to prepare and de-risk technology developments

Aim: evaluate added value, address critical issues, orient follow-on activities

- Activities include at least one of the following tasks:
  - Analysis of specifications, development actions, schedule and cost
  - Assessment of the benefits and disadvantages of the solution with respect to the state-of-the-art
  - Assessment of critical issues related to using a given technology for a specific application, using analysis/simulation and/or breadboarding
- <200 K€ (<80 K€ for studies) / Duration maximum 9 months
- 90 activities initiated so far for more than 15 M€ in 15 countries
- **ESA procurement time: <u>3-4 months</u>**

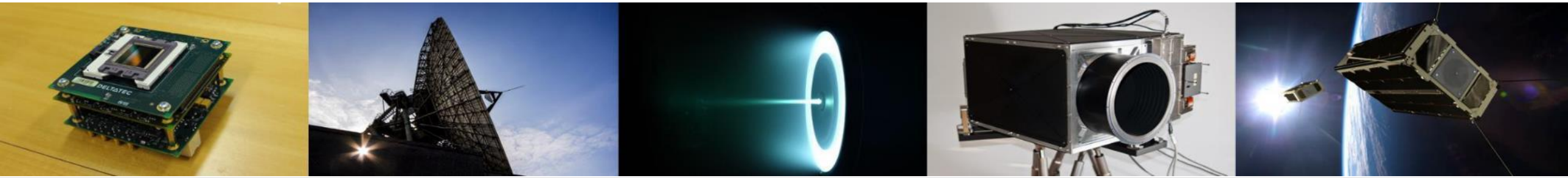
GSTP Element 1 - Develop: **Frameworks**

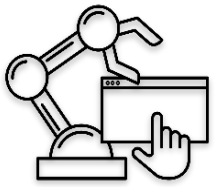
GT17-136TI, Activities to bridge national technology developments

- facilitates the continuation in the ESA context of technology developments performed in a national programme
- <€250K / Duration maximum 12 months

GT17-137TI, Preparation of enabling space technologies/capabilities

- targeted and coordinated development of capabilities in a given ESA Member State or across different Member States
    - nominal technology development activities, with typical deliverables
- < €500K per activity
- Support received from 4 Member States.
- 4 contracts and 3 under procurement / **ESA procurement time: <u>5 months</u>**





GSTP Element 2 - Make

Objective: offer to industry a mechanism for submitting at any time **unsolicited proposals** for market-oriented technology activities. A realistic business plan to be included – customer well identified (not only ESA projects)

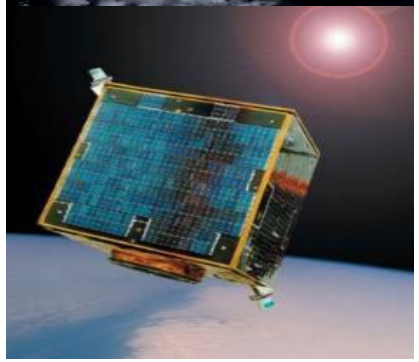
Funding schemes:

	SME	Non SME	Research Inst. & Universities
TRL <= 5	Up to 75%	Up to 75%	Up to 100% (<30% total)
TRL > 5	Up to 75%	Up to 50%	Up to 75%

Permanent call open in EMITS (AO7935)

90 activities now ongoing cover a broad range of products from component to systems level

GSTP Element 3 Fly



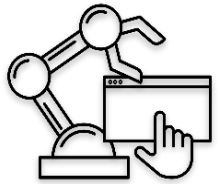
- In-orbit Demonstration of technologies and products
  - Target TRL is **7-8**
  - Essential for products requiring **flight heritage** for customers
  - Does **not** include technology development (Element 1)
- Flight **opportunities** are identified with ESA projects and launchers, with National agencies and with primes, and with commercial missions
- Accommodation/assessment study framework
  - Experiment accommodation (e.g. materials experiments)
  - Sound rocket / launcher service studies
  - In-orbit demonstration related systems (systems, payloads…)
- Cubesat framework

GSTP in 2019

GSTP in 2019 - Summary

GSTP E1 Develop – New GSTP Compendia 2019

- Generic Technologies and Techniques
- Sectorial key themes: Advance Manufacturing, Operations Innovation, Design to Produce, Artificial Intelligence, Cybersecurity



GSTP E2 Make – Segmentation:

- Segment 1: "Market Oriented Opportunities"
- Segment 2: "Strategic Opportunities"
- Segment 3: Implementation of National Priorities

GSTP E3 Fly

- Enabling new flight opportunities for in-orbit demonstration
- Segmentation of the cubesat framework

GSTP in 2019

New GSTP Compendia 2019

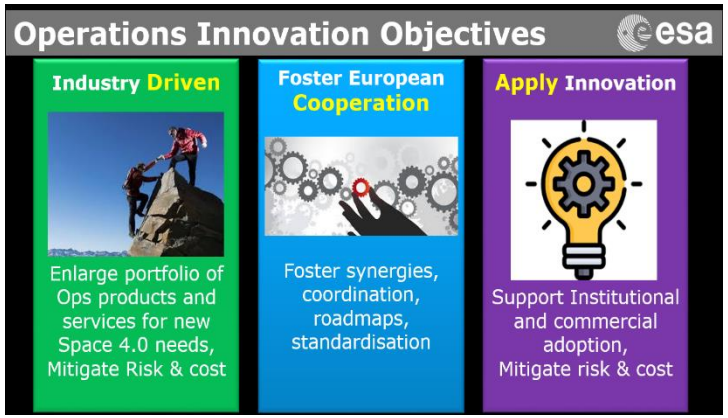
- Implementation in GSTP E1 WP
- Compendia intended to be published in EMITS NEWS in Q4 2019

- **ESA Driven:**
  - **Generic Technologies and Techniques** - Activity proposals and selection of activities made by representatives of the technical and application domains and internally coordinated.
  - **Advance Manufacturing** – Build-up on achievements from 2015 AM compendium/ESA expertise/dialogue with Industry.

- **Industry Driven - Open Calls for European Industry for submission of ideas/ topics of interest:** Issued through targeted calls to identified themes:
  - **Operations Innovation**
  - **Digital Engineering/Design to Produce**
  - **Cybersecurity**
  - **Artificial Intelligence**

GSTP in 2019

Operations Innovation – First GSTP Cross-Sectorial Area Call under preparation



Operations Innovation Themes:

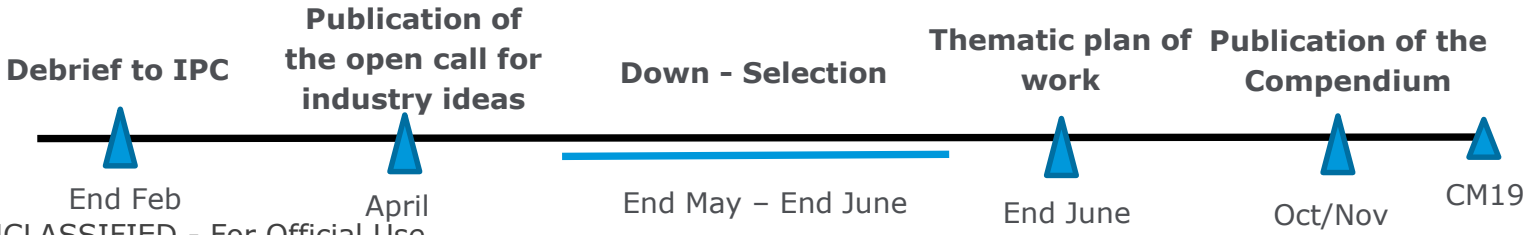
- Mission Operations Methodology
- Mission Operations Data Systems
- Astrodynamics Solutions
- Ground Stations

Central Gateway for ideas for GSTP: Independent campaigns for the specific themes

Revision/Evaluation of the ideas.

Channeling of the activity proposals through the different GSTP Mechanisms: Sectorial area compendium, E1 frameworks, E2.

Indicative timeline:



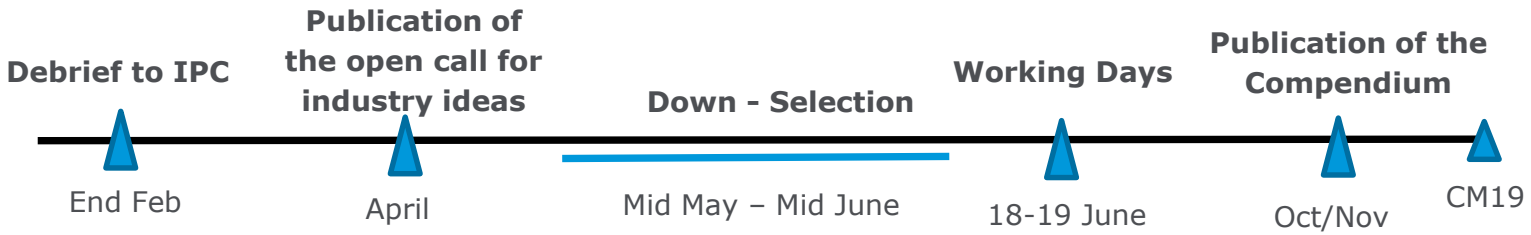
GSTP in 2019

Additional Targeted calls under preparation on the following themes:

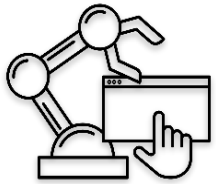
- **Digital Engineering/Design to Produce**
- **Cybersecurity**
- **Artificial Intelligence**

Indicative timeline:

- April 2019 - Open Call for Ideas
- **18th 19th June 2019 – Estonia Working Days.** Revision/Evaluation of the topics of interest and open iteration with industry through panels discussions/ round tables and presentations.



GSTP 2019 Evolution



GSTP E2 "Make" New Approach in preparation

Segment 1 Market Oriented Opportunities	Segment 2 Company Strategy Oriented Opportunities	Segment 3 National Priority Opportunities

- **Segment 1**: For market oriented activities, entities implement the classical approach and propose product developments targeting commercial market opportunities. They present the nominal business case.
- **Segment 2**: Entities propose developments of strategic relevance (i.e. leverage non-space capabilities for space, expand operations in the space domain or maintain strategic know-how).
- **Segment 3**: Entities propose activities that address specific priorities of ESA Member States. Countries may wish to maintain and develop capabilities that serve different national space considerations.

Economic Operator	Pre-outline	Outline Proposal	Full Proposal
Entry Point 1: Mature (entities with established market/product experience & with financial solidity)			+
Entry Point 2: Intermediate maturity level (with limited experience for the targeted market/product)		+	+
Entry Point 3: Limited maturity (entities just created and/or limited commercial market/product experience)	+	+	+

GSTP 2019 Evolution

GSTP E3 “Fly”

Evolutions under consideration related to:

- **Enabling new flight opportunities for in-orbit demonstration**

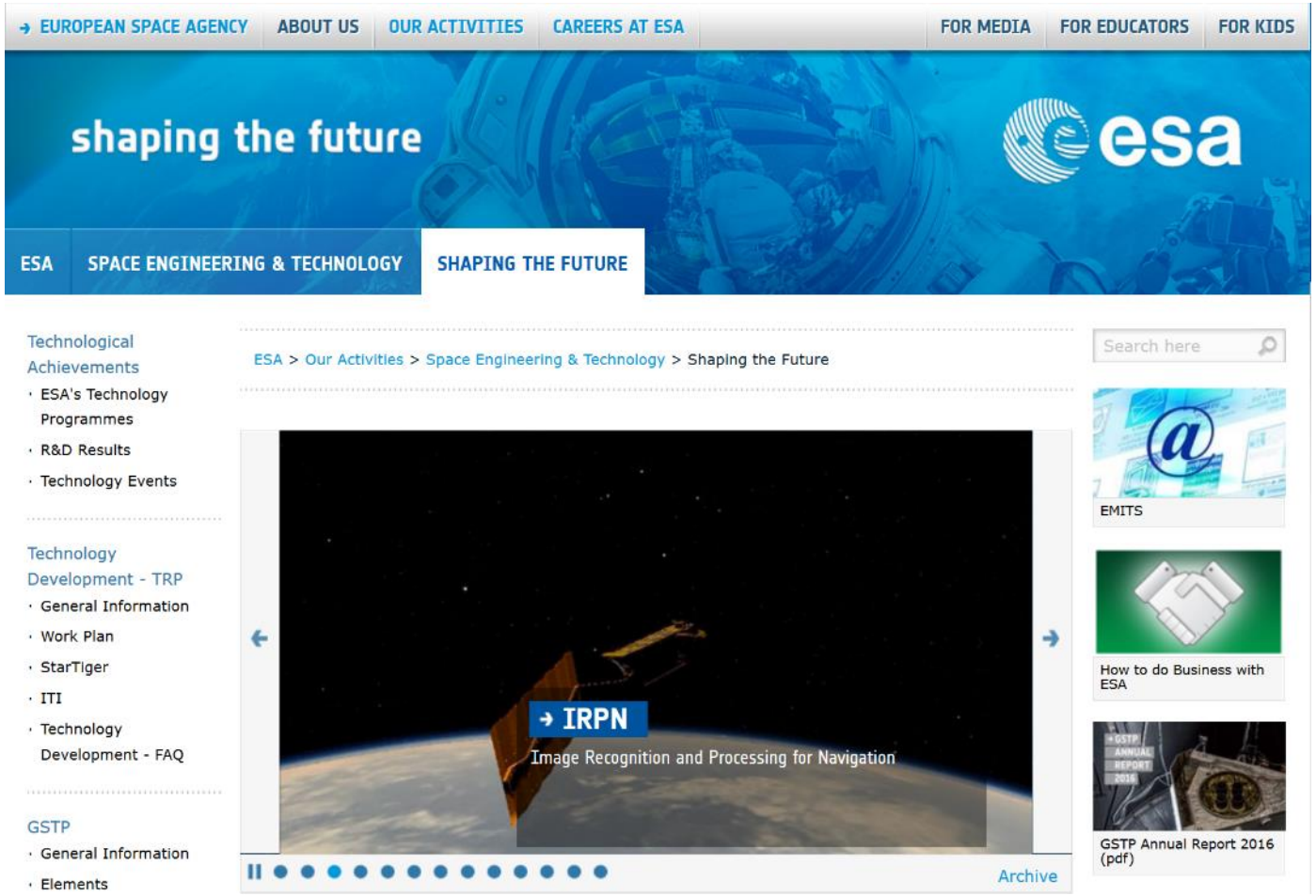
  Identifying/investigating the use of various types of flight opportunities that become available (e.g. flight opportunities on the International Space Station via initiatives such as ICE Cubes, Bartolomeo additional interfaces on main missions, etc.). These opportunities may be used to follow-up on recent GSTP technology development activities.

- **Cubesat projects:**

  Builds on the current experience with the cubesat projects under execution and under preparation. The projects bring large diversity in terms of the objectives and applications and also in terms of the experience and the economic nature of the entities that are involved. In this context, a segmentation of the projects is under consideration in order to tailor, for instance, the type of oversight (i.e. project and technical management) for a given project.

Dissemination and promotion of technology results

ESA website: Shaping the future



General information on the TDE and the GSTP programmes

Main achievements within technology programmes

Contacts with the Team

http://www.esa.int/Our_Activities/Space_Engineering_Technology/Shaping_the_Future

Space Engineering & Technology Final Presentation Days

- ✓ Advertise the achievements of the ESA technology programmes,
- ✓ Disseminate the results from recently completed R&D technology activities to a diverse and wide audience,
- ✓ Cover a broad range of technology developments from different technical competence domains,
- ✓ Bring together technology experts from European Industry, Academia and ESA to discuss Space R&D,
- ✓ Provide a forum for participants to share their views on R&D directions, strategies, technologies and investments.

Next SET-FPDs event is scheduled for 2nd, 3rd and 4th July

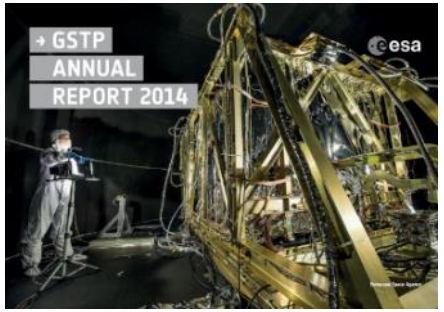
Each day will be dedicated to different topics, e.g. Electronics, Detectors, Advanced Material & Manufacturing, Electric Propulsion.

During the event will be shown the first results of the de-risk activities

GSTP on the ESA web pages

GSTP annual reports available online:

https://esamultimedia.esa.int/docs/GSTP/GSTPAnnualReport2017.pdf



Thank you for your attention

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Visit the GSTP Web side on “Shaping the Future”:

http://www.esa.int/Our_Activities/Space_Engineering_Technology/Shaping_the_Future/About_the_General_Support_Technology_Programme_GSTP