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GRIDDED ION ENGINE STANDARDISED ELECTRIC PROPULSION PLATFORMS GIESEPP

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CONTENT

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OBJECTIVES AND EXPECTED IMPACT

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GIESEPP – OBJECTIVES (1/2)

The aim of the GIESEPP program is to develop standardized Gridded Ion Engine Systems (GIESEPP), including Gridded Ion Engines (GIE), Power Processing Unit (PPU), Xenon Propellant Management System (XPMS) and Neutralizer Cathodes, to meet the future needs of the competitive GEO Telecoms, Navigation and LEO Constellation markets as well as for Space Transportation, Exploration and Interplanetary Missions. In particular our aims are to:

- Gain worldwide technology leadership in the fields of high Isp electric propulsion and Xenon fluid control systems and maintaining and securing European non-dependence
- Achieve a significant reduction of the EPS cost, targeting at least a 30% reduction of the current European products.
- Standardization of testing sequences and methods for significant cost reduction for the recurring phase
- Incrementally develop the European RIT-series and T-series GIE thrusters to improve performance (Dual Mode Functionality), share common interfaces and components (common Neutralizer) wherever possible, and drive down thruster costs
- Develop a PPU design that has the capability to drive either the T-series or the RIT-series thrusters, whilst driving down costs.
- Develop and implement an XPMS (Propellant Control) design that reduces complexity, mass and cost
- Assess and select an alternative propellant, and perform confidence tests using this propellant with breadboard model RIT-series and T-series GIE

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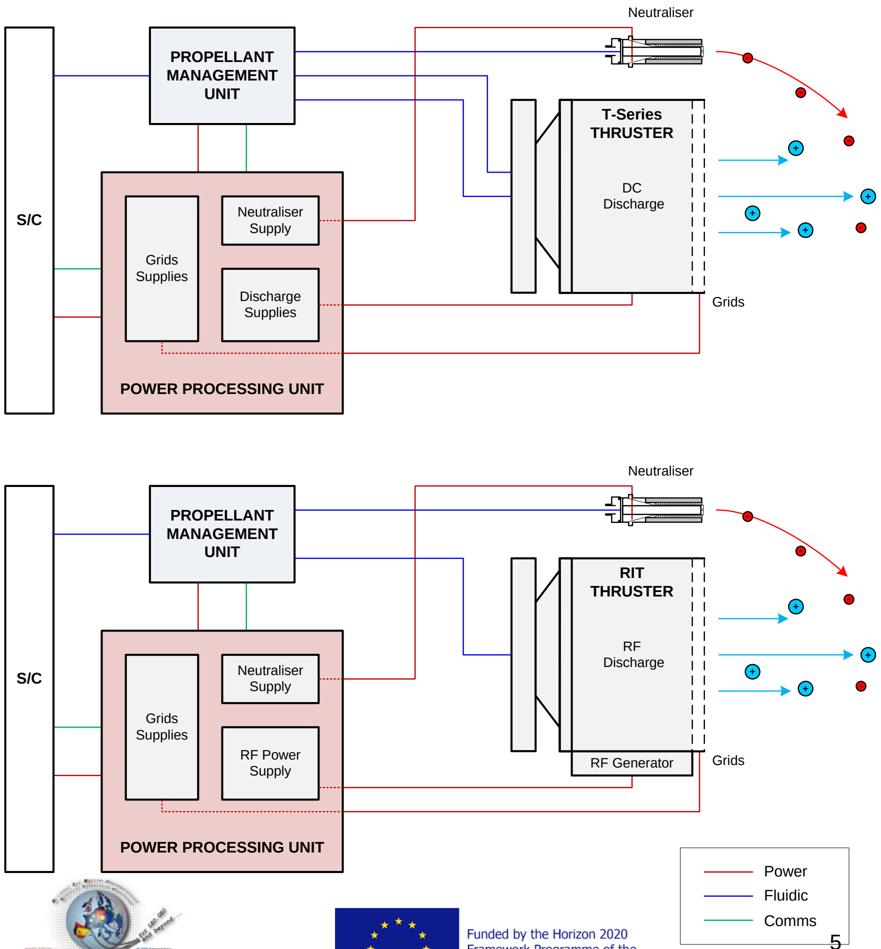
GIESEPP – OBJECTIVES (2/2)

Develop, build and test the first European Plug and Play Gridded Ion Engine Standardized Electric Propulsion Platform (GIESEPP) to operate Ariane Group and QinetiQ Space ion engines



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IMPACT AND AMBITION

The competitive advantage of GIESEPP technology undermines the necessity of maintaining and further developing Gridded Ion technologies in Europe:

- The GIESEPP technology has unique design feature which provides high performance at low complexity
- The GIESEPP can deliver the highest Isp and will lead therefore to the highest mass saving, resulting in half xenon mass compared to other technologies, smaller tanks and lower operating pressure. It is the best solution for satellite station keeping.
- For EOR, GIESEPP ensures thanks to the Dual Mode capability of the thruster high thrust performance and therefore overcomes the disadvantage w.r.t. to other technologies.
- With increasing payload power, the RIT system advantages become more dominant. Therefore the GIESEPP technology has the highest growth potential.

State of the Art (Pre GIESEPP)	Beyond State of the Art (Post GIESEPP)
• 5k W EP systems for single GIE thruster types (T and RIT series) • High PPU cost • Isp either below 2000 or above 4000 s • Low TRL or Part obsolescence for low power GIE EP Systems • Dingle unit production capacity for low and high power EP system • No high power commercial solution for 20kW segment • Xe as standard propellant	• EP system for transfer missions at 30% reduced cost and complexity for European competitiveness operating with no changes as plug and play for both QinetiQ and ASL thrusters • High performance thrusters operating in dual mode at a large range of specific impulses (2500 – 6000 s) to close the gap in performance range • Low cost EP system for small satellite mega constellation • Commercial high power systems • High production capability for low cost EP • Xe as standard propellant and additional alternative propellants

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CONSORTIUM AND COMPETENCIES

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CONSORTIUM AND COMPETENCIES

Alternative Propellants
University of Southampton

Analytical Design and Test Support
Mars Space

Satellite System Requirements
OHB

Testing
QinetiQ / ArianeGroup

GIESEPP
Project Needs
and
Team Involvement

Thrusters
ArianeGroup / QinetiQ

Propellant Control
AST

System Engineering
ArianeGroup / QinetiQ

PPU
CRISA / Airbus DS

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GIESEPP CONCEPTS

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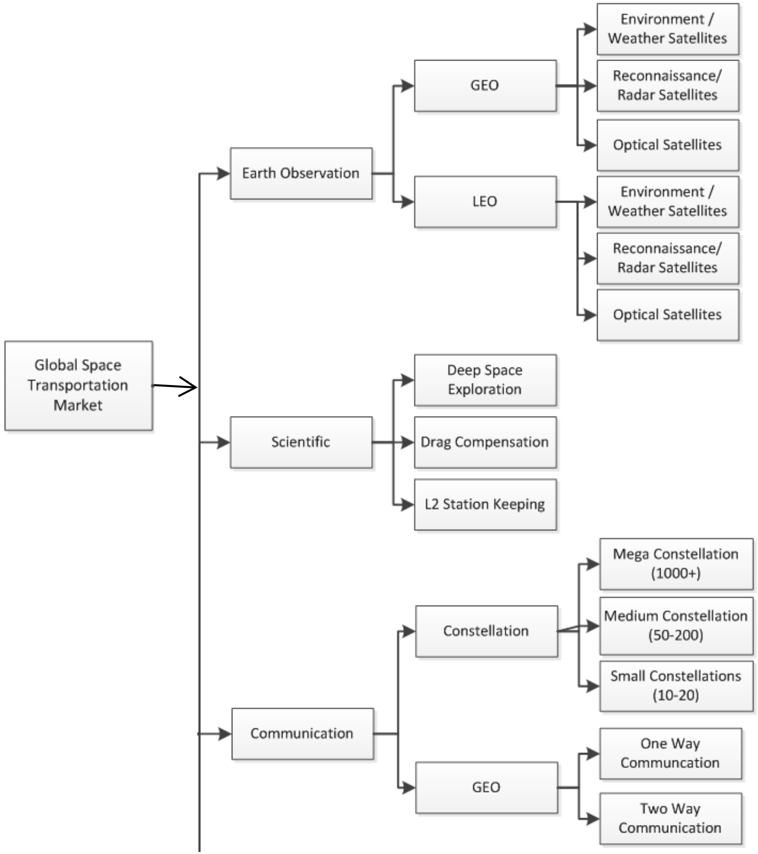
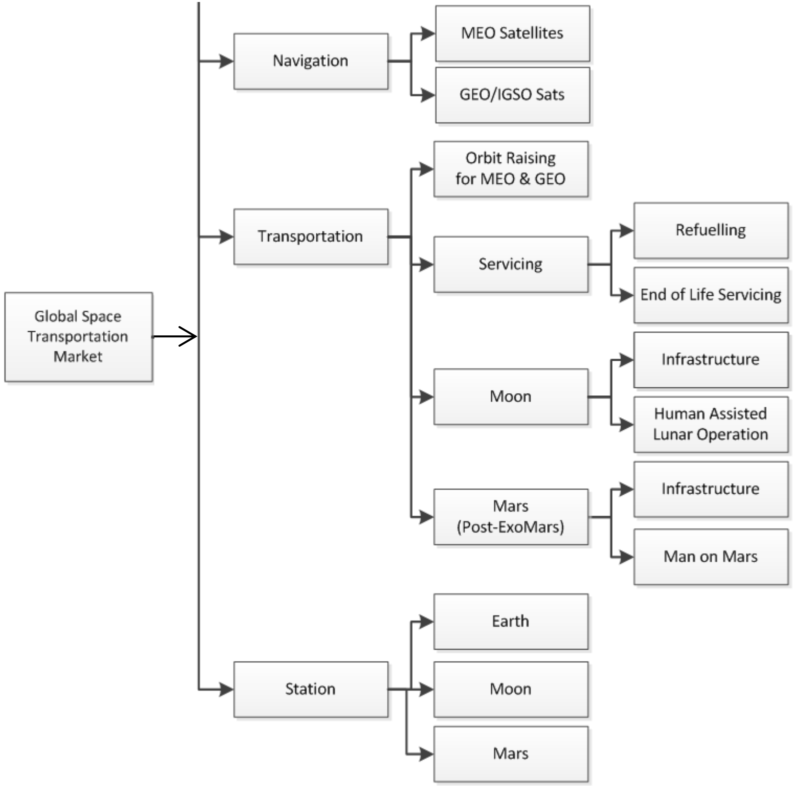
MISSION SCENARIOS





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MAIN REQUIREMENTS AND MISSION SCENARIOS - CONSIDERED PLATFORMS

500 W class

LEO Constellations
- Small/Medium – 1-2 t class
- Mega – 150-200 kg class

LEO EP Platform (500kg)

SmallLEO EP Platform (50kg)

GEO Station Keeping (8 Thrusters)

1500 W class

GEO Station Keeping (3 Thrusters)

LEO Constellations
- Small/Medium – 1-2 t class

In Orbit Servicing
- Refueling
- Station Keeping
- Debris Removal

Constellation Removal (tbd)

5000 W class

GEO Communication
- SmallGEO (2-3 t)
- Medium to Large GEO (4-6t)

MEO Navigation (2t)

20000 W class

Space Tug
- Navigation Sats
- GEO Sats
- Moon Station

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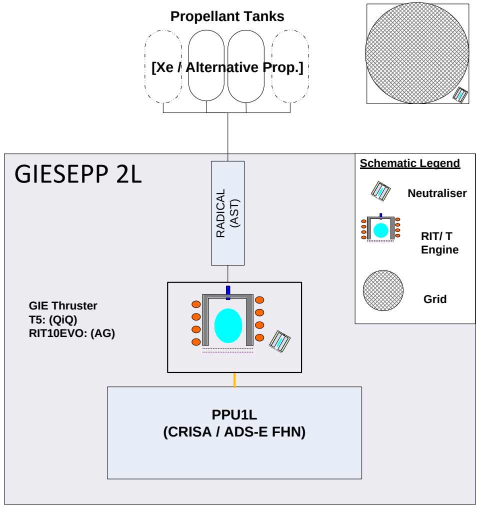
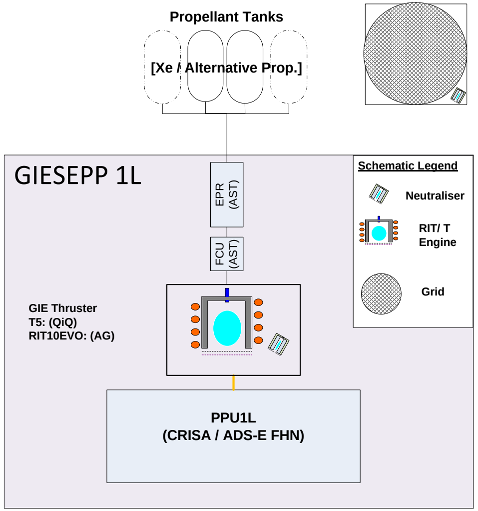
GIESEPP CONCEPT – GIESEPP 1L/2L – 200-700 W - LEO

- 1 x Thruster
- 1 x Power Processing Unit PPU 1L
- 1 x Electronic Pressure Regulator
- 1 x Flow Control Unit FCU
- For 2L RADICAL instead of FCU and EPR
- 1 x set of Harness, Filters and Sensors





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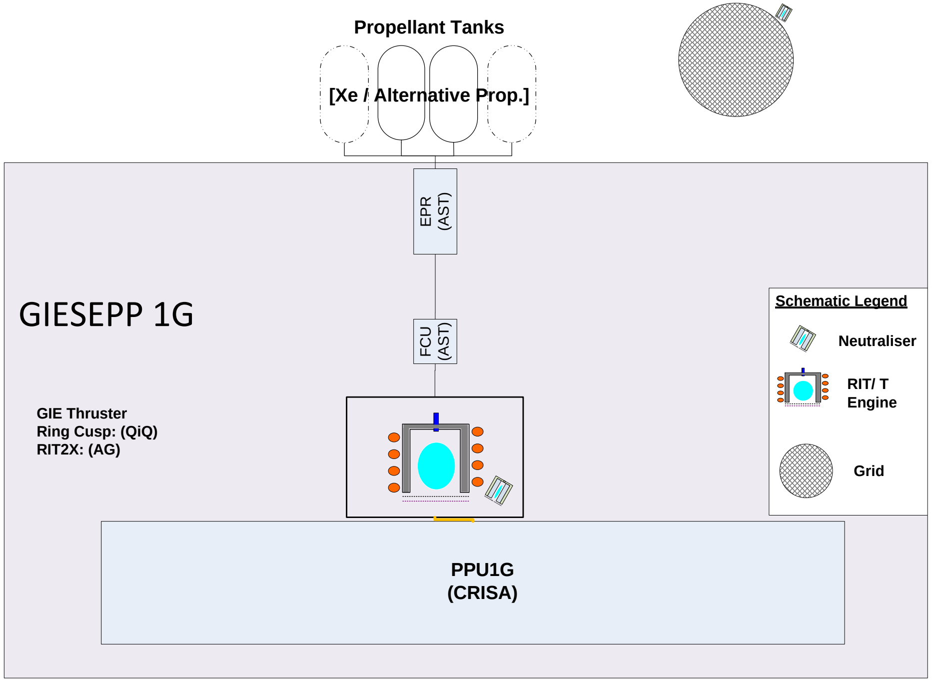
GIESEPP CONCEPT – GIESEPP 1G – 5KW – MEO/GEO

- 1 x Thrusters
- 1 x Power Processing Unit PPU 1G 1
- 1 x Electronic Pressure Regulator
- 1 x Flow Control Units FCU
- 1 x set of Harness, Filters and Sensors



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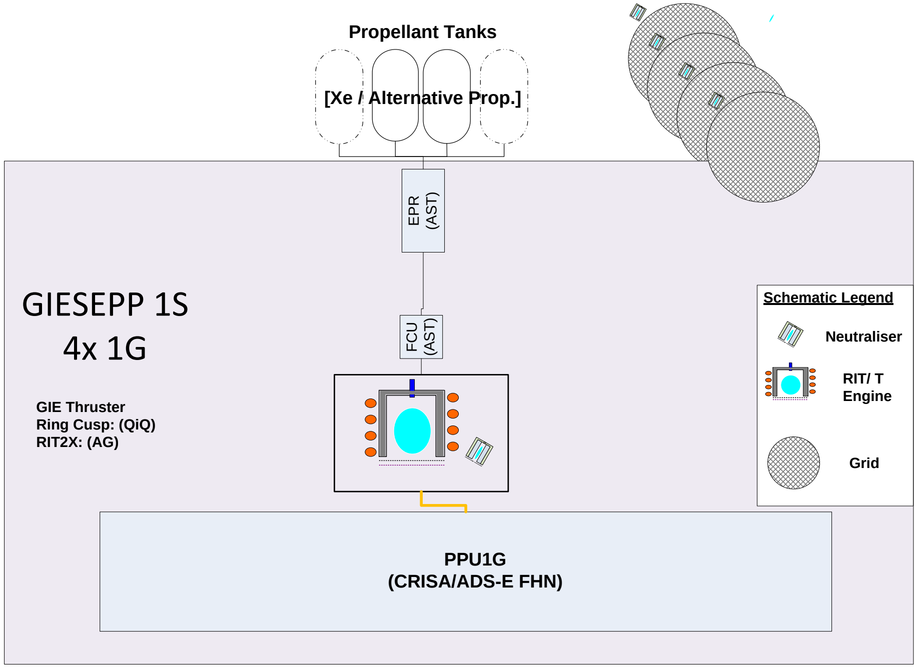
GIESEPP CONCEPT – GIESEPP 1G – 20KW – SPACE TRANSPORTATION, EXPLORATION AND INTERPLANETARY

- Clustering of GIESEPP 1G
- 1 x Thrusters
- 1 x Power Processing Unit PPU 1G 1
- 1 x Electronic Pressure Regulator
- 1 x Flow Control Units FCU
- 1 x set of Harness, Filters and Sensors



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ACTIVITIES AND SCHEDULE

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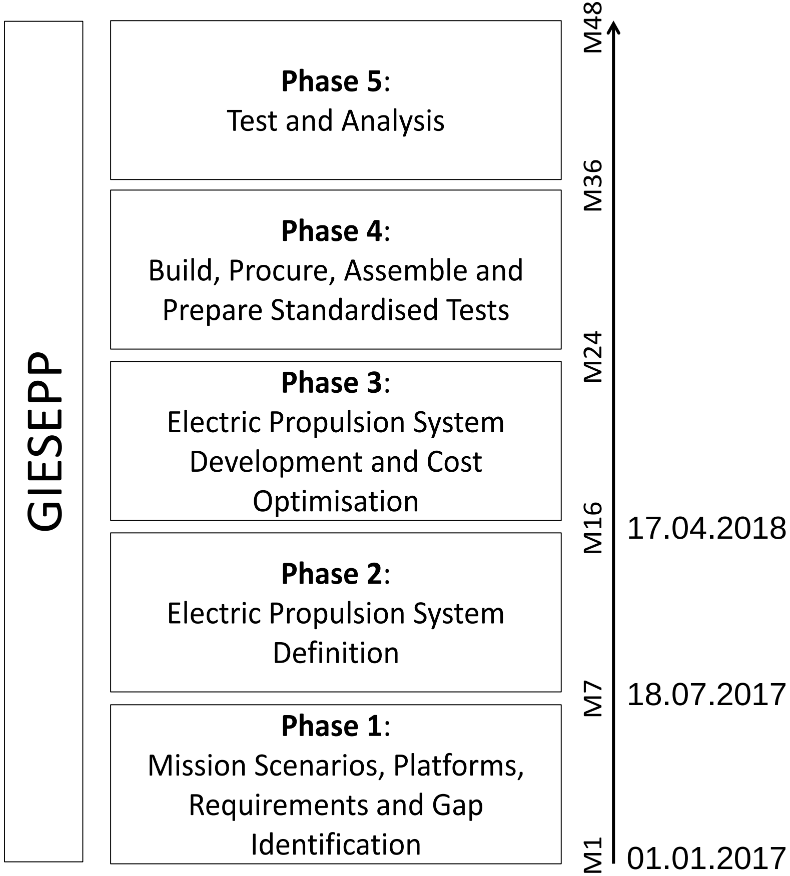
ACTIVITIES AND SCHEDULE



Project is fully in line with DOA w.r.t:

- Schedule
- Deliverables
- Costs

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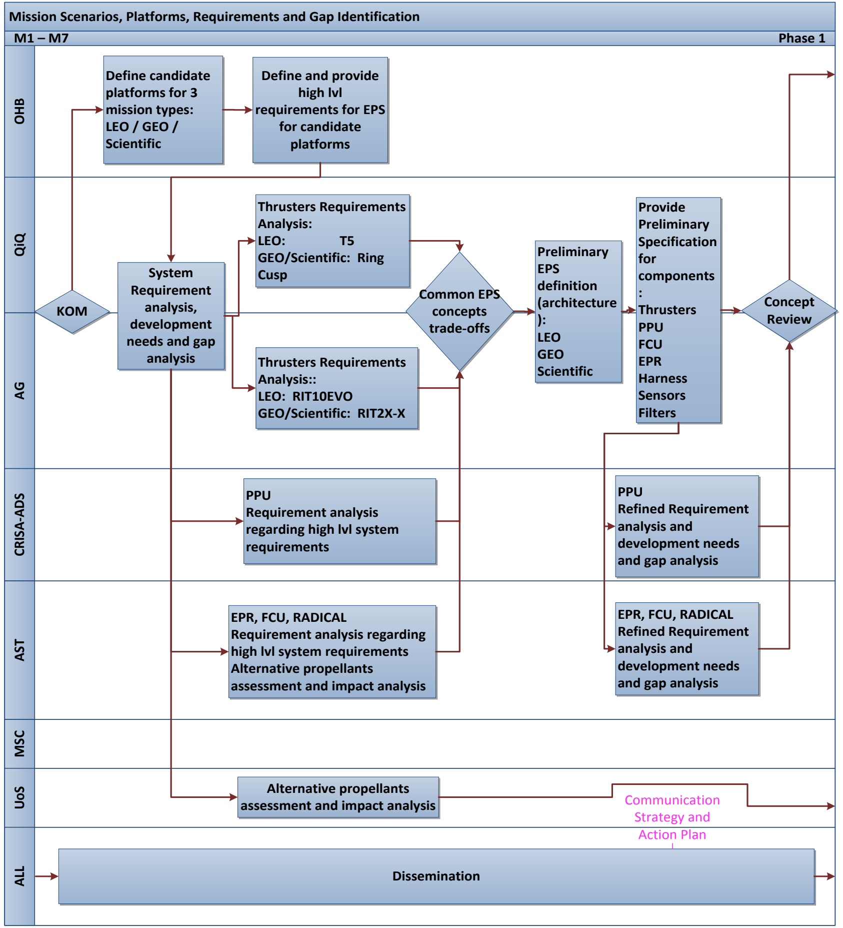
ACHIEVEMENTS BY TODAY

- Candidate platforms for 3 mission types: LEO/ GEO/Scientific
- System Requirements analysis, development needs and gap analysis
- Define and provide high lvl requirements for EPS for candidate platforms
- Thrusters requirements analysis: LEO: T5; GEO/Sci: Ring Cusp
- Thrusters requirements analysis: LEO: RIT10EVO; GEO/Sci: RIT2X-X
- PPU requirement analysis regarding high lvl system requirements
- EPR, FCU, RADICAL requirement analysis regarding high lvl system requirements.
- Alternative propellants assessment and impact analysis
- Common EPS concepts trade-offs
- Preliminary EPS definition (architecture): LEO, GEO, Scientific
- Preliminary Specifications for components: Thrusters, PPU, FCU, EPR, Harness, Sensors, Filters



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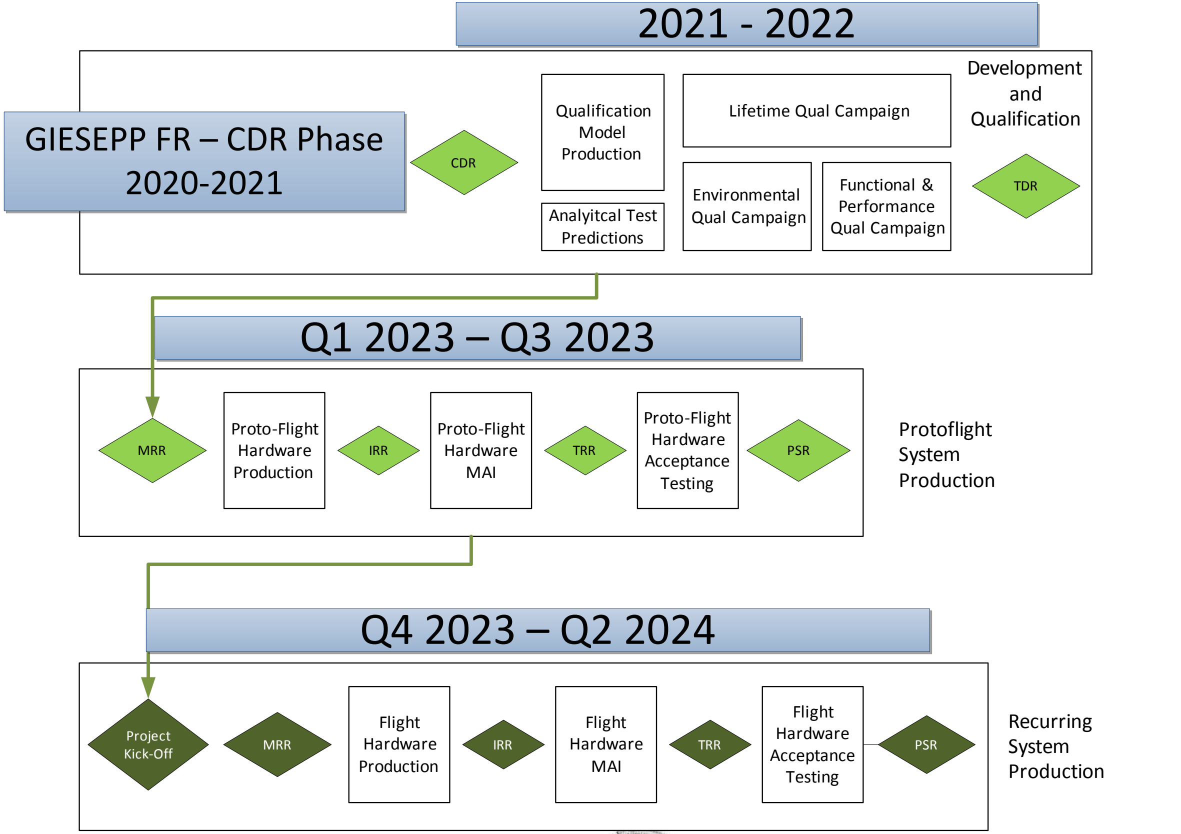
ACTIVITIES AND SCHEDULE – NEXT PHASE



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DESIGN AND DEVELOPMENT CHALLENGES

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MAIN REQUIREMENTS AND MISSION SCENARIOS - DESIGN DRIVERS

High Level Requirements	Flexibility (Input & Output) Accuracy Efficiency Environmental Loads
Materials and Components Manufacturing Testing	High Batch Numbers (Industrial/MIL) Parts & Processes Tolerances Complexity / Flexibility ECSS & GERD In-house vs. Outsourcing Cleanliness Margin Philosophy
Verification Documentation Meetings and Contract Discussion	Trust vs. Responsibility High cost of TVAC and Structural Test
Non Recurring Qualification	Life Time Qualification

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DESIGN AND DEVELOPMENT PLAN CHALLENGES

Goal	Challenge	Solution	Risk Mitigation
PPU Cost Reduction for 1L/2L	Maintaining maximum communalities between PPU1G and PPU1L	• Ensure common architecture • Provide flexibility in bus input voltage variation	• Define steps in DDP for BB's EM's • Elaborate possibilities for further disruptive approaches w.r.t. GIE technology specifics
• Increase impact and business case enlargement by targeting most possible LEO/New Space Platforms • Increase competitiveness to HET solutions	PPU1L shall be compatible with different EPS voltage inputs	Establish PPU architecture and electrical interfaces allowing wider range of voltage variation	Increase dissemination and communication with SAT primes to asses widest expected voltage variation
• Ensuring Plug and Play approach for cost reduction on S/C and EPS LvL • Ensure compatibility for potential need of cold gas systems	• Provide electrical and fluidic interfaces among all GIESEPP components with highest commonalties among GIESEPP 1G/1L/2L and 1S • Smart control	• Identification and very close tracking of harness, thermal control, fluidic control, mechanical, electrical and telemetry I/F • Ensure adequate adapters if necessary for different thruster types	Define steps in DDP for BB's EM's

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DESIGN AND DEVELOPMENT PLAN CHALLENGES

Goal	Challenge	Solution	Risk Mitigation
Dual Mode for increasing competition w.r.t. HET	• Optimize simplified and robust thruster design to cope with different Thrust/Isp Modes • Provide PPU1G coping with higher voltage variation to ensure best dual mode functionality	• Acceptable range for voltage has been identified • Perform BB and EM test for verification and confirmation of solution approach	• Define steps in DDP for BB’s EM’s • Elaborate possibilities for further disruptive approaches for further voltage variation at high power modes for both thruster types
Mass reduction	• Optimize simplified and robust thruster and PPU design • Provide adequate shielding for acceptable life time	Mass drivers identified	• Analytical assessments of life time vs mass reduction • Analytical assessments of performance loss w.r.t. load limitation

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DESIGN AND DEVELOPMENT PLAN CHALLENGES

Goal	Challenge	Solution	Risk Mitigation
Industrialization for significant cost reduction	• Provide robust design for high unit production • Change design for introduction of faster and cheaper manufacturing process	• Manufacturing sensitive parts identified • Focus on COTS parts for electronics • Introduce adequate manufacturing processes	• Identification of production cost drivers • Assess reliability vs. costs
Alternative Propellants for increasing market impact	• Ensure full functionality of optimized EPS with applicable alternative propellants	• Candidate propellants identified • Perform BB and EM test for verification and confirmation of solution approach	• Increase analytical assessments for EPS impact • Define in DDP BB and EM tests for fluidics and thrusters

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