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End-of-Life Technologies

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esa

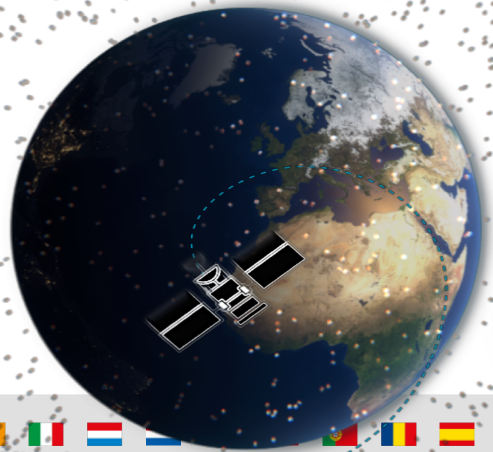
→ TECHNOLOGIES FOR SPACE DEBRIS MITIGATION

→ DEORBITING

Optimize tech for EOL deorbiting

→ PASSIVATION

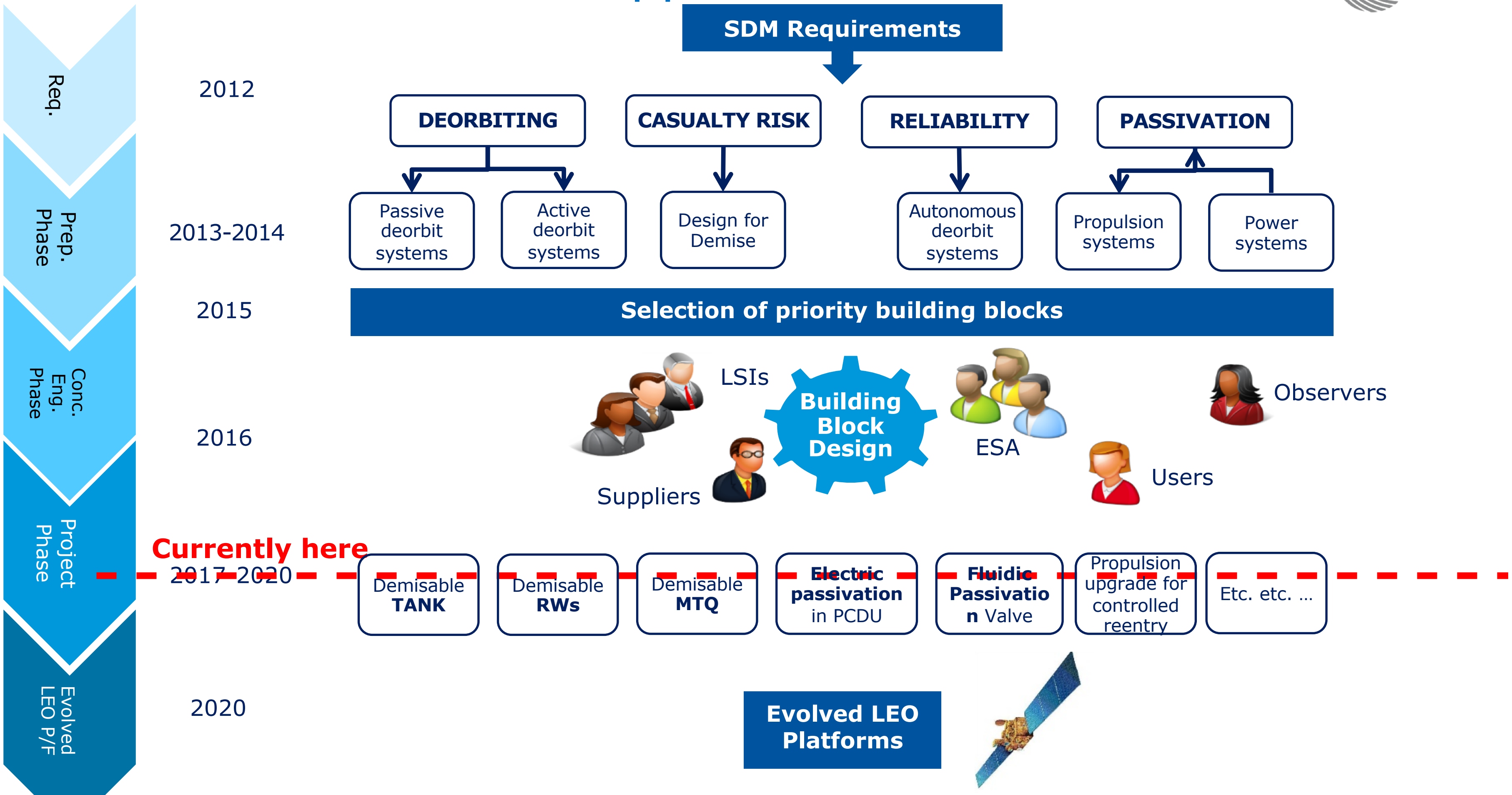
Ensure full passivation of Power & Propulsion subsystems



→ DESIGN FOR DEMISE

Maximize demise of S/C equipment during re-entry

CleanSat a coordinated approach



LEO platform evolution

- Activities to support the development of LEO platforms compliant with SDM
  - 2 parallel contracts kicked off
    - Goals
      - Support swift inclusion of SDM technologies in LEO platforms
      - Identify priority technologies and application cases
      - Define requirements for technology development
    - First milestone achieved in September
      - End-of-Life strategy defined for each element of the LEO platform family
    - Priority Building Blocks identified

Strong synergies with Copernicus Generic Platform Development

Where are we?

Deorbiting Technologies Roadmap

Harmonisation process carried out in the first half of 2108 involving European industry and National Delegations

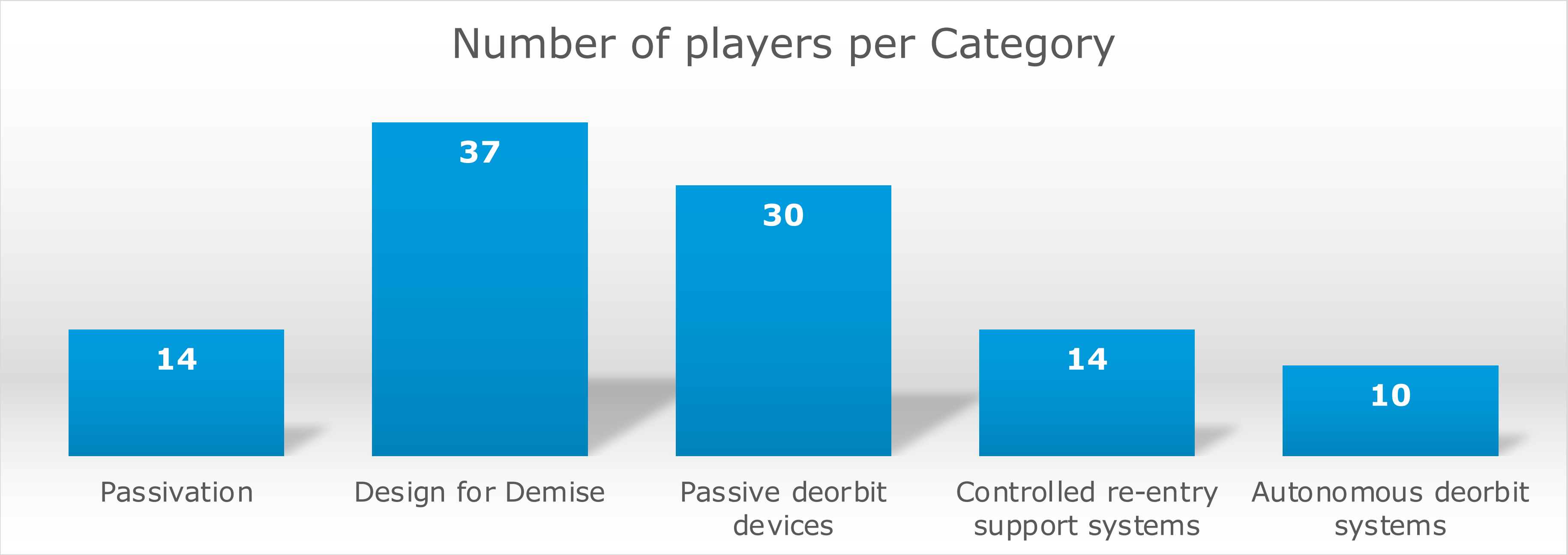
Technical Dossier on Deorbiting Technologies covers technologies to comply with End of Life Deorbiting requirements in future missions in all Earth orbits.

- Spacecraft operating in Low Earth Orbit required higher technologic effort due to the need to perform a safe atmospheric reentry, either in a controlled or in an uncontrolled manner.

Final Version will be presented for approval to the IPC in November 2018.

State of Art in Europe

108 companies working on deorbit technology topics in ESA MS & Canada



Proposed Development Approach

AIM A - Passive Deorbit Devices

- Stabilisation during and after the Deorbit Device's deployment and the satellite passivation must be addressed during the development.
- There is a need for IODs to qualify the de-orbiting devices under development

AIM B - Design for Demise - Improve reentry demise and on-ground casualty risk prediction and verification

- Validate re-entry simulation tools through ground test and re-entry experiments. Know how still very limited on break-up process and on some materials behavior.
- IOV and test data must be made available.
- Developing of reference re-entry simulation tools and models available in open source is important to allow users to have full visibility.

Proposed Development Approach

AIM C - Design for Demise - Develop spacecraft hardware designed for demise

- *High priority for Large Systems integrators.*
- *Equipment level priority expressed for demisable tanks and Reaction Wheels, but also SADM, magnetorquers and elements of the Optical Payloads.*
- *Need for demisable structural joints to break up the satellite at high altitude.*
- *New ways of verifying and testing for demisability are necessary.*

AIM D - Passivation - Risk characterization and development of propulsion passivation devices

- Propulsion passivation devices, applicable to LEO but also to GEO and MEO.
- A better characterization of the risk level is missing.

Proposed Development Approach

AIM E - Passivation - Risk characterization and development of power passivation devices

- Power passivation devices, applicable to LEO but also to GEO and MEO.
- Passively safe battery systems shall be developed, in particular for small systems.

AIM F - Controlled re-entry propulsion systems

- Systems to render the controlled re-entry more efficient are necessary.
- High specific impulse systems may support not only to lower the orbit but also to increase the performance and launch by using it also for orbit raising.
- Efficient solutions for re-pressurisation of the tanks are needed and shall be tested.
- There is interest in SRM for controlled re-entry given the high modularity.

Proposed Development Approach

AIM G - Mature designs for autonomous deorbit systems

- Autonomous deorbit systems can become a future product for highly reliable EoL.
- These systems need to be validated in orbit before market acceptance.

AIM H - Characterize and mature technology for semi-controlled reentry

- Can become more attractive with the increasing use of EP in LEO missions.
- Semi-controlled re-entry has important implications at system level.

AIM I - Model development for End of Life manoeuvres optimisation, vulnerability and lifetime extension reliability estimation

- Reliability of End of life operations is a major aspect for the orbit sustainability.
- New models, test approaches and tools to estimate EoL reliability are necessary.

Proposed Development Approach

AIM J Design for Removal System

- Future satellites shall include technologies to de-risk their removal from orbit in case of failure in performing the End-of-Life operations.
- Support the capture but also provide aids to the navigation of the removal mission and help decreasing potential tumbling motion of the satellite.

AIM K System level integration & validation aspects

- System level integration and validation must be studied in order to promote the successful integration of these technologies in future systems.

Conclusions

- International guidelines and regulations on Space Debris Mitigation are being enforced worldwide. There is an urgent need and a high demand for technology solutions.
- ESA MS and industry are strongly committed and have developed key knowledge and competences that place Europe in a strategic position in this new market.
- Developments
- The prioritisation of the technologies follows the most urgent needs for ESA missions, in particular EOP mission, but also commercial needs and in particular the needs of the emergent LEO commercial market.

Questions?