Autonomy and Operation Interactive session ADCSS 2018 ESTEC

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DEFENCE AND SPACE

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ADCSS 2018 Interactive session

The session is meant to provide open and interactive discussion about several topics of interest, spanning potentially several disciplines. The session will be run as described below:

Four Topics have been selected and they will be briefly introduced by selected moderators:
1.Digital engineering/transformation
2.Autonomy and operation
3.COTS avionics
4.Security.

To stimulate interaction, dedicated panels will be set-up for each topic. Around these panels attendees are encouraged to actively discuss the subjects with the help of the moderator, addressing in particular the Strength, Weaknesses, Opportunities and Threats (SWOT) of each topic. Attendees are encouraged to walk between the topics and participate in several discussions.

At the end of the session the moderators will draw the conclusions for each Main Topic that will be eventually presented to the audience.

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Autonomy Definition : Space Missions needs

Autonomy is the capacity of a system to make a decision about its actions, without the involvement of another system or operator.
Within the framework of Space missions with an increasing level of complexity, a higher level of integrated decision making is key.

- ***Autonomy will bring:***
  - Improvement of Reactivity, agility and versatility wrt mission requests and/or environment
  - OPEX cost reduction and less Ground/Human intervention
  - Deal with telemetry link optimization, large communications delays, jammed communications, military zone
  - Access to challenging areas for Humans and/or for manned assets
  - Improvement of mission Reliability, Availability, Maintainability

- ***What categories of missions will benefit from autonomy ?***
  - Space Exploration: Exploration & discovery of our Solar System, samples return & landing, rovers/ ascent & descent vehicles
  - Missions within the Earth vicinity (altitude ≤ GEO): Earth observations, Electric Propulsion (EP)- / Chemical Propulsion (CP)-based orbit control, EP-based transfer to GEO
  - Proximity Operations: Formation flying, In-orbit servicing & capture of space assets, assembly of large structures

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Autonomy Definition : Functions and Technical areas

- ***Autonomous GNC :***
  - Earth Orbit Control
  - Guidance for LEO agile satellite
  - Earth Orbit Raising for MEO/GEO
  - Debris & collision avoidance
  - End of life de-orbitation
  - Interplanetary navigation
  - Proximity operations
  - Orbital Rendez-vous and Landing

- ***Autonomous Command/control & FDIR***
  - Ground/ On-Board sharing
  - CONOPS and Mode transitions
  - Smart and optimized TM
  - Mass memory and download planning operations
  - Intelligent FDIR
  - Operational maintenance capability
  - Fleet / constellation management

- ***Autonomous Space Robotics***
  - Robotics arm & samples
  - Robotics docking and capture systems
  - In orbit services (refueling, repairing)
  - In Space Manufacturing & Assembly

- ***Autonomous Mission Planning***
  - Ground Automation
  - On-board tasking autonomy
  - Dynamic programming and reactivity
  - Priorities management
  - Alternatives planning
  - Optimised planning

- ***Autonomous Payload Data Processing***
  - On-Board Image, SDR, Radar Data processing & computing
  - Event or change detection : cloud
  - Smart payloads
  - Smart Sensors (Cameras, Lidar, GNSS)
  - Ground services

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Autonomy Definition : Enabling technologies

- ***Autonomous GNC :***
  - Vison & RF Based Navigation
  - On-board guidance
  - Hazard detection avoidance
  - On-board orbit propagation & determination
  - Autonomous EOR
  - Re-entry techniques

- ***Autonomous Command/control & FDIR***
  - Synthetic TCs
  - Model-based FDIR
  - File-based operations
  - Large & intelligent mass memories
  - Inter Satellite Links (ISL) & EDRS
  - Optical & RF ISL
  - Active / smart antennas

- ***Autonomous Space Robotics***
  - Autonomous path planning
  - Robotics arm & joints control
  - Docking & berthing mechanisms
  - Robotic Tools interoperability & interfaces
  - In Space ALM & assembly
  - End-to-end control

- ***Autonomous Mission Planning***
  - Multi-agent algorithms
  - Flexible mission plans
  - Real-time tasking
  - Direct tasking
  - Satellite to satellite tasking

- ***Autonomous Payload Data Processing***
  - High performance computing
  - AI & Machine learning
  - Complex algorithms Verification and Validation (Behavioral Models, formal techniques …)

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Autonomy Definition : some key challenges

- ***Which trend : Ground automation or On-Board autonomy or both ?***
- ***What are the key priorities on technologies gaps (Ground and On-Board) ?***
- ***Do we need ground simulators and/or in-orbit demonstrators ?***
- ***Will AI and Machine Learning be injected everywhere in Space Systems ?***
- ***Which type of Cooperation / Spin-in with other transportation domains : Automotive, UAV, Aircraft, Railway …. ?***
- ***Can we insure Safety/Quality objectives and standards on Autonomous Systems development ?***

AUTONOMY & OPERATIONS – ***To be elaborated***

STRENGTHS	WEAKNESSES
- xxxx	- xxxxx
OPPORTUNITIES	**THREATS**
- xxxxx	- xxxxx

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