

Book Review

SpaceOps 2016 Post Conference Book

Space Operations: Contributions from the Global Community.

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The SpaceOps 2016 Conference Book offers a lot of advantages for the SpaceOps community. On the one hand it provides all the most up-to-date, state of the art papers dealing with current issues offering solutions for the challenges to be tackled in the near and long term future. The book provides a peer reviewed compendium of the thirty most relevant papers – selected from 279 papers – presented during the 2016 international SpaceOps conference held in Daejeon, Korea.

On the other hand this book provides a handy and concise programmatic summary of planned and in progress projects. A third advantage of the book is that the provided background information and justifications given in the various papers also provide in retrospective how politics, commercial interests, various scientific goals and economic considerations determined the current situation we find ourselves in as of today.

As Dr. Bangyeop Kim said in his foreword to the book: “The field of space operations does not often capture the attention of the public’s imagination which is more soft en enamored and enthralled by elegance and high level of technology utilized in [the] spacecraft development – and understandably so.” This Conference Book shall help to change this perception: without successful mission operations no successful mission, and as this book shows “operations” embraces all disciplines.

The book is structured into 3 parts: Mission Design and Management (Part 1), Ground System Design for Efficient and Secure Operations (Part 2), Mission Execution (Part 3).

To give the potential reader more insight into the detailed subjects of all thirty papers, authors and affiliations are listed below in addition with an appraisal of each paper from the reviewer’s point of view.

In summary, the excellent printed book is complete with color graphics and high-resolution images, registers and extensive paper references justifying the investment to have the conference book available on your own bookshelf to be consulted not only for matters of the future but also for tracing background information on completed missions.

The unbiased international character – the conference is open and without any constraints – offers a look at the activities of non-mainstream agencies like Nigeria, New Zealand or University student activities.

As member of the space community or as an interested engineer – why should you read the book: because the book enables you to “look ahead and stay informed” in your field of expertise.

Don’t miss to read as a “teaser” the best student paper (paper 30 in the list below) in this issue of the “Journal” (see “Technical Papers”) – comments and discussions are welcome.

SpaceOps 2016 Post Conference Book Contents

	Topic	Title	Prime Author	Appraisal
1	Part 1	Robotic and Human Exploration on the Moon: Preparing a New Lunar Analogue	T.Hoppenbrouwers / Space Applications Services	Proposal to implement an European Surface Operations Laboratory (ESOL). This is a far reaching programmatic enterprise by ESA to prepare the next round of human lunar exploration which fits well with ESA's vision of a "Moon Village"
2		MODE: A System Infrastructure for Robotic Experiments	Mariarosaria Cardone ESA-ESOC	Ongoing development of a Multi-purpose End-to-End Robotic Operations Network" (METERON) for planning and preparing future human-robotic exploration missions to Moon, Mars and other celestial bodies. Basic conceptual and programmatic information is provided. It is performed on an international basis and interesting for participants dealing with similar subjects. Further relevant key words addressed are: Delay Tolerant Network (DTM) and CCSDS Mission Operations and CCSDS MO Monitoring and Control.
3		Leveraging the Autonomous Mobile On-Orbit Diagnostic to Initiate a Doctrinal Shift in Spacecraft Operations	Jin Kang / US Naval Academy	AMODS: "Autonomous Mobile On-Orbit Diagnostic System" presents an autonomous, low cost diagnostic and repair system for conventional and new satellites. AMODS is predicted to effect a paradigm shift in space operations. It is based on low cost Cubesat systems and consists of an individual Repair Sat (RSat) and a cold gas electrical propulsion Sat (BRICSat) which can be combined. In-orbit testing is under way.
4		Telecom satellite fleet unattended operations	Juan Carlos Gil / GMV Aerospace and Defence	"Telecom satellite fleet hassle free operations" discusses an end-to-end automation system. A novel concept is presented for telecom satellite fleet monitoring and control based on a long term plan (like 1 year) including all involved ground subsystems. No highly qualified operator must be in the loop, just one operator on shift irrespectively of the fleet size. The system is based on proprietary software modules.

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5		Robust Operations of Complex Satellite Systems: Using a Protection Layer Approach Safety and Reliability Management	Heinz Gloeckner DLR	The development of protecting large constellations from long term risks caused by system interactions and dynamic changes, including satellite even the environment. The approach is based on “Reason’s Swiss cheese accident analogy”. So far it was proven that the approach can be used in operational day-to-day work, however with growing challenges more work is needed.
6		The Lunar Space Communications Architecture: Beyond the NASA-KARI Study	Wallace Tai NASA-JPL	A very relevant study, reaching far into the future on how to increase the communications infrastructure including a Lunar relay configuration for Lunar missions with special emphasis on cross support standards (CCSDS) and disruption tolerant (DTN) networking. The added value of the paper: it provides a complete summary of all planned Lunar mission launch dates until 2020 (a surprising number of 21 missions). The “Moon Village” vision is coming alive!
7		Enabling International Data Relay at Mars	Daniel D. Wenkert NASA-JPL	A JPL study on how to implement an international communications network for ongoing future Mars missions. The study is based on the “Service Agreement” for the ESA ExoMars Trace Gas Orbiter (TGO) but also aiming for future missions. A complete list ongoing and future ESA/NASA Mars missions with mission duration schedules is provided.
8		Secondary Payload Opportunities on NASA’s Space Launch System (SLS) Enable Science and Deep Space Exploration	Jody Singer NASA-MSFC	This is a clever proposal how to utilize the SLS test flight EM-1 into an orbit around the Moon for accommodating payloads of NASA’s international partners “to hitch a ride” within the Orion stage adapter. Three payloads are identified and accepted already. Launch is expected in 2018.
9		MarCO: Interplanetary Mission Development on a CubeSat Scale	Josh Schoolcraft NASA-JPL	Mars Cube One (MarCO) is a novel JPL mission to accompany the InSight (Interior Exploration using Seismic Investigations) Mars mission Lander. The primary mission objective is to launch two Cube-satellites with InSight to independently fly to Mars to serve as communications relay during InSight’s EDL. If successful this method paves the way for efficiently improving the future Mars communications network by saving launch costs for additional communication satellites.
10		Pursuit of Nigeria into Space for Sustainable Development.	Ikpaya O. Ikpaya NASRDAS	This paper justifies the title of the conference book “Contributions from the Global Community”. This is a rare detailed glimpse of the Nigerian space activities and its space agency’s organization. Nigeria has currently three remote sensing satellites launched in cooperation with China.

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11	Part2	Designing and Deploying Meaningful Auditory Alarms for Control Systems	Bruno Sousa ESA-ESOC	This practical study is an effort by ESA to introduce an audible system into operations in a standardized yet customizable way. Great effort has been made to establish the requirements. The system has been tested with real operators using ongoing mission parameters as test cases. The introduction “at large” remains to be seen.
12		A Structured, Model-Based System Engineering Methodology for Operations System Design	Duane L. Bindschadler NASA-JPL	The paper describes a methodology for the development of a generic Multi Mission Operations Systems (MMOS) model to be adapted for a particular project. The benefit for projects having successfully used the described model is described. The MMOS is highly consistent with NASA’s efforts to find and create agency wide efficiencies such as the Mission Operations Capability Leadership effort.
13		Preparing a Ground System for Plug and Play Exchange of Hardware.	Armin Hauke DLR	An intelligent approach to implement the “dream” of “plug and play” for the operations of a ground segment helping to become more efficient for maintenance activities and reliability purposes. The described concept has been successfully implemented and tested for some device classes (such as up converters) at the DLR ground station. The scope will be widened for introducing this concept also for the monitoring and control system (MCS) at the German Control Center.
14		Ground Station Development at Awarua, New Zealand .	Robin G. McNeill Ventura Southland	This is a fine example of technology transfer born out of need: ESA was looking for replacing a the downrange tracking ship approach with a more efficient method and ended up by introducing and building a permanent antenna site at Awarua, New Zealand – which even didn’t have an Agency to handle the matter!
15		Commanding and Telemetry Operations Using Reliable CFDP Service	Eric D. Melin JHU-APL	The Solar Probe Plus (SPP) will have to withstand extreme thermal conditions. In order to maintain the integrity of the spacecraft APL, introduced a CCSDS file delivery protocol (CFDP) for maximizing the use of X-band uplink and downlink protocols.
16		RosettaBepiColombo Mission Planning System: From Mission to Infrastructure	Angela Dietz ESA-ESOC	With interplanetary probes and spacecraft growing more complex with every new mission the desire to re-use Mission Planning tools and systems (MPS) have grown also. A starting point was the ESOC decision to develop a joint MPS for two different projects: Rosetta and Bepi Colombo. The approach and results are described in detail. The potential use by other projects (e.g. CNES Earth Observation platform) is being investigated.

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17		SpaceSecLab: A Representative, Modular Environment for Prototyping and Testing Space-Link Security Protocols End to End.	Daniel Fischer, M ESA-ESOC	In order to be independent of ongoing project work a end-to-end security testing and integration environment was implemented by ESA. The SpaceSec Lab allows verification and validation of security protocols such as CCSDS SDLS and Extended SLDS allowing also rigorous penetration testing. In cooperation with NASA the SpaceSecLab is also used for developing a SLDS Extended Procedures standard.
18		Supercomputing Centers Tight Coupling to Face Big Data Processing. .	Pierre-Marie Brunet CNES	CNES developed a method to reduce the storage, processing and distribution of the ever increasing data volume generated by satellite Earth observation sensors (e.g., the EUCLID mission will produce up to 175 Peta bites). The result is a “cluster of clusters” using “Docker” technology. Partial integration with the CNES Earth Observation platform has started – research is ongoing.
19		The Use of Model-Based Engineering Methodologies in Complex Ground Data Systems	Anthony Walsh ESA-ESOC	ESA/ESOC is adopting a Model Based Engineering (MBE) approach for the development of complex software systems. Although challenging, increased productivity and improved quality is expected. The approach is described in detail and first “fielding” results are promising.
20	Part 3	Accommodating Navigation Uncertainties in the Pluto Encounter Sequence Design .	Ann Harch Southwest Research Institute	This paper describes in detail the very challenging but successful planning and execution of the New Horizon spacecraft encounter with Pluto and the once-in-a-lifetime” opportunity to take close-up images of Pluto. The historical P-HiPhase Hires image of Pluto near closest approach is included to demonstrate the success of the used approach.
21		Science Scheduling Challenge for Philae Lander .	Cedric Delmas CNES	The paper describes the successful science scheduling approach for the Philae Lander. Because of the many uncertainties high planning flexibility was called for. This was solved by introducing independent blocks which could be executed in any order including a “safe block” for anomalies. The method proofed robust even in the “bouncing case” of Philae Lander after “touch down”.
22		Dawn Navigation and Mission Design at Dwarf Planet Ceres .	Dongsuk Han, J NASA-JPL	This very specific paper describes the highly successful navigation of the Dawn probe to visit two bodies, Vesta and Ceres in the main asteroid belt under anomalous spacecraft conditions.
23		Venus Express End of Life Operations: Or the Art of Saying Good-Bye	Matthias G. Eiblmaier SCISYS Dcind GmbH	Using an operational spacecraft at its end of life as testbed for a technological experiment is a clever and efficient use of available resources: In this case an aerobraking experiment with Venus Express (VEX) using the Venus atmosphere was successfully executed. All details and constraints are described.

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24		Laser Interferometer Space Antenna (LISA) Pathfinder: New Methods for Acquisition of Signal After Large Apogee-Raising Maneuvers	G. Bellei, P ESA-ESOC	The paper describes in detail the approach, methods, and results of ground station signal acquisition after large apogee-raising maneuvers of the Laser Interferometer Space Antenna (LISA) Pathfinder.
25		TAKE5 Experiment Jazzes Up SPOTS's End of Operational Life, Repurposing SPOTS to Simulate the New Sentinel-2 Mission .	Martine Behague CNES	Another example of using an operational spacecraft at its end of life as testbed for new missions is the TAKE5 experiments on SPOT4 and SPOT5 for delivering representative images for developing, testing and validating Sentinel-2 image processing software. This was done by lowering the SPOT orbits at EOL by fulfilling all the challenging TAKE5/ Sentinel-2 requirements and constraints.
26		CNES and ESOC Flight Dynamics Operational Experience on First Nominal FOC Launch and Fine Positioning Activities of GALILEO	Laurence Lorda CNES	This very specific paper describes the challenges, experience and solutions for setting up an flight dynamics organization between CNES and ESOC for GALILEO operations.
27		Performance Analysis of LEO Space Object Tracking Using Monostatic and Bistatic Radar .	Ki- Young Yu University of Science & Technology Deajeon, Korea	The Korean paper describes the performance analysis using monostatic and bistatic radar equipment located at GOHEUNG and JEJU ground stations (Korea) for tracking objects in LEO using the ISS as test object. Results were considered to be effective for improving tracking performance.
28		Technical Overview of the Last Two STRATO SCIENCE Campaigns in Timmins, Canada ..	Stephane Louvel, J CNES	This selected paper describes the highly successful scientific and operational results of two STRATO balloon campaigns in 2014 and 2015 from the Canadian CSA Timmins base in close collaboration with CNES.
29		CANYVAL-X Mission Development Using CubeSats	Jae- Pil Park, S Yonsei University, Seoul, Korea	This very intriguing student paper describes the idea and proof of concept activities for using two Cubesats flying in a line-up formation to facilitate a virtual space telescope with variable focus length: one Cubesat would act as detector, the other would carry the lens system. The two Cubesats have been constructed by students of the Yonsei University, Seoul and are awaiting their launch in 2017 on a Falcon 9 rocket.

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30		<p>Future Mars Exploration Operational Simulation: Research Outcomes and Educational Benefit*)</p> <p>*) Remark: The complete paper (uncorrected proof) is published in this issue of the "Journal" in section "Technical Papers" to show the remarkable quality of this exercise.</p>	<p>Benjamin J. Morrell, J Student Member AIAA</p>	<p>This exciting student paper supported by AIAA, NASA-JSC et al. explores the benefits of a Mars operational paper simulation exercise by a group of students to learn in depth about human spaceflight operations, learning from past missions while also investigating how future Mars operations concepts might be performed. It was conceived as an open-ended task, starting with the group to define a possible layout of a Mars colony site and use this baseline architecture for the definition nominal and anomalous operations scenarios and operations concepts. No hardware (like in analog simulations) was involved.</p>

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