

Proposal for Forming an IAA Study Group - SG 4.21

Title of Study:

Distributed, Networked, Smart, Cooperating Small Satellite Formations

Proposer(s):

(Must be member(s) of the Academy M or CM)

Igor Belokonov and Klaus Schilling

Primary IAA Commission Preference:

(From Commission 1 to Commission 6) **Commission 4**

Commissions: 1 Space Physical Sciences, 2 Space Life Sciences, 3 Space Technology & Systems Development, 4 Space Systems Operations & Utilization, 5 Space Policy, Law & Economics, 6 Space and Society: Culture and Education

Secondary IAA Commission Interests:

(From Commission 1 to Commission 6) **Commission 3**

Members of Study Team

Chair(s):

Klaus Schilling (M), Igor Belokonov (CM)

(Must be member(s) of the Academy, M or CM)

Secretary:

Denis Avaryaskin, PhD student, Samara State Aerospace University

Dr. Stephan Busch, University Würzburg

Other Members:

(Open to members and non-members of the Academy)

Filippo Graziani , GAUSS Srl

Pini Gurfil, Technion Haifa

Jan Thoemel, VKI

Michail Ovchinnikov, Institute of Applied Mathematics of RAS,

Aleksey Romanov, Russian Space Systems Enterprise,

Martin Haunschild, Zentrum für Telematik

Finn Anckersen, ESA

Jean de Lafontaine, Université de Sherbrooke

Simone d'Amico, Stanford University

Pawel Kabacik, University Wrocław

Pedro Rodrigues, tekever

Eberhard Gill, TU Delft

Rene Laufer, Baylor University

Rainer Sandau, IAA

Shinichi Nakasuka, University of Tokyo

Paolo Teofilatto, Sapienza University of Roma
Freddy Pranajya, University of Toronto
Fernando Agelet, Unveristy of Vigo
Herman Steyn, Stellenbosch University
United Nations Office for Outer Space Affairs
TBD university in France, UK, India, China
Company representatives from GOMSPACE, ISIS, Clyde Space,...

Short Description of Scope of Study

Overall Goal:

(Expected scientific or practical benefit of the study group's efforts)

Networked distributed systems promise interesting potential for multiple small satellites, taking advantage of significant baseline distances. Sensor Networks opened in terrestrial applications very interesting perspectives. But also distributed data processing systems introduced a significant evolution of modern computing during the last 30 years, from traditional mainframe computers towards today's miniaturized networked systems. Similar technology trends can currently be observed in the spacecraft design context. Here miniaturisation enables at similar cost frames systems of several small satellites. Related advantages in comparison to traditional multifunctional large satellites include an improved temporal and spatial resolution, as well as graceful degradation in case of defects.

Nevertheless many classical approaches to realize spacecraft subsystems cannot easily be scaled to the size of pico-satellites, therefore related technologies need to be developed. Cooperating multiple satellites for joint observations are typically realized today by constellations, where each satellite is individually controlled from the ground control station, while in a formation a closed control loop based on relative navigation techniques has to maintain an appropriate topology between the spacecraft. In this context federated, fractioned or fragmented spacecraft topics are discussed, where also computational and storage resources are shared over several spacecraft. The significant increase of pico-satellite activities in the last years advanced in a fast way innovative miniature subsystems, instruments and components.

The state-of-the-art for the relevant subsystems and payloads will be reviewed and roadmaps to promote the related developments will be identified. This should encourage the initialisation of mission realisations and set up contacts in a related scientist community.

Practical benefit of this study group is to promote further growth of small satellite activities by clarifying the detailed definition and requirements of cooperating small satellites.

Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>

Intermediate Goals: state-of-the-art review, development of roadmaps to cooperating satellite systems

Methodology:

(Email works, workshops, stand alone conferences, interim publications, etc.)

A workshop will be held once a year (November or December) alternatively on different continents.

In addition, the study group will meet regularly at

- International Astronautical Congress
- IAA Spring meeting
- IAA Symposia / Conferences on Small Satellite Missions (by example in Rome, Berlin, Würzburg, Samara, ...)
- Other Cubesat and Micro-sat related workshops and conferences

E-mail list and a file-server will be utilized to exchange opinions and materials.

Time Line:

(Cannot exceed three years)

The study is expected to be completed in two years.

Final Product (Report, Publication, etc.):

The resulting Report will be published and distributed worldwide.

Target Community:

International Organisations for Small Satellites (UNISECglobal and UNISECEurope, IAF-SUAC), Small Satellite manufacturers, Small business, University satellite developers, Traditional satellite manufacturers, Launch providers, Satellite operators, Space agencies, International Telecommunication Union

Support Needed:

None identified at this time

Potential Sponsors:

Support will be sought at local space agencies and government ministries

To be returned to the IAA Secretary General Paris by fax: 33 1 47 23 82 16 or by email: sgeneral@iaamail.org

Date: June 2015

Name: Klaus Schilling

(No Signature required if document authenticated).