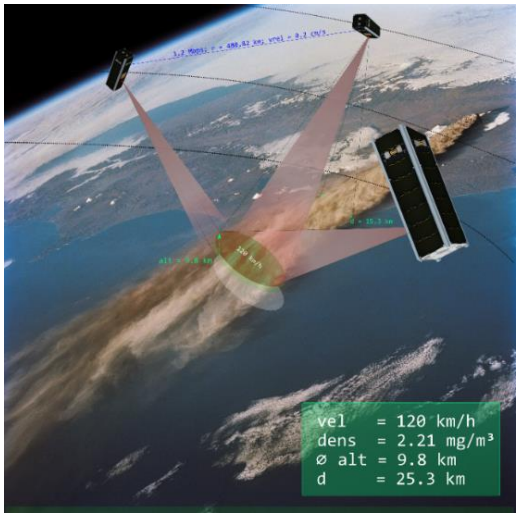
TIM - Telematic International Mission

A Regional Leaders´ Summit (RLS) supported space project

Newsletter Q1/2019

The prime ministers and governors of the RLS-partner regions Bavaria, Shandong, Quebec, São Paulo, Cape Town, Georgia, and Upper Austria together with key TIM team members.

The ***T***elematic International Mission (TIM) is an international nano-satellite mission initiated 2016 in Munich during the Regional Leaders´ Summit. RLS-partners from 5 continents are participating in this Small Satellites project of RLS-Sciences. The joint objective is 3D Earth observation from the different perspectives of the cameras onboard the satellite satellite formation. While some national projects contribute complete satellites to TIM, others provide components, or ground-stations. TIM use distributed, networked satellites, flying in formation to realize innovative Earth observation by cooperation.



Editorial

At the Regional Leaders´ Summit 2016 our dream for initiating TIM was the implementation of many small satellites from partner regions, cooperating in orbit to enable innovative joint observations. Now in the different TIM partner laboratories the satellites materialize and promise new cost-efficient observation capabilities, contributing to applications such as volcano ash cloud observation, monitoring of fires and floods, and environmental warning.

The international TIM team acknowledges the excellent support and engagement from the RLS partner regions in this joint effort for this exciting research !

The TIM Motivation

We believe that affordable missions of distributed small satellites will help to generate valuable environmental data to support decisions in disaster management, agriculture and administration. In TIM we want to show how a number of miniature satellites carrying different kinds of payload collaborate to create such data where each partner only has to contribute a manageable part of the mission.

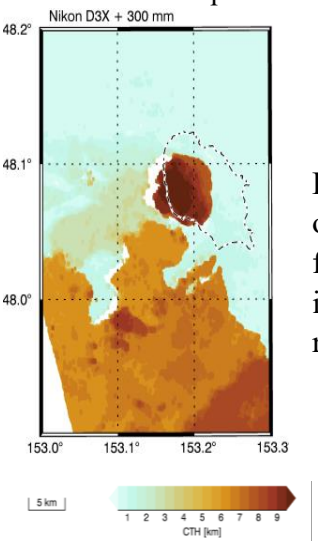
TIM will not only produce observation data but will also allow research of inter-satellite links and formation control. As an example for satellite formations for Earth Observation, the concept of photo-grammetric observations is presented.

Photogrammetric Observations

About 50–70 volcanoes erupt each year on the global scale. Of these, at least one large eruption, where material reaches the stratosphere and endangers the air traffic, occurs annually. The estimated direct loss of airlines during the 2010 eruption of Eyjafjallajökull was 1.3 billions EUR.

Such losses can be avoided by providing accurate data of ash cloud dispersion. In Volcanology the cloud height is a crucial parameter for reliable results of ash dispersion modelling required for safe air traffic. Simultaneous observations of the same area from three or more different satellites can be used to estimate the height not only of volcanic ash clouds, but also of meteorological, anthropogenic, or dust clouds using photogrammetric methods.

Sarychev Peak volcano eruption on 12. June 2009 seen by ISS astronauts
Credit: Earth Science and Remote Sensing Unit, NASA Johnson Space Center (NASA, 2017).



Post-processed observation data from the above image to test the related algorithms.

Further Applications

The partners will care of using the data in different potential application fields:

- photogrammetric cloud observation,
- cloud height measurements,
- monitoring of lightnings,
- fires and floods,
- soil moisture monitoring,
- maritime applications (illegal fishing, coast monitoring),
- environmental warning
- traffic characterization.

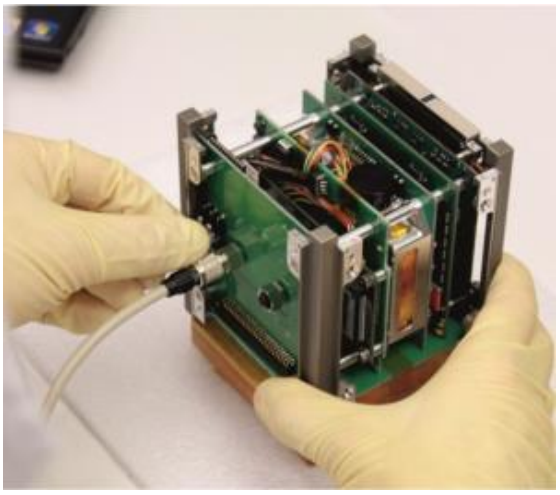
The TIM Technologies

Nano-Satellites

The project partners have experience in the preparation and operation of nanosatellite missions.

To support cooperation the CubeSat electrical interface standard developed by UNISEC Europe was selected and will be used on all TIM satellites. The design has been optimized with respect to mass, size and energy efficiency while trying to maintain a modular and flexible architecture. Thus, the proposed bus supports robust and rapid development, integration and testing of the satellite as well as simple maintenance, extension and replacement of subsystems in any configuration during flat-sat development or flight model integration.

The interface definition and further information on implementing it is published by UNISEC Europe on their website: http://unisec-europe.eu/standards/bus/



Formation Flying

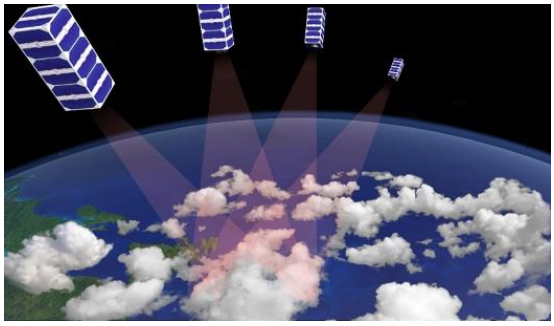
The TIM satellites are planned to fly in a spacecraft formation. This means they are exchanging relative state information using inter-satellite links and control their orbit accordingly.

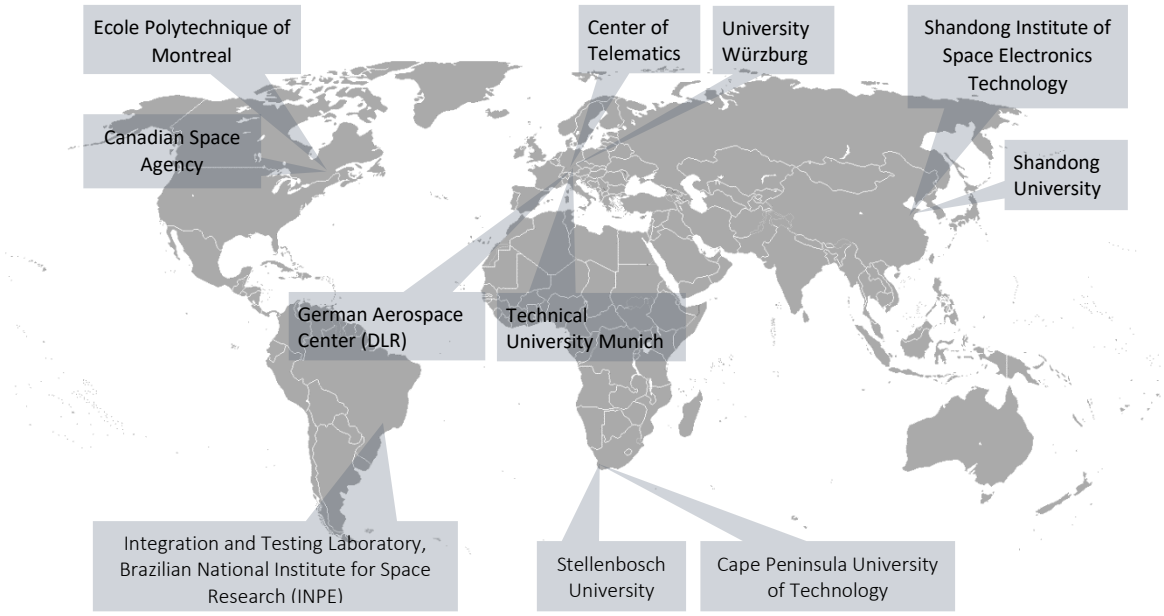
Formation flying also enables collaborative observations leading to improved measurement resolutions, possibility of 3D measurements and fusion of data from different satellites on ground.

Test facility at ZfT composed of two high precision turntables for photogrammetric observations.

Future Perspectives

The next technology step following TIM will be application of more elaborated data fusion and formation flying techniques to Earth observation. Thus on basis of TIM technologies the high reputation ERC Synergy Grant “CloudCT” was 2018 awarded to the Israeli-German team of the professors Schechner, Koren and Schilling to characterize the interior of clouds by generating 3D-images.





The Partners within TIM

Bavaria, Germany

In Bavaria, the University Würzburg coordinates the international teams. Emphasis is on definition of satellite interfaces and ground station networks. This work is based on experiences from the UWE program, realizing CubeSats since 2005.

The Bavarian project contribution ***T***ele-matics earth ***O***bservation ***M***ission (TOM) realizes three nano-satellites equipped with cameras. Main mission goal is to create three-dimensional images of volcanic ash-clouds by photogrammetric methods taking advantage of sensor data fusion methods. TOM is realized by Zentrum für Telematik (ZfT), which is supported by the partners University Würzburg (board computer system, image processing) Technical University of Munich (camera selection), and DLR, Oberpfaffenhofen (optical communication link). ZfT hosts a unique multi-satellite test environment with high precision turntables used in TIM.

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Shandong, China

The Shandong Institute of Space Electronic Technology (SISET) in Yantai received funding from Shandong government to contribute 3 small satellites to the TIM project. TIM satellites of China are developed by Micro-nano Satellite Engineer Center of SISET. The team has a total of 32 people. Additional expertise from software and hardware are contributing. This way the SISET experience from earlier development of 11 small satellites in cooperation with Chinese universities will be brought in. SISET is an institute of CAST - the Chinese Academy of Space Technology.

In addition, SISET established contact to the launch provider “Great Wall” to receive favorable launch conditions for the TIM satellites. In November a workshop was held in Yantai to discuss and promote details of TIM system design.

Project Webpage:

www.spaceshandong.com

São Paulo Region, Brazil

The test center LIT (Laboratory of Integration and Testing), in São José dos

Campos, is part of the Brazilian Institute for Space Research (INPE) and hosts impressive facilities for functional and environmental satellite tests. The facilities are offered for use in TIM performance tests. Based on LIT previous Cubesat experiences (AESP14, SUCHAI, SERPENS 1, Tancredo 1), at least one satellite will be added to the TIM fleet. Visiona (an EMBRAER and Telebras owned company) is interested in taking part of the project.

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Western Cape, South Africa

Stellenbosch University in cooperation with the Cape Peninsula University of Technology coordinate on basis of their experience with CubeSats in orbit and involvement in international projects like QB50 the Cape Town contribution. Using their already existing ground station they will support the TIM satellite operations.

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SCS-Space and Space Advisory Company (SAC) are part of the SCS Aerospace Group, and are based near Cape Town, Western Cape, South Africa. Their contribution to the international TIM partnership is to supply the Gecko imaging payload to all partners. This payload comes with valuable operational space heritage. The SCS group is able to support mission partners with knowledge on payload integration and CubeSat design, obtained during the course of the nSight-1 mission.

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Quebec, Canada

In Québec the project has been discussed in several occasions, and Québec has hosted the 2018 TIM project meeting. Despite not having secured funding for a contribution yet, the team led by Polytechnique Montreal is looking forward to contribute to the project if not with a full satellite, with technology for inter-satellite communication and coordination. A potential partner that would join Poly-technique is the Computer Research Institute of Montreal (CRIM), which could provide resources for in-mission data collection and analysis.

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Upper Austria, Austria

The Keppler University in Austria is specialized in mechatronic components and will use the opportunity of TIM to bring their components and control approaches into space, if funding can be provided.

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The key contact persons of the TIM Project

The TIM Project Progress

Meetings

Meetings take place regularly during Regional Leaders Summits in partner countries. In 2016, TIM has been presented at the 8th RLS conference in Munich, Bavaria. In 2017, a dedicated TIM meeting was organized in Würzburg, Bavaria.

Also, during the 2018 9th RLS in Quebec-City, Quebec, a meeting of TIM partners took place to discuss the contributing missions and schedule. Representatives of the Bavarian, Shandong and Quebec national projects have been on site, as well as additional counsellors from Quebec and Georgia. Other partners have participated via phone conference.

The next meeting is at LIT, São José dos Campos, SP, Brazil, from 27th to 31st May 2019, including a small satellite course delivered by Prof. Schilling.

Publications

Scientific results, presented at conferences include:

Schilling, K., Tzschichholz, T., Loureiro, G., Zhang, Y., Steyn, H., Beltrame, G., de Lafontaine, J., Schlacher, K., "The Telematics International Mission TIM for 3D Earth Observation by Pico-Satellites", Global Space Exploration Conference (GLEX 2017), Beijing 2017, GLEX-17,12.4x36789

Zakšek, K., James, M.R., Hort, M., Nogueira, T., Schilling, K., "Using Picosatellites for 4D-imaging of Volcanic Clouds: Proof of Concept Using ISS Photography of the 2009 Sarychev Peak Eruption", Journal Remote Sensing of Environment, Vol. 210 (2018), pp: 519-530

Schilling, K., "TIM – A Small Satellite Formation for Earth Observation. Proceedings 9th International Workshop on Satellite Constellations and Formation Flying", Toulouse. 2017, IWSCFF 17-67

Zakšek, K., Haber, R., Tzschichholz, T., Nogueira, T., Dombrovski, S., Busch, S., Niklasch, N., Schilling, K., "Telematics Earth Observation Mission", IAA Symposium on Small Satellites for Earth Observation. 2017, IAA-B11-0409P

Schilling, K., Tzschichholz, T., Motroniuk, I., Aumann, A., Mammadov, I., Ruf, O., Schmidt, C., Appel, N., Kleinschrodt, A., Montenegro, S., Nüchter, A., "TOM: A Formation for Photo-grammetric Earth Observation by Three CubeSats", IAA Conf. on University Satellite Missions, Roma 2017, IAA-AAS-CU-17-08-02

Schilling K., Aumann A., Motroniuk I., Mammadov I., Garbe D., Ruf O., Dombrovski V., Hladký M., Nüchter A. „TOM – A Pico-Satellite Formation for 3D Earth Observation", 4S Symposium, Sorrento, 2018

Loureiro, G., W.F. Panades, A. Silva, "Lessons learned in 20 years of application of Systems Concurrent Engineering to space products", Acta Astronautica 151 (2018), p. 44–52.

Aumann A., Motroniuk I., Mammadov I., Scharnagl J., Schilling K. „Prototypen-Mission für die Erstellung von 3D Wolkenhöhenkarten - Kleinstsatelliten für Erdbeobachtung", Work-shop AK Umweltinformationssysteme, 2018

Kleinschrodt A., Motroniuk I., Aumann A., Mammadov I., Hladky M., Bilal M., Freimann A., Minshi L., Lianxiang J., Malan F., Feng L., Beltrame G., Schilling K. „TIM: An International Formation for Earth Observation with CubeSats, 12th Symposium on Small Satellites for Earth Observation, Berlin, 2019

Further Information

Further information about the Small Satellites project within RLS-Sciences can be found on the TIM website

https://www.rls-sciences.org/small-satellites.html