Trip Report from SmallSat Conference 2017

Traveller: Mariusz E. Grøtte[1];
Location: Utah State University, Logan, Utah, USA;
Dates: 04/08/17-10/08/17

PURPOSE

1) To network in the international SmallSat community with emphasis on academia, institutions and businesses primarily at exhibitions, poster sessions, speaker sessions as well as at evening gatherings and events.
2) Being introduced to the community and most importantly learn about up-to-date topics in relevant domains such as in hyperspectral imaging, launch systems, satellite communications related to our NTNU SmallSat project.
3) To learn about available COTS products, launch services, integration and testing services as well as connecting with key people inclined for collaboration.
4) Finally, effort was made on colloquially presenting our project to attract attention to potential collaborators and providers for COTS and various services.
5) Meet up with Miguel Nunes (Hawaii Space Flight Laboratory), Marcus Murbach (NASA Ames), Chad Frost (NASA Ames)

OVERVIEW

This report includes detailed daily summaries and relevant session talks during the conference, following a short summary with regards to persons connected with, a list of relevant companies, and finally follow-up actions. Summary for Thursday 10th of August is excluded due to departure that day.

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[1]Center for Autonomous Marine Operations and Systems (AMOS), Department of Engineering Cybernetics, Norwegian University of Science and Technology, Trondheim, Norway.

FRIDAY 4TH AUGUST - ARRIVAL

Highlights

Arrival; Made friends and good connections that we may learn from regarding reliability and also system studies. Exchange ideas/collaborate with **Technical University of Munich (TUM)**.

Summary

1) Connected **Sebastian Rückerl** and **Nicolas Appel**, two German PhD students from **TUM** at PDX, Portland Airport. We informally chatted on our projects and travelled together to Salt Lake City (shared same row of seats during the flight).

   - They were to hold poster presentation at the conference on interesting engagement in Reliability Studies of SmallSats, i.e. history of failures, lessons learned and how to mitigate risks in development phases. Their poster name was "Methods for Developing Reliable Hard- and Software for the Next Generation of Small Satellites". Definitely worthwhile to investigate.
   - Sebastian and Nicolas became very good friends during the whole conference and we spent most of our time during the day and night events.

Relevant talks

None.

SATURDAY 5TH AUGUST - PRE-CONFERENCE WORKSHOP

Highlights

Connection made with **TGV Rocket and Propulsion Systems**; **Space Systems Design Lab at Georgia Tech**; **Technical University of Munich (TUM)**; **Object Management Group**; **Aerospace Coorporation**

Summary

1) Arrived at Utah State University at 09:30 AM. Met **Patrick Bahn**, CEO of **TGV Rocket and Propulsion Systems**, before registration for the conference.
   - Regarding our systems sizing of the NTNU `SmallSat` , he strongly suggested we aim for 6U instead of a 3U or 2U, this related to talks about possibilities of installing liquid/chemical micro-propulsion subsystems for attitude control and orbital maneuvers (with somewhat unjustified thoughts for that).
   - Although I assume he purely aimed at selling his products to us, I believe we should investigate the idea of having larger sized `SmallSat` given the possibility of having a propulsion system on-board.
2) During a session break I connected with **Prof. Glenn Lightsey**, a Professor at School of Aerospace Engineering at **Georgia Tech**, former colleague during my M.Sc. degree at Space Systems Lab, Georgia Tech.
   - He currently works on Systems Engineering and GNC-related topics on SmallSats and his lab is currently engaged in development of 3 SmallSats (ITAR), two of them, RECONSO and RANGE, prospected for launch in 2019 and 2020 respectively.
   - Limited to what we may want to collaborate with, but non-ITAR material may be requested from them. Since they were former colleagues, this should be no problem.
3) **Sebastian Rückerl** and **Nicholas Appel** connected me with **Martin Langer**, Dipl.-Ing. at Department of Astronautics at **TUM** and the main researcher for the SmallSat Reliability Studies.
   - They suggested that our NTNU group should visit their lab at TUM and learn from what they are working on, which I think would be highly relevant, especially for the lessons learned in development phases.
   - They have experience with one SmallSat failure (software failure in-orbit) and aim to mitigate the risks for next launch.
4) During lunch session I had a nice chat with **Steven MacLaird**, retired Col (Ret.) at USAF and currently Senior Vice President at **Object Management Group (OMG)**. Strong Air Force background.
   - He strongly advocated for standardized guidelines and a CubeSat reference model, which would be good to look at, given that SmallSat launches are rapidly increasing.
   - Electronic documentation is available from him.
5) Talked shortly with speaker **Jerry Fuller**, Mechanical Designer at **Aerospace Coorporation**, about his talk on "Shape-Memory Alloy Actuators for Small Satellites", which is interesting for deployment of structures in solar panels and antennas.
6) Attended several more sessions and left back home after last session of the workshop at approx. 5:30 pm.

Relevant talks

- Methodology for Software-in-the-Loop Testing of Low-Cost Attitude Determination Systems. University of Minnesota. Link
- A Data-Driven Approach to CubeSat Health Monitoring. California PolyTech. Link
- Communications for the TechEdSat5/PhoneSat5 Mission. NASA Ames.
  - Interesting talk on TechEdSat series heritage and what they aim for. Marcus Murbach is PI.
- The Distributed Universal Satellite Technology (DUST) Tech Demo: an Inter-satellite Communications Mission. University of Michigan/NASA JPL.
  - Constellation prospected to launch from ISS. Meshed information relay. Nadir & Zenith sensors. S-band and X-band utilization. Uses GomSpace power management system. ISIS solar panels. Interesting Link budget.
- Integration and Testing of the Nanosatellite Optical Downlink Experiment. MIT STARLab.

- – Slewing accuracy required of 0.1 deg (2σ). Uses optical comms. Aiming at 100 Gb/day of data transfer.
- UWE-4: Integration State of the First Electrically Propelled 1U CubeSat. University of Würzburg. Link
  - – Interesting with regards to the electric propulsion system.
- What We Learned from the Tokyo Tech 50 kg-satellite "TSUBAME". Tokyo Institute of Technology. Link
  - – Very good about lessons learned. Other talks were more about success stories and not so much lessons learned...
  - – DC/DC converter survived only 1 week Redundancies malfunctioned. Heat dissipation of electronics.
- On-Orbit Performance of the BCT XB-1 Spacecraft and GN&C Components.
  - – Used both SPI and I2C interfaces. Control error less than 0.6 degrees. Misalignment of sun sensor and solar panel. Zero-speed crossings analyzed.
  - – Aim for a 12 U SmallSat to GEO in 2018.
- Standardizing the CubeSat Standard: a Review of the Core Elements of the CubeSat Design Specification. ISIS.
  - – EVT testing. Payload requirements. Defined waiver for requirements need. Defining new way for design.
- Small Spacecraft Systems Virtual Institute-Mid-Year Status and Plans for 2018. NASA Ames.
  - – spoonsite.com. Provides overview for launch schedules and opportunities (only for NASA?). Interesting to follow this development.
- Advancement, Testing and Validation of an Innovative SmallSat Solar Panel Fabrication Process. UColorado. Link

SUNDAY 6TH AUGUST - PRE-CONFERENCE WORKSHOP

Highlights

Connected with people from **University of Michigan**, **Leaf Space**, **MIT**, **South Dakota State University**

Summary

1) Talked shortly with M.Sc. student **Andrew Kennedy** from **MIT**.
   - We mostly discussed the availability of mission design software developed by M.Sc. student **Veronica Foreman** and her group at **MIT**, which might come in handy for our project. This software is called **TAT-C** (talk given same day - see below).
   - Otherwise, his talk later on **ACCESS** in the conference would become interesting in relevance to optical cross-links in a satellite constellation (see relevant talks on Tuesday).

2) Connected with **Emanuella della Bosca**, M.Sc. at **University of Michigan**, regarding her talk about the DUST mission.
   - My questions were about her link budget, communications and choice of constellation as well as procedures for proof-of-concept constellation launched from ISS. She offered to send us updated material on her on-going mission design.
   - She introduced me to both **Giovanni Pandolfi**, CTO at **Leaf Space**, and **Prof. Marco Ciarcia**, Assistant Professor at Department of Mechanical Engineering at **South Dakota State University**.

3) **Giovanni Pandolfi** offered us, NTNU `SmallSat` group, to make a deal to use their ground stations across the world.
   - Of interest to us are ground stations in Madrid, Iceland and Lithuania. 13 passes per day will be the limit and depends on amount of data downloaded. X-band and Ka-band available.
   - Showcased our NTNU `SmallSat` project to him.

4) Had highly interesting talks with Prof. **Marco Ciarcia** throughout the conference.
   - He does some high-level robotics and optimization studies on robotic platforms (relevant to us), UAVs, `SmallSat` and even docking systems in-orbit.
   - He introduced the concept of real-time optimization and trajectory planning as applied to a system of multi-agents. He invites us to his **Aerospace Robotics Lab**, either to see his lab (which might be fruitful) or potentially collaborate with him.
   - He liked our concept for NTNU `SmallSat` very much, and could offer some guidelines or even collaboration.
   - We also discussed potential interest in having a Visiting PhD Researcher over, or exchange M.Sc. student for one year.
   - This is a contact worthwhile to have in the loop. Showcased our NTNU `SmallSat` project.

5) Emanuella, Giovanni, Marco and me went for dinner and later to play pool at B&B Billiards in Brigham City.

Relevant talks

- CubeSat Model Based System Engineering (MBSE) Reference Model - Development and Distribution - Interim Status #3
  - SysML. INCOSE, MBSE, SSWG.
- NOAA EON-IR CubeSat Study for Operational Infrared Soundings.
- Preparations for the NOAA Earth Observing Nanosatellite-Microwave (EON-MW) Mission.
- Launch Services 101, Managing a 101 CubeSat Launch Manifest on PSLV-C37. ISIS.
- Studying the Earth at Night from CubeSats. Link
  - Multi-spectral imager. Responsive attitude control.
- Shields-1 Technology Demonstration on ELaNaXIX.
  - Interesting about shielding. Polar and SSO has more radiation hazards. Tested on polar LEO mission.

- Distributed Spacecraft Mission Design: Goddards Trade-space Analysis for Constellations (TAT-C). MIT.
  - Outputs risk evaluation for each system and mission segment. May output optimal constellation based on requirements. Mission and science success criteria fulfilled or not. Quantitative vs. qualitative input/outputs. Tradespace analysis. DSM software tool.

MONDAY 7TH AUGUST - CONFERENCE

Highlights

Familiarizing myself with exhibitions; Attending session talks; Connected with **Kongsberg Silicon Valley**, **Kongsberg Satellite Services (KSAT)**, **Hyperion Technologies**; made more friends from **NASA Goddard**.

Summary

1) Conference and exhibitions didn't start until 1:15 PM. Emanuella, Giovanni, Marco and me visited the Hill Aerospace Museum which was highly interesting about history of US aircraft. Not much space, but still cool to see.
2) Visited **Stig Are Thrana** and **Vidar Tyldum** at their **KSAT** exhibition booth.
    - Showcased our NTNU `SmallSat` project and they immediately showed interest and openness in collaborating. They want to stay in-the-loop during the mission design and evaluating the mission requirements and architectures.
    - As soon as we come up with a draft for communications architecture then we should contact them.
    - Agreed on potential utilization of their ground station facilities at Svalbard and Vardø and their willingness to give sponsorship. Suggested X-band downlink for our `SmallSat` and S-band for uplink. Keep open mind for Ka-band. We need to update them on our proposed SDR architecture (GnuRadio is possible).
3) Talked about products from **Hyperion Technologies** and discussions about specifications with **Steven Engelen**, CTO.
    - They do not provide tranceivers for S-band and X-band, but only optical/laser downlink module. Expressed ability to work with other companies on tranceivers if we were to choose their components.
    - Easy interfacing and good accuracy for 3-axis attitude control. Provides star tracker for orbit determination, as well as outer structure. Ability to interface with GomSpace products.
4) Together with Sebastian and Nicolas (TUM) I attended at the SmallSat Conference Opening Social Event arranged by Space Dynamics Lab at USU and later at White Owl (a local pub). Nicolas introduced me to young engineers at **NASA Goddard**. Talks about visiting their research center if/when I get security clearance while at NASA Ames as visiting researcher.

Relevant talks

- Planet's Open Water Imaging - Geo-Accuracy Assessment. Link.
- NASA CYGNSS Mission Update; A Pathfinder for Operational GNSS Scatterometry Remote Sensing Applications. Link
- The Rainbow Connection - Why Now is the Time for Smallsat Optical Downlinks. Link.

TUESDAY 8TH AUGUST - CONFERENCE

Highlights

Connected with **TYVAK**, **GomSpace A/S**, **Pumpkin Inc.**, **AGI**, **University of Würzburg**; Attended session talks

Summary

1) Had a conversation with **Justin Carnahan**, **TYVAK**, about their launch and testing services. Showcased our project to him. They are very inclined to support us.
   - They have nice deployment modules (railtype and tabtype) and can arrange everything with regards to launcher.
   - Availability is 6U for 480k-600k USD and 3U for 250-500k USD. Also have available 2×3 deployer dispensers.
   - We have to provide them mission and system requirements for review when we get there. For launcher, we give them a desired orbit and the specifications of the satellite. Not sure if they provide testing services for vibrations, thermal, shock environment, outgassing etc.
   - Upon deployment from launcher, TYVAK may support us with state vector estimation and tracking.
   - For further collaboration we discussed a potential meeting in San Francisco during our visit to NASA Ames in October 2017. We need to provide them time/dates for prospected launch, desired price range for launch, payload specifications and requirements, size of spacecraft as well as mass and link budgets. Non-disclosure Agreement for services with our NTNU `SmallSat` project.
2) Connected with **Jacob Bach Sanden** at **GomSpace A/S**. I showcased our project and he was very interested to support us.
   - They normally give 10-12 weeks delivery time on components and can give products for up to 6U/12U sizes.
   - Also have chemical propulsion.
   - 75000$ for launcher opportunities.
   - SDR not configurable by us if bought from Gomspace(?).
   - 1-2 days training available for us (integration and systems).
   - Before acquiring any products they need more requirements from us.
   - They will have S-band ground station infrastructure this year, but do not develop any X-band tranceivers yet but may be arranged and configured for our needs (maybe SDR is not configurable here!).
   - Normal SPI/CAN/I2C onboard-processing.
   - For further technical specifications, then we should talk to Morten.
3) Did an overview of products from **Pumpkin Inc.** and connecting with **Andrew Kalman**, CEO. Good products on structure/outer frame, power systems and batteries. We might set up a meeting in October if desired.
4) Asked **Adam Gorski**, from **AGI**, about guidelines during my mission design. He showed some neat stuff about energy mangagement and optimization tools for determining the right orbit given payload and environment constraints. May also be integrated with UAVs and ships. Willing to support us during our mission design process in STK.
5) Talked with **Philip Bangert** from **University of Würzburg** regarding his talk on UWE-4 on Saturday. He may aid us with providing lessons learned from the other UWE-x series. Also propulsion system might be of interest.
6) Together with Sebastian and Nicolas (TUM), I attended a AGI-invited party. Japanese **CANON** also develop Hyperspectral Cameras (?). Met with former colleagues at Georgia Tech.

Relevant talks

- Temporal Experiment for Storms and Tropical Systems Technology Demonstration (TEMPEST-D) Mission: Enabling Time-Resolved Cloud and Precipitation Observations from 6U-Class Satellite Constellations. Link.
- NASA's Pathfinder Technology Demonstrator. Link.
- GOMX-4: Demonstrating the Building Blocks of Constellations. Link.

- Two Aerospace Corporation CubeSat Remote Sensing Imagers: CUMULOS and R3. Link.
- SmallSat Express - Meeting the Needs for a Launch Capability for Small Satellites. Link.
- Improving Launch Vibration Environments for CubeSats. Link.
- Initial Results from ACCESS: An Autonomous CubeSat Constellation Scheduling System for Earth Observation. MIT. Link.
- Comprehensive Vicarious Calibration and Characterization of a Small Satellite Constellation Using the Specular Array Radiometric Calibration (SPARC) Method. Link.
- The NASA TROPICS CubeSat Constellation Mission: Overview and Science Objectives. Link.
- TRL6 Testing of Hyperspectral Fourier Spectrometer Instrument for CubeSat Applications. Link.
- CHIEM: A New Compact Camera for Hyperspectral Imaging. Link.

WEDNESDAY 9TH AUGUST - CONFERENCE

Highlights

Connected with **Miguel, Luke Flynn, Eric Pilger** at **Hawaii Space Flight Lab**, **Marcus Murbach** at **NASA Ames**, **ClydeSpace**, **UTIAS**, **Surrey Satellite Technologies**, **Swedish Space Coorporation (SSC)**, **Braxton Tech**

Summary

1) Had good talks with **Andrew Strain, Clydespace,** about our project.
   - He was very interested, especially the hyperspectral imaging part, and expressed support for integrating our payload.
   - They provide all necessary on-board components to fulfill all the system and payload requirements.
   - We cannot buy a single component, rather we need their full service (even launch).
   - They seem like a promising candidate. Suggested a visit/meeting with them in Glasgow.

2) Had a chat with **Robert E. Zee at UTIAS Space Flight Laboratory** about the NorSat series and our project.
   - I understood that they will not be part of development in Norsat-3 and 4, but this may change (no request on this yet).
   - They expressed support for providing training to students from NTNU (semester-based) for exchange students (M.Sc. or PhD), this involving integration of components and systems engineering. Will contact them after further discussions with leads in AMOS.

3) Showcased our project for **Ed Stevens at Surrey Satellite Technologies**. He seemed very interested, especially about the Earth observation/remote sensing part. They may also provide training and services.

4) Met up with **Miguel Nunes and connected with Eric Pilger and Luke P. Flynn, Hawaii Space Flight Laboratory**.
   - We chatted about COSMOS, the intention with it and integration issues with LSTS toolchain. Seems like we have to decide on either COSMOS or LSTS - COSMOS is more oriented at the space-segment and mission control operations.
   - Matters to look into: performing a survey of architectures with such capability needs in having autonomous multi-agent architectures and efficient communications, investigating cross-link capabilities in a constellation of several satellites and uplinking/downlinking directly to/from UAVs and other agents in architectures.
   - Re-defined what agent means: this can also be separate (software) components in a satellite itself that communicate with each other.
   - Miguel and Eric proceeded to install COSMOS on my PC and showed another open-source product that might come in handy for energy management analysis and orbit design - a potential replacement or parallell tool for mission design.
   - We started working on defining requirements for Miguel's pre-proposal document which I will lead the progress of. We might collaborate with them as soon as we can define our robotic platform and software architecture.
   - For now I will look into their self-developed orbit design and analysis software.

5) Stopped by **Swedish Space Coorporation and its US representative Daniel White**. They are starting to build infrastructure for orbital launch mainly aiming at delivering payload in polar/sun-synchronous orbits. Staying in touch on the progress and opportunities for us in 2020.

6) Met shortly with **Marcus Murbach from NASA Ames** and showcased our project. He expressed strong interest and wants to stay in-loop regarding mission design and setting mission and system requirements. Discussed a bit on the Visiting Researcher opportunity in January 2018. Was not able to talk with Chad Frost unfortunately.

7) Had a short chat with **Rob Patterson from Braxton Tech** about our project.

8) After speaker sessions and meetings I attended night events arranged by Arianespace and Moog Inc.

Relevant talks

- Big Data Downlink Enablers for Next Generation Tactical U.S. Army Applications. Link.

- Dove High Speed Downlink System. Link.
- Solving the Thermal Challenge in Power-Dense CubeSats with Water Heat Pipes. Link.
- Development Status of Compact X-band Synthetic Aperture Radar Compatible with a100kg-class SAR Satellite and Its Future Plan. Link.
- Different Approaches to Developing Small Satellite Missions. Link.
- The Development of "nSight-1" - Earth Observation and Science in 2U. Link.

Summary & Complete List of Connections Made

- Stig-Are Thrana, Head of Kongsberg Silicon Valley, Kongsberg Defense Systems
    - stiga@ksat.no
- Vidar Tyldum, Lead Software Engineer for Satellite Operations, Kongsberg Satellite Services
    - vidar@ksat.no
- Marco Ciarcia, Assistant Professor at Department of Mechanical Engineering, South Dakota State University
    - marco.ciarcia@sdstate.edu
- Jacob Bach Sanden, Commercial Product Manager, GomSpace A/S
    - jbs@gomspace.com
- John P. Lucas, Systems Engineer, NASA Goddard
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- Marcus Murbach, NASA Ames
    - marcus.s.murbach@nasa.gov
- Chris Purdy, Electrical Engineer, NASA Goddard
    - christopher.c.purdy@nasa.gov
- Eric Pilger, Researcher, Hawaii Space Flight Laboratory
    - pilger@higp.hawaii.edu
- Miguel Nunes, Researcher, Hawaii Space Flight Laboratory
    - manunes@hsfl.hawaii.edu
- Justin Carnahan, Mission Manager for Launch Services, TYVAK Nano-Satellite Systems Inc.
    - justin.carnahan@tyvak.com
- Robert E. Zee, Director at Space Flight Laboratory, University of Toronto (UTIAS)
    - rzee@utias-sfl.net
- Adam Gorski, Manager at West Coast Business Unit, AGI
    - agorski@agi.com
- Steven A. MacLaird, Col (Ret.) at USAF, Senior Vice President at Object Management Group (OMG)
    - maclaird@omg.org
- Ed Stevens, Surrey Satellite Technology
    - e.stevens@sstl.co.uk
- Andrew E. Kalman, President, Pumpkin Inc.
    - aek@pumpkininc.com
- Daniel White, Executive Vice President for Americas, Swedish Space Coorporation
    - dan.white@sscspace.com
- Giovanni Pandolfi, CTO and Co-Founder, Leaf Space
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- Sebastian Rueckerl, PhD student, TUM
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- Nicolas Appel, PhD student, TUM
- Patrick R. Bahn, CEO, TGV Rocket & Propulsion Systems
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- Martin Langer, PhD, TUM
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- Andrew Strain, Vice President of Engineering, Clydespace
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- Jeroen Rotteveel, ISIS

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- Rob Patterson, Chief Revenue Officer, Braxton Tech
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- Philip Bangert, Research Assistant, University of Würzburg
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- Luke P. Flynn, Director, Hawaii Space Flight Laboratory
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- Andrew Kennedy, M.Sc. Student, MIT
- Veronica Foreman, M.Sc. Student, MIT
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- Emanuella della Bosca, M.Sc., University of Michigan
- Glenn Lightsey, Professor at School of Aerospace Engineering, Georgia Tech
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- Dr. ir. Steven Engelen, CTO, Hyperion Technologies
  - – s.engelen@hyperiontechnologies.nl

LIST OF RELEVANT COMPANY EXHIBITIONS VISITED

- TYVAK Nano-Satellite Systems Inc.
  - – integration, testing, launch
- Surrey Satellite Technologies
  - – remote sensing services and training
- Kongsberg Satellite Services (KSAT)
  - – ground stations and comms.
- GomSpace A/S
  - – COTS, integration
- Pumpkin Inc.
  - – power systems, batteries
- Innovative Solutions in Space (ISIS)
  - – COTS, integration, testing, launch
- UTIAS Space Flight Laboratory
  - – integration, launch
- Hyperion Technologies
  - – COTS, integration
- Clydespace
  - – COTS, integration, launch
- Leaf Space
  - – ground stations and comms.
- German Orbital Systems
  - – COTS
- Berlin Technologies
  - – COTS
- SpaceX
  - – launch
- SpaceFlight Industries
  - – launch
- Vulcan Wireless Inc.

– propulsion
- Berlin Space Technologies GmbH
    – COTS
- Analytical Graphics Inc (AGI)
    – STK software support

FOLLOW-UP ACTIONS

1) Coordinate a 2-3 days visit to TUM, Germany. We should also invite people from the SmallSat lab either to look at the HSI `SmallSat` development or NUTS. Contact: Sebastian Rueckerl, Nicolas Appel, Martin Langer.
2) Coordinate a visit to Prof. Marco Ciarcia's Aerospace Robotics Lab at South Dakota State University. I think this would be fruitful in terms of exchanging students, collaboration and working across robotic domains together. I believe we have much to learn from him and his students about robotic platforms including a `SmallSat` . I sent him some material about our project already (but not too much!). I believe further talks will be applicable when concept is developed further.
3) Further coordinate writing the proposal with Miguel (Hawaii) and installing COSMOS. Evaluate risks and feasibility of using such software for our architecture. It seems very applicable at least to the space segment. Investigate also the feasibility of mission design software tool developed by Eric Pilger. Need to define our software architecture before evaluating the feasibility of COSMOS for a ground station-mission operations-space architecture.
4) Include Marcus Murbach and NASA Ames in the mission design, iterations and requirements definition.
5) Extend discussions with GomSpace A/S. As they do not provide X-band tranceivers directly, we may have to think about alternatives. Also we need to clear up about the issue in non-configurable SDR if we choose a custom-made X-band tranceiver. Further talks about software architectures necessary. Follow-up on meeting in Aalborg in september 2017.
6) Coordinate a visit to TYVAK Nano-satellite Technologies Inc., based in San Francisco. We may do this during our NASA Ames visit in October 2017.
7) Coordinate a visit to Pumpkin Inc., based in San Francisco. We may do this during our NASA Ames visit in October 2017.
8) Coordinate a meeting with Clydespace, based in Glasgow. I believe they are robust and a good candidate if we are only concerned about integrating our payload. SDR should be configurable.
9) Talk further with former colleagues at Georgia Tech about their SmallSat programs. More interested in lessons learned and management schemes.
10) Request CubeSat Reference Model Documentation from Object Management Group.
11) Look into Shape-Memory Alloy Actuators for Small Satellites if interested in deployment of structures.
12) Request documentation/slides/budgets from Emanuella della Bosca from University of Michigan.
13) Request documentation/slides/budgets from Philip Bangert from University of Würzburg.
14) Investigate NASA Ames' SPOONSITE.
15) Request non-ITAR documentation/slides/budgets on TAT-C and ACCESS from Veronica Foreman/Andrew Kennedy from MIT.
16) Talk with Leaf Space when we have link budgets and orbit design done.
17) Talk with Kongsberg Satellite Services (KSAT) when we have mission requirements, link budgets and orbit design done. They want to stay in-the-loop and open to collaborate early on.
18) Talk with Hyperion Technologies about their availability and flexibility when we start our systems design for `SmallSat` .
19) Request support when needed from Adam Gorski at AGI when doing mission design in STK.
20) Coordinate a visit to UTIAS. Ask about their availability for integration of systems.
21) Update Surrey Satellite Technologies on the mission design and purpose for science when we have that ready.
22) Look into X-band and Ka-band for communications, as S-band will be insufficient for big data transfer such as from Hyperspectral Imaging (given we also will have short revisit times) and limited number of ground stations. S-band is OK for uplink. A lot of research is currently done on optical data transfer.