ISSUE 5

QB50 Newsletter

Https://www.QB50.eu

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QB50 Project and Launch Vehicle Selection Status

The QB50 project, kicked-off in November 2011, has now, in January 2014, passed its half-time of the previously defined duration with the conclusion of the M24 review. The European Commission has inspected the progress of the project in very detail and congratulated the QB50 consortium that all aspects of the mission have been addressed sufficiently and first hardware has been assembled.

In particular, the selection of the new launcher, the new GENSO independent ground segment, the progress on the sensor development and deployment system and the enthusiasm of the cubesat teams have been emphasized as important assets of the project. Now, the project can go ahead with excited motivation until launch.

The year 2014 commenced with a highlight. On the 28th and 29th of January, we did not only hold our QB50 workshop at the von Karman Institute – we also signed the launch service contract with Alcantara Cyclone Space. The launcher Cyclone-4, developed by the Ukrainian company Yuzhnoye, will send our satellites into orbit in January 2016.

The QB50 Newsletter is issued approximately twice a year with the purpose to inform the QB50 community on the status of the Project and the most important upcoming events. Experience has shown that many persons do not regularly visit the QB50 website; the Newsletter is a more direct way of disseminating new information. The first QB50 Newsletter was issued on 12 July 2011, the second on 7 December 2011, the third on 26 March 2012 and the fourth 31st May 2012.

The Newsletter is issued to a mailing list of 280 persons worldwide. It is likely that these persons will distribute the Newsletter to interested colleagues and CubeSat team members so that eventually over 1000 persons will read the Newsletter. If you wish to be added to the Newsletter mailing list or wish to unsubscribe to the Newsletter, please contact thoemel@vki.ac.be
The Newsletter also provides a forum for posting short messages by CubeSat teams (e.g. lessons learned) and for asking questions and providing useful contact names and addresses. Such short messages should be sent to the Editor Jan Thoemel thoemel@vki.ac.be with a request for publication in the next Newsletter.

Copies of the first three Newsletters can be downloaded from https://www.qb50.eu/newsletter.php

Launcher Cyclone-4.

This means a little more than 6 months of delay for the cubesat teams allowing them to increase confidence in the design or additional testing.

The remainder of the year 2014 will be dedicated to the building of first qualification hardware and later possibly some flight hardware. On the QB50 consortium side, we will continue to develop the Quadpacks, our modules for the final deployment system, the scientific sensor units, which will be send to you in part in the end of the year and also the QB50 developed attitude determination and control system (ADCS). An important milestone being the launch and the operations of the QB50 precursor satellites will also be achieved.

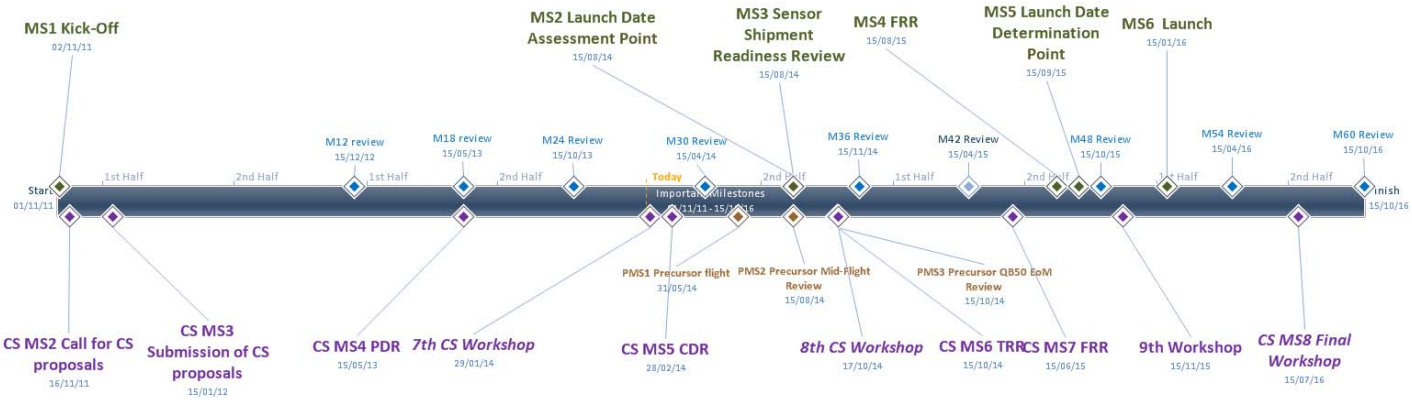


Figure 1: QB50 milestone planning.

Now that all aspects of the project have been consolidated, a through and detailed planning has been established in order to assure that the activities are well concerted. The most important milestones are shown in Figure 1.

J. Thoemel and J. Muylaert, VKI

Precursor flight

A monumental highlight of the QB50 project is approaching very quickly. By May 2014, the first two satellites of the project will be launched into orbit. A large part of the consortium has contributed to the design and manufacturing of our Precursor satellites.

By May 2014, the first two satellites of the project will be launched into orbit

Subsystem	Contributer
Attitude Determination and Control System (ADCS)	Surrey Space Centre (SSC), UK
Ion & Neutral Mass Spectrometre (INMS)	Mullard Space Science Laboratory (MSSL), UK
Oxygen Flux Probe (FIPEX)	Technical University Dresden (TUD), DE
Satellite Control Software (SCS)	Ecole Polytechnique Federale de Lausanne (EPFL), CH
PA support	Astrium GmbH/Airbus GmbH
Thermal Analysis & Payload	Von Karman Institute (VKI), Belgium
Quadpack deployer, Satellite Design, Assembly, Testing & Launch Campaign	Innovative Solutions in Space (ISIS), NL
2 x Communication Payload	Amsat Francophone, Amsat NL

Developing and launching CubeSats into orbit typically involves higher risks compared to classical, commercial or governmental, missions. This is due to the use of cost-efficient components and often due to the educational character of such projects. This was not enough for QB50 and hence, we insisted that key subsystems of the mission are being tested, de-risked as we say, in orbit before we use them on the main mission. In addition, the campaign serves as an end-to-end rehearsal for the involved engineers and managers. All of this will enable the consortium to provide flight proven technology, optimally manage the main mission and to support QB50 community with hand-on experience.

For this purpose two 2-Unit CubeSats will be built, launched and operated by the QB50 consortium. As part of the precursor risk-reduction campaign, the newly developed deployment system will be qualified and used to deploy the two QB50 precursor satellites. The deployment system consists out of a 3-Unit QuadPack (that has a total of 12-Units of launch capacity in 4 individually controlled launch-tubes and the associated deployment sequencing electronics. This activity derisks:

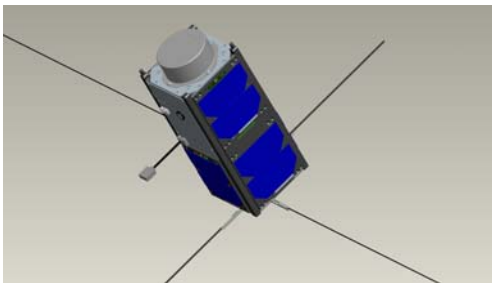
- The QuadPack CubeSat deployer and its electronics, which form the main building blocks for launching the 50 QB50 satellites is an essential building block in the provision of affordable access to space. The ground qualification and subsequent demonstration during the precursor flight, will provide heritage for the deployment system and provides a flight tested system for the main flight.

- The launch campaign itself will allow the launch team and all other involved consortium members involved in the launching of the QB50 precursor satellites to gain experience from a modest launch campaign and draw valuable lessons from this activity for the main flight.

The development of the two satellites is currently ongoing at the ISIS premises in Delft. The first satellite (QB50p1) will carry an INMS payload and the second satellite (QB50p2) will carry a FIPEX payload. Furthermore both satellites will carry a thermocouple experiment from VKI and an amateur radio payload provided by the AMSAT-ML and AMSAT-FR. These last payloads serve as a return favour to the satellite radio amateur community for the fact that the QB50 main mission can use the amateur bands during the full flight in 2016. Lastly, the satellites will fly the SSC provided ADCS system that is available for the QB50 flight. The satellites will be delivered for launch at the end of Q1 2014. Flying these satellites allows the consortium to de-risk a number of elements including:

- The developed payloads as the payloads will be flown and tested on-orbit,
- The ADCS system as its performance will be tested on orbit,
- The satellite development as it provides proof and a reference to a QB50 capable satellite design.

QB50 Satellite with INMS payload



The operations of the satellites will also be performed in a similar way as for the QB50 main flight operations, which means that payload tasking will be performed by MSSL and implemented by mission control. This will largely be representative of how a significant amount of QB50 teams will operate their satellites for the main flight. Furthermore, the option of implementing the EPFL SCS is planned to be tested later in the precursor mission, which would also validate the data path for the teams that use this system in their baseline QB50 mission. Performing operations like this de-risks:

- The interface between the payload and the ground segment
- The interface between a typical ground station and the central payload data server
- The interface between an EPFL SCS ground station and the central payload data server

All in all, the precursor flight will provide everyone with a boost of confidence for the QB50 main flight!

The consortium has finalized the detailed design phase in December 2013 for two 2-unit CubeSats. We have convened on the 16th of January 2014 at ISIS premises to conclude that all hardware is available and to commence the assembly and testing activities.

Ultimately, the Precursor satellites will be launched by a Russian Dnepr rocket into a near Sun Synchronous Orbit at 624 km altitude, now scheduled for May 2015. For 6 months, we will then operate and test all subsystems. Afterwards, we will hand-over the satellites to the radio amateur community.

J. Rotteveel, J. Elstak, J. Thoemel

Schedule, preparation and first results of the CubeSat

Deadline to submit the Critical Design Reviews (CDR) datapackages: 29th February 2014

Those QB50 CubeSat teams that have successfully passed the Preliminary Design Review (PDR) are invited to submit their Critical Design Reviews (CDR) datapackages by the latest by 29th of February 2014. The QB50 CDR procedure is designed upon the lessons learned from the PDR experience, which resulted in the following recommendations for CDR:

- CubeSat teams should have at least one independent reviewer that can make a face-to-face review session with the core team
- The CDR should be a complete review, where the CS teams should hand in not just a summary of the design, but a whole information package without page limits.
- Provision of templates was a good idea, making life easier for the CubeSat teams and the reviewers
- There should be more reviewers from the QB50 Consortium
- Peer reviewing among the QB50 CubeSat teams should be encouraged
- The CubeSat teams should prepare and submit a development plan with associated risks and mitigation techniques
- Critical information such as requirements compliance and also subsystem choice is needed electronically in MS Excel format allow to a quick processing of all 50 cubesat datapackages

In line with these recommendations, templates for Critical Design Overview Report/Spread Sheet, Risk Analysis and Mitigation Plan Report, Assembly Integration and Test Plan Report, Management Plan report and Compliancy Tables are prepared and sent to the CubeSat teams. An online CDR package submission site will be at the service of the CubeSat teams and the reviewers. The number of reviewers per CubeSat team is also increased significantly. Any CubeSat team should have at least one independent reviewer that they should find, at least one peer reviewer from another CubeSat team and at least two reviewers from the QB50 Consortium.

In January 2014, in total 25 datapackages have been received. The datapackages are of high quality and some of them reveal common issues. Among them are:

- missed opportunities for design robustness and redundancy of antennas, battery circuitry
- operating modes:
  - on the one hand: violation of the KISS (Keep It Simple Stu..) principle
  - on the other hand: insufficient distinction of modes (QB50 sensor unit operations – cubesat payload operations)
- missing thermal or mechanical considerations, e.g., no statement on the expected eigenfrequency is provided. As the requirement on the first eigenfrequency is essential an analysis or assessment by other means such similarity is needed.

- mass budget:
  - missing items such as harness
  - excess of mass. It is likely that an excess of 100 g would be waived in the course of the project.
- ITAR components not identified
- model philosophy not mentioned

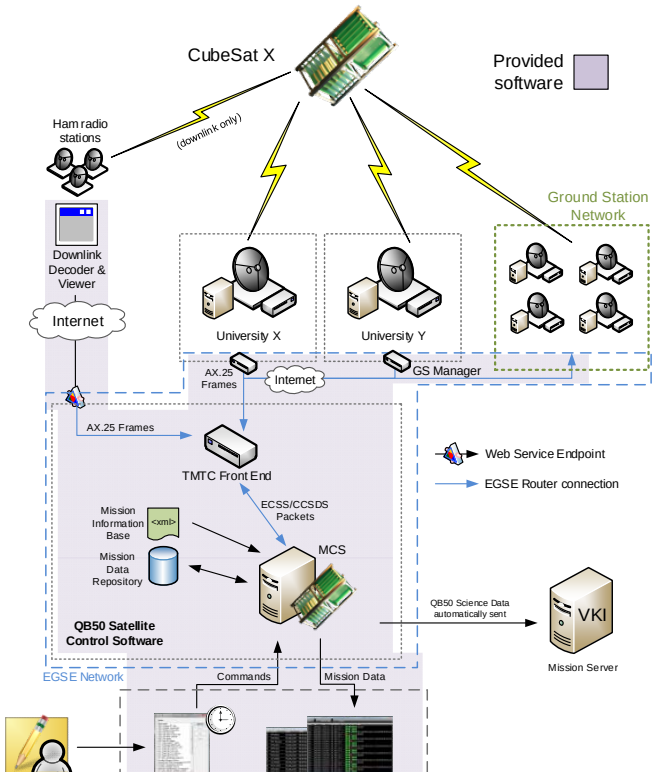
Such items are not unusual and can be resolved in short time allowing closing the CDR process

C. O. Asma, S3 & J. Thoemel, VKI

Satellite Control Software for QB50 CubeSats

The Satellite Control Software is the part of the ground segment that monitors and controls the CubeSat. It is highly modular as each part of the software are together through a single network.

Its most basic function is to receive telemetries (in an AX.25 frame and ECSS packet) and separate them by type such as housekeeping and payload data. It also sends telecommands for which the user will receive an acknowledgement at different levels of the reception or the execution of it.



Raw data is automatically stored at the TMTC Front End level of the software to allow a replay of the reconstruction packets processing. Packets are stored as well to keep the whole history.

Satellite Control Software will 1 year before launch

The SCS is highly configurable, using a Mission Information Base based on XML, which values will be calibrated and checks performed automatically.
As the SCS works in network, it is easy to add a node to add a ground station. The software will support this extra ground station for downlink and uplink (in agreement with ground station's owners). For multiple downlinks, a decoder for the radio amateur will be available.

SCS is based on Microsoft technology, AX.25 protocols and ECSS packet's formatting, which are well-known technologies and protocols, which ensure the availability and support in a long term. Interfaces, installation and configuration are fully documented for an easy use of the software. The SCS can be used during the ground testing of your CubeSat.

The SCS will be delivered to the CubeSat teams 1 year before launch. There is no fee but a license will need to be established between EPFL and the CubeSat University. For more technical information, please check the web site qb50.eu.

M. Richard

6th QB50 Workshop on 6 June, QB50 Asia Workshop, 7th Workshop 28th/29th of January 2014

6th QB50 Workshop

The 6th QB50 Workshop was held on 6 June 2013 at von Karman Institute, right after the 5th European CubeSat Symposium (3rd-5th June 2013, Brussels). The Workshop involved presentations by the QB50 Consortium Partners, focusing on:

- Contractual and Legal Issues
- CubeSat PDR Results
- System Requirements
- Deployment System
- Science Units
- Surrey ADCS
- Ground Station Network
- Satellite Control Software
- CDR Procedures

An additional "QB50 Asia Workshop" was organised with the support of the QB50 Partner Northwestern Polytechnical University on 28th Sep. 2013 in Beijing, China.

This event was just after the International Astronautical Congress (IAC) 2013 in the same city and allowed the QB50 representatives to have face to face discussions and presentations with (mostly) the Asian CubeSat teams who were not able to attend to the previous Workshops at VKI. It was also an advantage to be able to have technical discussions with the students who are actually doing the CubeSat development work. The QB50 Asia Workshop was also well attended by representatives of IAF, Amsat-China, representatives of Chinese Space authorities and of the China Great Wall Corporation.

QB50 Asia Workshop

The 7th QB50 Workshop took place on 28-29 January 2014 at von Karman Institute. The Workshop involved presentations by the QB50 Consortium partners, aiming at giving information on:

- Announcement of the signing with the launch service provider Alcantary Cyclone Space
- Details on the QB50 launch vehicle
- First CubeSat CDR Results
- Planning of the upcoming QB50 Precursor Flight
- System Requirements Update
- Deployment System Status
- Science Units Status
- Satellite Control Software Status
- Upcoming Events and Reviews
- Demonstrations of and lessons learnt from cubesat projects

70+ community CubeSat team members, QB50 consortium partners, representatives from the European Commission, the launch provider, the European Space Agency and companies offering CubeSat technologies and services participated in the workshop making it again a great success.

C. O. Asma, S3, J. Thoemel, VKI, D. Masutti, VKI

4S Symposium QB50 Session

The Small Satellites Systems and Services Symposium (4S) will be organised by the European Space Agency on 26-30 May 2014 in Porto Petro, Majorca, Spain. The history of the 4S goes back to 1992 and has had an ever increasing international participation over the years. The maturity of the event is marked by the close cooperation with two other prominent Small Satellite conferences: The Symposium on Small Satellites for Earth Observation (IAA and DLR) and The Small Satellites Conference (AIAA and USU). The information synergies and idea exchange originating from these close links ensure high standard of contributions and a very wide attendance. The QB50 CubeSat teams are highly encouraged to submit abstracts focusing on the in-orbit technology demonstrations on board of their QB50 CubeSats. If a minimum number of adequate quality abstracts are received from the QB50 CubeSat teams, a devoted session will be held for the QB50 CubeSats. The deadline for abstract submission is 14 January 2014. The Symposium web site is http://congrexprojects.com/2014-events/4S2014/home

C. O. Asma, S3

GAMANET: Disrupting communications and networking in Space

GAMANET is an ambitious endeavour in space communications. Its challenge is the creation of the largest ad hoc communications network ever in Space. Its goal is to bring networking capability to satellite constellations, as closely as possible as we see it today on Earth. As GAMANET participants, CubeSat Teams will have the networking resources required to send commands from Ground and to receive satellite telemetry, even when their own satellites are not within range of their Stations. Joining CubeSats and Ground Stations in a seamless communications network, the GAMANET initiative aims to:

- Validate innovative communication technologies in space.
- Improve the overall QB50 communications and scientific results.

GAMANET

Validate innovative communication technologies in space

Improve the overall QB50 communications and scientific results.

The major challenges faced in GAMANET have been not so much to handle and master the technologies involved, but to adapt them to the mission requirements. GAMALINK, the SDR platform that is the base for GAMANET, had to be adapted to fit the CubeSat standard - this was the first priority and has been achieved flawlessly. GAMALINK is already operating in S-Band (2.45 GHz), with a 40 MHz bandwidth and a new capability to allow communications also in the UHF/VHF band is under feasibility testing to be implemented as well. GAMALINK is thus perfectly compatible with the amateur radio formats of QB50 and may be used for redundancy of the primary system.

All major software capabilities have also already been implemented, and the team is right now going through an optimization phase for some of the functions. A data interface (API) was also created for testing purposes, providing a serial protocol and an initial set of command functions. A new version, with additional capabilities and an enhanced set of command options is being prepared for delivery to all GAMANET participants.
Development of the GAMANET Ground Segment is also well under development, and ground stations are being built and adapted. The antenna system design includes motors with independent azimuth and elevation control, providing faster and smoother movement, in order to increase aiming and satellite tracking capabilities. The GAMANET Ground Segment software development is also well underway, including all planning, programming and control capabilities for network coordination.
The GAMANET Team is excited about all the work being done and all the milestones already achieved, and looking forward to making history in Space together with the entire QB50 Community!

P. Rodrigues