

Canadian CubeSat Project – Building Space Capacity Across Canada

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More than CubeSat Subsystems!



50 CubeSats from 50 States in 5 Years



Canada "Spacescape"

- Geographically, Canada spans 5.5 time zones
- Canada has a population of 37M spread over 10 provinces and 3 territories
 - The top 4 provinces account for 76% of the population
- The space industry is highly concentrated in only 4 provinces
- In the academia, space science (including astronomy), atmospheric science, and spacecraft engineering subjects are available in almost all provinces
- There is virtually no space education or industry in the 3 territories

Atlantic

Newfor

Mountain

Central

Canadian Satellite Design Challenge

- A satellite design contest organized by a non-profit organization
- It started in 2011 and each contest lasts about 20 months
- Each team has to build a 3U engineering model is led by students and professor involvement is optional
- The final step in the contest is the vibration test of the engineering model
- 15 university teams in 5 provinces have participated in the last 4 contests





Canadian CubeSat Project Objectives

- Primary goal: 1 CubeSat developed by a post-secondary institute in each of the 10 provinces and 3 territories, for a total of 13.
 - A grant will be provided to each selected team
- Second goal: provide students with hands-on experience in communication with the satellites while conducting valid scientific or technology demonstration research projects
- Third goal: provide a platform for technology validation for university developed miniaturized satellite components.
- Finally: encourage communications and outreach activity related to CubeSat in promoting Science, Technology, Engineering and Mathematics (STEM) to younger generation

Announcement of Opportunity

- CCP will accept proposals of 1U, 2U or 3U.
 - The proposal must be led by a professor of faculty in a postsecondary institute as the Principal Investigator (PI).
 - The PI is encouraged to have Co-investigators (Co-I) on the team;
- Each successful application will be responsible for the design, build, test and operation of the CubeSat
 - CSA is responsible for the procurement of the launch and interface with the launch provider;
- Each selected team will receive a grant between 140 K€ to 170 K€ which can be used to cover materials, part purchase, laboratory setup, student salary and travel expenses.

Launch Options

- Two option analysis were considered
 - The first one looked at launch procurement: team vs CSA procured launch
 - Considering additional complexity for the teams, CSA procured approach was accepted
- The second one looked at different launch providers
 - Launch altitude, which drives mission lifetime and compliance with space debris guidelines, becomes a major driver
 - Launch logistics, number of opportunities, and price/kg were also considered
- Decided to select NanoRacks to utilize ISS launch opportunities
 - The orbit altitude of 350–400 km ensures the CubeSats will be de-orbited very quickly.
 - launching from ISS will broaden the learning experience





Proposal Selection

- 18 proposals were selected
 - Minimum one from each province and territory
 - Multiple proposals came from Ontario and Québec two most populous provinces
- Decided to increase the funding to 15 instead of 13 an increase of one in both Ontario and Québec
- Proposed missions are very diverse: novel science instrument, monitoring potato crop, GPSS reflectometry, space radiation monitoring, education outreach, etc.

Format	Number
1U	1
2U	11
3U	3
Total Volume	32U

Quantum Magnetics Satellite (QMSAT)

- In the presence of earth magnetic field, a diamond bombarded by 2.87 GHz microwaves and 532 nm laser will generate red photoluminescence
 - The strength of this phenomenon is dependent on magnetic field
- Demonstrate the sensitivity of Quantum Magnetometer in space



ManitobaSat-1

- University of Manitoba (Winnipeg, Manitoba) proposed a CubeSat mission to explore how the space environment changes the optical properties of asteroids and the moon over time.
- A tray containing about 20 geological samples are exposed to direct solar radiation.
 - A camera mounted overhead the tray records the change in reflectance over time.
- The measurements will be the average of R, G, and B reflectance of each sample once per day for the entire mission.



ManitobaSat-1

- The CubeSat samples were powdered and pressed under vacuum and sintered to form a solid pellet
- The samples are approximately 10 mm x 2 mm
- All sample compositions are known





AuroraSat

- The team is from Inuvik (68°N 133°W) located about 200 km in the Arctic Circle
- Mission objective is to promote Northern culture
 - Northern Images: Art from the region is displayed and captured by a screen fixed to the satellite
 - Northern Voices: Stories and sayings from the region will be transmitted
 - Northern Games: Broadcast pieces of puzzles through messages



Implementation

- Held the Kick-Off Meeting by Webinar and emphasized the following:
 - Encouraging collaboration among the teams and there is no competition;
 - Sharing of non-proprietary information;
 - Reminding the importance of licensing and regulations
- Created online forum for students to ask questions
- Increasing the knowledge base of the teams will increase the probability of success
- Multiple approaches were adopted:
 - Webinars on technical subjects
 - Internships
 - Workshop

CubeSat Workshop





CCP 2019 Hands-on **Workshop** with CSA experts

Knowledge Sharing and Work Ethics





Challenges

- At MCR, some teams expressed challenges in recruiting and retaining students
- At PDR, additional challenge faced almost all the teams
 - Knowledge loss in student transfer (due to graduation)
 - Participation of students from different years of study can minimize the impact
- The licensing process for radio frequency and remote sensing took much longer than expected

Remote Sensing vs Educational CubeSat

- Canadian Remote Sensing Space Systems Act (RSSSA)
 - Passed by Canadian Parliament in 2007 with the intent to balance public interest with commercial remote sensing activity
- The definition of "remote sensing space systems" is broad
 - It includes the space segment, ground segment as well as the personnel
 - The space segment covers any orbiting imager that has the ability to take images of the Earth
- Educational CubeSat falls under the RSSSA regulations

Current Status

- Completed PDR in 2019/10 and aim for CDR in 2020/10
- Aim for the first launch in 2021.
 - The launch contract allows the CubeSats to be launched in two batches
- Number of U has changed from 32U to 33U



Format	Initial	Final
1U	1	0
2U	11	12
3U	3	3
Total Volume	32U	33U

Outlook

- CCP success is not defined by the number of CubeSats that will be launched. Rather, success is measured by:
 - the number of space HQP that will be trained,
 - the number of space outreach activities undertaken by the teams,
 - the increase in educational space activity in each province and territory,
 - the creation of new collaborations among educational institutes.
- A year after the CCP KOM, CSA discovered that all the targets had already been reached.
 - Educational space activity is now undertaken in every province and territory.
 - Currently, more than 250 students are working on CCP.





Concordia









Memorial

Aurora

PEISaskatchewanDalhousieMcMasterOver 250 studentsworking...

Yukon





York

