The 3rd Mission Idea Contest for Micro/Nano-satellite Utilization

WATSAT
University of Waterloo Satellite Team
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University of Waterloo

Sea Ice Measurements using GNSS Reflectometry from Nano-Satellites

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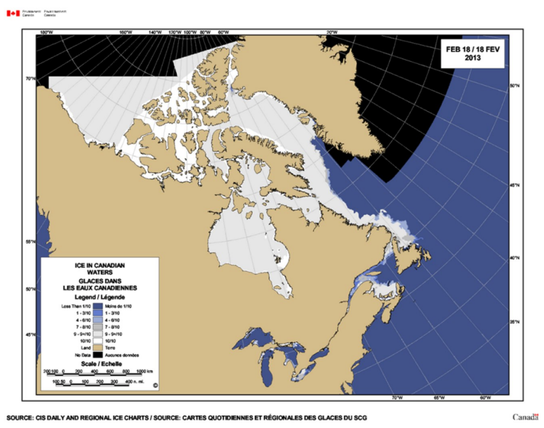
Introduction

WatSat is the University of Waterloo Satellite team and is participating in Canadian Satellite Design Challenge (CSDC) which is a 2 year challenge to design and build a 3U nano-satellite (10cm x 10cm x 34cm, <4kg) that would survive 1 year in orbit.

WatSat has entered the next CSDC and has begun redesigning the satellite as of October 2014. The team is comprised of 35 undergraduate and graduate students.

Importance and Application



Shipping & Navigation

- Northwest Passage reduces shipping distance between Asia and Europe / North America
- Gulf of St. Lawrence busiest shipping lane in Canada

Oil, Gas, & Mineral Exploration

- Large oil and gas reserves under the Arctic Ocean
- Melting ice opens up the Arctic for resource extraction

Target Areas

Northwest Passage

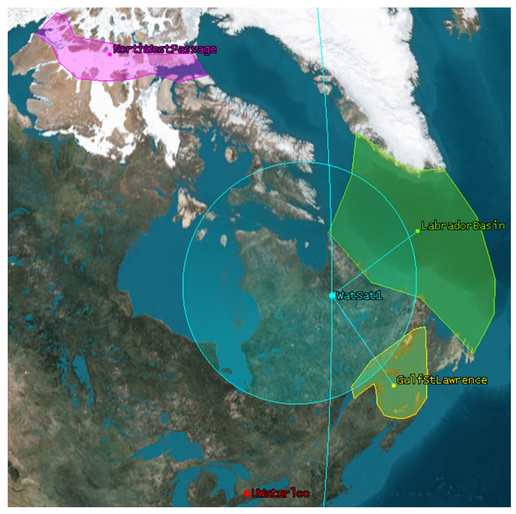
- Ice thickness for ships navigating passage

Labrador Sea

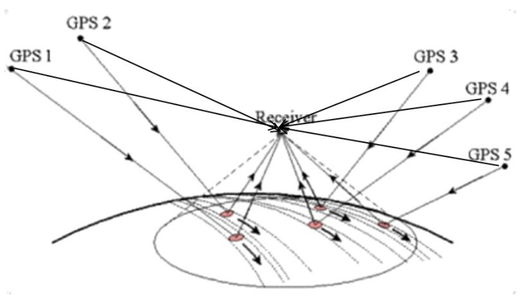
- Ice flows coming from Arctic into shipping lanes

Gulf of St. Lawrence

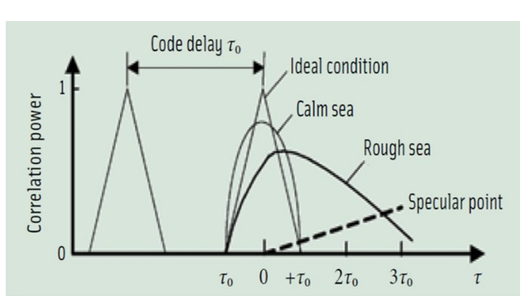
- Ice concentration in Canada's main shipping passage



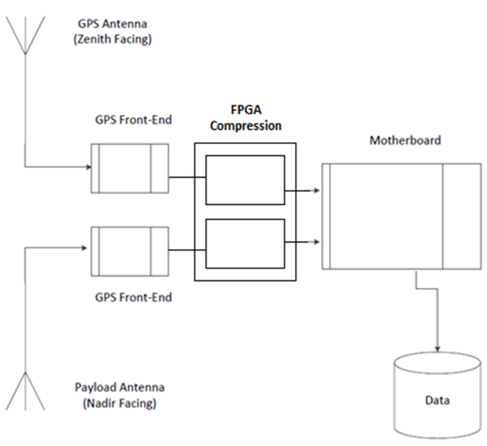
GNSS Reflectometry Payload



- Satellite detects direct and reflecting GPS signals
- Specular points create swaths of coverage over target areas
- Two 4dB patch antennas: one Zenith facing, one Nadir facing

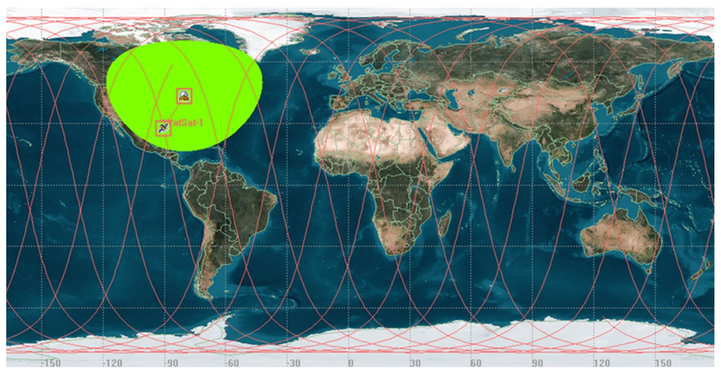


- Reflected signal correlated with clean signal creates different profiles depending on reflecting surface
- (Left) Technique has been used to classify different sea conditions
- Tested prior to launch using aerial platform



- 34MB/s of raw GPS Data generated by GPS Front Ends
- FPGAs run lossless LZ4 compression algorithm to reduce file sizes
- Stored compressed onboard, decompressed once transmitted to ground
- Main satellite computer handles turning on and shutting down system

Orbit Characteristics

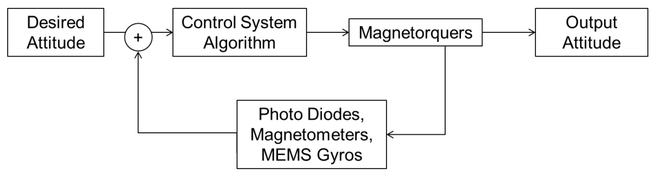


- 10:30 AM/PM Equatorial Crossing Time
- Sun-synchronous 700km orbit
- Communication with satellite: 5-6x / day
- Communication with satellite: ~36min / day

Satellite Systems

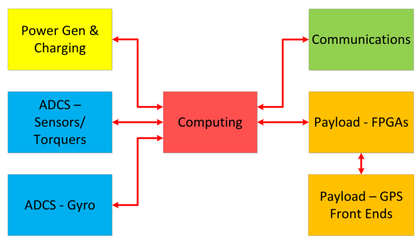
ADCS

- +/- 10° designed control accuracy
- Actuation done with Magnetorquers



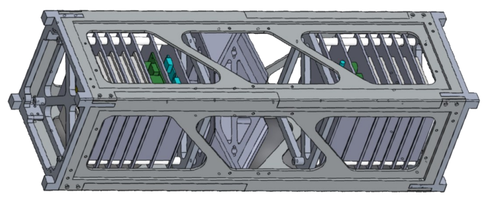
Computing

- 1GHz ARM Processor
- 256MB RAM with 64GB storage
- Linux kernel



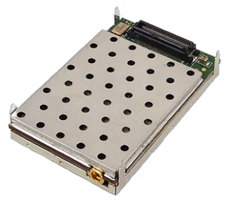
Structure

- Stacked PCB interior
- Aluminum 6061 exterior
- PCB exterior panels for solar cells and sensors



Communications

- S-Band 2.4GHz @ 230kbps
- ~60 MB / day

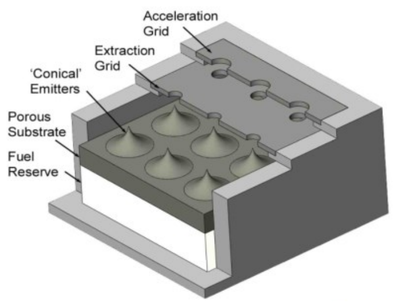


Power

- (20) 28.3% solar cells
- 2 Li batteries (26WHr)

Propulsion (future)

- Ion electrospray thruster system to help lengthen mission or de-orbit sooner



Implementation & Timeline

Task Name	2014	2015	2016	2017	2018
1 Competition Kickoff					
2 Project Management Plan					
3 Preliminary Design Review Prep.					
4 Critical Design Review Prep.					
5 Assembly					
6 Satellite Testing					
7 Projected Launch					
8 Projected Satellite Mission					

- WatSat will be participating in the next CSDC, satellite will be completed by 2016

Acknowledgements

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exactEarth