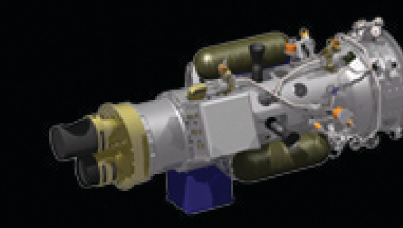
# Drone Satellite for Live Coverage, Imaging and Virtual Reality

**François-Joseph Lacroix**

fjlacroix@gmail.com



GAUL
Groupe Aérospatial de l'Université Laval

## Description

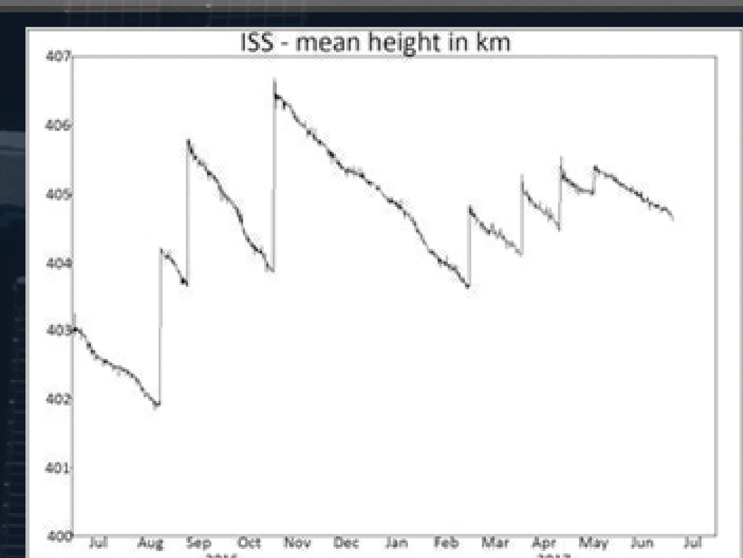
This proposal is for a small satellite to be launched from the ISS that would provide high definition video content of the station for education and public outreach. The drone would stay in the vicinity of the ISS to image it from all angles and provide live video of the station. The drone would also be tasked with inspecting the parts of the station that Canadarm2 can't access. The goal of this project is to make people, especially students, learn about the ISS and the science that is being done there. The objective is to captivate students and give them a passion for space. This project would concretize what the station is to a lot of people. The concept of a station the size of a football field floating in space is quite hard to conceive, especially for children, so this project would be a great teaching and engaging tool. To engage the students even more, they could design paths for the satellite to take and show them the views of the ISS they wish to see. It would help teach these students about orbital mechanics, propulsion systems and everything related to the functioning of this satellite and the ISS itself. With the help of virtual reality, these images will become an experience the students and the general public can live instead of relying on their imagination to piece a complete picture of what the ISS is. This satellite would be innovative in that it would provide a unique view of the ISS. Live coverage of arriving and departing vehicles could be done. Time lapses would let people see the station in action over the course of hours or even days. The satellite could film the astronauts while they are performing an extravehicular activity and give an unprecedented perspective on their work. The drone could record the deployment of other satellites from the station which would again bring a never before seen look at the activities taking place on the ISS. One of the most interesting things the system could do is navigate very close to the station to make an interactive model of the station through virtual reality. By taking 360° video meters away from the station, virtual reality content would be created that would let users explore the station by themselves from very unique vantage points. This concept would truly fuel the space enthusiasm that lives inside most of the public.

Image: ©Boeing

Ball Aerospace's Space Based Space Surveillance (SBSS) satellite bus, part of the U.S. Air Force Space Surveillance Network.

## Maneuvering

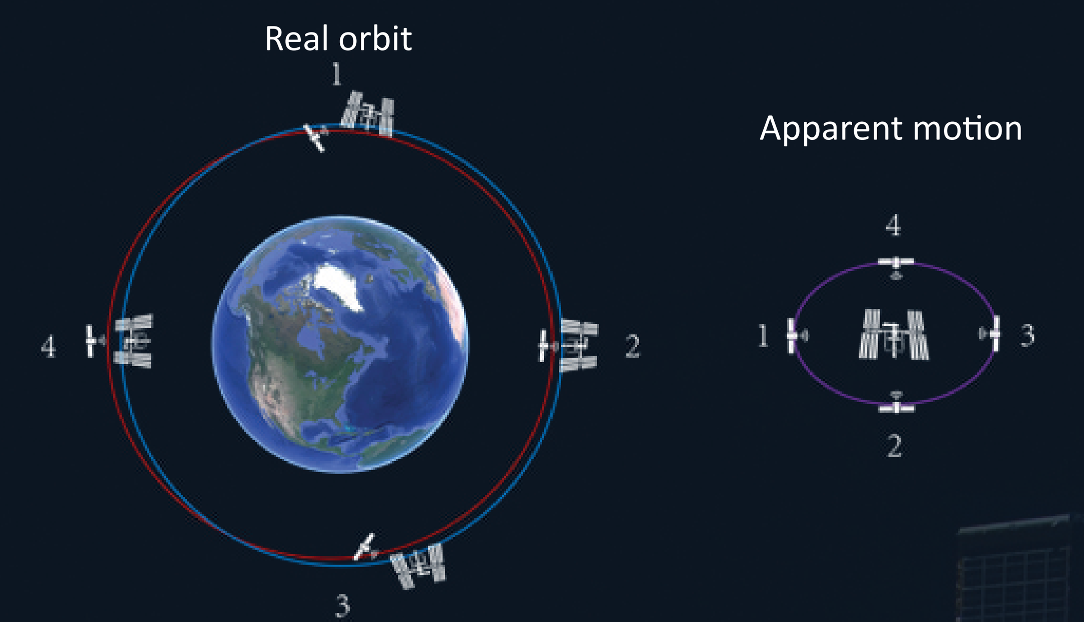
The satellite would be equipped with an ion thruster which would control its orbit and ensure that the ISS always remains in view. The advantage to having an ion thruster is that this type of engine has a very high specific impulse, meaning that it takes less propellant mass to accelerate the spacecraft than conventional rocket engines. As the station is hit by the very thin atmosphere, drag lowers its orbit and reboosts must be performed. These reboosts can increase the station's altitude by many tens of kilometers. In order for the satellite to always follow the station, it must be able to return to the station in time for reboosts. Reaction control thrusters would be needed to maneuver close to the station. A grapple fixture would be part of the satellite so one of the station's arms can hold it while reboosts are being performed. If such a procedure cannot be achieved, the ion thruster would have to be used to bring the satellite to the new higher orbit, but this would probably take many days. The satellite's ability to be grappled by an arm would give it the capacity to be refueled by Dextre. This would allow for a smaller satellite design and would extend its useful life. Occasionally, the station has to perform a debris avoidance maneuver on short notice. In these events, the satellite would use its ion thruster to place itself in the same orbit as the new orbit the station would occupy.



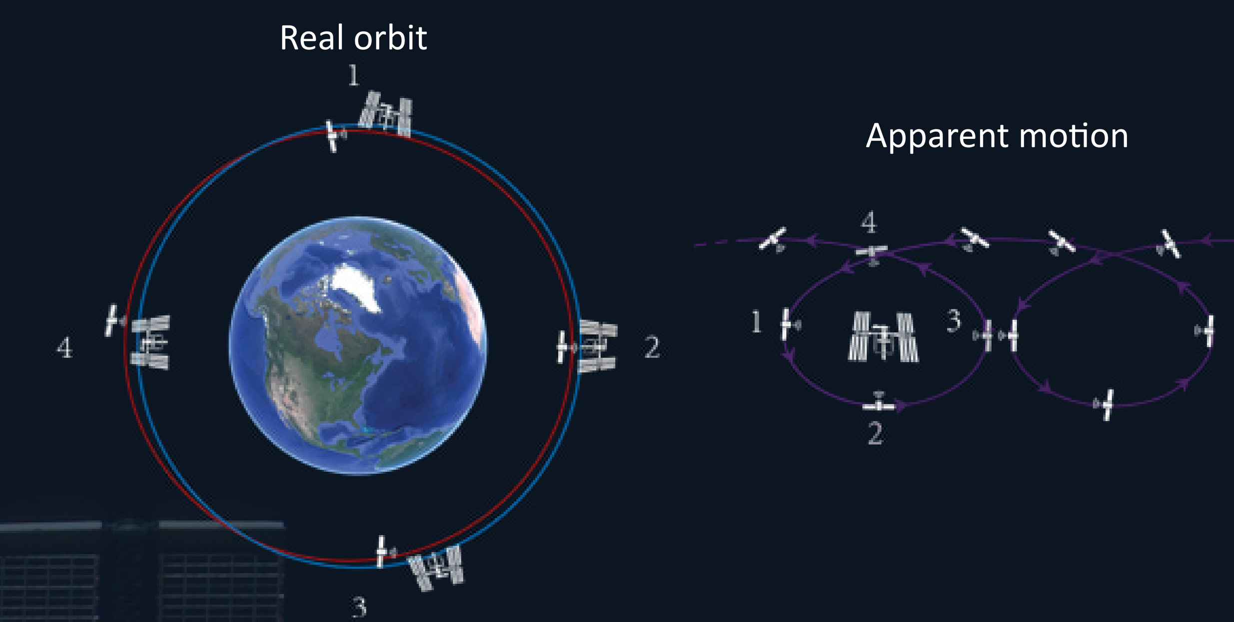

## Trajectories and orbits

The satellite could be placed in a number of different orbits to achieve interesting visual effects. By modifying the inclination, eccentricity, period and other orbital parameters of the satellite's orbit, different apparent motions can be created. Four basic cases are illustrated here, though not to scale. These four cases constitute free trajectories, meaning that once the orbital parameters are set, the paths shown would be achieved without the need for course correction.

The first case depicts a scenario where the drone's orbit is slightly more elliptical than that of the ISS and where the inclination and period of both orbits are equal. The drone would complete one revolution around the ISS every orbit.

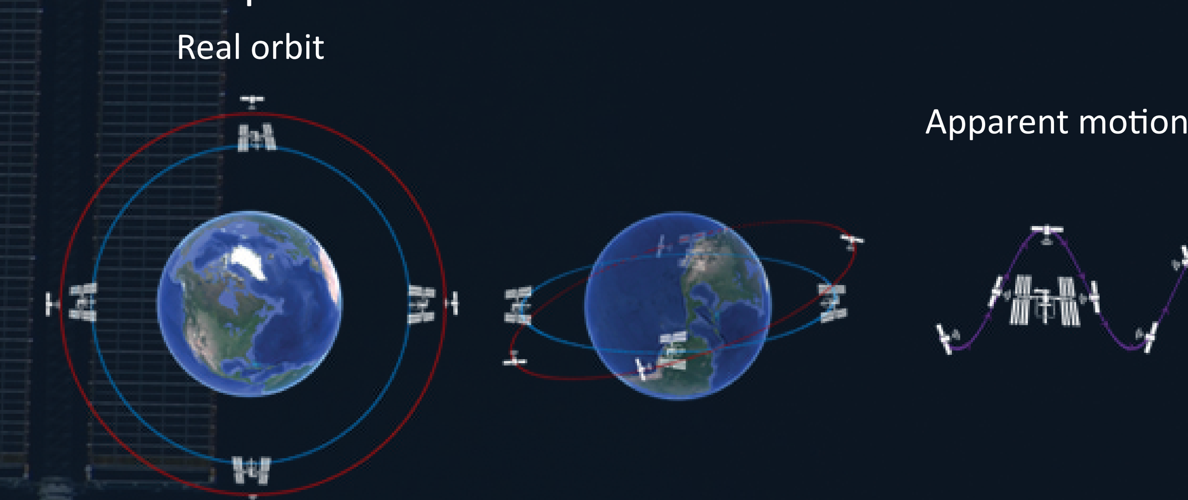



In the second scenario, the drone's orbit is slightly more elliptical than that of the ISS and both periods differ. Both orbits have the same inclination. The effect is a revolution around the station that constantly shifts to one side, which creates a spiral.




The third case shows the pattern created when the orbits have different inclinations, but keep the same period and eccentricity. The apparent motion is that of an arc, as if the drone was a pendulum attached to the center of the Earth.


The fourth scenario occurs when the two orbits differ in period and inclination, but keep the same eccentricity. As the drone moves up and down from the difference in inclination and drifts to one side due to the difference in period, the effect created is a sinusoidal pattern.




The onboard ion thruster and cold gas thrusters would be used to change the orbital parameters in a matter of a few hours or days to achieve all the patterns mentioned above and even more exquisite ones. The motions described can be combined and tweaked to create more complicated patterns that would be hard to illustrate, but nonetheless stunning.

## Satellite bus and payload

The satellite would carry many high definition cameras. A wide-angle camera would be necessary to capture the whole station and the Earth behind it. A camera with a sizeable zoom would be needed to take great shots from afar and detailed images from near the station. The drone would be equipped with an array of cameras to produce virtual reality content. The satellite will need to have a direct link with the station and with the Tracking and Data Relay Satellite System (TDRSS) to downlink the images and videos live to the ground. The power would be supplied by solar panels and batteries. In order for the camera systems to be stabilized, reaction wheels would be part of the satellite as well as an altazimuth mount for the main camera.

Poster design by Jean-Christophe Blais