



PROJECT HERMES Ecuadorian Civilian Space Agency - EXA Aerospace Operations Division Engineering Division

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PROJECT HERMES The First Internet-to-Orbit Gateway

Ex Equatoris Ad Humanitatis



PROJECT HERMES

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Project HERMES Backgrounds: What is the EXA

- EXA is the Ecuadorian Civilian Space Agency, a civilian NGO in charge of the administration and execution of the Ecuadorian Civilian Space Program.
- It is the only Ecuadorian institution that has been accepted in to the International Astronautical Federation, with voice and vote into their General Assembly.
- EXA achieved for Ecuador the first latin american zero-G plane alongside the Ecuadorian Air Force, on May 6 2008, the FuerzaG-1 CONDOR, as a result of its Project DAEDALUS, built with its own resources and technology.
- On June 19 2008, with Project POSEIDON, EXA achieved for Ecuador the microgravity world record, certified on site by Guinness and the World Records Academy.
- EXA studied the ozone layer over the equatorial latitudes and built the HIPERION Reactive Alert Network, the most advanced early warning system in latin america for real time, on line monitoring of UV radiation, protecting more than 4 million people in the most populated areas of the country in real time.
- On 2007 EXA trained the first Ecuadorian astronaut, Cmdr. Ronnie Nader, who works as the Aerospace Operations Division director and flies at the command of every mission in the zero-g plane.





Project HERMES Definition

- HERMES is an Space flight Control Center or SFCC.
- Also, HERMES is a robotic SFCC.
- HERMES is capable of detection, tracking, command, control and receive/transmit data and voice from spacecrafts within its range
- But most importantly: HERMES can be controlled and operated completely over the Internet, sending spacecraft signals over the network to authorized entities, that otherwise will need their own ground station to access those signals.
- HERMES has been built with the academic community cubesat program in mind, to give them access to their satellites when passing over south america.
- HERMES can also be used by universities and research institutions to have access to weather and research satellite signals avoiding the need to setup their own ground stations.





Project HERMES Work Simulation







Project HERMES General Objectives

-HERMES is the first ground station in the world to be publicly available, connecting the Internet to the orbit in real time with voice and data capabilities.

-The main objective of HERMES is to give academic and education community access to spacecrafts in orbit without them having to setup their own ground stations, lowering the cost of access to space for education and research and opening this gate to sectors previously excluded due the cost and expertise needed to setup their ground stations.





Specific Objectives

- Phase 1: To offer academic and education community access to real time signals of spacecrafts passing over HERMES-A coverage areas, mostly the southern hemisphere. A virtual, online and real time Ground Station.
- Phase 2: Spacecraft tracking and command and data capture for cubesat community.
- Phase 3: To participate with other nations or institutions in the control of manned spaceflight missions.





Project HERMES Scope

- HERMES is the first Internet-to-Orbit public data/voice gateway (accordingly to available information to us and the preliminary research made by Dr. Andrew Klesh from Michigan University).
- HERMES will serve the cubesat community for free, only in exchange of useful knowledge about aerospace engineering and astronautics that will be used to help the Ecuadorian Civilian Space Program and for one of our most cherished objectives: To build and launch the first Ecuadorian satellite.





Project HERMES Scope:



Just in the USA :

University of California Berkeley: 3 sat.
University of Boulder Colorado: 4
University of Harvard: 2
University of Texas: 2
University of Miami: 2
California Institute of Technology: 2
California Polytechnic State University: 4
Hampton University: 1
Penn State University: 1
Colorado State University: 1
University of Louisiana at Lafayette: 1
MIT Lincoln Lab: 1





Project HERMES Benefits

- HERMES will serve the cubesat community cutting development costs and saving manpower and time.
- HERMES can be used to give access to scientific research satellites to those who will use it for educational and peaceful research purposes, especially in technologically underdeveloped areas of the world, supporting the efforts of the developing nations to raise their levels of education and hence progress.
- HERMES can be used to pass along the signal of weather satellites to entities that would decode the signal and use it for disaster warning, prevention and mitigation, helping save properties and possibly lives.
- HERMES can be used to speak directly to the astronauts and cosmonauts on the ISS, within the bounds of the ARISS program, just with any computer connected to the internet, bolstering the interest of people and specially children in science and technology, and avoiding the cost of having to setup their own ground station.





Project HERMES Benefits

- Project HERMES introduces a new paradigm: To be paid for our services not with money, but with useful knowledge, that in due course will avoid us the need to spend our very little and valued financial resources in the task ahead of achieving the goals of our space program.
- This new model can be applied by many other institutions
 conducting research in many other areas of science and education
- When we share money only half of it remains, but when we share knowledge, it will always remains the double.





Project HERMES Implementation

ORIS AD HUM

- HERMES-A home is at the UEES University campus in Guayaquil, Ecuador.
- Is an small (30m2) command center and a control office (30m2).
- It is composed by the CMC (command and control center) and the MINOTAUR sensor array
- The CMC houses the HERMES-A radio engine, the audio processing module, the audio frequency (AF) internet server, the database server the firewall and the 2 control stations
- The first control station manages the radio engine and the antenna array tracking for the target spacecraft
- The second control station manages the data decoding process and the target's space flight simulation and orbital prediction



Project HERMES Implementation



Space flight dynamics control and simulation station



Project HERMES: How does it works?

HERMES-A relays the signal via internet in real time to any user in the world

Signal can be live audio frequency or 2 way voice audio

HERMES-A receives the signal from orbit

b-

HERMES-A-TO-JSS STATION TRACK DATA-slim WCocal Time-(CCLG): No Access Found Azimuth (deg): DElevatyon (deg): Range (km): InTrackAnge (km):

9.1

deg, 0.06

LLA Position (UTCG):

Rate (deg/sec): Rate (deg/sec): Rate (km/sec):

Lať

Lat

3 Aug

27 805 AT 20537 03 be (Diet 27003 355 be)





Project HERMES Implementation

 The antenna array, MINOTAUR is a 10 mts high tower and the array itself is a 4 mts long by 2mts tall sensor matrix that houses 7 radiometric sensors and 1 optical sensor/actuator

OVECT

TORIS AD HUMA

• MINOTAUR max gain is of -130dB



Project HERMES MINOTAUR Array Implementation





Project HERMES MINOTAUR Array design



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Project HERMES MINOTAUR Array during construction



Project HERMES MINOTAUR Array during testing

AGENCIA ESPACIAL CIVIL ECUATORIANA







Project HERMES MINOTAUR Array on UEES

ULTIMO SEGMENTO DE 3 METROS, COMIENZA EN 0,5m Y TERMINA EN 0,25m







Project HERMES Client station implementation 2-Way Voice RX/TX





Project HERMES Network expansion

- HERMES-A is the first SFCC of a planned network of 5 SFCCs.
- HERMES-B will be installed in the Galápagos islands
- HERMES-C y HERMES-D should be installed on Tacna, Peru and in Puerto Montt, Chile
- EXA has very good relationships with the Peruvian CONIDA and with the Chilean Air Force.
- Our field SFCC design is very compact, economical, portable and easy to maintain, so we believe the expansion plan goals are achievable and realistic.
- HERMES-E should be installed on the Ecuadorian Antarctic research base Pedro Vicente Maldonado.
- In its final configuration, the network can offer more than an hour of uninterrupted connection between Internet users and the earth orbit.





Project HERMES

The future expansion of the network





Project HERMES Results today

- On the first day of testing run HERMES-A received what we are sure are the beacon signals of 2 satellites believed to be lost since 2005: the Wurzburg University UWE-1 and the first Norwegian satellite NCUBE-2.
- 2 days later HERMES-A was used to receive imaging from the weather satellites NOAA-15, NOAA-17, NOAA-18 and NOAA-19.
- EXA and UEES are planning to pass the audio frequency of this satellites to research institutions in the region that can use it to decode the images to monitor climatic conditions over their countries.
- This imaging feed will help EXA's Planetary Sciences Division to improve the capabilities of the HIPERION Reactive Alert Network which is already widely used in Ecuador and academic institutions in the region for monitoring purposes, as well as many other individuals and companies that uses it to have a better perspective of their businesses that deals with the environmental conditions, like agro industries and farmers.





Project HERMES Final comments

- HERMES SFCCs are robotic and does not needs human intervention, however, it embodies an excelent laboratory for high end education and research in latin america.
- The idea of installing HERMES-A in an University is just to provide the learning grounds to students not only in Ecuador, but around the world, as it will be the only SFCC available in the region for learning and practicing about aerospace engineering and astronautics.
- Alongside the UEES, EXA is developing an education plan that will allow students from around the world to make studies and practices on HERMES-A SFCC.
- The HERMES project has been developed by EXA with their own resources and technology, minimizing the use of money as little as possible and maximizing the use of human talent as much as possible too.
- In all, EXA has invested less than US\$ 25000 in the materials and equipment needed to make HERMES-A a reality, and some of that capital came from ecuadorian citizens donations in materials and equipment.





Thank you for your attention