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IOS Modular Rocket and Small-Sat Technology Update

Presenter: Randa Milliron, CEO/CoFounder, Interorbital Systems
Cal Poly CubeSat Workshop, San Luis Obispo, April 23-25, 2014

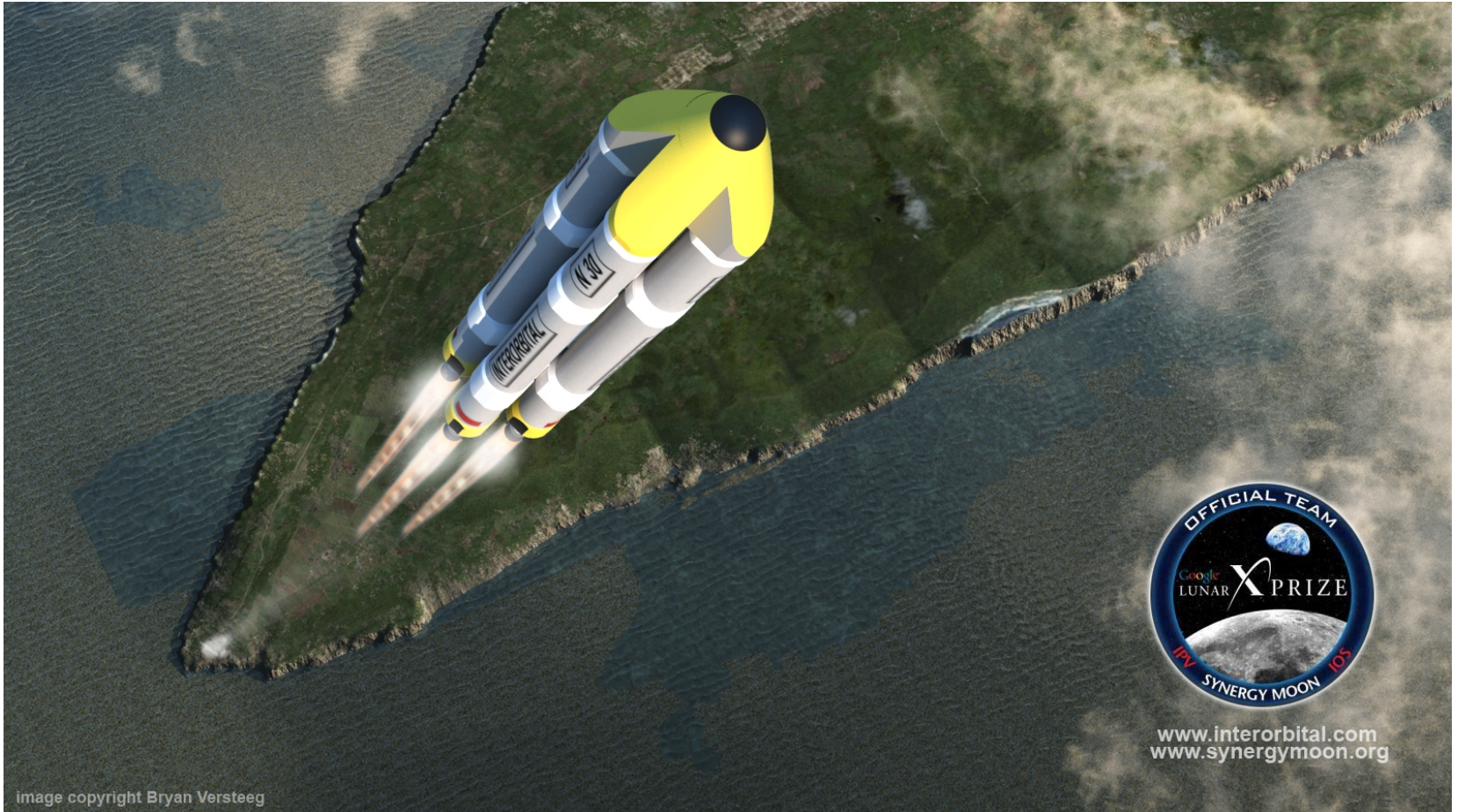


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- R&D and manufacturing : Mojave Spaceport
- Two rocket engine test sites: Mojave Spaceport
- Low-altitude Flight Test Area: MTA
- Orbital Spaceport (ocean): Worldwide





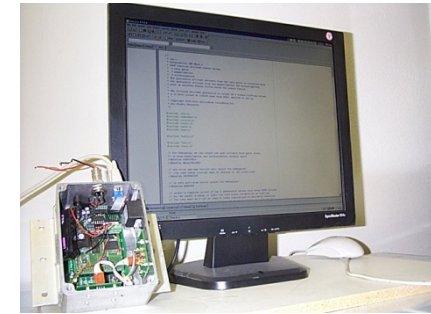
KEY ROCKET HARDWARE BUILT IN-HOUSE



Advanced Composites including state-of-the-art lightweight propellant tanks



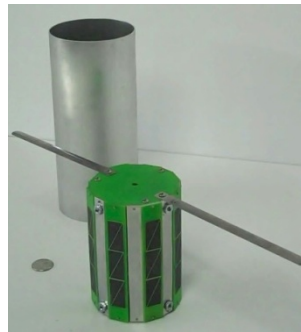
Ablative Rocket Engines and Components



Advanced Guidance Hardware and Software



Modular Rocket Components



Small Satellites: TubeSat and CubeSat Kits



Rocket Injectors, Valves Systems, and Other Metal Components



IOS UNIQUE ROCKET TECHNOLOGIES



- **NEPTUNE Modular Rocket System (three- and four-stage)**
 - Assembled from multiple Common Propulsion Modules (CPMs)
 - Parallel- and tandem-staging options
 - Radically reduced rocket system development costs
 - Can be customized for a wide range of payloads
 - Ideal design for assembly-line mass production

- **Environmentally Safe, Storable, High-Density Hypergolic Propellants**
 - White Fuming Nitric Acid (WFNA) and Turpentine/Furfuryl Alcohol
 - Instantaneous chemical ignition eliminates need for an ignition system

- **Low-Cost Propellant Tank Technology**
 - Proprietary acid-resistant tank liners and tank ends
 - State-of-the-art carbon composite tank reinforcement technology

- **Blowdown Propellant Feed**
 - Eliminates the need for turbopumps or a separate pressurant system

- **Unique Rocket Engine Injector**
 - Automatically maintains propellant jet flow rate in blowdown mode
 - Maximizes specific impulse over a wide pressure input range

- **CPM Engine is Ablatively Cooled and Gimballed**
 - Ablative engines allow lighter propellant tanks
 - Gimbaling allows rapid attitude correction in a rough-sea environment

- **Canister Ocean Launch**



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- Basic building block of the N-Series Rockets
- Bi-propellant storable, hypergolic liquid rocket system
- Blowdown propellant feed
- State-of-the-art , all-composite propellant tanks
- Single gimballed rocket engine
- CPMs clustered together in multiples to meet mission requirements for both small and large payloads



COMMON PROPULSION MODULE (CPM) Launch

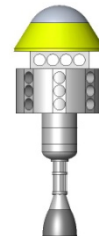


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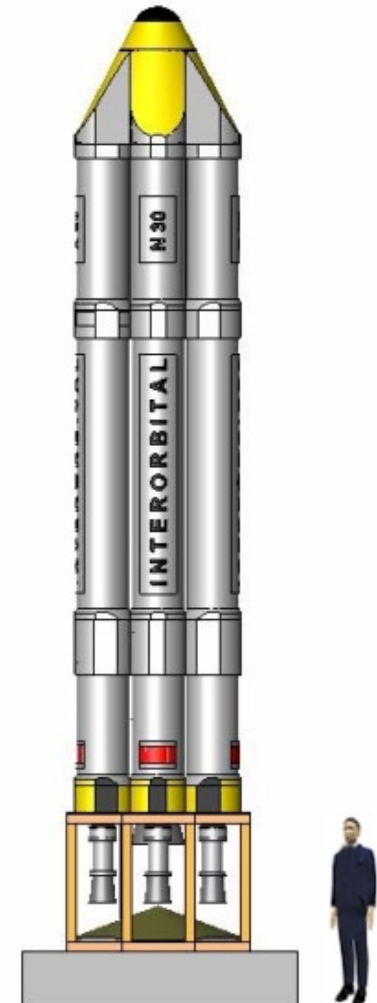
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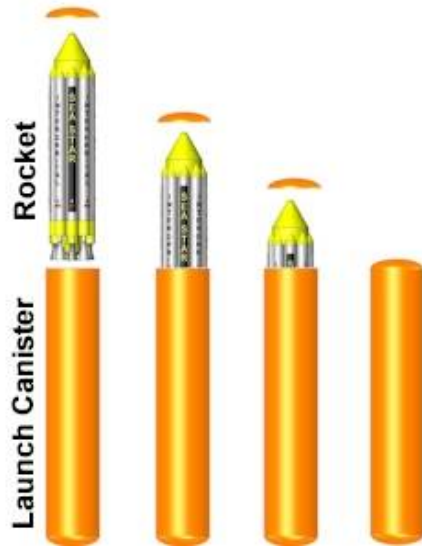
Three-Stage Launch Vehicle with Parallel and Tandem Staging

- Five (5) Common Propulsion Modules (CPMs)
- Stage 1: 4 CPMs with parallel staging
- Stage 2: 1 CPM
- Stage 3: Kick stage with solid motor (tandem staging)
- Length: 31.5 feet (10.3 m); Maximum diameter: 6.2 feet (1.89 m)
- GLOW: 20,000 pounds (9.070 kg)
- Payload: 66 lbs (30 kg) to a 192 mile (310 km) polar orbit

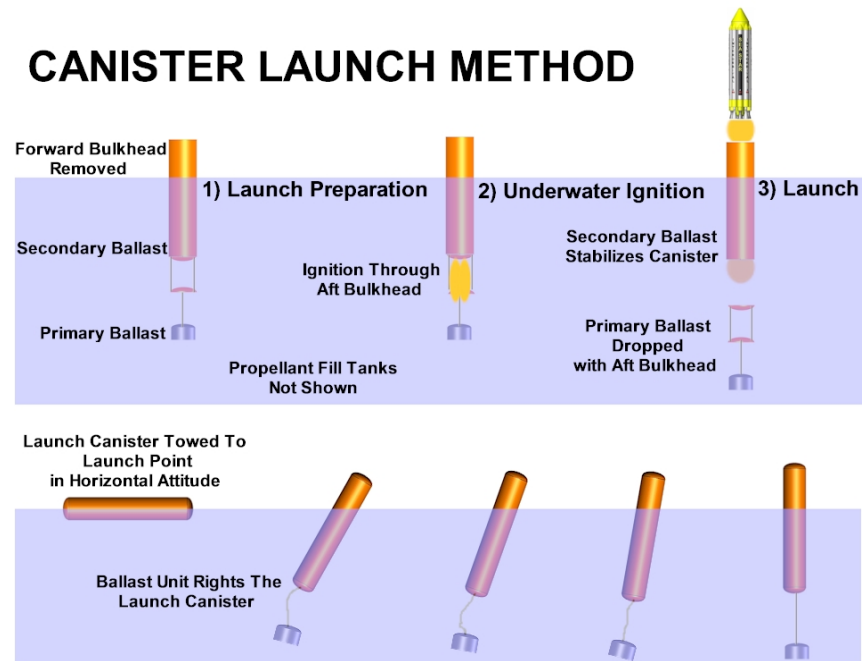


Stage 3





CANISTER LAUNCH METHOD

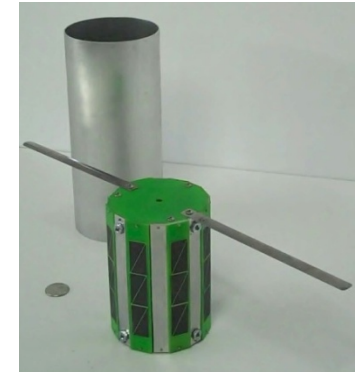


FEATURES

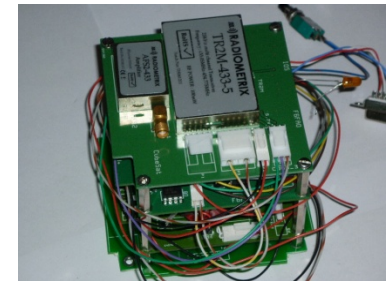
- PCB Gerber Files
- Spectrolab TASC solar cells
- A Li-ion battery pack (3.7 V 5200 mAh)
- Microcomputer (NetMedia BasicX-24 or Arduino Mini)
- Transceiver (Radiometrix)
- Antennas
- Fasteners
- Complete instructions and assembly guide



IOS CubeSat Kit



TubeSat with Sample Ejection Cylinder





NEPTUNE 5 (N5) LAUNCH MANIFESTS 2014-16



CubeSats

UC Irvine, UCISAT1

FPT University, Vietnam, F-1 CubeSat

Nanyang Technological University, Singapore VELOX-P CubeSat,

Google Lunar XPRIZE (GLXP) Team PLAN B (Canada)

GLXP Team EuroLuna, Romit 1 (2-Unit CubeSat from Denmark)

NASA Independent Verification and Validation (IV&V) Facility, 1 CubeSat & 2 TubeSats

King Abdullah University, Saudi Arabia (KAUST) (2 IOS CubeSats; 1 TubeSat; 1 suborbital payload)

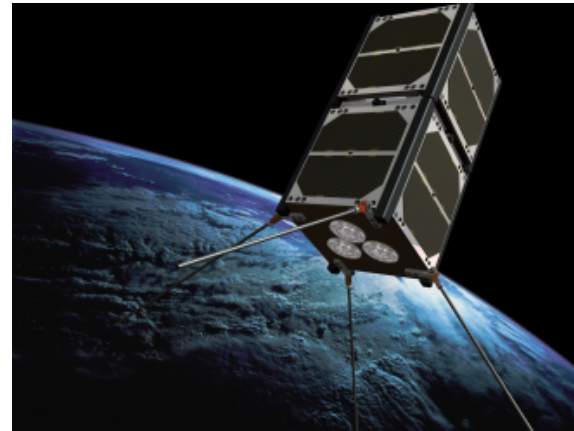
The Golden iPod: Voyager revisited; Earth to Sky, spaceweather.com, Bishop, CA STEM Program

Pakistan's ICUBE-1 Islamabad Institute of Science and Technology

Boreal Space, California / M2M2Sky, Brazil; Wayfinder I

Rufs the Space Lion, Sweden

**Denmark's GLXP Team EuroLuna: *Romit 1*
2U (2-Unit) Cubesat**



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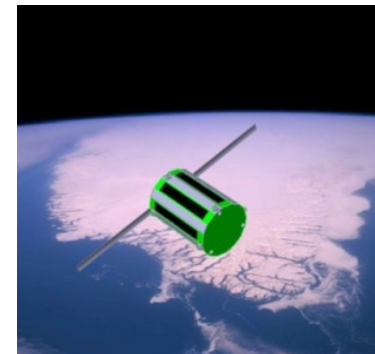


NEPTUNE 5 (N5) LAUNCH MANIFEST 2014-16



TubeSats

Morehead State University (Kentucky Space) (TubeSat and 2 suborbital payloads)
InterAmerican University of Puerto Rico
University of Sydney (Australia) (2) *i-INSPIRE (initial-INtegrated SPectrograph, Imager & Radiation Explorer)*
Aslan Academy (Private LA High School) STEM Program
Project Calliope (Space Music Project)
Universidad de Puerto Rico / Marcelino Canino Canino Middle School, STEM micro-meteoroid impact study
GLXP Team SYNERGY MOON Space-Qualifying Rover Team Astronomska Udruga Vidulini's (AUV) Comms
GLXP Team Part-Time Scientists / Fluid & Reason Software (2) (US/Germany)
Naval Postgraduate School (3) (TubeSats as ad-hoc orbital communication nodes) and 2 suborbital payloads
Defense Science and Technology Lab (DSTL) United Kingdom
Austrian Arts Group mur.at with MURSAT: Earth-as-Art Project
United States Military Academy at West Point (2)
Brazilian Space Institute/108 5th-7th Grade Students, Ubatuba, Sao Paulo, Brazil STEM Program
Mexican Satellite Project ULISES Sat from PLAY Festival's Arts/Soccer Opera from Space
TriVector Services (Huntsville) TRACsat – TriVector Radiation and Attitude Control Satellite
La Despensa (The Pantry) Advertising Agency/Iniciativas en Idiomas (Madrid, Spain)
NASA Independent Verification and Validation (IV&V) Facility (2)
Galaxy Global, 1 TubeSat, donated to NASA Educational Program
Institute of Advanced Media Arts and Sciences/The Science Project, Inc., Japan (7)
AKQA Advertising, San Francisco
Universidad de Chile, Santiago
University of Sao Paulo, Brazil (2)
David Lawrence K-8 School, North Miami, Florida
RADG, Ohio—Undisclosed Advertising Project
Jose Virgilio Braghetto Neto/OMNI LABS, Brazil
4-H/Ute Mountain Youth/Colorado State University Outreach
KEN KATO—Personal Satellite Project, Japan
Ryerson University, Toronto, Canada
DOCTOR WHO TARDIS in Orbit; Robert Doyle and Team
Emmanuel Lesser, Private Satellite Project, Belgium
University Nova de Lisboa, Portugal
National University of Singapore, RSPL (3)
Manhattan Satellite Lab; NYCSAT-1



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MILESTONES AND UPCOMING MISSIONS



IOS Completed NASA NanoLauncher Phase I SBIR 2012

CPM TV: Common Propulsion Module Test Vehicle

Low-altitude suborbital test flight March 29, 2014 FAA Class 3 Waiver



Olav Zipser High-Altitude Jump Record Attempt from SR 145 CPM

High-Altitude Suborbital Test launch 310km Apogee 2014

IOS Satellite Missions I & II, Early 2015

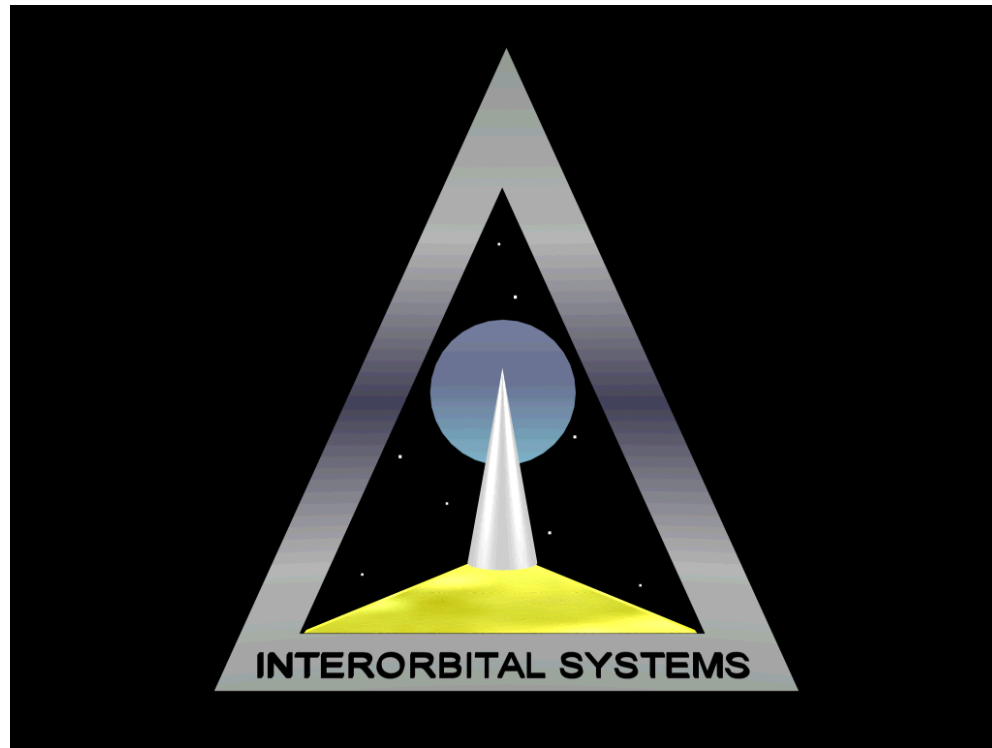
Google Lunar X PRIZE Lunar Mission, Late 2015

Orbital Expeditions Space Tourism Flights 2016-17



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