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# **Massively Clustered CubeSats Nuclear Cryogenic Propulsion Stage (NCPS) Demo Mission**

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## NCPS Demo Mission



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Technologies under development for the proposed Nuclear Cryogenic Propulsion Stage (NCPS) will require an unmanned demonstration mission to flight qualify them over distances and time frames representative of a Mars mission.



The NCPS technologies are to be carried into space using NASA's Space Launch System (SLS) - an advanced, heavy-lift launch vehicle which will provide an entirely new capability for science and human exploration beyond Earth's orbit.



## NCPS Demo Mission



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A NCPS demo mission will not be cheap. Cost savings for a NCPS demo mission can be realized through shared support between NASA and other government agencies, as well as leveraged commercial aerospace and academic community involvement.

- Specifically in relation to a “Hitchhiker” payload -

A “Hitchhiker” payload on demo missions of the NCPS offers a unique opportunity to invigorate the public on an unprecedented and global scale through direct individual participation.

This can be achieved by the development of a “Hitchhiker” payload called a

“Massively Clustered CubeSat Payload”

comprising a cluster of CubeSats, possibly accommodating 100s of CubeSats as the primary payload with each individual CubeSat being independently funded and developed by various organizations, companies, and academia so as to reduce the total mission cost.

Further, by properly selecting CubeSats that carry instrumentation needed by the NCPS Demo Mission (or directing them to carrying low cost instrumentation as part of the flight package, like radiation dosimeters, temperature gages & etc.), part of the NCPS demo mission instrumentation cost can be levied onto the CubeSats as a whole.



# CubeSats



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**CubeSats offer a hope that other approaches cannot.**



**CubeSats are a class of research spacecraft called nanosatellites. The cube-shaped satellites (aka, CubeSats) are approximately 10 cm cubes, having a volume of about one liter, and weigh 1-2 kg.**



# CubeSats



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The value of CubeSats has been recognized by many organizations.

A few examples:

- NASA's CubeSat Launch Initiative
- National Science Foundation (NSF): CubeSat-based Science Missions for Geospace and Atmospheric Research
- Navy: Novel CubeSat Payloads for Naval Space Missions
- Clyde Space: A SmallSat Company
- Interplanetary CubeSat Workshop



# CLUSTERED CUBESATS AS A PRIMARY PAYLOAD



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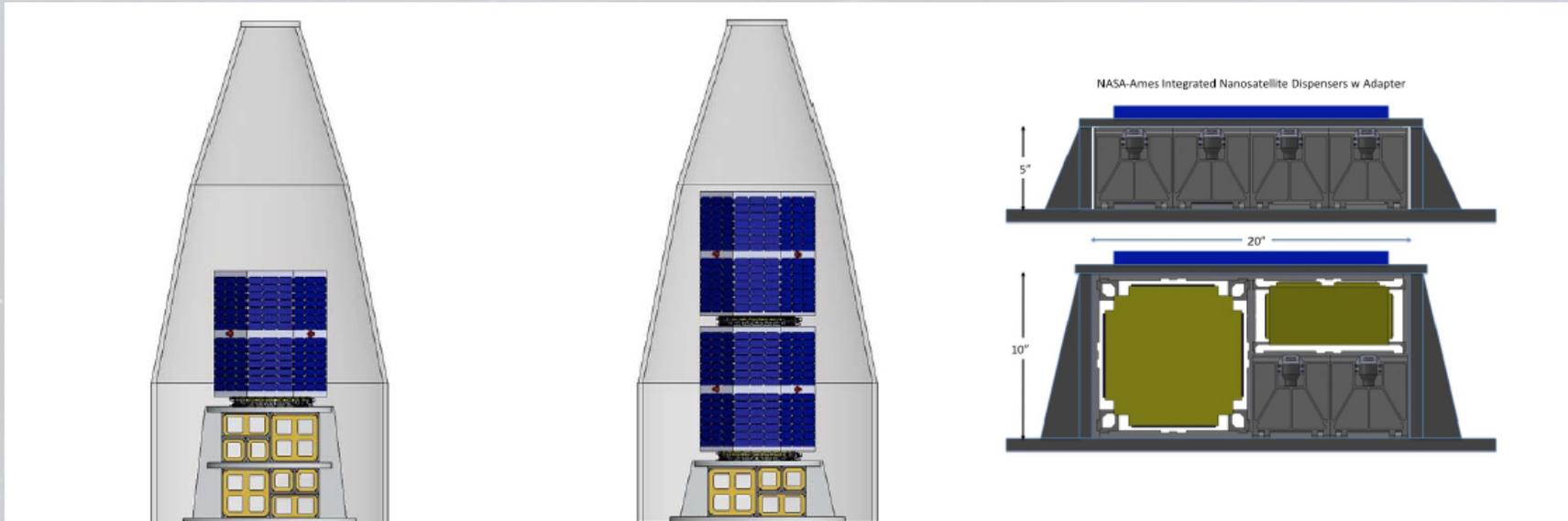
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## CubeSats “Hitchhiker” Payload Examples

- From an academic viewpoint, CubeSats can be sought with the only purpose to monitor conditions of the NCPS vehicle with video as well with other instruments while on board and as they move away from the NCPS to carryout their intended mission.
- From a commercial viewpoint, CubeSats can be sought to provide data on the long term radiation exposure on new space technologies or to demonstrate new space technologies in general.
- From NASA mission directorate review point, CubeSats can be sought with the only purpose to increase TRLs of previously unflown technologies or to provide data on a specific object or place in space.
- From NASA publicity viewpoint to invigorate the public, CubeSats size payloads can be sought to carrying cameras which could be accessed by smart phones and the internet as if one is on board and looking out a window – virtual passengers.

Generally speaking, the range of tasks for CubeSat size payloads is near endless compared to the space that could be available on a NCPS demo mission.

# CLUSTERED CUBESATS FAIRING



1 small satellite, 2 PADs

2 small satellites, 1 PAD

- Large fairing capacity for multiple small satellites
- NASA Ames Payload Adapter and Deployer (PAD)
  - PAD can carry 24 1-u Cubesats or a combination of 1-u, 3-u, 6-u, & 12-u Cubesats

Different fairing designs should be investigated if CubeSats are the only payload .



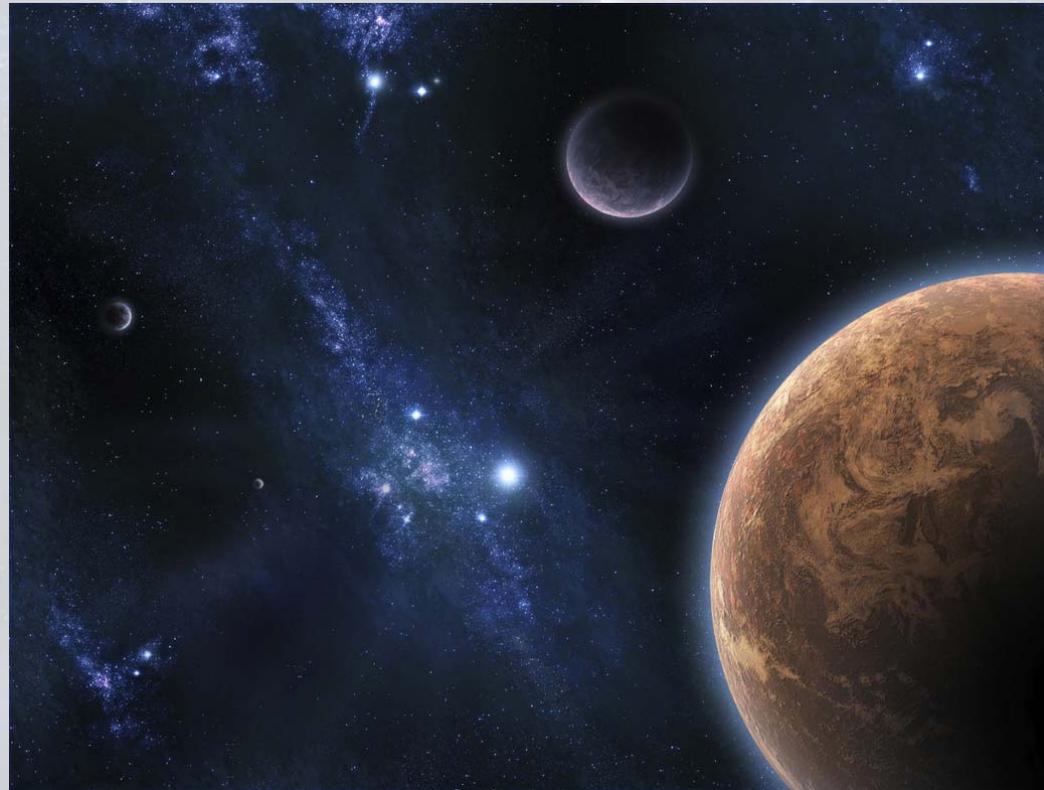
## NCPS CHALLENGE TO INSPIRE THE GLOBAL COMMUNITY



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*“What would you do if you could place a small personal satellite almost anywhere from a parking orbit 407 km above the earth to an orbit as distant as Mars?”*



**It is envisioned that NASA, as the architect of the NCPS demo mission and CubeSat challenge, would describe the framework, standards, interface control, review processes, safety protocols, etc. and would make this available globally, without charge, through a web-based collaboration engine.**



### NCPS CHALLENGE TO INSPIRE THE GLOBAL COMMUNITY

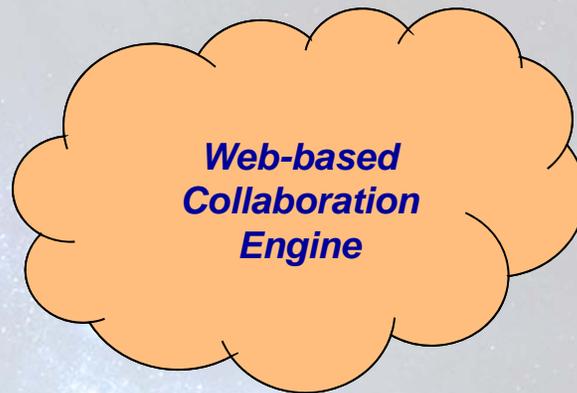
*Only when the global community of CubeSat developers are enabled to freely and interactively create, within pre-established constraints, will concepts and capabilities unimagined by the architects emerge.*



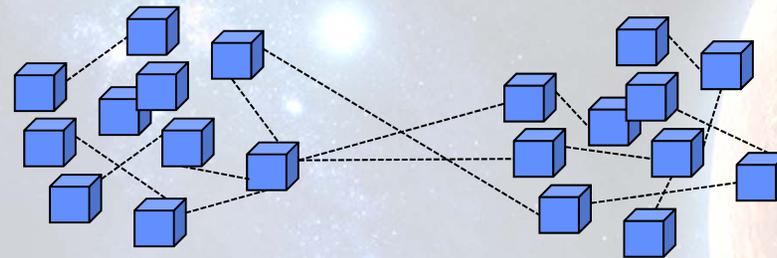


**Just as small satellites benefit by networking to collaboratively solve problems, so can CubeSat development benefit by networking developers through a global collaborative environment**

**Developers around the world,  
Inspired by the challenge,  
work independently or  
collaboratively on projects**



**Collaboration Engine  
streamlines design activities,  
controls information access,  
manages events and messages**



**The open spacecraft architecture is extensible and evolves  
within the collaborative environment redefining interface  
controls, topologies, and shared computing resource protocols**



## Public education initiatives such as STEM can inspire young minds with this challenge

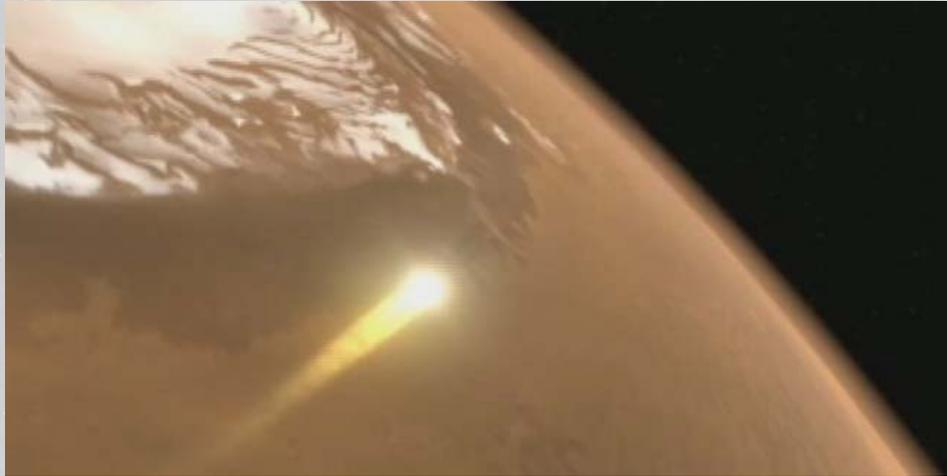
A new STEM program to design interstellar CubeSats carried aboard NCPS and other future deep space propulsion demonstration missions



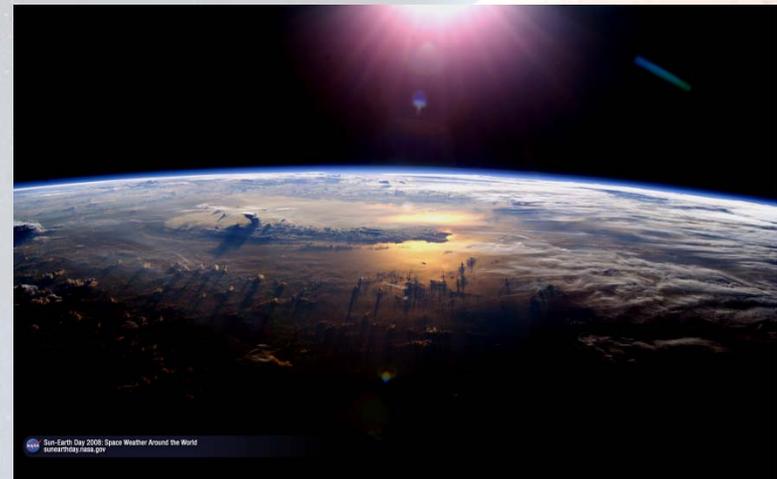
...an impressive item on any student resume.



## Public interest can also be engaged through virtual tourism



Online customers might pay for time at the controls of small independent CubeSats on route to Mars, pointing and focusing cameras at will for truly out of this world images.



And let us not forget the interest companies would have for a chance to put their logo in front of that camera lens.



End Charts