National Aeronautics and
Space Administration

Small Satellite Conference 2015

NASA Town Hall Meeting

Hosted by the

Small Spacecraft Technology Program

August 10th, 2015

NASA Town Hall Meeting

- **Introduction** Andrew Petro, Program Executive, STMD
- **Small Spacecraft Technology** – Andres Martinez, Program Manager
  - Smallsat Technology Partnerships - Selections for 2015
  - Pathfinder RFI and Tipping Point NRA
  - Upcoming Demonstration Missions
  - State of the Art Report - Update
- **SMD/STMD Joint Study** – Charles D. Norton, JPL
- **CubeQuest Challenge** – Eric Eberly, Deputy Program Manager, Centennial Challenges
- **Cubesat Launch Initiative** – Garret Skrobot, Mission Manager
- **Flight Opportunities** – Ron Young, Flight Opportunities Program Manager
- **Small Class Launch Site** – Jerad Merbitz, Operations Manager
- **Q&A, Feedback and Dialog**

Smallsat Technology Partnerships
2015 Selections

COMMUNICATIONS

High Data Rate Ka-Band Software Defined Radio for Small Satellites
University Of Vermont, Burlington & Worcester Polytechnic Institute
PI: Tian Xia NASA Collaborator: Wai Fong, GSFC

Miniaturized Phonon Trap Timing Units for Cubesats
University Of Michigan, Ann Arbor
PI: Mina RaiesZadeh NASA Collaborator: Serhat Altunc, GSFC

Integrated Solar Panel and Antenna Array for Cubesats
Utah State University
PI: Reyhan Baktur NASA Collaborator: Serhat Altunc, GSFC

SIMPLE, LOW-COST DEORBIT

Solid-State Inflation Balloon Active Deorbiter
University of Arkansas, Fayetteville
PI: Po-Hao NASA Collaborator: Elwood Agasid, ARC

Smallsat Technology Partnerships
2015 Selections

ATTITUDE CONTROL

Film-Evaporation Reaction Control System Small Spacecraft
Purdue University
PI: Alina Alexeenko NASA Collaborator: Eric Cardiff, GSFC

Propellantless Attitude Control of Solar Sails Using Reflective Control Devices
University of Maryland, College Park
PI: Jeremy Munday NASA Collaborator: Tiffany Russell, MSFC

POWER AND THERMAL CONTROL

Small Spacecraft Integrated Power System with Active Thermal Control
University Of Illinois, Urbana-Champaign
PI: Alexander Ghosh NASA Collaborator: Elwood Agasid, ARC

Active CryoCubeSat
Utah State University
PI: Charles Swenson NASA Collaborator: A.J. Mastropietro, JPL

Pathfinder Technology Demonstrator Request for Information (RFI)

Solicitation Number: NNA15ZPX001L - **Responses Due August 18, 2015**
https://www.fbo.gov/spg/NASA/ARC/OPDC20220/NNA15ZPX001L/listing.html

NASA is interested in a spaceflight-qualified 6U cubesat spacecraft bus to be operated by NASA for its Pathfinder Technology Demonstrations to accommodate propulsion and other new technology payloads.

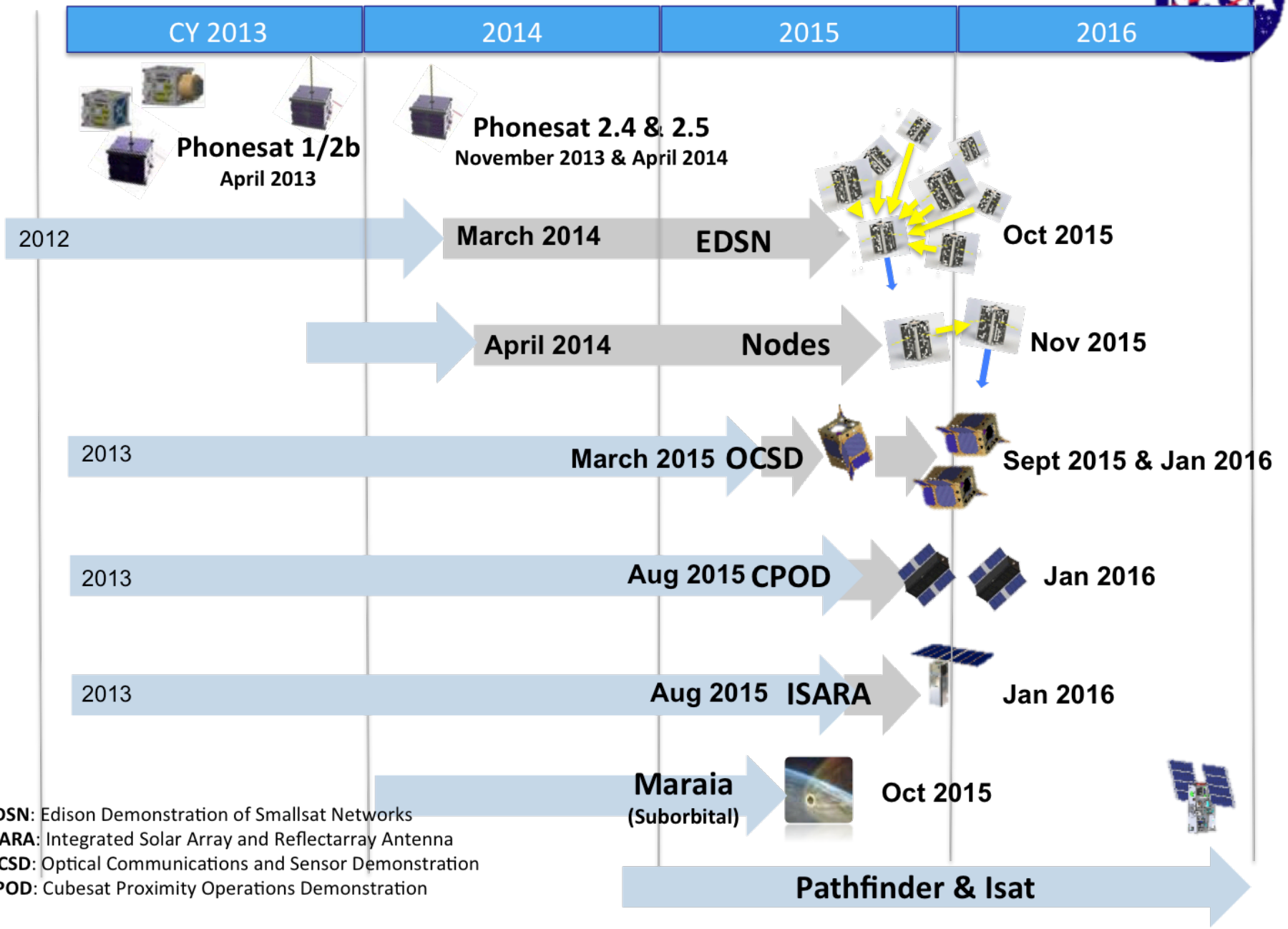
Tipping Point Research Announcement

Closed August 3, 2015

Topics Include:

- Small Spacecraft Propulsion
- Attitude Determination and Control for Small Spacecraft
- Low Size, Weight and Power Instruments

Small Spacecraft Technology – Flight Demonstrations



EDSN: Edison Demonstration of Smallsat Networks
ISARA: Integrated Solar Array and Reflectarray Antenna
OCSD: Optical Communications and Sensor Demonstration
CPOD: Cubesat Proximity Operations Demonstration

Small Spacecraft Technology - State of the Art Update Underway

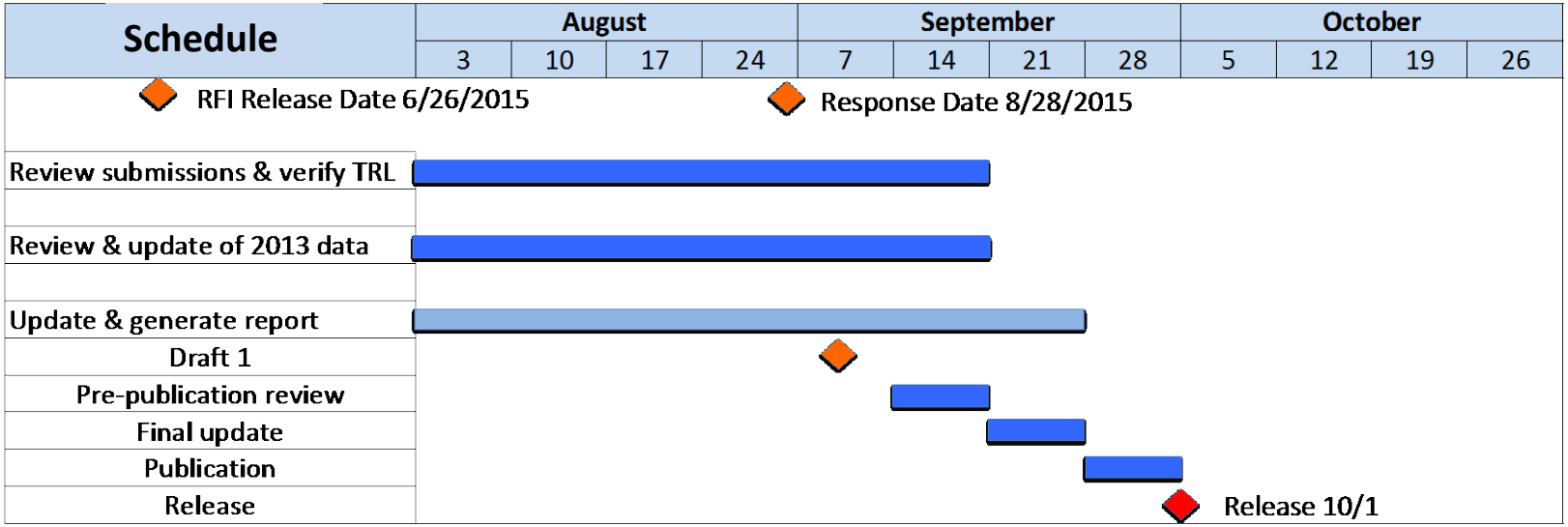
Technology Domains: Power; Propulsion; ADCS; GNC; Thermal Systems; Structure, Materials & Mechanisms; C&DH, Communications; TT&C; Software; Integration, Launch & Deployment; Ground Systems & Operations; Deorbit Systems

- Desk research – NASA Ames Engineering
- Outreach to Small Spacecraft Community
  - Academia: peer-to-peer networking
  - Industry RFI – **Responses due Aug 28, 2015**

  Submit responses via email to **umetria.y.thomas@nasa.gov**

  https://www.fbo.gov/spg/NASA/ARC/OPDC20220/NNA15ZRD001L/listing.html

www.nasa.gov/smallsats



Objective of The NASA SMD/STMD Joint SmallSat Study

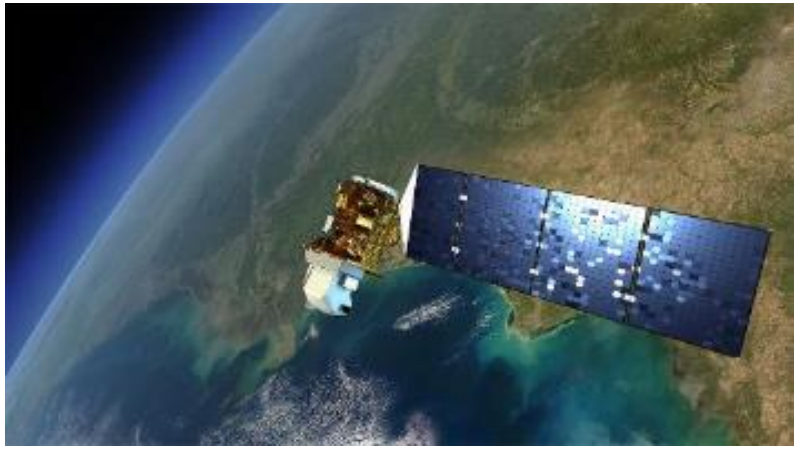
To explore alternative paradigms for key SMD science measurement requirements

Identify new paradigms where strategic science objectives might be achieved using novel SWaP instruments, coupled with small platforms and innovative mission architectures, provided current technology gaps are overcome

Study is organized into 5 distinct tasks

- Survey SOA for platforms and mission architectures
- Survey emerging capabilities
- Identify potential new paradigms
- Perform mission concept studies for candidate science measurements
- Deliver final report in 2016

Includes Heliophysics, Astrophysics, Planetary Science and Earth Science with RFI for community input in development



LandSat 8

Launch Mass: 2,071 kg

Instruments: Operational Land Imager (9 bands + panchromatic) and Thermal Infrared Sensor (2 bands)

Spectral Resolution: 15-100 meters (pending frequency)

Development to Launch: 2002 - 2013

Manufacturers: GSFC, Ball Aerospace, Orbital Sciences

Potential of Small Satellite Measurements

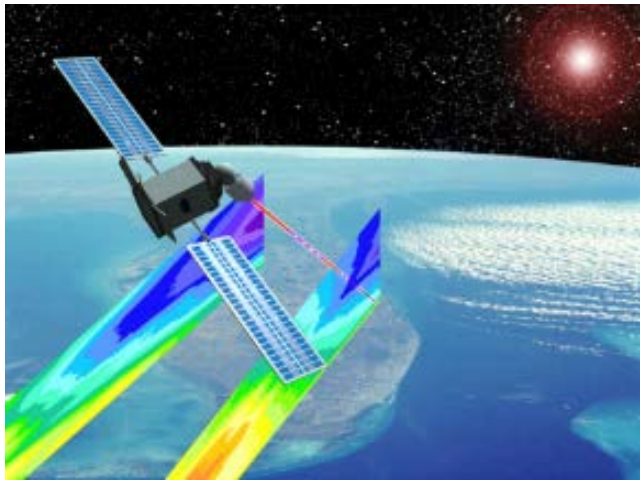
An alternative architecture to obtain global 3D wind measurements?

2007 NRC Decadal Survey identifies 3D tropospheric wind measurements as "transformational" for NWP

Significant challenges remain to deliver an operational global 3D Lidar winds mission at an acceptable cost

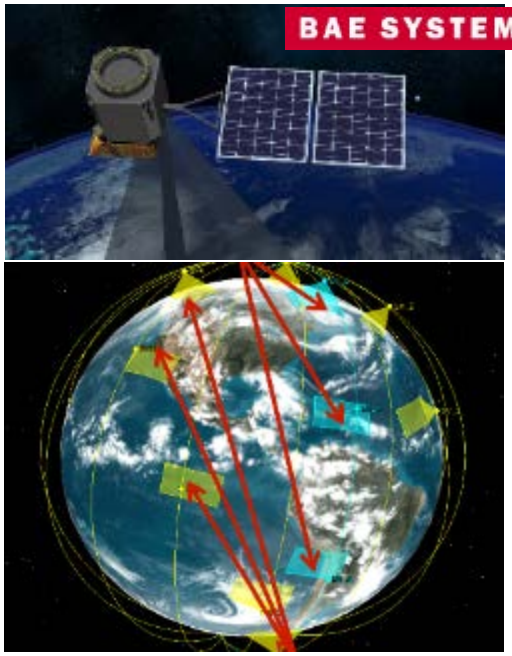
The proposed "MISTiC Winds" approach is to use a series of low-cost micro-satellites in a string of pearls constellation to provide global tropospheric IR profiles of temperature and humidity at high resolution

The rapid refresh rates from the constellation would enable global 3D winds from the troposphere



Recent Concept: Global Wind Observing Sounder (GWOS)

Would consist of a coherent aerosol Doppler receiver with a direct detection molecular Doppler receiver



Midwave IR Sounding of Temperature and Humidity in a Constellation (MISTiC) Winds

27U Instrument on ESPA Constellation in LEO may offer lower cost/risk than alternatives

PI: Kevin Maschoff (BAE Systems)

The NRC Achieving Science Goals With CubeSats Study

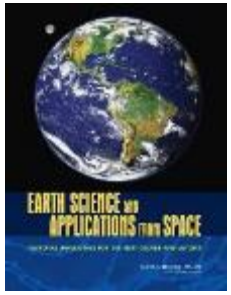
Key elements of charge to the committee

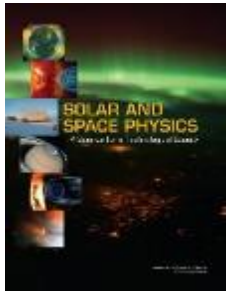
Review the current state of scientific potential and technological promise of CubeSats

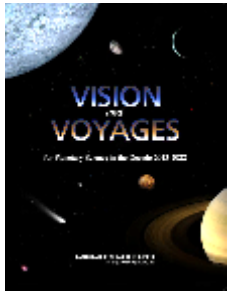
Review the potential of CubeSats as platforms for obtaining high-priority science data

- From recent decadal surveys
- Science priorities from 2014 NASA science plan

Provide a set of recommendations on how to assure scientific return on future federal agency support of CubeSat programs







The NRC Achieving Science Goals With CubeSats Study

Committee Actions

Develop summary of status, capability, availability and accomplishments in government, academic and industrial sectors

Recommend any potential near-term investments that could be made to

- Improve the capabilities that have a high impact and return
- Enable the science communities' use of CubeSats

Identify a set of sample priority science goals that describe near-term science opportunities

Completion expected in Spring 2016

September 2-3 Symposium, Beckman Center, Irvine CA:

http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_160539

CubeQuest Challenge Overview

The objective of the Cube Quest Challenge is to design, build, and deliver flight-qualified, small satellites capable of advanced operations near and beyond the moon.

	1st / 2nd Prize
• **Lunar Derby Prizes**	
Achieve Lunar Orbit *($1M max per team)*	$1.5M *(shared,*
Error-free Communication	
Burst Rate	$225k/25k
Total Volume	$675k/75k
Longevity *(Orbit maintenance needed)*	$450k/50k
• **Deep Space Derby Prizes**	
Error-free Communication	
Burst Rate	$225k/$25k
Total Volume	$675k/$75k
Longevity *(no maintenance needed)*	$225k/$25k
Distance	$225k/$25k

- **Ground Tournament (GT) Prizes**
  - 4 Rounds
  - Approximately every 6 months
  - Top 5 teams receive incremental funding (max $100k per team)
  - Culminates with top 3 teams launching on EM-1

Foster innovation in small spacecraft propulsion and communications techniques

CubeSat limited to 6U volume and 14 kg mass

$5.5M Allocated Prize Money

On the web:

Challenge: www.nasa.gov/cubequest
Program: www.nasa.gov/winit

Current Competitor List

Industry

Alpha CubeSat
Xtraordinary Innovative Space Partnerships, Inc.

Novel Engineering
Novel Engineering Inc.

Ragnarok Industries
Ragnarok Industries, Inc.

Team Miles
Fluid & Reason LLC

True Vision Robotics
Isakson Engineering

University

Cislunar Explorers
Cornell University

HuskySat
University of Washington

OpenOrbiter Lunar I
University of North Dakota

MIT KitCube
Massachusetts Institute of Technology

ERAU Eagles
Embry-Riddle Aeronautical University

SEDS UC San Diego
University of California – San Diego

Lunar CubeQuestador
Missouri University of Science and Technology

High School

Project Selene
Flintridge Preparatory School

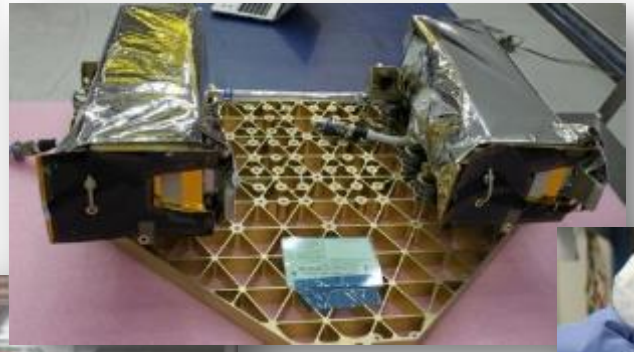
Lunar Derby
Deep Space Derby
Lunar & Deep Space Derby

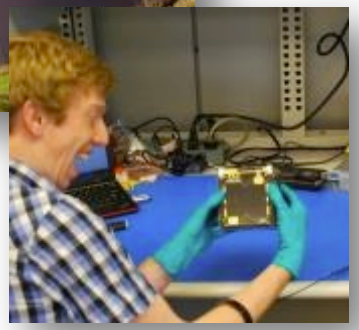
Plus 2 new teams for GT-2!
Registration is still OPEN

GT-1 Winners Announced
Late August 2015

What's going on!

"ELaNa is moving forward, launching CubeSat missions for CubeSat Launch Initiative (CLSI) and Science Projects!"





ELaNa and CSLI Score Card

CubeSat Launch Initiative Missions				
Selected	Awaiting Manifest	Manifested	Launched	ELaNa Missions Launched
106	54	15	38	9

Total U-Class Payloads (Cubes) Readiness			
2015	2016	2017	2018
15	28	10	1

CSLI Announcement of Flight Opportunity 2015

Release Date: August 7, 2015

Response Date: November 24, 2015

NAIS website
https://prod.nais.nasa.gov/cgibin/eps/bizops.cgi?gr=D&pin=04#166762

FedBizOpps.gov Website
https://www.fbo.gov/index?s=opportunity&mode=form&id=c3197fa9ee4773efc7555909dec6c7af&tab=core&_cview=1

ELaNa and CSLI – Developing the Tool Box

- **Commercial Brokers**
  - **Work with the Commercial broker to secure launches for small payloads as primaries or secondaries**
  - **First request for Commercial Broker's proposals are in review for an award this FY**
- **FAA Small Launch Services**
  - **Venture Class Launch Services are underway to procure a launch service to deliver up to 60kg of CubeSats to Orbit by April 2018**
  - **Dedicated Small Launch Vehicle for those missions with unique orbital requirements**
- **ISS Deployments**
  - **Contract in place where NASA can procure ISS UCP deployment slots from the ISS through NanoRacks**

Space Technology Mission Directorate
Flight Opportunities Program

Virgin Galactic

Up Aerospace

Masten Space Systems

World View Enterprises

Near Space Corporation

- Mission
  - Utilize Commercial Flight Opportunities to Facilitate Rapid Development of Space Technology in support of STMD
- Our Top-Level Objectives
  - Facilitate the maturation of technology payloads to higher TRL's through flights that simulate relevant space environments on parabolic, balloon, suborbital reusable launch vehicles (sRLV), and orbital platforms.
  - Foster growth in the emerging commercial suborbital and orbital platforms

Payload Solicitation
(Next Opportunity Opens Fall 2015)

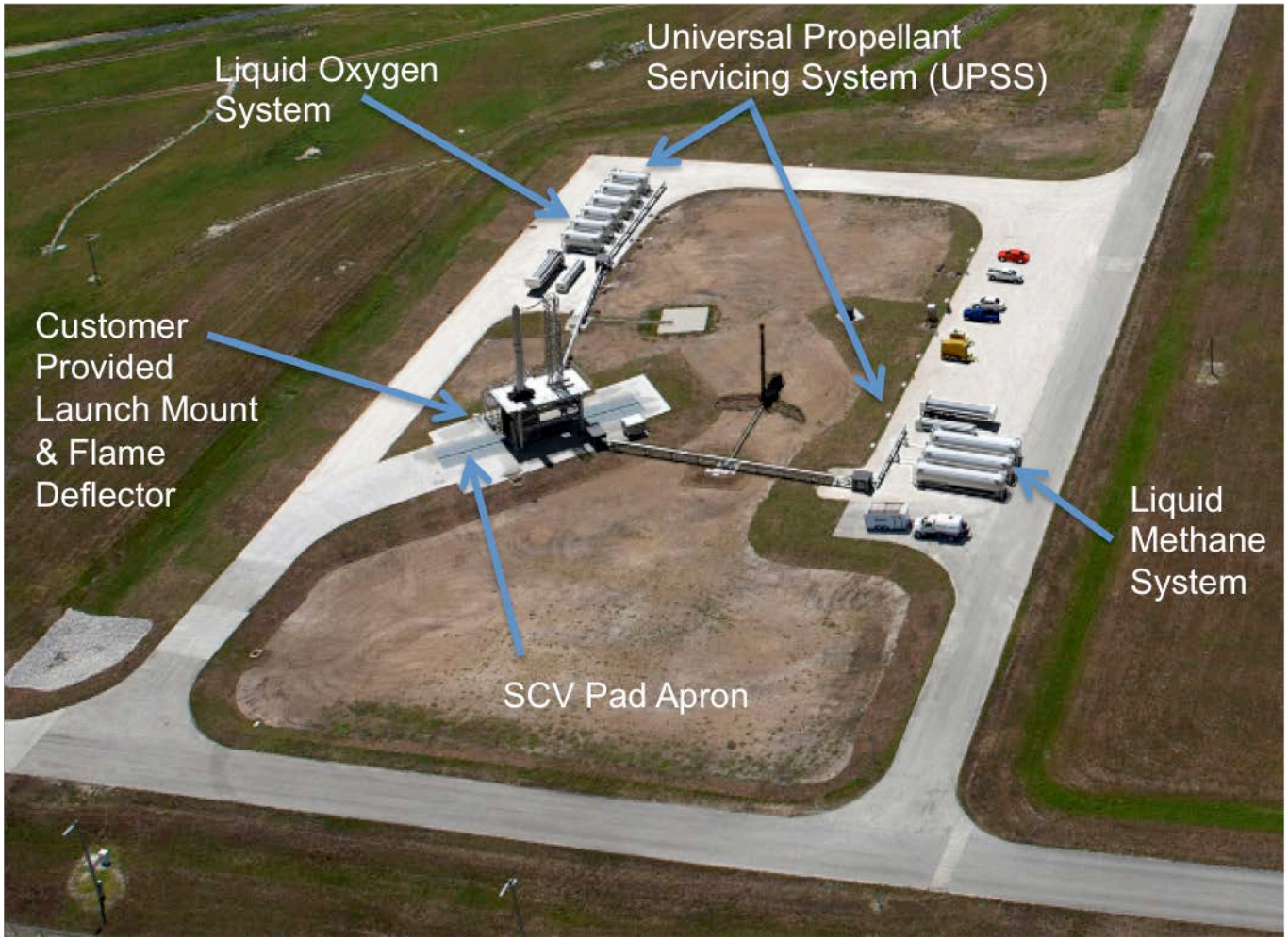
- "Hands-Off" Technology Demonstration Partnerships with Technology Developers
- Funding Available for Flight and Standard Payload Integration Costs
  - Up to $250K for Payload Integration/Flight
  - Up to $50K for Payload Preparation and Other Costs
  - Awardees to purchase flights on their own from U.S. commercial flight vendors
- STMD NASA Research Announcement REDDI-15 Appendix F1
  - Topic 1: Demonstration of Space Technology Payloads
  - Topic 2: Demonstration of Vehicle Capability Enhancements and Onboard Research Facilities for Payload Accommodation

Details at http://goo.gl/KGHmyz

Small Class Launch Site - Pad 39C Location

LC-39B location

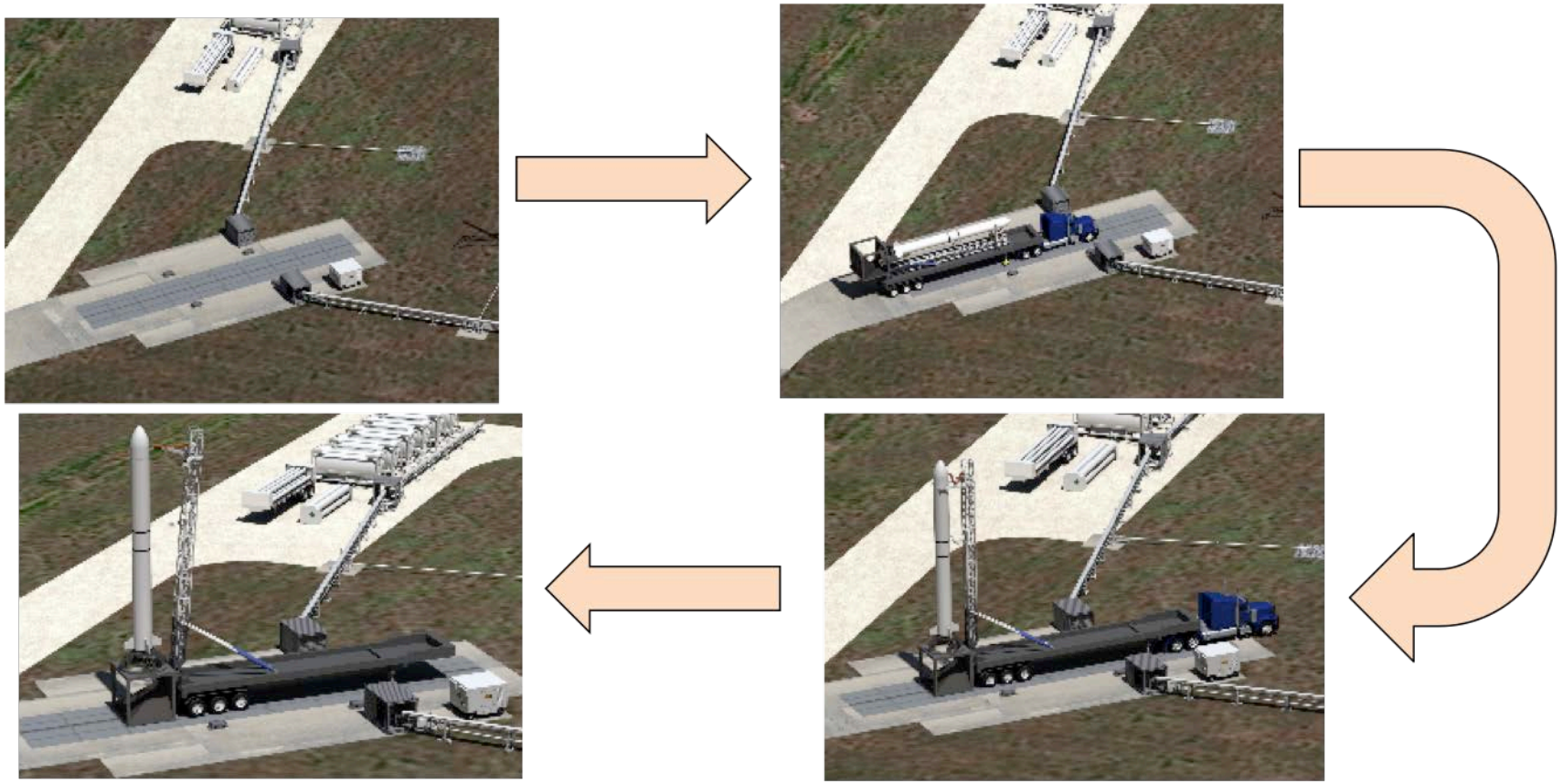
Pad 39C Launch Site Architecture



- Pad surface was designed to handle 200,000 lbs of thrust, but can potentially handle more based on the design weight of vehicle, respective GSE, fuel, payload, etc.
- Capability analysis will be performed for each commercial customer

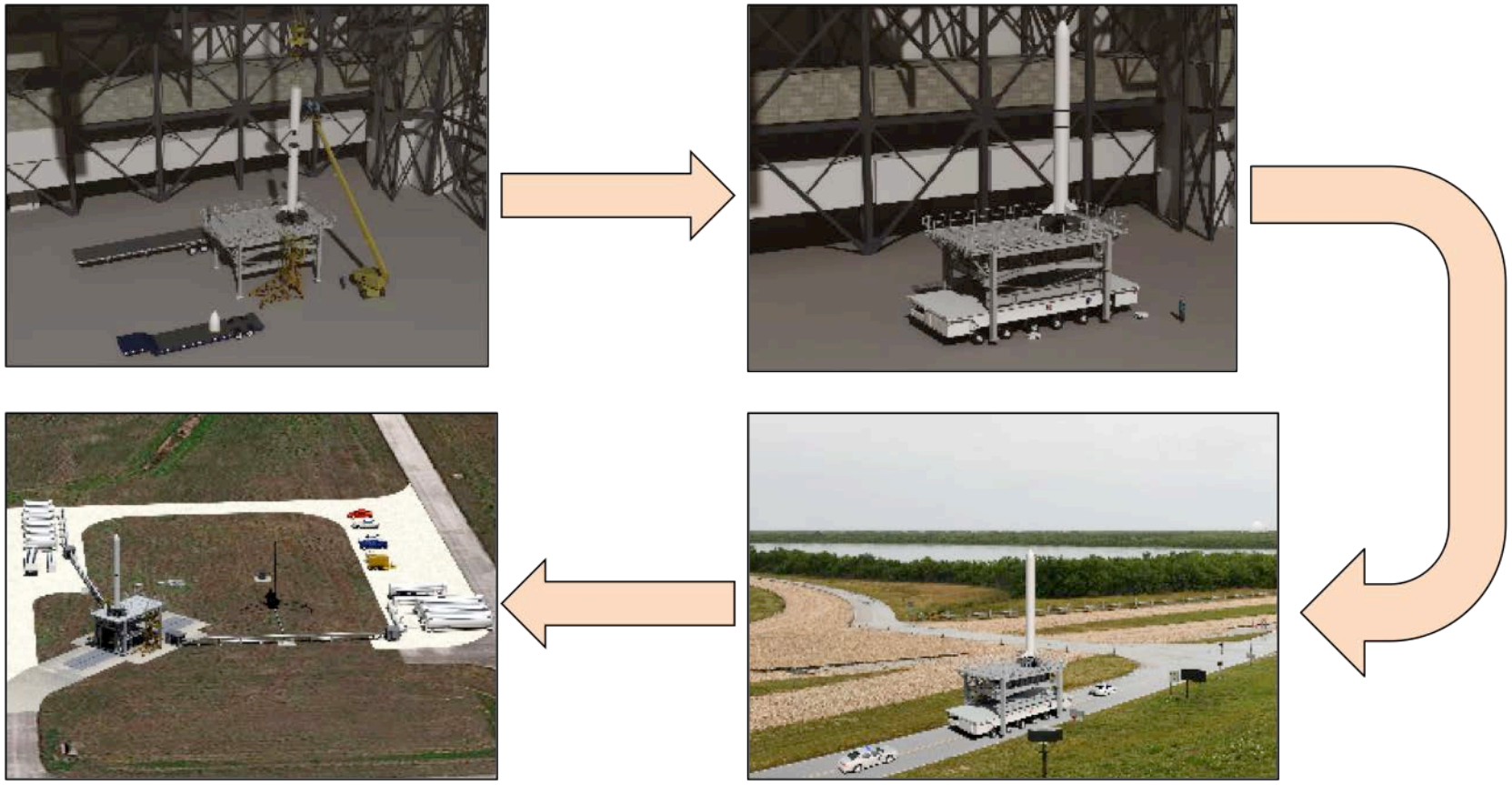
Concept of Operations: Clean Pad

- **Clean Pad Integration (components customer provided) → Launch**
  - Customer transport vehicle to launch site on flatbed equipped with vehicle erector
  - Vehicle erector erects vehicle on launch mount/flame deflector
  - For liquid engine vehicles, cryogenic propellant servicing would be provided via UPSS

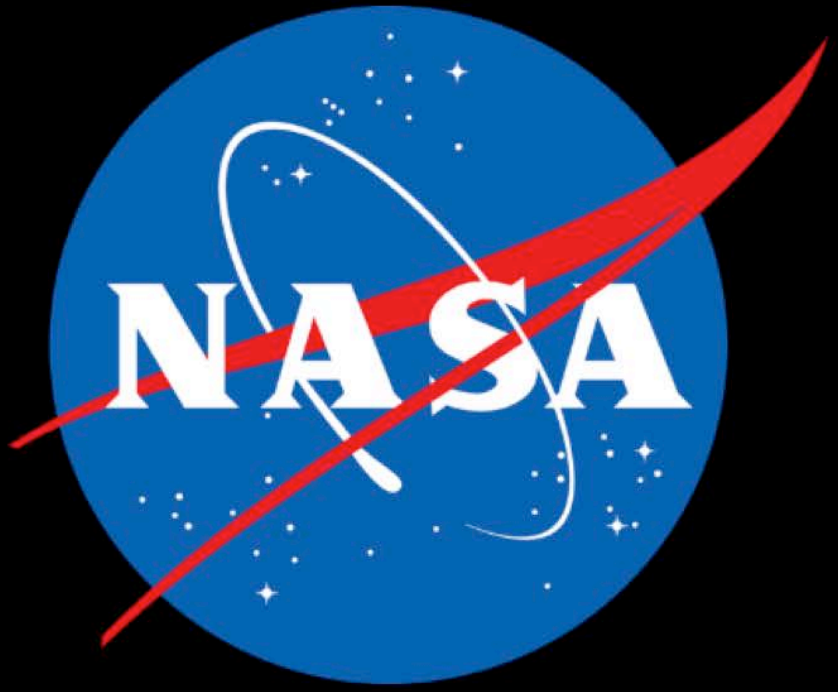


Concept of Operations: VAB Integration

- **Vehicle Integration in the VAB → Rollout → Launch**
  - Vehicle processing and integration with the DLS in a VAB highbay by use of cranes/scaffolding
  - Rollout to the Pad B SCV launch site via KAMAG Transporter
  - For liquid engine vehicles, connection to the UPSS would occur once rollout and set up is complete at Pad B




QUESTIONS?
Q&A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