



Some Thoughts on a Potential NASA Strategy for achieving Low-Cost and Reliable Access To Space (LCRATS)

Adopting an N.A.C.A. approach

To create a new partnership between U.S. Government and Industry

DATE: February 9, 2010

TO: 13th Annual Commercial Space Transportation Pre-workshop

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Executive Summary



- Low-Cost and Reliable Access to Space (LCRATS)
 - Inspire the next generation, as well as the rest of America
 - Will transform how all Americans relate to space — it will become “personal”
 - Children can realistically imagine themselves working & living in space
 - Generate hundreds-of-billions of dollars per year in economic growth
 - Make human spaceflight both affordable and sustainable
 - Deliver national security benefits
- NASA is developing a new (very old) approach
 - N.A.C.A. partnership approach is proven & successful
 - *Stimulated* world-leading aeronautics industry a Century ago
- NACA Approach — “Build an industry, not a program”
 - Inclusive interagency partnership (NACA was interagency)
 - Do not pick any 1 or 2 “winners”, “concepts”, “solutions”, etc.
 - Broadly *stimulate* emerging commercial space transportation industry
 - NASA is beginning to implement NACA approach for this purpose

Policy Statements of New Administrator

Senate Comm on Commerce, Sci and Trans, 8 July 2009



- *“I now dream of a day when any American can launch into the vastness of outer space and see the magnificence and grandeur of our home planet, Earth, as I have been blessed to do.*
- *the government cannot fund everything that we need to do, but we can inspire and open the door for commercial entrepreneurial entities to become partners with NASA in this research and development that will enable things to come about.*
- *Together we can find innovative ways to advance space exploration, reduce the costs of access to space and further push the boundaries of what we can achieve as a nation.”*

Administrator Bolden Announces CRuSR

Speech to Nat'l Assoc. of Investment Companies, Oct. 20, 2009*



- *NASA must determine efficient and effective ways to leverage the power, and innovation of American industry and the American entrepreneur.*
- *In the 1920s, the U.S. Post Office became a major customer for airmail, which created the demand that justified the private investment in many airlines.*
- *NASA is doing something similar right now. We are engaged in a new program — the Commercial Reusable Suborbital Research program — that will buy space transportation services from the emerging reusable spaceflight companies to conduct science research, technology development, with a keen focus on education.”*

* http://www.nasa.gov/pdf/395165main_Bolden_NAIC_Speech.pdf

Deputy Administrator Garver

Announces Commercial RLV Technology Roadmap study



NASA Press Release 09-238, October 13, 2009

- *"NASA is committed to stimulating the emerging commercial reusable launch vehicle industry,*
- *There is a natural evolutionary path from today's emerging commercial suborbital RLV industry to growing and developing the capability to provide low-cost, frequent and reliable access to low Earth orbit.*
- *One part of our plan is to partner with other federal agencies to develop a consensus roadmap of the commercial RLV industry's long-range technology needs."*

Everybody wants LCRATS Real Question is “How”



- United States has made 3 major attempts at LCRATS
 - In 1970s, Congress gave NASA tens-of-billions for Shuttle
 - In 1980s, Congress invested billions in NASP (same purpose)
 - In 1990s, Congress invested \$1.2 Billion in X-33 (same purpose)

- None of these attempts succeeded at LCRATS objective
 - Shuttle did become a successful operational space access system

- A fourth emerging LCRATS attempt collapsed in 2000s
 - USAF and NASA attempted to create National Aerospace Initiative
 - The proposal collapsed
 - When budget estimate reached \$50 Billion

We are Repeating History*

Those who fail to learn from history are ...



- In 1898, Dept of War granted \$50,000 to Dr. Sam Langley
 - To invent the airplane
 - Was the largest federal R&D project in U.S. history
 - Langley was the clear choice to lead such this national project
 - He was nation's leading expert on flight research
 - Langley promised to build an airplane within one year
 - Langley took 5 years, and overran budget by \$20,000
 - When he failed, he was not close to inventing a practical airplane
 - Embarrassed, Department of War shut down the project
 - Dec. 17 1903, two bicycle-shop mechanics fly first airplane
 - Wright Brothers spent \$1,000 of their own money

- ALL of these historical events have one thing in common
 - Centrally-planned programmatic approach to “pick a winner”

- **SOLUTION:**
 - Utilize an open innovation approach
 - Adopt NACA approach ... “Build an industry, not a program”

Why Did We Create N.A.C.A.?



- **Americans invented the airplane in 1903**
 - **Leadership quickly went to Europe**
 - Aggressive investments created European technical lead
 - American firms fought (over patents) instead of building & innovating
 - U.S. govt bought very few planes before WWI, weakening industry
 - 10 nations created aeronautical research programs before the US govt
 - **U.S. finally creates NACA in 1915, copying British model**
 - **Caused major U.S. national security problems in WWI**
 - U.S. was forced to buy European-designed airplanes for WWI
 - U.S. Trainer/Bombers: British De Havilland DH-4
 - U.S. Fighters: French Nieuport 28 and the Spad XIII
 - Dayton-Wright Corp. was only Dayton airplane company in 1917
 - built 3,604 British-designed De Havilland DH-4s for WWI
-

NACA's Mission was (in part) to *Stimulate an Industry Capability*



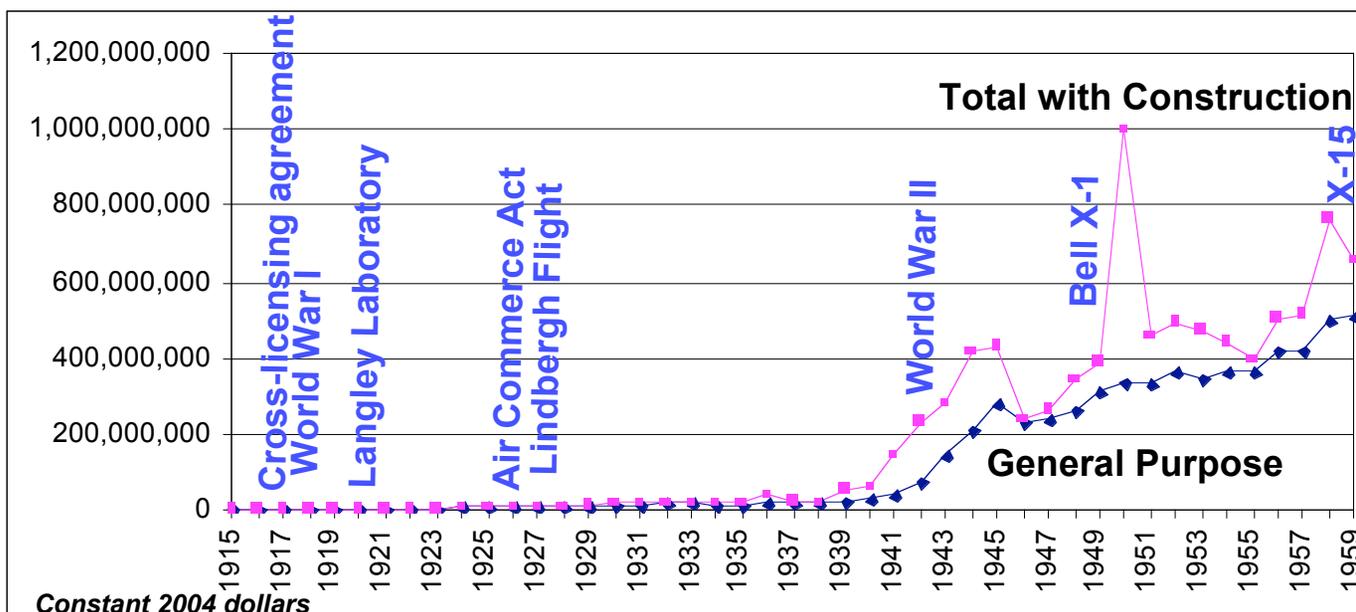
- **“... the members of the NACA believed to a man that the future of aviation in the United States depended on a healthy and prosperous aircraft-manufacturing industry, and that it was the NACA’s duty to help where it could. From the outset, the NACA was an industry booster limited only by its need to be fair and impartial in disbursing favors and assistance.”**

— Alex Roland, “Model Research”, NASA History SP-4103, page 34



NACA Early History

- NACA brought together diverse federal agencies
 - Army, Navy, Smithsonian, Bureau Standards, Weather Bureau
 - Committee developed national consensus on critical problems
- NACA had greatest impact in early decades
 - When its budget was lowest
 - Coordination/cooperation function was as important as R&D



Source: Gary Oleson, Northrop Grumman IT TASC, "Toward Frequent, Affordable Space Access," Space Frontier Conference 14, Los Angeles, CA, October 2005

NACA's Early Successes did not involve lots of cash



- NACA took “holistic” systems view of national priorities
 - Clearly focused on building a healthy competitive industry

 - Solved practical aviation problems for U.S. Govt & industry
 - Facilitated aircraft patent cross-licensing agreement
 - Ended destructive U.S. industry patent fight between Wright's & Curtiss
 - Created cooperative partnerships between government & industry
 - Intervened on WWI aircraft engine deadlock resulting in Liberty engine
 - Started advocating purchase of air mail services (beginning in 1916)
 - Leading to Kelly (Air Mail) Act in 1925
 - Persuaded commercial insurers to start insuring aviation
 - Recommended budget increase to President for Weather Bureau
 - to promote safety in aeronautics
 - Recommended the creation of Bureau of Aeronautics
 - Predecessor of the Federal Aviation Administration
 - Developed methods for mapping from planes
-

NACA Technical Successes Also Critical, But Came Later



- Langley wind tunnel begins research operations in 1920
 - Produced many broad technical advancements
 - Specialized in drag reduction for all vehicles
 - Openly published test data
 - Developed low-drag engine cowling
 - De-icing, airfoils, variable pitch propeller, etc.
 - **KEY POINT:**
 - NACA focus was still on needs of external customers
 - Solving prioritized “practical problems” of DoD & Industry
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Another Benefit of NACA Approach

A National Consensus on Priorities



- **NACA structure generates holistic consensus on**
 - Priority problems of industry and government users

 - **Benefits of national consensus on priorities**
 - Breaks through the background noise of competing voices
 - Enables each USG agency to be more effective in activities
 - Clearly communicates prioritized problems

 - **Holistic approach eliminates gaps in problem solving**
 - Each committee member at the table will have its own focus
 - But committee “as a whole” can take broad “systems” view
 - About all the practical problems that must be solved
 - Defining the “top problems” is half the battle
 - If a top priority problem can’t be addressed by committee
 - The committee can make recommendations (as appropriate)
-

Examples of Use of NACA Model in other focus areas



- **National Defense Research Committee (WWII)**
 - Led by Vannevar Bush, Chairman of NACA
 - To improve coordination/cooperation among scientists
 - Produced critically needed innovation in War War II
 - Radar, sonar, proximity fuses, bomb sights, amphib. vehicles
 - Set up Manhattan Project

 - **Advanced General Aviation Transport Experiments (AGATE)**
 - Led by Bruce Holmes & Langley RC (1994-2001)
 - Problem: Decline of American general aviation
 - Formed consortium of more than 70 organizations
 - Conducted consensus-based research of broad utility to industry
 - Utilized NASA “Joint Sponsored Research Agreement”
 - <http://www.nasa.gov/centers/langley/news/factsheets/AGATE.html>
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NASA Beginning an NACA Approach for LCRATS



- 1) Commercial Responsive Access to Space Tech Exchange**
 - a) A technology exchange between NASA, USAF and industry
 - b) Government acts as a “marriage broker” to bring RLV industry together
 - c) Annual event, rotating between USAF/NASA locations

- 2) Commercial Reusable Launch Vehicle Tech Roadmap**
 - a) Interviewed 30+ companies
 - b) Interim results to be reported on by Dr. Rasky for discussion

- 3) Commercial Reusable Suborbital Research (CRuSR)**
 - a) To purchase “space transportation services” from commercial RLV industry as soon as they are available.
 - b) Intended to stimulate RLV industry as airmail stimulated airplane industry
 - c) Will initially purchase automated experiments for research, education, and technology development purposes.

NASA-USAF Co-sponsoring Annual Event to Enable Technology Exchange in Industry



- NASA working with USAF
 - Annual tech exchange
 - IPP is NASA lead
 - 2009 at WPAFB
 - 2010 at Ames
 - Rotates thereafter
- CRASTE Purposes:
 - Facilitate technology transfer
 - Enable partnerships
 - “Marriage broker” service among firms
 - Forum for understanding industry technology needs
 - CRLV Tech Roadmap



2009 CRASTE Commercial and Government Responsive Access to Space Technology Exchange

October 26 - 29, Dayton, Ohio

What is CRASTE?

The Commercial and Government Responsive Access to Space Technology Exchange (CRASTE) is a joint Air Force Research Laboratory (AFRL) and NASA technology exchange forum for the space launch community to meet, discuss, and collaborate on technologies that deliver improved, responsive, and cost effective access to space capability.

The CRASTE is an excellent opportunity for space access customers (DoD and NASA) to present their space access requirements and objectives. The event is designed to bring large military system integrators and emerging entrepreneurial space companies together to identify and promote viable solutions to space access challenges.

NASA and AFRL initiated a Reusable Launch Vehicle (RLV) technology roadmapping effort to identify technologies with the largest impact for enabling future space access capabilities. The primary goal of NASA and AFRL is accelerating development of Commercial Reusable Launch Vehicles (CRLV's) with significantly lower cost, improved reliability, availability, and robustness compared to current launch systems.

Commercial space organizations attending the CRASTE have an opportunity to provide analysis, options and recommendations for the roadmap to the government team during one-on-one, closed door discussions. Based on the discussions, the government will make recommendations in the form of technology tasks and milestones for the upcoming roadmaps. CRLV categories will then be compiled and documented, along with initial budget and resource requirements.

In addition to one-on-one discussions with the Government, the CRASTE provides multiple networking opportunities to facilitate potential collaborations among the attendees. Members of the space community are exhibiting at the CRASTE and private meeting rooms are available for attendee use throughout the CRASTE.

Why should I attend?

The CRASTE is the optimal forum to:

- Gain insight on future commercial/responsive access to space research directions and programs from Air Force and NASA executives.
- Hear updates on the latest technology developments and breakthroughs from an array of government and industry speakers.
- Meet with and provide private input to the AFRL/NASA RLV road mapping team.
- Network with members of the CRASTE community and explore possible collaborations.
- Broaden and update familiarity with and connections to members of the space launch community through the informative exhibit show.

How do I register?

To register for this important event, including one-on-one contractor meetings and roadmap review meetings, visit the CRASTE website at:
<http://www.usasymposium.com/craste/default.htm>

CRASTE is ITAR restricted and only U.S. Persons (citizens and permanent residents) may attend.

CRASTE Contacts:

Air Force Research Laboratory Mr. Bruce Thieman Responsive Space Lift Capability Lead AFRL/RBOT Bruce.Thieman@WPAFB.AF.MIL	NASA Dr. Robert J. Shaw Chief, Business Development and Partnership Office NASA Glenn Research Center Robert.J.Shaw@nasa.gov
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Symposium Coordinator
Ms. Cathy Griffith, GDIT
Cathy.Griffith@gdit.com



Commercial RLV Technology Roadmap Study

- NASA partnership with USAF and FAA-AST
 - Focused primarily on understanding “commercial industry needs”
- Primary Goal:
 - Accelerating development of Commercial Reusable Launch Vehicles
 - that have significantly lower cost, and improved reliability, availability, launch turn-time, and robustness compared to current launch systems.
- Planned Outputs:
 - Roadmaps with recommended government technology tasks and milestones for the four different vehicle categories
 - Including initial budget and resource requirement estimates
 - Final roadmap ready for publication in May 2010
- For more information, <http://csi.arc.nasa.gov/crlv>

NASA Sponsored Two Workshops With Researchers in 2009



NASA has started asking scientists and researchers

- “What could you do with 4 minutes of frequent, low-cost, predictable microgravity”?

Earth Science Workshop
Dec. 15, 2008
AGU Fall mtg



**Gravitational Biology
Workshop**
May 3, 2009
AMA 80th Annual mtg

Commercial Reusable Suborbital Research (CRuSR) — Some Areas of Interest



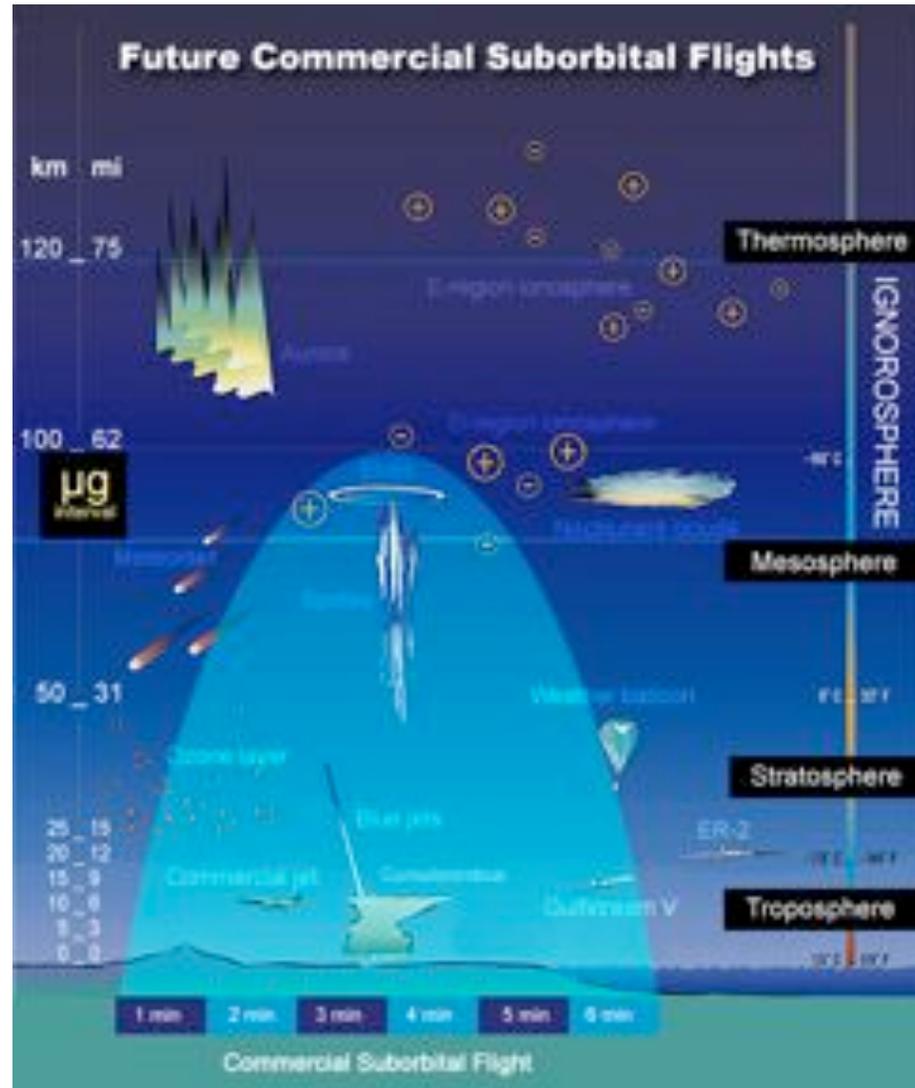
- **Sensing**
- **Climaterics**
- **Vertical Atmospheric Sampling**
- **Gene Expression**
- **Fluids**
- **Physiology**
- **Emergency Procedures**
- **Countermeasures**
- **Cardiovascular Deconditioning**
- **Workforce Development**
- **Resistive Exercise Devices**
- **Inner Ear Neural Signal**
- **Dust Particle Agglomeration**
- **Metal Alloy Phase Separation**
- **Glovebox Investigations**
- **Combustion**
- **IR and NIR Optics**
- **Technology Testing**
- **STEM Education**
- **Cell Cultures**

CRuSR and the Earth's Ignorasphere



Ignorasphere

- Above high-altitude balloons
- Below satellites
- Generally 80-120 km



Commercial Suborbital RLVs Could Be a Gamechanger for Education



- President has asked NASA to “inspire” again
- If Commercial Suborbital RLVs succeed
 - Could be a gamechanger for inspiration
 - SpaceShipOne success was #2 “above the fold” story for all of 2004
 - Could be a gamechanger for STEM
- Some possibilities to consider:
 - Young children will see hundreds, if not thousands,
 - Of people travelling to space each and every year
 - Low-cost frequent predictable flights to space enable
 - Incorporation as a baseline experiment in semester courses
 - Private non-profits are proposing:
 - Nation should fly hundreds of teachers per year into space, and
 - Put them right back into the classroom
- ~~National competitions w/ grand prize for students to fly in space~~

CRuSR Co-sponsoring Event

Next Generation Suborbital Researchers Conf.



➤ **NGSR Purposes:**

- Support space research
 - Tech development
 - Science
 - Basic research
- Facilitate innovative partnerships
- Educate and inform researchers
- Support STEM and inspire next generation
- Stimulate industry by market creation

Four minutes of micro gravity.
Repeated chances to experiment.
And **YOU** can be the Payload Specialist in flight.
WHAT WOULD YOU DO?

NEXT GENERATION SUBORBITAL RESEARCHERS CONFERENCE
BOULDER COLORADO
FEB 18-20, 2010
Abstract Deadline: Nov 12
Student Contest Deadline: Dec 5
For more information visit:
www.lpi.usra.edu/meetings/nsrc2010/

Logos: COMMERCIAL SPACEFLIGHT FEDERATION, COSGC, NASTAR, ECLIPTIC, NASA, SpaceRef, LUNAR AND PLANETARY INSTITUTE, SPACE X, SAS, ULA, and others.

For More Information



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