NAC TECHNOLOGY & INNOVATION COMMITTEE MEETING

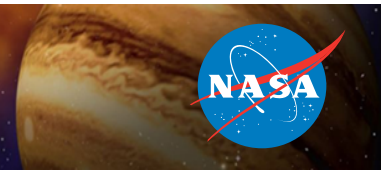
CROSSCUTTING CAPABILITIES DEMONSTRATION DIVISION

Dr. Prasun N. Desai

Crosscutting Capabilities Demonstration Division Director (Acting)

August 3, 2010

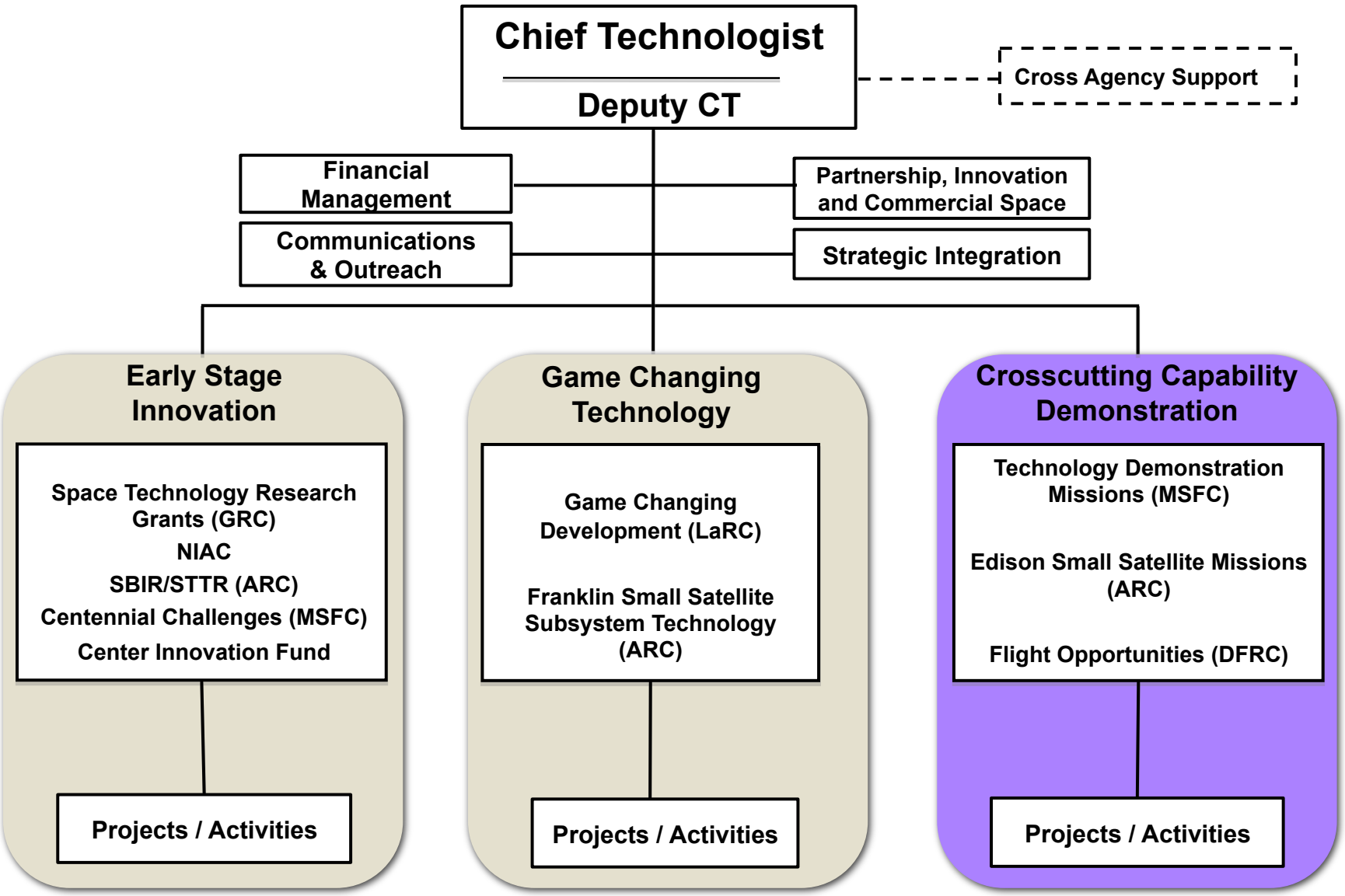
Space Technology: A Different Approach



- **Strategic Guidance**
  - Grand challenges
  - Technology roadmaps
- **Full spectrum of technology programs that provide an infusion path to advance innovative ideas from concept to flight**
- **Competitive peer-review and selection**
  - Competition of ideas building an open community of innovators for the Nation.
- **Projectized approach to technology development**
  - Defined start and end dates
  - PMs with full authority and responsibility
  - Project focus in selected set of strategically defined capability areas
- **Overarching goal is to reposition NASA on the cutting-edge**
  - Technical rigor
  - Pushing the boundaries
  - Take informed risk and when we fail, fail fast and learn in the process
  - Seek disruptive innovation such that with success the future will no longer be a straight line.
  - Foster an emerging commercial space industry

Space Technology: The Innovation Engine required to fuel the Agency's long-term needs in aeronautics, science and exploration while advancing our Nation's technological future.

Office of the Chief Technologist Organization



Crosscutting Capability Demonstrations Division

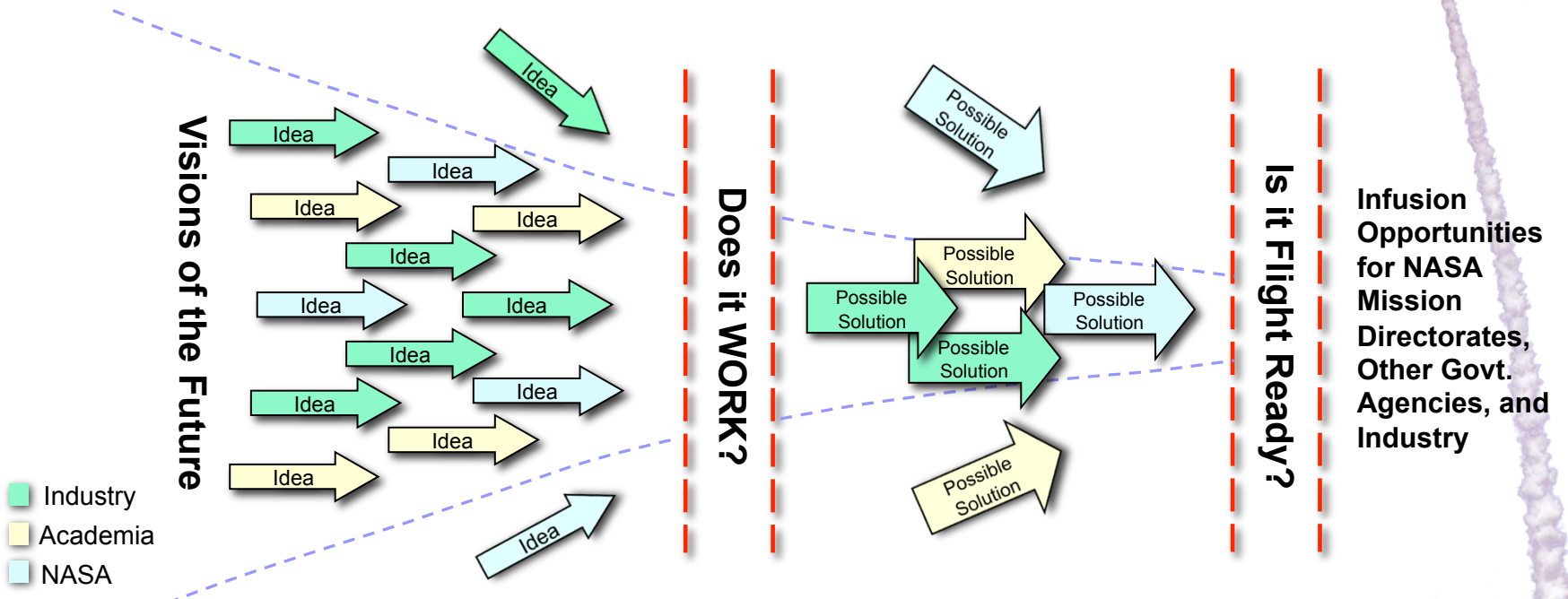
- ***The Crosscutting Capability Demonstrations Division focuses on maturation to flight readiness of cross-cutting capabilities that advance multiple future space missions, including flight test projects where in-space demonstration is needed before the capability can transition to direct mission application.***
- ***Matures a small number of technologies that benefit multiple customers to flight readiness status [Technology Readiness Level (TRL) 6] through Projects that perform relevant environment testing.***

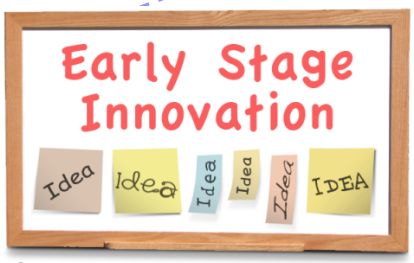
Crosscutting Capability Demonstrations (CCD) Division includes:

- **Technology Demonstration Missions Program** which matures, through flight demonstrations, a small number of Agency crosscutting technologies in partnerships with the Mission Directorates, other government agencies, and industry
- **Edison Small Satellite Missions Program** which develops and operates a series of NASA-focused small satellite demonstration missions in collaboration with academia and small business
- **Flight Opportunities Program** which provides flight opportunities of reduced-gravity environments, brief periods of weightlessness, and high-altitude atmospheric research

Greater than 70% of CCD funds (FY11-FY15) will be applied to competitive selections

Space Technology Development Approach



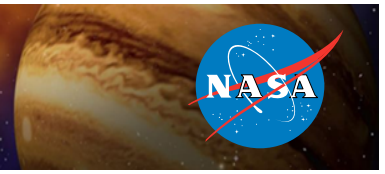


Creative ideas regarding future NASA systems or solutions to national needs.

Prove feasibility of novel, early-stage ideas with potential to revolutionize a future NASA mission and/or fulfill national need.

Mature crosscutting capabilities that advance multiple future space missions to flight readiness status

Space Technology Program Elements



TRL	1	2	3	4	5	6	7

Early-Stage Innovation

- System Concepts and Analyses
- Concept and Technology Assessment
- Foundational Disciplinary Advances
- Technology and Innovation Incentives and Prizes

Game Changing Technology

- New Capabilities
- Proof of concept
- Measurable Performance Advantages & Hardware Validation
- Balanced Risks with Moderate Expected Failure Rate
- Partnerships with Other Govt. Agencies, Industry & Academia

Crosscutting Capability Demo.

- Relevant Environment Testing
- Tailored 7120 Flight Processes
- Not Mission Specific Technology
- 25% Cost Share Req. for Flight Tests

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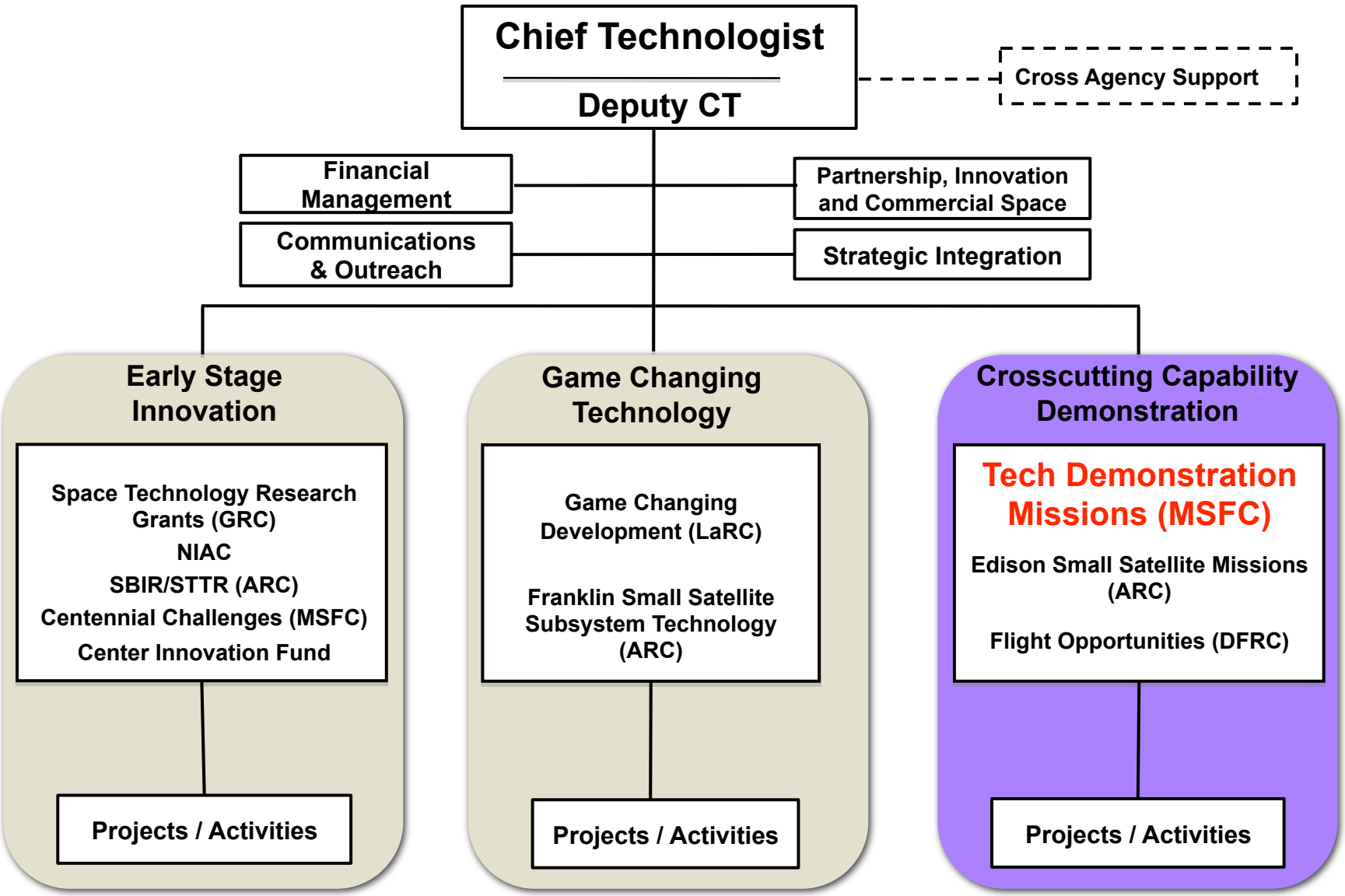


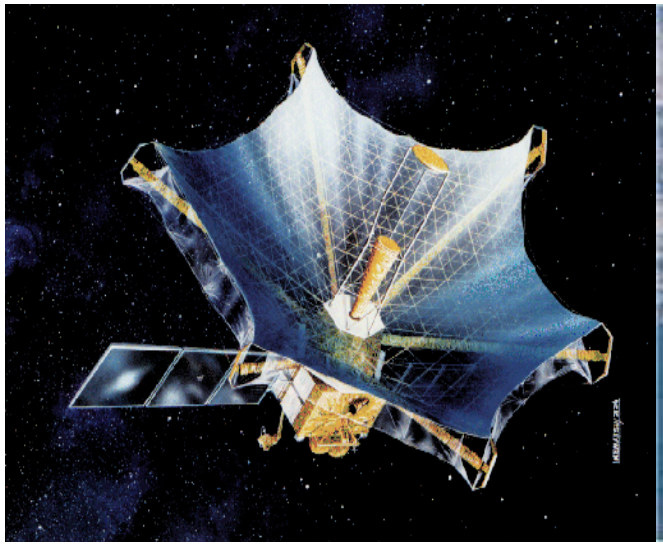
Technology Demonstration Missions Program

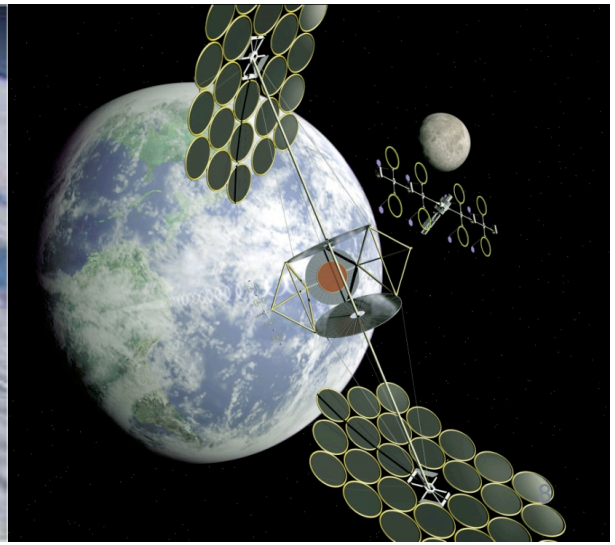
Bridging the Gap:

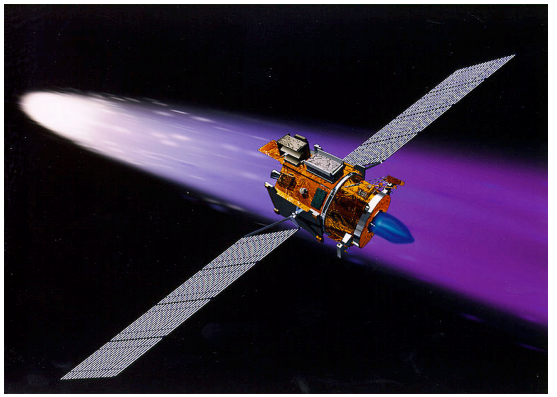
One of the greatest challenges that NASA faces in incorporating advanced technologies into future missions is bridging the gap between early development and mission infusion.

Primary Objective:

The primary objective of the Technology Demonstration Missions Program is to help “bridge the gap” by maturing system-level space technologies through flight readiness and mission infusion.



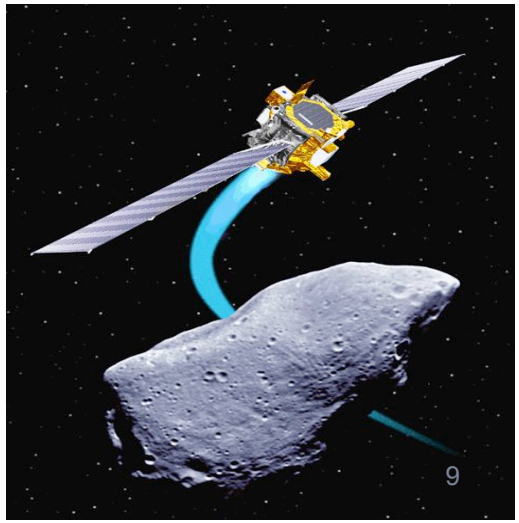




Bridging the Gap - Ion Propulsion Technology

1906: Robert Goddard theorizes about ion propulsion. Performs the first experiments with ion thrusters in 1916.
1959: A working ion thruster is built at NASA GRC.
1960's through 1990's: Many tests in the laboratory, but no mission uses the new technology as a primary propulsion system.

1998: The NASA New Millennium Program (NMP) Deep Space 1 (DS1) mission launches in 1998; DS1 is the first flight for NMP. DS1 was the first flight demonstration of an ion engine as the primary method of propulsion on a NASA spacecraft.
2001: NASA approves Dawn, as Discovery Program mission.
2007: Dawn launches. Dawn mission utilizes ion propulsion on journey to asteroid belt. Initially tested and proven successful on DS1 mission, this innovative technology is now applied for the first time in a dedicated science mission.
Ion propulsion allows Dawn to undertake a mission that would be unaffordable—and even impossible—with a more conventional propulsion system.



Bridging the Gap – Aerobraking Technology

- Science fiction writers referencing aerobraking in the 1940's
- Many technical references to aerobraking in the 1950's, 60's, 70's, 80's

1993: NASA Magellan mission to Venus demonstrates aerobraking at the end of the primary science mission. The Magellan spacecraft at Venus was the first planetary spacecraft to try aerobraking, as a demonstration, in the summer of 1993. The success of this demonstration cleared the way for its implementation in the Mars Global Surveyor mission design.

1994: NASA decides to utilize aerobraking for the Mars Global Surveyor (MGS) mission. Much like an airplane uses spoilers and flaps to slow down prior to landing, the MGS spacecraft uses the drag of the Martian atmosphere on its solar panels to slow down as an alternative to using thrusters which requires extra fuel and, therefore, extra weight and cost.

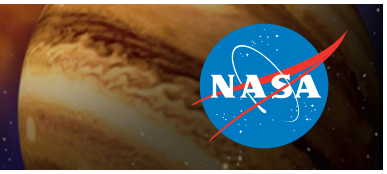
1996: MGS is launched, MGS orbiter is the first spacecraft to use aerobraking as the primary technique of orbit adjustment. The MGS aerobraking team used the data gathered from the Magellan mission to Venus.

2001: Mars Odyssey utilizes aerobraking.

2005: Mars Reconnaissance Orbiter utilizes aerobraking.

MRO Aerobraking

Technology Demonstration Missions Program



Key Elements of the OCT Technology Demonstration Missions Program:

Crosscutting: Defined as a technology with potential to benefit multiple NASA mission directorates, other government agencies, or the space industry.

System-level: Seeking system-level demonstrators, not component-level.

Technology Readiness: Must be mature technologies and the proposed flight demonstration must raise the Technology Readiness Level (TRL) of the candidate technology to a TRL of 6+, such that it may be infused into the critical path of future missions.

Project Life Cycle: Maximum of three year effort.

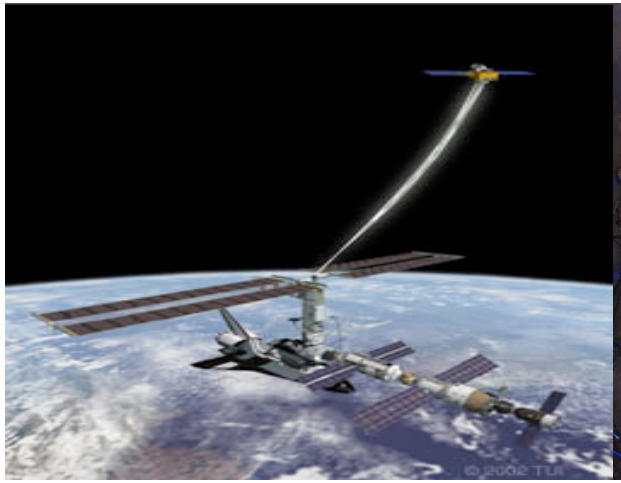
Life Cycle Costs: Typical project costs: $150M. Funding includes all elements of the flight test demonstration: planning, hardware development, software development, launch costs, ground ops, post test.

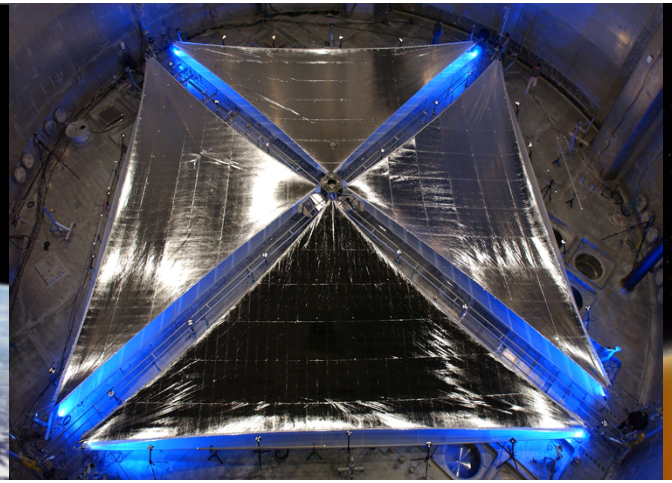
Cost Sharing Partnerships: To demonstrate a potential infusion path, teams will be required to have a sponsor (or sponsors) to cost share the proposed demonstration. A minimum of 25% of the total Life Cycle Cost (LCC) must be contributed by another source outside the OCT.

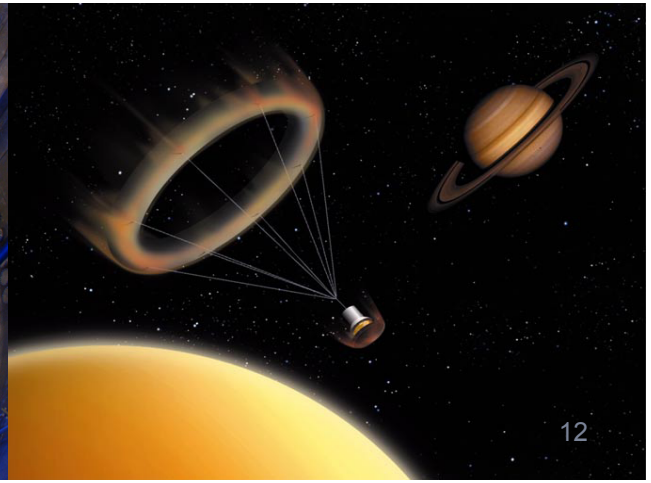
Technology Demonstration Missions Program

Opportunities for Participation:

- Yearly calls for proposed system-level flight test demonstrators
- Goal: several proposals selected each year
- Open competition: NASA Centers, other government agencies, academia, industry, international participation
- Working flexibilities on issues such as intellectual property, data rights, title to rights and property
- Request for Information (RFI) followed by Request for Proposals (RFP)
- RFP approach will be Broad Area Announcement (BAA)







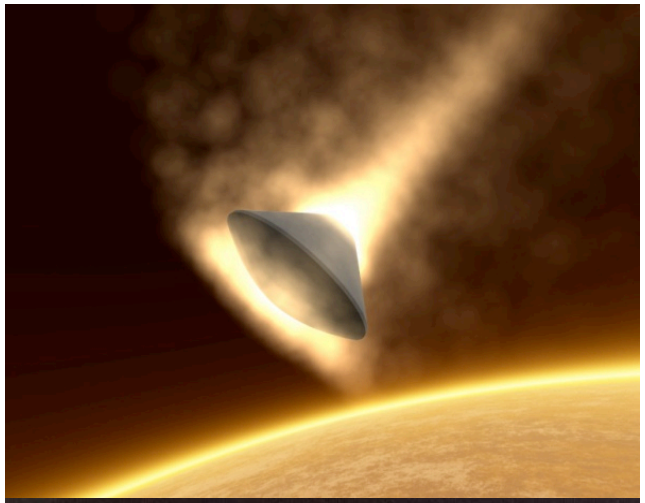
Technology Demonstration Missions Program

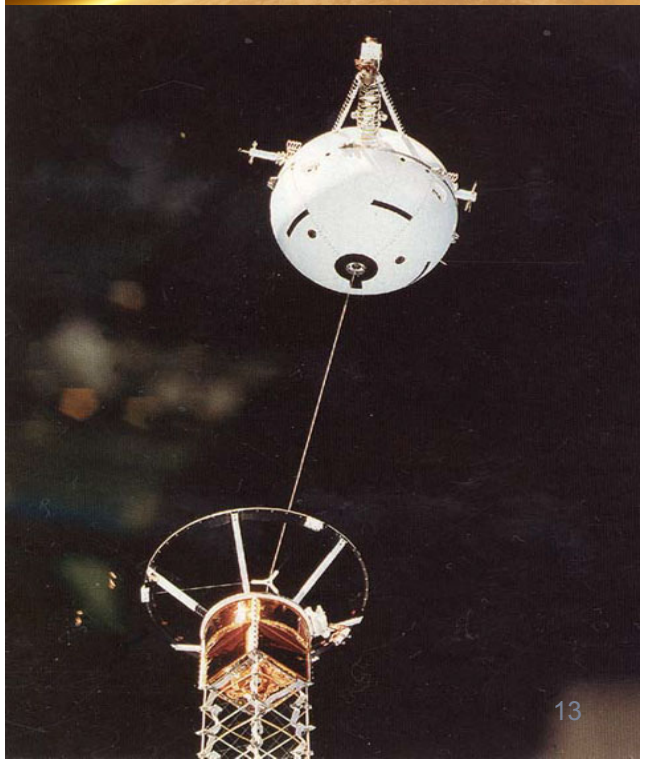
Request for Information (RFI):

- RFI released May 27th
- RFI closed June 30th

Summary of Technology Demonstrations RFI Results:

- Over 200 responses received
- Broad participation: NASA, other government organizations, industry, academia
- Diverse technology capability areas represented
- RFI responses are being used to formulate BAA

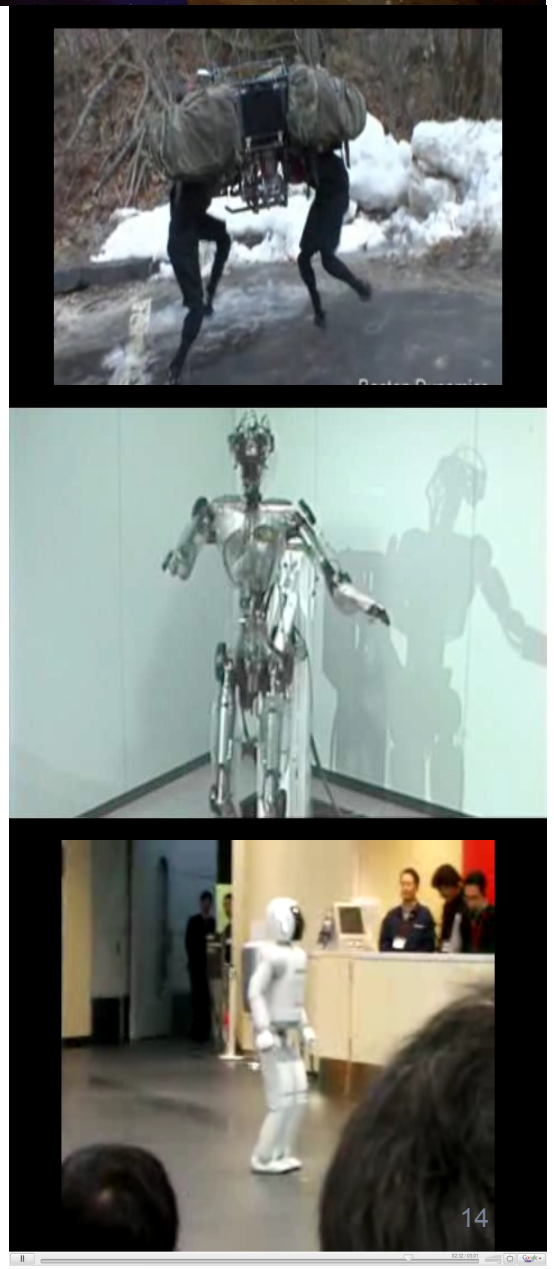




Technology Demonstration Missions Program

Two step proposal process:

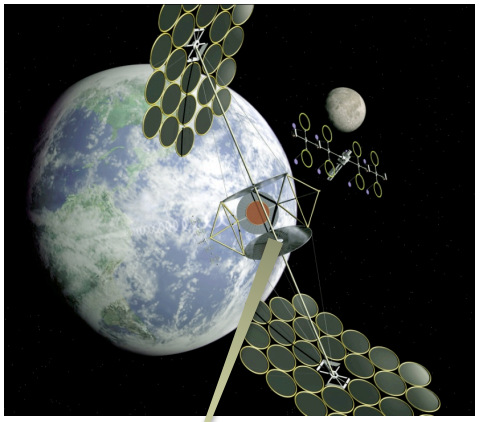
- **Release BAA - Step One/Screening Proposal**
  - Step One proposal must provide: crosscutting proof, preferred carrier, ROM cost, cost sharing source(s)
  - 10 pages or less
  - Two months to formulate team/prepare submit
  - OCT establishes a review team (OCT, MDs, external reviewers) to determine which proposals move to Step Two
- **Release BAA - Step Two/Flight Demonstration Proposal**
  - Full flight demonstration proposal
  - 50 pages or less
  - Three months for full proposal preparation/submit
  - Same review panelists as in Step One
  - Selection Official: NASA Chief Technologist
- **BAA release currently targeted for October** 1

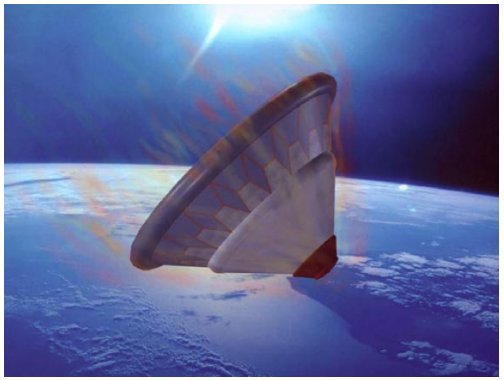


Management of Space Technology Programs

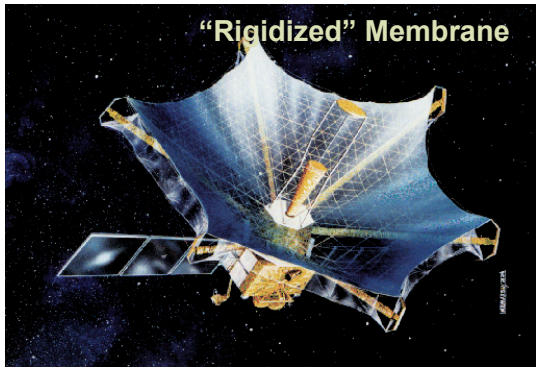
- **The NASA Chief Technologist is the final authority of the Space Technology Programs.**
- **Management of the Space Technology Programs will report through the equivalent of Directorate Program Management Council (DPMC) within the Office of the Chief Technologist.**
- **Agency Reporting and Management:**
  - All Space Technology Programs will be subject to tailored versions of 7120.8 at the Program Level
  - As flight projects, the Technology Demonstration Missions will report through the Baseline Performance Reporting (BPR) and the Agency level PMC. These flight projects will be subject to tailored versions of 7120.5
- **The Space Technology Programs (with exception of NIAC and Center Innovation Fund) have Level 2 Center Program Offices.**
  - The Center Program Offices report to Level 1 Program Executives at HQ who report through the OCT Division Directors to the NASA Chief Technologist.

Potential Space Technology Demonstrations



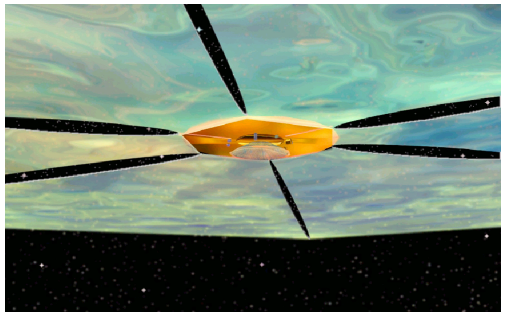


Inflatable Decelerators



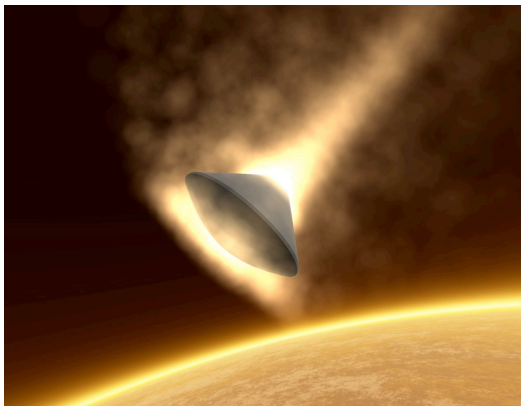
25-40 m Class Telescopes

Space Solar Power: In-Space Power Transmission

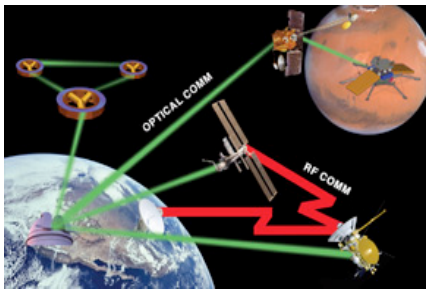


Solar Sail Propulsion

Electrodynamic Tether Propulsion
Artist Concept of ISS Reboost



Aerocapture



Optical Communications

Technology Demonstration Missions Program

The OCT Technology Demonstration Missions Program will allow flight qualification and infusion of a range of advanced space technology systems, “bridging the gap”, enabling new capabilities and exciting new missions.

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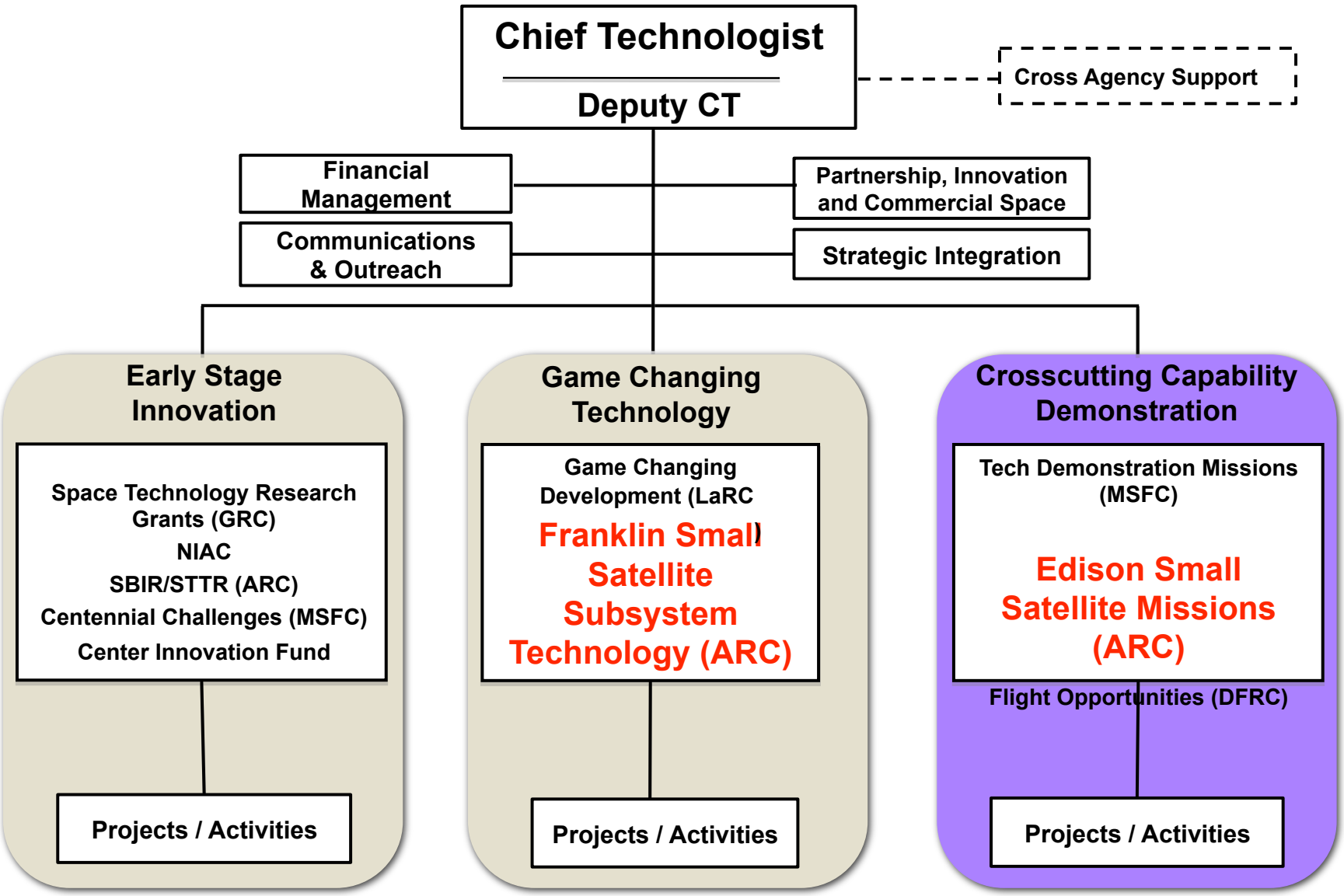
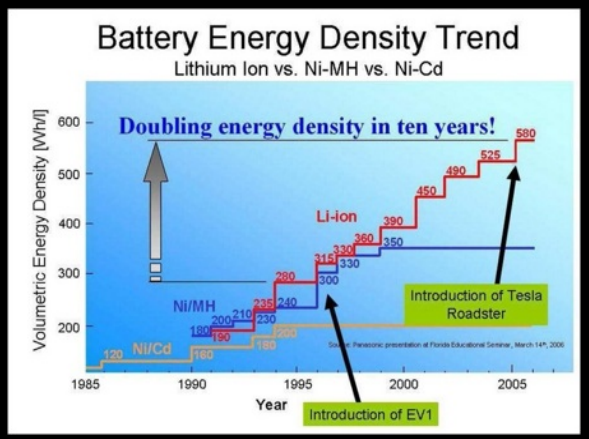


OCT Small Spacecraft Programs
Why Small Spacecraft?

Innovation Rapidly Making Technology Smaller, More Powerful and Less Costly



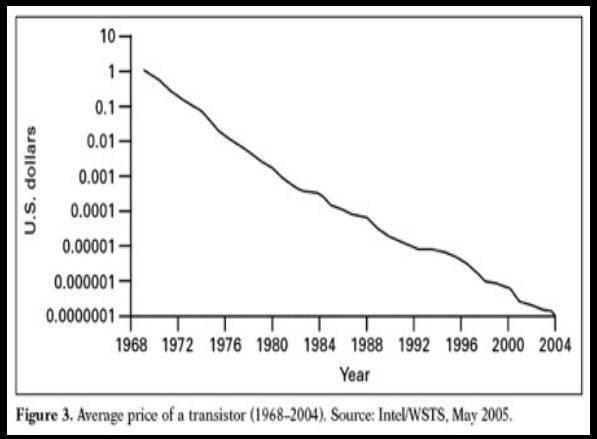
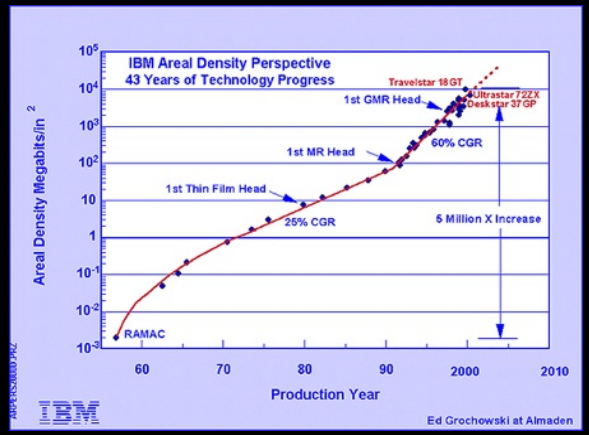
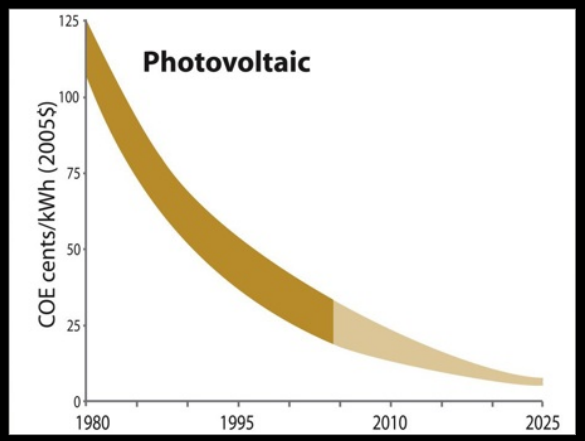
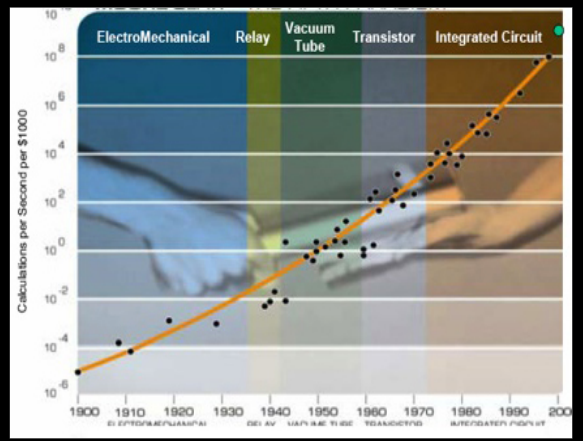
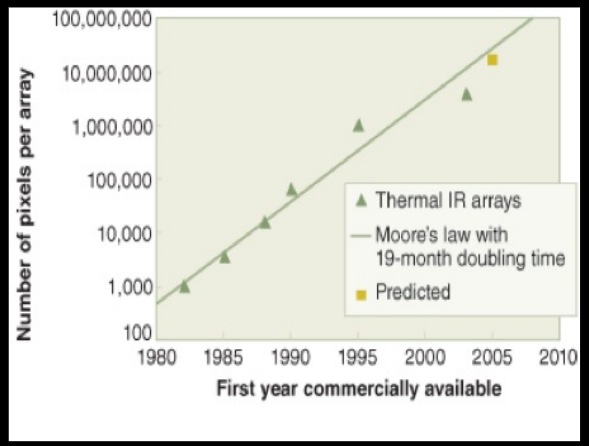


Figure 3. Average price of a transistor (1968–2004). Source: Intel/WSTS, May 2005.





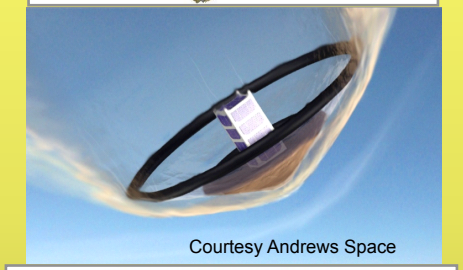


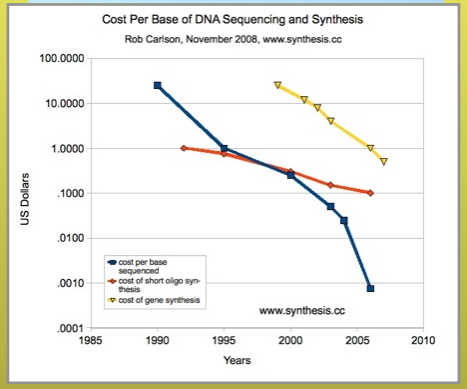


Infuse Technology Faster and Perform Missions Better and More Affordably

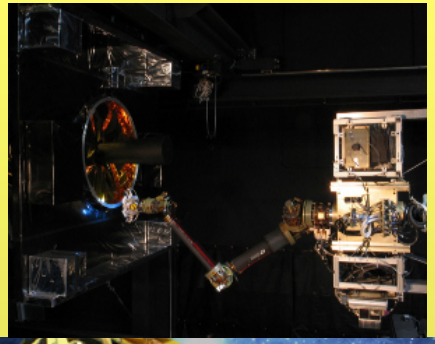
OCT Small Spacecraft Programs
Why Small Spacecraft?

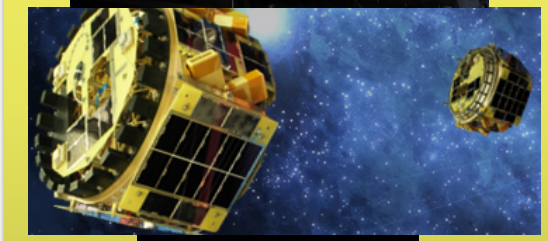
Take Risks on New Applications



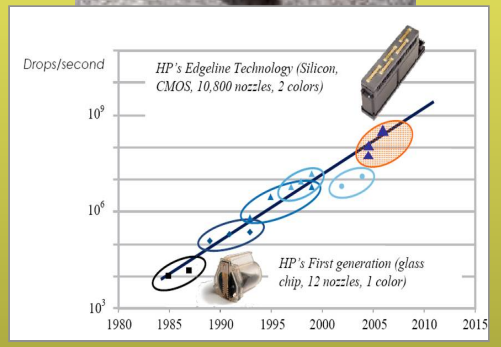


Biological and Physical Research





In-Space Servicing And Orbital Debris



Planetary Research and Resources

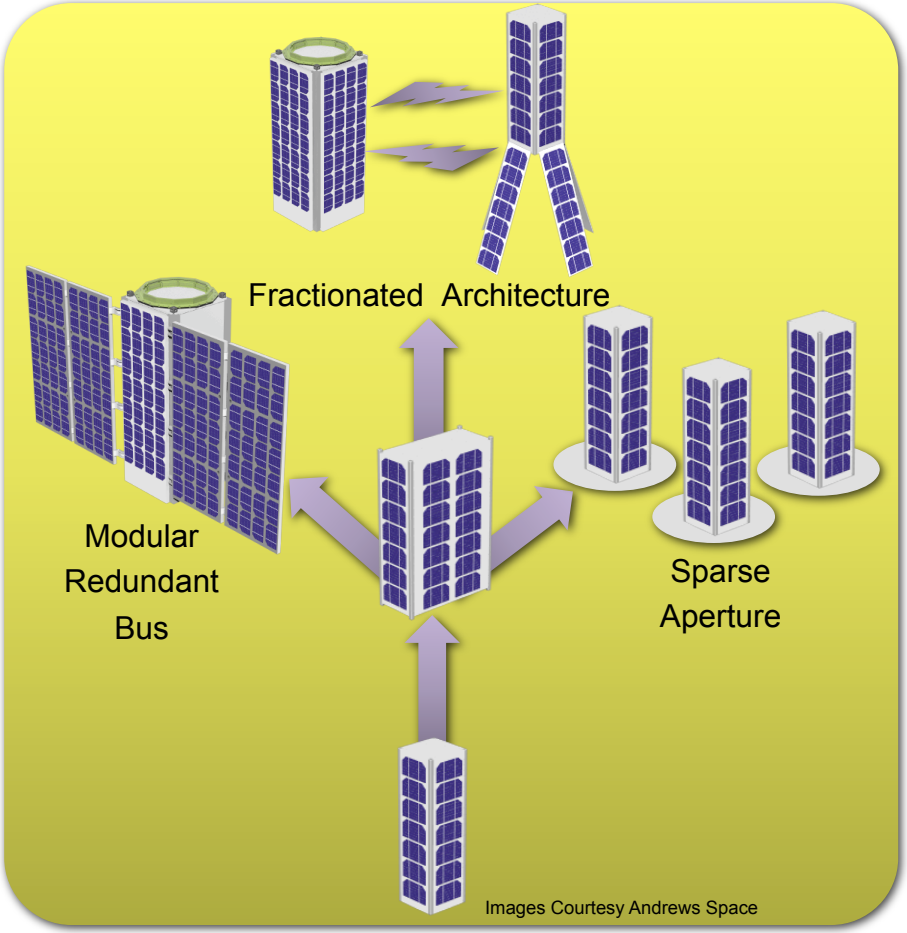
OCT Small Spacecraft Programs
Why Small Spacecraft?

Enable New Approaches to Satellite Communications and Remote Observation

OAO to HST

TDRS-1 to TDRS-10

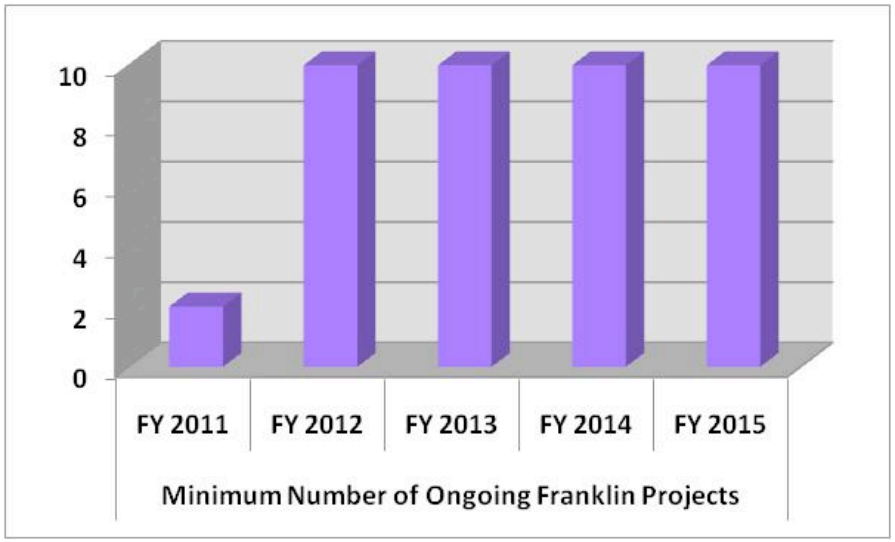
Spacecraft Evolution Usually Starts Large and Gets Larger

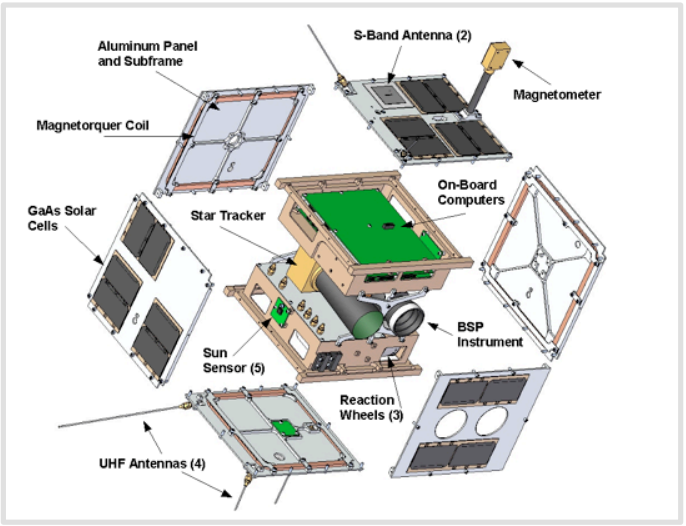


Radically Rethink Design Fundamentals By Starting Small

OCT Small Spacecraft Programs
Franklin Small Satellite Subsystem Technology Program

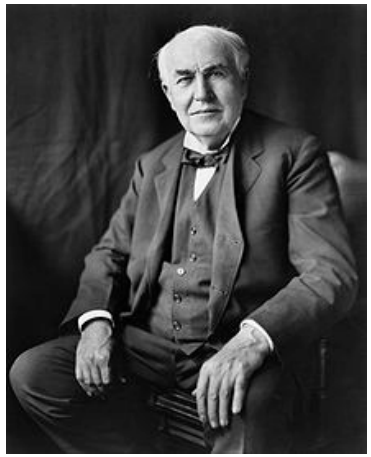
- **Objectives:** The Franklin Program will mature technologies that enable small satellites to provide game changing capabilities for the government and commercial sectors. At completion, the subsystem deliverables should be ready for demonstration in space.
- **TRL Maturation:** From TRL 3-4 to TRL 5-6
- **Solicitation:** Annual BAA. At least 2-8 competitively selected awards.
- **Awards:** One-year base activity with two, one-year options. Estimate $1-3 million per year.
- **Collaboration:** Competitions open to academia, industry, and federal laboratories with partnering strongly encouraged.

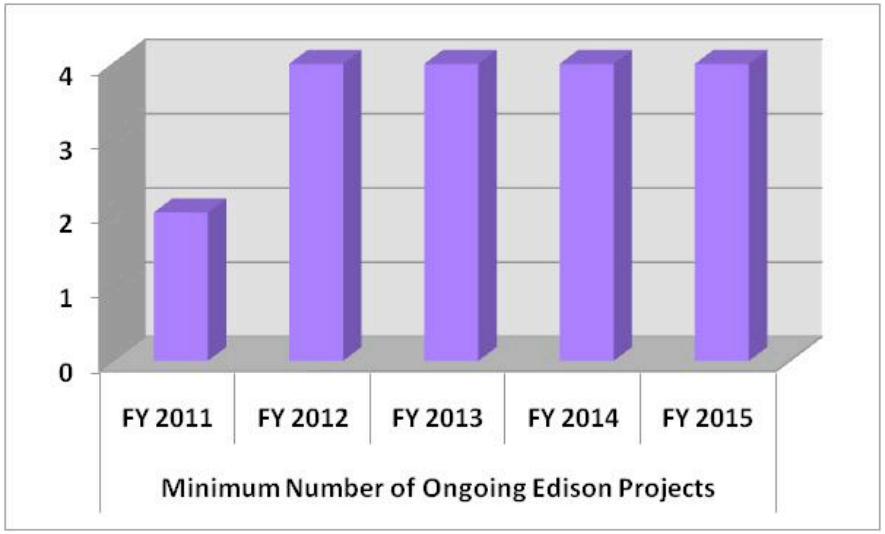


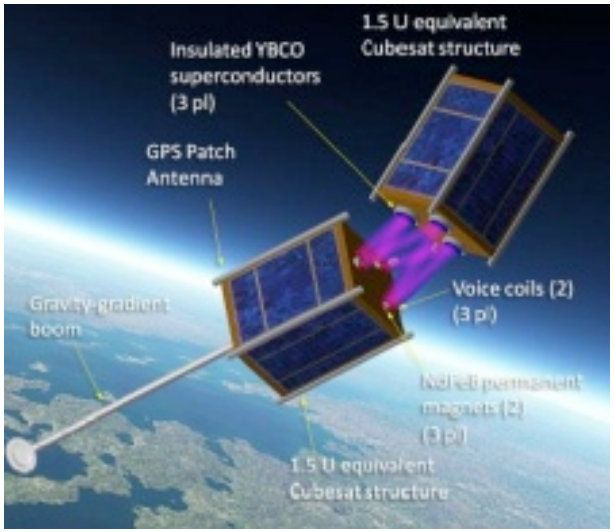


OCT Small Spacecraft Programs
Edison Small Satellite Demonstration Mission Program

- **Objectives:** Develop and operate a series of small satellite technology demonstration missions with game-changing and crosscutting potential for government and commercial sectors. Provide science and educational missions of opportunities as secondary objectives. Improve secondary payload space access.
- **TRL Maturation:** From TRL 5-6 to TRL 6-7
- **Solicitation:** Annual BAA. At least 1-2 competitively selected awards.
- **Awards:** Two years to launch readiness with development and launch gates. Estimate $1-10 million total mission cost range.
- **Collaboration:** Competitions open to academia, industry, and federal laboratories with partnering strongly encouraged.







OCT Small Spacecraft Programs
Joint Management

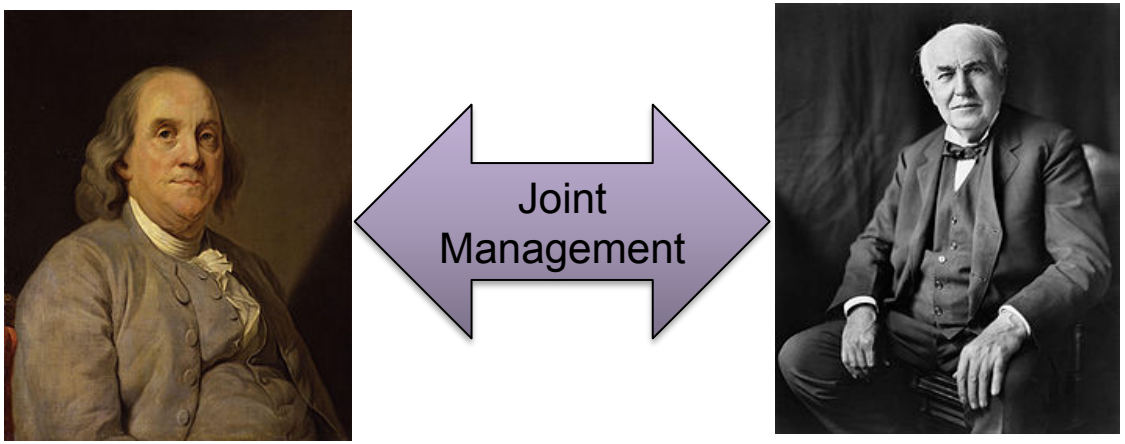
One Joint Program Office for Both Franklin and Edison Programs

- Resides at NASA Ames Research Center
- Firewall with proposing NASA organizations
- Franklin Level II Lead: Kimberly Hines, ARC
- Edison Level II Lead: Bruce Yost, ARC

One Program Executive for Both Franklin and Edison Programs

- Resides in NASA Headquarters Office of the Chief Technologist
- Small Spacecraft Acting PE: Brant Sponberg, HQ OCT

One Annual Solicitation for Both Franklin and Edison Programs



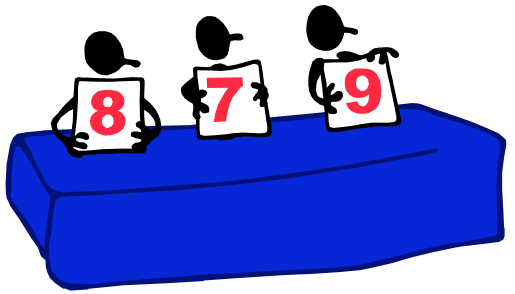
OCT Small Spacecraft Programs
BAA and TAP

Planned Solicitation Is a Broad Agency Announcement (BAA)

- Three Potential Types of Awards
  - Contracts
  - Grants
  - Cooperative Agreements

BAA Process Advised by Technology Assessment Panel (TAP)

- Help define the state-of-the-art in small spacecraft and subsystems
- Help set technology and mission priorities in the BAA
- Provide proposal peer review function
- Avoid duplication of other federal small spacecraft activities
- Membership Will Be ~10 Non-Proposers With Experience From:
  - NASA
  - DOD
  - Academia
  - Industry



OCT Small Spacecraft Programs
Likely Key Evaluation Criteria

Technical Concept

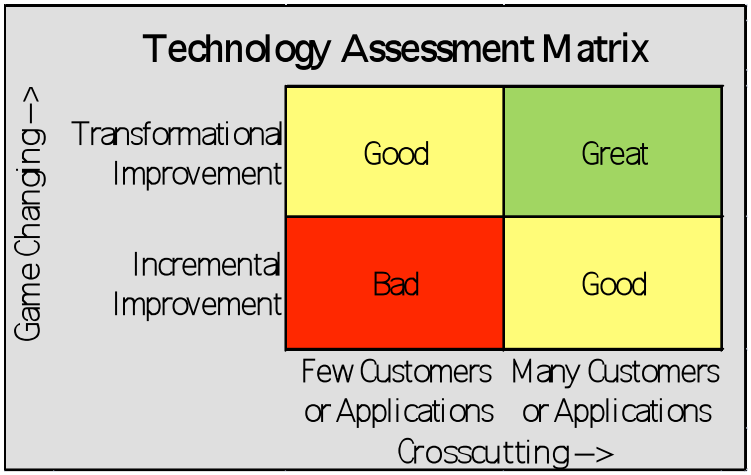
- Game-Changing, Crosscutting or Both
- Relevant TRL and Not Duplicative of Other Efforts

Technical Merit

- Degree of Game-Changing or Crosscutting Potential (or Both)
- Suitability of Approach, Including Criteria for Subsequent Phases and Evaluating Success
- Maturity of Risk Assessment

Project Viability

- SOW
- Proposed Costs
- Key Personnel



Final selection decisions made considering cost, available funding, and the best overall portfolio to meet the program objectives with respect to providing for a broad range of innovative activities and participation

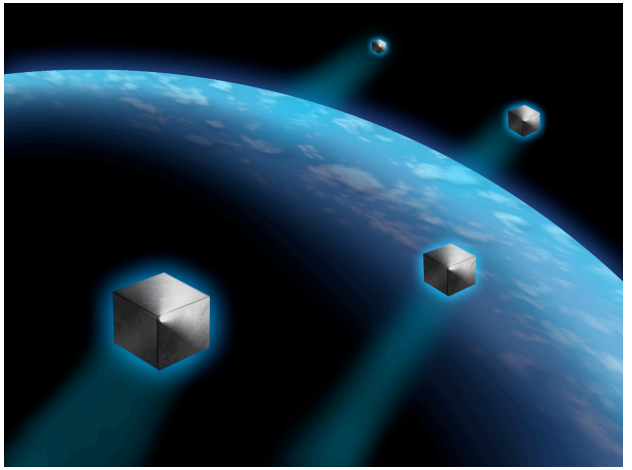
OCT Small Spacecraft Programs
Space Access

Now:

- Government-Furnished Secondary and Hosted Payloads Accommodations
  - BAA will provide orbits, adaptors, and accommodations/interfaces on common Government launches for proposers to design to
  - If selected, mission will be placed in queue for future flight
- Proposer-Furnished Secondary and Hosted Payload Accommodations
  - Can propose own or partner's accommodation

Future:

- Dedicated Small Spacecraft Launch
  - Follow-on launch service procurement to Centennial Challenges Nano-Satellite Launch Challenge or industry developments
- Interplanetary
  - Upper-stage reuse or host spacecraft



OCT Small Spacecraft Programs
Federal, Commercial, Science, and Education Opportunities

Cost Sharing

- Encouraged but not a requirement or selection criterion
- Enables programs to make more awards and develop/demonstrate more technology

Coordinate With, Not Duplicate, Other Federal Small Spacecraft Programs

- USAF ORS, DARPA F6, NSF Cubesats
- Proposals building on funding from other federal programs are welcome

Programs Will Work Flexibilities on Commercially Important Issues

- Intellectual property
- Data rights
- Title to rights and property

Science Opportunities

- Anticipate that scientific investigations will be performed in the course of many Edison demonstrations
- Some Edison missions may also be become platforms for peer-reviewed SMD and ESMD missions of opportunity

Educational Opportunities

- Anticipate hands-on university student involvement in many Edison and Franklin Projects
- Formulating complementary university consortium or institute

OCT Small Spacecraft Programs
Upcoming Events

NASA Town Hall at AIAA Small Satellite Conference

- August 9 in Logan, Utah
- Discussion with small spacecraft community

Draft BAA Release

- Targeting ?
- Seek comments from potential proposers

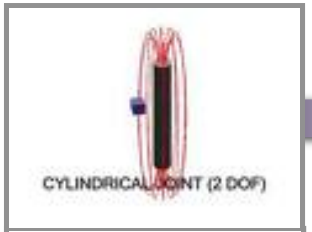
Final BAA Release

- Targeting October 1

OCT Small Spacecraft Programs

Good Things Come in Small Packages

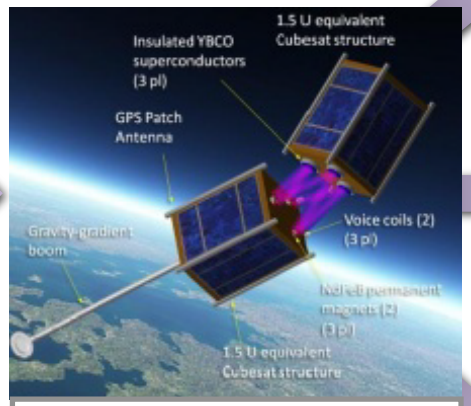
Example: Flux-Pinned Spacecraft



NIAC
NASA Institute for Advanced Concepts

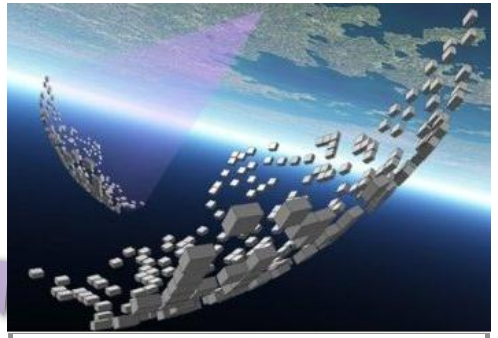
FAST

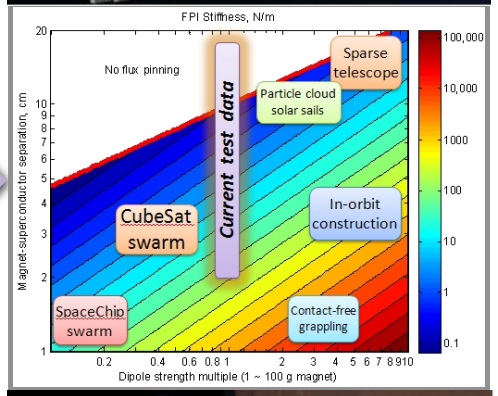
Facilitated Access to the Space Environment for Technology

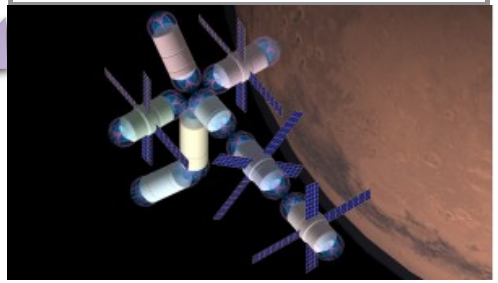


TBD:

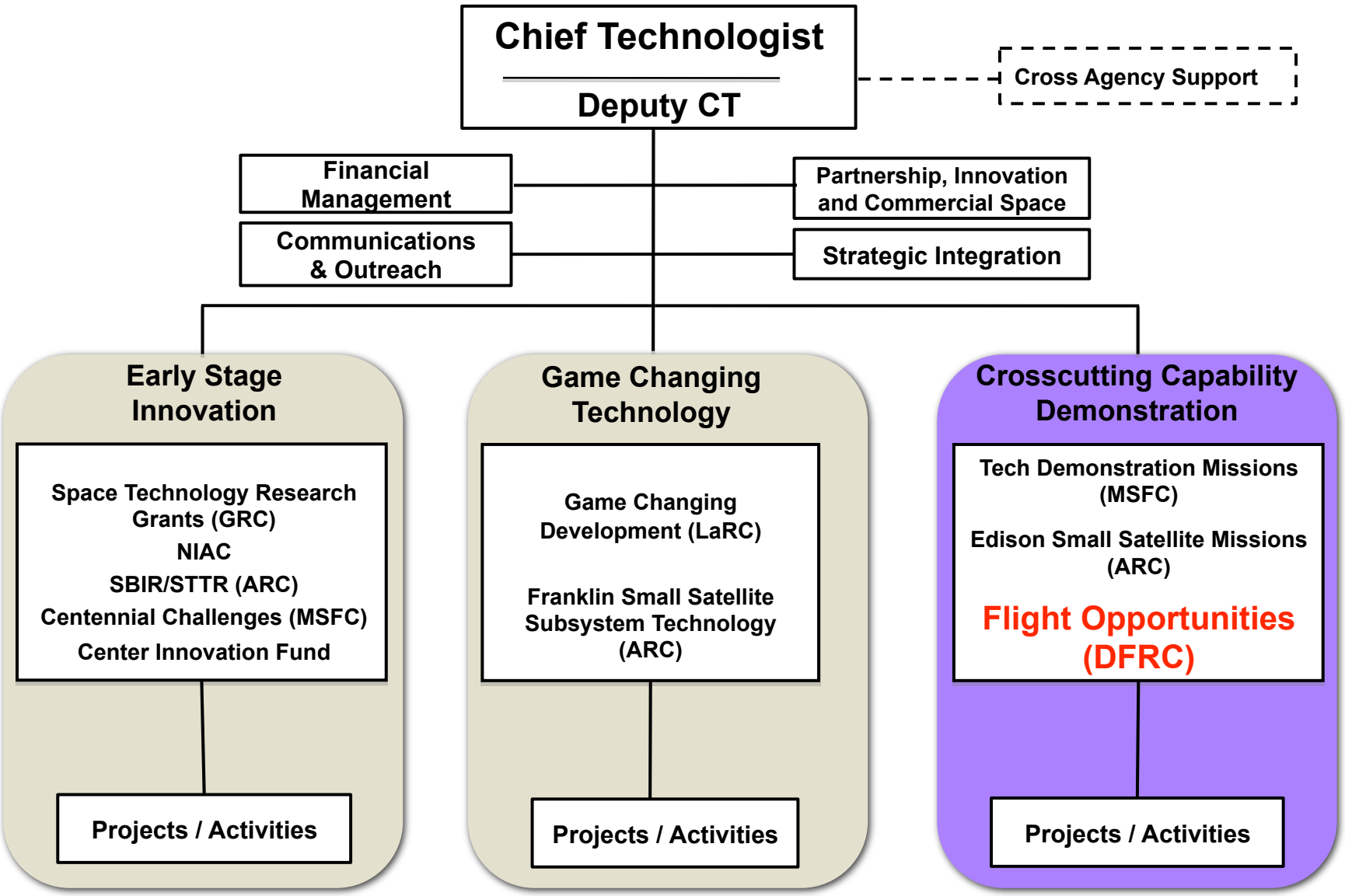
Small Spacecraft Demonstration





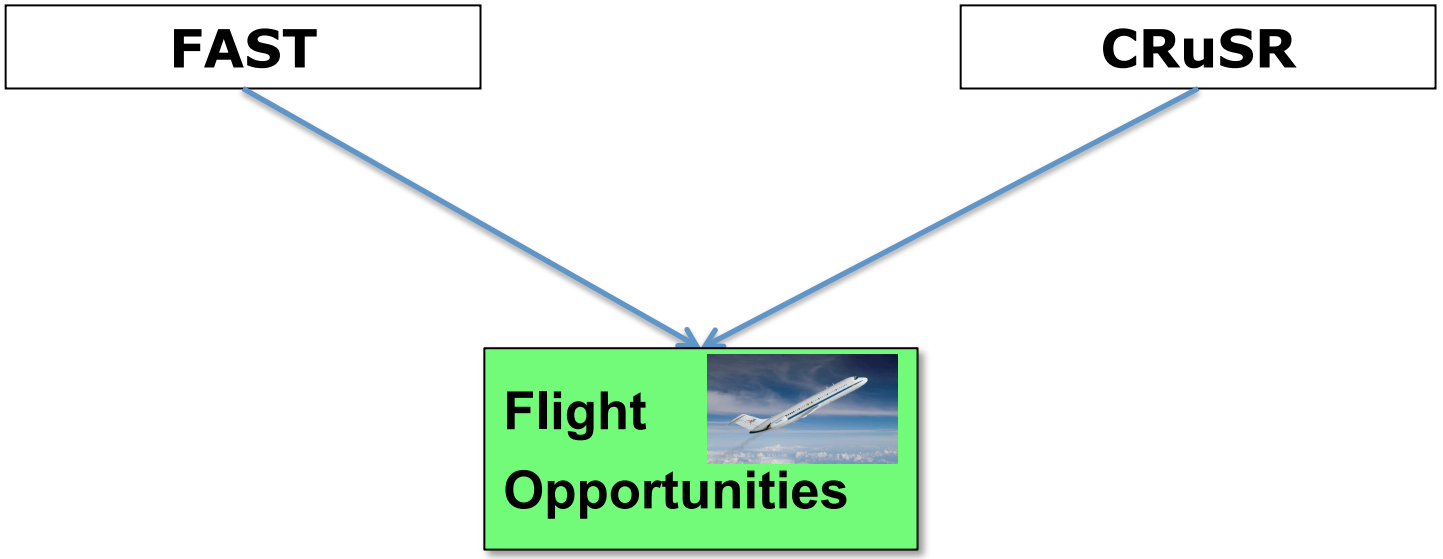


Office of the Chief Technologist Organization



Flight Opportunities - Overview

The Commercial Reusable Suborbital Research (CRuSR) activity and the Facilitated Access to the Space Environment for Technology (FAST) activity will be transitioned into the Flight Opportunities Program within the Office of the Chief Technologist in FY11.



Facilitated Access to the Space Environment for Technology (**FAST**)

Access to 25 sec of microgravity across 40-60 parabolic paths

Past Participants in FAST

- First FAST Flight Week – August 11-12, 2008
  - –Five SBIR projects
- Second FAST flight week - August 11-14, 2009
  - –19 projects – 2 flights with zero-g, 2 flights with lunar-g
    - Seven universities
    - Nine private companies (2 SBIR firms)
    - Five NASA Centers
- Third FAST flight week – September 27-Oct, 2010
  - –17 projects – with zero-g and lunar-g
    - Nine universities
    - Three private companies (1 SBIR firm)
    - Five NASA Centers

See details and updates at:
http://www.nasa.gov/offices/ipp/innovation_incubator/FAST/index

Next Call for Proposals – October 2010

Commercial Reusable Suborbital Research (CRuSR)

Virgin Galactic

Blue Origin

XCOR Aerospace

Armadillo Aerospace

Masten Space Systems

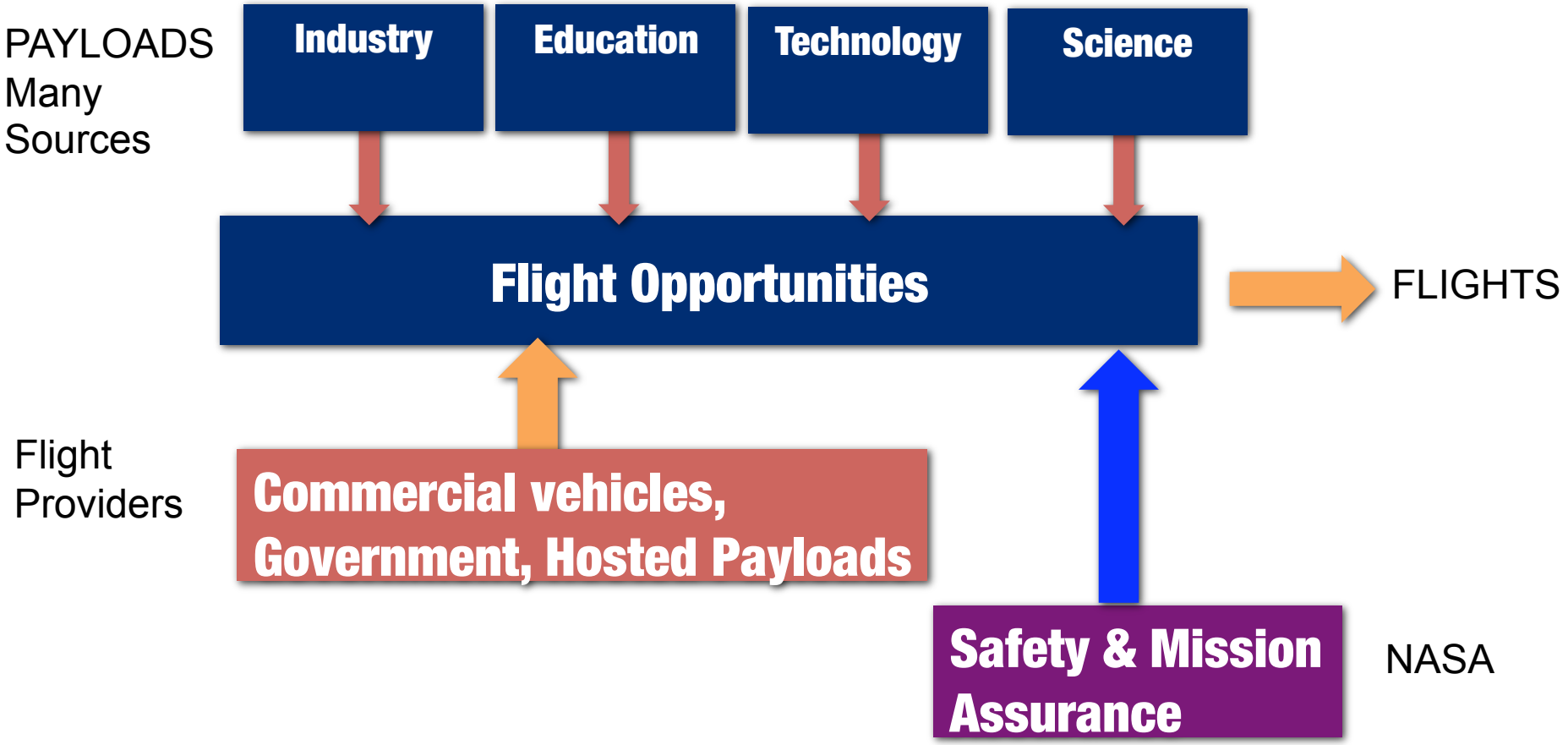
- Many approaches (horizontal & vertical take-off and landing)
- Significant private investment
- Designing for high flight rates & low cost operability
- Microgravity, pressurized, temperature-controlled payload environment

Current CRuSR Activities

- CRuSR to procure space transportation services to provide 3-4 minutes of microgravity environment for tech development, scientific and university research
- RFI released: Suborbital providers submitted technical information about their vehicles
  - http://crusr.arc.nasa.gov/platforms for information on individual providers, including RFI responses
  - http://crusr.arc.nasa.gov/files/CRuSR-SuborbitalPlatformCapabilitiesMatrix.xls for a spreadsheet side-by-side comparison of the different providers
- Released RFQ to procure flight opportunities on early developmental commercial suborbital vehicles. http://suborbitalex.arc.nasa.gov/node/284
- Approx. $300K available for awards (~2-4 awards; Sept 2010 start anticipated)
- Early flights will:
  - Develop standardized processes and procedures
  - Detail interfaces and logistical operations
  - Payloads will include:
    - » Environmental monitors to characterize the vehicle operational flight environment (acceleration, vibrations, quality of microgravity)
    - » An FAA ADS-B payload meant to broadcast position and velocity information to air traffic controllers and other aircraft in real time
    - » Berkeley / SETI payload to improve understanding of the electrostatic behavior of granular materials

RFQ Due Date July 20, 2010

Flight Opportunities - Facilitating Access to the Space Environment



Level II Program Office @ NASA Dryden Flight Research Center
- Working with NASA Ames in payload accommodation

Fly Early – Fly Often – Fly Safely

Opportunities for Commercial Suborbital Flights

- **FY 11:** The Program will competitively procure suborbital flights on commercial vehicles to develop standards (e.g. characterize the payload environment, safety, interfaces, etc.)
  - Approximately $11M available for multiple awards
    - Expect to supplement FY10 RFQ awards
    - Number of awards dependent on readiness level of providers
  - Solicit peer-reviewed science payloads through 2010 SMD ROSES NRA for commercial vehicle flight opportunities
    - http://science.nasa.gov/researchers/sara/grant-solicitations/
  - Solicit technology development payloads through OCT Game Changing Technologies and other sources within OCT

- **FY12:** The Flight Opportunities Program will competitively secure commercial suborbital flight services for technology, science, and education payloads
  - Focus on payloads that reduce risk for use of new technologies in future missions

Participants bring payloads; NASA pays for flight

Opportunities for Parabolic Flights

FY11/FY12

- The parabolic flights will test technologies in a space environment that could simulate microgravity and the reduced gravity environments of the Moon or Mars
- Approximately $2M available for awards:
  - ~4 flight weeks/year
  - Each flight provides 40-60 parabolas; participants typically receive several flights
  - ~15 payloads flown/flight week
  - Next Call for Proposals – October 2010

Participants bring payloads; NASA pays for flight

Office of the Chief Technologist Organization