National Aeronautics and Space Administration

Overview
Strategic Integration Activities

NAC Technology and Innovation Committee Meeting
December 10, 2013
Kennedy Space Center

Mason Peck
Office of the Chief Technologist

Discussion Topics

- Overview – Office of the Chief Technologist
- Updates
- TechPort Data Call
- Strategic Space Technology Investment Plan (SSTIP)
  - Relates to Technology Portfolio
  - SSTIP Development
  - SSTIP Content Overview
  - SSTIP Governance – NASA Technology Executive
- Roadmap Update

NASA - Building Upon Past Excellence….
Creating the Path For the Future

Office of Chief Technologist Strategic Integration

NASA's Office of the Chief Technologist advises the Administrator on strategy for technology and innovation across the entire agency. It tracks and coordinates investments across NASA and serves as a point of entry for contact with other government agencies, academia, and the commercial aerospace community in technology partnerships. It advocates for innovation within the agency and shares NASA's technology developments outside the agency through management of the agency's Tech Transfer function.

- **Technology Strategic Planning, Policy and Requirements** -- develop and implement NASA technology policies to guide NASA technology and innovation activities.
- **Technology Coordination, Councils, and Partnerships --** coordinate technology needs inside NASA; reach outside to encourage partnerships and enable the broad use of NASA technologies; and manage NASA councils to provide decisions that address priorities & gaps, anticipate future needs, and avoid duplication of effort.
- **TechPort Development and Operation** – make information about NASA's technology investments openly available and accessible to NASA and the public via a web based database of NASA-developed technologies.
- **Portfolio Tracking and Analysis** -- track NASA's technology investments, comparing the portfolio against the strategic technology investment plan and work with stakeholders to make appropriate adjustments.

Technology Roadmaps

Strategic Technology Investment Plan

Coordinate external technology portfolios & partnerships

Develop & operate the TechPort and analyze NASA's portfolio

TechPort

Office of Chief Technologist

- OCT provides the strategy, leadership, and coordination that guides NASA's technology transfer and commercialization activities

- OCT is focused on extending the benefits of NASA's technology investments to have a direct and measurable impact on daily life and provide the greatest benefit to the Nation

Companies featured in recent issues of NASA's *Spinoff* report have used NASA technology to:

- Create more than 14,000 jobs
- Save more than 444,000 lives
- Generate more than $5 billion in revenue
- Save $6.2 billion in costs

Active NASA-Patents	1034
Active NASA–Funded Patents (Non-Govt owned)	1132
All time Total Patents	8345
Technologies available for Licensing	831
Recorded Spinoffs	1,800+

What is Technology?

NASA Technology Definition:

A solution that arises from applying the disciplines of engineering science to synthesize a device, process, or subsystem to enable a specific capability.

Government-Wide
Office of Management and Budget Circular No. A-11
Conduct of Research and Development

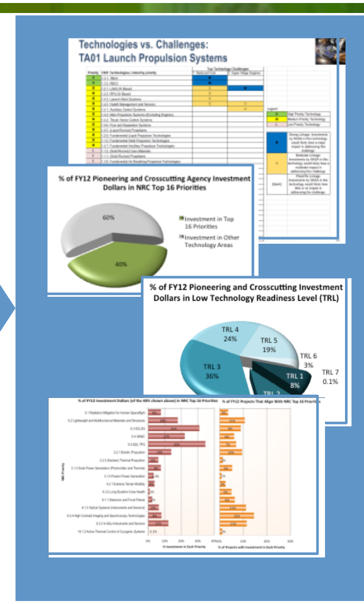
6.1 Basic Research:	A study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products.
6.2 Applied Research:	Systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.
6.3 Development:	Is directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

The Conduct of Research and Development Can be downloaded at: http://www.whitehouse.gov/omb/circulars_a11_current_year_a11_toc

Technology Portfolio

Technology Portfolio Addresses Challenges of Working In Air & Space

Background: Roadmap and Strategic Space Technology Investment Plan (SSTIP)



FY 2010

Space Technology Roadmaps

- *140 challenges (10 per roadmap)*
- *320 technologies*
- *20-year horizon*

- *Revised every 4 years*

FY 2011

National Research Council (NRC) Study

***Prioritization**:*

- *100 top technical challenges*
- *83 high-priority technologies (roadmap-specific)*
- *16 highest of high technologies (looking across all roadmaps)*

- *Requested every 4 years*

FY 2012

SSTIP Development

Updated ST Roadmaps:

- *Incorporate NRC Study Results*

Developing a Strategic Space Technology Investment Plan:

- *current investments*
- *current MD/Office priorities*
- *opportunities for partnership*
- *gaps vs. current budget and capabilities*
- *20-Year horizon with 4-year implementation cadence*
- *Revised every 2 years*

FY 2013

Execution

Investment Portfolio

- *NASA Technology Executive Council Uses SSTIP to Make Decisions*
- *Must accommodate:*
  - *Mission Needs & Commitments*
  - *Push Opportunities*
  - *Affordability*
  - *Technical Progress*
  - *Programmatic Performance*

- *Budgeted annually*

Update of both Technology Roadmaps and Strategic Technology Investment Plan in 2014:

Technology Roadmap Update

Will Consider:
- Updates in Science Decadal Surveys
- Human Exploration Capability Work
- Advancements In Technology

Will Include:
- State-of-Art
- Technology Challenges
- Capability Needs
- Performance Goals

Expanded Scope
- ✓ Aeronautics Technology
- ✓ Information Technology
- ✓ Radiation
- ✓ Space Weather
- ✓ Avionics
- ✓ Orbital Debris

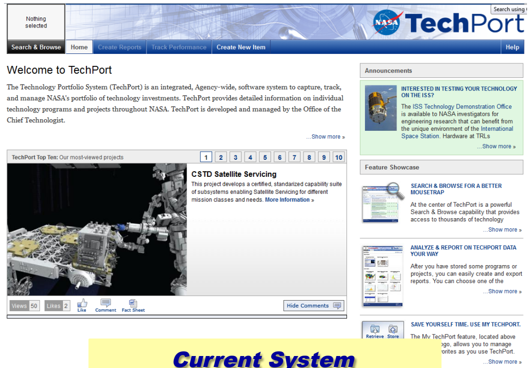
TA01 • LAUNCH PROPULSION SYSTEMS
TA02 • IN-SPACE PROPULSION TECHNOLOGIES
TA03 • SPACE POWER & ENERGY STORAGE
TA04 • ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS
TA05 • COMMUNICATION & NAVIGATION
TA06 • HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS
TA07 • HUMAN EXPLORATION DESTINATION SYSTEMS
TA08 • SCIENCE INSTRUMENTS, OBSERVATORIES & SENSOR SYSTEMS
TA09 • ENTRY, DESCENT & LANDING SYSTEMS
TA10 • NANOTECHNOLOGY
TA11 • MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING
TA12 • MATERIALS, STRUCTURAL, MECHANICAL SYSTEMS & MANUFACTURING
TA13 • GROUND & LAUNCH SYSTEMS PROCESSING
TA14 • THERMAL MANAGEMENT SYSTEMS

Strategic Technology Investment Plan Update

Will Consider:
- ➢ New Priorities
- ➢ Current Investments
- ➢ Unmet Needs
- ➢ Partnerships & More

Expanded Scope:
- ✓ Aeronautics Technology
- ✓ Information Technology
- ✓ Other Technologies as influenced by other roadmap updates

TechPort Overview



Current System
On Line Since Oct 1, 2012

Public User Interface
~Late January, 2014

- Supports Technology Portfolio Tracking, Analysis, and Optimization
- Enables Transparency to Public: Open Data (EO) and Release of Federally Funded R&D (OSTP Memo)

FY2013 Examples of Agency Data Uses:

Roadmap Update - Portfolio Analysis in support of Roadmap updates (e.g., determines current investments to show where we are on the path to capability development)

STIP - Portfolio Analysis in support of the update of the Strategic Technology Investment Plan

NTEC studies and decisions

External Response to Questions (e.g., gain detail and POC that can be used to answer questions from news media, hill, or other external stakeholders)

Partnerships - Identification of specific technologies of interest identified by potential partners (e.g., Other Government Agencies, commercial, and international partners)

Return on Investment – Comparison of TA with types of benefits and quantity of realized benefits (used as one of the sources of data in a recent HQ study on ROI).

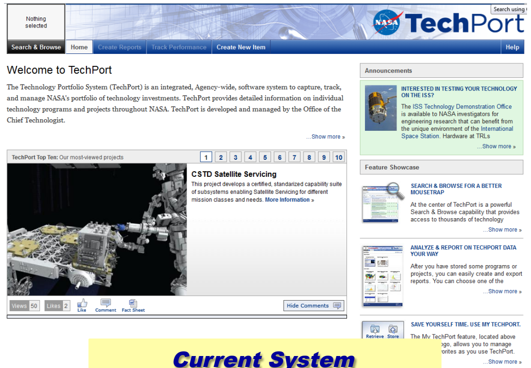
Supports initial data calls for Agency technology **audits** (e.g., GAO audit)
Creation of **BPR charts** (TDM)

Verification during proposal review that selection of a project does not result in duplicate funding
OIC support (e.g., TCAT support. CIO study, etc.)

Most Recent Requests
**OCFO AFR – Requested a list of projects that supported National technology priorities
**OCE Software Working group requested a list of software projects for annual PPMD review

Public Release
Per signed plan in SSTIP (as requested by WH advisor during review)
Compliance with Open Data Initiative and Release of Federally Funded R&D

TechPort Overview



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TechPort Data Request

TechPort Data Request – Begins January 2014

- Add missing projects (ARMD, SMD, HRP, Recent New Starts, etc) – All 6.2 and 6.3
- Update existing records and add missing data elements necessary for STIP/Roadmap analysis
- Verify public section is ready for release
- Enable understanding of Information Technology (IT) Portfolio for STIP and Roadmap work
- Facilitate OCFO request for SOAR (Tracking National Technology Priorities)
- Support Technical Capability Analysis Team (TCAT)

Strategic Space Technology Investment Plan (SSTIP)

- NASA is moving forward with prioritized technology investments that will support NASA's exploration and science missions, while benefiting other Government agencies and the U.S. aerospace enterprise.

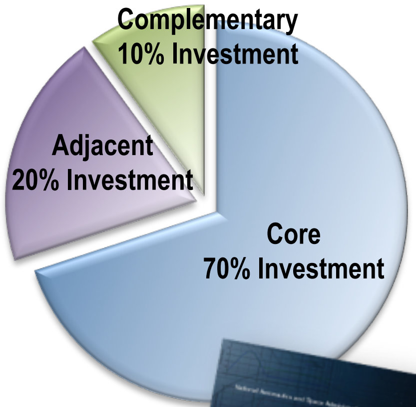
- The plan provides the guidance for NASA's space technology investments during the next four years, within the context of a 20-year horizon.

- This plan will help ensure that NASA develops technologies that enable its 4 goals to:
  - sustain and extend human activities in space,
  - explore the structure, origin, and evolution of the solar system, and search for life past and present,
  - expand our understanding of the Earth and the universe and have a direct and measurable impact on how we work and live, and
  - energize domestic space enterprise and extend benefits of space for the Nation.

"Sparking the imagination and creativity of our people, unleashing new discoveries—that's what America does better than any other country on Earth. That's what we do. We need you to seek breakthroughs and new technologies that we can't even imagine yet." -President Obama.

Strategic Technology Investment Plan: Overview

- **4-year Investment Approach**
  - ➢ Three levels of investment
    - Core (70%)
    - Adjacent (20%)
    - Complementary (10%)
  - ➢ Together these investments:
    - Span the four goals
    - Include pioneering, crosscutting and mission specific technology development
    - Guide future technology expenditures
    - Rapidly produce critical capabilities
    - Seed future innovation
- **Governance**: NASA Technology Executive Council (NTEC)
- **Principles of Investment and Execution**



SSTIP found at: http://www.nasa.gov/pdf/726166main_SSTIP_02_06_13_FINAL_hires=TAGGED.pdf

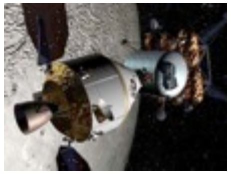
Strategic Technology Investment Plan (STIP) Update

Strategic Technology Investment Plan: Core Technology Investments

- Core technologies represent 8 focus areas of technology investment that are indispensable for NASA's present and planned future missions
- Core technologies are the central focus of technology investment and will comprise approximately 70% of the Agency's technology investment of the next 4 years (★= highest investments now)

Launch and In-space Propulsion ★

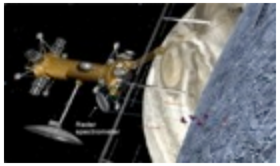
Environmental Control and Life Support Systems



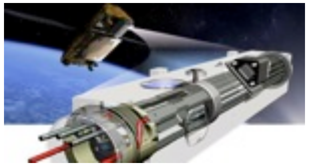
High Data-Rate Communications

Space Radiation

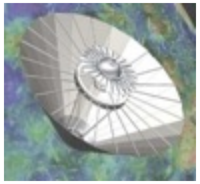
Lightweight Space Structures and Materials



Scientific Instruments and Sensors ★



Robotics and Autonomous Systems ★



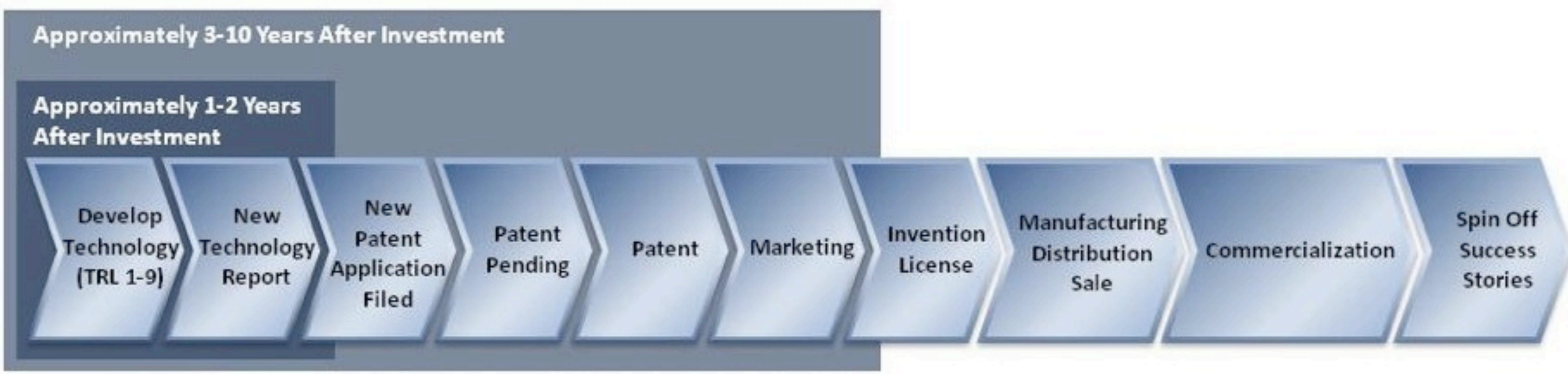
Entry, Descent, and Landing ★

SSTIP Overview
Principles of Investment and Execution

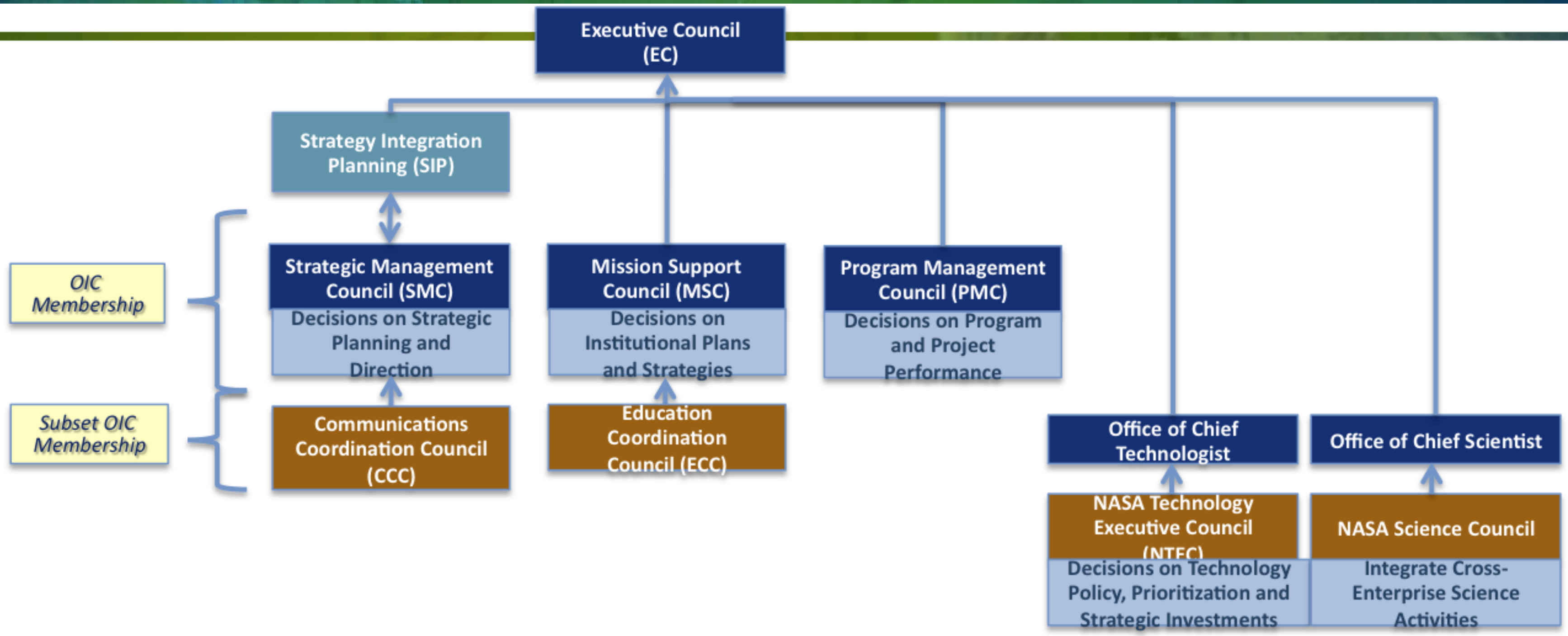
Principles optimize investments, maintain a balanced portfolio, use developed technologies, and provide transparency to the American public

<u>Principles Guide Future Portfolio Investment and Execution</u>

- Achieve the agreed upon balance among investments:
    - Across all 14 Space Technology Areas in the Roadmaps
    - Across all levels of technology readiness
- Ensure developed technologies are infused into Agency missions
- Develop technologies through partnerships and ensure developed technologies are infused throughout the domestic enterprise
- Use a systems engineering approach when planning technology investments
- Reach out to the public and share information about its technology investments



NASA Technology Executive Council in Council Hierarchy



PURPOSE.
The NASA Technology Executive Council (NTEC) serves as the Agency's senior decision-making body for technology policy, prioritization, and strategic investments. The NTEC determines NASA's overarching portfolio content and ensures Agency progress toward achieving NASA's Vision.

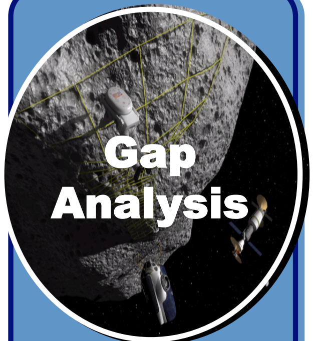
The NTEC will work together to align the Agency's technology investments with the current priorities, new mission needs, and partnership opportunities, taking full advantage of leveraged resources adopting an Agency-level perspective to provide ensure that needed capabilities are developed.

MEMBERSHIP
Chair: Chief Technologist
Members:
Assoc. Admin- Aeronautics Research Mission Directorate (ARMD)
Assoc. Admin- Human Exploration & Operation Mission Directorate (HEOMD)
Assoc. Admin- Space Technology Mission Directorate (STMD)
Assoc. Admin- Science Mission Directorate (SMD)
Chief Engineer
Chief Health and Medical Officer
Chief Scientist

Strategic Technology Investment Plan FY2014 Development Process

Collect Information:

State-of-the-Art
NASA's Current Investments
National Policy and Priorities
NASA MD/Office Needs/Priorities
Other Government Partnership Priorities
Commercial Sector Partnership Priorities
International Partnership Priorities



Identify Unmet Capability Needs

Compare
State-of-the-Art with Capability Needs

Compare
Current Investment with Capability Needs Policy and Priorities

Identify gaps where there is no SOA or Investment

Establish Criteria To Rank Unmet Needs

Consider the following:

All Priorities

Crosscutting Needs

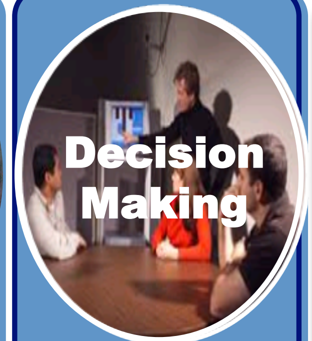
Potential Partnerships

Benefits

Capabilities & Facilities

Use Criteria to Rank Unmet Needs

Prioritize Technologies That Address Unmet Capability Needs



Establish Strategy for Core, Adjacent and Complementary

Specific Goals
Top Capability Objectives
Technology Challenges
Investment Approach

NASA Technology Executive Council Approval

Conduct Reviews

MD/Center Review

NAC Review

LRM Review

A-Suite Review

Final Report

STIP Development Process Completed Activities

Pre- Planning Activities	Comment	Date
Discuss STIP Update With External Stakeholders	✓ Satellite Industry Association (SIA) ✓ Commercial Space Federation (CSF) ✓ Aeronautical Industry Association (AIA) ✓ International Partners (ISECG), ESA, EU, ISAS/JAXA	May-July 2013
Gathered Recommendations From Internal and External Stakeholders	Portfolio Analysis Technical Interchange Meeting (Representatives From 11 Government Agencies, Industry, NASA Centers, Mission Directorates)	June 2013
Discuss STIP Update With CTC	Provide overview briefing at CTC Face-To-Face	July 2013
Discuss update with NTEC	**Provide overview briefing**	**Sept 18, 2013**
Briefing with Associate Administrator		Nov 2013

STIP Development Process
FY2014 Schedule

Activity	Date
Kickoff Meetings	Jan
Data Collection Activities	Jan - March
Gap Analysis Activities	March - June
Ranking and Decision Making	May - July
Reviews	Aug - Dec
Final Concurrence on Update	Feb 2015

Technology Roadmaps

2010 Roadmaps

NASA Teams generated 14 Technical Area Roadmaps That Provided the Foundation for the Space Technology Investment Plan

Excellent products developed by some of NASA's most talented professionals.

<u>We are not starting over!</u>

<u>We are enhancing the existing roadmaps</u> to be responsive to:

- changing needs and priorities
- advances in technology development
- Needed improvements that will increase the utility and ease of use by NASA and our external stakeholders.

2012 Roadmap

Needed Improvements

- Address Missing Technical Areas (TAs) & Associated Technologies
- Inclusion of New Science Decadals
- Inclusion of HEOMD Capability Driven Framework (architecture and capability studies)
- Reduce of duplication and provide consistent types of data
- Some TAs Lack A Real Starting Point – Start with State of Art (SOA)
- Vague – Some TAs Lack a Real Ending Point (e.g., more reliable)
  What's the goal? When will you reach goal and do something else? - Add Capability Goals
- Different End Dates (18, 20, 25 years) – Provide a Consistent 20 Year Horizon
- Unreadable Graphics – Improve Graphics Legibility
- Standardization in Definitions, Symbols, Format or Type of Content
- Internal: Insufficient Opportunity to Participate In Reviews

Space Technology Roadmap
14 Technical Areas + Additional Areas

TA01

- LAUNCH PROPULSION SYSTEMS

TA02

- IN-SPACE PROPULSION TECHNOLOGIES

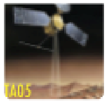
TA03

- SPACE POWER & ENERGY STORAGE

TA04

- ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS

Autonomous Systems & AI Enhancements

TA05

- COMMUNICATION & NAVIGATION

Avionics Tech Enhancements

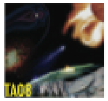
Radiation Tech Enhancements

TA06

- HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS

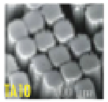
TA07

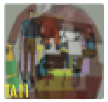
- HUMAN EXPLORATION DESTINATION SYSTEMS

TA08

- SCIENCE INSTRUMENTS, OBSERVATORIES & SENSOR SYSTEMS

TA09

- ENTRY, DESCENT & LANDING SYSTEMS

TA10

- NANOTECHNOLOGY

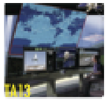
TA11

- MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING

Information Technology Section Expanded

Include NITRD and more

TA12

- MATERIALS, STRUCTURES, MECHANICAL SYSTEMS & MANUFACTURING

TA13

- GROUND & LAUNCH SYSTEMS PROCESSING

TA14

- THERMAL MANAGEMENT SYSTEMS

Space Weather Tech

TA15


AERONAUTICS

Roadmap Update Will Incorporate New Science Decadal Surveys

- NASA relies on the science community to identify and prioritize leading-edge scientific questions and the observations required to answer them. One principal means by which NASA's Science Mission Directorate engages the science community in this task is through the National Research Council (NRC).

2013 – Visions and Voyages for Planetary Science*

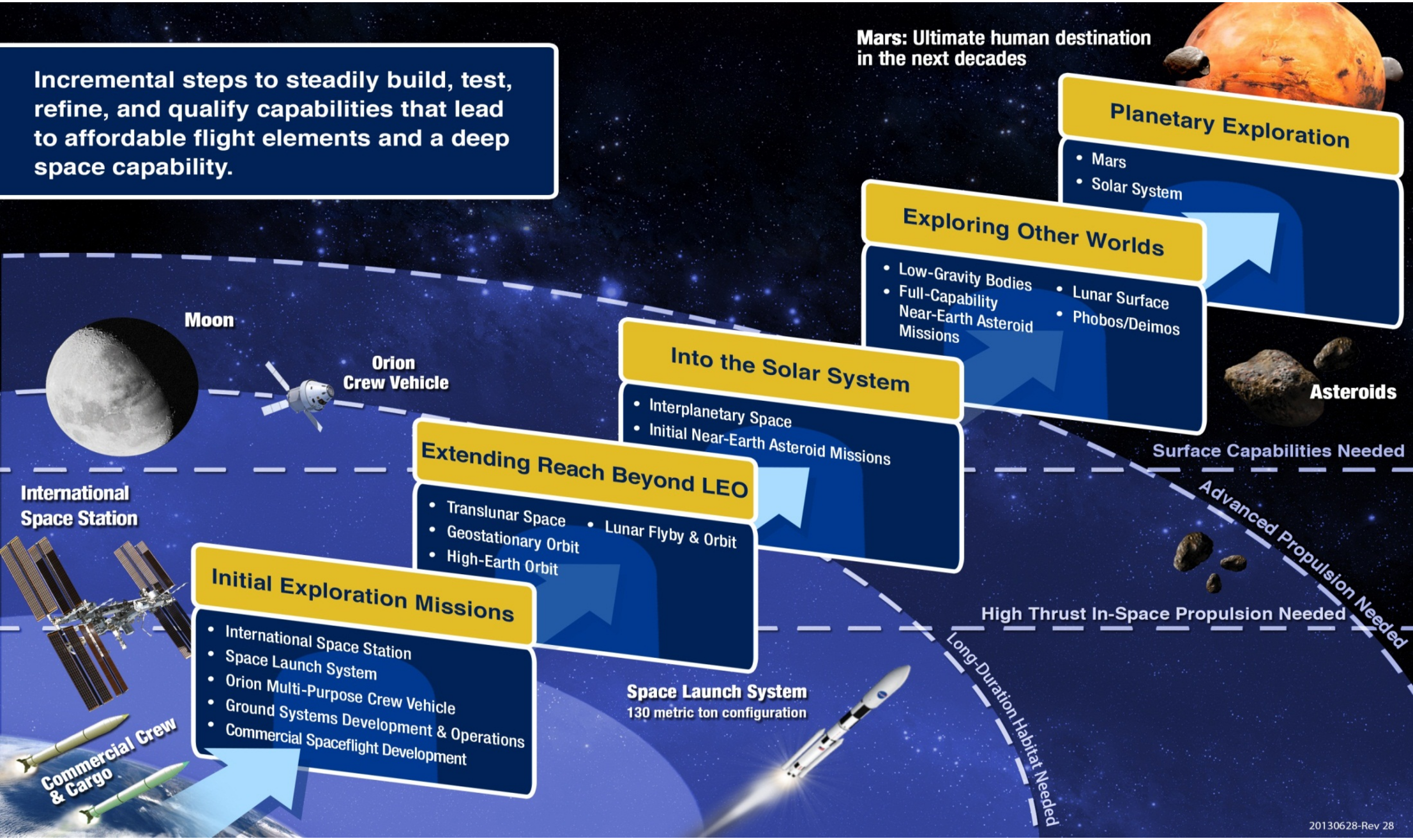
2012 – Solar and Space Physics: A Science for a Technological Society*

2010 – New Worlds, New Horizons in Astronomy and Astrophysics*

2007 – Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond

* **3 of the Decadal surveys are new and can influence the Technology Roadmap updates**

Roadmap Update Will Incorporate Capability Driving Framework



Roadmap Data Tables
To Address Inconsistent Data

		State of the Art		Performance Goal				Design Reference Mission				
Technology	Description of Capability	Parameter; Value	Technology Readiness Level	Parameter; Value	Technology Readiness Level	Gap	Technology Challenge	Proposed Start Date	Need Date	Design Reference Mission	Mission Source	Mission Class
Near Infrared and Thermal Infrared Radiometer Detectors (TA8.1.1)	Near-Infrared Radiometer is an optical sensor for measuring surface reflectance in 3 visible bands and 1 near-infrared band.	Pixel Array; 2k x 2k	3	Pixel Array; 4k x 4k	6	2x	Technologies need to be developed to lower operating temperatures.	2011	2014	Exploration Missions 1-4 (Pull)	Earth Science Decadal, page x	Exploring other Worlds
Ultraviolet and Infrared Charge Coupled Device Arrays (TA8.1.1)	Charge coupled devices are used for the movement of electrical charges in digital imaging.	Pixel Array; 4k x 4k	4	Pixel Array; 10k x 10k	5	2.5x	Technology challenges include an order-of-magnitude increase in sensitivity of the arrays.	2011	2014	Exploration Missions 1-4 (Pull)	Astro. Decadal, page x	Exploring other Worlds
Resistojets (TA2.2.1)	Resistojets use an electrically heated element in contact with the propellant to increase the enthalpy prior to expansion through a nozzle.	Thruster Size; TBD Power; TBD	9	Thruster Size; Micro-fabrication Power; TBD	3	TBD	Scaling technology to much smaller sizes and power levels.	2013	2020	DRM 5: Mars (Push)	Planetary Decadal, page 10	Planetary Exploration
Ion Thrusters (TA2.2.1)	Ion thrusters are a form of electric propulsion that creates thrust by accelerating ions.	NEXT Ion Thruster; 7.2 kW	6	High Power Ion Thruster; 20 to 30 kw	4	3.5x	Scaling to high-power and achieving sufficient lifetime are central challenges.	2014	2030	DRM 5: Mars (Push)	Planetary Decadal, page 12	Planetary Exploration

Text in Blue comes directly from the associated roadmap.
Text in Black is an EXAMPLE of how this field could be completed.

Roadmap Development
Comparison Architecture to Capability Driven

Content Development

2010 Roadmap Development Process

1. Design Reference Missions
2. Architectures
3. Mission Directorate Priorities
4. 14 Technical Areas
5. Technical Challenges
6. Potential Technologies / Paths (Roadmaps)

2014 Roadmap Development Process — Mission Directorates - Decadals

1. Mission Class (Aero Thrust Area) ★
2. Design Reference Missions (Type)
3. Capability
4. Function
5. Parameter
6. Performance Goal ★
7. State of Art (SOA) ★
8. Performance Gap ★
9. Technical Challenges
10. Potential Technologies/ Paths (Roadmaps)

★ = New Content For Some or All of TAs

Capability Driven Helps Align Priorities

Mission Directorates - Decadals

2014 Roadmap Development Process

Technology Roadmap & Prioritization

1. Mission Class
2. Design Reference Missions (Type)
3. Capability
4. Function
5. Parameter
6. Performance Goal
7. State of Art (SOA)
8. Performance Gap
9. Technical Challenges
10. Potential Technologies/ Paths (Roadmaps)
11. Current Investments
12. Unmet Needs (Investment Gap)
13. Stakeholder Priorities / Possible Partnerships
14. NASA Priorities

Extending Reach Beyond LEO

Crewed Mission to Surface

Entry, Descent and Landing

Perform Entry

Entry Location and Velocity

Earth; 10.99 km/s; Mars, 14 km/s

Process to Select Roadmap Chairs and Members

Broad participation in process to select the best experts from across the Agency

DATE	ACTIVITY
July 16, 2013	Centers' Input/Votes Requested – Worked by Chief Technologists
September 8, 2013	OCT Center Input
September 9, 2013	Mission Directorates and Offices Input/Votes Requested
October 25, 2013	OCT Reviewed Compiled Votes and Identified Candidates
October 25-Nov 4, 2013	OCT Requests Concurrence on TA Chairs from MDs/Offices
November 5-11, 2013	AA Review Draft Candidates
November 18, 2013	OIC Concurrence on Roadmap Teams (Waiting for AA Input)
November 25, 2013	OCT compiles results and prepares announcement of new teams
January 14-15, 2014	Roadmap Kick-Off Meeting

Roadmap Update
Completed Activities

Pre- Planning Activities	Comment	Date
Discuss Update Plans With External Stakeholders	✓ Satellite Industry Association (SIA) ✓ Commercial Space Federation (CSF) ✓ Aeronautical Industry Association (AIA) ✓ International Partners (ISECG), ESA, EU, ISAS/ JAXA	May-July 2013
Gathered Recommendations From Internal and External Stakeholders	Portfolio Analysis Technical Interchange Meeting (Representatives From 11 Government Agencies, Industry, NASA Centers, Mission Directorates)	June 2013
Discuss with NRC	Requested 3 review options	June- July 2013
HEOMD Kick Off – Technology Maturation	Feeds into Updated Roadmaps	June 2013
Discuss Update With CTC	Provide overview briefing at CTC Face-To-Face	July 2013
Reformatting Roadmaps to Draft Template	20 Years, standard organization, standard tables, capability driven	July-Sept 2013
Gather Recommendations From CTC	Recommendations about Process, Content, Teams, and Kick Off meeting	Aug 2013
Selected Candidates	Obtained Candidates to Serve as Chairs and Members from Centers, Mission Directorates, and Offices.	Aug – Nov 2013

Roadmap Update Schedule

Activity	Date
Kick Off Meeting	January 2014
Complete Drafts	July 2014
Center Review of Draft Roadmaps	August 2014
Disposition Comments	Sept 2014
Headquarters Review	Oct 2014
Finalize Roadmaps	Dec 2014
Provide to Independent Review Organization	Dec 30, 2014

Strategic Technology Investment Plan: Impact to NASA's Future

- Using TechPort and other tools, NASA conducts comprehensive data analysis enables understanding of the current technology portfolio – **New Data Call starts in Jan 2014**
- Roadmap Teams Selected. **Kickoff – Jan 2014**.
- The Strategic Technology Investment Plan provides guidance on NASA's space technology investments – **To be updated in FY2014**
- NASA Technology Executive Council uses the Strategic Technology Investment Plan to make integrated Agency-level decisions - **Quarterly**
- NASA Implements actions that strengthen NASA's position for the future

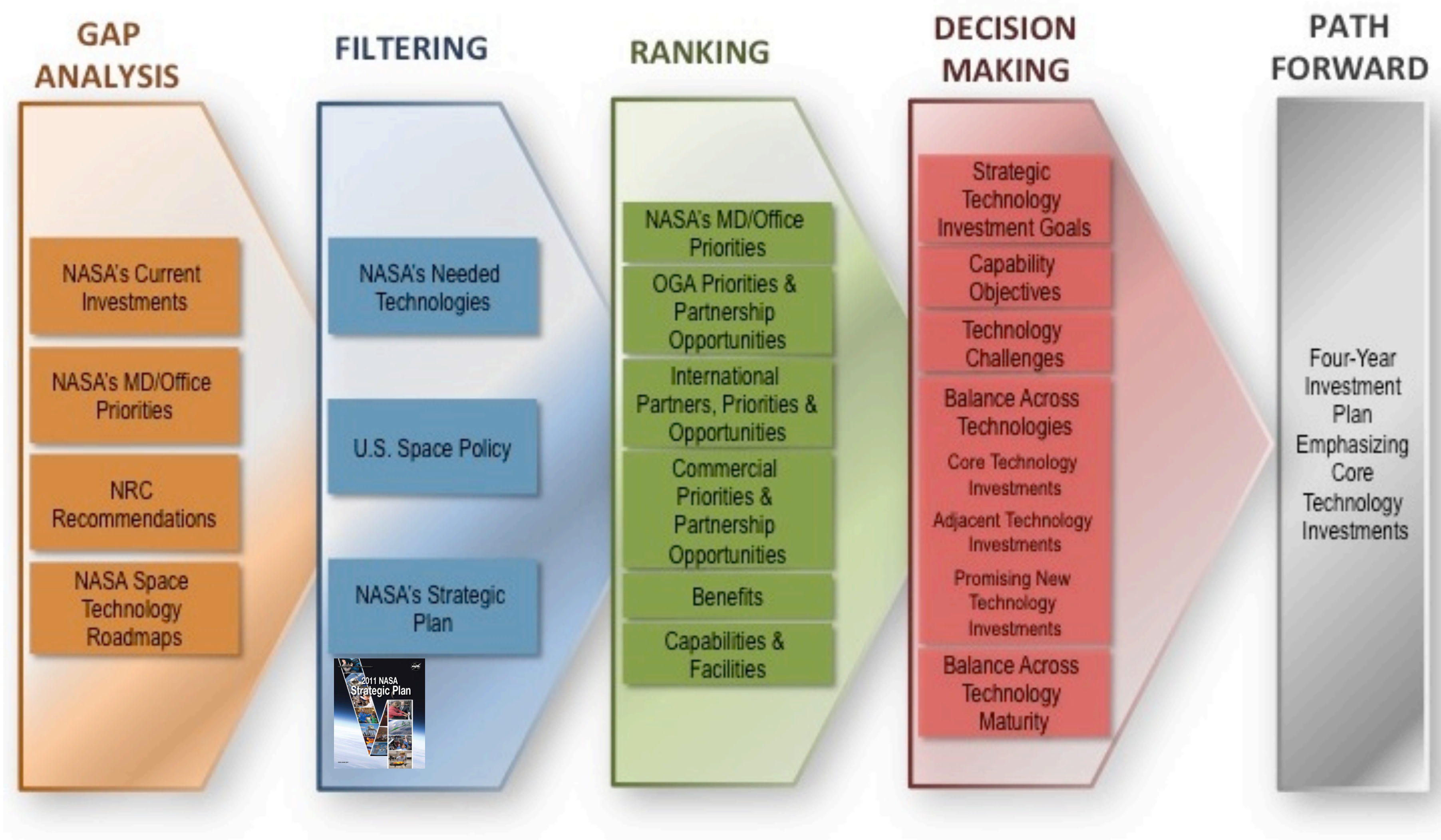
➢ <u>Optimizes technology investments to maximize technological breakthroughs</u>:
  - ➢ Provides depth in key focus areas (core) - launch concepts, in-space propulsion, life seeking missions
  - ➢ Ensures breadth across far-term technology areas (adjacent and complementary)
  - ➢ Increases strategic cooperation with other government agencies
  - ➢ Builds stronger ties across industry (consider their priorities & develop crosscutting capabilities)

> "Scientists discover the world that exists;
> Engineers create the world that never was."
> Theodore von Karman

Back Up

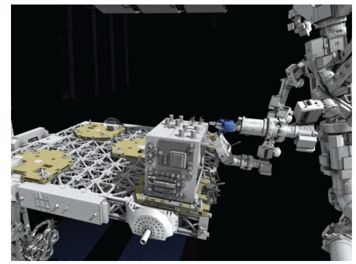
Strategic Technology Investment Plan (STIP) Update

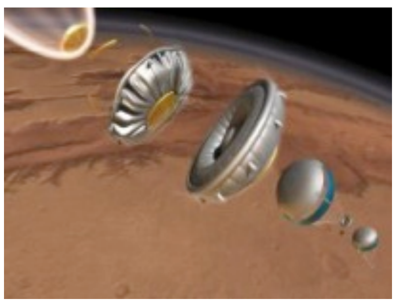
Change From 2012 SSTIP Development Process



Goal 1: Extend and Sustain Human Presence and Activities in Space

Autonomous systems such as satellite servicing will advance technologies to achieve improved spacecraft system reliability and performance.





Transportation to planetary bodies will be enabled through entry, descent, and landing (EDL) technologies, such as low density supersonic decelerators.

Every human space mission requires a thorough radiation mitigation plan, using a wide variety of technologies and systems.

GOAL: EXTEND AND SUSTAIN HUMAN PRESENCE AND ACTIVITIES IN SPACE

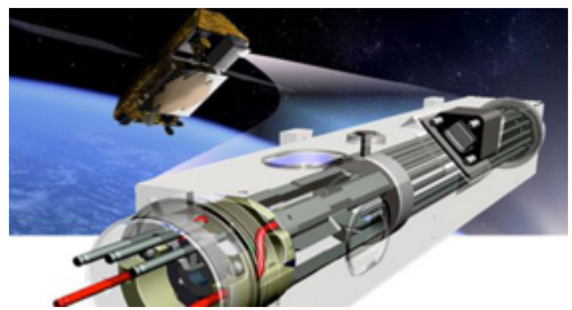
CAPABILITY OBJECTIVES

1. Achieve improved spacecraft system reliability and performance
2. Enable transportation to, from, and on planetary bodies
3. Sustain human health and performance
4. Enable payload delivery and human exploration of destinations and planetary bodies

Goal 2: Explore the Structure, Origin, and Evolution of the Solar System, and Search for Life Past and Present

Exploring the solar system will require high-bandwidth communications to improve spacecraft performance. The Mars Science Laboratory will use high-bandwidth communication technologies as it searches for life past and present.

Deep space atomic clock technologies are necessary for efficient and accurate navigation and enable transportation to and from planetary bodies.



Autonomous robotic technologies allow for maneuvering and manipulation of samples on planetary surfaces, enabling in-situ measurement and exploration.

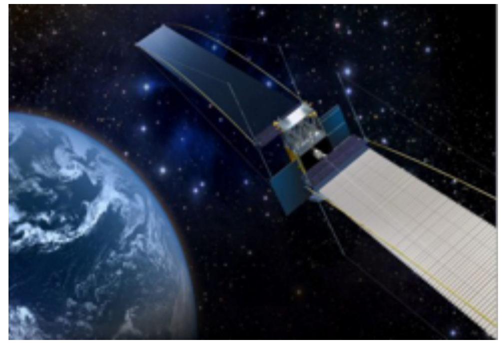
GOAL: EXPLORE THE STRUCTURE, ORIGIN, AND EVOLUTION OF THE SOLAR SYSTEM, AND SEARCH FOR LIFE PAST AND PRESENT

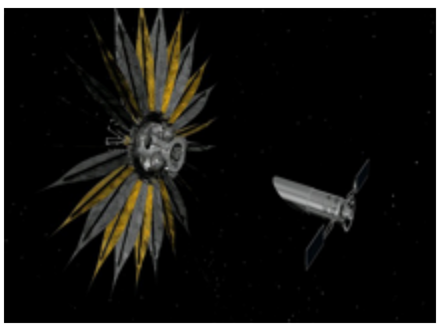
CAPABILITY OBJECTIVES

1. Achieve improved spacecraft system reliability and performance
2. Enable transportation to, from, and on planetary bodies
3. Enable advanced in-situ measurement and exploration

Goal 3: Expand Understanding of the Earth and the Universe (Remote Measurements)

Technologies such as those being advanced for solar electric in-space propulsion will help enable space transportation.





New techniques for using scientific instruments and sensors, like telescopes with a starshade, will enable future space-based observations.

Efficient computing and data management will be enabled by technologies for improving flight computers, such as low-power flight computers for cubesats.

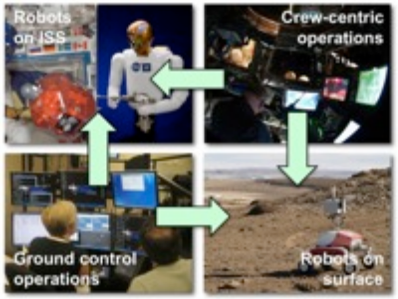
GOAL: EXPAND UNDERSTANDING OF THE EARTH AND THE UNIVERSE (REMOTE MEASUREMENTS)

CAPABILITY OBJECTIVES

1. Achieve improved spacecraft system reliability and performance
2. Enable transportation to space
3. Enable space-based and earth-based observation and analysis
4. Enable large-volume, efficient flight and ground computing and data management

Goal 4: Energize Domestic Space Enterprise and Extend Benefits of Space for the Nation

Technologies for hazard detection and avoidance enable descent and landing on Earth and other planetary bodies.



Advancements in robotic and autonomous technologies will support future on-orbit assembly activities

Autonomous mission operations require high data rates. Technologies to improve computing will extend benefits to domestic space enterprises.

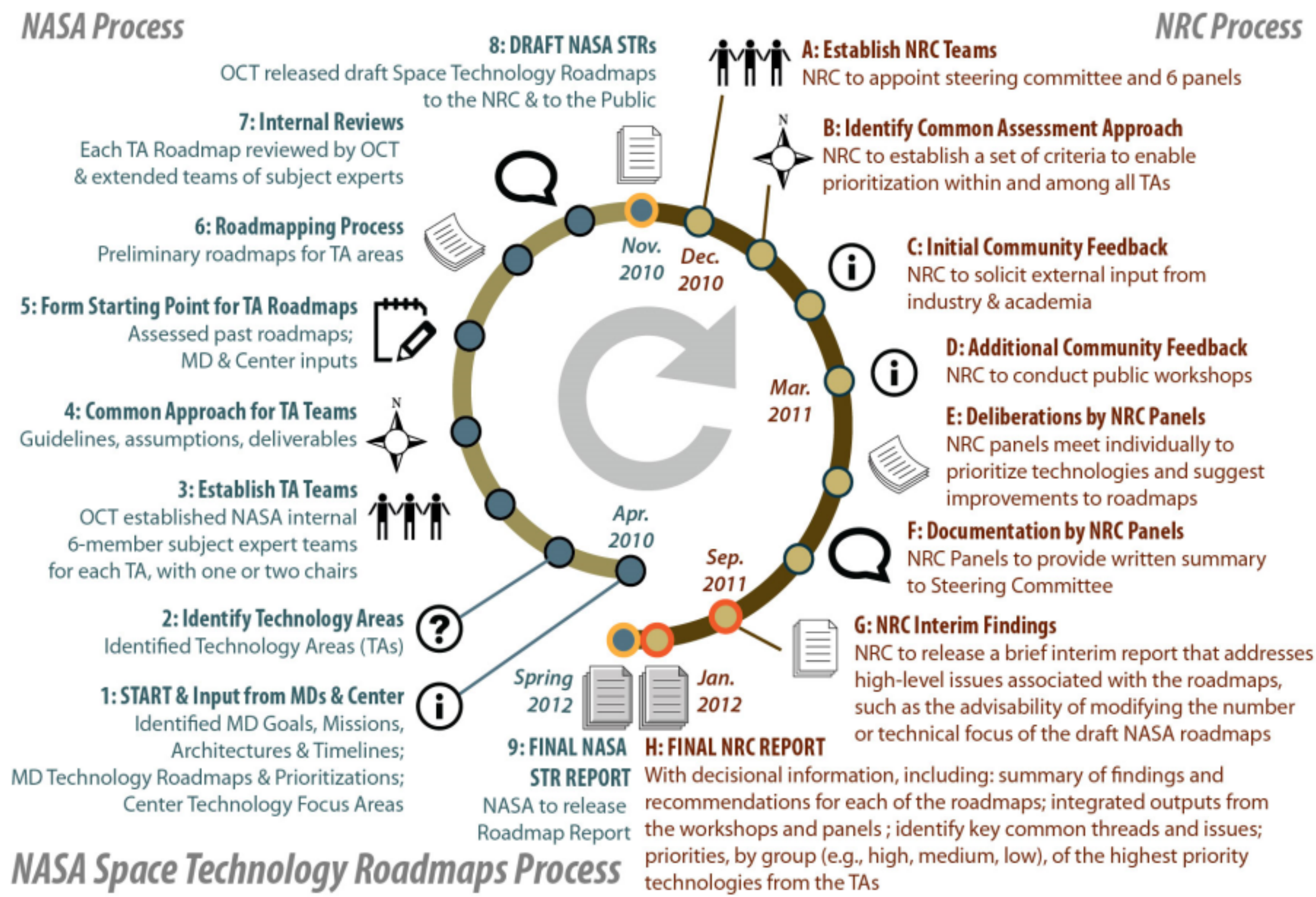
GOAL: ENERGIZE DOMESTIC SPACE ENTERPRISE AND EXTEND BENEFITS OF SPACE FOR THE NATION

CAPABILITY OBJECTIVES

1. Achieve improved spacecraft system reliability and performance
2. Enable transportation to and from space
3. Sustain human health and performance
4. Meet the robotic and autonomous navigation needs of space missions
5. Enable large-volume, efficient flight and ground computing and data management

Technology Roadmaps

2012 Roadmap Development Process



The National Research Council (NRC) Review Of NASA Space Technology Roadmaps

NASA requested that the National Research Council (NRC)

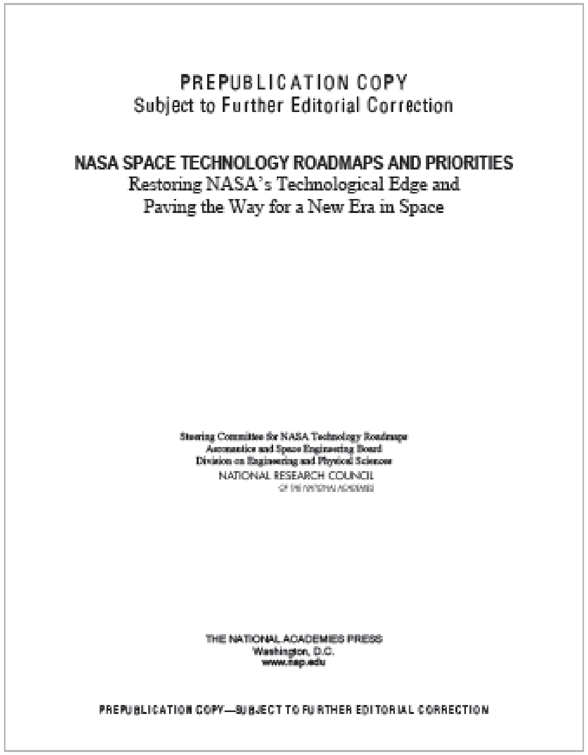
- *Review the technology area (TA) roadmaps*
- *Rank the top technical challenges and highest priority technologies*
- *Make additional recommendations*

Through a standardized, systematic methodology, the NRC review process resulted in

✓ Recommended technology development priorities during the next five years – incorporated into SSTIP

✓ Crosscutting findings and recommendations to maintain or improve effectiveness – being integrated into process for FY2014 roadmaps

✓ Recommended revisions to the TA roadmap taxonomy – incorporated into final FY2012 roadmap



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NASA SPACE TECHNOLOGY ROADMAPS AND PRIORITIES
Restoring NASA's Technological Edge and
Paving the Way for a New Era in Space

Steering Committee for NASA Technology Roadmaps
Aeronautics and Space Engineering Board
Division on Engineering and Physical Sciences
NATIONAL RESEARCH COUNCIL

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Addressing The National Research Council (NRC) Recommendations

NRC Recommendation	Final FY12 Roadmaps	SSTIP	FY14 Roadmap Process	Other
Technology Development Priorities		✓		
Advanced Stirling Radioisotope Generators		✓	✓	
Cryogenic Storage and Handling		✓	✓	
Systems Analysis		✓	✓	HEOMD Systems Analysis
Managing the Progression of Technologies to Higher Technology Readiness Levels	✓	✓	✓	
Foundational Technology Base		✓		10% low TRL
Cooperative Development of New Technologies		✓		SSTIP
Measure Technology Transition				Mission use agreements
Industry Access to NASA Data		✓		TechPort
NASA Investments in Commercial Space Technology		✓		
Crosscutting Technologies			✓	
TA Breakdown Structure Recommendations	✓		✓	

Information Technology Definitions

CIO responsible for IT as defined by Clinger Cohen

The term Information Technology, with respect to an executive agency means any equipment or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the executive agency. Information technology includes computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources

References:

- 40 U.S.C. ºº 11101 et seq., Clinger-Cohen Act of 1996, also known as the Information Technology Management Reform Act
- FAR 2.101

This is not just your desktop computer and network!

Information Technology in Roadmaps

Action: Bolden request to include a Information Technology Roadmap in the Agency technology roadmaps and incorporate IT in the NASA Strategic Space Technology Investment Plan.

NTEC Decision:

- NTEC prefers IT development to be **integrated with the Technical Areas in NASA's current Technology Roadmaps, not described in a separate roadmap**, because IT is integral to virtually all of NASA's technology development activities. NASA will perform a detailed assessment of mission-specific IT (known as "highly specialized IT" in NPR 7120.7) and will expand the content in the roadmaps as needed.

- The roadmaps will not include evolving IT infrastructure development and commodity technology infusion (e.g., email, and Internet Protocol version 6 (IPv6) implementation).