

Space Sciences  
Radiation Shielding Activities

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# Topic 1

## Radiation Shielding Evaluations in Space Science Programs

# Evaluation of Shielding

- New space science programs have more demanding requirements for radiation transport software.
  - Next Generation Space Telescope (NGST) – Contact - Janet Barth, GSFC
    - Need to understand background rates on detectors with a high degree of accuracy – concerns include particle cascades, electron production, and emission from materials
  - Europa – Contact – Bill McAlpine, JPL
    - Need to reduce design margins for the extremely high Europa radiation environment - concerns include speed of calculations in complex geometric structures
  - Star Tracker Development
    - Need to predict secondary particle production in massive amounts of shielding
- GSFC and JPL are outlining requirements for radiation transport codes and are planning to evaluate existing codes.
- Expectation is that more than one code will be required to meet requirements.
- Codes under consideration for evaluation are NOVICE, HZETRN/BRNTRN, ITS, GEANT
- Propose to participate in HEDS workshops
  - Share results of investigations
  - Avoid duplication of efforts

# Topic 2

Space Science Support for Applications

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Living with a Star Program

Space Environment Testbed Program

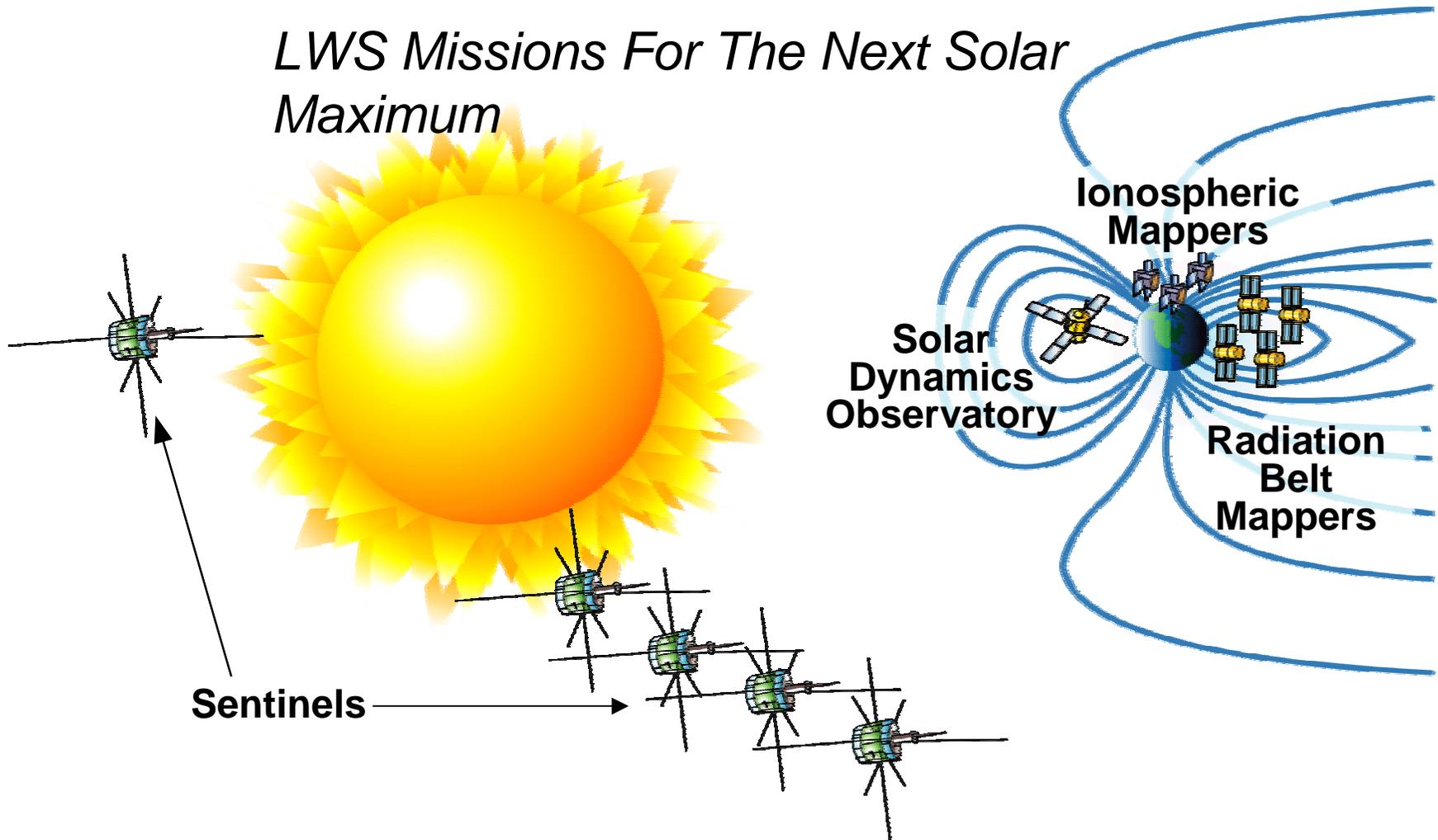
# Living with a Star Program Architecture

- Goal of LWS
  - Develop the scientific understanding necessary for us to effectively address those aspects of the Connected Sun-Earth system that affect life and society.
- LWS Elements
  - Science Missions
    - Gather basic science data needed to achieve understanding
    - NASA/HQ science definition teams will include application scientists and engineers
  - Theory and modeling program
    - Defines environment at surface of spacecraft
  - Space environment testbed program
    - Defines environment interaction with spacecraft
    - **Completes the transition from science to applications**
  - Close partnerships with DoD, DoE, DoI, FAA, and NSF
    - Under the aegis of the National Space Weather Program

# LWS Missions

Establish a Network to Quantify the Sun-Earth Connected System

*LWS Missions For The Next Solar Maximum*

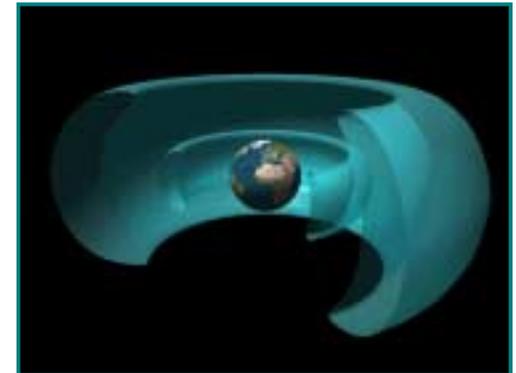
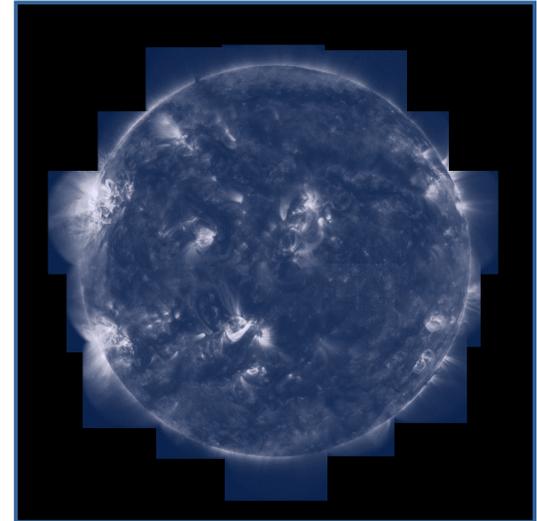


# Theory and Modeling Program

## Overview

This LWS research program is targeted toward the research needed to refine understanding of space weather and the role of solar variability in terrestrial climate change.

- Improve understanding of space weather and solar variability, and its effect on long term climate change
- Perform research and development to enable improved specification models and predictive capability
- Cover solar atmosphere to Earth's ionosphere



# SET Program

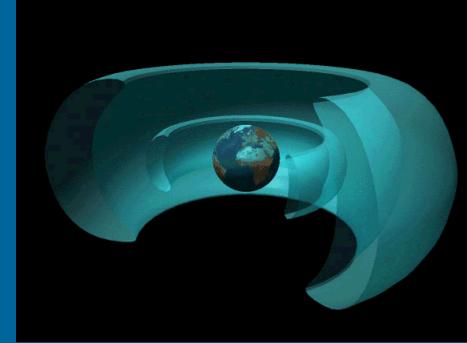
Completes the Transition from Science to Applications

## *Technology Validations & Demonstrations*

Use the MEO environment to demonstrate technology for space use

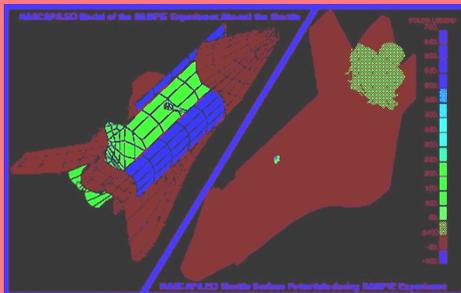
## *Flight Experiments*

### Space Environments Testbeds (SETs)



Perform technology validations to enable routine operation in high-radiation orbits beyond LEO

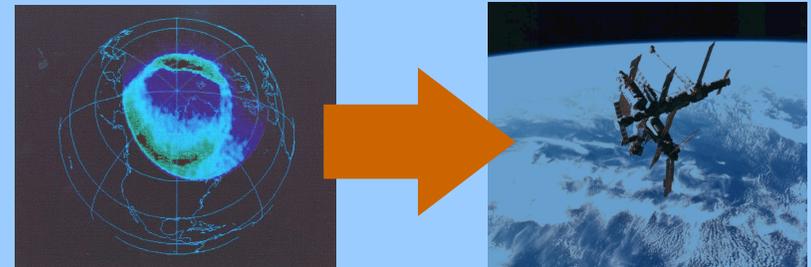
## *Technology Development Activities in Radiation, Spacecraft Charging, Meteoroids, and Thermo/Ionosphere*



- Models
- Guidelines
- Databases
- Definitions

## *Science - Data Link*

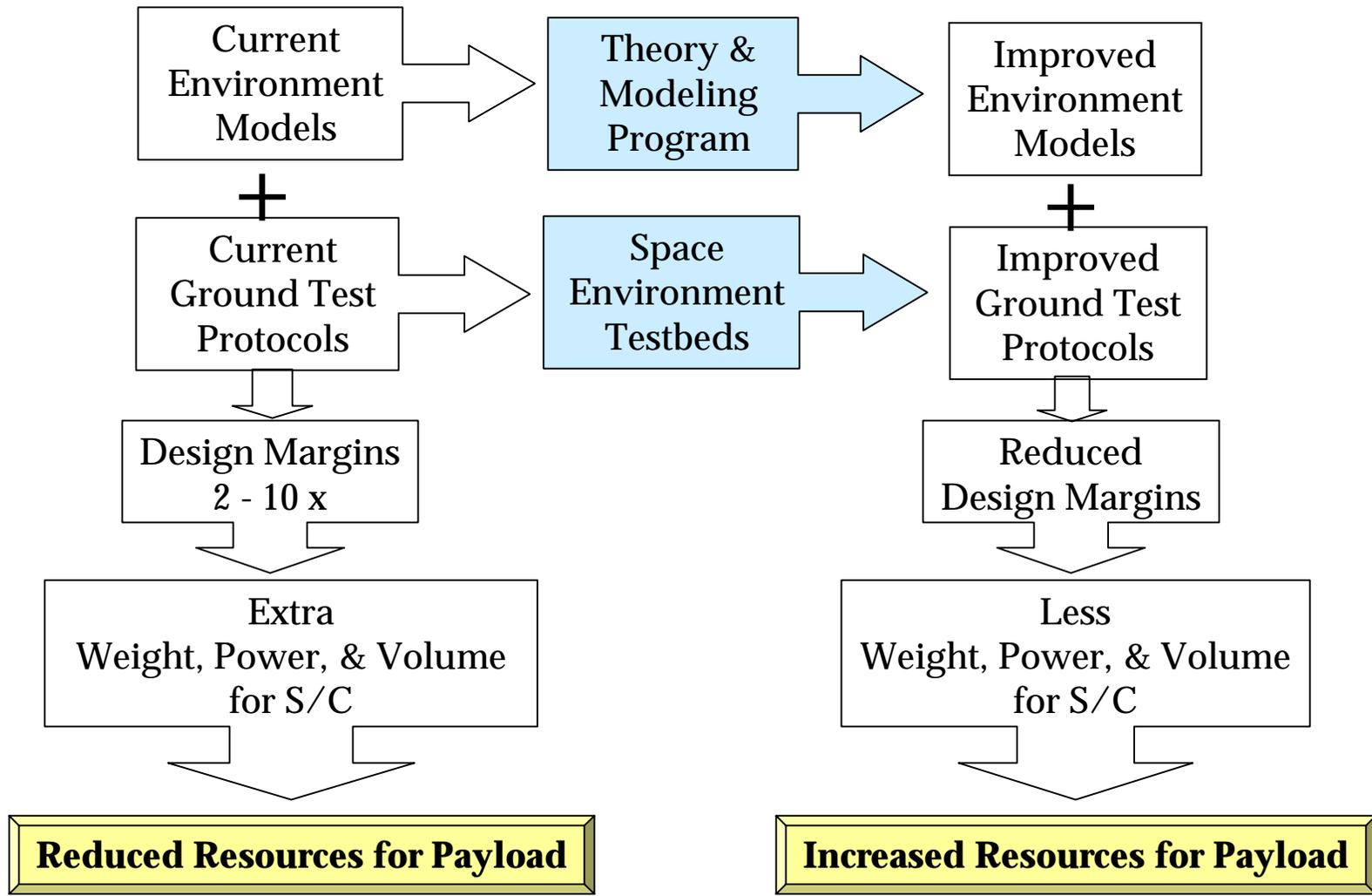
Bridges Gap Between Science & Engineering Communities



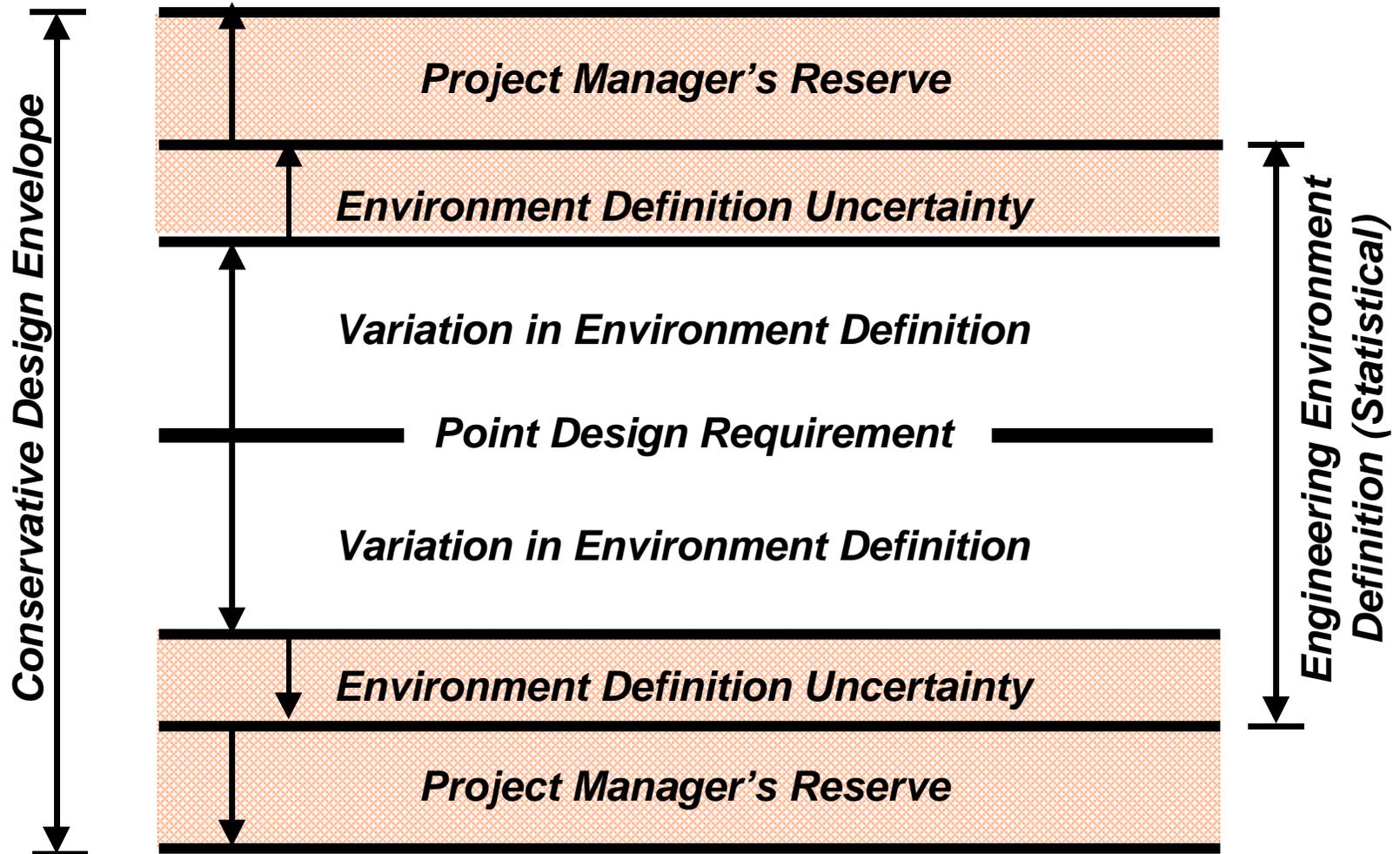
# Goals of SET Program

- Improve system engineering approach to environment mitigation
- Implement accurate environment effects accommodations into spacecraft design and operations
  - Improved models increase capability (lower design margins)
    - Less mitigation overhead
    - Reduced shielding weight means reduced launch costs and increased payload
  - Improved models increase reliability
- Enable operation in higher radiation environments
- Increase technology infusion into Government/Industry programs

# An SET Goal - Increase Capability



# Reducing the Uncertainties & Reserves Improves Performance & Reduces Costs



# SET Program Tasks

- Understand environmental effects on emerging technologies
- Establish ground test protocols for emerging technologies and commercial off the shelf components
- Support engineering tool development activities
- Develop on-orbit Space Weather risk management techniques
- Validate environment models (LWS & others)
  - Environment Specification
  - Space Weather
- Validate engineering models & ground test protocols
- Demonstrate instrumentation and sensors for LWS Missions

# SET Program Implementation

- Establish Definition Team
- Design modular approach to testbed design to capitalize on launch opportunities
- Fly orbiting testbed every 2 years – First in late 2003
- Hold bi-yearly workshops
  - Requirements definition & partnering
  - Presentations of results
- Leverage off other programs
- Fund NASA Research Announcements
  - Sensor development
  - Technologies of interest to NASA/Industry
  - Analysis of testbed data
  - Development of prediction/engineering tools
- First solicitation anticipated prior to the end of 2Q FY01

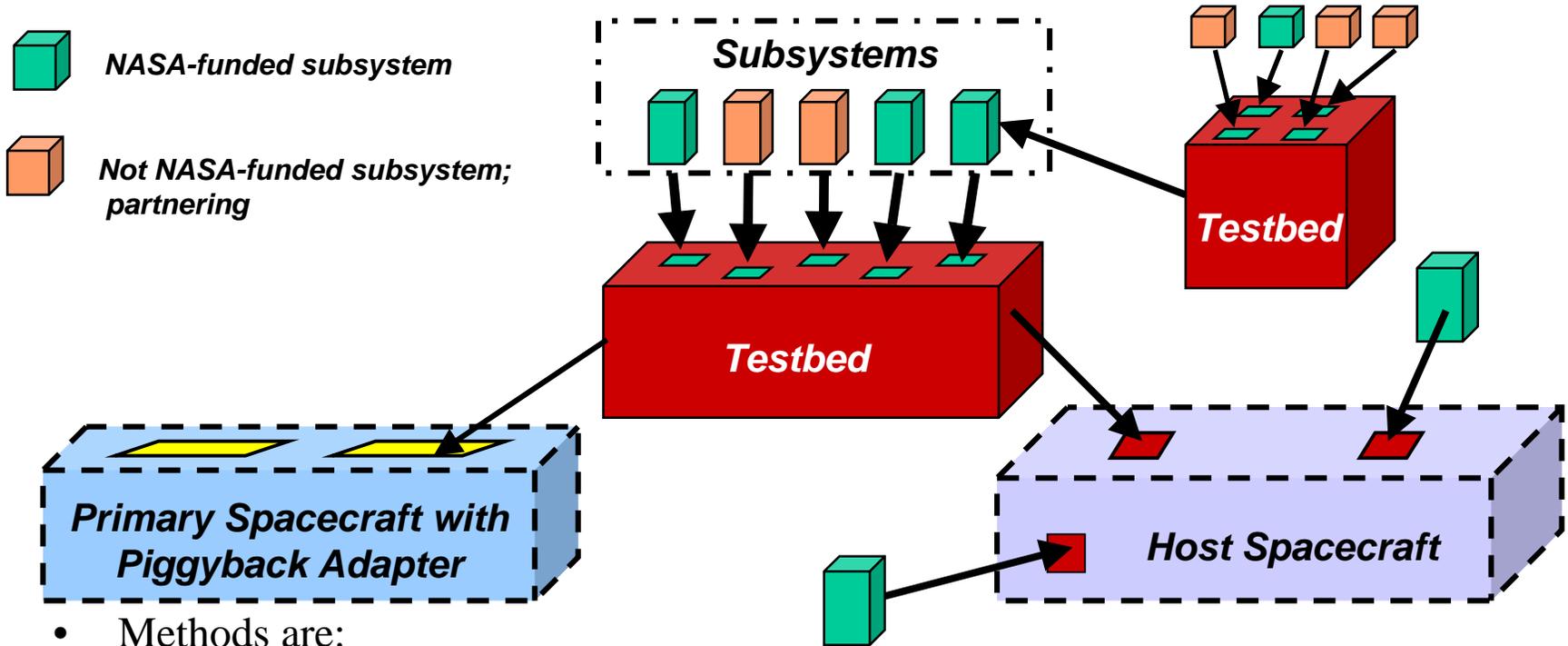
# SET Program Leveraging

- NASA Electronic Radiation Characterization Project – ground tests
- DoD ground test programs
- Space Environment and Effects Program
- New Millennium Program
- DoD technology development programs
- NASA technology development programs
- Seeking other partnerships
  - Contact Janet or Ken
  - August Workshop

# LWS/Space Environment Testbed

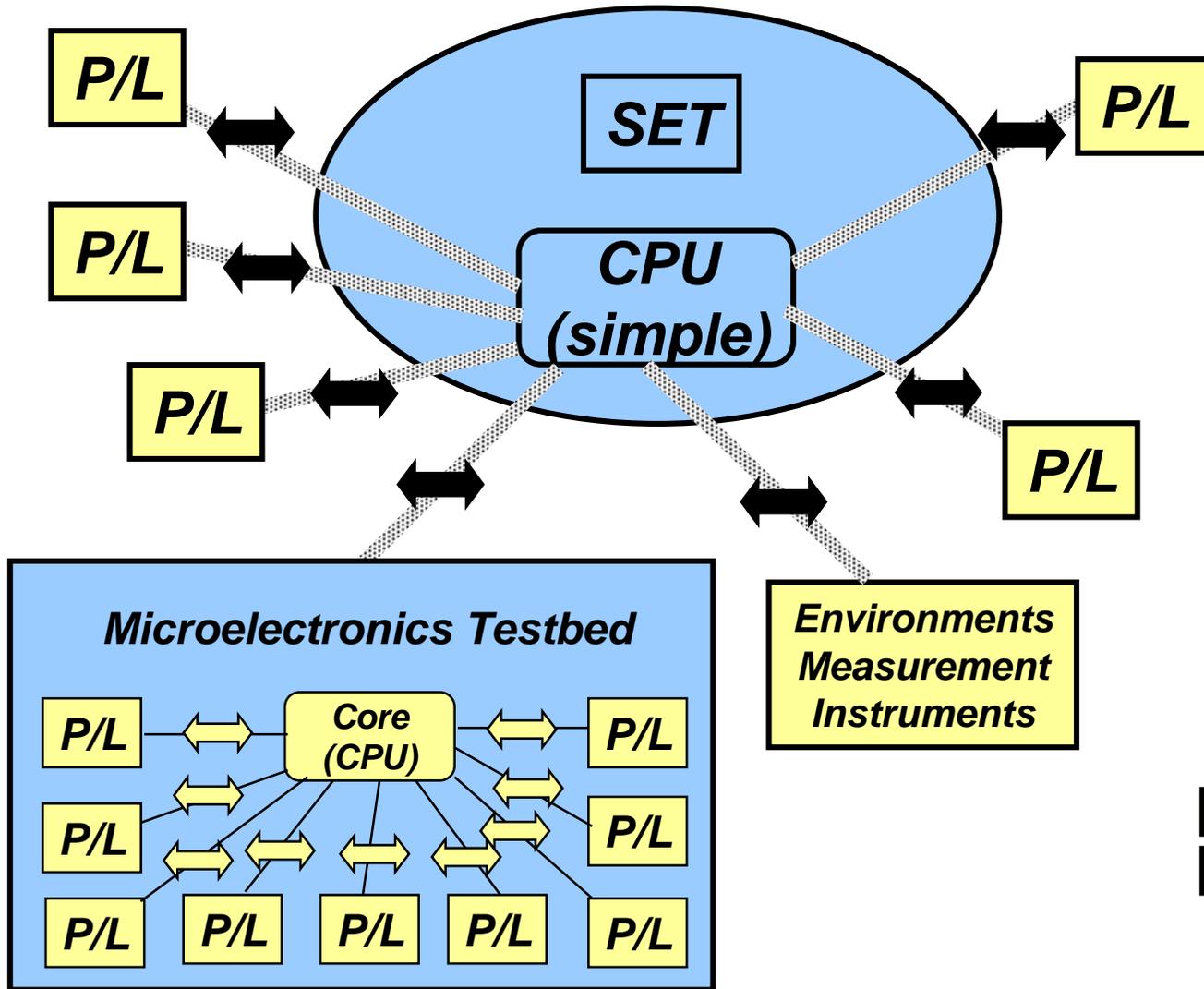
- Common support hardware and software to validate several sub-systems or components on orbit
  - Each mission will include a suite of appropriate environment sensors (space radiation, plasma, etc.) based on the technology experiment needs and launch constraints.
- NASA provides launch, on-orbit operation, and data return
- Standard agreement with payload partners requires partners to provide ground test data, on-orbit data after reduction, and funding for integration
- Partnering agreement is negotiable based on NASA interest and partner contribution to launch

# Methods for Subsystem Technology Validations in Space Science



- Methods are:
  - Subsystems directly interface to host spacecraft as secondary payloads
  - Subsystems interface to testbeds
    - What is a testbed? Common support hardware & software to validate several subsystems or components
  - Testbeds either retain permanent attachment in space (host spacecraft) or are jettisoned (piggyback)

# Testbed Concept



## Assumptions:

- 5 testbeds
- Launch: 2-year centers
- 1-2 year life
- Weight: <150 kg
- Piggyback
- >1 launch vehicle
- Candidate payloads will meet the interface & fail safe

-  *Provided by Partners*
-  *Provided by the SET*

# Experiments

- Experiments take the form of materials, components, cards, sensors, or subsystems
- Technologies must show clear traceability to proposed criteria
- Potential experiment categories may include:
  - Microelectronics
    - Commercial (un-hardened)
    - Radiation Tolerant
    - Radiation Hardened
  - Photonics
  - Detector technologies
  - Materials
    - Degradation
    - Shielding properties
  - Mechanisms
  - Microelectromechanical systems (MEMS)
  - Subsystems
  - Space and induced environment tolerance methods
  - Spacecraft charging/discharging

# SET Program Workshop

- CBD Announcement, July 7, 2000
- August 23<sup>rd</sup>-24<sup>th</sup>, 2000
- Key Bridge Marriott, Arlington, Va
- WEB Site: <http://lws.gsfc.nasa.gov/lws.htm>
- Joint Workshop with New Millennium Program
- Contacts –
  - Janet Barth NASA/GSFC
    - 301-286-8046
    - JLBARTH@pop700.gsfc.nasa.gov
  - Ken LaBel NASA/GSFC
    - 301-286-9936
    - ken.label@gsfc.nasa.gov
  - Dana Brewer NASA/HQ
    - 202-358-1678
    - dbrewer@hq.nasa.gov

# Workshop Participation

- Potential technology providers attending the workshop are requested to:
  - describe how their technology solutions can meet future requirements,
  - assess the readiness for flight of their technology in the 2003-2005 timeframe, the time of the first flight opportunity,
  - estimate the cost for providing the technology for the flight,
  - describe the criteria for successful flight test/validation,
  - describe the rationale for space flight,
  - identify approaches for partnering/cost sharing in support of the technology test/validation.
- Register at WEB Site: <http://lws.gsfc.nasa.gov/lws.htm>

# Summary

- What does LWS offer to the space community?
  - Improved trapped and solar particle models
    - Information mining of existing data sets
    - New measurements for environment models
    - Advocacy for particle instruments on other missions
    - Removes burden of environment model development from SET
  - Improved space weather predictions for on-orbit operations
  - Long term commitment to an on-orbit environment test bed PROGRAM
  - A path to cost effective operations in MEO