NEPP Mission

- To provide guidance to NASA:
  - Selection and application of microelectronics technologies
  - Improved understanding of risks related to the use of these technologies in the space environment
  - Appropriate evaluations to meet NASA mission assurance needs for electronic systems

- NEPP evaluates new* and emerging** electronic parts technologies and provides assurance support for technologies in current use in NASA spaceflight systems

*New – Recently marketed, commercially available
** Emerging – Available in limited quantities for evaluation, on path to commercial products
NEPP Overview

• NEPP supports all of NASA for >20 years
  – 7 NASA Centers and JPL actively participate
• The NEPP Program focuses on the reliability aspects of electronic devices
  – Three prime technical areas: Parts (die), Packaging, and Radiation
• Alternately, reliability may be viewed as:
  – Lifetime, inherent failure and design issues related to the electronic parts technology and packaging,
  – Effects of space radiation and the space environment on these technologies, and
  – Creation and maintenance of the assurance support infrastructure required for mission success.

*Electrical overstress failure in a commercial electronic device*
NEPP Works Two Sides of the Equation

• Assurance
  – Issues that are applicable to space systems being designed and built (i.e., currently available technologies)
    – Examples
      • Cracked capacitors
      • DC-DC converter reliability
      • Enhanced Low Dose Rate Sensitivity (ELDRS)
    – Communication infrastructure via website and working groups
      • NASA Electronic Parts Assurance Group (NEPAG)
    – Audit and review support

• New electronics technology
  – Issues that are applicable to the next generation of space systems in conceptualization or preliminary design
    – Examples
      • 45-90 nm CMOS
      • SiGe
      • State-of-the-art FPGAs
    – Collaboration with manufacturers and government programs for test, evaluation, and modeling
    – Development of new predictive performance tools

1st NEPP ETW Overview presented by Kenneth A. LaBel at JC 13.4 Meeting, Nashville, TN – May 18, 2010
The NEPP Program

**Management**
- Ken LaBel: Radiation Effects, Advanced Actives, NEPP Events
- Mike Sampson: NEPAG, Passives, Packaging

**Core Elements**
- Electronic Parts Reliability
- Radiation Effects
- Parts Assurance (NEPAG)
- Advanced Packaging
- Information Dissemination

**Focus Technologies**
- Extreme Environments
- Sensor Technology
- Fiber Optics
- Radio Frequency
- Power Devices
- Lead-free Interconnects
- Systems on a Chip (SOC)
- Programmable Logic
- Area Arrays
- Memories
- Discretes
- Embedded Technologies
- Scaled CMOS
- Mixed Signal
- Interconnects

**Products/Deliverables**
- Guidelines
- Specifications and Standards
- Test Methods
- Website Content
- NASA Parts Selection List
- Tools
- Data
- Technical Reports
- Bodies of Knowledge
- Conference Papers

*1st NEPP ETW Overview presented by Kenneth A. LaBel at JC 13.4 Meeting, Nashville, TN – May 18, 2010*
Typical Spacecraft Electrical Architecture

Diagram showing the typical spacecraft electrical architecture:
- C&DH (Command and Data Handling)
- GN&C (Guidance, Navigation, and Control)
- Propulsion
- Thermal
- Instruments/Payload
- Power Bus (ses)

Connections:
- C&DH connected to COMM (direct link)
- COMM connected to RF to/from Ground or other spacecraft
- Ground Antenna

Legend:
- RF to/from Ground or other spacecraft
- Ground Antenna
The 90/90 Goal

Sample NEPP Technology Areas
- Memories
- FPGAs
- Capacitors
- SiGe
- Power devices

90% of NEPP efforts should support
90% of NASA flight missions

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Typical Spacecraft Electrical Architecture

The 90/90 Goal - Example

Sample NEPP Technology Areas

Memories

Used in any processing application and for data storage on a spacecraft.
NEPP Has a Wide Range of Efforts

- Tasks vary extensively in the technologies of interest
  - Building blocks like capacitors
  - Standard products like DC-DC Converters, linear bipolar devices, and A-to-D Converters
  - New commercial devices such as FPGAs and memories
  - Test structures on emerging commercial or radiation hardened technologies
  - Specialized electronics such as IR arrays and fiber optics
  - New assurance methods and investigations

- NEPP ETW provides forum to present recent results, as well as current and future plans

- Currently in FY11 planning cycle
  - **PRELIMINARY PLANS FOLLOW**
NASA Electronic Parts Assurance Group (NEPAG)

Core Areas are Bubbles; Boxes underneath are elements in each core

Legend

<table>
<thead>
<tr>
<th>DoD and NASA Funded</th>
<th>NASA-only funded</th>
<th>Overguide</th>
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NEPAG Focus Areas

- **Failure Investigations**
  - Investigate
  - Assess NASA Impact
  - Test/Analyze
  - Corrective Action
  - Lessons Learned

- **Specs and Standards**
  - US MIL
    - VCS

- **Audits**
  - US MIL

- **Collaborations**
  - National
    - International

- **Parts Support**
  - NPSL
    - Technical Expertise Resource
    - Bulletins
    - Connectors

- **Consortia**
  - CAVE
    - CALCE

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FY11 Radiation Plans for NEPP Core (1)

Core Areas are Bubbles; Boxes underneath are variable tasks in each core

NEPP Research Categories – Active Electronics

SiGe. Mixed Signal
- SiGe on SOI
- Scaled SiGe
- Advanced Data Conversion, Amplifiers, Drivers
- Architectural comparison
  - Develops students at Georgia Tech, Vanderbilt, Auburn

Scaled CMOS
- Commercial Devices
  - Memories – Non-volatile, volatile
  - FPGAs
  - Processors, SOCs
  - Structured ASICS
  - Test Structures
  - Silicon on Insulator (SOI)
  - Ultra-low power
  - 32 and 45 nm
  - CNTs
  - RHBD Support
  - 32 and 45 nm CMOS

Sensor Technologies
- IR
- Visible
- Cryo SEL
- Others
- Low proton energy
- Compact model based rate prediction
- Fiber Amplifiers
- Exotic-doped Fiber components
- Wavelength Division Multiplexing
- Free space Optical interconnects
- Fiber Data Links
- Optocouplers and PM Optocouplers

Photonics
- 32 and 45 nm CMOS
- SiGe
- Develops students at Vanderbilt

Performance Tools
- DoD and NASA funded
- NASA-only funded
- Overguide

Legend

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FY11 Radiation Plans for NEPP Core (2)

Core Areas are Bubbles;
Boxes underneath are variable tasks in each core

NEPP Research Categories – Hardness Assurance

ELDRS Test
- NSC, LT, TI, Intersil, STM Support
- Hydrogen Effects
  - High dose

Temperature Effects
- SEE - Elevated
- TID – Elevated post
- SEE - Cryo
- TID – Elevated during
- Cryo BOK

Power Devices
- SEGR Model/Tool
- Vendor Eval
- POLs
- GaN, SiC
- High V DC-DC

Combined Effects
- NVMs – Radiation and Reliability
- TID on SEE
- DDD on SEE
- SETs on Reliability
- <90nm Reliability of Irradiated Devices
- Heavy Ion DD of<65nm

Guidelines
- ADC Test
  - Low Proton Energy
  - SOC Test Guideline
  - NVM Test Guideline
  - Standard FPGA Test Method
  - SDRAM Test Guideline

Other Overguide Tasks
- Education/training modules
- Microwave Technologies
- Additional SOC Testing
- Partners at vendors listed, RLP Research, ASU
- Partners at NSWC, IR, Fuji, STM, Microsemi

Legend
- DoD and NASA funded
- NASA-only funded
- Overguide

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FY11 Parts Plans for NEPP Core (1)

Core Areas are Bubbles; Boxes underneath are variable tasks in each core

NEPP Research Categories – Parts Assurance

SiGe, Mixed Signal
- Cold temperature effects
- Scaled SiGe
- Advanced Data Conversion, Amplifiers, Drivers
- GaAs, InP, Antemonides

Scaled CMOS
- Commercial Devices
  - Memories – Non-volatile
  - FPGAs
  - Processors, SOCs
  - Memories - SDRAM
- Test Structures
  - Silicon on Insulator (SOI)
  - Ultra-low power
  - 32 and 45 nm
  - CNTs
  - Sub 90nm

Sensor Technologies
- IR
- Visible
- ROICs - Cryo
- Others

Photonics
- Fiber Amplifiers
- Exotic-doped Fiber components
- Wavelength Division Multiplexing
- Free space Optical interconnects
- Fiber Data Links
- Optocouplers and PM Optocouplers

Rf Electronics
- RF Reliability Guide
- Advanced RF

Legend
- NASA-only funded
- Overguide

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FY11 Parts Plans for NEPP Core (2)

Core Areas are Bubbles; Boxes underneath are variable tasks in each core

NEPP Research Categories – Parts Assurance

Passives
- Polymer Caps
- BME Caps
- Embedded Passives
- Advanced devices

Temperature Effects
- Cryo CMOS
- Mixed Signal - Cryo
- Extended COTS
- Hot spot test method
- Cryo BOK

Power Devices
- Power Mosfets
- DC-DC Eval
- POLs
- GaN, SiC
- High V DC-DC

Combined Effects
- NVMs – Radiation and Reliability
- TID on SEE
- DDD on SEE
- SETs on Reliability
- <90nm Reliability of Irradiated Devices
- Heavy Ion DD of<65nm

Guidelines
- ADC Test
- Embedded device
- SOC Test Guideline
- NVM Test Guideline
- Standard FPGA Test Method
- SDRAM Test Guideline

Other Overguide Tasks
- Education/training modules
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Legend
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- Overguide

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Core Element - Packaging

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Core Areas are **Bubbles**;
Boxes underneath are variable tasks in each core

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**NEPP Research Categories – Advanced Packaging**

- **Area Arrays**
  - Ball Grid Arrays
  - Column Grid Arrays
  - Microcoil Spring Array
  - Land Grid Arrays
- **Complex Non-Hermetic**
  - Area Array
  - MIL Class Y Materials
- **Embedded Technologies**
  - Actives
  - Passives
- **Lead-free**
  - Assemblies
  - Tin Whiskers
- **Board Installation Damage**
  - Cracking
  - Parametric Drift
  - Reverse Polarity

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1st NEPP ETW Overview presented by Kenneth A. LaBel at JC 13.4 Meeting, Nashville, TN – May 18, 2010
1st NEPP ETW

This meeting will focus on the presentation of the work being performed under the NEPP Program for the betterment of NASA and the greater aerospace community. This meeting will describe NEPP tasks that provide critical guidance, qualification methodologies, risk trades, and technology insertion information for current and new electronic technologies. This meeting will be of specific interest to flight project managers, system and design engineers, technologists, parts, packaging, and radiation specialists.

The meeting will be held at NASA/GSFC in Greenbelt, MD on June 22-24, 2010 and open to all US citizens from NASA, other government agencies, industry, and academia. Pre-registration is required. We are currently taking people for an overflow waiting list.

Details can be found at http://nepp.nasa.gov
ETW Format

- 2.5 days of presentations
  - Invited talks on NASA and technology, power system architectures, FPGA studies, counterfeit electronics, workmanship, and more
  - Oral and poster presentations from task and area leads
    - Topical: Ex., Dealing with next generation of device complexity
    - Task specific: Ex., On-Going Radiation Effects on FPGAs - Lessons Learned and Plans
  - Preliminary program at NEPP website

- Breakout sessions on the last day
  - Talk to the experts
    - We will have ~ 4 breakout meetings to discuss issues and challenges in specific topic areas
    - This should be set shortly

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QUESTIONS?