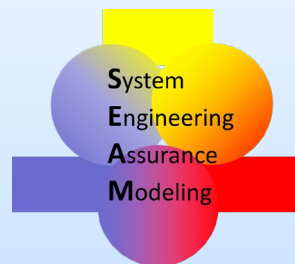


Status of NEPP Model-Based Mission Assurance Efforts



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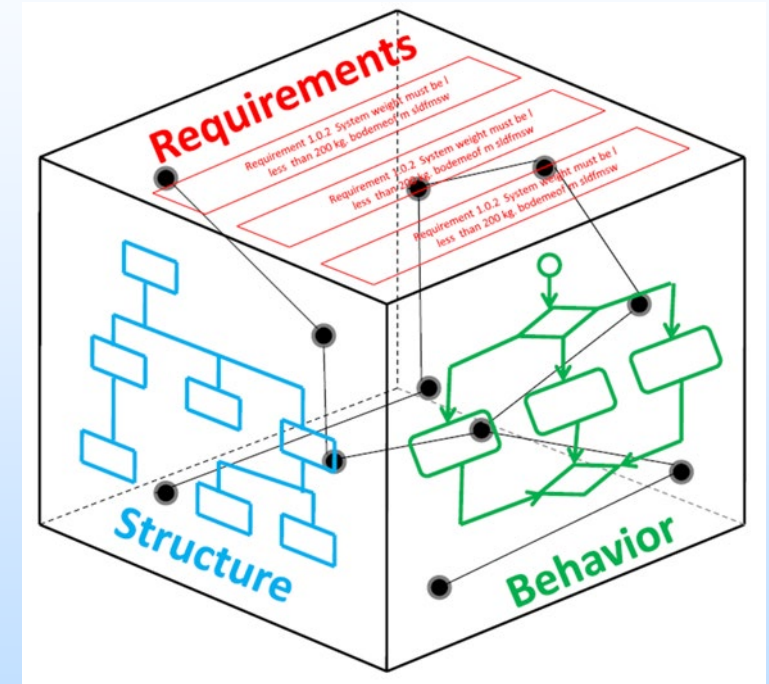


What is a Model?

- The Department of Defense defines a model as “A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process”.

Modeling and Simulation Coordination Office, Ed., Modeling and Simulation (M&S) Glossary. 1901 N. Beauregard St., Suite 500 Alexandria, VA 22311: Department of Defense, Oct. 2011. <https://www.msco.mil/MSReferences/Glossary/TermsDefinitionsI-M.aspx>

- We are used to working with mathematical representations of systems, entities, phenomenon, or processes
- Model-Based Mission Assurance (MBMA) is adding logical representations of our systems and processes to enhance and improve Radiation Hardness Assurance (RHA)

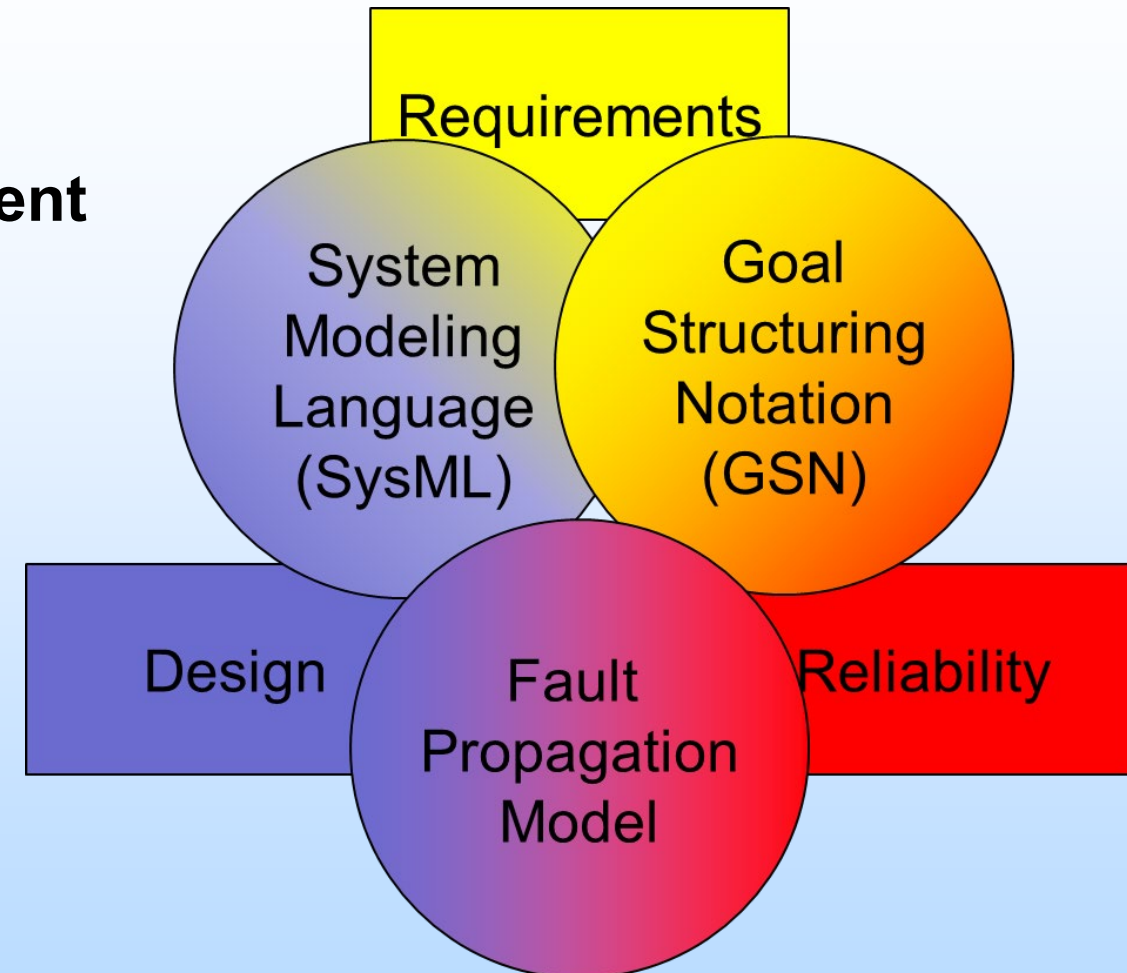


M. Bajaj, B. Cole, and D. Zwemer, “Architecture to geometry - integrating system models with mechanical design,” in *Proc. AIAA SPACE*, 2016.



When Logical Models can improve RHA

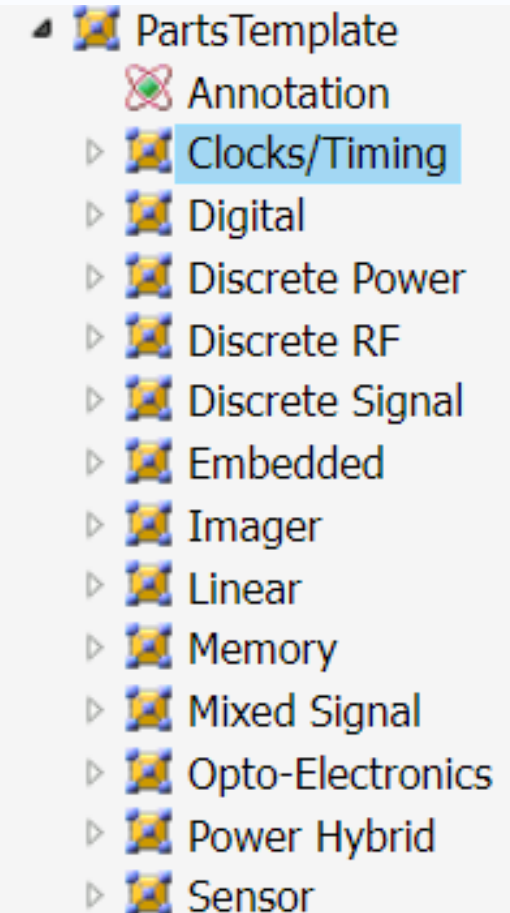
- **Non-destructive Single-Event Effects (SEE) identified in Single-Event Criticality Analysis (SEECA)**
OR
- **Limited resources**
 - **Example 1: Incomplete test data for COTS system, including box-level proton testing**
 - **Example 2: Non-destructive SEE data taken during destructive SEE testing**
 - **Example 3: System is still in development and/or too complicated for simulation like FPGAs**



SEAM Update Highlights



- **User Guide Draft complete**
 - Reviewing currently
- **Part Template Library complete**
 - Default library on modelbasedassurance.org
- **R-GENTIC Import to SEAM**
 - Working on GSN Assurance argument templates
- **NASA SEAM Deployed**
 - Working out a couple of usability issues
 - OSTEM Summer intern – Jasleen Batra, University of Colorado



SEAM Update Highlights

- PartsTemplate
 - Annotation
 - Clocks/Timing
 - Circuit-Based Oscillator
 - Crystal-Based Oscillator
 - Delay-Locked Loop
 - Phase-Locked Loop
 - Digital
 - Comparator
 - Discrete Flip-Flops
 - Discrete Logic Gates
 - Driver (Buffer)
 - Multiplexer/Demultiplexer
 - Receiver

- Discrete Power
 - BJT
 - HEMT
 - IGBT
 - JFET
 - MOSFET
 - PIN Diode
 - Schottky Diode
- Discrete RF
 - Amplifier
 - Attenuator
 - Demodulator
 - Detector
 - Mixer
 - Modulator
 - Receiver

- Transmitter
- Discrete Signal
 - BJT
 - Diode
 - JFET
 - MOSFET
- Embedded
 - Digital Signal Processor
 - FPGA (Anti-fuse)
 - FPGA (Flash)
 - FPGA (SRAM)
 - Microcontroller
 - Microprocessor
- Imager
 - Charge Coupled Device
 - CMOS Imager

- Focal Plane Array Assembly
- Linear
 - Comparator
 - LDO
 - Op-amp
 - Voltage Reference
 - Voltage Regulator
- Memory
 - Content Addressable Memory (CAM)
 - DRAM
 - Dual-Port Memory (SRAM)
 - EEPROM
 - FRAM
 - MRAM
 - NAND Flash
 - NOR Flash

- SDRAM
- SRAM
- Mixed Signal
 - ADC
 - Analog Multiplexer/Switch
 - Current-Mode PWM
 - DAC
 - Integrated PWM DC-DC Converter
 - Voltage-Mode PWM
- Opto-Electronics
 - Discrete LED
 - Optocoupler
 - Photodiode
- Power Hybrid
 - Battery Charger
 - DC-DC Converter

- Load Switch
- Motor Drives
- Multi-(Voltage) Regulator IC
- Peak Power Tracker
- Switching Power Supply
- Sensor
 - Accelerometer
 - Current Sensor
 - Hall Effect Sensor
 - Pressure Sensor
 - Readout IC
 - Resolver to Digital Con
 - Temperature Sensor

Deployed Versions of SEAM

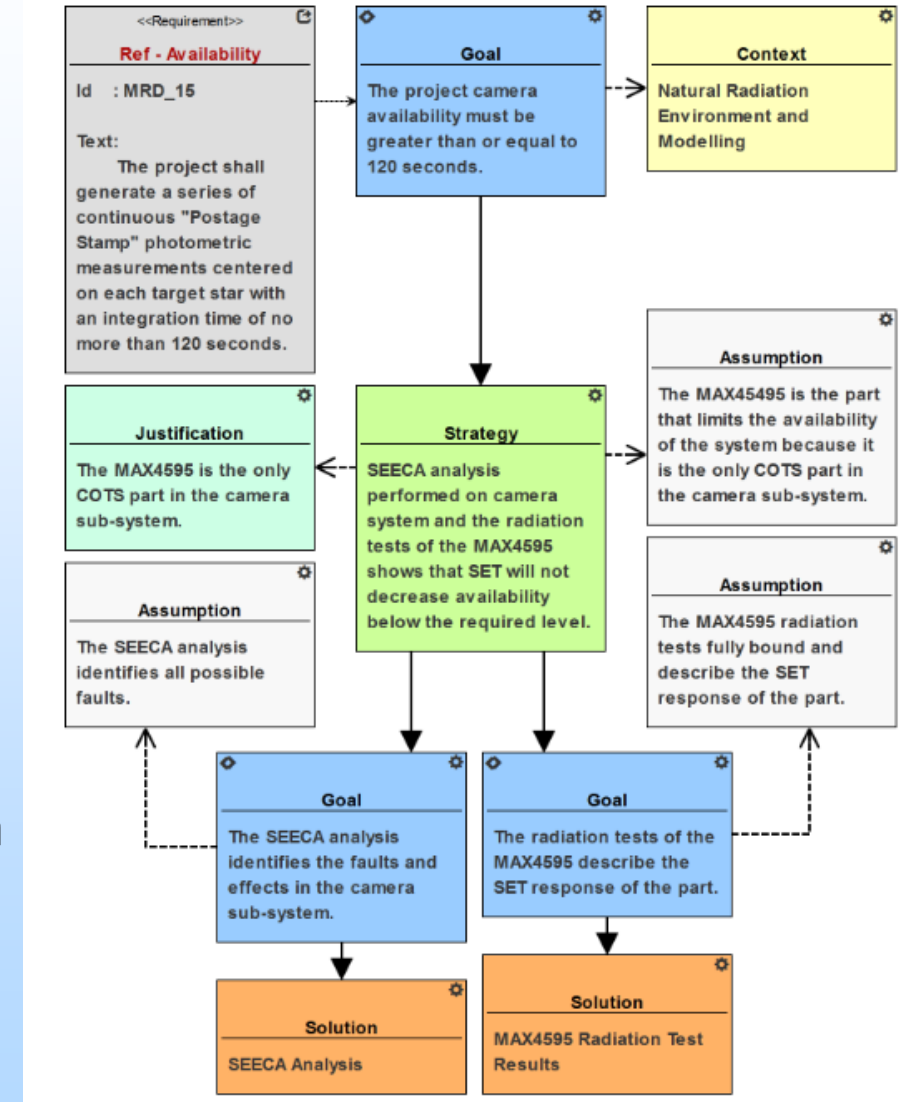


- **Vanderbilt internal site**
- **Public site: modelbasedassurance.org (AWS)**
- **NASA internal site (AWS GovCloud)**
- **Los Alamos National Lab internal site**
- **AlphaCore, Inc. internal site (STTR Tech transfer)**

Examples Models in SEAM



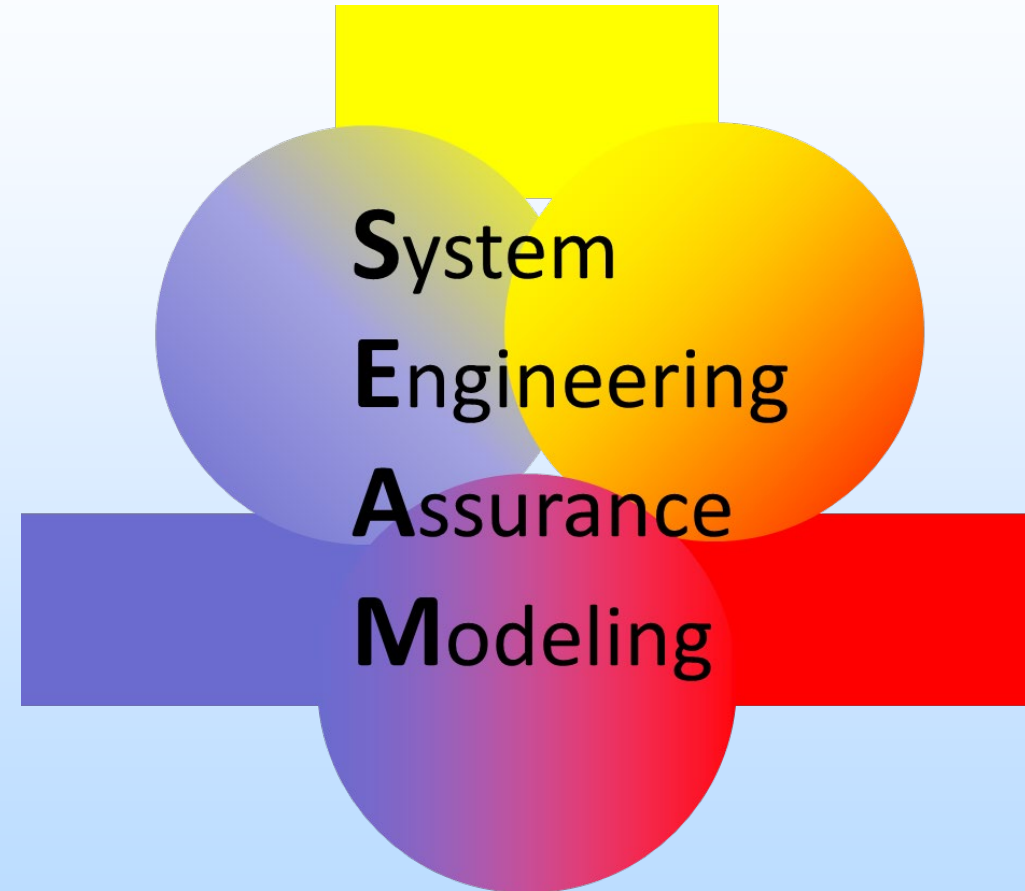
- Do not use new part template library
 - CubeSat Radiation Experiment ([SEAM Model](#))
 - MBMA over the mission life cycle ([MRQW Presentation](#))
 - SEECA SET Op-Amp ([TNS Paper](#))
- Will use new part template library
 - LiDAR System – next presentation
 - SpaceCube Processor Card – Summer Intern project
 - Your examples!



Summary



- **Reducing the barriers to entry**
 - Tutorial
 - Examples
 - Part Template Library
- **Increasing User Base**
 - NASA and external instances
- **Increasing Use Cases**



Acronyms



- **ADC: Analog to Digital Converter**
- **AWS: Amazon Web Services**
- **BJT: Bipolar Junction Transistor**
- **CAM: Content Addressable Memory**
- **CMOS: Complementary metal-oxide semiconductor**
- **COTS: Commercial Off The Shelf**
- **DAC: Digital to Analog Converter**
- **DC: Direct Current**
- **DT: Digital Transformation**
- **EEPROM: Electrically Erasable Programmable Read-Only Memory**
- **FPGA: Field Programable Gate Array**
- **FRAM: Ferroelectric Random Access Memory**
- **GPU: Graphical Processing Unit**
- **GSN: Goal Structuring Notation**
- **HEMT: High-Electron-Mobility Transistor**
- **IC: Integrated Circuit**
- **IGBT: Insulated-Gate Bipolar Transistor**
- **JFET: Junction-Gate Field-Effect Transistor**
- **LDO: Low-DropOut**
- **LED: Light Emitting Diode**
- **MBMA: Model-Based Mission Assurance**
- **MBSE: Model-Based System Engineering**
- **MOSFET: Metal-on-Silicon Field Effect Transistor**
- **MRAM: Magnetic Random Access Memory**
- **NAND: NOT AND**
- **NEPP: NASA Electronics and Packaging Program**
- **NOR: NOT OR**
- **OSMA: Office of Safety and Mission Assurance**
- **OSTEM: Office of STEM Engagement**
- **PWM: Pulse Width Modulation**
- **R&M: Reliability & Maintainability**
- **RF: Radio Frequency**
- **R-GENTIC: Radiation Guidelines for Notional Threat Identification and Classification**
- **RHA: Radiation Hardness Assurance**
- **SDRAM: Synchronous Dynamic Random Access Memory**
- **SEAM: System Engineering and Assurance Modeling**
- **SEE: Single Event Effects**
- **SEECA: Single Event Effects Criticality Assessment**
- **SoC: System-on-Chip**
- **SRAM: Static Random Access Memory**
- **STEM: Science, Technology, Engineering, and Mathematics**
- **STTR: Small Business Technology Transfer**