NRC Workshop on NASA's Modeling, Simulation, and Information Systems and Processing Technology

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Summary Comments

- **Lack of Specific Benefits and Purposes for Technology Concepts makes me think that all technologies from TA-11 will be passed over for technologies from other roadmaps when money is given out.**
  - Fundamental Question of “Why is this needed for NASA?” never correctly addressed throughout...encourage doing this on the technology by technology level.
  - Can’t just do something because its cool or available
- **No Holistic Approach (Discussions of Testing not married to discussion of Adaptive systems, or to modeling & simulation or on-board computing)**
  - Consider: Modeling, Simulation, Autonomous Operations, and Information Processing are all related and can be unified into a better approach that reduces mission cost.
  - Single Biggest thing stopping more adaptive systems is TESTING!!! “<<TOP TECHNICAL CHALLENGE!!>>
- **No Focus on Enablers**
  - No discussions on on-board computing for large data flows
  - No discussion on virtual observatories, clearing houses, search engines and other tools for NASA science data necessary to perform multi-mission data analysis or anchor models
  - No discussions of frameworks or process to enable M&S

On-board Computing

- **Entire On-board computing section in proposal is focused on multi-core processors. <this is also the TA-11 #1 top item>**
- **Where is NEED?**
  - Never discusses What specific NASA mission needs multi-core processors; Uses statements like “Time is right”
- **Other Considerations:**
  - Examine co-processor solutions targeted at specific NASA missions; IFF there is a mission need!!!!
    - Explore GPUs
      - Example: CPU with GPU for Terrain Relative Navigation for Lunar or Mars Landing; For computer vision activities like AR&D & ProxOps.
    - Explore Software-Defined <fill in blank>
      - Example: Flight Programmable FPGAs (Virtex-5) for image processing paired with a CPU for re-programmability and organization
  - Encourage the development of companies (and Rad-Hard Processors) other than BAE (Rad750)
  - Examine data architectures for large data flows (two instruments at 100 Mbps simultaneous feeding redundant 1 Tb recorders with file systems)

Modeling and Simulation

- **Modeling and Simulation can increase understanding, enable early-on analysis, and estimate utility...ALL GOOD!**
- **When can modeling go wrong? If...**
  - Models never keep up with Actual Design (*Ex: Europa Orbiter M&S*)
  - Draws resources away from performing engineering into the upkeep of models
  - Fidelity modeled is useless (too high or too low) to the development team.
  - Out-product is just documentation
- **TA-11 M&S seems without a focus that will make M&S useful...**
  - Why focus on larger and larger models without sanity check
    - TA-11 #3 Top Item: NASA Digital Twin is already here...called HWIL testbed
  - Models for models sake (Distributed, Integrated Lifecycle, etc)
    - TA-11 #2 Top Item: Integrated Simulation - NASA is not here yet...because missions are not 'systems-of-systems' like DoD yet.
- **Consideration: Keep M&S relevant...**
  - Relevant means...Ensuring M&S work gets into flight software, system architecture, engineering operations, and science operations

Autonomous Operations (Adaptive Systems)

- **DS-1 is 12 years old, why hasn't any mission used the technology?**
  - Bernard Paper (AIAA-99-4512); Aljabri Paper (DS-1 Lessons Learned)
    - "*methods do not yet exist to characterize RA's* [the Adaptive System] *expected behavior in novel situations. This made it difficult to precisely specify the boundaries within which RAX* [the Adaptive System] *was guaranteed to act correctly."*
    - *"It is difficult to move past the mindset of expecting complete predictability from the behavior of an autonomous system."*
    - *"It is incumbent upon autonomy technology providers to codify a strategy for system-level verification and validation, and then communicate that to the system test team"*

- **Any Roadmap must consider TESTING for Autonomous Systems**
  - "Trusted Autonomy" is top thing in new Air Force roadmap "**Technology Horizons"**

- **What about Intelligent data understanding (IDU)...**
  - Have you checked with scientists?
    - *IDU vs. "I want all my data back"*
  - Question to consider: Is IDU too mission specific to be on a large scale roadmap?

Food for Thought: Going Holistic

- **Models, Simulations and Flight/Ground S/W are the Same Thing...**
  - Output of M&S can be implementation (not documentation)
  - Provides Rapid Prototype and Test environment (w/ Monte Carlo) early in program life cycle
  - *Where is this starting to happen now...*
    - ***Spacecraft G&C*** *(Matlab Simulink M&S with RTW Autocode)*
    - ***MDA PTSS PAVE*** *(Large Event-based framework with Matlab/C/C++ algorithms that will end up in all CSCIs on the program)*
    - ***Solar Probe Autonomy*** *(FSM diagram-based Executable Specification)*

- **Models, Simulations, and Science Sequences are the Same thing...**
  - Need to make an interface for scientists at their level/context so that they can focus on science and not care about spacecraft
  - *Where is this happening now...*
    - ***SPIKE (Hubble)*** *– scientists submit observations, get data*
    - ***SciBox (CRISM/MESSENGER)*** *–Allows scientist to decide how to use data resources to capture high priority targets. M&S output is directly linked into spacecraft operations planning & commanding.*