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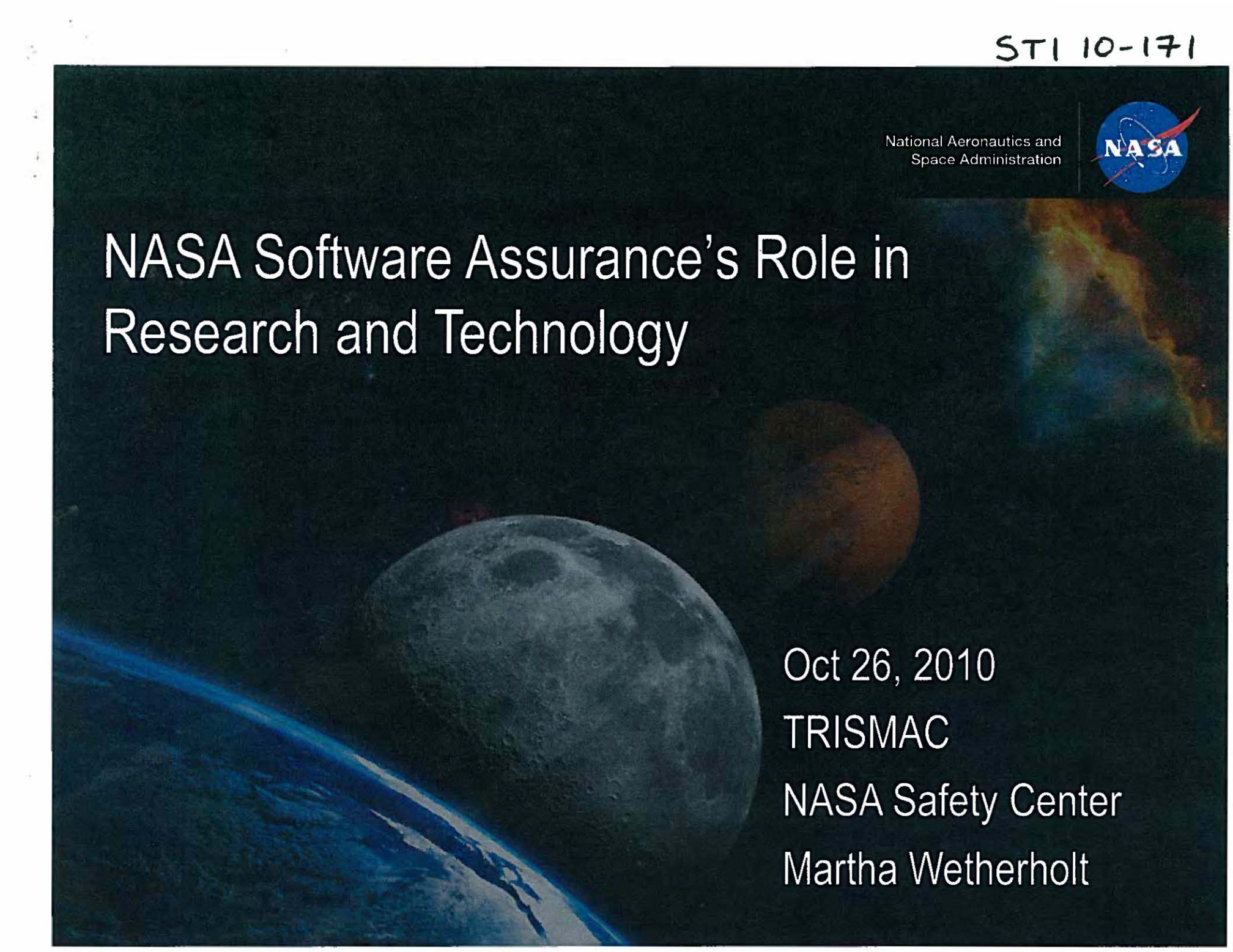

NASA Software Assurance's Role in Research and Technology

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TRISMAC

NASA Safety Center

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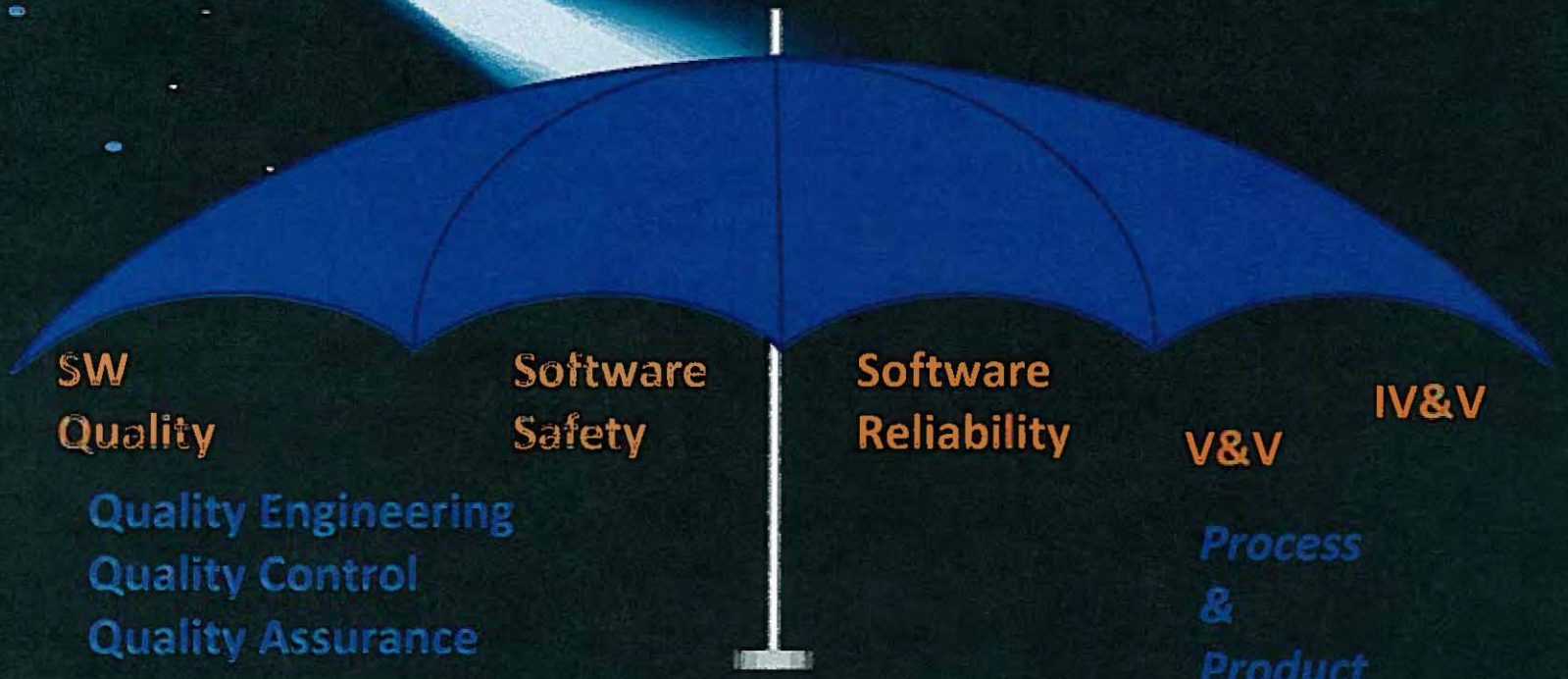
Discussion

- Software Assurance – what it is to NASA
- Research and Technology Use of Software
- Research of New Software Technologies
- Research for Software Assurance
- The Future

What is Software Assurance?

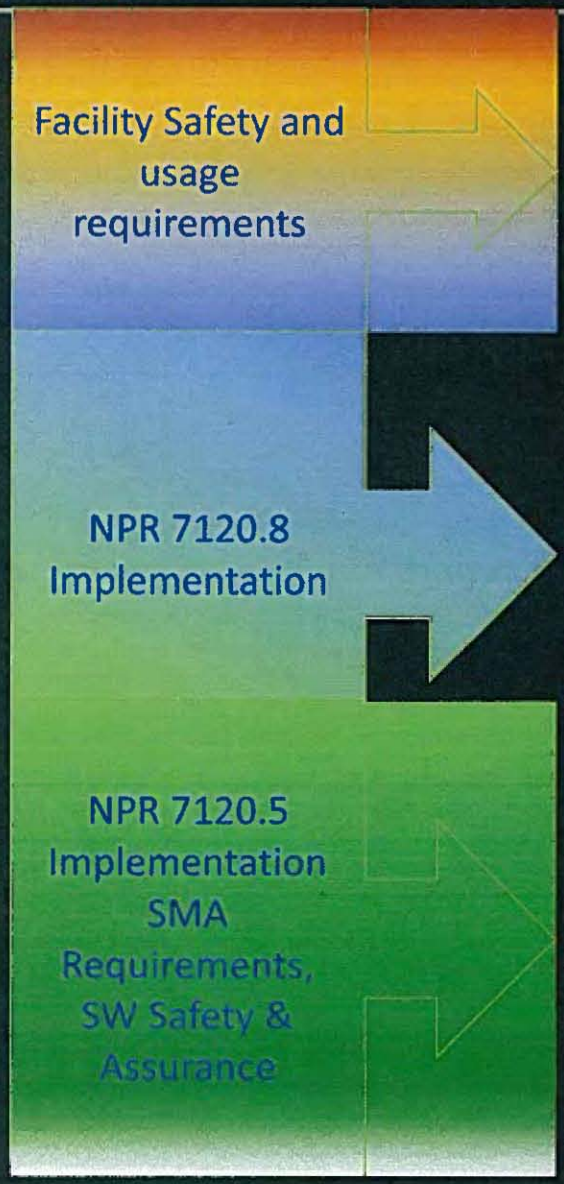
Software Assurance is an umbrella risk identification and mitigation strategy for safety and mission assurance of all NASA's software



Research and Technology Use of Software

- Software is often used to perform simulations and models to prove out ideas and concepts prior to proceeding to another level.
- Software is used to measure and record results
- Software can be used to control and monitor experiments
- Software used to analyze results and predict
- In this role it is critical that the models and/or simulations accurately depict conditions as well as criteria understudy.
- Focus would be on:
  - SW accuracy and limitation of models and or simulations
  - Ability to add health monitoring to experiments w/o changing experiment
  - Speed and amount of data to be collected and processed
  - Software programmer's understanding of needs of researcher
  - Researcher's understanding of software's capabilities and limitations

2 General, Graduated SMA Coverage



Technology Readiness Levels Summary:

TRL 1 Basic Principles observed and Reported

TRL 2 Technology concept and/or application formulated

TRL 3 Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 4 Component and/or breadboard validation in laboratory environment

TRL 5 Component and/or breadboard validation in relevant environment

TRL 6 System/subsystem model or prototype demonstration in a operational environment (ground or space)

TRL 7 System prototype demonstration in an operational environment

TRL 8 Actual system completed and "Flight qualified" through test and demonstration (ground, airborne or space)

TRL 9 Actual system "flight proven" through successful mission operations

Center Institutional Safety Requirements
- High Risk Test Facilities
- Labs
- OSHA
- Industrial Hygiene
- Fire/Life Safety
- Emergency Preparedness

•Awareness and insight both ways

Project dependent,
*Area targeted for SMA improvements

NASA and Center SMA Requirements
- System Safety
- Quality Assurance
- R&M
- Software Assurance
- Risk Management

Research and Technology Use of Software
TRL Level Discussion

TRLs 1-3: mostly paper concepts/theories, simulations, possibly Facility or bench top

TRLs 4-6: use of Facilities and some experimental build up, proof of concepts, where decision to go to flight demonstration is made

TRL 6-9: Flight or Ground Demonstrations

- Software usually written by researcher. SMA may or may not know of any software used in the experiment. If use a NASA Facility to prove out, then must follow facility restrictions and safety requirements.
- Software involvement more extensive and used to monitor and control experiments. Also to analyze results
- As SW becomes more relied on, need to involve SA must be considered to make sure results can be trusted, safety parameters are met and held, possible new software methods are verified.
- SA participates on varied basis based on need/risk which has to be assessed individually
- Project needs to meet flight development requirements for engineering and SMA already in place.

Through out, SMA should gain insight and prepare for possible advancement of technology.

Research of *NEW* Software Technologies

- Software itself is constantly changing, evolving
- How software development is performed
  - Models to code (e.g. UML), auto code generation,
  - New emphasis on architecture paradigms and schemes for certain kinds of SW systems
  - Autonomy
  - Cloud computing
  - Etc.
- What does software run on, what ***will*** it run on?
  - Platforms, OS
  - The FPGA, ASIC, CPLD debate and what else?
  - Parallel processing
  - Distributed networks
  - Systems of systems
  - Net and phone based technologies
- So, how does SW Assurance keep up?

Research for Software Assurance

OSMA has it's own ***Software Assurance Research Program*** (SARP)

- Funded and overseen by OSMA
- Run out of NASA's IV&V Facility
- Yearly Agency-wide survey of SA needs as basis
- Internal and external researchers
  - Center based research
  - Academia
  - Industry
- Peer review of all proposals
- Selection via executive committee
- Selections made and followed up on to assure success (incl. yearly public presentation)
- Most projects are for 3 years
- Technology Transfusion for most promising techniques, processes, etc.

SW Assurance Research Program

OSMA SW Assurance Research

- ~$3. M into SARP annually
- 12-20 Center projects in any one year
- Usually fund each for 3 years
- The most promising research gets and additional year or 2 for SW Technology Infusion
- Sometimes we can go outside and have academic projects

Sample Research we fund or have funded:

- **Contingency SW in Autonomous Systems**
- **SW Process Assurance for Complex electronics**
- **Analyses of defect data and defect detectors**
- **Model Checking of Artificial Intelligence Planners**
- **Testing framework for reproducible execution & race condition detection in real-time embedded systems**
- **Interface Validation for Distributed Software Systems – Phase II**
- **Test Coverage Analysis – A Tandem Experiment using Available Prototypes**
- **Research and Development of Deployable IV&V Methods for FPGA Applications**

SMA considerations for R&T Projects

(Right tools, right time, right extent)

- Criteria for determining S&MA level of involvement [e.g. Pure "paper studies" or data mining may not need S&MA involvement but awareness may still be needed]
  - Current TRL level
  - Difficulty scale to advance technology ("is it a hard nut to crack?"), complexity
  - Risks & risk tolerance (analyzing/managing uncertainties)
  - $$
  - Verifiable outcome
  - Damage likelihood
  - Impact of failed research (including public opinion)
    - Who cares and how much do they care?
  - Potential for future growth/development
  - Ability to test
  - Path to build with reproducibility
  - "Period of performance" drivers?

SW Assurance considerations for R&T Projects

(Right tools, right time, right extent)

1. **Degree of Control:** *The degree of control that the software exercises over safety-critical functions in the system.*
2. **Complexity:** *The complexity of the software system. Greater complexity increases the chances of errors.*
3. **Timing criticality:** *The timing criticality of hazardous control actions.*
4. **Likelihood** a hazard would occur
5. **Severity** of a potential hazard – always take the worst possible case
6. **Reliance on Software to determine successful experiment determination or operation of a demo**
7. **Need for repeatability**
8. **…..**

Challenges - Change the Paradigm

- Same as rest of SMA only more so…..
- Each Researcher sees software as their **tool** to perform or analyze their project
  - Inconsistent approach to how software is written, maintained and used
  - Software not even considered as something that needs to be considered in it's own right
- R&T sees any involvement in SW development itself as potential "road blocks"
  - Expensive and slow
  - Unnecessary
  - Seen as one size fits all
  - We just don't understand their problem… which we may not!
- We need early involvement and awareness to avoid becoming a roadblock if and when the project moves up the TRL scale.
- May be able to point out helpful innovations in SW technologies and methodologies
- Still, We, SA, need to understand the science, technologies, complexities, and risks in order to advise the R&T communities of what SA can do for them.
- Need to shift the paradigm to seeing us as a time and expense savings, not a mindless requirements enforcer ad then live up to that!!

Summary (Cont.)

We need to "Change the Paradigm" :

- Work with the rest of SMA to improve communications & understanding as well as create Training and Awareness Campaigns
- Increase visibility and presence with a questioning interest in what they are trying to achieve
- Make sure Researchers are aware of the benefits of all aspects of S&MA contributions including SA – how do we quickly show them some direct benefits to their project from use of the right software processes for them
- Make sure Software Assurance personnel are aware of the differences in our roles and responsibilities in an R&T environment - keep a light hand in, but keep them safe and help them achieve their goals
- Walk the talk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