Best Practices in Software Assurance

Risha George
Software Safety Lead, GSFC

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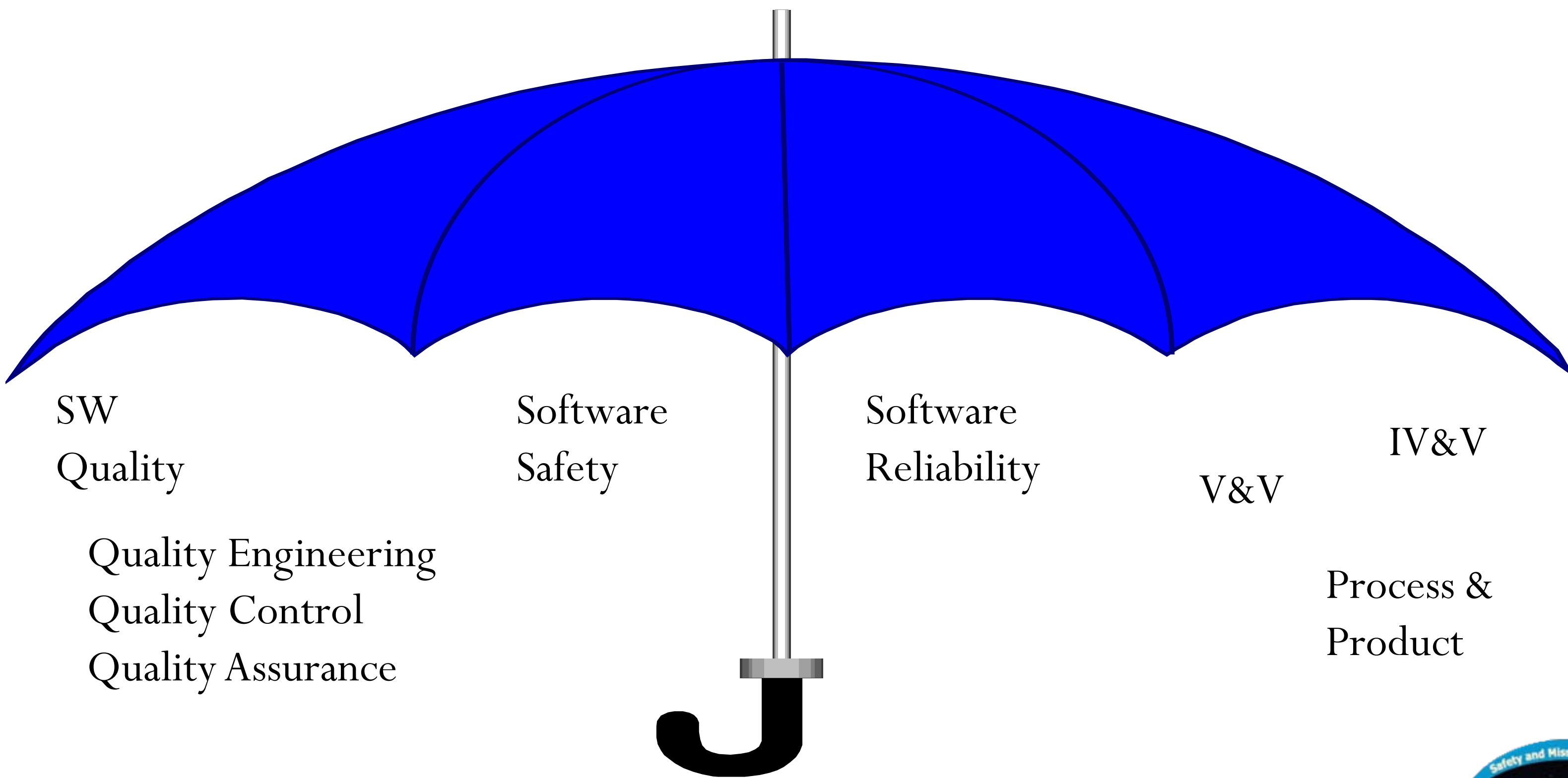
Software Assurance Overview

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



What do we do

- The planned and systematic set of activities that ensure conformance of software life cycle processes and products to requirements, standards, and procedures.
- Assure that software products are of high quality and operate safely
- Assists in risk mitigation by minimizing defects and preventing problems
- Assures that software meets its specified requirements, conform to standards, are consistent, complete, correct, safe, and reliable and satisfy customer needs.
- Assures that all software processes are appropriate and implemented according to plan, meet any required standards, and quality requirements.

Software Assurance Disciplines

- **Software Quality**: planned and systematic set of activities to assure quality is built into the software. Assures that the standards, processes, and procedures are appropriate for the project and are correctly implemented.

- **Software Safety**: a systematic approach to identifying, analyzing, and tracking software mitigation and control of hazards and hazardous functions to ensure safer software operation within a system.

- **Software Reliability**: defines the requirements for software controlled system fault/failure detection, isolation, and recovery; reviews the software development processes and products for software error prevention and/or reduced functionality states

- **Verification and Validation**: verification ensures "you built it right" and validation ensures "you built the right thing"

- **Independent Verification and Validation**: Verification and validation performed by an organization that is technically, managerially, and financially independent.

Early Involvement

- Software assurance activities begin during the concept/initiation phase of the development process and proceed throughout maintenance.
- The goal is to build safety, reliability, and quality into the software product.
- Software assurance partners with engineering, early in the project, to build the highest quality software.
- Software assurance personnel must assure that the right requirements are in place from the beginning.
- Don't wait until CDR or even PDR to add software assurance to a given project.

We need a plan

- Document your software assurance activities in a Software Assurance Plan.
- Software Assurance Plans are typically due at the System Requirements Review (SRR).
- Most organizations have a template for Software Assurance Plans or they follow IEEE-STD-730-2002.
- Don't just write the plan and let it collect dust on the shelf or in your hard drive. Revisit the Software Assurance Plan as the project progresses.
- Get buy-in from the project and your organization on your approach. This is your communication tool.

Tailor Software Assurance Efforts

- Software assurance is a balancing activity that must be tailored as appropriate for each project
- Software assurance activities should be tailored based on risk
- Determine software classification and safety criticality upfront to help scope efforts
- Software assurance engineers must make trade-offs, based on their experience and the software risks on a project.

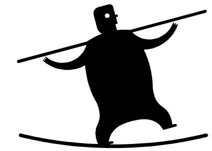
Not a checklist!

- Software assurance is not only about using a checklist to perform process and product audits

- Checklists are important because they provide objective evidence by which a process or product may be evaluated BUT…

- If our main focus becomes a checklist, then we are missing the mark

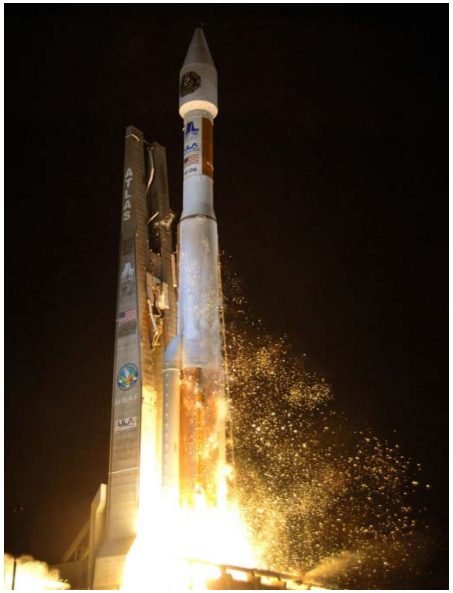
Focus on Reducing Risk



- Identify, address and eliminate software risk items before they become threats to success or major sources of rework.
- Software assurance activities should be driven by risk (includes safety, reliability and quality).
- Need a communication path to management for Software Assurance engineers to raise issues and concerns that they have on a project
- Get involved in the project’s formal risk management process.
- Software assurance engineers can rely on Safety & Mission Assurance technical authority, if necessary.

Good communication is key

- A good software assurance engineer must possess good communication skills.
- Essentially, we are evaluating software products and processes; must be as diplomatic as possible.
- Must win the trust and respect of the software system developers



- In order to make a difference, your ideas and suggestions must be accepted by the project team.
- Building relationships with the project team members is the best way to ensure that your voice is heard.

Maintaining Independence

- Independence implies performing product quality evaluations by an outside organization (NASA governance model)

- Need for independence arises because developer may have a biased expectation of what a product should be; could miss anomalies; could fail to perform certain checks

- Notion of independence is applied to reduce errors resulting from extensive familiarity with the product being evaluated

- Important to maintain independence while still being a team player

It's not ALL about Quality

- Safety and Reliability are critical aspects of software assurance as well as Quality
- A system safety process usually contains the following elements:
  - Planning
  - Identifying and characterizing the hazards
  - Assessing and prioritizing risks and making risk decisions
  - Reducing risks to acceptable levels through valid controls
  - Verifying that risks are reduced
  - Tracking hazards, risks, and problems
- Software safety efforts should include each element of a good system safety process
- Qualitative reliability analysis should also include software as part of the system (e.g. Fault Tree Analysis, Failure Modes and Effects Analysis)

Identifying safety-critical software

- Don’t be afraid to declare software as safety-critical ☺

- How do I know if software is safety-critical?
  - Resides in a safety-critical system (as determined by a hazard analysis) AND at least one of the following apply:
    - 1) Causes or contributes to a hazard.
    - 2) Provides control or mitigation for hazards.
    - 3) Controls safety-critical functions.
    - 4) Processes safety-critical commands or data.
    - 5) Detects and reports, or takes corrective action, if the system reaches a specific hazardous state.
    - 6) Mitigates damage if a hazard occurs.
    - 7) Resides on the same system (processor) as safety-critical software.
  - Processes data or analyzes trends that lead directly to safety decisions.
  - Provides full or partial verification or validation of safety-critical systems, including hardware or software subsystems.

- Software Safety efforts should be based on risk. (See the NASA Software Safety Guidebook, NASA-GB-8719.13 for details)

- Software Assurance engineers must maintain close communication with System Safety engineers in order to make this determination. They should be the liaison between System Safety and the Software Engineers.

Ariane 5 Explosion

Software Safety generic requirements

NPR 7150.2, NASA Software Engineering Requirements, section 2.2.12:

- Safety-critical software is initialized, at first start and at restarts, to a known safe state.
- Safety-critical software safely transitions between all predefined known states.
- Termination performed by software of safety critical functions is performed to a known safe state.
- Operator overrides of safety-critical software functions require at least two independent actions by an operator.
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- Safety-critical software rejects commands received out of sequence, when execution of those commands out of sequence can cause a hazard.
- Safety-critical software detects inadvertent memory modification and recovers to a known safe state.

Software Safety generic requirements

- Safety-critical software performs integrity checks on inputs and outputs to/from the software system.
- Safety-critical software performs prerequisite checks prior to the execution of safety-critical software commands.
- No single software event or action is allowed to initiate an identified hazard.
- Safety-critical software responds to an off nominal condition within the time needed to prevent a hazardous event.
- Software provides error handling of safety-critical functions.
- Safety-critical software has the capability to place the system into a safe state.
- Safety-critical elements (requirements, design elements, code components, and interfaces) are uniquely identified as safety-critical.
- Incorporate requirements in the coding methods, standards, and/or criteria to clearly identify safety-critical code and data within source code comments.

References

- NASA Software Assurance Standard, NASA-STD-8739
- NASA Software Safety Standard, NASA-STD-8719.13B
- NASA Software Safety Guidebook, NASA-GB-8719.13
- NASA Software Engineering Requirements, NPR 7150.2