IV&V at NASA

Presentation to the Software Engineering Workshop

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IV&V

- Verification is defined as the process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase. “Did we build the ***system right***?”
- Validation is defined as the process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements. “Did we build the ***right system***?”
- Independent is defined as being free from fiscal, managerial and programmatic controls by the project that is receiving the IV&V effort

IV&V at NASA

- Recently, in the course of the investigation of some of NASA's most prominent mission failures, it was discovered that faulty software played a large role

- It was further concluded that the lack of proper application of IV&V was a factor in producing the faulty software

- The Agency already had a "Center of Excellence" for IV&V in Fairmont W. VA., but mainly only HEDS (manned) projects were making use of this available resource

NASA's Solution

- Link the IV&V Facility at Fairmont W.V. to a mission development and operations Center (shift management of the IV&V Facility to Goddard)
- Strengthen an existing policy on IV&V performance to the point that all projects, that contain mission critical software, must now consider **and document** their planned IV&V implementation (consultation with the IV&V Facility is also required)
- Develop and publish the criteria for an initial determination of IV&V necessity
- Final IV&V implementation approval left to Governing Program Management Council
- Work with projects to implement IV&V

NASA IV&V Policy

- NASA IV&V Facility is responsible for the management of all software IV&V efforts within the Agency
- Pertains to all programs/projects that provide aerospace products and capabilities, i.e., space and aeronautics, flight and ground systems, technologies, and operations (may exclude projects where NASA is a minor partner)
- Each project must produce, document, and implement a plan that addresses the performance of V&V, and if appropriate, IV&V, over the life cycle of the software

NASA IV&V Policy

- Apply criteria, discuss results with a representative of the NASA IV&V Facility
- Facility personnel jointly with the project office provide recommendations to project what sections and what extent IV&V should be performed
- Project manager documents the IV&V that is intended to be performed
- Level of IV&V activities subject to Facility review
- Conflicts first resolved by Center management
- When the project undergoes significant changes, the project manager must revisit the criteria

NASA IV&V Criteria

- IV&V is intended to assist in mitigating risk

  1) the probability (qualitative or quantitative) that a program or project will experience an undesired event such as cost overrun, schedule slippage, safety mishap, or failure to achieve a needed breakthrough

  2) the consequences, impact, or severity of the undesired event were it to occur

Probability of Failure - Factors

- Software team complexity
  - Contractor support
- Organization complexity
  - Schedule pressure
- Process maturity of software provider
  - Degree of innovations
  - Level of integration
- Requirements maturity
- Software lines of code

Potential for Failure - Categories and Factors

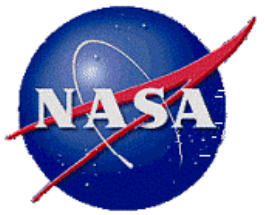
- **Grave, Substantial, Marginal, Insignificant**

- Potential for loss of life
- Potential for serious injury
- Potential for catastrophic mission failure
- Potential for partial mission failure
- Potential for loss of equipment
- Potential for waste of resource investment
- Potential for adverse visibility
- Potential effect on routine operations

Project Projections

Number of Projects Receiving IV&V Support by Year

FY00	FY01	FY02	FY03	FY04	FY05
11	37	42	41	43	37



Back-Up Information

IV&V Budget Projections

Estimated IV&V Budget for NASA Missions

$ M

FY00	FY01	FY02	FY03	FY04	FY05
17.2	33.7	37.9	40.3	41.1	39.6

IV&V Facility Staffing Projections

	FY00	FY01	FY02	FY03	FY04	FY05
At Facility --						
Contractors-IV&V	79	113	123	127	122	111
Contractors-non-IV&V	40	55	49	49	49	49
IV&V Facility CS Staff	12	24	29	35	40	45
Sub-Total in IV&V Facility	131	192	201	211	211	205
At Development Sites	72	94	107	110	112	111
TOTAL	203	286	307	320	323	316

Probability Factor Weighting

Factors contributing to probability of software failure	Un-weighted probability of failure score					Weighting Factor	Likely-hood of failure rating
	1	2	4	8	16		
Software team complexity	Up to 5 people at one location	Up to 10 people at one location	Up to 20 people at one location or 10 people with external support	Up to 50 people at one location or 20 people with external support	More than 50 people at one location or 20 people with external support	X2	
Contractor Support	None	Contractor with minor tasks		Contractor with major tasks	Contractor with major tasks critical to project success	X2	
Organization Complexity*	One location	Two locations but same reporting chain	Multiple locations but same reporting chain	Multiple providers with prime sub relationship	Multiple providers with associate relationship	X1	
Schedule Pressure**	No deadline		Deadline is negotiable		Non-negotiable deadline	X2	
Process Maturity of Software Provider	Independent assessment of Capability Maturity Model (CMM) Level 4, 5	Independent assessment of CMM Level 3	Independent assessment of CMM Level 2	CMM Level 1 with record of repeated mission success	CMM Level 1 or equivalent	X2	
Degree of Innovation	Proven and accepted		Proven but new to the development organization		Cutting edge	X1	
Level of Integration	Simple - Stand alone				Extensive Integration Required	X2	
Requirement Maturity	Well defined objectives - No unknowns	Well defined objectives - Few unknowns		Preliminary objectives	Changing, ambiguous, or untestable objectives	X2	
Software Lines of Code***	Less than 50K		Over 500K		Over 1000K	X2	
Total							

Table 1 Likelihood of Failures Based on Software Environment

Criteria Results Determination