



FAQ 04

Did NASA implement Independent Verification and Validation (IV&V) as part of a solution to their software problems?

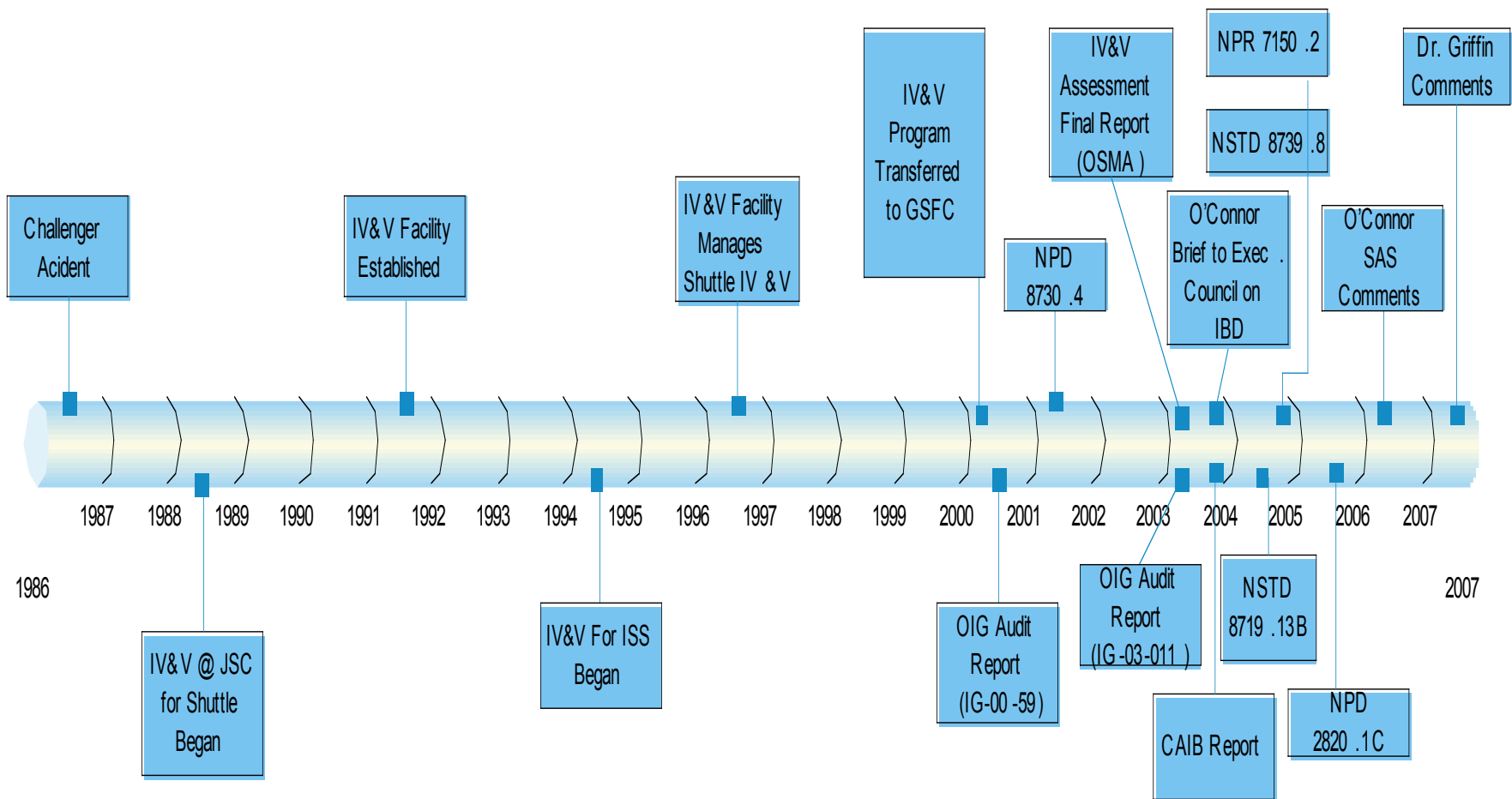
The Beginning of IV&V in NASA



- Independent Verification and Validation (IV&V) has evolved to become a major part of the Agency's solution to their software problems.
- After the Challenger accident in 1986, the President asked for an independent review of the incident. The following report was generated:
*Report of the Presidential Commission on the Space Shuttle Challenger Accident (In compliance with Executive Order 12546 of February 3, 1986)*¹

–In the Safety Organization section, the commission made this recommendation:
“NASA should establish an Office of Safety, Reliability and Quality Assurance to be headed by an Associate administrator, reporting directly to the NASA Administrator. It would have direct authority for safety, reliability, and quality assurance throughout the agency. The office should be assigned the work force to ensure adequate oversight of its functions and should be independent of other NASA functional and program responsibilities.”
- The Office of Safety and Mission Assurance (OSMA) was created and Independent Verification and Validation (IV&V) became a valuable part of the assurance program and the Space Shuttle Program starting in 1988.

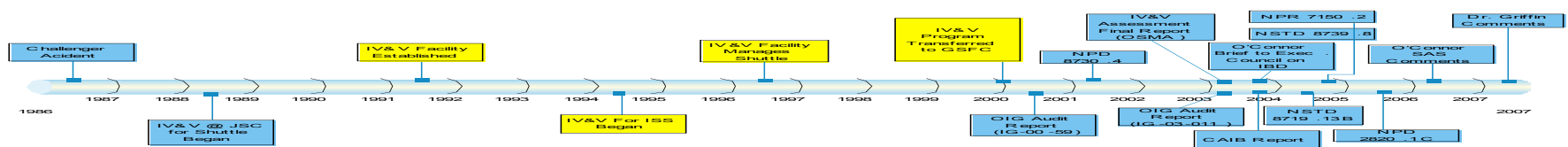
The IV&V Program Has Evolved Over Time





NASA Created the IV&V Program

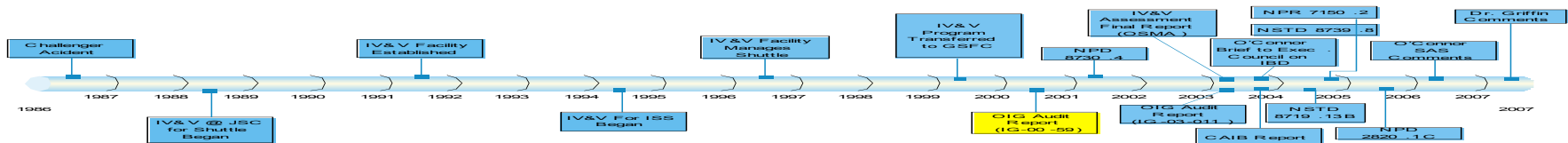
- 1991 - In recognition of the benefits of and need for IV&V as part of NASA's assurance program, NASA established the IV&V Facility in Fairmont, West Virginia.
 - Initiated through the FY92 VA-HUD-Independent Agencies Appropriations Act (P.L. 102-139)
- 1994 - The IV&V Facility started performing IV&V for the International Space Station (ISS) Program via a Navy Sub-contract.
- 1995 - OSMA transferred the management of the IV&V Facility from NASA HQ to the Ames Research Center. Ames was the Center of Excellence for software development at that time.
- 1996 - IV&V established its first NASA contract enabling IV&V be performed for projects and programs across the Agency.
- 2000 - NASA transferred the management responsibility from Ames to Goddard. The transfer was intended to better integrate the IV&V Facility into the software development life cycle of NASA's programs and projects.



NASA OIG Evaluated the IV&V Program



- A September 28, 2000, OIG Audit Report focused on determining whether the Agency had established adequate guidelines for using independent verification and validation (IV&V) during the software life cycle and whether program and project managers had implemented NASA's IV&V Facility recommendations to perform IV&V. ²
 - Findings:
 - NASA lacked adequate management controls for using IV&V in software development projects.
 - NPD 2820.1 did not include specific criteria for determining whether IV&V is appropriate for a software development project.
 - "...NASA had not established guidelines to help ensure that program and project managers adequately address the recommendations." (referring to IV&V recommendations to perform IV&V on a project)



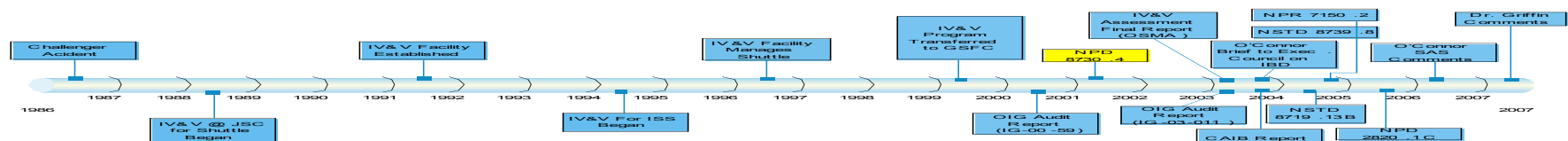


NASA Software IV&V Policy

- 2001 - NPD 8730.4 Software IV&V Policy, was created which:
 - Defined the criteria and characteristics utilized to define the IV&V effort
 - Assigned management of all IV&V efforts to the NASA IV&V Program
 - Required all projects and programs to work with NASA IV&V to assess the level of IV&V required, and required that all decisions regarding the use of IV&V be documented

Note: NPD 8730.4 was cancelled in 2005 because the following two documents captured what was originally in NPD 8730.4:

- NASA Standard (STD) 8719.13B, July 8, 2004, Software Safety Standard ³
- NASA Standard (STD), 8739.8 w/change 1, July 28, 2004, Software Assurance Standard ⁴





Another NASA IG Report

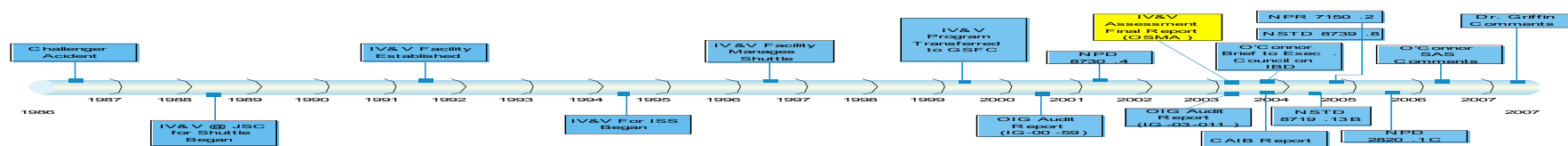
- 2003 – Another Office of Inspector General Audit Report was generated titled, *Independent Verification and Validation of Software, March 28, 2003 (IG-03-011)* ⁵
(www.hq.nasa.gov/office/oig/hq/audits/reports/FY03/pdfs/ig-03-011.pdf)
 - Report was to focus on IV&V effectiveness and ability to ensure that the appropriate level of IV&V was performed for each project.
 - The IG found that NASA had not effectively ensured that all applicable software development projects were assessed to determine their appropriate level of IV&V.
 - As a result of this condition, the report stated that the safety, quality, and reliability of some of the Agency’s programs and projects, including mission-critical programs and projects, could be compromised.
- The primary recommendation was that the Agency should ensure all projects are assessed for IV&V by providing a list of software development efforts to IV&V.
 - As a result, the NASA Chief Engineer and OSMA initiated a process to ensure that a complete and accurate list of programs and projects was provided to IV&V.



OSMA Initiated Review



- In response to the OIG report, OSMA initiated another review to ensure that IV&V was meeting the needs of the Agency ⁶
- Purposes of the assessment:
 - Understand the current IV&V procedures, processes, and products
 - Document IV&V penetration across the Agency
 - Compare of IV&V usage within NASA to DOD
 - Review IV&V customer feedback to identify areas for improvement
 - Understand IV&V impacts on projects, enterprises, and the Agency
 - Understand cost estimates and profiles
 - Identify similarities/differences between NASA IV&V and Industry

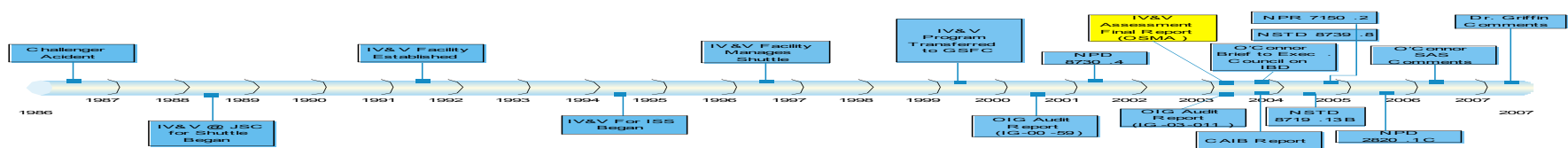


OSMA Review Findings



- Major findings of the IV&V Assessment Final Report:
 - The startup process needs improvement to minimize cost negotiation with projects – was delaying IV&V start for more than a year at times
 - Link IV&V effort to project software milestones, and refine the self assessment criteria and process
 - All of this was intended to allow IV&V to activate quicker and earlier in the lifecycle
- The resulting recommendations were:
 - Assign Code Q the responsibility for oversight of IV&V funding
 - Identify liaisons to facilitate coordination between IV&V and centers, programs and projects
 - Establish a NASA HQ IV&V Review Team (now called the IV&V Board of Directors) to select projects for IV&V, recommend IV&V annual budget, and review IV&V expenditures and accomplishments
 - Establish a team to revise the self assessment criteria, document the IV&V cost model(s), and create an IV&V work breakdown structure
 - IV&V should respond to the finding regarding the lack of metrics

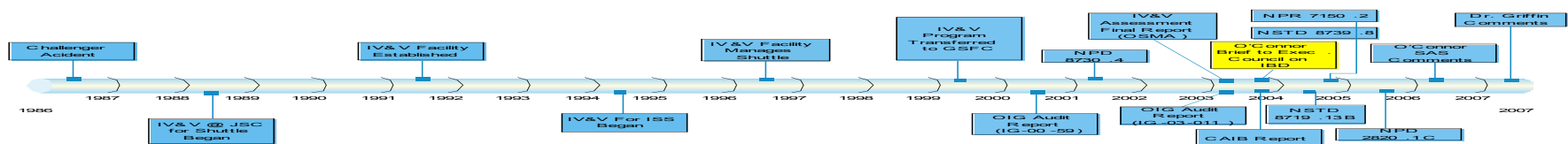
All recommendations were implemented; the last two were completed internally by the NASA IV&V Program



OSMA Report to Executive Council



- The 2003 OIG and OSMA assessment recommendations were summarized and presented to the NASA Executive Council by Bryan O'Connor on May 13, 2003⁷
 - Concerns presented:
 - Lack of independence
 - Lack of stable funding basis
 - Recommendations:
 - Create HQ IV&V Board of Directors to select projects for IV&V support and set annual IV&V budget
 - Centralize financial management of IV&V funding under Code Q (OSMA) using Agency G&A funds
 - Code Q to assure IV&V performance (as a functional management role)



Significance of Independent Funding



- **Financial Independence (IEEE definition):** Requires that control of the IV&V budget be vested in an organization independent of the development organization.
- NASA providing independent funding to the IV&V Program instead of having IV&V negotiate with each Mission Directorate or project each year was a critical issue in making the IV&V Program more effective and efficient!
 - Eliminate the problem of IV&V getting started late in the life cycle due to negotiations with the project as identified by the IG and the OSMA Review
 - Allow IV&V to focus on technical work
 - Enable IV&V to establish long term IV&V plans for projects
 - Enhance the initial relationship between the project and IV&V - remove the unfunded mandate of IV&V from the project

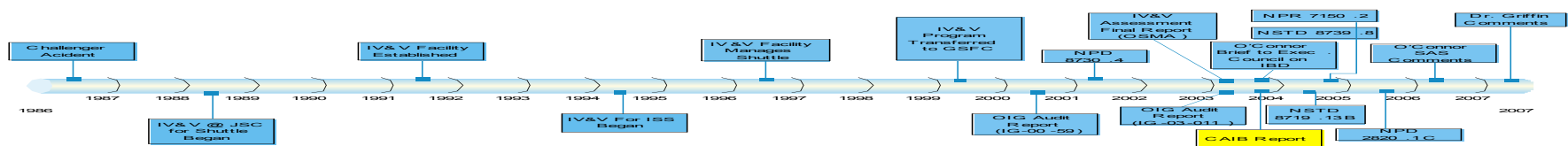
Removing IV&V funding from the Mission Directorates and projects would address the negative OIG and OSMA findings and remove the hindrances of performing IV&V appropriately!



Columbia Accident Investigation Board



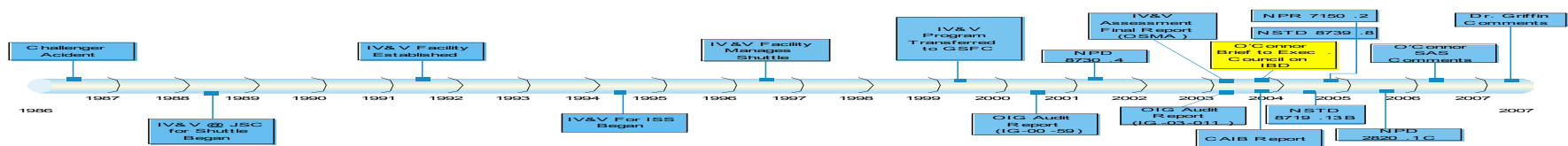
- The August 2003 Columbia Accident Investigation Board (CAIB) report made some comments regarding IV&V ⁸
 - provided additional justification for an "all or nothing" approach to IV&V
 - OSMA should be independently resourced (from the program safety organizations)





IBD Brief to Executive Council

- September 16, 2003, Bryan O'Connor, OSMA Associate Administrator, briefed the Executive Council on the status of the IV&V Board of Directors⁹
- Primary Goals of the IBD
 - Allow IV&V to be an Agency Service
 - IV&V support determined at Agency Level
 - Level of IV&V should be based on software criticality
 - Allow IV&V to do independent assessments
 - No financial or technical control by projects
 - IV&V is not necessarily required by the projects, but is in addition to verification and validation done by projects
 - OSMA to oversee IV&V
 - Assure technical expertise through auditing
 - Assure stable funding thru IBD and agency service pool



NASA Software Safety Standard



- July 8, 2004 – NASA Software Safety Standard (STD) 8719.13B, w/Change 1, was generated³
 - Defines IV&V as: Verification and validation performed by an organization that is technically, managerially, and financially independent of the development organization. IV&V, as a part of Software Assurance, plays a role in the overall NASA software risk mitigation strategy applied throughout the life cycle, to improve the safety and quality of software systems.
 - Clearly establishes that IV&V plays an important role in Software Assurance
 - Requires that IV&V be addressed in Project's Software Safety Plans



NASA Standard for Software Assurance



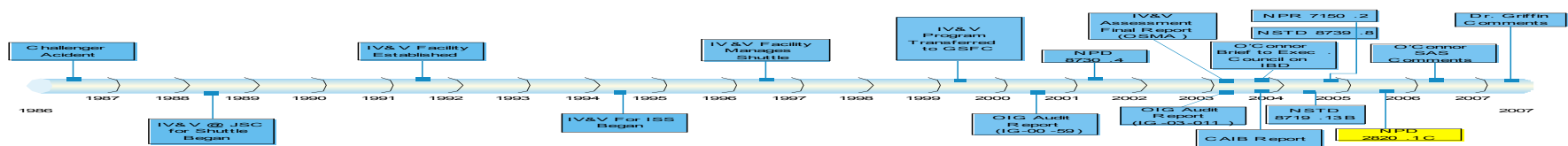
- July 28, 2004 - NASA Software Assurance Standard (STD), 8739.8 w/change 1, was generated ⁴
(www.hq.nasa.gov/office/codeq/doctree/87398.pdf)
 - Defines IV&V just as the Software Safety Standard did: Verification and validation performed by an organization that is technically, managerially, and financially independent. IV&V, as a part of software assurance, plays a role in the overall NASA software risk mitigation strategy applied throughout the life cycle, to improve the safety and quality of software.
 - Clearly establishes that IV&V plays an important role is Software Assurance.
 - IV&V is a NASA software risk mitigation strategy applied throughout the life cycle of the project
 - Selection of software projects for IV&V support will be based on the results of the Software Assurance Classification Assessment (section 7.5)
 - IV&V focuses on mission critical software with the highest risk





NASA Software Policy

- August 31, 2005 - NASA Policy Directive 2820.1C, NASA Software Policy ¹⁰
 - Establishes the policy for NASA to use the NASA IV&V Facility as the sole provider of IV&V services when software created by or for NASA is selected for IV&V (section 1, statement c)
 - Gives the Chief of OSMA the responsibility to oversee the functional management of the NASA IV&V Program and assure the performance of all of IV&V processes, services, and activities (section 5, statement c.6)
 - Directs the NASA Chief of OSMA to chair the IV&V Board of Directors which makes prioritized recommendations for allocating IV&V services based upon the annual Software Inventory (section 5, statement c.8)



OSMA Chief Supports Early IV&V Involvement



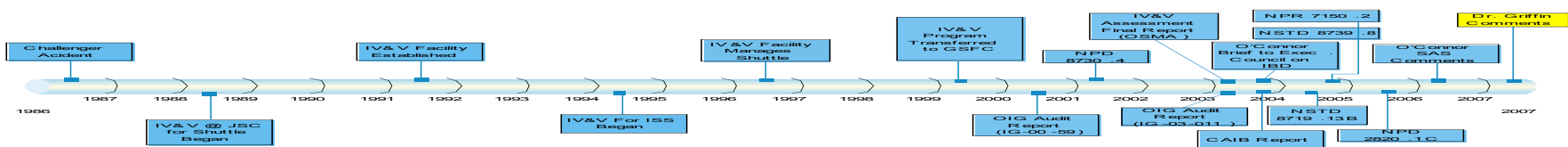
- August 2006 – Mr. Bryan O’Connor, Chief of the Office of Safety and Mission Assurance, during his presentation at IV&V’s annual Software Assurance Symposium (SAS’06), made several statements supporting IV&V being applied early to ensure the requirements are correct
 - ... we need to remember that we are doing systems engineering when we do IV&V, when we do software assurance, when we do software reliability and safety. That’s systems engineering and a key part of that systems engineering is the front end of the V (the systems engineering V), the part where we’re looking at the requirements. We need to do a better job of that. We need to incorporate the users in a way that we become them when we test their stuff.
 - The one area I worry most about in software is the requirements part. I think we’ve really nailed how to check to see if the software works as we want it to . . . what I worry a little bit about is how to capture the knowledge that it takes to figure out if the requirements are good in the first place. A lot of the SW related mishaps had to do with bad requirements.
 - One of the things we have to do is figure out how to do all this stuff. . .and do it more efficiently. [Reference specifically to IVV] “more bang for the buck”



Administrator Supports Early IV&V Involvement



- August 2007 - Dr Griffin, NASA Administrator, on his 8/30/07 visit to IV&V, made several statements supporting IV&V being applied early to ensure the requirements are correct: :
 - **IV&V's Approach is in-line with the Administrator's guidance** of having the most affect early on in the Development Life-Cycle.
 - **The Administrator endorsed IV&V's early, upfront philosophy.** “We need more players contributing to the early development efforts rather than umpires at the end.”
 - **The NASA Administrator directed the Facility to help lead the way regarding software engineering.** “NASA IV&V must maintain software engineering excellence and continually incorporate state-of-the-art software engineering advances to support NASA programs and projects.”
 - **Full concurrence and support for ideas instituted by Dr. Caffall (IV&V Program Manager):** Iterative thinking/mindset; Agile/Value Chain Thinking; Early and upfront feedback on the system being developed provides greater benefit, as opposed to, after the fact and/or end of the lifecycle.





IV&V Plays an Important Role in NASA

- IV&V is recognized by industry and NASA as a systems engineering activity that improves the software development process
- NASA has evolved the IV&V Program significantly over the past several years
- The IV&V Program has been assessed and validated several times
- NASA has fully adopted and documented IV&V as a major contributor to mission assurance
- NASA management has clearly expressed and documented the expectation that IV&V needs to get involved early in the life cycle

Remaining independent (technically, managerially, financially), involving IV&V early, and staying in phase with the development life cycle provides the best value to NASA and to the projects' mission success!

FAQ-4 Bibliography



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