Standard Processes for Verification and Validation of Sensors and Systems in Drilling

SOUTHWEST RESEARCH INSTITUTE®

Maria Araujo

Southwest Research Institute

©SOUTHWEST RESEARCH INSTITUTE

Verification and Validation Standardization JIP

- What is V&V
- SwRI Background and IV&V Experience
- Rationale
- Business Impact
- Technical Objectives
- Principal Investigators
- Methodology
- Deliverables
- Start-up, duration, cost

©SOUTHWEST RESEARCH INSTITUTE

What Is Independent Verification and Validation (IV&V)?

- Independent – A separate organization from the provider of a service or product
- Verification – Checking that a work product meets requirements
- Validation – Checking that a work product operates properly in its intended environment
- IV&V uses independent organizations to develop test procedures that are used together for checking that a product, service, or system meets requirements and specifications and that it fulfills its intended purpose
- IV&V is typically applied to life/safety critical systems and high value systems
- IV&V is often applied to critical sensors and critical systems by organizations such as NASA, DoD, and other organizations with high value assets and life/safety concerns

©SOUTHWEST RESEARCH INSTITUTE

Need for Independent Verification and Validation of Sensors and Systems in Drilling

©SOUTHWEST RESEARCH INSTITUTE

Why Do We Need a Standard Way to Do IV&V of Sensors and System in Drilling?

- Some critical equipment and sensors employed in drilling are inadequate in a number of ways; e.g. some equipment:
  - Are not regularly calibrated nor maintained
  - Measure properties in the wrong location invalidating the value they purport to represent
  - Are not fully adequately designed for the function they are intended to operate.
- Communication channels transferring the data from point of acquisition to an end operator or analyst are susceptible to reliability problems, such as latency problems and packet drops.
- The Operators Group on Data Quality (OGDQ) has identified multiple drilling sensors in use today that exhibit output errors greater than the accuracy needed for current drilling operation and analysis.
- The growing application of drilling automation to various aspects of drilling operations (steering, tagging bottom, drilling-a-stand, etc.) increases requirements on sensor data as well as proof that systems function as described.

©SOUTHWEST RESEARCH INSTITUTE

Why Do We Need a Standard Way to Do IV&V of Sensors and System in Drilling? (Cont'd)

- Multiple systems are emerging as panaceas to mapping missing data, analyzing large amounts of data (big data and predictive analytics), and modeling various drilling processes
- Many of these systems have not been verified in terms of capability, reliability and validity
- Often, each client (operator / drilling contractor) tries to validate these systems as black boxes, with various methods and varied results
- DSA has brought to the fore a need for formal verification and validation certification to ensure reliability and safety of interconnected drilling automation systems

©SOUTHWEST RESEARCH INSTITUTE

There is a need to formally verify and validate sensors and systems

- The value in aviation, transportation and space from verification and validation programs for sensors and systems is millions of dollars.
- The cost of poor quality data from sensors and systems can range from performance reduction through to catastrophic events
  - The former amounts to at least $100,000's for the lower cost operations
  - The latter can eventually ruin a company.

©SOUTHWEST RESEARCH INSTITUTE

What's IV&V Again?

- The PMBOK guide, a standard adopted by IEEE, defines verification and validation as follows in its 4th edition:

  - "Verification. The evaluation of whether or not a product, service, or system complies with a regulation, requirement, specification, or imposed condition. It is often an internal process. Contrast with *validation*."

  - "Validation. The assurance that a product, service, or system meets the needs of the customer and other identified stakeholders. It often involves acceptance and suitability with external customers. Contrast with *verification*."

©SOUTHWEST RESEARCH INSTITUTE

Business Impact and Benefits of IV&V

- Suppliers
  - Externally defined program through which sensors and systems can be verified
  - Accelerate delivery to market via a single formal test
  - Do not have to individually satisfy a sequence of tests for each customer
- Customers
  - Have an expert-defined test to verify sensors and systems
  - Do not have to invent their own tests
  - Faster access to certified sensors and systems
- Overall
  - Verification of accuracy and efficacy of sensors and systems
  - Transparency of quality of sensors and systems
  - Avoiding safety, risk, and costly consequences

©SOUTHWEST RESEARCH INSTITUTE

Joint Industry Program

Independent Verification and Validation of Sensors and Systems in Drilling

©SOUTHWEST RESEARCH INSTITUTE

IV&V JIP Technical Objectives

- While individual operators have conducted verification and validation activities, there has been no consistent set of defined requirements for the sensors and systems
  - There has been no consistent verification standards or standards for validation of sensor and systems functionality.
- The IV&V JIP will facilitate the development and implementation of standardized verification and validation activities that can provide common and standardized results that can be used by oil industry players to ensure that the sensors and systems used in drilling displays, drilling controls, data analytics and automating drilling activities provides the capabilities and accuracies needed.
- The results from the program will be the publication of an agreed industry methodology which can be implemented by any recognized and competent independent organization including, but not limited to, SwRI.

©SOUTHWEST RESEARCH INSTITUTE

IV&V JIP Technical Objectives (Cont'd)

- IV&V applied to drilling sensors and systems will require a tiered approach that recognizes the various different uses of the data.
- The specific levels will be developed by the Steering Committee; however an indication is given below based on the various uses of sensor data on drilling rigs and drilling operations:
  - Display onsite real time: to the operator (driller, directional driller, etc.) for action implementation by that person and for alarms
  - Display remote: to the remote engineers and analysts
  - Detailed analysis: suited for real time use in models and simulations
  - Control: of equipment and machines under human supervision
  - Autonomous: fully autonomous acquisition, analysis, decision and action implementation.

©SOUTHWEST RESEARCH INSTITUTE

Technical Objectives

- Objectives
  - To ensure that sensors and systems provide the capabilities and accuracies needed
  - Develop a set of requirements for sensors and systems
  - Based on agreed to standards develop standards for the verification and validation of sensors and systems in drilling
- Phases
  - Phase I Stage I
    - Using drilling experts, clarify the scope of sensors and systems
    - Develop solution for one or more primary systems
    - Demonstrate the validity of the method
  - Phase I Stage II
    - Rank importance of sensors and systems
    - Schedule development of solutions
    - Align schedule to funding
    - Develop and review stage gate timeline

©SOUTHWEST RESEARCH INSTITUTE

Methodology

- Independent verification and validation is a well-developed and defined (e.g. IEEE Std. 1012-1998) practice based upon systems engineering.
- As defined in the IEEE standards, IV&V processes include activities such as assessment, analysis, evaluation, review, inspection, and testing of software products and processes.
- Realistic, fit for purpose and effective IV&V programs are driven by industry experts to which the IV&V program will apply.

©SOUTHWEST RESEARCH INSTITUTE

Methodology: Details

- Classify the sets of sensors and systems for which standards should be developed
  - Use DSA Roadmap systems of systems/systems of interest
  - Use Drilling Information Model for classifying data sources
- Prioritize the classes of sensors and systems based on impact
- Create sub-groups for the high priority classes of sensors and systems
- For each of the high priority classes:
  - Identify a set of minimum characteristics
  - Identify additional relevant characteristics
  - Specify minimum requirements
  - Define a set of tests the class must pass
  - Implement the minimum set of tests
  - Define additional tests to further characterize the members of the class
  - Validate the tests by testing a sample of members of the class

©SOUTHWEST RESEARCH INSTITUTE

Deliverables

- The Verification and Validation Working Group will develop a series of deliverables that begin with general planning documents and proceed through identification of working group members, classes of sensors and systems to be evaluated, prioritization of the classes, plans for the development of class specific requirements and resulting verification and validation tests, and eventually of operational verification and validation tests for various classes of sensors and systems.

- The deliverables will be phased such that successful completion of a phase opens the door to funding and implementation of the next phase. The initial phase is designed to develop the scope of application and to develop one application with immediate benefit in order to demonstrate the validity of this approach to drilling sensors and systems.

©SOUTHWEST RESEARCH INSTITUTE

Deliverables

- Phase I
  - The initial deliverable from the Working Group will be a fully fleshed out plan for the development of standards for the verification and validation of sensors and systems used in drilling operations and drilling analytics including the automation of drilling.
  - An initial set of working group members will be identified and tasks will be assigned to those members.
  - Phase I deliverables will also include an initial set of classes of sensors and systems and a rough prioritization of those classes.
  - One simple high priority application will be developed as proof of concept (application of IV&V to drilling).

©SOUTHWEST RESEARCH INSTITUTE

Deliverables

- Phase II – For each class
  - In Phase II the workgroup's efforts will be separated by sensors and system class according to the Systems of Interest in drilling operations.
  - Sub-work groups will be created and will focus on the identification of the minimum requirements for each class of sensors and system followed by the identification of the various characteristics that further identify the capabilities and attributes of the members of that class of equipment.
  - Phase II will end with the identification of test strategies and tests to characterize the members of the various classes.
- Phase III
  - In Phase III the subgroups formed in Phase II will focus on the creation of the tests that illuminate the characteristics of the members of a class of sensors or systems.
  - The tests will not only determine whether an item meets the minimum requirements for that class, but will also illuminate the other characteristics deemed important by the subgroup so that operators can determine if a specific item is appropriate for a given task.

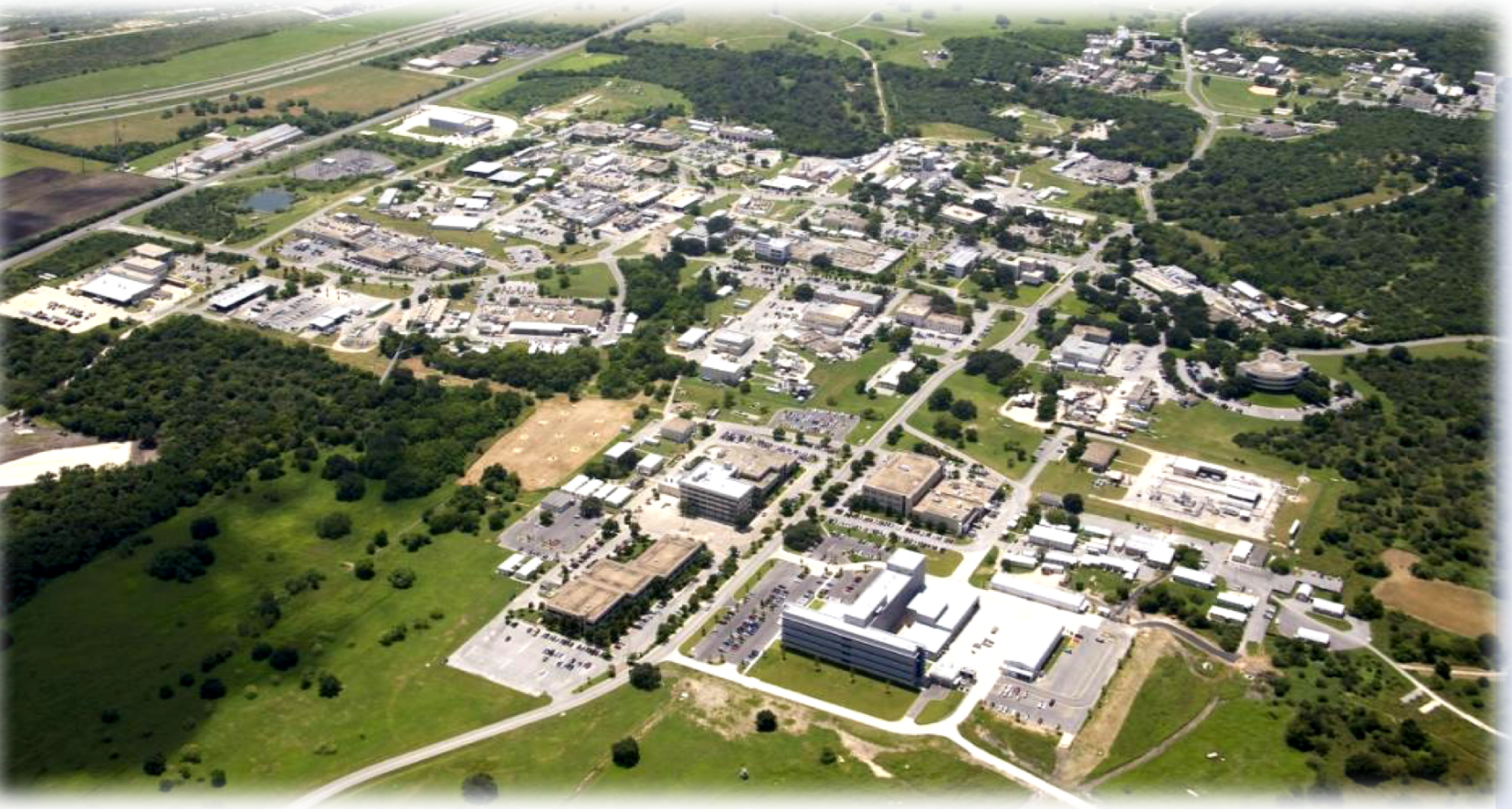
©SOUTHWEST RESEARCH INSTITUTE

Leading Organization: SwRI

- SwRI has significant experience in a number of areas relevant to the development of a set of standards for the verification and validation of sensors and systems used in Drilling.
- SwRI has been involved in the development and implementation of IV&V in advanced industries that rely on data for analysis, control and automation namely commercial aviation, transport, aerospace for decades.
- SwRI has also conducted verification and validation of a variety of sensors and systems, both as a part of the development of the sensors and systems and on behalf of a variety of clients.
- As an independent, not-for-profit organization, SwRI is uniquely positioned to lead the working group in developing common standards for sensors and systems, including standards for the verification and validation of the equipment.

©SOUTHWEST RESEARCH INSTITUTE

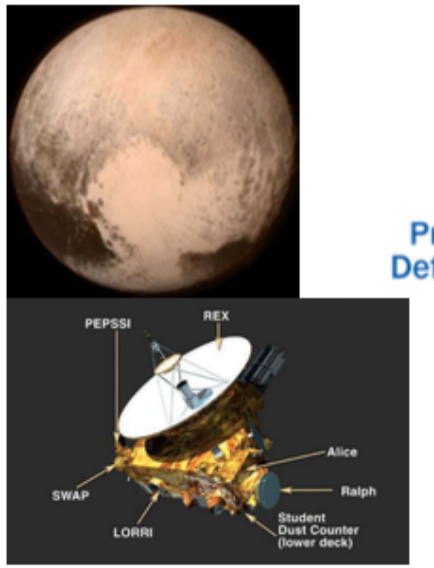
SwRI Background



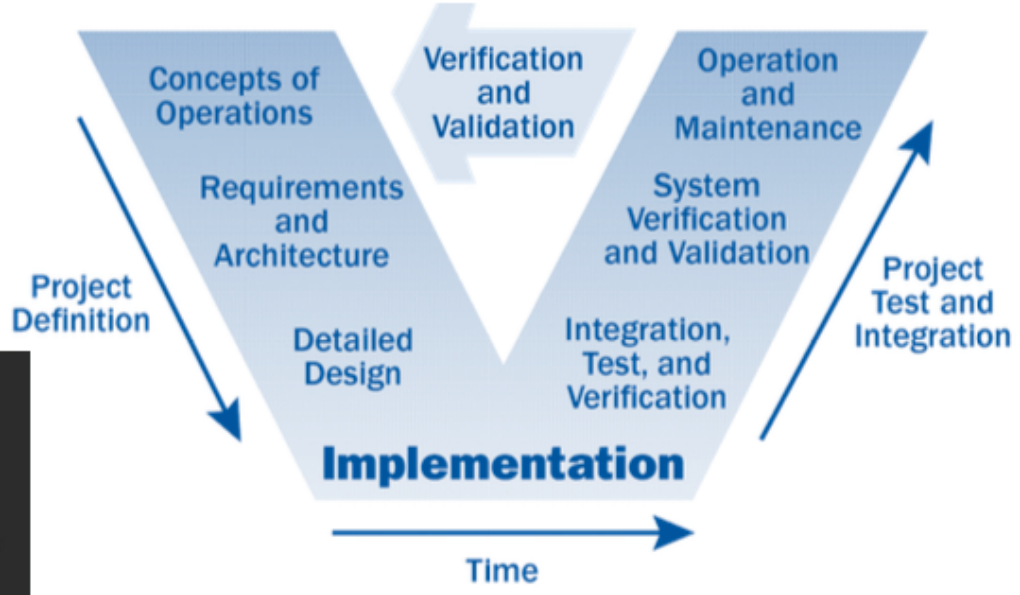
- Nonprofit
- Founded in 1947
- Independent & unbiased
- Betters mankind through science and technology
- Develops and transfers technology
- Over 2,600 employees
- Over 1,200 acres / 4.86 km^2 facility in San Antonio, Texas
- 2.2 million ft^2 / 204,400 m^2 of laboratories & offices

©SOUTHWEST RESEARCH INSTITUTE

IV&V at SwRI – Experience Across Multiple Industries



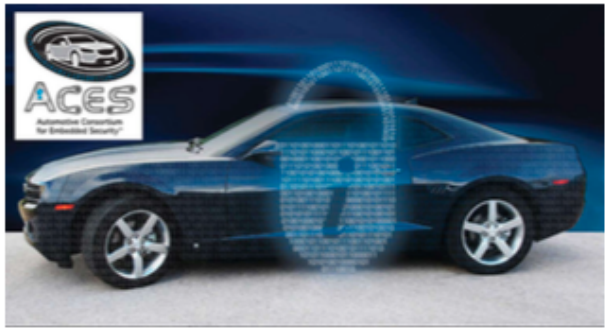
Space



Leisure

Military

Nuclear



Transportation

©SOUTHWEST RESEARCH INSTITUTE

SwRI IV&V and DSA Roadmap

- SwRI has extensive IV&V experience in multiple domains including power systems, space systems, transportation (air and ground systems), aerospace, and medical systems.
- SwRI performs IV&V across disciplines (mechanical/materials, electronics, and software)
- Most systems include real-time embedded software, programmable logic controllers, and other programmable hardware, and typically feature high energy potential (safety critical)
- SwRI have been steering committee member of the DSA Roadmap initiative since its inception
- SwRI was requested by the DSA Roadmap Industry Initiative to address IV&V for the drilling industry through leading a group JIP

©SOUTHWEST RESEARCH INSTITUTE

JIP Leadership

- Southwest Research Institute
  - Program Manager: Maria Araujo (Manager R&D, SwRI). Manage the program using SwRI knowledge of the process.
  - Deputy Program Manager: Paul Wood, (Staff Analyst, SwRI). Co-manage the program along with Maria using SwRI knowledge of the process.

- DE WARDT AND COMPANY
  - Deputy Program Manager: John de Wardt, President, Program Manager DSA Roadmap Industry Initiative, Board Member SPE DSATS
  - Provides primary link between SwRI and relevant industry groups (SPE DSATS, SPE WBPTS, SPE DUPTS, IADC, IADC ART, OGDQ, Energistics, OPC Foundation, …..)
  - Provides primary link between SwRI and relevant drilling industry experts
  - Primary advisor on plan and implementation

©SOUTHWEST RESEARCH INSTITUTE

JIP Steering Committee

- Selected drilling industry leaders from various organizations whose purpose is to steer this initiative in the best interests of the industry and JIP Funders and to identify the right industry experts to advise technical aspects of drilling, drilling sensors and drilling systems. Members nominated by their respective organizations.
  - SPE DSATS
    - Mark Anderson, Deputy Chairman SPE DSATS, Manager Drilling Mechanics Technologies, Shell Int E&P
    - Tony Beebe, Board Member SPE DSATS, Sr. Vice President, Project Management and Engineering, Northern Offshore
  - IADC ART
  - OGDQ
  - ISCWSA / SPE WBPTS
  - Energistics
    - Ross Philo, President and CEO, Energistics
  - JIP Funders:
    - One person per funder

©SOUTHWEST RESEARCH INSTITUTE

JIP Advisors and Experts

- Advisors
  - Some important, knowledgeable people who say they are too busy to be involved but yet ones we want to give us their guidance (intermittently).
- Experts
  - Drilling industry experts from across the chain of sensors through to end users who are selected by the steering committee to provide the technical input to SwRI for formulating the proposed solution. These experts will also review and verify the planned solutions together with the steering committee to ensure suitability in the drilling industry.

©SOUTHWEST RESEARCH INSTITUTE

JIP Cost, Duration, Etc.

- **Start-up Date:**
  - Start-up date for the initial phase can occur within 30 days of the confirmation of funding for the program.
- **Project Duration:**
  - The duration of the first phase of the effort is estimated at 9 months. Additional phases will occur for specific classes of sensors and systems and their start dates and durations will be determined by the sub-working groups formed for those classes of equipment and systems.
- **Project Cost:**
  - The quoted price for Phase I of the effort includes:
  - Costs of SwRI leadership and implementation
  - Costs for DE WARDT AND COMPANY (John de Wardt) project advise and steering.
  - The budget for Phase I is $TBD.
- **Cost per participant:**
  - The funding for Phase I is proposed as $TBD from 10 companies
  - Additional Phases – based on class complexity and size

©SOUTHWEST RESEARCH INSTITUTE

Questions?

Maria Araujo

Manager R&D

Southwest Research Institute

210-522-3730

Maria.Araujo@swri.org

©SOUTHWEST RESEARCH INSTITUTE