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

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#### **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



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#### 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



#### **SwRI Mission and Purpose**

Benefiting government, industry and the public through innovative science and technology

- Founded in 1947 by Thomas Baker Slick, Jr.
- Charter
- Nonprofit organization
- Independent & unbiased
- Betters mankind through science and technology
- Develops and transfers technology





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#### SwRI Today



#### – Nonprofit

- Over 2,600 employees
- Over 1,200 acres / 4.86
  km<sup>2</sup> facility in San Antonio, Texas
- 2.2 million ft<sup>2</sup> / 204,400 m<sup>2</sup>
  of laboratories & offices
- Over 1,280 patents
- 43 R&D 100 awards



### **Operational Characteristics**

- Revenue from Contracts
- Applied RDT&E Services
- Physical Sciences & Engineering
- Broad Technological Base
- Capital-Intensive Operation
- Internal Research Program
- Independent & unbiased



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#### **SwRI** in the Technology Spectrum





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#### **IV&V** at SwRI – Experience Across Multiple Industries





swri.org

#### 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



#### Rationale

- Critical Sensors are known to be inadequate (OGDQ) / have unknown qualities
  - Uncalibrated
  - Not maintained
  - Measure in the wrong location
  - Poorly designed for their purpose
- Communications channel problems
  - Insufficient reliability
  - Latency issues
  - Packet drops
- Emerging systems verification issues
  - Systems which map missing data, analyze data, and model processes are not verified
  - Difficult for individual operators to verify the systems
- There is a need to formally verify and validate sensors and systems



#### **Business Impact**

- 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



### **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



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## **Principal Investigators**

- Southwest Research Institute
  - Maria Araujo, Manager, High Reliability Software Section
  - Independent not-for-profit research and development organization
  - 70 years of research and development, much of it in the oil and gas industry
  - Experience with development, verification, and validation of a variety of equipment from deep ocean to deep space
  - Performance on other JIPs
- DE WARDT AND COMPANY
  - 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
- Selected drilling industry consultants
  - Experts in relevant sensor and system technologies



## Methodology

- 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



#### **Deliverables**

- Phase
  - Fully fleshed plan for the development of standards
  - Initial set of working group members
  - Assignment of initial set of tasks to working group members
  - Draft set of classes for which standards will be defined
- Phase II For each class
  - Create sub-group
  - Identify minimum requirements
  - Identify additional relevant characteristics (characteristics and attributes)
  - Identify test strategies and tests needed to characterize class members
- Phase III
  - Create tests
  - Validate tests



#### Start-up, duration, and cost

- Start-up
  - The targeted start date is within 30 days of the confirmation of funding for the effort
- Duration
  - First phase: 9 months
  - Additional phases variable per class of sensor or system
- Cost
  - Phase I-TBD
  - Additional Phases based on class complexity and size

