ADS2
The Technology Platform
Covering the Entire Development Process
ADS2 – The Development Tool

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Development Approach
V-Model Enhanced by Boosting $v_0$

- A/C System Specification
- System Specification
- Item Specifications
- Item Models
- SW HLR
- SW LLR
- SW/SW Integration
- HW/SW Integration
- System Model
- Integrated Model
- Reuse Test Cases
- System Integration
- System V&V
- Equipment V&V

Use Cases for the ADS2 Technology Platform
V-Model Development Approach
Model Based & Test Driven

- Model based design validation – risk mitigation for system design errors
- Continuous SW integration and early host based testing – better SW maturity
- Automatic code generation from models – faster, reduced low level testing

System Spec

Req. Model

Integrated Model

Model and Test Case Reuse

System V&V

System Integration

Item SW V&V

Item SW Integration

HW/SW Integration

Host Based Testing

Item SW LLR

Item SW HLR

Item Models

Item SW

Item Specs

Item SW

MATLAB/Simulink, SCADE, ...

MDVS

MDVS & Simulator

DOORS + ICD DB

SCADE Models

SCADE AutoCoding

Equipment TB

System IB

A/C Level System Spec
Use Case: Requirement Validation

Principle Idea

Objective
During the early stages of a development process the functional requirements should be validated thoroughly to minimize later project risk and to get valid requirements and related test cases early in the process.

Process Steps
- Translating requirements into functional behavior models (e.g. using MATLAB)
- Execute models in representative runtime environment
- Validate dynamic model behavior report to functional requirements
- Iterate until behavior conforms to requirements
Use Case: Requirement Validation

ADS2 Solution

Model Execution for Validation
- Model behavior based on functional requirements
- Run and stimulate model
- Verify model behavior
- Iterate modelling and validation of requirements

Quality Improvement by Automation
- Basic ADS2 features like Record / Replay can be used to automate tests
- Improved automated tests can be defined based on requirements using an ADS2 Addon test automation like Test Frame Generator (TFG)
Objective

Applications can be implemented by modelling requirements and generating code.

Dynamic runtime environments are used to execute and integrate application models. Functional behavior of these applications is verified with appropriate test procedures.

Process Steps

- Implementation of applications in modelling environment (e.g. SCADE)
- Run and integrate multiple models
- Verify behavior and analyze test results
Use Case: Model Based Implementation

**ADS2 Solution**

**Model for Code Generation**
- Implementation of requirements by models, e.g. using SCADE
- Automated code generation and functional verification
- Reuse of functional test procedures for model test coverage and code coverage analysis, e.g. using SCADE scenario simulation

**Multi-Model Integration**
- Integration of multiple models from same or different modelling environment (e.g. SCADE to MATLAB)
Use Case: Target Transition
From Host to Target

Tasks
- SW/SW integration
- SW/HW integration
- SW/HW verification

Risk
- SW/SW and SW/HW interface control problems
- Availability of suitable target hardware

Opportunity
- A typical target with layer architecture allows starting integration earlier using target platform (OS) simulators and technology or target prototypes
Use Case: Target Transition
ADS2 Based Virtual Target Simulator

Objective
A virtual target simulator allows starting SW/SW integration in advance by simulating target OS APEX interface layer (grey) on top of ADS2 APIs. The ADS2 based solution supports interprocess as well as I/O communication to allow early SIL/HIL based testing without adaption of application interfaces.

Use Cases
- Interprocess and I/O communication verification
- Run application/model in simulator environment without interface adaption effort
- Enhanced host debug capabilities
- Interaction with any ADS2 compatible simulation and HW
Use Case: Target Transition

ADS2 Based from Virtual to Real

Use Cases

- Model in the Loop (MIL)
  Model developer verifies model in a software only environment with automated tests.

- Software in the Loop (SIL)
  Software developer verifies the SW on a suitable laboratory prototype using automated tests.
  Identical Signal Configuration
  Identical Test Procedures

- Hardware in the Loop (HIL)
  System developer verifies the SW/HW system on the real target using automated tests.

SCADE Suite
- Modelling & Code Generation

Lab. Item (Prototype)

Real Item (LRU)

Identical Signal Configuration
Identical Test Procedures
Objective
Testing at boundaries and out-of-range tests are required to assure correct behavior of the UUT in all foreseeable conditions. They are a complement to the tests provided for verification of functional requirements.

Process Steps
- Perform functional verification to assure the UUT behavior is as required
- Perform robustness test on UUT to assure correct UUT functionality under boundary or abnormal conditions
Functional UUT Test

- Real UUT is tested in operational conditions incl. performance tests
- Stimulation of all inputs within nominal ranges
- Monitoring of all outputs to verify correct behavior relative to input stimulation

Robustness Test

- Stimulation of UUT inputs beyond nominal ranges by injecting data and protocol errors using ADS2 error injection feature
- Inject electrical errors using FIBO
- Monitoring of all outputs to verify correct behavior
**Objective**

The system functionality has to be verified according to system level functional requirements under normal operation conditions.

Additionally, the system robustness has to be verified by testing at boundaries and out-of-range conditions to assure correct behavior.

**Process Steps**

- Perform functional verification to assure the system behavior is as required
- Perform robustness test to assure correct system functionality under boundary or abnormal conditions
System V&V - Function and Robustness
ADS2 Solution

Normal Operation Test
- Real system UUTs are tested in operational conditions
- Simulation of system environment by stimulating all system inputs within nominal ranges
- Monitoring of all system outputs and necessary system internal data links

Robustness Test
- Environment simulation beyond nominal ranges by injecting data and protocol errors using ADS2 error injection feature
- Inject electrical errors using FIBO
- Monitoring of all system outputs and necessary system internal data links
Use Case: Iterative Integration & HITL

Principle Idea

Objective
Start system integration before all UUTs are available to save system integration and verification time.

Process Steps
- Provide functional simulations and I/O resources for UUT that are not available
- Iterative system level integration with real UUTs and simulations
- Full system integration with all UUTs available
- HITL test system capability may be used if any human factors aspects have to be analyzed
Use Case: Iterative Integration & HITL

**ADS2 Solution**

### Full SUT Integration
- All UUTs can be integrated with the test system in REAL operation mode

### Iterative SUT Integration
- Unavailable UUT functions are replaced by simulations (reuse from former project phases)
- Missing UUT I/O is replaced by test system I/O routed to the real system equipment using ADS2 controlled sim/real switching

### HITL
- Cockpit mockup is used to integrate Human in the Loop
Example: Requirement Validation
C919 CDS Development Support

C919 CDS Development Environment
- 15 MDVS Model Development and Validation Systems

C919 CDS Development Staff (approx.)
- 14 TechSAT support team members
- 70 customer employees

Full functional SW prototype development and integration in less than 9 months
- Model Based Development with SCADE very efficient, especially with a team of unexperienced SW developers
- Test Driven Development with early model validation through comprehensive set of test cases and automatic test procedures developed in parallel with the model
Example: Target Transition
C919 CDS Development Support

C919 CDS Targets
- 8 HDD prototypes using COTS components
- 5 IDU Simulators using ADS2 PC
- 5 Real IDUs

Development Support
- IDU Simulator for SW/SW integration of SCADE Display models and A661 handcoded software
- IDU Simulator for early display system integration into IMA at FSIB
- HDD prototypes for low level SW development of graphics interface, graphics mixer, and BSP
- Real IDU for final SW/HW and display system integration and verification
Example: Function & Robustness
C919 CDS Development Support

C919 CDS Development Environment
- 15 MDVS Model Development and Validation Systems
- 5 SDIB Single Display Integration Benches
- 2 Full System Integration Benches
- 5 IDU Simulators
- 8 HDD Prototypes

Main Elements of the Success
- Model Based Development
- Test Driven Development
- Automatic ICD processing and generation of middleware (IO Manager) configuration (tools and middleware developed by TechSAT team during the project)
- Sufficient and suitable test equipment
Example: Iterative Integration & HITL
A350 Cabin0

A350 Cabin0 Testing Factory
- 10 FIBs Cabin0 Cluster with 36 ADS2 RTPC and 21 ADS2 workstations
- 1 V&V Platform with 4 ADS2 RTPC and 3 ADS2 workstations
- Highly configurable → Rapid setup of FIB clusters for cabin function tests within 2 hours
- Low downtime
- Flexible allocation of FIBs to test up to 500 UUTs of various MSNs in parallel

A350 MSN06 Session Example
- 6 FIBs clustered
  - 69 AFDX UUT involved
  - 17 RTPC, 12 workstations
  - Frame rate = 10 ms
- Simulation models
  - 38 simulations and 71 panels
  - Up to 30 Mio Tx signals per second
  - Up to 10 Mio Rx signals per second
- Data complexity
  - Namespace 936,946 signals
  - AFDX Tx: ~ 28 Gbps Rx: ~ 9 Gbps
  - A429 Tx: ~ 308 kbps Rx: ~ 91 kbps
  - CAN Tx: ~ 79 kbps Rx: ~ 30 kbps
  - RSS: 124 channels
  - AIO: 154 channels
  - DSIO: 1436 channels
  - FCS: 314 channels

*MSN = Manufacturer’s Serial Number
Example: Iterative Integration & HITL
A350 Cabin0 Buildup
ADS2 – The Development Tool
Installed Licenses

- **ADS3000** ~ 430
- **ADS2R2** ~ 730
- **ADS2R3** ~ 150
- **ADS2R4** ~ 100

**ADS3000 … ADS2R3**
- ~ 1310 licenses sold
- World-wide distribution
- Active maintenance contracts

**ADS2R4 to come**
- 2016 Projects (HLS, WBS, …)
  - ~50
- 2017 Projects (KFX, R80, …)
  - High performance ADS2R4 required
  - Estimated additional licenses ~50
Successful Development Projects in Time, Cost, and Quality

ADS2

Complete Development Cycle

Modular Test Systems

Scalability

Realtime Performance

Transparent Data Layer

Intuitive User Interface

Tools Integration

Additional Tools

Application Interface

Proven Service Record

Future Proof
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