ADS2 – Features & Functions
A User’s Perspective
ADS2 Core Concepts
ADS2 Characterization

ADS2 is a platform

- To host applications, e.g.
  - Simulations
  - Test applications
  - Scripts
  - Monitoring and control panels
  - Complex visualizations
  - I/O resources (by means of driver applications)

- To run all these types of applications in a well-defined, deterministic, and reproducible way

- To exchange data between these applications in the form of process variables, always guaranteeing consistency
ADS2 Core Elements

Recorder
Data View
Replay

Argus Viewer
Graph Viewer
Table Viewer

Session Manager

Panel Editor

Configuration Editor

Recorder
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ADS2 Kernel

CVT

Session / Cluster Cfg.
I/O Mapping

Scheduling

Panel

Simulation

I/O Driver

I/O
Current Value Table (CVT)

- Storage for process variables
- Data atoms “CVT points”
  - Referred to by name with additional attributes (min, max, type, unit, …)
  - Scalar data types (numeric, string)
  - Arrays (bus messages as byte arrays)
- Sampling and queueing access
  - Sampling: only newest value
  - Queueing: value history
  - Sampling outputs can be attached as queueing inputs
- Publish / subscribe model
- Applications always read/write groups of CVT points (consistency)
- System CVTs: part of system state available via CVT points
- Control CVTs: allow behavior to be manipulated
- CVT links: connection between PVs of different name and type
I/O Mapping

- Isolating and decoupling applications from direct access to I/O
- Mapping of process variables to I/O channels (i.e. I/O hardware)
- Channels denote all types of I/O handled by the I/O subsystem
  - Busses
  - Discretes
  - Analog
  - Ethernet-attached measurement devices
- EU conversion (e.g. scaling)
- Composition and decomposition of messages
Scheduling

- Deterministic and reproducible execution of applications
- Execution properties of:
  - User applications
  - Built-in applications (e.g. recording)
  - I/O applications (i.e. drivers)
  - Node-to-node data transfer (i.e. cluster data exchange)
- Frame rate, length, offset, and subframe (sequencing of applications within a frame)
Clustering & Time Synchronization

- Pooling of
  - Computing resources
  - I/O resources
  - Logical functions (e.g. FIBs)

- Combining multiple nodes into a cluster

- Mix of real-time capable nodes and display nodes

- Mix of soft and hard time-synchronized nodes

- I/O typically distributed over multiple nodes

- Each node can act as a master in the cluster for (re)configuration and control purposes
Partitioning and Virtualization

- Resource sharing / reuse
- Partition a single node into multiple sub-nodes
  - i.e. multiple ADS2 kernels on a single computer
- Assign hardware resources (I/O, CPUs) to sub-nodes
- Sub-nodes become part of different clusters
- Through partitioning a cluster configuration can be developed without having a real cluster
Runtime Dynamics

- On-the-fly reconfigurability
- So-called components pack multi-platform binaries with their scheduling attributes and the necessary configuration items (CVTs, I/O maps) into a bundle
- Components can also represent the two forms of the same thing: the simulated form and the actually connected form
- Configuration from human readable files
- Reconfiguration is not recompilation
- Drivers are ordinary applications, (re-)startable at any time
I/O Virtualization

- Developing I/O configurations without access to real HW
- Virtualization of I/O channels (e.g. A429 via Ethernet)
ADS2 Key Properties

- Scalability: upward and downward
- Flexibility: system configurations and virtualization
- Usage dynamics: high iteration speed
- Modularity: small, highly modular kernel heavily tuned for performance
Built-in Functions and Tools
Functions & Tools
Session Manager

- Top-level configuration and control user interface
- Access to system and configuration management tools
- Status and performance monitoring
- Distribution of simulations, monitors, panels, recorder and replay instances, etc. to displays and computing devices
- Creation and control of session files
- Online consistency check
- Configurable operator log
Functions & Tools
Configuration Editor

- Configuration, creation, and maintenance of hardware devices, CVT, and I/O map configurations
- Templates (schemas) define structure of the data; used for validation and by the generic editor to configure itself
- On-the-fly consistency check
- Human readable configuration files
- Easy to generate as part of a configuration toolchain
Functions & Tools
Data Monitoring – Online Viewers

For interactive data monitoring several modes are available:

- Formatted text for raw messages, labels, etc.
- Graph for numeric values
- Table for a combination of numeric and string values; also allows modification of PVs
- Tools are easy to use interactively without complex setup
- Error injection on PVs can be enabled / changed on-the-fly
Functions & Tools
Panel Editor and Runtime Panels

- WYSIWYG editor to create interactive control and monitor panels for test and simulation purposes
- Rich set of graphical objects
- Object animation
- Tabbed panels
- Runtime Interpreter
  - Fast update
  - Touch screen support
  - Networked architecture
  - Windows and Linux platforms
  - Thousands of PVs per panel
Functions & Tools
Recorder and Data Viewer (offline)

- Recording of any set of CVT points
- Various modes supported:
  > Continuous recording
  > Triggered snapshot recording with pre/post-trigger time window
  > Recording can be triggered / enabled / started / stopped by an arbitrary expression via CVT variables

- Data analysis and post-processing of recorded data with native ADS2 Data Viewer tool
  > Display of data as formatted text (all data types) or as graph (numeric data)
  > Data conversion for post-processing and analysis (e.g. export as CSV, NI DIAdem)
Functions & Tools
Replay

- Replay of recorded data into the system (by writing to CVT points)
- Timing is identical to the timing as recorded
- Simultaneous replay of multiple streams
  > Scalable speed factor
  > Triggered by signal events
- Playback of data from other sources (i.e. flight test data) after being converted to ADS2 recording file format.
Functions & Tools
Health Monitor & Status

- Comprehensive health monitoring concept allowing to quickly detect and isolate problems in the system hardware, configuration, or application

- Based on status system CVT variables in which all relevant information is continuously updated by the system
Functions & Tools
Error Injection, Function Generator

Error Injection
- Works directly on arbitrary CVT points, no ADS2 API call necessary
- Controlled via auxiliary CVT points
- Works via data manipulation tools (Argus, Table Viewer), simulations or scripts

Function Generator
- Works on arbitrary CVT points simultaneously
- Functional API
- Generator types:
  - Ramp
  - Toggle
  - Triangle
  - Sine
  - Arbitrary expression
Software and Hardware Interfaces
Integrating Applications

APIs

Tools

- MATLAB
- SCADE
- TechSAT TPM

Framework

- Config. & Control (HTTP)

API

- EXAPI
- Native API

Data and Events

- I/O Driver
- I/O DDK
- A653 APEX API

Standardized Open Protocols

Protocol Adapter

ADS2 Kernel
Integration Applications
Other Tools

Automation and Test
- TechSAT Test Process Management (TPM)
- TechSAT Test Frame Generator (TFG)
- TechSAT IMA Test Suite (IMATS)

Model Integration
- MATLAB/Simulink
- SCADE
- AP2633

Gateways
- GE VAIS
- VCOM
- SYSTeam
Hardware Support

- **TechSAT Versatile I/O**
  - AFDX (ARINC664, Boeing EDE), CAN, ARINC 429, MIL-STD-1553
  - ARINC 629
  - FAST (various digital and analog I/O, load unit, relay)
  - PCIe I/O

- **TechSAT Auxiliary I/O**
  - AFDX TAP

- **Computing Platform**
  - PICNG 1.3 standard
  - PCI Express 3.0, PCI
  - Slot CPU (Intel Xeon 3.6 GHz, 8 cores) + backplane (max. 18 PCIe slots) in 4HE enclosure
  - I/O bandwidth: 32 GByte/sec
  - 10 GBit Ethernet, 40 GBit Infiniband

- High I/O density
- Complex I/O uniquely tailored for testing purposes (e.g. sophisticated error injection capabilities)
Hardware Support
I/O Drivers

- Driver Development Kit for end users
  > Drivers are ordinary applications
  > Drivers can attach to a kernel via TCP/IP (i.e. remotely), i.e. on a host where no ADS2 is running

- Full integration with ADS2 tools possible
  > Templates for configuration data
  > Integration with devices configuration, I/O mapping, etc
  > I/O becomes indistinguishable from standard supported I/O

- Integration of proprietary HW
  > Cost
  > Intellectual property
  > Secrecy (military projects)
  > Security
Compatibility, Portability, Unification

- VME
  - PowerPC / VxWorks 5.5
  - ADS2 R2
- CompactPCI, PCI
  - ADS2 R3
- PCI Express, PCI
  - RT Linux (customized)
  - ADS2 R4

- ADS2 R4
  - R2 and R3 backward compatible
  - Configuration compatible
  - Behavior compatible
  - Upgrading of all old system is possible
  - Support for all computing platforms
Performance

Single Node Throughput

A350 Cabin0 / 2AIR

- 10 FIBS
  - 36 RT nodes, 21 workstations
  - 69 AFDX UUTs (total ca. 500 UUTs)

- Models
  - 38 simulations, 71 panels
  - Ca. 30 mio. Tx events / sec., 10 mio. Rx events / sec.
  - 10 ms frame time

- Data Complexity
  - Ca. 1.000.000 signals
  - I/O bandwidth: AFDX Tx 28 Gbit/s, RX 8.7 Gbit/s

1 MB ~ 60,000 PVs
1 PV / 30 nanoseconds
Successful Development Projects in Time, Cost, and Quality

ADS2

Complete Development Cycle
From concept stage to formal system verification

Scalability
From virtual platform to entire test factory

Modular Test Systems
TechSAT and COTS allow tailored test systems to customer needs

RT Performance
10^7 process variables
Deterministic data handling

Transparent Data Layer
CVT concepts • Distributed

Intuitive User Interface
ADS2 core tools and customizable panels

Tools Integration
Modelling tools • Gateways

Additional Tools
Automatic testing (TPM, IMATS)
ICD management

Application Interface
Third-party HW
Customer drivers

Proven Service Record
In use for over 2 decades
Worldwide customer base

Future Proof
Multi-platform compatibility
Modular software design
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