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Leveraging Java and JDT for Scripting to Enable AUTOSAR Engineering à la MATLAB

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About…

- Stephan Eberle
  - Paris, France
  - Development lead of Geensys' AUTOSAR Builder product
  - Committer for EMFT Teneo component
  - 10+ years experience in OO and automotive embedded
  - Frequent presenter at conferences and events
- Geensys
  - **G**lobal **E**mbedded **E**lectronics & **N**etworked **SY**stem **S**olutions
  - Embedded system engineering and IP
  - Embedded system engineering tools
  - Consulting services

Outline

- **AUTOSAR from 4000 meters**
- Success factors for AUTOSAR tool environments
- Definition of an open AUTOSAR tool platform
- Building extensions using the MATLAB/Simulink way
- Conclusion

Objectives of AUTOSAR

= **AUT**omotive **O**pen **S**ystem **AR**chitecture

- Mastering the ever increasing number of functions and complexity of E/E systems
  - Getting out of “one function – one ECU” trap
  - Transparent collaboration between OEMs and suppliers and reduction of integration pain
  - Reuse of E/E functions
    - In different product lines (high end .. low cost)
    - With different hardware platforms/communication systems (protection of investment)

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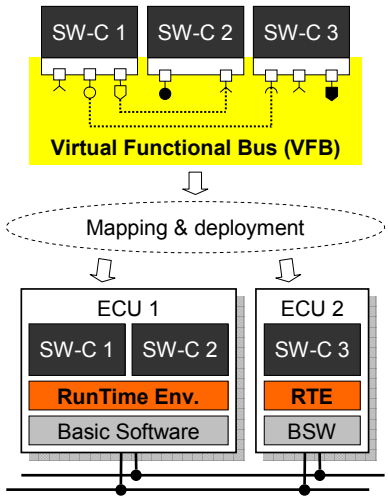
How it works

- Decoupling of application software from ECU hardware and communication systems through VFB/RTE
- Formal (XML-based) description of
  - Application software components
  - ECU hardware
  - System topology
- Arbitrary mapping of application software components to ECUs
- Formal (XML-based) configuration of standardized basic software modules
  - Operating system
  - Device drivers
  - Communication drivers



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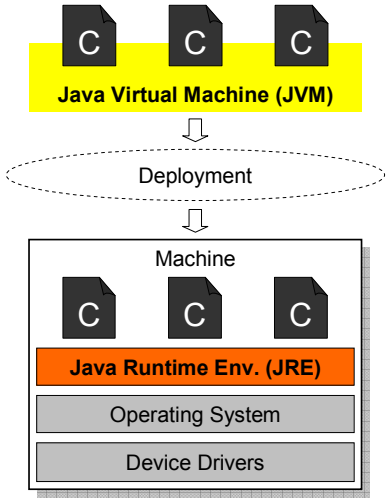
Déjà vu?

- JRE
  - Fixed function set
  - Implemented according to JSRs
  - Dependent on machine
  - **Independent** of application software
- RTE
  - Only functions requested by application software
  - Generated according to system description
  - Dependent on machine
  - **Dependent** on application software
  - **Resource consumption optimized**



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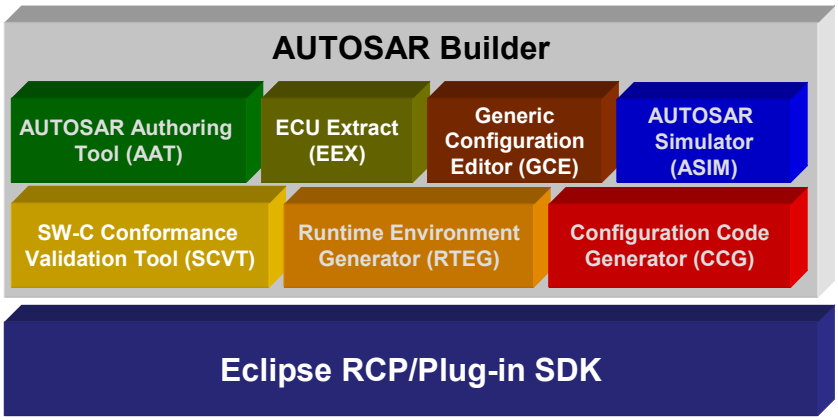
Geensys' Eclipse-based AUTOSAR Tooling



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Demo

- Software component description
- Software component validation
- ECU mapping and extract
- BSW configuration

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Scope of AUTOSAR

- Standardization in AUTOSAR is focused on
  - Enabling exchangeability and reuse of E/E functions
  - Decoupling of application software from hardware & communication
- Consequence
  - Covers only a part of the design phase of E/E systems
    - Very detailed, grey box like description of component boundaries
    - But not: internal structure and behavior of components
  - Missing connection to upstream and downstream development activities, e.g.
    - High-level functional design
    - Component implementation

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To do list for AUTOSAR adaptors

- Coping with migration issues, e.g.
  - Import/conversion of legacy description formats
  - Conversion between AUTOSAR releases
- Handling of domain/vendor-specific aspects within AUTOSAR, e.g.
  - Automatic configuration of BSW modules from ECU Extract
  - Restriction of AUTOSAR design activities wrt custom development process and roles
- Integration with non-AUTOSAR development tools, e.g.
  - Model-based design tools
  - Build tool chains

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What does all that mean to AUTOSAR tooling?

- AUTOSAR tool environments
  - Will never be complete out of the box
  - Must be highly adaptabe to domain/vendor-specific contexts
- Idea
  - Provide an **open and extensible AUTOSAR tool platform** as common core for off-the-shelf and custom tool components
  - Final environment must enable both **creating and using AUTOSAR tool components**

↳Solution 1:

Extend Eclipse Platform towards an AUTOSAR tool platform

What does all that mean to AUTOSAR tooling? (cont'd)

- Creation of custom AUTOSAR tool components requires
  - Detailed knowledge of domain/vendor-specific context
  - Strong expertise of tool development infrastructure and technology
- Role/competence gap: involved domain/vendor experts typically
  - Have general programming knowledge
  - But are rarely true tool smiths and Eclipse experts
- Idea
  - Provide a really **simple way to create custom AUTOSAR tool components** by
    - Hiding the complexity of underlying development infrastructure and technology
    - Enabling custom tool components to be developed on a minimum learning curve basis

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Learning from a similar case: MATLAB/Simulink

- Interesting characteristics
  - Powerful model-based engineering environment
  - Well-known, long lasting … successful
  - Based on an **open and extensible core** being maintained and evolved by The MathWorks
  - Anyone else can build custom "ToolBoxes" and "BlockSets" on top of it using a **simple** C++ like **scripting language**

↳Solution 2:

Provide AUTOSAR tool platform with a MATLAB/Simulink-like scripting facility

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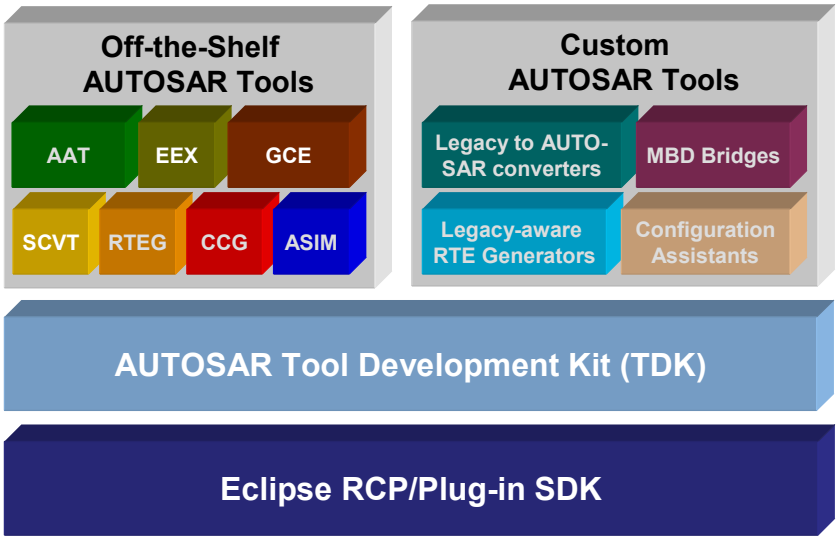
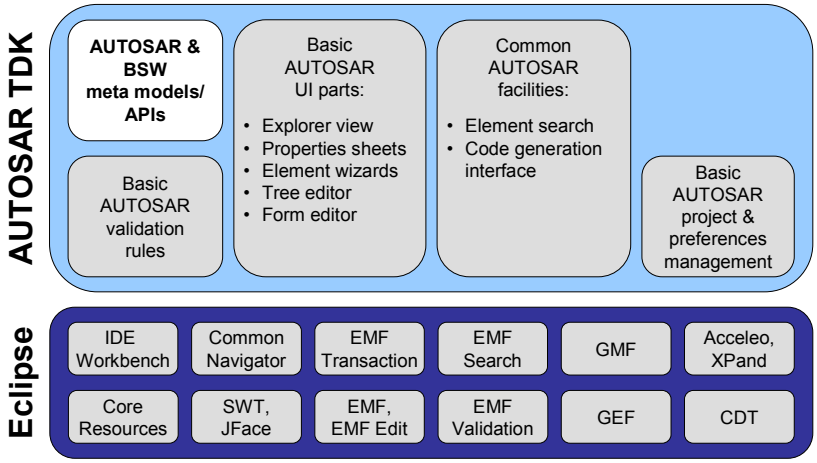


AUTOSAR TDK Components



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Translating MATLAB/Simulink principles to Eclipse

1. MATLAB Programming language (M-files)
   - ✘ Groovy, Ruby, Monkey?
     - ⇨ Too emerging, not established enough
     - ⇨ Difficult to get placed in vertical industries
   - ✓ Java!
     - ⇨ Broadly known, well-understood
     - ⇨ "Old" enough to be adoptable in vertical industries

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Translating MATLAB/Simulink principles to Eclipse (cont'd)

2. Toolboxes ("bundle" of M-files)
   - ✘ Plug-ins?
     - ⇨ Statically handled OSGi bundles
     - ⇨ Not deployable/executable on the fly
     - ⇨ Separate environments for development and execution
     - ⇨ Handling not obvious for non tool smiths, creates need for dedicated trainings
   - ✓ Plug-lets!
     - ⇨ Dynamically handled OSGi bundles
     - ⇨ Deployable/executable on the fly and within same environment
     - ⇨ Write scripts and see their effect with minimum roundtrip time
     - ⇨ Intuitive handling, enables to get started very quickly

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New Scripting/Plug-let Environment for Eclipse

- Main Features
  - Java-based “scripts”
  - Bundled up in plug-lets
  - Dynamic compilation and deployment
  - Editable and executable within same environment
- Basic Building blocks
  - Plug-let Runtime
  - Plug-let Development Tools
  - Scripting Runtime
  - Script Development Environment

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Plug-let Runtime and Development Tools

- Conversion of plug-in projects to plug-let projects
  - Via context menu action in Package Explorer
  - Identification through new header in the manifest file:
    `Automatic-Registering-Services: true`
  - Dynamic installation and start of bundle
- BundleListener
  - Scans starting plug-lets for scripts (classes implementing `IScript`)
  - Loads, instantiates, and registers each script as OSGi service
- ResourceChangeListener
  - Updates (i.e. reinstalls and restarts) plug-lets when contained scripts have been created or changed

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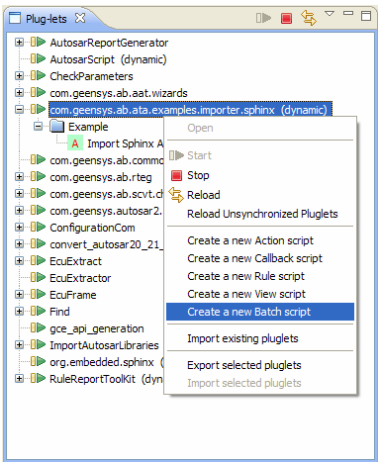
Plug-let Runtime and Development Tools (cont'd)

- Plug-lets view
  - Displayed information:
    - Plug-lets with nested categories and scripts
    - Activation state of plug-lets and scripts
  - Supported operations:
    - Start/stop of plug-lets and scripts
    - Import/export to/from workspace
    - Creation of new plug-lets and scripts



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Scripting Runtime

- Reads scripts from OSGi service registry
- Contributes scripts to Eclipse UI (where applicable)
  - Users just write script code and don't need to (but still can) cope with Eclipse extension points
- Runs scripts according to execution semantics of underlying script type
- Currently supported script types and execution semantics:
  - **ActionScript**
    Launched on demand via context menu option
  - **BatchScript**
    Launched via Ant task at command line; with or without arguments
  - **RulesScript**
    Runs some validation rules and reports results via Problems view
  - **CallbackScript**
    Launched automatically in response to some user interaction
  - **ViewScript**
    Generates some graphical output in a dedicated Display view

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Script Development Environment

- Largely reuse popular Eclipse JDT:
  - Script editing
    - JDT Java Editor
  - Dynamic script compilation
    - Incremental JDT Java Builder
  - Script debugging
    - RCP application reusing JDT debug kernel
    - Communicates via socket connection with host environment

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Demo: Import/conversion of legacy description formats

- Starting point: Illustrative example of proprietary embedded application description format (“Sphinx”)
- Objective: Import/conversion to AUTOSAR system description

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Conclusion

- Need for **customizability**:
  - AUTOSAR is used in many different domain/vendor-specific contexts
  - It is unlikely that a single AUTOSAR tool can satisfy all needs
  - Providing an open and extensible tool platform is crucial for achieving the required degrees of customizability
- Need for **simplicity**:
  - People working on domain/vendor-specific extensions are normally not tool smiths
  - MATLAB/Simulink shows how customization of complex engineering environments can be kept simple
  - Proposed Java-based scripting/plug-let approach tends to add this capacity to Eclipse

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Outlook

- OSEE
  - Platform for full life cycle embedded engineering environments
  - Geensys' AUTOSAR TDK could be regarded as extension covering automotive E/E function design

  ↳We would be happy to collaborate!
- e4
  - JavaScript support, PDE support, development tools
  - Geensys' Java-based scripting/plug-let environment seems like an early case study for that

  ↳We would be happy to contribute!