Tools and Ecosystem for Automotive Development
AA105

Patrick W. Menter
Manager, Automotive Silicon Support Tools
High Level Tool Depiction – V Model

Model Based Development
Modeling / Simulation
Tool supported: Mathworks – Simulink/Stateflow

Code Generation
Tools Supported:
- Mathworks ECoder or dSpaceTargetLink
- Mathworks / Greenhills Embedded IDE LINK Multi
- TargetLink Target Optimized Module – S12
- TargetLink Target Optimized Module – MPC55xx
- Freescale RApidToolbox - 32Bit PPC
- Simuquest Quantiphy - S12
- AUTOSAR:
  - ECoder / TargetLink - Application Runnable Generation

Target Development
Power Architecture® / S12 / S08 Core support:
- Compiler: CodeWarrior™, GHS or Windriver DIAB - 32 Bit PPC
- Compiler: CodeWarrior™, Cosmic - S12, S08
- Debugger: Lauterbach, MULTI, P&E Micro - 32 Bit PPC
- Debugger: P&E Micro – S12, S08
- Profiler & Analysis: Lauterbach, MULTI
- eTPU/eTPU2 support:
  - Compiler & debugger: Freescale or Ash Ware
  - Cycle accurate Simulator: Ash Ware
System Level Development Support:
- AUTOSAR: dSPACE SystemDesk System Authoring Tool, Simulation, RTE Generation
Full chip development support:
- Initialization Tool: Freescale RApidInit 32 Bit/Processor Expert 8/16 bit
- AUTOSAR: Tresos Freescale MCAL Generation
- Functional full chip simulator: CoWare, VaST, Synopsis or OSCI

Validation & Calibration
H/W: Freescale VertiCal
Tool supported: Vector CANape
- XCP/FlexRay/Nexus

Testing
Code coverage tool: tbd.
Dynamic analysis tool: tbd.
Evaluation Boards

- Freescale
- Axiom
- P&E Micro
- iSystems
- Phytec
Compilers – Supporting Power Architecture for Automotive

Compilers Supporting the 32-bit/S12/S08 family of processors.

► Green Hills Multi

► Wind River Diab

► Freescale CodeWarrior™ tool suite

► Cosmic
Debugger Tools

► Ashling

► iSystems

► Latuerbach

► P&E Micro

► GHS Multi-Probe

► Wind River
### Main Features:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>GUI interface embedded into development tools</td>
<td>Consistency checking with visual feedback on warnings &amp; errors</td>
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<tr>
<td>Generates production quality runtime source code based on property settings</td>
<td>Allows migration of application code from one processor to another more easily</td>
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<tr>
<td>Provides a SW component packaging mechanism for sale of drivers &amp; source code algorithms</td>
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### Supported Processors: 430, adding ~60 / year

- HC08, HCS08, RS08 – all 8-bit parts
- HCS12, HCS12X – all 16-bit parts
- DSC – all digital signal controllers
- ColdFire® – all shipping ColdFire v1–v4e parts
- Power Architecture® MPC5121e

### Host Platforms: 1

- Windows hosts running CodeWarrior™ IDE (today)
- Eclipse hosted supporting Linux® and Windows (by 2010)

### Scalability Factor: High

- Leverages knowledgebase technology to drive efficiency from similar processors
- Applies models & transforms to produce components

### Team: 28 Brno; 4 GDL; 3 Austin

- 5 research projects (CZ and EU)
- Production team is 20 staff (cost competitive)

### Expansion / Future use:

- Basis for HAL project supporting RTOS partners
- Knowledgebase leverage across Freescale
- Silicon validation models possible
- Eclipse based host systems (Windows, Linux) by 2010

### Synopsis:

1. Knowledgebase already leveraged by several technologies and processes in Freescale
2. Supports over 65 new parts each year, with varying packages, etc.
3. Expanding beyond CodeWarrior tools to support init/config functionality for Freescale partners
4. From February 2009, Processor Expert and all its technologies are owned by Freescale
5. This team has built the best test harness for on-target software peripheral tests, exercising hundreds of configurations per part
Basic Product Highlights

► GUI-based tool for rapidly, intuitively developing Initialization code

► Automatic report generation of initialization configuration and register settings

► Efficient C and Assembly code generation for a multitude of compilers

► On-line documentation and built-in tool tips for ease of use

► Performs consistency checks to eliminate mistakes and inconsistencies

► Built-in tutorials with sample projects

► Initialization code for single/dual core startup from CRT0 upward

► Interrupt and Exception handler software frame work generation

► Ability to define section map and place code into any memory section desired

► VLE/Non-VLE code generation supported

RApplD V2.2.0.7
MPC555x
MPC556x
MPC553x

RApplD1x V1.1.0.9
MPC551x

RApplD563xM V1.0
MPC563xM

RApplD560xB V1.1
MPC560xB/C

RApplD560xP V1.1
MPC560xP

RApplD560xS V1.0
MPC560xS
RAppID - Rapid Application Initialization & Documentation: RAppID Pin Wizard

RAppID Pin Wizard Tools
MPC563xM
MPC560xP
MPC560xB
MPC560xS
MPC551x
MPC5668E/G
MPC5674F

Allows for Function to Pin Allocation
Pre-Sales Support Tool
Hardware/Software Engineers
Target Users

Allocate Functions to Pins
Generate Excel Spread Sheet and html Report
Generates RAppID Init Project for pin initialization code generation later
eTPU Tools

► Ashware eTPU “C” Compiler
► Ashware eTPU Simulator
► Ashware eTPU Debugger

► ByteCraft eTPU “C” Compiler

► Freescale eTPU “C” Compiler

► Freescale eTPU Configuration Tool
► Freescale eTPU Web Interface for eTPU Function download
Automatic Code Generation - Model Based Design Tools

► Mathworks - MATLAB/Simulink/Stateflow
  • Application level Algorithm modeling and simulation.

► Freescale Processor Target Based Development
  • Mathworks
    ▪ Link for MULTI support MPC55xx family of processors for Processor In the loop development.
    ▪ On-Target Prototyping/PIL Blocksets for MPC5xx Family of processors.
  • dSpace
  • Freescale
    ▪ RAppID Toolbox for MPC5554 based on-target rapid prototyping to any ECM.
  • Simuquest Quantiphi
    ▪ S12 on-target rapid development environment

► Production Code Generation
  • Mathworks - Realtime-Workshop/Embedded Coder production code generation
  • dSpace – TargetLink production code generation tools, target processor based optimization packages
MATLAB and Simulink Code Generation Support for Freescale Processors
MATLAB and Simulink Code Generation Support for Freescale Processors

Real-Time Workshop

► Generates tunable code for rapid prototyping
MATLAB and Simulink Code Generation Support for Freescale Processors

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Real-Time Workshop Embedded Coder
MATLAB and Simulink Code Generation Support for Freescale Processors

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  Links and Targets

► Verifies and optimizes code for specific compilers and processors
  • For example, Power Architecture using Green Hills MULTI
MATLAB and Simulink Code Generation Support for Freescale Processors

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You can deploy code on any Freescale processor using Real-Time Workshop and Real-Time Workshop Embedded Coder because they generate standard C/C++ (ANSI/ISO) plus offer target optimization customizations.
RAppID ToolBox Capabilities

► RAppID ToolBox is an add-on library to MATLAB/Simulink that includes:
  • RAppID for initialization
  • Configurable low-level drivers (blocksets) for MPC55xx peripherals
  • Optimized code blocks for SIMD functions
  • Scheduler and hooks to support the Freescale OSEK operating system

► The block-sets are seamlessly integrated into automatic code generators, such as Real-Time Workshop® Embedded Coder

► RAppID ToolBox enables engineers to quickly take control algorithm models directly onto any MPC55xx target board

► The target-optimized code blocks for DSP functions, such as IIR, FIR and FFT, enable engineers to take advantage of the SIMD functionality of the MPC55xx family

► Engineers can use the profiler block function to measure algorithm performance
SimuQuest QuantiPhi MCU Support Packages
Freescale S12, S12X, and MPC56X

► Provides production viable configurable low level drivers
► Intuitive in-model utility for configuring the drivers -- quick enough for prototyping, powerful enough for production.
  - User does not have to understand the details of the micro and its registers.
  - Many settings are determined automatically, but can be overridden by advanced users.
  - Dynamically manages cross-peripheral dependencies and warns of invalid settings.
  - Practically eliminates manual error and expensive debugging and rework.
► Powerful tool for developers using Simulink Models for prototyping through to production
  - Useful for systems, controls, and software engineers.
  - Access to drivers and registers through comprehensive Simulink blocks.
► Enables On-Target prototyping and production ECU code generation from a fully unified model
  - Customized driver code from QuantiPhi’s Simulink blocks is automatically integrated with the rest of the automatically generated code.
  - SimuQuest’s UniPhi data dictionary and architecture tool is included.
AUTOSAR software products from Freescale:

- **MCAL** (Microcontroller Abstraction Layer)
- **OS** (Operating System)

**Freescale AUTOSAR Basic Software**

AUTOSAR Runtime Environment (RTE)

- **Operating System**
  - System Services
  - Memory Services
  - Communication Services
- **Onboard Device Abstraction**
- **Microcontroller Drivers**
- **Memory Drivers**
- **Communication Drivers**
- **I/O Drivers**
- **I/O Hardware Abstraction**
- **Complex Driver**

Full Speed USB 2.0 Device
AUTOSAR Development Environment

Application Development Environment

- Application components
  - .c/.h runnable source files
  - .xml runnable description files

AUTOSAR-OS Configuration Tool

- OS .c/.h configuration code
  - .xml/.oil OS configuration files

System Level Authoring Tool

- Generates RTE
  - .c/.h source code
  - .xml interface descriptions

AUTOSAR-MCAL Configuration Tool

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Application Development Environment

- Automotive – MATLAB / Simulink / Stateflow
  - Code Generation from Simulink Models with RTW/EC or TargetLink

Block Diagram Model to C Source Code and Description File – Application Runnable
Application Development Environment - Simulink AUTOSAR Support

- Import/export AUTOSAR software component XML files with Simulink
  - Information can be merged back into AUTOSAR authoring tools such as Vector DaVinci products

- Generate runnables with Real-Time Workshop Embedded Coder
  - Code can be integrated with an RTE and executed on processors such as Freescale products
Freescale AUTOSAR Basic Software

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AUTOSAR Runtime Environment (RTE)
MCAL Development

Tresos Studio Tools

Configure, generate code and description files

```c
#include "Port.h"

#include "PORT_PRERELEASE_SUPPORT"

#define PORT_MINOR_VERSION_CFG_C 1
#define PORT_MAJOR_VERSION_CFG_C 2
#define PORT_PATCH_VERSION_CFG_C 0
#define Port_Start_Sec_Const_UNSPECIFIED

/* This table holds all the parameters of a list name: Port Number */
```

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AUTOSAR OS Configuration

General configuration of the AUTOSAR OS done in Tresos Studio
Freescale AUTOSAR Basic Software

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AUTOSAR-MCAL Configuration Tool

.c/.h source code
.xml MCAL/Driver configuration files
System Authoring Tool

System authoring tool ties application runnables to OS tasks, MCAL, and other runnables.

Most tools do NOT simulate. Generates RTE source and description files.

**SystemDesk by dSPACE**
integrated with EB Tresos Studio

Provides simulation, authoring and RTE generation
AUTOSAR MCAL Product

- MCAL drivers + Flash EEPROM Emulation, compliant to AUTOSAR 2.1 or 3.0
- AUTOSAR 2.1/3.0 MCAL releases do not contain RAM Test module
- All components configurable in any AUTOSAR-compliant configuration tool
- Including plugins for EB Tresos Studio
### AUTOSAR 2.1 Releases Tools Compatibility

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<td>S12XE/F/S MCAL 2.1</td>
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</table>

(*) BSW components other than MCAL/OS, and integration, by Elektrobit

AUTOSAR 2.1 not supported.

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AUTOSAR 2.1 AutoCore not supported.
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Thank you for attending this presentation. We’ll now take a few moments to review the audience questions, and then we’ll begin the question and answer session.