Supporting Dependability for Infineon’s Automotive MCUs with Model Based Design

Thomas Schneid, Infineon Technologies
# Table of contents

<table>
<thead>
<tr>
<th></th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dependability</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>System Development Customer Journey</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>MathWorks Hardware Support Package (HSP) for TC4x</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>In Conclusion</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Dependability</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>System Development Customer Journey</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>MathWorks Hardware Support Package (HSP) for TC4x</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>In Conclusion</td>
<td>15</td>
</tr>
</tbody>
</table>
Automotive market is facing two simultaneous, fast paced, paradigm shifts:

- **E/E architecture innovation has brought new requirements to microcontrollers**
  - More ASIL-D performance
  - Increased security & connectivity
  - New SW development methods

- **Trend toward Electrification further accelerates**
  - Emissions legislations towards Zero Emission
  - Major OEM with clear focus on Battery Electric Vehicle
  - Strong reduction of hybrid vehicles expected
  - Development of next generation of Engine & Transmission questionable
AURIX™ “Dependability”: More than a technical feature but a holistic value proposition

- **Best in class AURIX™ family concept** further improved and continued with the AURIX TC4x family
- Dependability is **more than a set of technical features** and system properties
- Robustness of an architecture has a strong **influence in product and engineering quality**
- Constant **innovation in safety and security technologies** is important for highly dependable MCU families
- **Technical and commercial scalability** is a key advantage in dynamic markets

More than 1 Billion TriCore™ shipped since 1999
Autonomous driving functions require highly available systems which require dependable electronics.

**High Availability** | Ensure high availability beyond critical operations; a safe and secure system, that operates in all conditions.

**Fail-Operational** | Mitigate potentially hazardous effects by ensuring critical operations in the event of a failure.

**Fail-Safe** | in the event of a failure, system enters safe state.

Lower levels (ADAS, <L2) | Higher levels (AD, =L3)

Vehicle enters safe mode | Vehicle continues safety critical tasks

Reliable, robust, safe, secure | Fail safe + available

Higher levels (AD, ≥L4+) | High availability in all conditions for extended time

Fail operational + highly available
**AURIX™ TC4x defines the next controller standard for safe & secure ECUs with strong networking capabilities**

### Higher Performance
- **New 500MHz TriCore™ 1.8**
- **PPU**: Private scalar core + **wide vector unit** with up to 48 GOPS
- **SPU3**: High-performance **radar processing sub-system**
- **A/D Converter sub-system with integrated DSPs**
- **Data Routing Engine** for CAN – Ethernet - Mem communication

### Safety and Security
- **AURIX™** meets **ISO26262-2018 ASIL D safety** standard
- **CSRM**: high-performance security module with private CPU, memories and crypto accelerators
- **CSS**: Distributed crypto and hash engines for secure CAN/Ethernet communication
- Security according to **ISO 21434** standard planned

### Freedom From Interference
- **Hardware isolation** at core and peripheral level
- **TriCore™ 1.8** with **up to eight VMs per core and Hypervisor**
- Ultra-fast **context switching**
- **Enhanced memory protection** for cores and virtual machines
- **Fine-granular access protection** to peripherals
- **Isolated DMA protection**

### Rich Connectivity
- Up to **2x 5GBit Ethernet** incl. Bridge
- **Accelerated MACsec support** by HW accelerator in CSS and application SW driver
- **4x10/100MBit Ethernet** supporting 10Base-T1S standard
- Up to **2x 8GBit/s PCIe 3.0 1x lane**
- Up to **20x CAN-FD**
- **CAN-XL**
# Table of contents

1. Dependability .................................................. 3
2. System development Customer Journey .................. 8
3. MathWorks Hardware Support Package (HSP) TC4x .. 12
4. In Conclusion .................................................. 15
Heterogeneous AURIX™ TC4x supports Requirements for Electric- and Autonomous Vehicle

PPU is a compute subsystem that extends the classical MCU compute performance for approaches like AI, model predictive control and advanced signal processing.

### eMobility / xEV
- On-board Charger and DC-DC converter
- Traction inverter
- Battery management system

### Autonomous driving / ADAS
- Trajectory Planning & Control
- Radar
- Sensor Fusion / Processing

### Integration Platform & connectivity
- Infrastructure controller for V2V/V2X
- Communication gateway
- Domain/Zone controller
AURIX TC4x is a heterogenous Compute Architecture

The homogeneous TriCore™ Compute Cluster from AURIX™ TC3xx is enhanced by PPU

The classical C/C++ programming model has to be enhanced by a parallel compute programming model.

Model-Based Design using AURIX™ TC4x HSPs utilizes the advantages of the heterogeneous compute architecture for system engineers.
Model-Based Design Support for AURIX™ TC4xx

Hand Crafted Software
- C/C++
- OpenCL
- VectorC

Model-Based Design
- TensorFlow
- Keras
- ONNX
- MATLAB® Simulink®

MetaWare NN ARC Compiler (NNAC)

Generated C/C++ Code

PPU Optimized Libraries
- Code Replacement Library (CRL)
- Machine Interference Library (MLI)

AURIX™ TC4xx Eco-System
- Compiler C/C++, OpenCL C, Linker, assembler, debugger, profiler, simulator

AURIX™ TC4xx Binary (TriCore™ & PPU)

Development Workflow

- Heterogenous compute architecture of AURIX™ TC4xx is covered by an automatic multi-core code generation using SoC Blockset and Embedded Coder
- Parallel programming model of PPU is supported by specific libraries
- Embedded AI workflow is currently supported by the NN SDK from the Synopsys ARC(R) MetaWare Toolkit for AURIX(TM) TC4x
A rich Software and Tool partner ecosystem exists for AURIX™

**Embedded Software Solutions**

- dSPACE
- easycore
- VECTOR
- ETAS
- INTEGRITY
- Green Hills Software
- AWS IoT
- TASKING
- TTeach
- KPIT
- Synopsys
- ARGUS
- expresslogic
- KRONO-SAFE
- Embedded Office
- Euros
- WitterSTEIN

**Hardware and Software Development Tools**

- Compiler toolchains
- Debugger and test tools
- Software automation
- Timing and program analysis
- Simulation and modelling
- Virtual prototyping
- Data measurement
- Rapid prototyping
- Verification and rule checker
- Flash programer

**Training and Services**

- Software and hardware coaching
- Flash programming services
- Engineering services and training

**Free Tools**

- Compiler and debugger toolchains
- Configuration and pin mapper
- Flash programer
# Table of contents

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dependability</td>
<td>3</td>
</tr>
<tr>
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<td>12</td>
</tr>
<tr>
<td>4</td>
<td>In Conclusion</td>
<td>15</td>
</tr>
</tbody>
</table>
TC4x HSP simplifies System Development: First version of the HSP supporting fast prototyping is available

- TC4x HSP is available!
- Provides realistic simulation capability
- Translates Simulink models to executable code
- Already optimized for specific processor = TriCore™, PPU
- Automatically connects to peripherals
  - Fast evaluation of application model on HW
  - Accessible through SIMULINK block libraries
  - Does not require deep knowledge of HW/iLLD
Engagement

› Infineon and MathWorks have partnered to develop Simulink® support for Infineon’s latest AURIX™ TC4x microcontrollers
› AURIX TC4x is now integrated into Model-Based Design, enabling automotive engineers to accelerate the development of electric vehicle and driver-assistance functions

Benefits

› Engineers using Model-Based Design with MATLAB® and Simulink® can accelerate embedded-system development and verification by 30 to 40% over traditional approaches
› Validate use cases, automatically generate embedded software, and test algorithms - even before silicon is available
› Utilize the full capabilities of the AURIX TC4x without deep embedded expertise

This is the latest engagement in an ongoing series of strategic collaborations between Infineon and MathWorks
| 1 | Dependability | 3  |
| 2 | System development Customer Journey | 8  |
| 3 | MathWorks Hardware Support Package (HSP) TC4x | 12 |
| 4 | In Conclusion | 15 |
Supporting Dependability for Infineon’s Automotive MCUs with Model Based Design

› Automotive market is facing two simultaneous, fast paced, paradigm shifts
  › E/E Architecture
  › Electrification

› Infineon’s AURIX™ TC4x is here to address these paradigm shifts
  › The SW eco-system is prepared for AURIX™ TC4x

› Infineon and MathWorks have a strategic partnership to provide MBD solutions for Infineon Automotive Microcontrollers

Visit us at www.mathworks.com/aurix

› System design challenge need Model-Based Design
  › The AURIX™ TC4x HSP are available and growing in features
Thank you
Part of your life. Part of tomorrow.