

MIPS ARC MetaWare Toolkit for AURIX TC4x

Highlights

- Comprehensive set of tools and software enabling the use of AI in automotive applications for the Infineon's AURIX TC4x
- Optimized NN model compiler with automatic mapping to PPU to reduce computation, memory, and bandwidth requirements
- Optimizing and vectorizing compilers for efficient software development
- Based on familiar open-source industry standards
- Complete Simulation tool flow with near cycle accurate profiling for early application software development

Overview

The MIPS ARC® MetaWare Toolkit for AURIX™ TC4x is a complete suite of tools, runtime software and libraries that provides everything needed to program the Parallel Processing Unit (PPU) on the Infineon AURIX TC4x family of microcontrollers. The PPU is an implementation of the MIPS ARC EV71FS Processor.

The toolkit consists of the MetaWare Development Toolkit, Neural Network Software Development Kit (NN SDK), vector DSP and linear algebra libraries. In addition, the Toolkit also includes a PPU Dispatcher module to schedule tasks on the PPU and an AUTOSAR Complex Device Driver (CDD) for the PPU for integration into AUTOSAR Classic applications.

The main components of the ARC MetaWare Toolkit for AURIX TC4x are shown in Table 1.

Component	Description
MetaWare Development Toolkit	The toolkit is used to compile, debug, simulate, profile, and optimize applications and kernels
MATLAB® Plugin	Model-based development methodology enablement: this plug-in automatically generates optimized code from a MATLAB model to execute on the PPU
DSP & Math Libraries	These are libraries optimized for execution on the PPU and include separate Vector DSP and Vector Linear Algebra Libraries
MetaWare Neural Network SDK	The SDK enables compilation, execution and profiling of neural network models optimized for execution on the PPU. Several examples are also included
AUTOSAR Complex Device Driver (CDD) & Low-level Device Driver (LLD for PPU)	The CDD provides PPU services to the Software Components (SWCs) of an AUTOSAR application. The LLD is a bare-metal library to handle communication between TriCore and the PPU
PPU Dispatcher	The PPU dispatcher is a static library executing on the PPU, responsible for managing the execution of service requests from TriCore processors

Table 1: MIPS ARC MetaWare Toolkit for AURIX TC4

MIPS ARC MetaWare Development Toolkit

The ARC MetaWare Debugger is used to debug, profile, and optimize applications and kernels built with these compilers. ARC nSIM NCAM is an Instruction Set Simulator with near cycle accurate profiling used for early software development such as algorithm development.

MATLAB Plug-in

The MATLAB Plug-in enables the advantages of TC4x Hardware Support Package (MATLAB HSP). This plug-in enables model-based design for algorithm development and allows users to generate vector DSP C code with highly optimized library function calls to the PPU at a higher level of abstraction. The flow includes automatic code replacement feature that replaces certain “vanilla” ANSI/ISO C functions with the highly optimized functions included in the ARC MetaWare Vector DSP Library and Vector Linear Algebra Library. It achieves this by integrating the ARC MetaWare Development Toolkit into the MATLAB/SIMULINK environment. The MATLAB/SIMULINK-generated C code can then be compiled for the PPU.

Figure 1 shows three approaches to translate NN models to source code:

- Use language extensions to enable auto-vectorization feature of MetaWare
- Use optimized libraries that provide wide range of functions such as standard C library, DSP and platform-specific runtime
- Use Model-based Development support to take full advantage of automatic code generation for TC4x PPU with:
 - MATLAB flow powered by Hardware Support Package for AURIX TC4x
 - TensorFlow or ONNX format passed to MetaWare NN compiler that outputs an optimized C code to compile with MetaWare

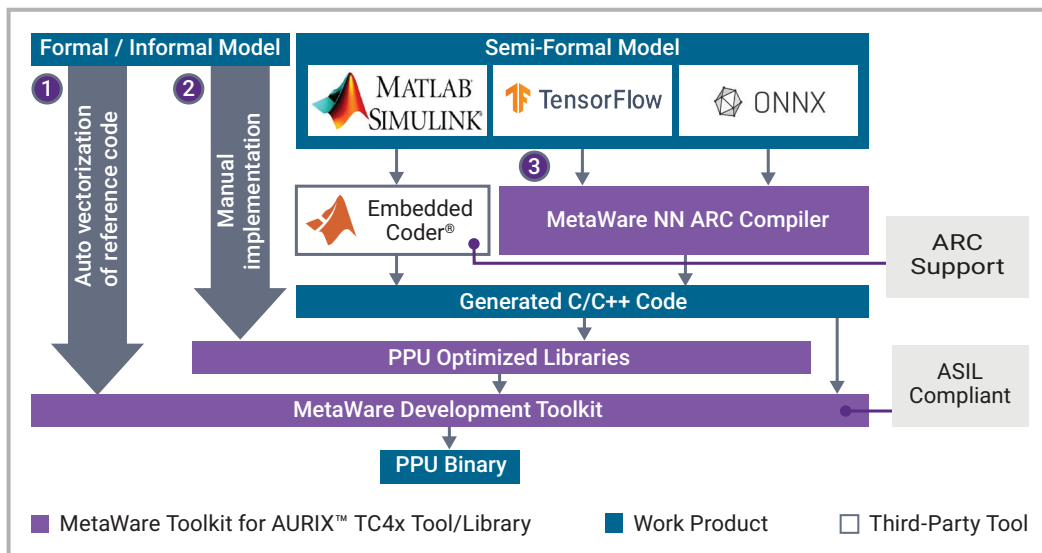


Figure 1: Model-based Development Support for TC4x PPU

DSP and Linear Algebra Libraries

The ARC MetaWare Vector DSP library is a software library that provides a set of optimized software DSP functions that can ease the development of applications for the Vector DSP of the PPU. By using the library, you can benefit from applying pre-verified functions that have been optimized for the PPU.

The MetaWare Vector Linear Algebra Library is a software library of BLAS/LAPACK and supplementary algorithms. It is available in an OpenCL C and a C/C++ version. This library can be used to easily develop applications requiring linear algebra functions.

These libraries can be used by the MATLAB Plug-in for code replacement to produce highly optimized code for the PPU.

MetaWare NN SDK

The ARC MetaWare NN SDK provides a Neural Network Compiler and runtime software to execute a neural network model on the PPU (Figure 2). The MetaWare NN Compiler takes a pre-trained model, implemented in the TensorFlow framework or available in the ONNX format, and compiles it to run on the PPU. It can also produce a standalone fixed-point model to aid in comparing the accuracy when moving from floating point to fixed point. The MetaWare NN SDK includes benchmarking and profiling capabilities, providing users with full featured AI workflow.

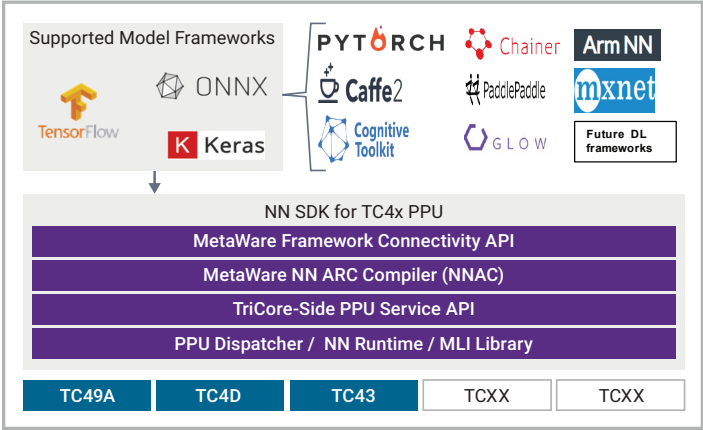


Figure 2: Easy-to-Use Neural Network SDK for AURIX TC4x

AUTOSAR CDD and LLD

The Complex Device Driver (CDD) provides PPU services to the Software Components (SWCs) of an AUTOSAR application. It is a driver for the TriCore processor that enables communication with the PPU. The Low-Level Device Drive (LLD) is a bare-metal version of the driver to support other non-AUTOSAR environments (Figure 3).

PPU Dispatcher

The PPU Dispatcher is a static library to communicate between a TriCore processor core and the PPU. The PPU Dispatcher runs on the PPU and provides scheduling and execution services requested by the TriCore processor. The PPU Dispatcher can also execute periodic tasks. An example application is provided to run and test the library on the MIPS TC49 Virtual Development Kit (VDK).

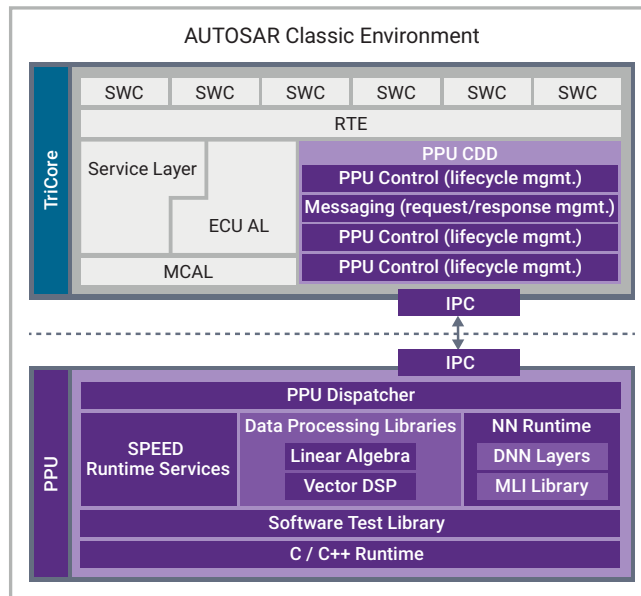


Figure 3: MetaWare Toolkit for AURIX TC4x Runtime Software Components

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