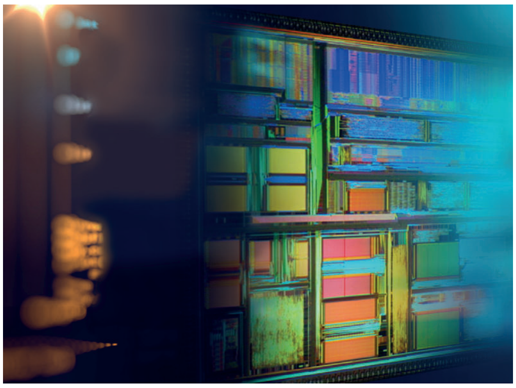
emmtrix
Technologies



Automation Tools for Better Code

Our Solutions

Performance Estimation

Page 5

- Early in workflow
- Master your timing budgets
- Continuous integration support
- Estimation methods:
    - Static source code
    - Simulation
    - Profiling on hardware
- Intuitive visualization
- Continuous performance monitoring during the development

Automated Vectorization

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- Easy exploitation of parallel vector hardware
- Correct-by-construction code generation
- Speedup > 10x

Parallelization

Page 6

- Parallel C code for
    - Multi-/Manycore CPUs
    - GPUs
    - DSPs
- Interactive workflow
- Functional safety according to standards like ISO 26262, DO-178C and others

Dependency Analysis

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- Identify data dependencies
- Verify your specification
- Document for (re-)certification
- Event chain analysis
- Data flow analysis

Code Generation Code Conversion

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- Conversions:
    - Simulink to MATLAB®
    - MATLAB® / Octave / Scilab to C
    - C++ to C
- User-controlled optimizations
- Aimed at embedded systems and automatic analysis

Some Supported Platforms

- infineon AURIX™ TC2x-TC4x
- NSI-TEXE RISC-V CPU
- STM32
- NXP iMX.8
- Texas Instruments DSP
- NVIDIA Jetson
- arm
- PowerPC
- RISC-V

Welcome to emmtrix Technologies

We are an innovative company in the field of software development for embedded systems from Karlsruhe, Germany, founded in 2016.

As experts in the development of software development tools specifically for programming high-performance multicore systems (multicore and vector processors as well as accelerators (e.g. GPUs, DSPs)), we assist companies in industries such as automotive, avionics and automation in using the latest embedded hardware architectures efficiently and error-free. Our software tools help to increase the performance of embedded computer systems, reduce development costs, shorten development times and give our customers a significant competitive advantage.

The integration into existing development workflows and processes is smooth and easy. We can even provide a path to software parallelization according to functional safety standards such as ISO 26262 / DO-178C.

Your emmtrix team

What Our Clients Say

> We have been working with emmtrix for a couple of years now and we find their technology of great interest. Their expertise in the field of source-to-source compiler technology and their tool suite emmtrix Parallel Studio help us in developing and improving our high-performance hardware solution. Sadahiro Kimura, Manager of Advanced Technology, NSITEXE

> ePS shows where and how performance can be increased. As a „side-effect“ of using ePS the developer quickly learns to design his application to be suitable for multicore HW.
>
> Arndt-Michael Meyer,
> Solution & Partner Manager, ETAS GmbH

Your Solution to Estimate the Performance of Applications

Performance Estimation

The emmtrix tools support different ways to acquire the duration of the tasks of an application. These vary in accuracy and additional software or hardware requirements. Static code analysis provides basic information without the need for hardware or special software. More accurate numbers can be collected with interfaces to simulators or the hardware. Depending on the requirements, the methods can be combined as desired.

The result of the performance estimation (below right) can be visualized using our interactive and zoomable hierarchical program view. The X-axis represents the time, therefore the width of each block depends on the actual duration. On the Y-axis, the control structure of the program can be seen. Additional levels are added for structures like function calls, loops or conditions.

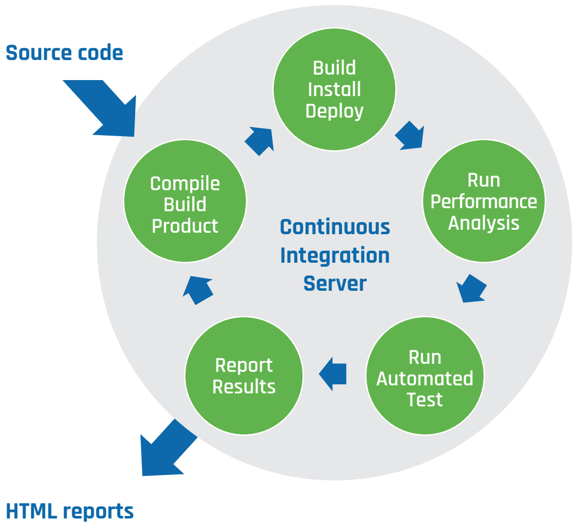
Features

- Automatic generation of reports and visualization for more detailed information
- Confidence levels for classification of results
- Easy to integrate into the development workflow
- Fast evaluation for different target platforms
- Static performance estimation based on C or assembly code
- Integration of simulators or hardware profiling into your workflow

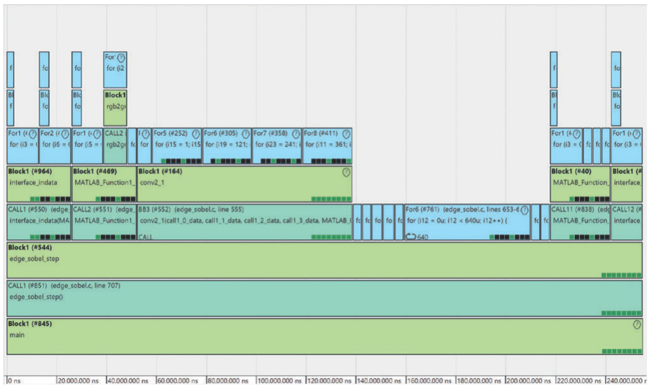
Benefits

- Performance estimation early in the development process
- Continuous monitoring of performance changes during the development
- Comparison of performance for different or heterogeneous target platforms
- Detect high-runners or critical parts of your software application

Visualization Workflow



Performance Estimation in Continuous Integration Workflow



Intuitive Visualization of the Performance Estimation

Your Solution for Parallel Programming

Parallelization

emmtrix Parallel Studio (ePS) helps you to optimize the performance of your embedded applications on multicore, GPU and DSP architectures as well as any combination of these processing units. Our tool automates and radically simplifies the parallelization process to the point where you simply need to take a few decisions to get good results. The patented graphical user interface (GUI), together with a number of reports, provides full transparency and leaves you in complete control at every step of the process.

Develop your applications in model-based software languages such as MATLAB®, Simulink®, Scilab and GNU Octave or use your existing C code as starting point for the parallelization in ePS. Together with ePS Qualification Kit the parallelization can be performed for applications with functional safety requirements like ISO 26262 or DO-178C.

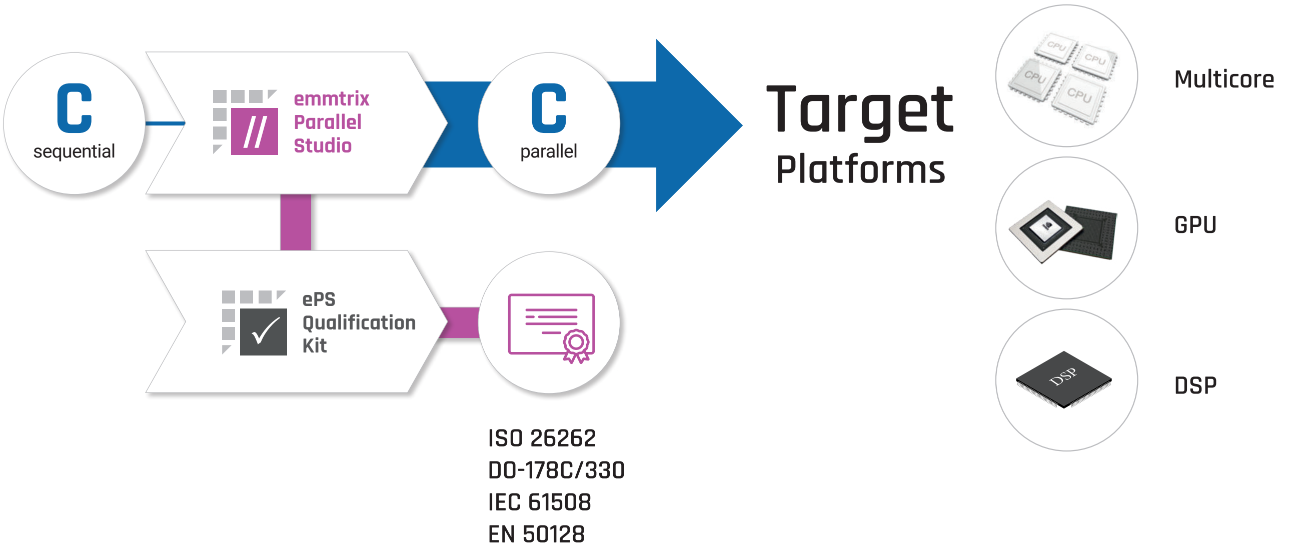
Features

- Automated generation of parallel code
- Interactive optimization with user-friendly Eclipse-based GUI
- Interactive code transformations to optimize parallel code
- Parallelization on runnable-level or function-level and sub-function-level
- Direct deployment of the parallelized program to evaluation boards

Benefits

- Improved application response time and processing throughput
- Correct-by-design approach
- Integrated functional tests for sequential and parallel code (ISO 26262 and DO-178C)
- Model-based software development for multicore targets
- Easy workflow integration

ePS Workflow



Your Solution to Vectorize Your Application

Automated Vectorization

The vector units of upcoming microcontrollers promise to speed up the execution of data-parallel applications based on linear algebra by factors greater than 10.

Programming such accelerators manually is challenging because it requires deep knowledge of their instruction set and microarchitecture. emmtrix Parallel Studio is your solution to simplify this task significantly.

infineon
AURIX™ TC4x

NSI-TEXE
DR 1000C

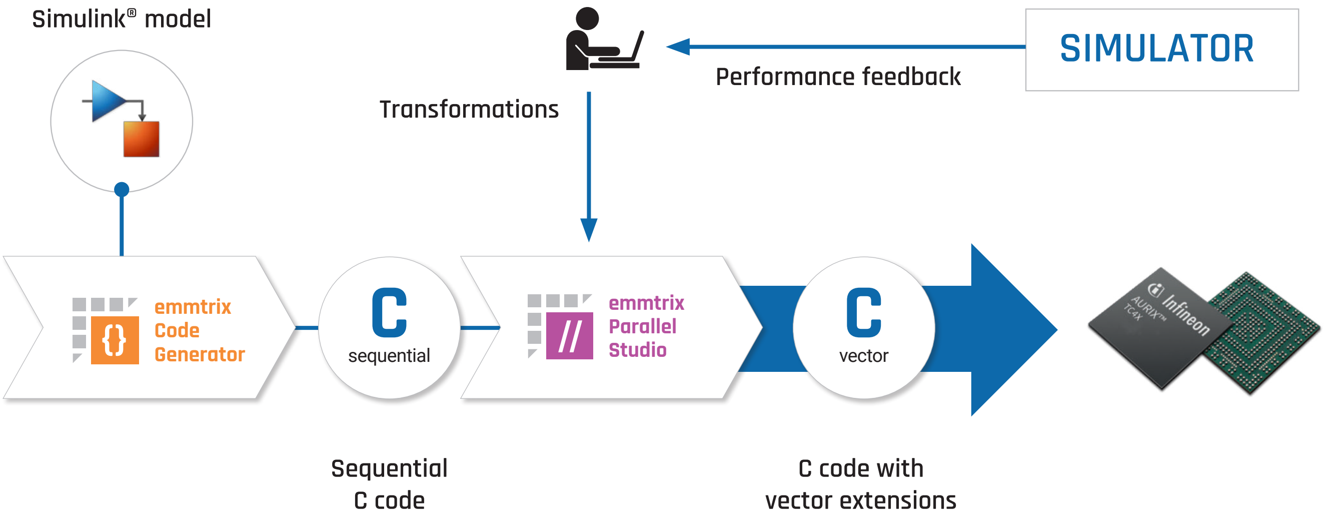
Features

- Functional testing of vector code independent of target platform
- Code transformations improving data level parallelism and optimizing code for vectorization
- Integration of target platform simulators for performance estimation
- Vectorization-aware code generation from Simulink® models
- Code Fusion: block-crossing vectorization of Simulink® models
- Generation of C code with vector extensions using generic libraries or target specific intrinsics

Benefits

- Easy exploitation of parallel vector hardware
- No need to write vectorized code manually
- Limited hardware knowledge required
- Reduced testing effort
- Functional testing without hardware
- Short development cycles

Vectorization Workflow



Your Solution to Analyze the Data Dependencies of Your Application

Dependency Analysis

Data Dependency Analysis provides crucial information on how different parts of the software interact, e.g. to fulfill system functions. Growing complexity of the software architecture as well as increasing regulatory requirements, e.g. for re-certification, lead to a demand for automation tools to detect and keep track of data dependencies.

A dependency analysis of C source code is necessary to perform correct parallelization of C software within ePS. Therefore, emmtrix has already more than 10 years of experience in this field. The data dependency chain analysis uses the internally available dependency information to calculate dependency chains. For any given C function it is analyzed which output variables depend on which input variables. This allows the identification of all output signals that are influenced by changes of selected input signals.

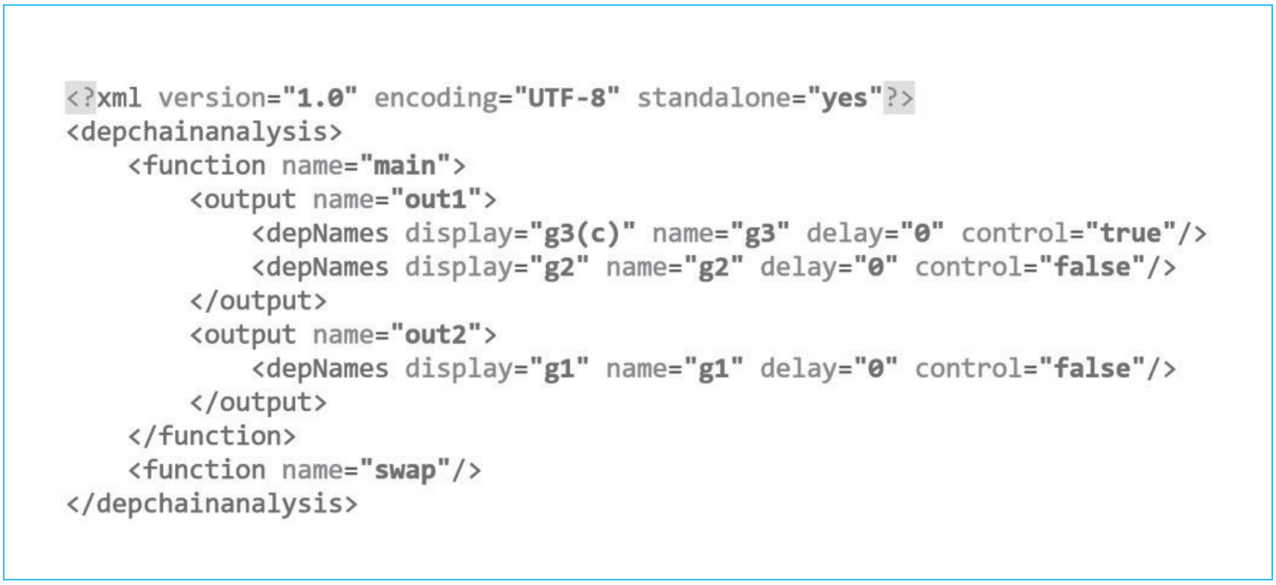
Features

- Analysis takes all possible paths of the control flow graph into consideration to ignore dependencies that can never occur
- Data and control dependencies between variables are calculated
- All calls to sub-functions are taken into account
- Supports analysis of programs consisting of multiple compilation units (source files)
- Supports analysis of delayed dependencies where values are stored in a variable and only fed to the output when the function is called again

Benefits

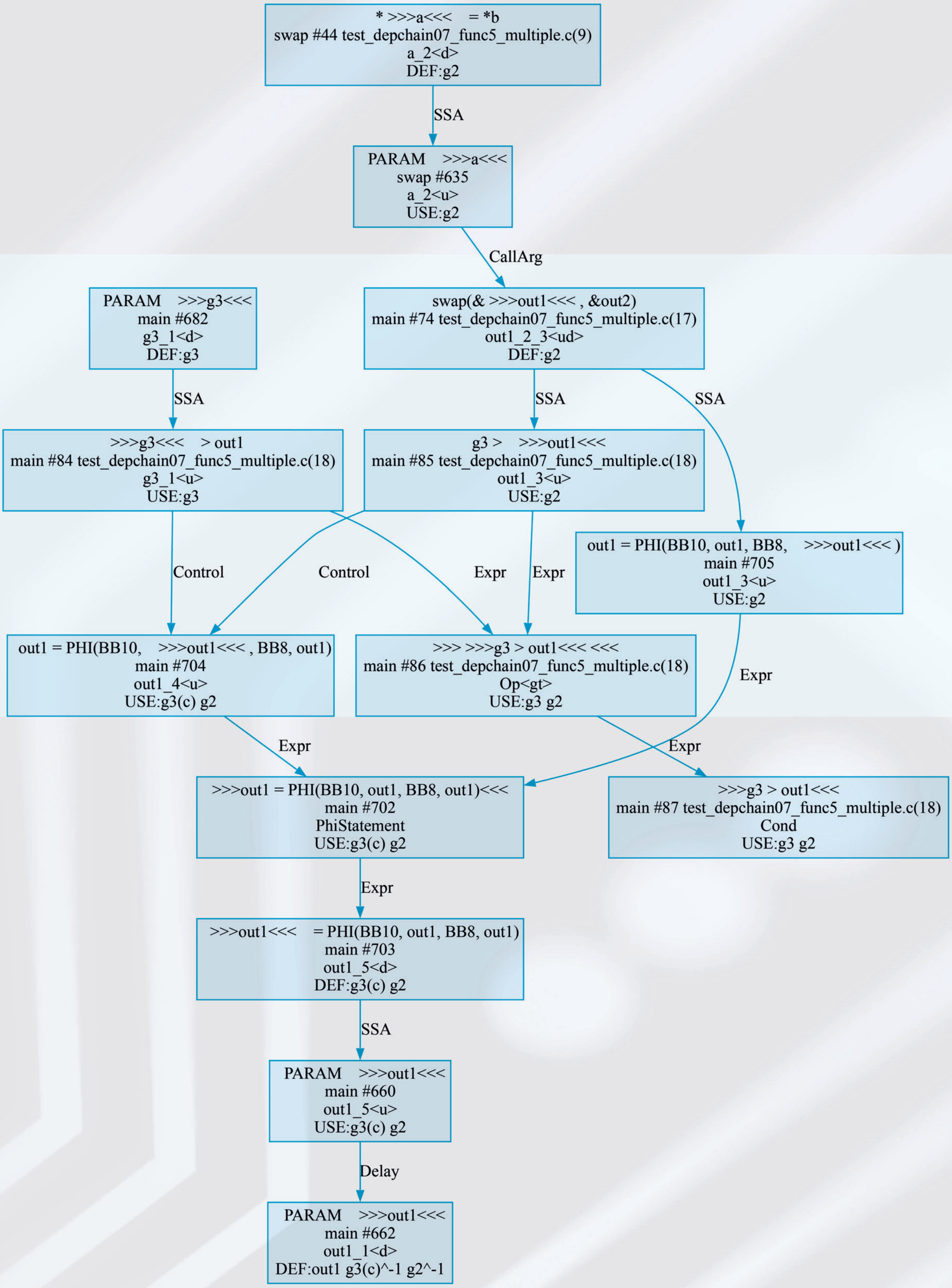
- Verify your expected dependencies
- Ensure that there are no unwanted connections between input and output signals
- Identify code clusters to help you better distribute your code onto the available resources
- Track down all modules affected by an input signal
- Identify which code will be affected by code changes
- Document all dependencies for the certification process

Dependency Analysis Report (XML file)



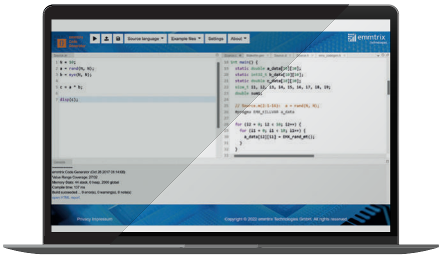
```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<depchainanalysis>
    <function name="main">
        <output name="out1">
            <depNames display="g3(c)" name="g3" delay="0" control="true"/>
            <depNames display="g2" name="g2" delay="0" control="false"/>
        </output>
        <output name="out2">
            <depNames display="g1" name="g1" delay="0" control="false"/>
        </output>
    </function>
    <function name="swap"/>
</depchainanalysis>
```

Visualization of Dependency Analysis



Your Solution for MATLAB® Code Generation

Code Generation



emmtrix Code Generator (eCG) translates MATLAB®, GNU Octave or Simulink® code into platform-independent and readable C or C++ code suitable for embedded processors. The generated code is easy to understand, prepared for parallelization and can be adjusted to individual requirements. Automatically generated reports help with the code certification process. In combination with emmtrix Parallel Studio, eCG enables multicore programming or vectorization directly from *.m or *.sci script files. Furthermore, eCG works hand in hand with emmtrix Model Code Generator to support C code generation from Simulink® models.

**Try it out:
emmtrix Code
Generator Online**

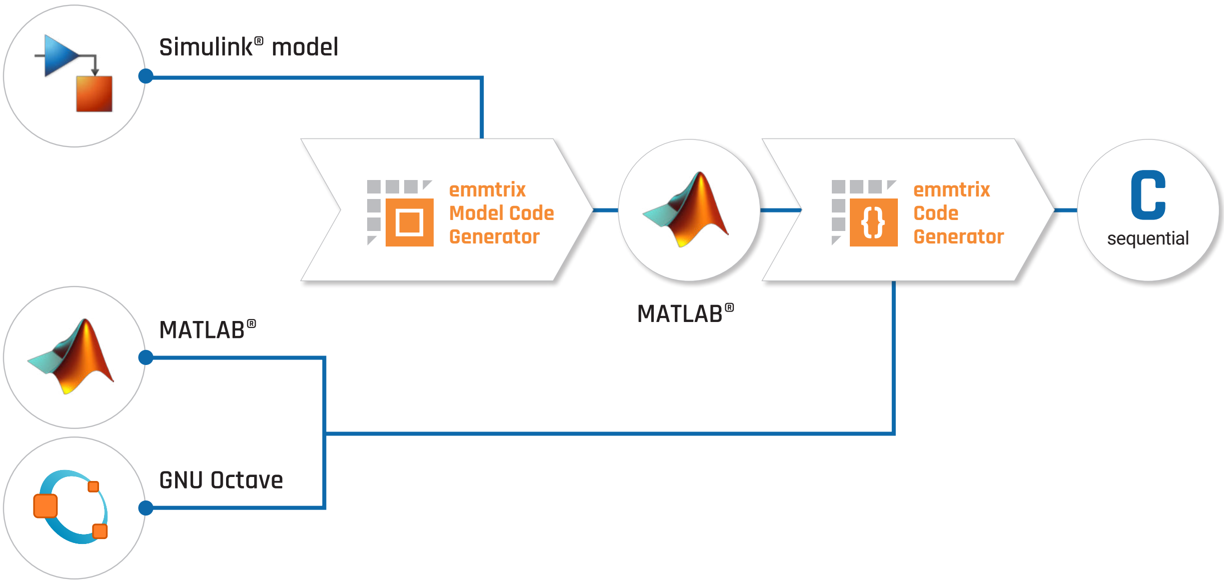
Features

- ISO C90, C99, C11, C18, C++98, C++11, C++14 and C++17 compliant code generation
- Performance & memory analysis
- User-controlled cache and memory optimization
- Embedded code generation without dynamic memory allocation
- Automatic floating-point to integer number conversion
- Profiling-based performance analysis and visualization within GUI

Benefits

- Bidirectional traceability via code generation reports
- Generate highly comrehensible target-optimized C/C++ code
- Automatable back-to-back tests for functional validation
- Can easily be adapted to your requirements

eCG Workflow



Your Solution for C++

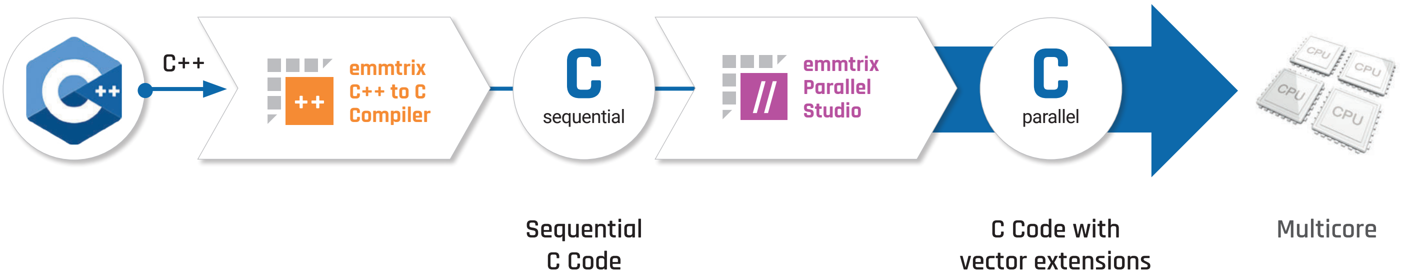
Code Conversion

emmtrix C++ to C Compiler (eCPP2C) automatically translates your C++ source code into analyzable C code. The design goal was to keep the binary compilation of the original C++ code and the binary compilation of the translated C code mostly identical. This guarantees the functional correctness of the generated C code. eCPP2C utilizes the LLVM/Clang compiler technology to enable support of the latest features of the fast evolving C++ standard. In combination with emmtrix Parallel Studio, eCPP2C enables software parallelization of C++ applications.

Features

- Translation of C++ to C source code
- Utilizes latest LLVM/Clang compiler technology
- Gurantees functional correctness of generated C code by verification tool
- ECPP2C Qualification Kit (ISO 26262, DO-178C/330 or any comparable standard) can be provided on request
- Demystifies how your C++ code is compiled to assembler
- Can be used in combination with (certified) C compilers and C code analysis tools
- Is integrated into emmtrix Parallel Studio GUI to enable C++ code parallelization

C++ Parallelization Workflow



Our Services

Integration & Tool Customization

- Customization of emmtrix tools for your target domain's requirements
- Individual interfaces for the seamless integration of emmtrix tools into your existing workflow
- New product features on demand
- Support for your target architecture of choice (i.e. multicore, DSP, GPU)

Trainings & Support

- Guidance and exercises to learn the efficient use of emmtrix products
- Comprehensive introductions to all aspects of multicore software development
- Individual trainings on related topics upon request

Technical Consulting

- Performance optimization for single-core architectures (e.g. cache optimization, floating-to-fixed-point conversion)
- Deployment of applications on multicore architectures, DSPs and GPUs (shared/ distributed memory, homogeneous/ heterogeneous)
- Evaluation and selection of appropriate single- and multicore architectures individually and with DSP and GPU accelerators if applicable

emmtrix
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