



We are the link
between the real and
the digital world.

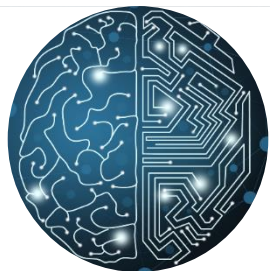
How to speed up the development of automated
driving with the virtual prototype for the next
generation of MCUs?

Infineon's virtual show 2020



Parallel Processing Unit enables affordable artificial intelligence use cases

Artificial Intelligence & Neural Networks



Optimize Automotive Use Cases

- › Cost Reduction
- › Innovation
- › Improve Performance
- › Accelerate Time to Market

Automotive AI Use Cases



Domain/Zone Control

- › Modelling
- › Model Predictive Control
- › IDPS & other security methods



ADAS

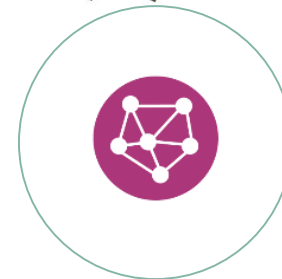
- › Object classification
- › Advanced Radar Signal Processing
- › Sensor Fusion



xEV Applications

- › Predictive Control
- › Virtual Sensing

TC4xx PPU Co-processor

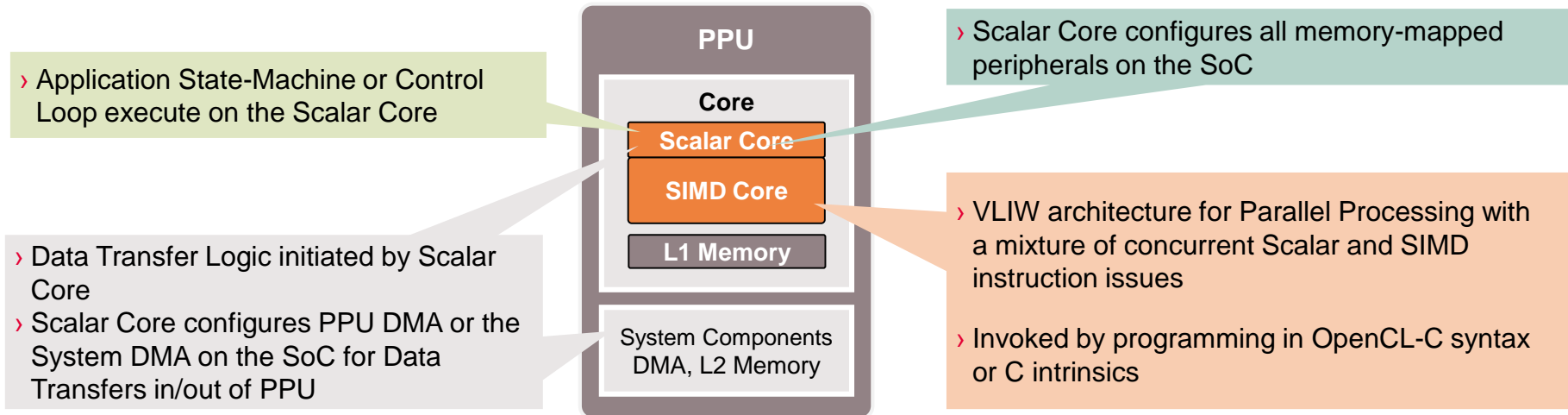
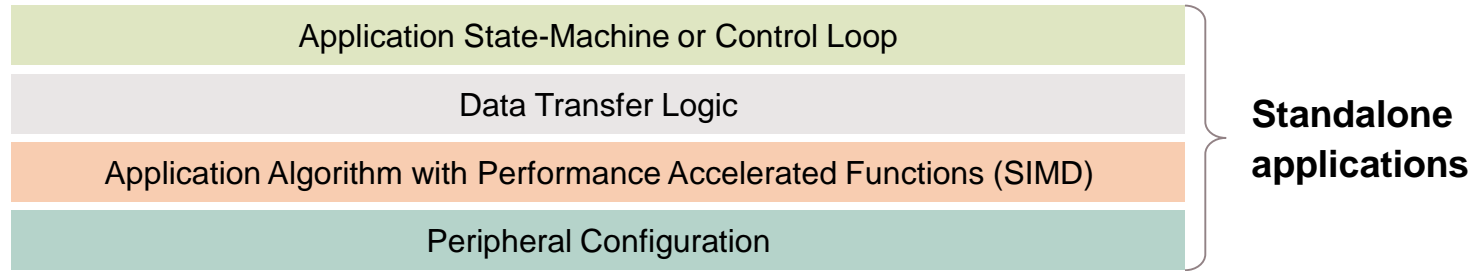


Computes mathematical problems like:

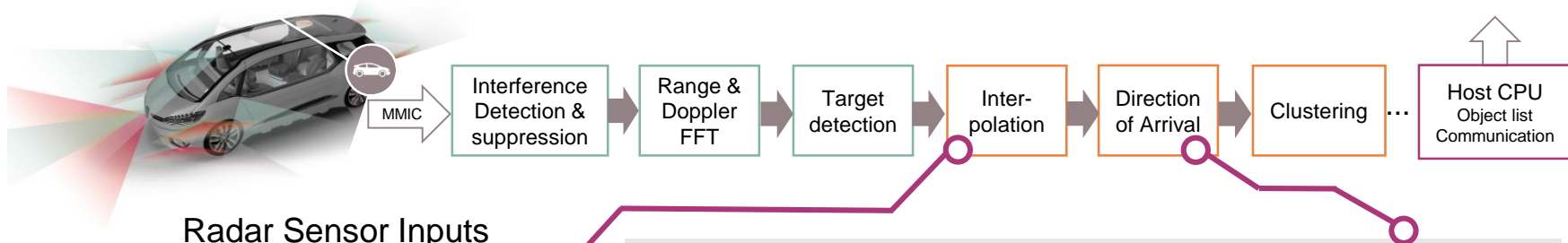
- › Linear Algebra (e.g. matrix operations)
- › Signal Processing (convolutions, filtering)

PPU acting as standalone processor

Higher autonomy than a DSP

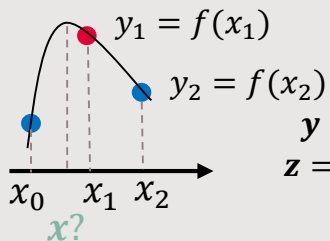


PPU enables enhanced radar post-processing through acceleration of matrix/vector operations



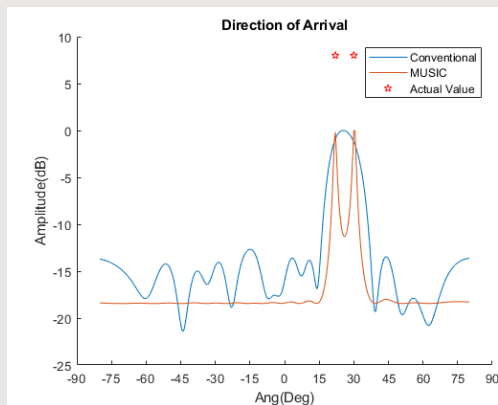
Radar Sensor Inputs

- › Increase accuracy for detection points in range and velocity dimension
- › Example Method:
 - Quadratic interpolation



$$y = X * z$$
$$z = X^{-1} * y$$

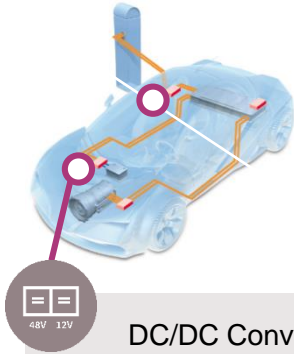
- › Estimating the angles of arrival using phase difference
- › Example Method: MUSIC algorithm



- › **Input:** Antenna Vector of virtual antenna array ($RX * TX$)
- › **Output:** Spatial power spectrum with peaks indicating a target angle location

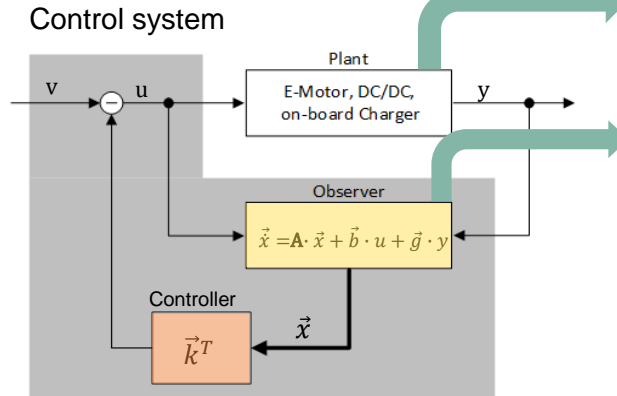
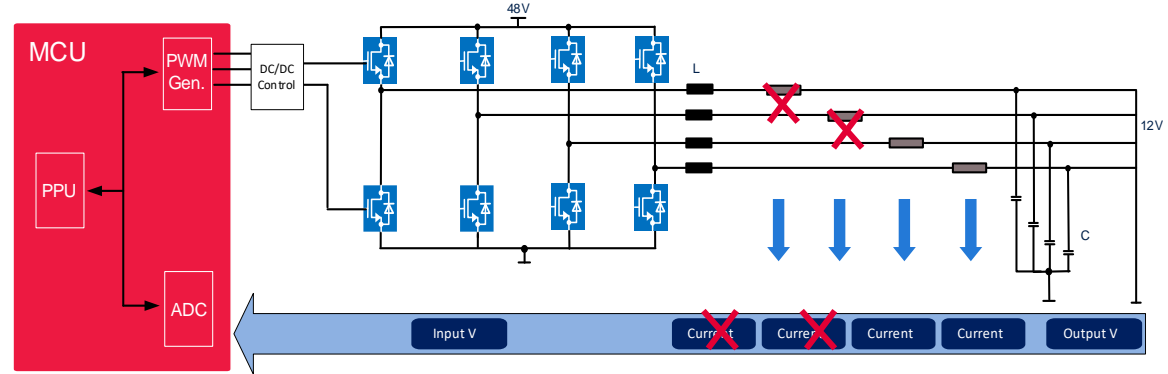
PPU Computational Steps
Matrix/Vector operations,
EigenValue Decomposition

In electric vehicles, PPU can be used for implementing model predictive control in DCDC converters to reduce system cost



DC/DC Converter

- › Charges the conventional 12V power supply net from the high voltage battery
- › Replaces the former belt driven alternator
- › Part of On-Board-Charger (OBD) to charge battery via AC/DC & DC/DC module



Plant can be mathematically described by differential equations

System Matrix sizes are defined by number of passive components
e.g. 4 x LC

Vector DSP performance to accelerate real-time observer computations

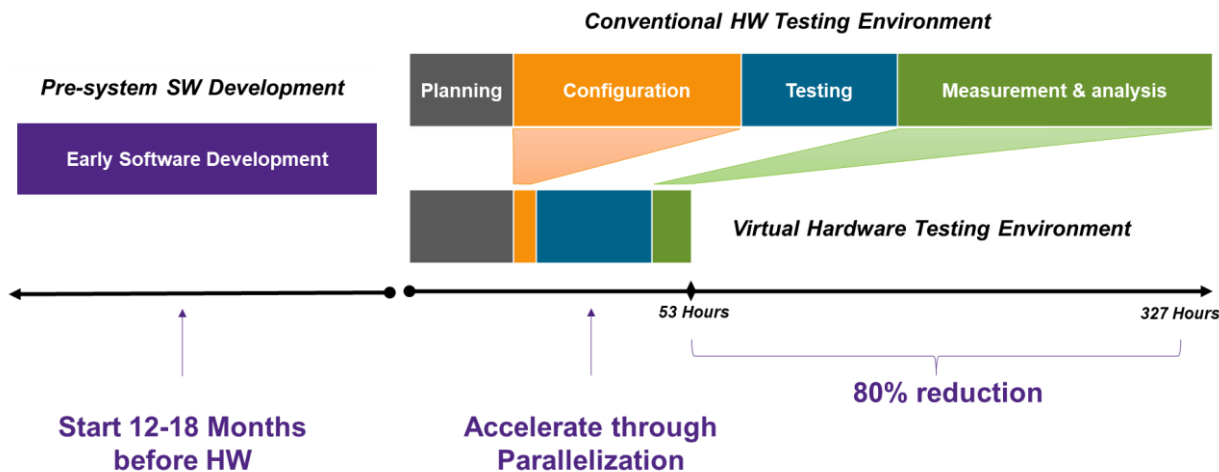
Advantages of Virtual Prototyping



- › Execute unmodified binary production SW
- › Embedded SW development before real HW is available
- › Complete visibility into system enables fast debugging
- › Fast simulation speed with reasonable timing accuracy
- › Integrated co-simulation with external Peripheral/ASIC models

Start Software Development Early

Increase Testing Throughput

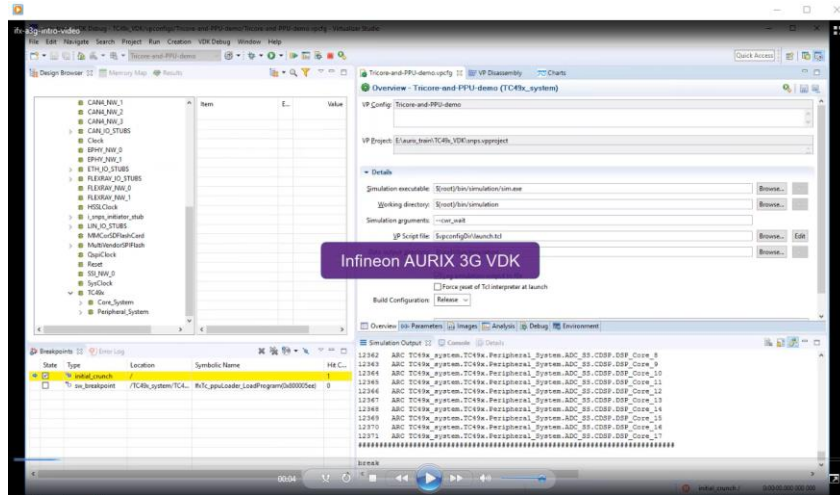


- › Develop HW dependent SW earlier
- › HW/SW Analysis
- › Frontload test development, increase fault and coverage testing
- › Accelerate testing cycles in regression
- › Fault injection/functional safety testing
- › Virtual Hardware-in-the-Loop

Synopsys and Infineon have collaborated to develop the AURIX™ TC4xx Virtualizer Development Kit



Virtual Prototype (VP) is integrated into the Virtualizer Development Kit (VDK) from Synopsys and includes access to AURIX™ PPU



SYNOPSYS® Virtualizer Development Kit

- › Provides runtime environment for the VP
- › Full debug and analysis support, connects to regular HW debuggers
- › Scripting framework for flexible control and stimulation of the embedded SW
- › Various interfaces to Simulink, SABER and CANoe, etc

First Step: Sensor Fusion has already been demonstrated with partners Vector and Baselabs...

Radar
sensor
inputs

VECTOR 

**Vector
VX1000
Data
Recorder**

Records raw
object data

AURIX™ TC3xx Target



VECTOR 

VECTOR MICROSAR SW

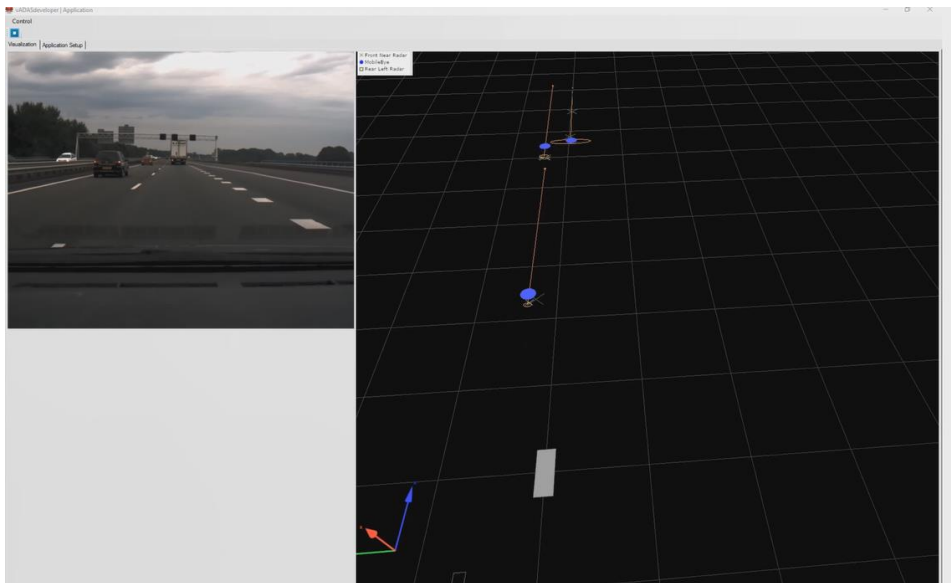


**BASELABS Fusion Lib
Use Case: Highway Pilot**

Visualization



Results: Sensor Fusion Visualization with the AURIX™ TC3xx



Real traffic scene was recorded by video



Radar data was recorded for the same scene

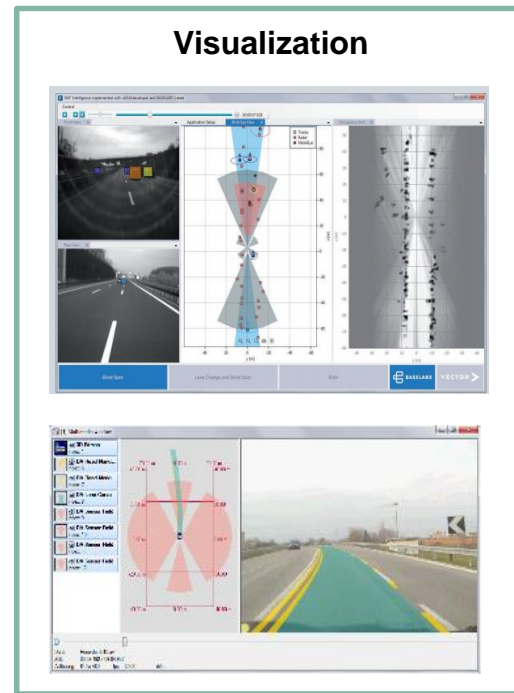


Observe Visualization:

The environment model of the fused object corresponds exactly to the object (cars,...) seen on the video

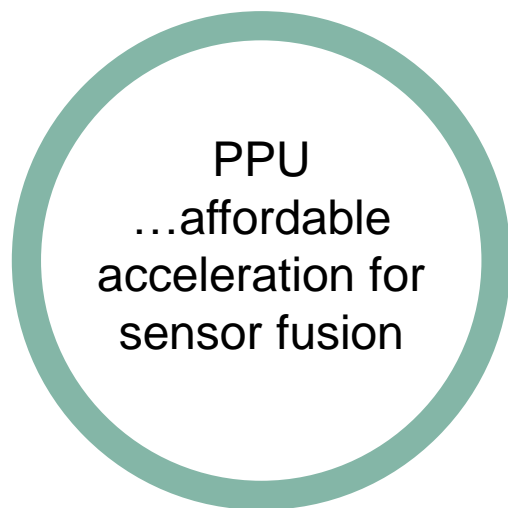
Second Step: Upgrade the demo to show AURIX™ TC4xx PPU performance benefits using Synopsys Virtual Prototype

Radar sensor inputs



A Virtual Prototype is a simulation platform of HW that can execute target SW applications without any modifications

Results observed...



NEW! AURIX™ TC4xx Parallel Processing Unit (PPU)

- › Enhances post processing of radar signal through acceleration of matrix & vector operations

50% performance improvement observed due to PPU

- › The PPU SIMD function was used to vectorize the Baselabs fusion library and the functionality was tested in the Synopsys TC4xx VDK
- › An performance improvement of 50% could be achieved compared to though only a small portion of the library could be vectorized

The AURIX™ TC4xx VDK from Synopsys is available, as well as an evolving getting started ecosystem



Development tools and SW for the Synopsys AURIX™ TC4xx VDK



3rd party Embedded automotive SW

- › Planned from multiple partners



3rd party SW Development Tools

- › **Synopsys** PPU tool chain including Open CL/C and libs
- › **Altium/High Tec:** TC1.8 Compiler Tool Chains
- › **Lauterbach/PLS:** Debugger tools



IFX TC4xx Embedded SW

- › Peripheral driver package, example projects
- › MCAL pre-Si alpha



- › **MICROSAR** – Vector's AUTOSAR Classic software – available and used for AURIX™ TC2xx and TC3xx families
- › **MICROSAR** stack porting already available for 3rd generation TC4xx via VDK environment
- › Connection to TC4xx VDK environment via Vector's CANoe

Availability and questions:

embedded@vector.com



- › **BASELABS** Create Embedded – software library for sensor fusion
- › Production-grade object fusion for ADAS systems like AEB, ACC, Highway Pilot
- › **ASPICE**, ISO26262 compliant
- › Reduces development project risks and costs

Availability and questions:

info@baselabs.de



Part of your life. Part of tomorrow.