



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

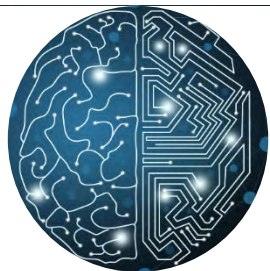
How to speed up the development of automated driving with the virtual prototype for the next generation of MCUs?

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

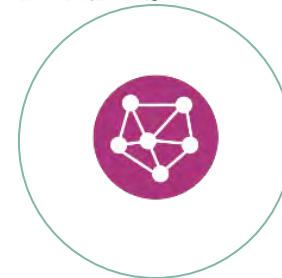
- › Object classification
- › Advanced Radar Signal Processing
- › Sensor Fusion



### xEV Applications

- › Predictive Control
- › Virtual Sensing

## TC4xx PPU Co-processor

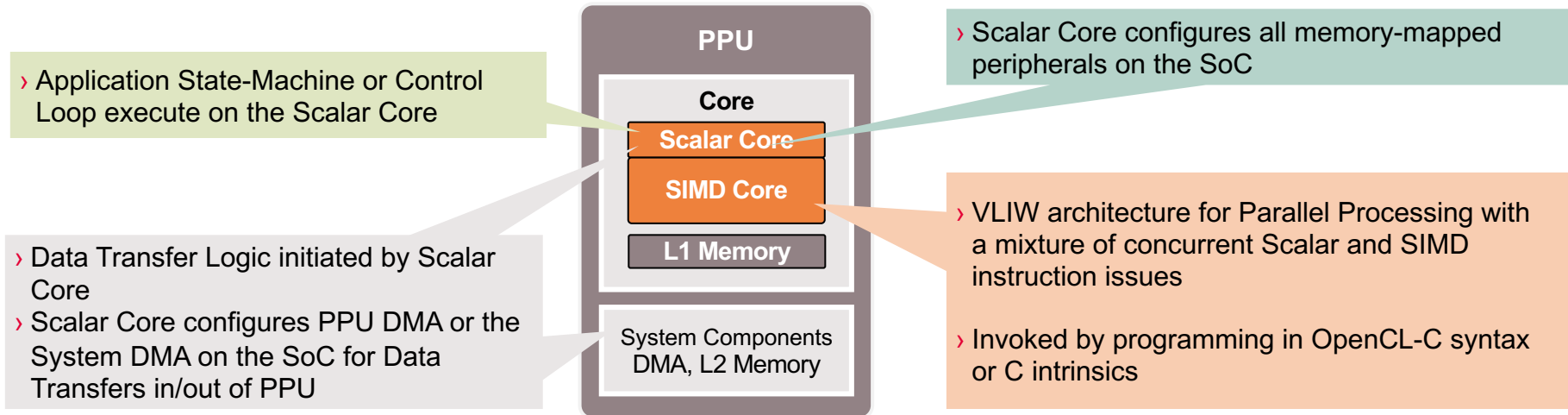
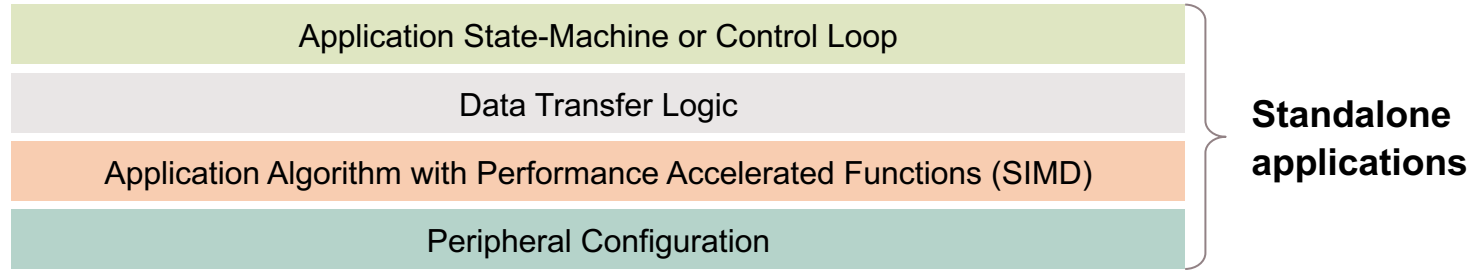


Computes mathematical problems like:

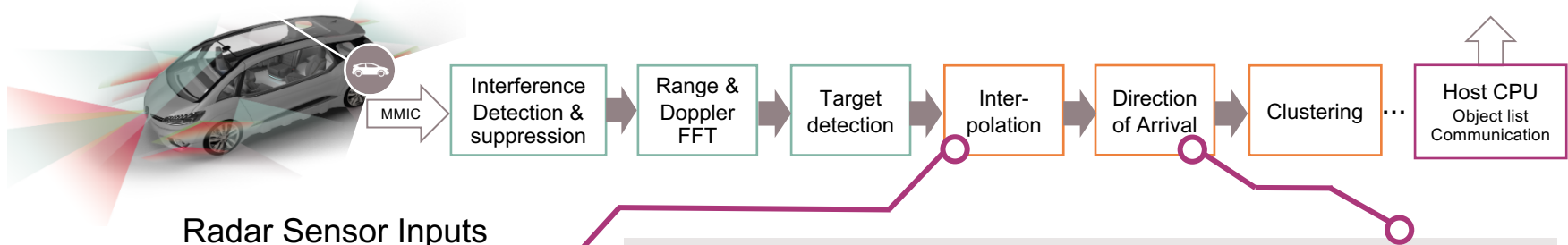
- › Linear Algebra (e.g. matrix operations)
- › Signal Processing (convolutions, filtering)

# PPU acting as standalone processor

## Higher autonomy than a DSP

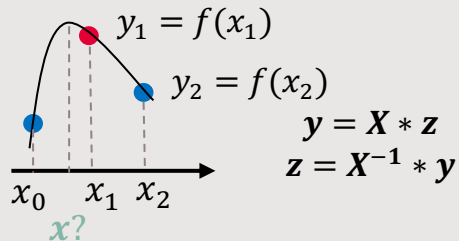


# PPU enables enhanced radar post-processing through acceleration of matrix/vector operations

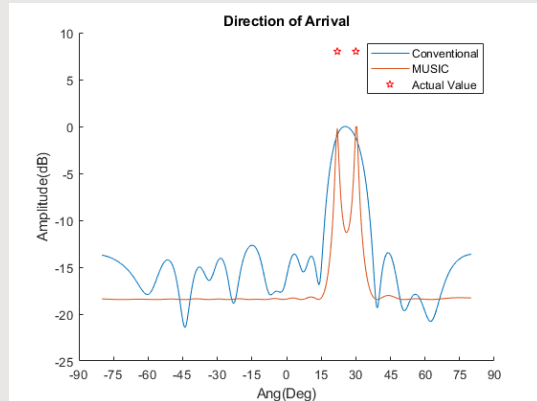


## Radar Sensor Inputs

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



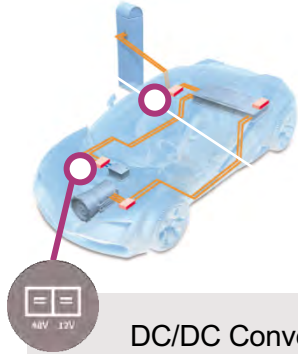
- › Estimating the angles of arrival using phase difference
- › Example Method: MUSIC algorithm



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

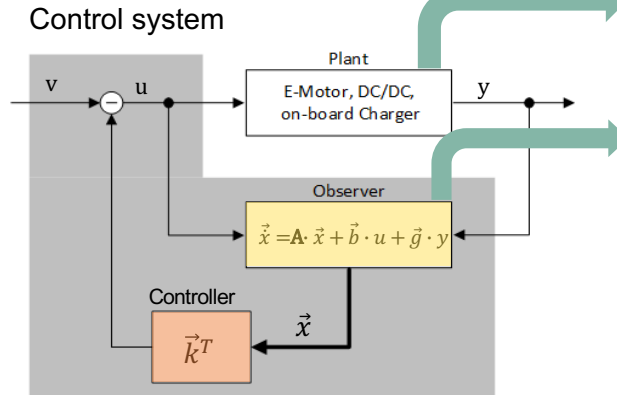
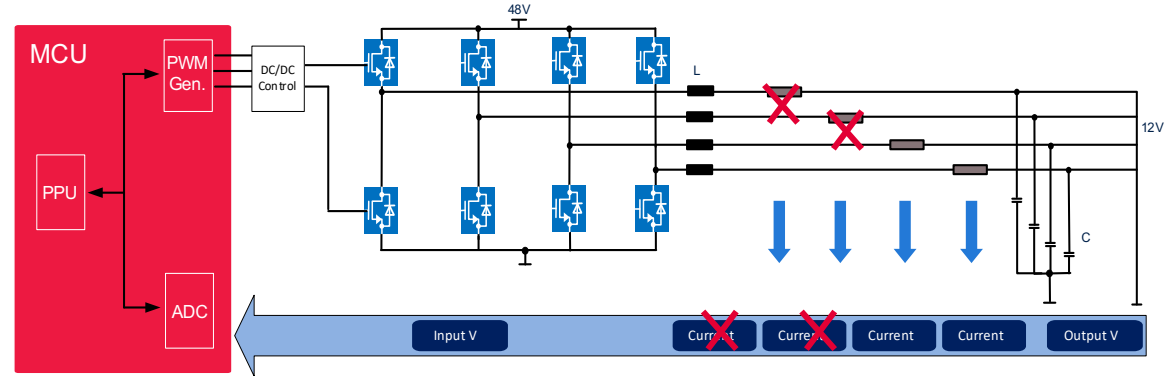
**PPU Computational Steps**  
Matrix/Vector operations,  
EigenValue Decomposition

# 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

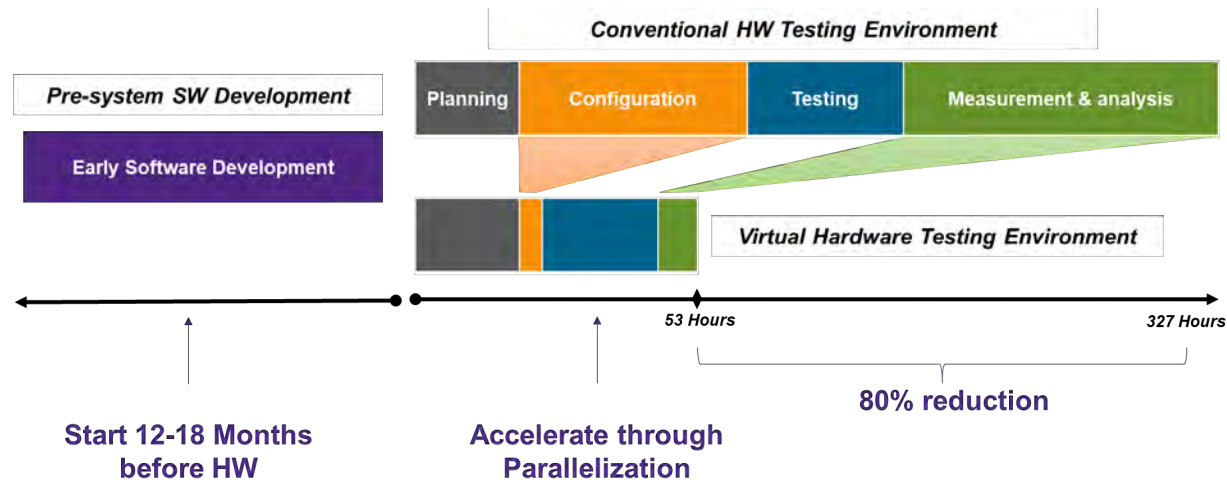
# Advantages of Virtual Prototyping



- › 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

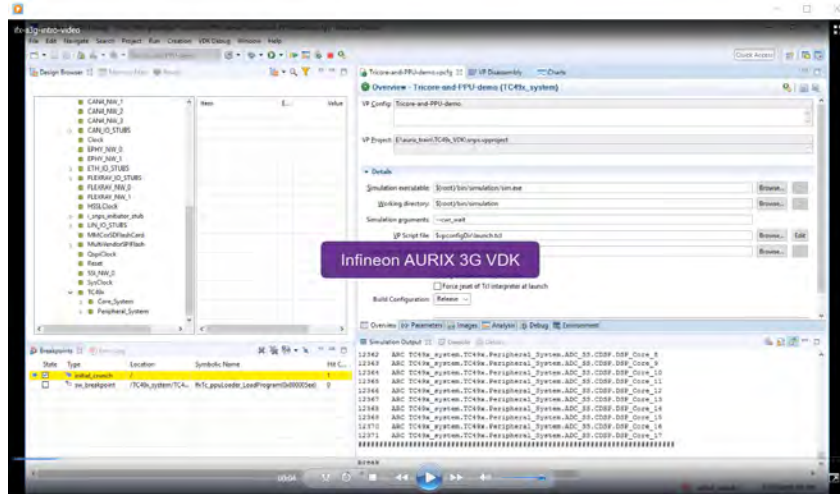


- › Develop HW dependent SW earlier
- › HW/SW Analysis
- › Frontload test development, increase fault and coverage testing
- › Accelerate testing cycles in regression
- › Fault injection/functional safety testing
- › Virtual Hardware-in-the-Loop

# 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**

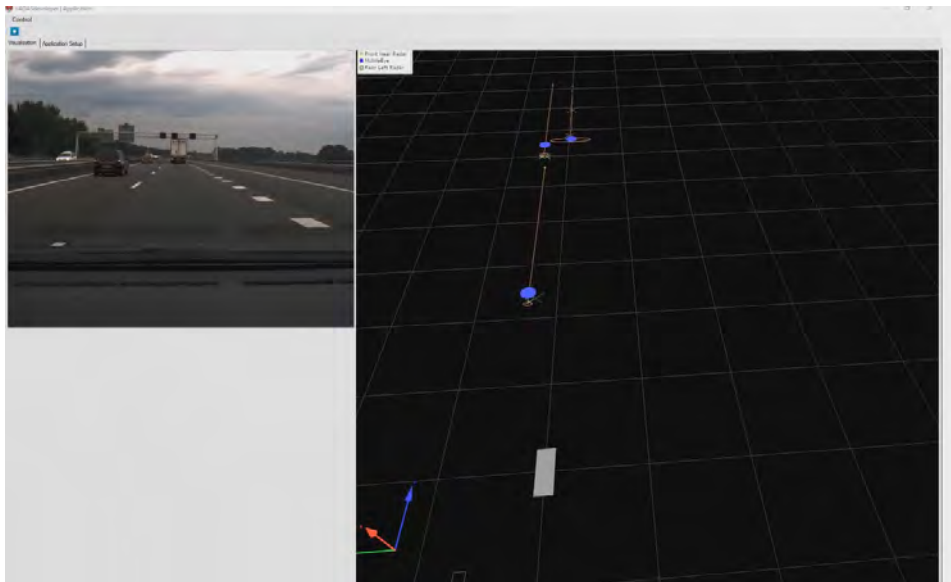


**BASELABS Fusion Lib  
Use Case: Highway Pilot**

**Visualization**



# Results: Sensor Fusion Visualization with the AURIX™ TC3xx



Real traffic scene was recorded by video



Radar data was recorded for the same scene

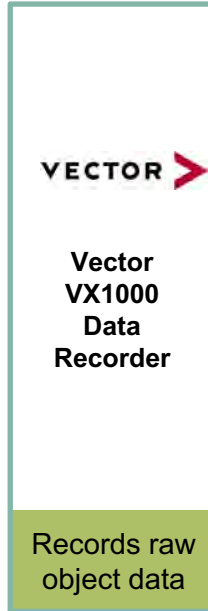


## Observe Visualization:

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

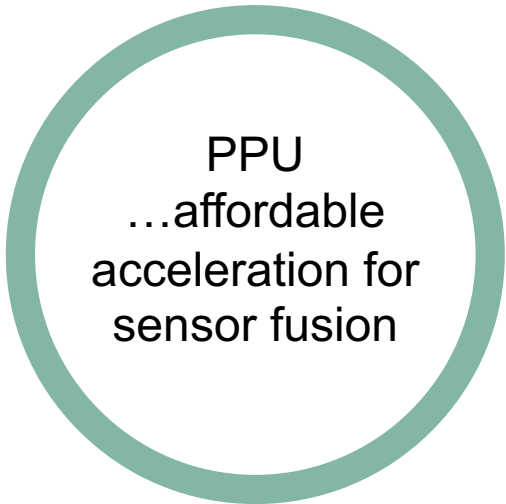
# Second Step: Upgrade the demo to show AURIX™ TC4xx PPU performance benefits using Synopsys Virtual Prototype

Radar sensor inputs



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

## Results observed...



PPU  
...affordable  
acceleration for  
sensor fusion

### **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



### 3<sup>rd</sup> party Embedded automotive SW

- › Planned from multiple partners



### 3<sup>rd</sup> 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 3<sup>rd</sup> generation TC4xx via VDK environment
- › Connection to TC4xx VDK environment via Vector's CANoe

Availability and questions:

[embedded@vector.com](mailto: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](mailto:info@baselabs.de)



Part of your life. Part of tomorrow.