



We make IoT work

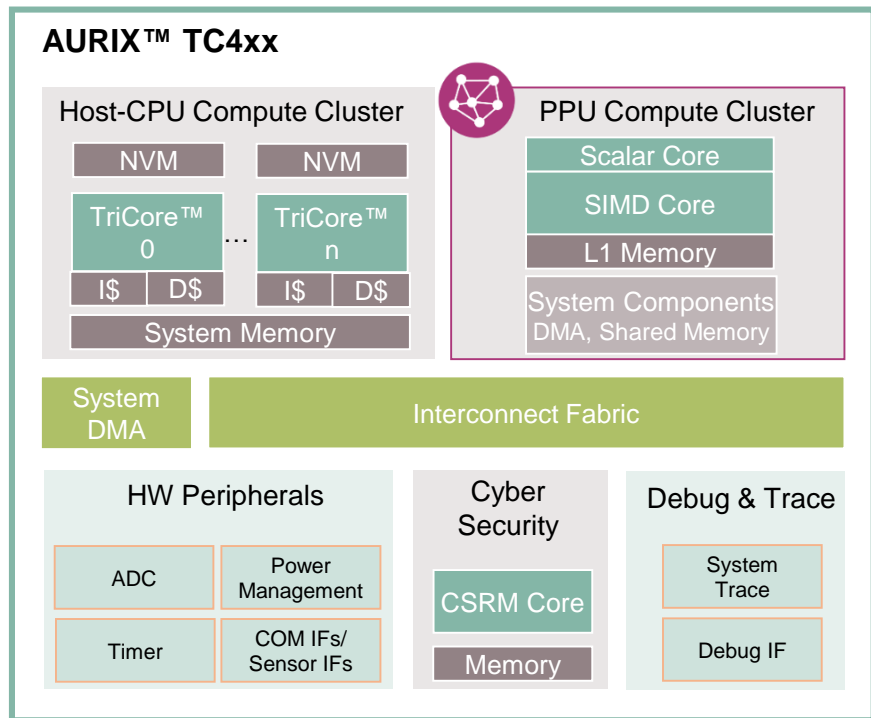
AURIX™ TC4xx SW Application Architecture

Supports next level of automotive applications

Embedded Solutions Conference 2021



New SoC architecture includes PPU compute cluster to support next level of automotive applications



AURIX™ TC4xx Parallel Processing Unit (PPU)

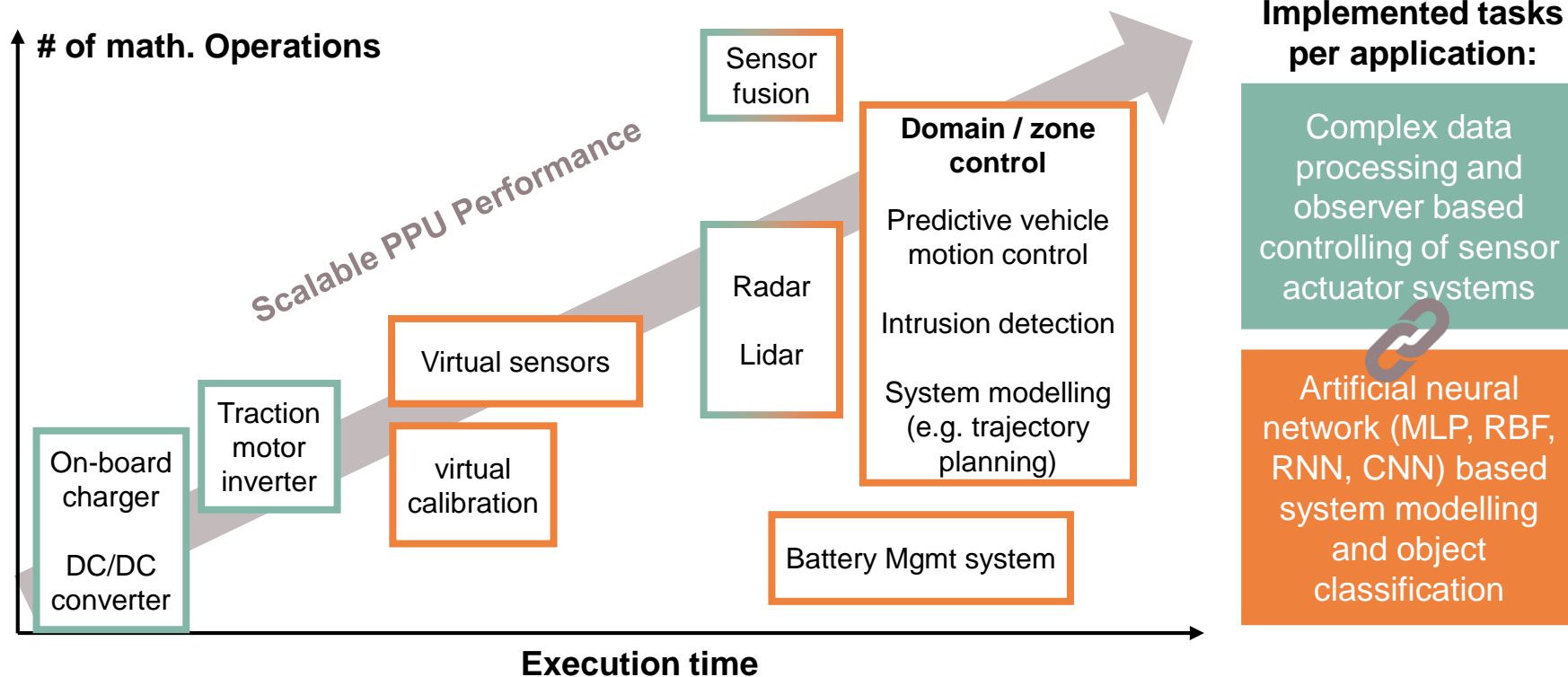
- › Enables affordable artificial intelligence use cases
- › PPU is a SIMD vector DSP, speeding up computation compared to traditional CPUs
 - Matrix operation acceleration
 - Data processing
 - Neural network based algorithms
 - High speed control implementations



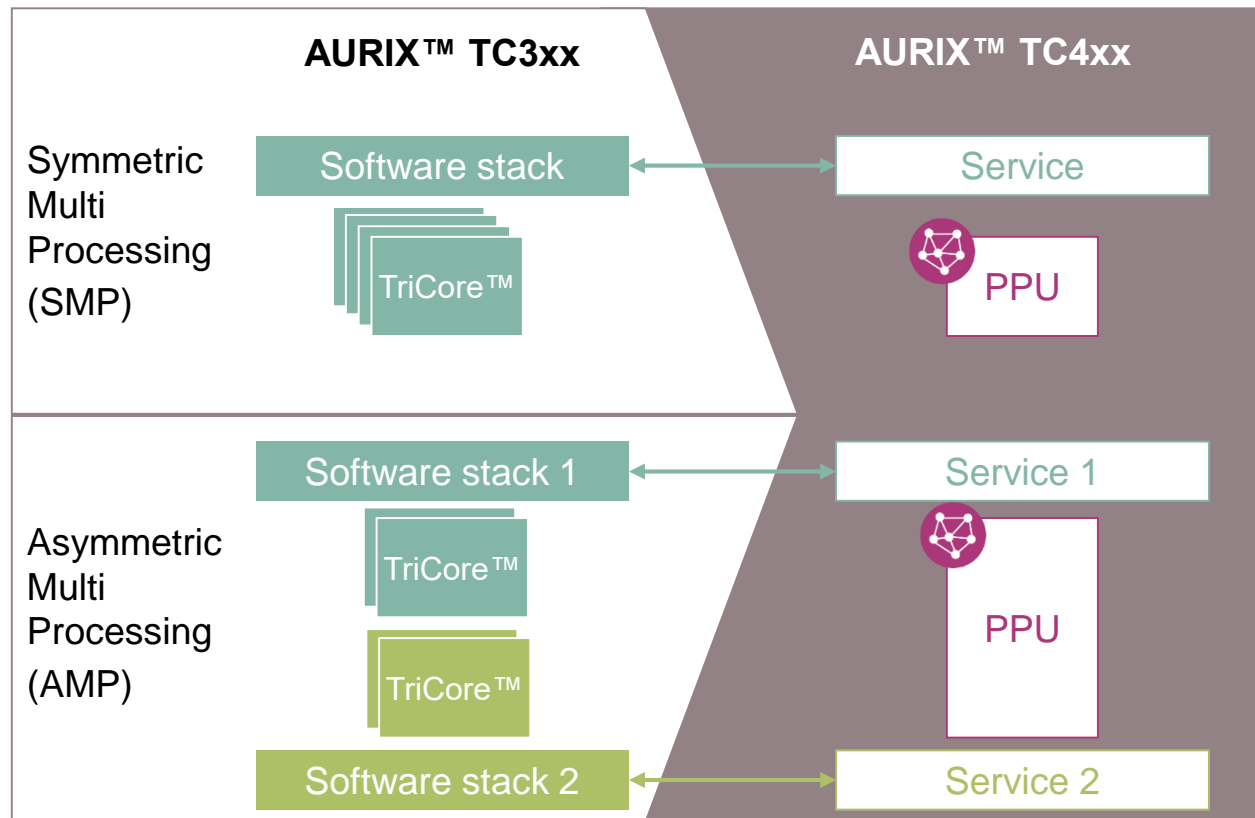
AURIX™ TC4xx SoC architecture

- › Means that applications can now be distributed to run on TriCores and PPU

PPU is a flexible architecture to address applications with fast execution times and/or large data processing requirements



Next generation AURIX™ is a heterogeneous architecture providing new computing abilities for new implementations



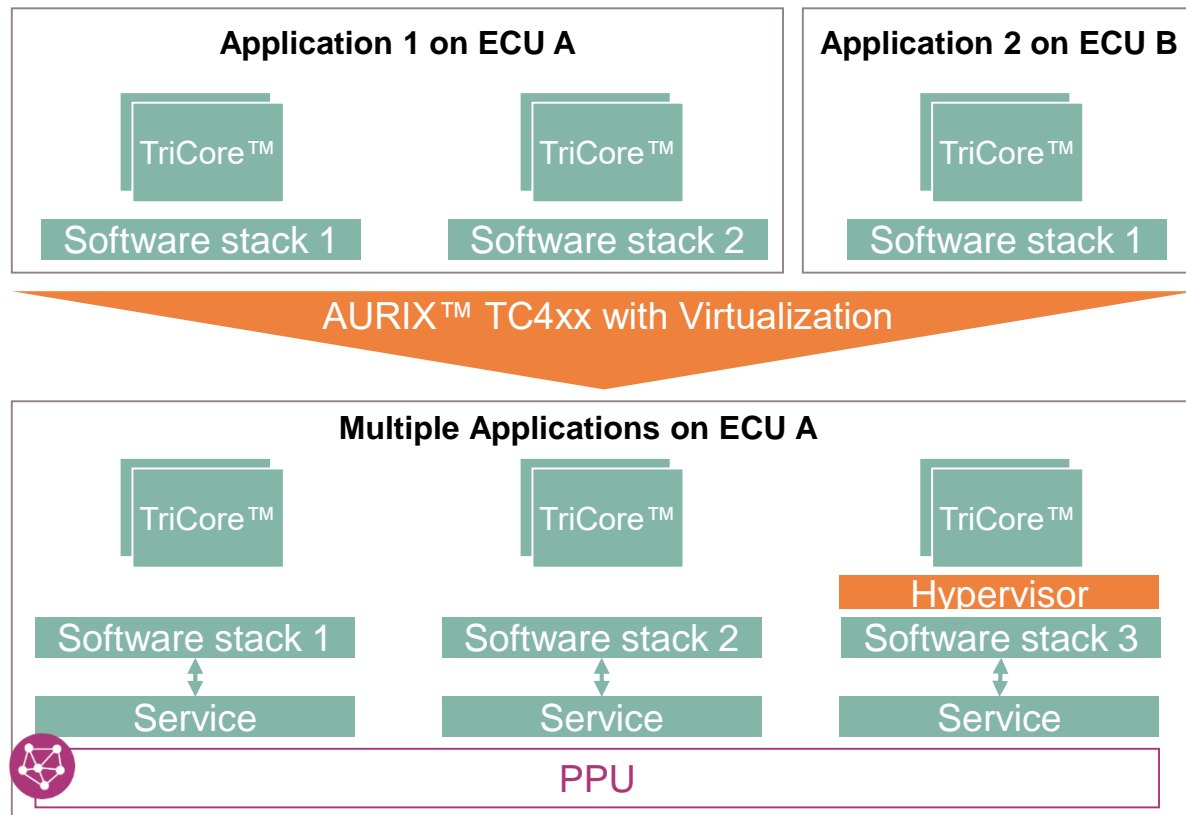
AURIX™ TC3xx

- › Enables SMP and AMP

Next gen AURIX™ TC4xx

- › Offers heterogeneous variant of SMP and AMP
- › PPU can accelerate any functional block stack
- › PPU is service provider
- › Opens new computational opportunities

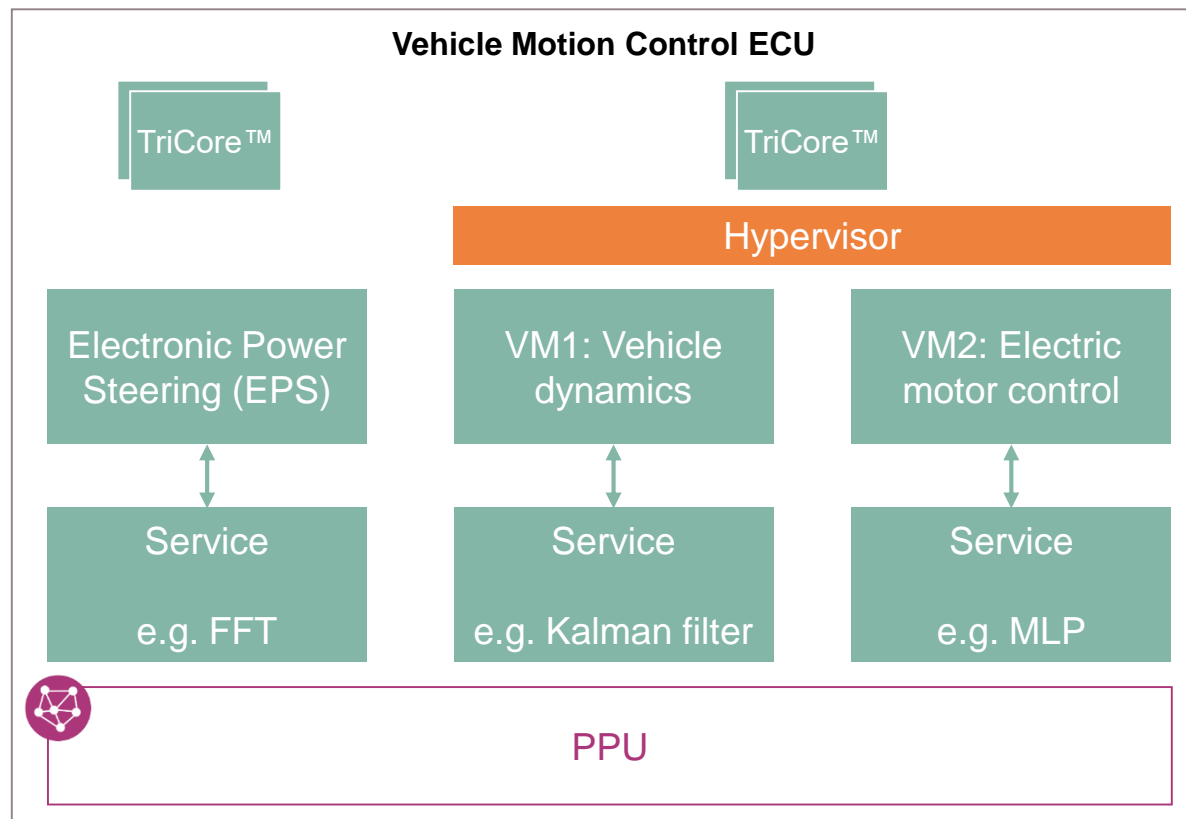
PPU acts as seamless service provider when using virtualized CPUs



Asymmetric Multi Processing (AMP) with Virtual Machines

- › AURIX TC4xx offers TriCore™ virtualization
- › Seamless integration of functions, reducing standalone ECUs
- › PPU does not distinguish between virtualized and non virtualized clients
- › Benefits for new and legacy application stacks

Example: In a Vehicle Motion Control ECU, PPU can be used to implement performance heavy functions of different stacks



Example: Vehicle Motion Control ECU

› Application partitioning:

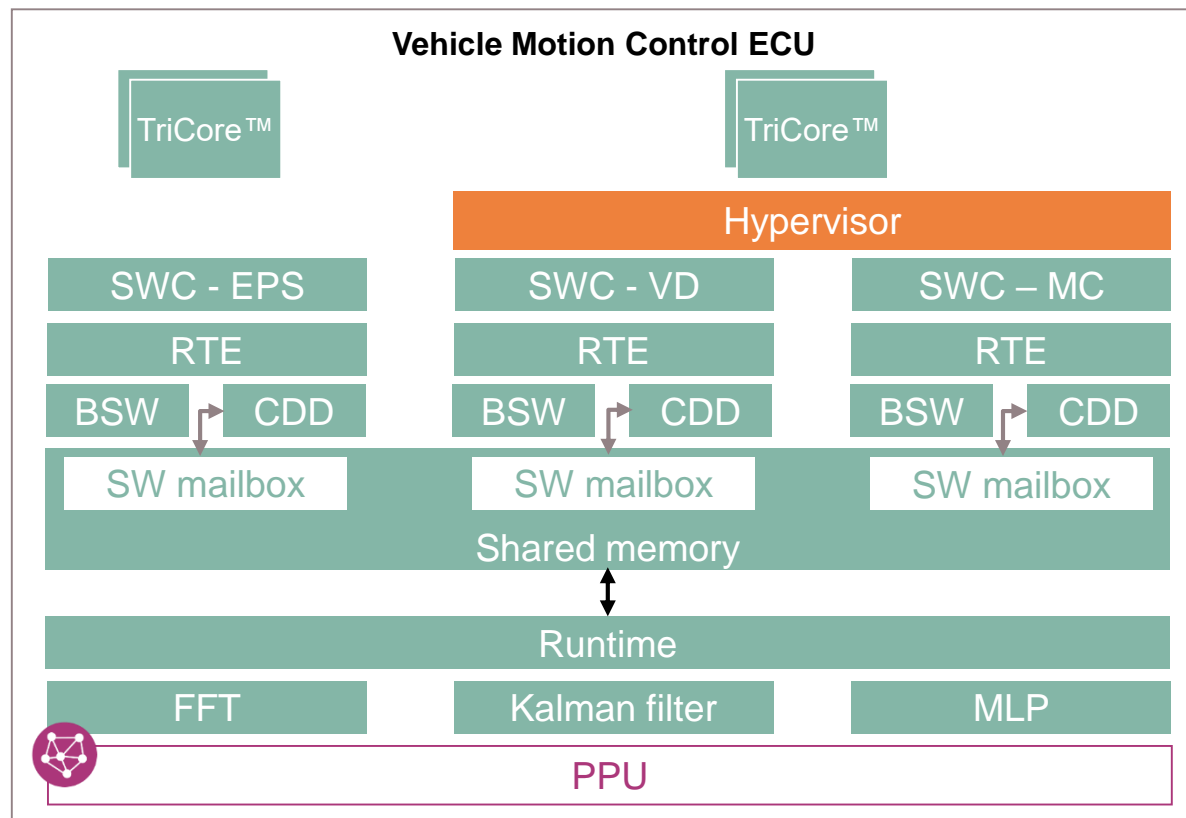
- **Dedicated TriCore™**: Hosts Electronic power steering
- **Second TriCore™**: Hosts two stacks as virtual machines



PPU acceleration functions

- › Can be used by all 3 stacks
 - MLP for sensor less FOC
 - Kalman filter, predicts g-forces on vehicle
 - FFT for plausibility checks

Example: PPU middleware detects requests by dedicated AUTOSAR stacks and handles prioritized execution



Example: AUTOSAR Environment

- › Three physically isolated AUTOSAR stacks
- › Each communicates with PPU using dedicated complex device driver (CDD)
- › CDD communicates with middleware on PPU



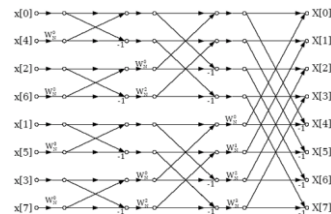
PPU middleware detects requests and executes

- › Software on PPU does not differentiate its clients

PPU enables implementation of algorithm types, which benefit strongly from SIMD performance vs. legacy CPU

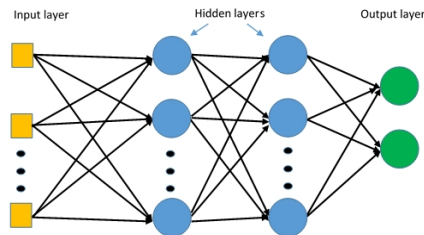
Fast Fourier Transform (FFT)

Used for plausibility checks (e.g. determining that rotor position yielded by resolver system is legitimate)



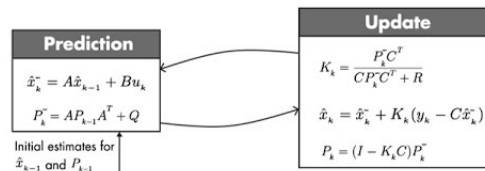
Multi Layer Perceptron (MLP)

Simplifies and accelerates function approx. by eliminating look up tables and interpolation



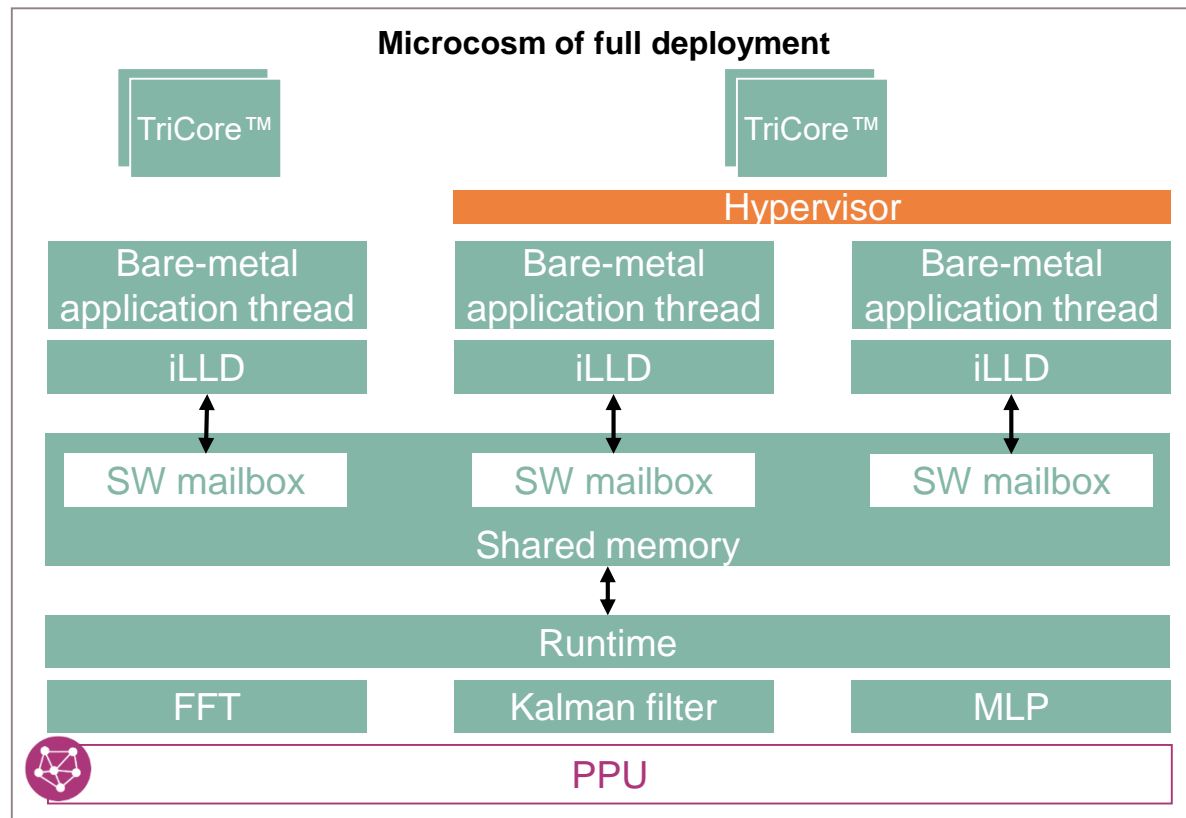
Kalman filter

Predicts measurements of entities where a direct measurement is not possible



All three examples demonstrate SIMD-based computation capabilities of PPU

For demonstration, PPU capabilities when computing FFT, Kalman filters and MLPs



Demonstration: Using Bare Metal approach

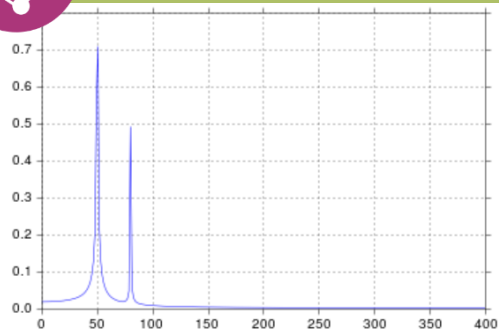
- › Demonstration of isomorphism of AUTOSAR concept
- › Stacks built using Infineon Low Level Device drivers (iLLDs)
- › Stacks communicate with PPU to request service
- › Stacks operate concurrently but PPU only serves one client at a time
- › Output produced by PPU will be plotted as part of the demo ...

The demonstrator showcases implementations of FFT, Kalman Filters and MLPs by plotting the outputs

VM ID



PPU Output 1

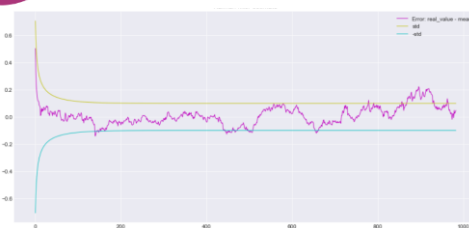


Frequency spectrum analysis
FFT

Time domain sensor data plotted by
its frequency spectrum



PPU Output 2



G-Forces prediction
Kalman Filter

Incremental plot of g-forces as a
vehicle is negotiating a sharp bend



PPU Output 3



Traffic sign detection
MLP

Radar or camera sensor data
analysed and object classification
performed

New SoC architecture includes PPU compute cluster to support next level of automotive applications



AURIX™ TC4xx offers tremendous computational power boost compared to previous generation deploying new applications with complex computing needs



AURIX™ TC4xx SoC architecture means that applications can now distributed to run on TriCores and PPU



The demonstration shows that the PPU:

- › Middleware detects requests by dedicated AUTOSAR stacks and handles prioritized execution
- › All forms of computations are preserved – traditional AMP and SMP
- › They are extended in their topologies by heterogeneous computing



SW ecosystem will support AUTOSAR and tool-chain enabling high level programming languages



Part of your life. Part of tomorrow.