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Vienna University of Technology

MPSoC, SoA, and Dynamicity

Engaging challenges in cyber-physical systems using emerging technologies

Institute for Computer Engineering

- Introduction
 - SoA for embedded systems, Project: Genesys
 - Mixed-Criticality MPSoC, Project: ACROSS
- EMC² MPSoC redesign, increasing performance
- Exploring dynamic behavior
- Conclusion
- References

Demands on Cyber-physical Systems

- Legislative
 - Certification for safety
- Economic
 - Energy consumption, size, time to market
- Consumer
 - Keep track with consumer electronic trends

Challenges

- Analyzability (IP Protected Systems)
- Predictability
- Composability
- Complexity Management
- Mixed-Criticality
- Certification

Constraints

- COTS Architectures
- Concepts, Tools, Methods

- GENESYS: Generic Embedded System Platform ¹⁾
 - Provides a framework for building embedded applications
 - Ensures essential system properties
 - Reduces design and implementation times



ACROSS: ARTEMIS CROSS-Domain Architecture ²⁾

ACROSS

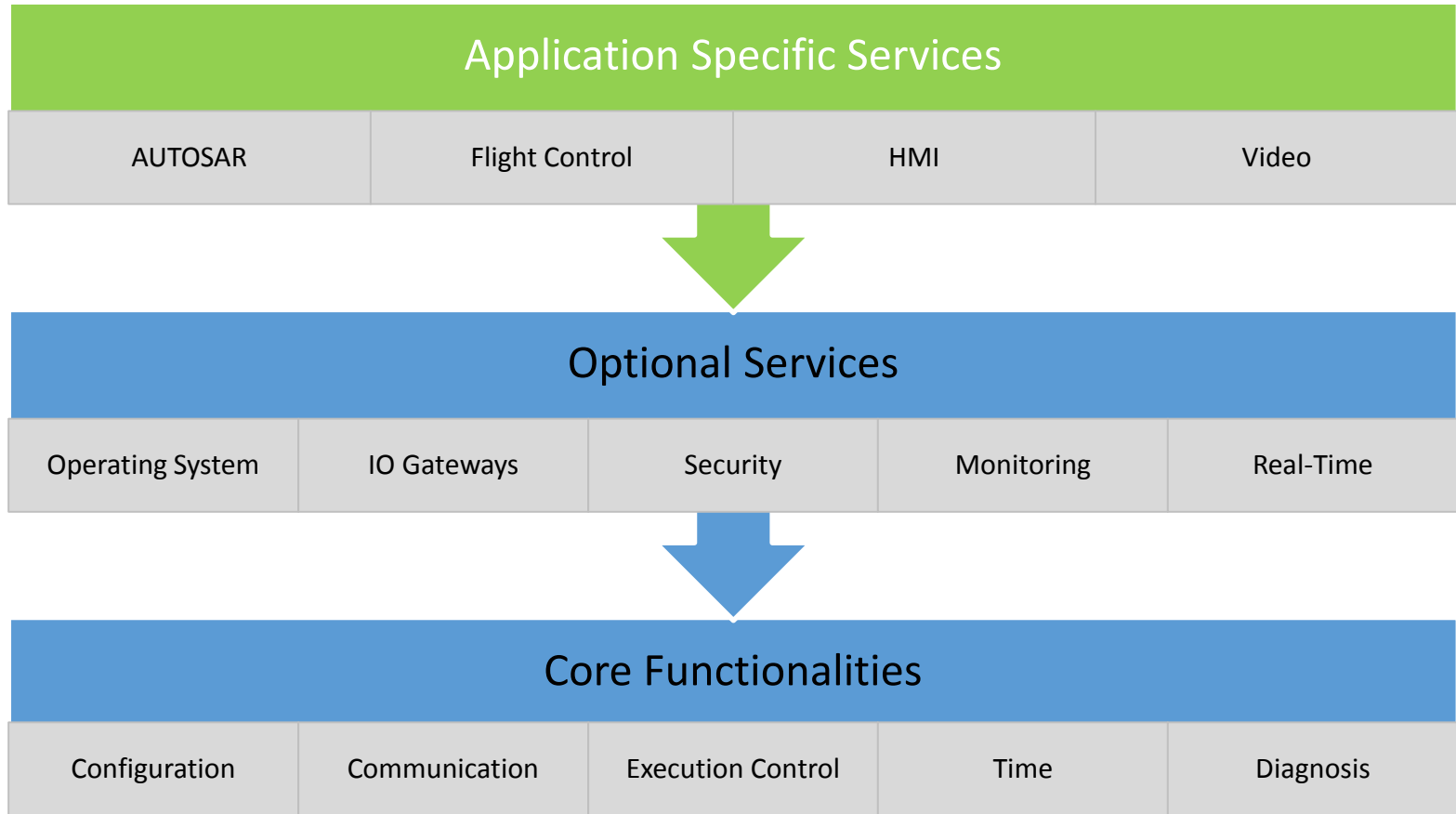
- Using GENESYS approach to build an MPSoC
- Enables mixed-criticality integration
- On the road towards certification

1) GENESYS: An ARTEMIS Cross-Domain Reference Architecture for Embedded Systems Roman Obermaisser; Hermann Kopetz

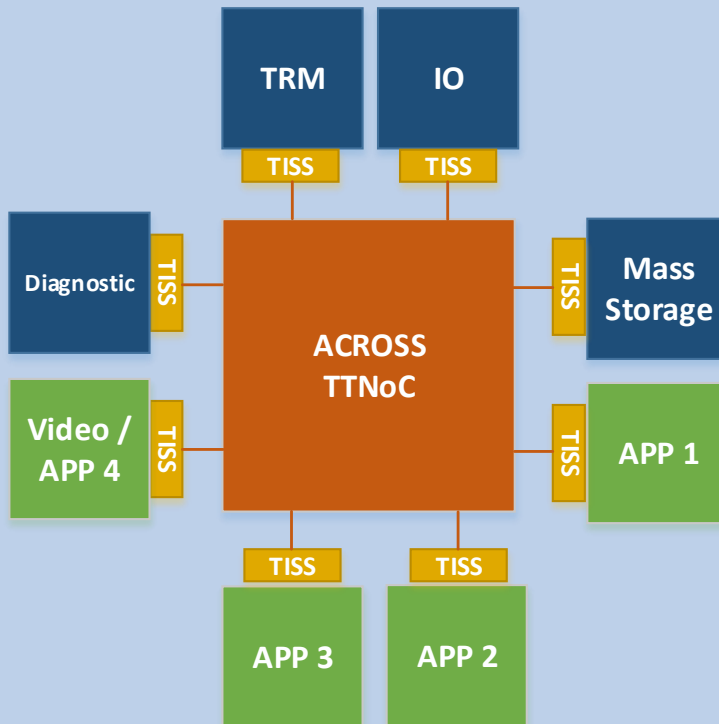
2) *The ACROSS MPSoC -- A New Generation of Multi-core Processors Designed for Safety-Critical Embedded Systems* Salloum, C.E.; Elshuber, M.; Hoftberger, O.; Isakovic, H.; Wasicek, A.,

Service-oriented Development

A generic template for embedded systems



ACROSS MPSoC



FPGA

Time-Triggered Network On-Chip (TTNoC)

- Deterministic communication
- Encapsulated channels

Trusted Interface Sub-System (TISS)

- Temporal and spatial isolation
- Heterogeneity

System Components

- Support core functionalities

Application Components

- CPU, DSP, dedicated HW
- Automotive, Avionic, Industrial Control

Demonstrators

- Automotive
- Industrial Control
- Aerospace
- Mobile Communications

Service Oriented Approach

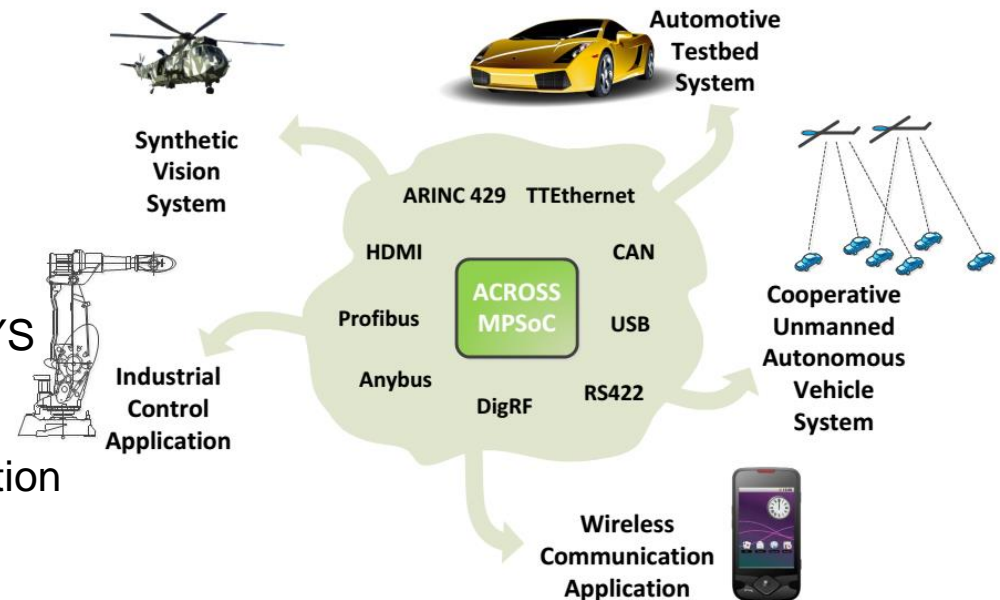
- Implementation of GENESYS

Mixed-Criticality Integration

- Temporal and Spatial Isolation
- Certification ready

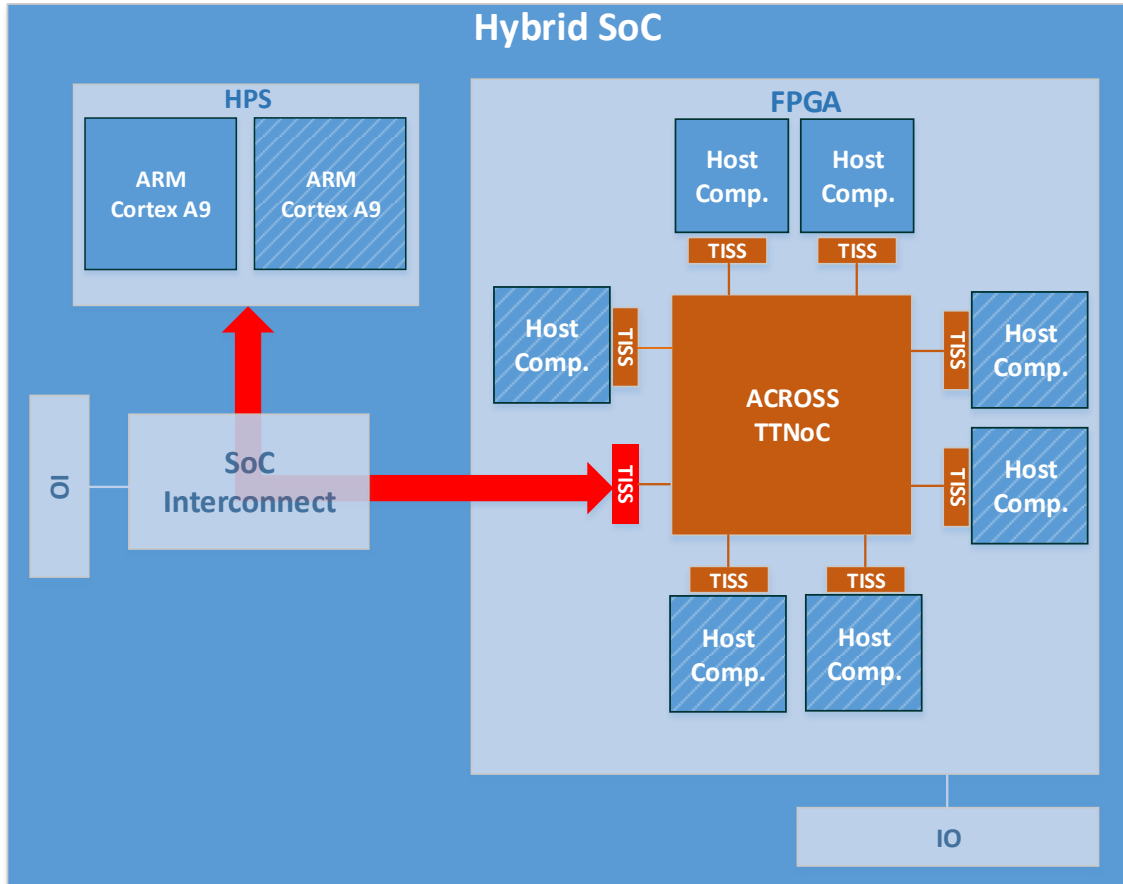
Performance






- TTNoc throughput 400MB/s
- Memory limitations
- Soft-coded Processors

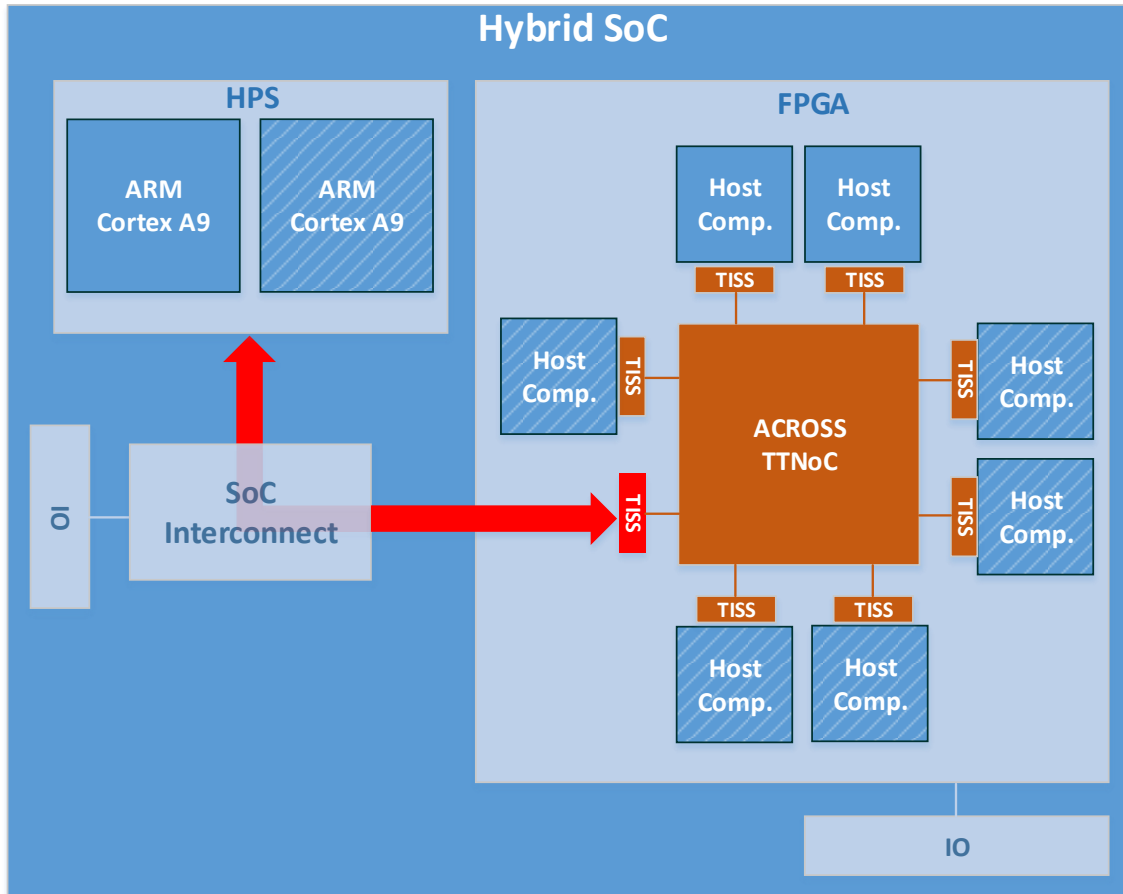


Extending MPSoC in EMC²

Increasing performance



-  Hybrid-SoC
-  TTNOC as the communication backbone
-  Extended TISS for hard-coded CPU(s)
-  Test performance on a minimal use case
-  Extended use case with additional cores



Prototype

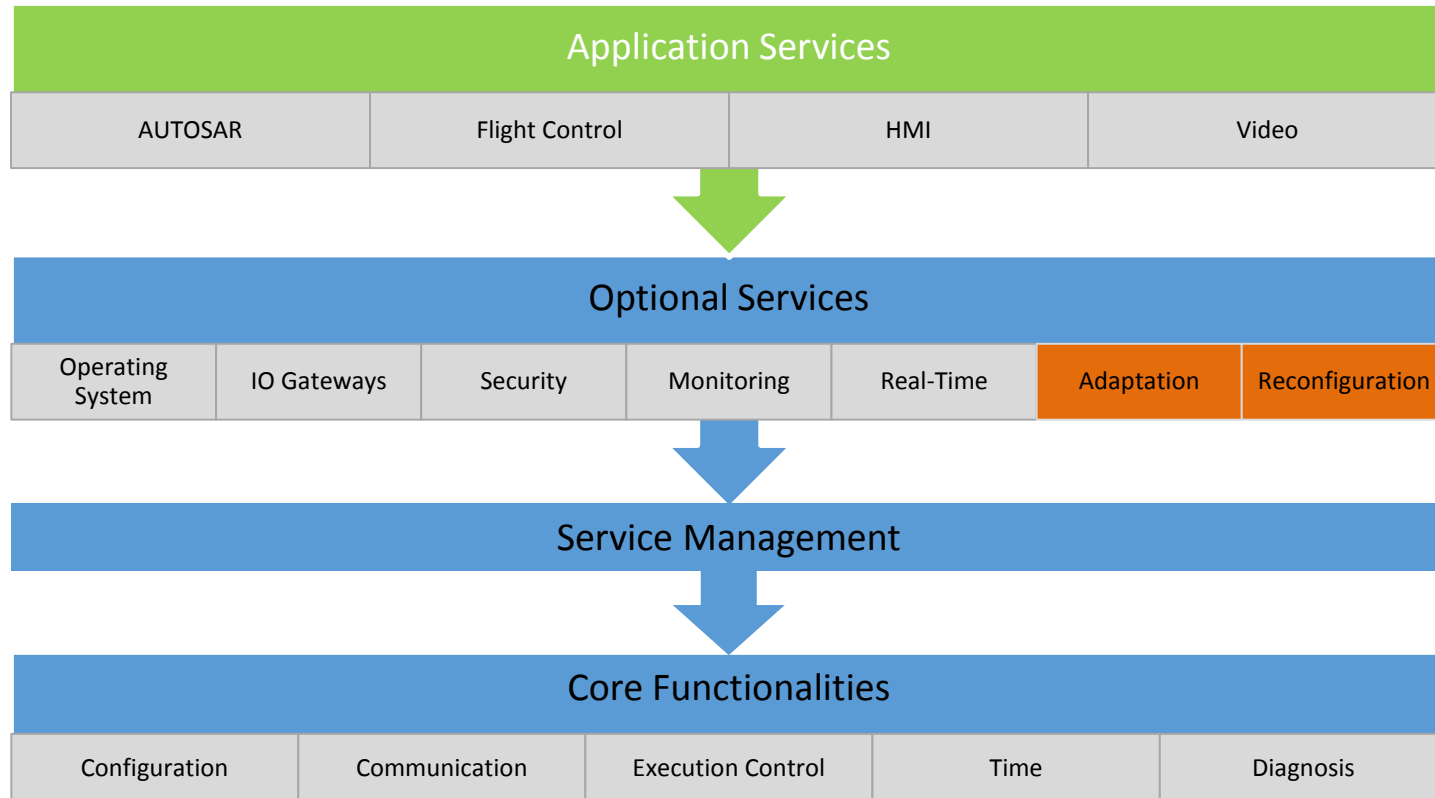
- Altera Arria V
- Xilinx Zynq (considered)

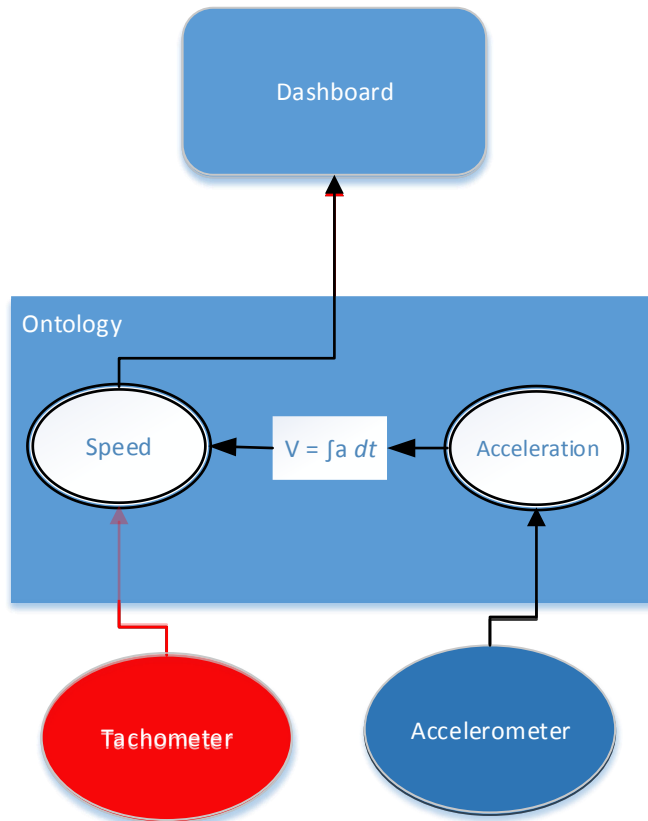
Demonstrators

- Space

Focus

- Performance
- Limitations of TTNOC
- Platform evaluation
- Multi-core components
- Heterogeneity
- Dynamic behavior





Ontology ³⁾

- Concepts
 - Structure
 - Property (Speed, Length,...)
 - Transfer functions
- Relations
 - Describe sub-system dependencies
 - e.g. controls, inputs, provides...

Reconfiguration

- On failure find an alternative way to acquire service

Challenges

- Architectural support
- Methodology
- Time predictable algorithms

3) Ontology-based runtime reconfiguration of distributed embedded real-time systems

Hoftberger, O.; Obermaisser, R.,

4) Runtime Evaluation of Ontology-based Reconfiguration of Distributed Embedded Real-Time Systems

Hoftberger, O.; Obermaisser, R.,

- MPSoC with hard-coded CPU component
 - Evaluate overall capabilities
 - Maintain temporal and spatial isolation
- Exploring service based development
 - Dynamic service management
 - Connect existing architecture with new tools and methods
- Dynamic reconfiguration of systems
 - Increasing system effectiveness and dependability

- 1) *GENESYS: An ARTEMIS Cross-Domain Reference Architecture for Embedded Systems*
Roman Obermaisser; Hermann Kopetz
- 2) *The ACROSS MPSoC -- A New Generation of Multi-core Processors Designed for Safety-Critical Embedded Systems*
Salloum, C.E.; Elshuber, M.; Hoftberger, O.; Isakovic, H.; Wasicek, A.,
- 3) *Ontology-based runtime reconfiguration of distributed embedded real-time systems*
Hoftberger, O.; Obermaisser, R.,
- 4) *Runtime Evaluation of Ontology-based Reconfiguration of Distributed Embedded Real-Time Systems*
Hoftberger, O.; Obermaisser, R.,

Thank you!