Seven Challenges of Embedded Software Development

EC consultation meeting
“New Platforms addressing mixed criticalities”

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Introduction

Corporate Technology

Sectors / Divisions

Energy
Healthcare
Industry
Infrastructure & Cities

Regions

Customers

- Chief Technology Officer (CTO)
- Review innovation strategies
- Drive technology-based synergies
- Secure innovation power
- Technology assessments
- Governance and guidance

Corporate Technology (CT)

Chief Technology Office (CT O)
- Direct support of CTO

Corporate Research and Technologies (CT T)
- GTFs with multiple impact
- Pictures of the Future
- Accelerators

Corporate Development Center (CT DC)
- Software development partner for the Sectors

Corporate Intellectual Property and Functions (CT IP)
- Intellectual property
- Standardization and regulation
- Information research

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Introduction
Embedded Systems in Siemens Domains

Industrial control systems
- e.g. rolling mill

Transportation systems
- e.g. railway, car

Medical equipment
- e.g. magnetic resonance imaging

Communication systems
- e.g. network switch

Energy management
- e.g. smart meter
Vision
Future Evolution in General

- Embedded Systems
- Pervasive Computing
- Cyber Physical Systems
- Ambient Intelligence

Time

2000
**Vision**

**Enabling Technologies**

**Multicore processors** will provide still increasing computing power, even in embedded environments with electric power limitations.

Increasing **semiconductor integration** levels provide powerful on-chip networking facilities.

Progress in **wireless communication** allows for flexible interconnect topologies.

Hardware and software **commoditization** and Open Source provide powerful platforms.
Challenges

1. Consolidation

Hardware Consolidation

- Reduced number of controllers and DSPs
- Increased flexibility due to software solutions

Real-time system architectures

- Ensure real-time behavior with partitioning and virtualization technologies

Architectures for mixed critical systems

- Separation of safety-relevant subsystems on the same processor
- Efficient development and evolvability of safety-critical systems (e.g., independent certification of safety-critical (software) components)
- Dependability in open systems
Challenges

2. Decentralization

e.g., HMI/SCADA and MES functionality integrated in controller devices
Challenges

3. Heterogeneity

Heterogeneous multi-/many-core architectures

- Utilization of special purpose cores of multicore processors (portable programming models, load balancing)

Hardware accelerators

- Optional acceleration units (e.g., GPUs)

Cloud computing

- Flexible deployment
- Scalability of resources
- Communication bottleneck
- Security and data privacy
The more complex and interconnected a system is, the bigger the number of security vulnerabilities: We have to defend against cyber-attacks.
Challenges

5. Energy Management

Power Efficiency

- Mobility: Energy consumption of on-board electronics must be minimal. (public transportation, eCar)
- Mobile devices driven by battery or energy harvesting (e.g., healthcare in rural areas with unreliable energy supply)
- Limited installation space in industrial devices or energy management (waste heat problem)

⇒ Universal energy management architecture needed!
Challenges

6. Programming Models

For parallel hardware architectures today's Programming Models are
- too complex
- error prone
- not scaling with number of processing units
- non-deterministic

We need programming models that are
- suitable for the masses
  “taking parallelism mainstream” (Microsoft)
- development efficiency comparable to sequential software development
- abstraction from hardware architectures to the greatest possible extent
- compatibility to common programming languages (huge code base available)
- flat learning curve for developers
Challenges

7. Migration Strategies

Parallel processing units enable
- doing more \(\rightarrow\) data volume increases constantly
- doing faster \(\rightarrow\) interactive work with IT systems in healthcare and industry (simulation)

huge code base of sequential code to be parallelized
- where to start?
- how to parallelize?
- how to ensure correctness?
Summary
The 7 Challenges of Embedded Software Development

1. Consolidation
   - shift from HW to SW
   - utilization of multi-/many-core systems
   - taking into account safety and real-time requirements

2. Decentralization
   - flexible deployment of functionality in distributed systems

3. Heterogeneity
   - heterogeneous multi-/many-core architectures
   - hardware accelerators
   - cloud computing

4. Security
   - data privacy
   - protection against manipulation

5. Energy management
   - power-efficient hard- and software

6. Programming models
   - Development efficiency and future-proofness
   - Portability, HW-independence
   - Scalability with processing power (more cores)

7. Migration strategies
   - utilize parallel hardware preserving existing code bases
Thank You!