

Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems

Peter Marwedel
TU Dortmund,
Informatik 12



© Springer, 2010

2012年 10 月 17 日

These slides use Microsoft clip arts.
Microsoft copyright restrictions apply.

Characteristics lead to corresponding challenges

- Dependability

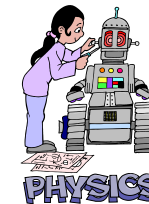


- Efficiency

- In particular: Energy efficiency



- Hardware properties, physical environment



- Meeting real time requirements



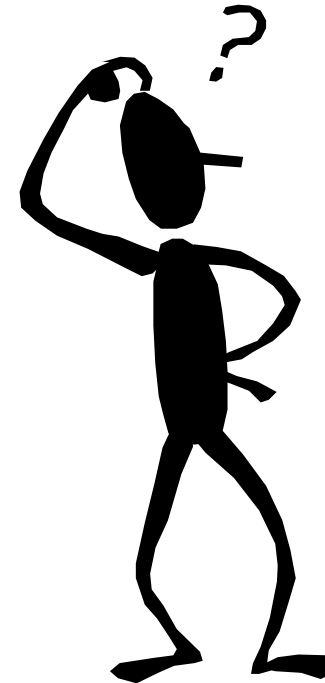
-

Challenges for implementation in hardware

- Early embedded systems frequently implemented in hardware (boards)
- Mask cost for specialized application specific integrated circuits (ASICs) becomes very expensive (M\$ range, technology-dependent)
- Lack of flexibility (changing standards).
- ➡ Trend towards implementation in software (or possibly FPGAs, see chapter 3)

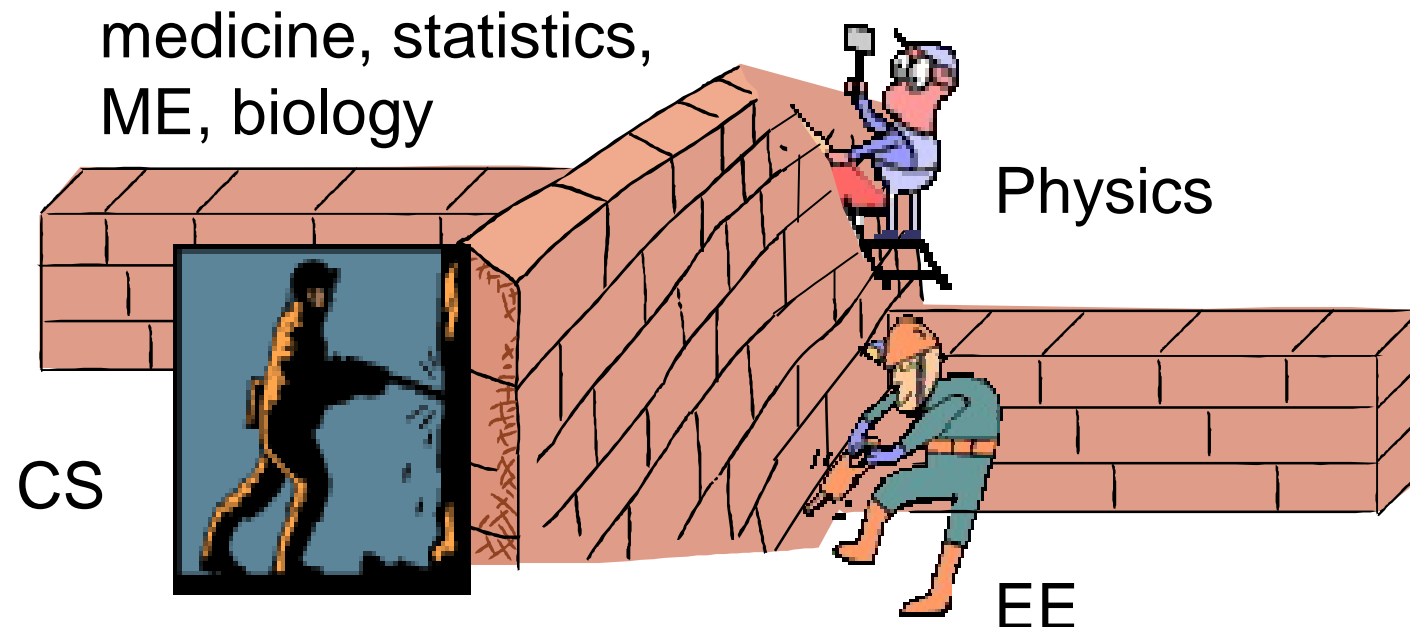
Challenges for implementation in software

If CPS/ES will be implemented mostly in software, then why don't we just use what software engineers have come up with?



It is not sufficient to consider CPS/ES as a special case of SW engineering

Knowledge from many areas must be available,
Walls between disciplines must be torn down



Challenges for CPS/ES Software

- Dynamic environments
- Capture the required behaviour!
- Validate specifications
- Efficient translation of specifications into implementations!
- How can we check that we meet real-time constraints?
- How do we validate embedded real-time software? (large volumes of data, testing may be safety-critical)



Software complexity is a challenge


Software in a TV set

- Source 1*:

Year	Size
1965	0
1979	1 kB
1990	64 kB
2000	2 MB

- Source 2°: 10x per 6-7 years

Year	Size
1986	10 KB
1992	100 kB
1998	1 MB
2008	15 MB

-  Exponential increase in software complexity
- ... > 70% of the development cost for complex systems such as automotive electronics and communication systems are due to software development [A. Sangiovanni-Vincentelli, 1999]

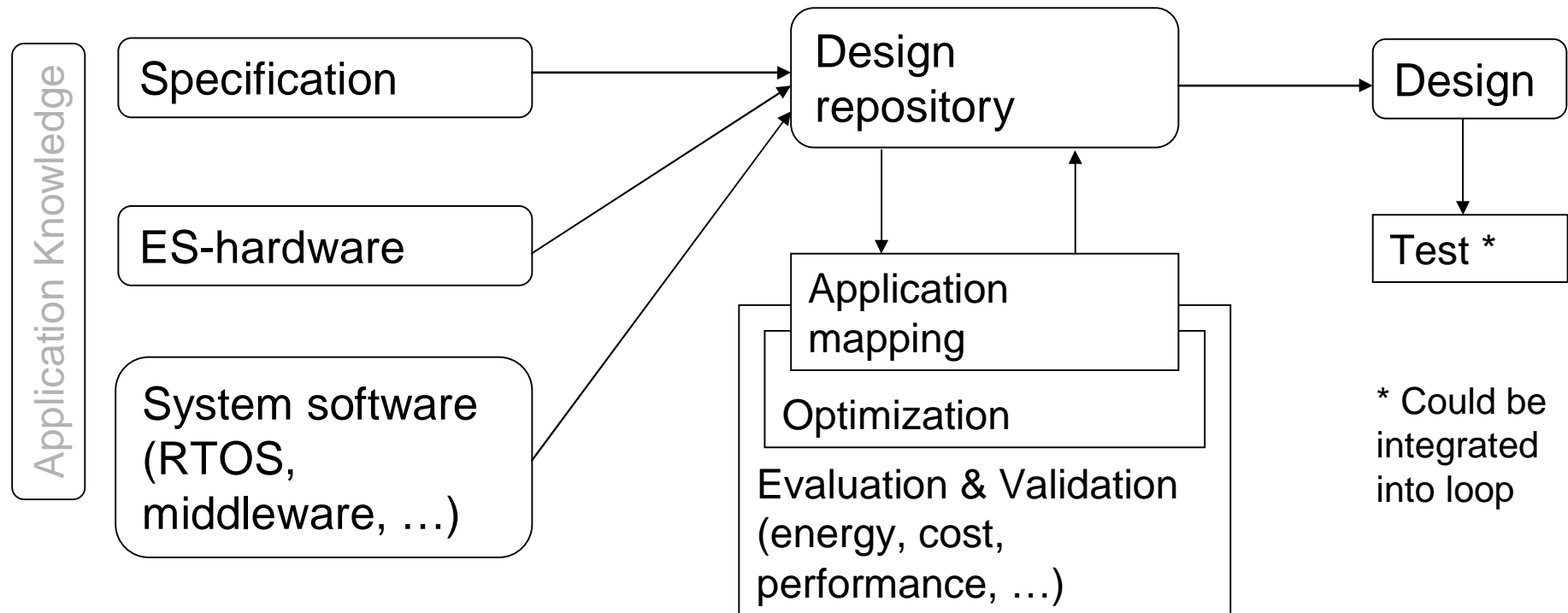
* Rob van Ommering, COPA Tutorial, as cited by: Gerrit Müller: Opportunities and challenges in embedded systems, *Eindhoven Embedded Systems Institute*, 2004

° R. Kommeren, P. Parviainen: Philips experiences in global distributed software development, *Empir Software Eng.* (2007) 12:647-660

Design flows



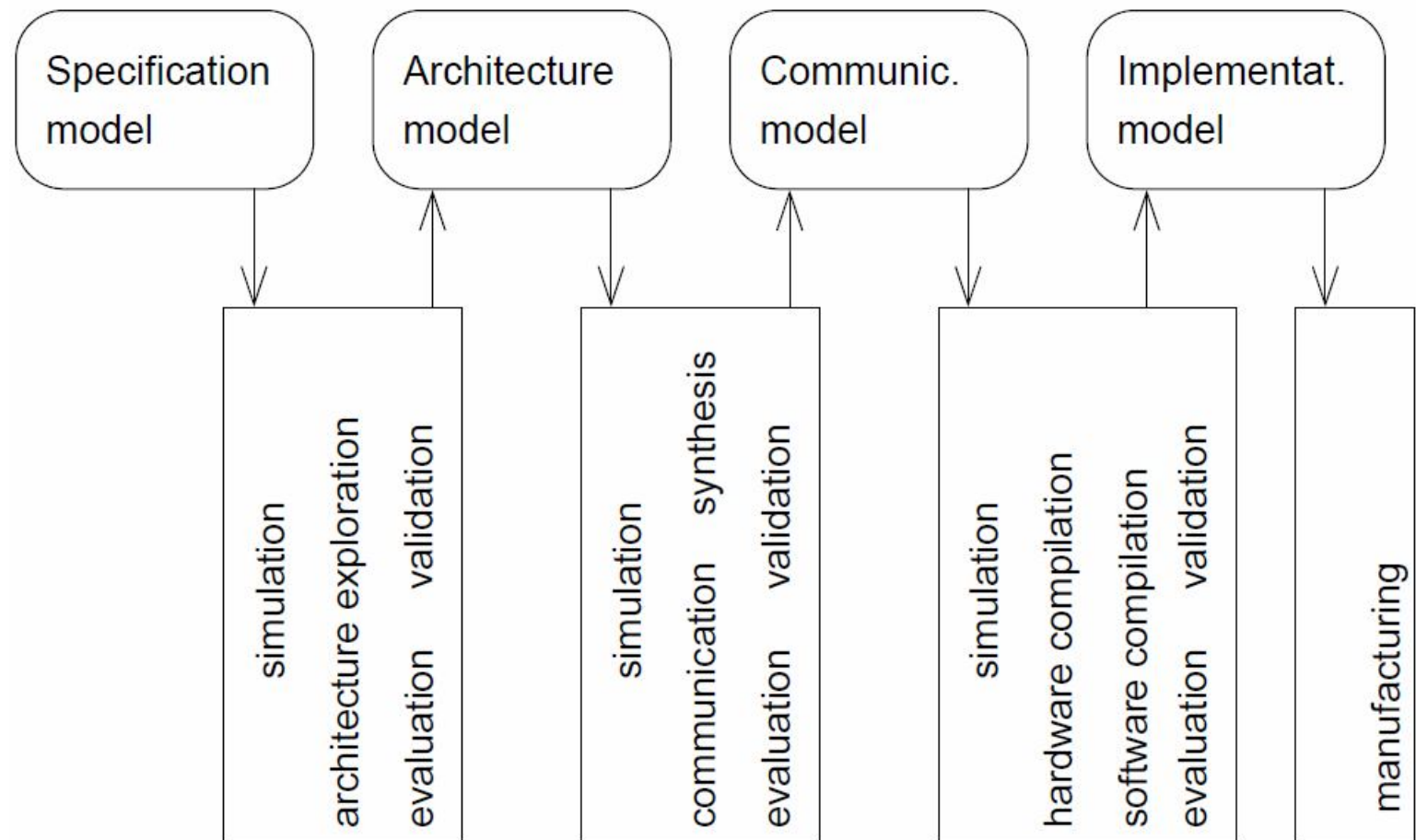
Hypothetical design flow



Generic loop: tool chains differ in the number and type of iterations

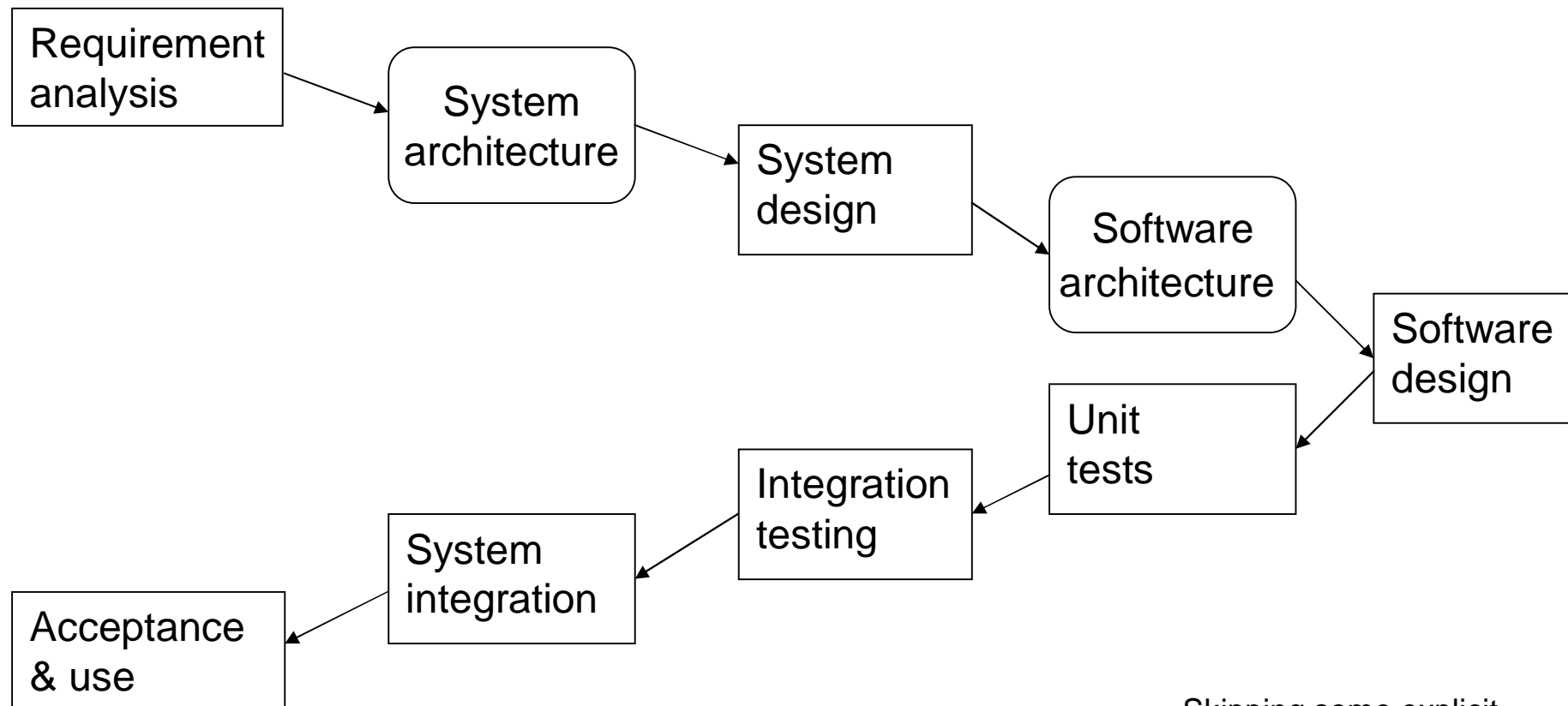
Iterative design (1): - After unrolling loop -

Example:
SpecC
tools



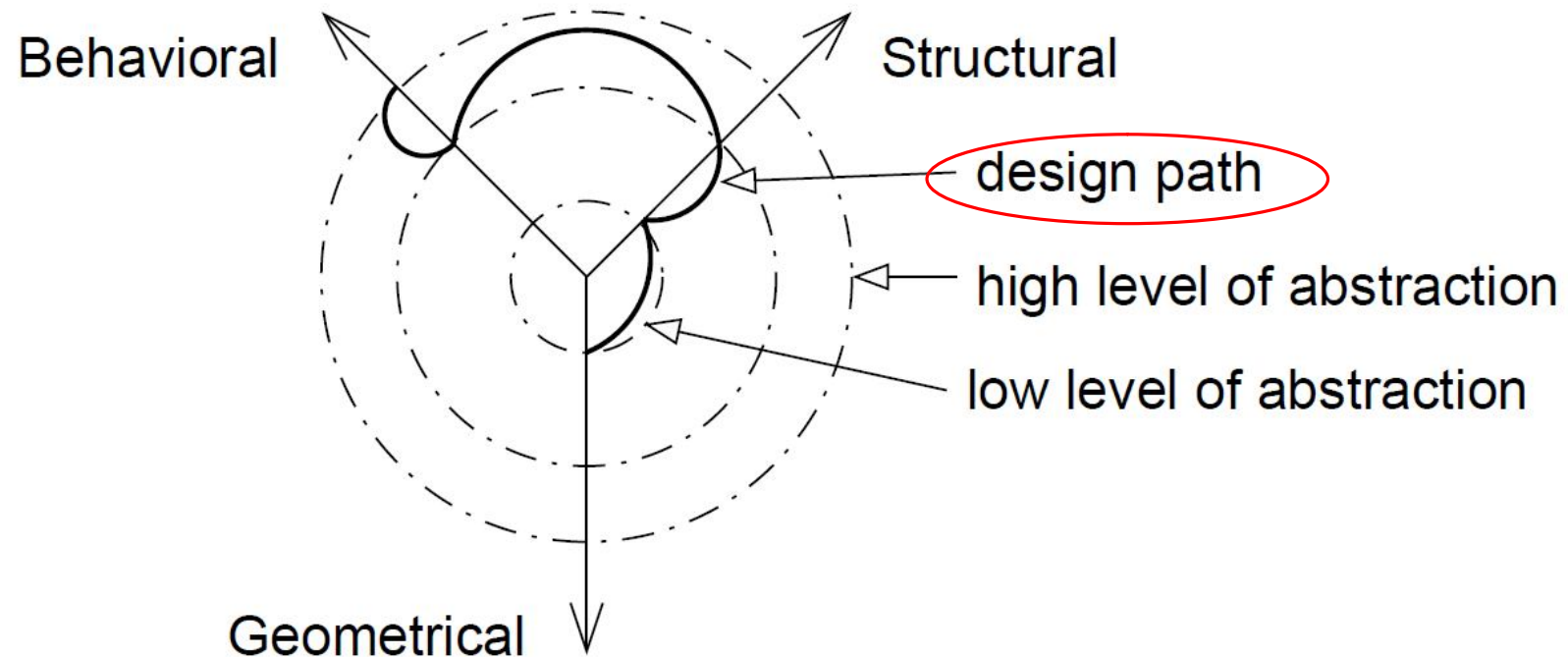
Iterative design (2): - After unrolling loop -

Example: V-model



Skipping some explicit repository updates ..

Iterative design (3): - Gajski's Y-chart -



Summary

- Challenges (resulting from common characteristics)
- Design Flows