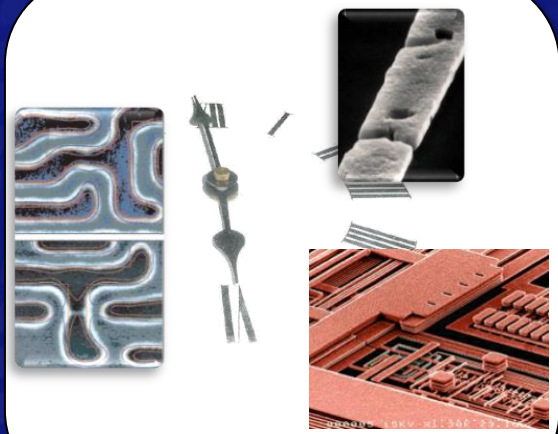
OFFIS Transportation
INSTITUTE FOR INFORMATION TECHNOLOGY

Let's get physical - EDA Tools for Mobility

Communication –
Mobile and Green



Aging and Reliability

Mobility - Smart and Safe

Frank Oppenheimer
OFFIS – Institute for Information Technology

OFFIS at a glance

Application-Know-How
concentrated in R&D-Divisions

- Energie / Energy
- Gesundheit / Health
- Verkehr / Transportation

ICT-Know-How
concentrated in interdisciplinary Technology Clusters

- Ambient Health Technologies
- Analytical Information Systems
- Dependable Systems
- Embedded System Design Automation
- Human Machine Interaction
- ICT for Smart Grids

3 Socio-economic drivers for embedded systems of the future

Mega cities → **Industry 4.0 || Smart grid || Smart mobility || …**

Source: http://www.dailydealmedia.com/?p=28742

↓

System of cyber physical systems (CPS)

↓

CPS || … || CPS

↓

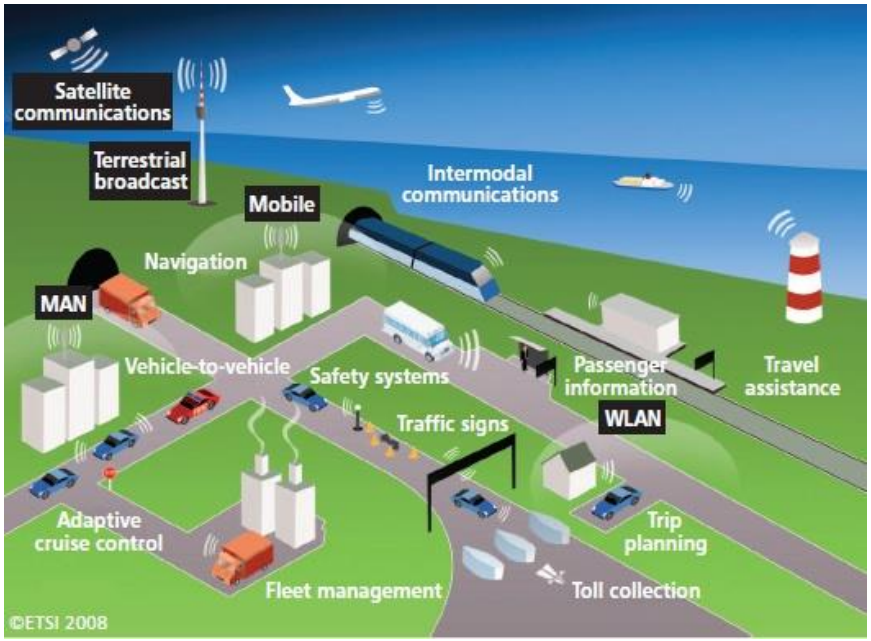
… || Embedded system || … → **… || Computing platform || …**

4 Vision: Technologies for Smarter Mobility

Information on current situation is used by road users in real-time for safe, efficient, environmentally sound and comfortable mobility.

Application examples:

- Autonomous driving
- Multi-modal mobility
- “The car that cares”
- Adaptive routing up to 4D harmonization



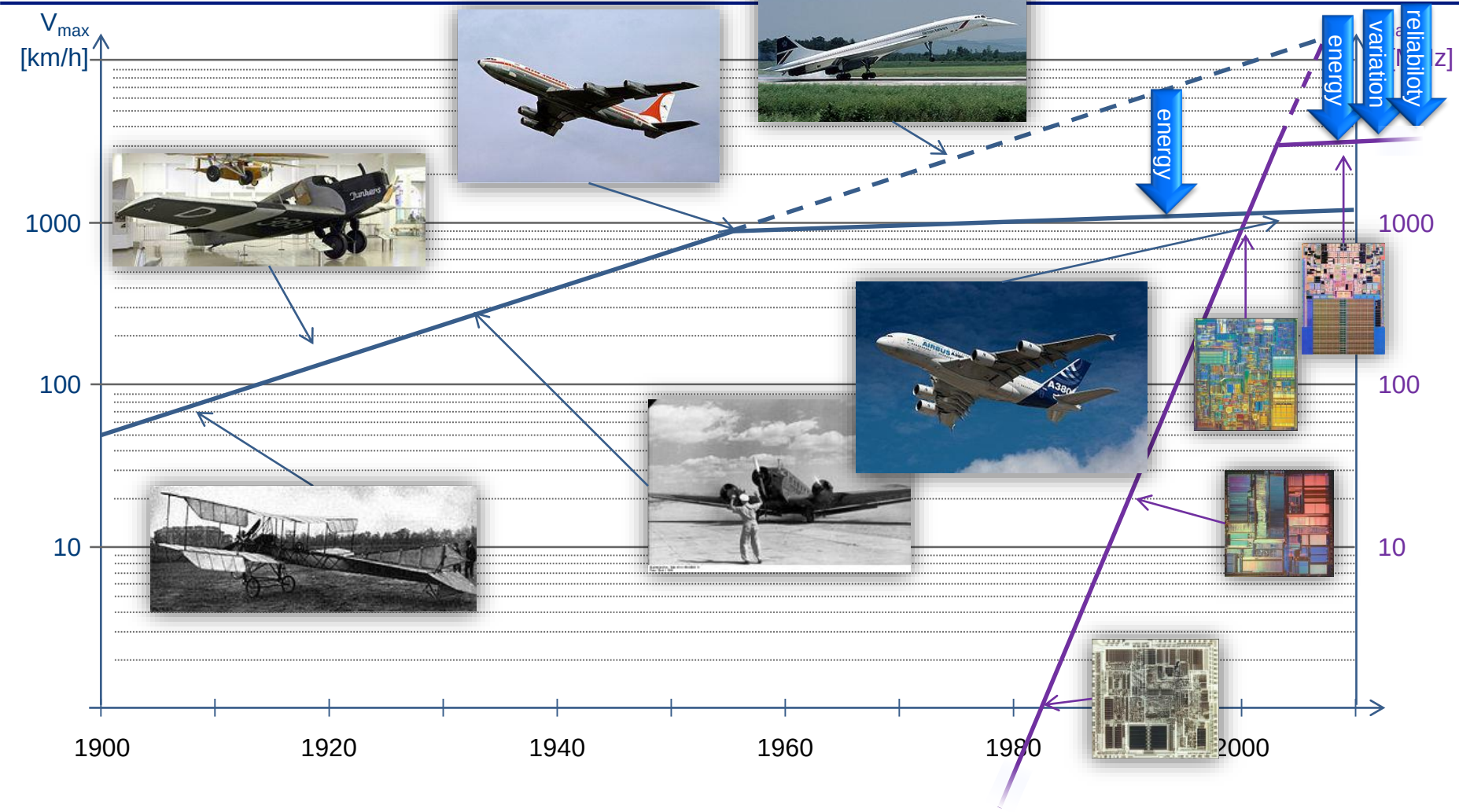
Requirements for real-time information processing and control increase.

Requirements on computing density (no. applications/computing platform) increases significantly.

Physical properties of computing platforms need to become analyzable and predictable to guarantee real-time, power, and reliability requirements of the applications.

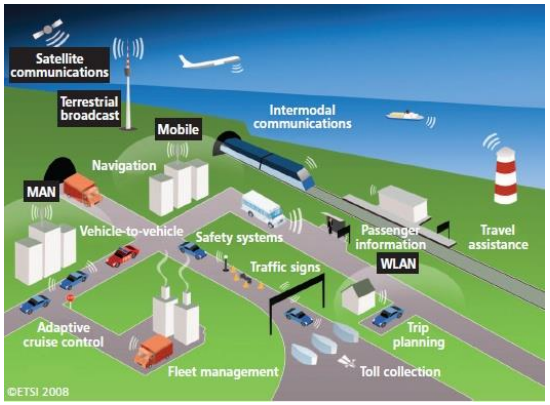
5 The Importance of Extra-functional Properties

Influence on the development of systems



6 Challenge I: Communication - Mobile and Green

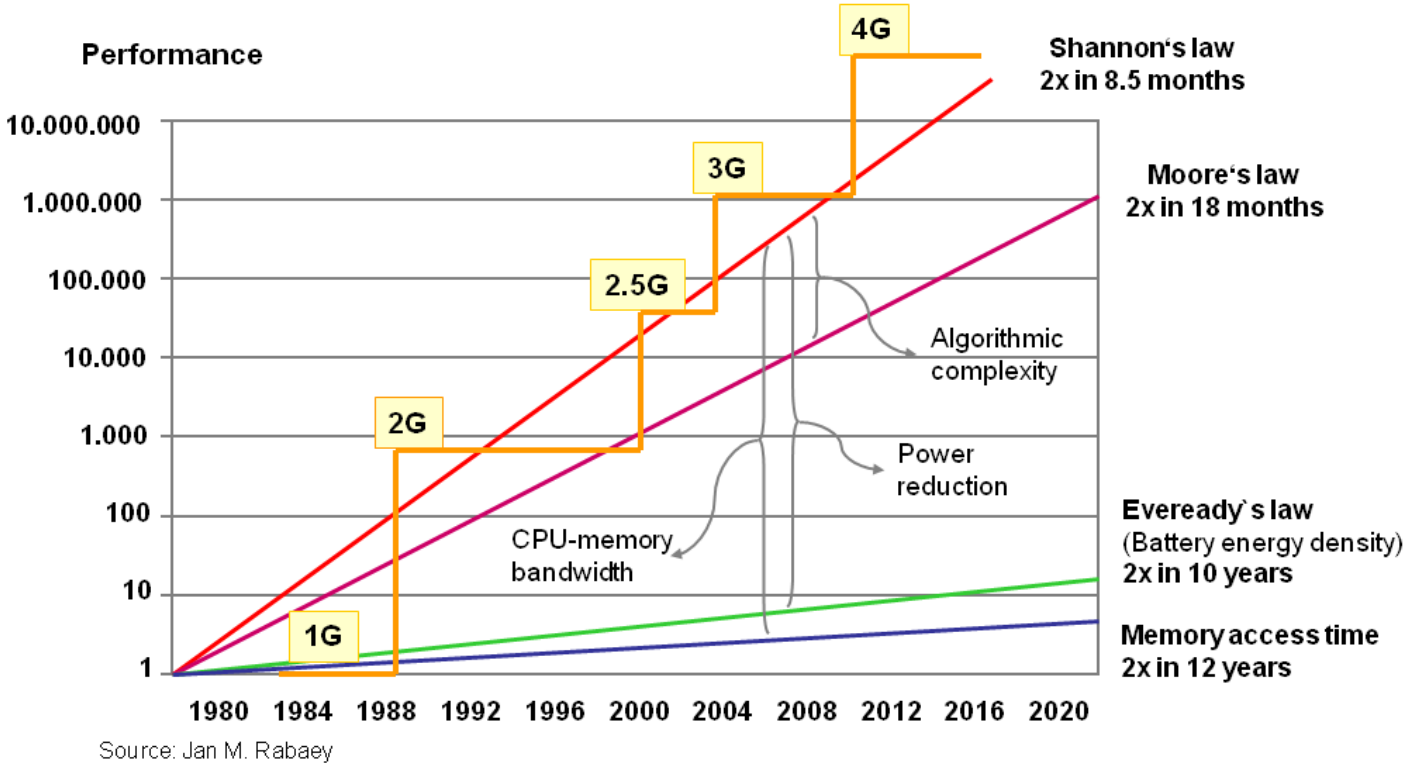
Overview



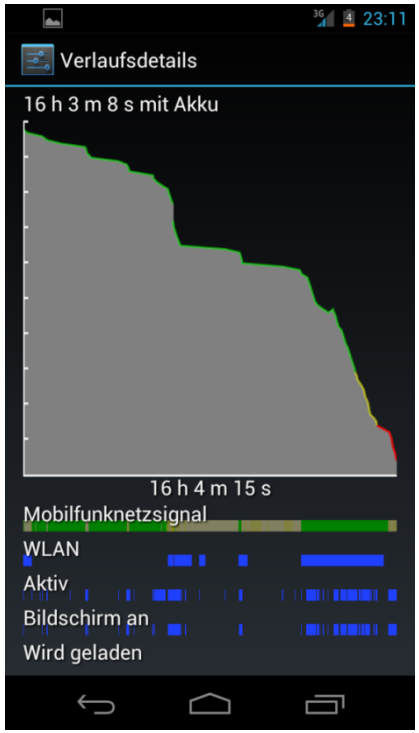
Smart mobility

7 Communication - Mobile and Green

Ever increasing demand for (computational) power

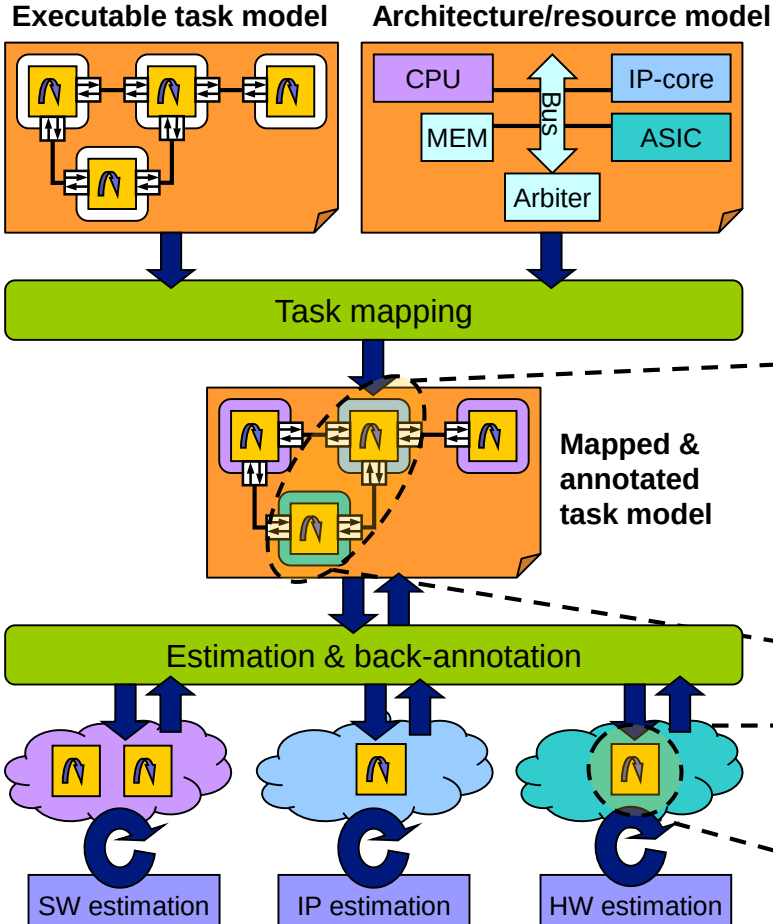


Source: Jan M. Rabaey

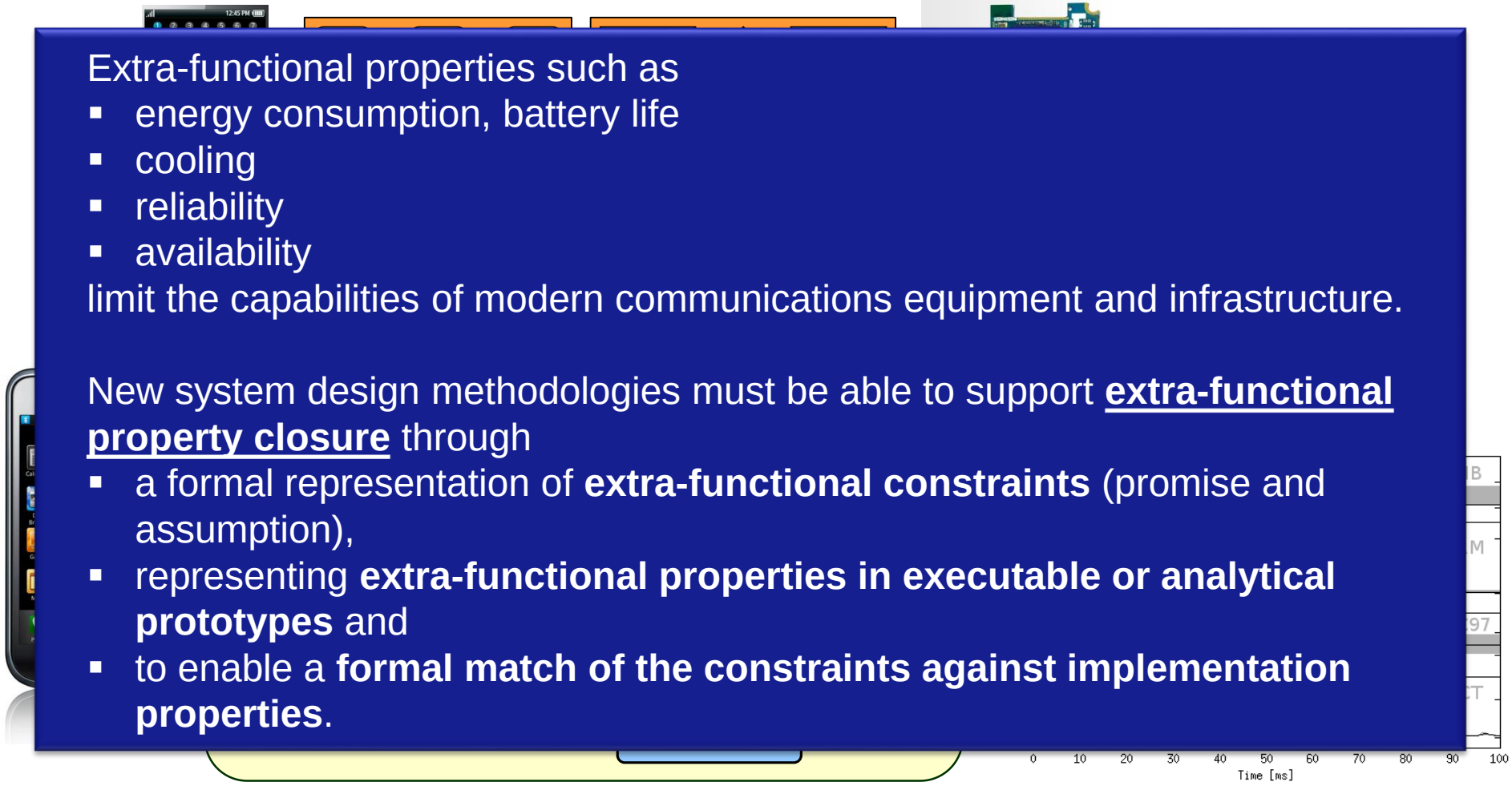


Extra-functional properties limit the power of modern communication equipment and infrastructure

8 HW/SW power & timing estimation with back-annotation



9 Virtual System Generation



Extra-functional properties such as

- energy consumption, battery life
- cooling
- reliability
- availability

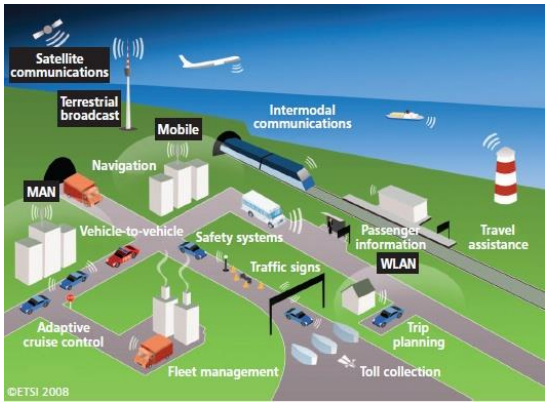
limit the capabilities of modern communications equipment and infrastructure.

New system design methodologies must be able to support **extra-functional property closure** through

- a formal representation of **extra-functional constraints** (promise and assumption),
- representing **extra-functional properties in executable or analytical prototypes** and
- to enable a **formal match of the constraints against implementation properties**.

10 Challenge II: Aging and Reliability

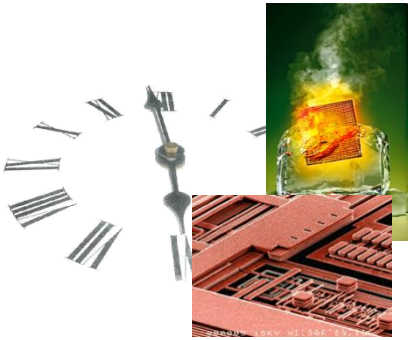
Overview



Smart mobility

Communication and energy

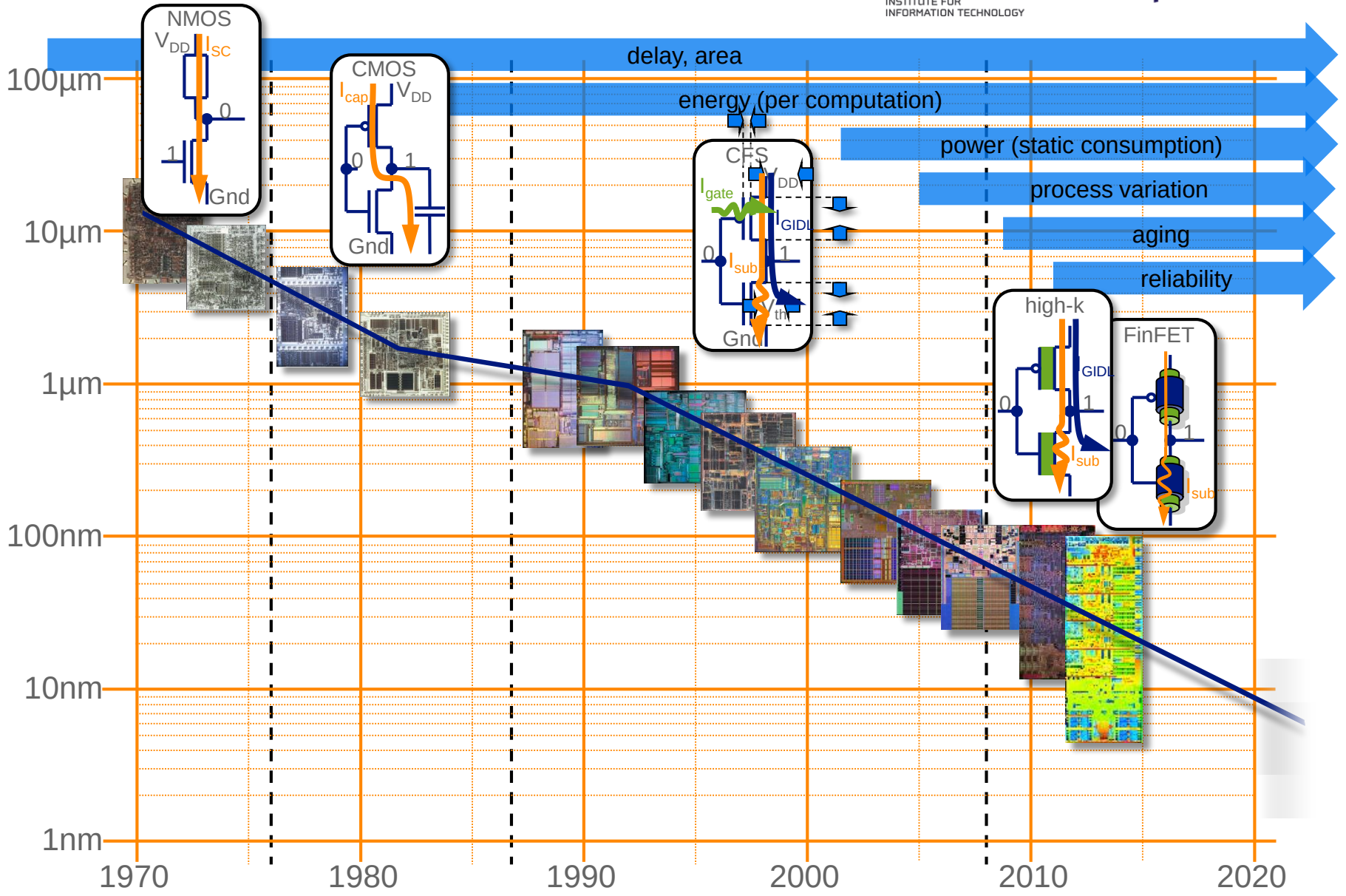
Function, timing & energy demand under variation and aging



What drives Technology

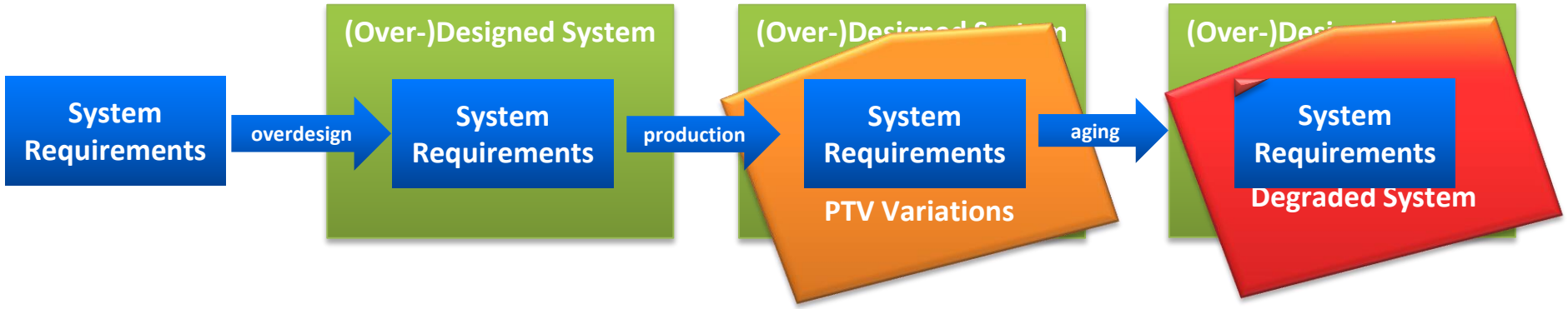
and what's next?

OFFIS Transportation
INSTITUTE FOR INFORMATION TECHNOLOGY

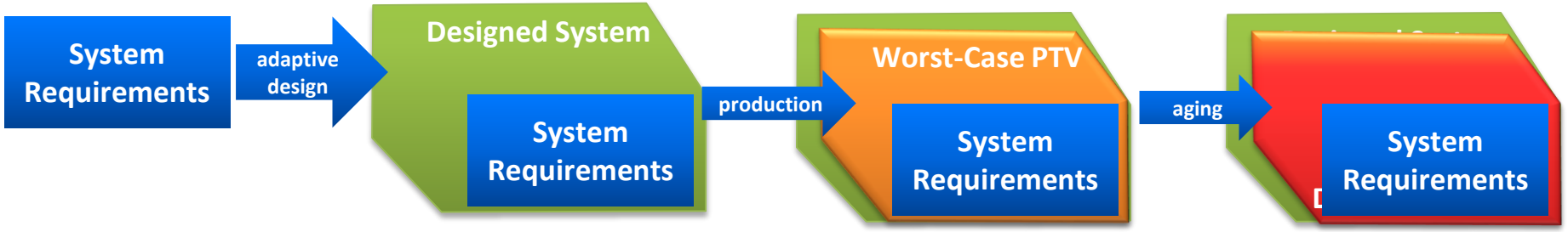


12 Reliability by design

State-of-the-art design:

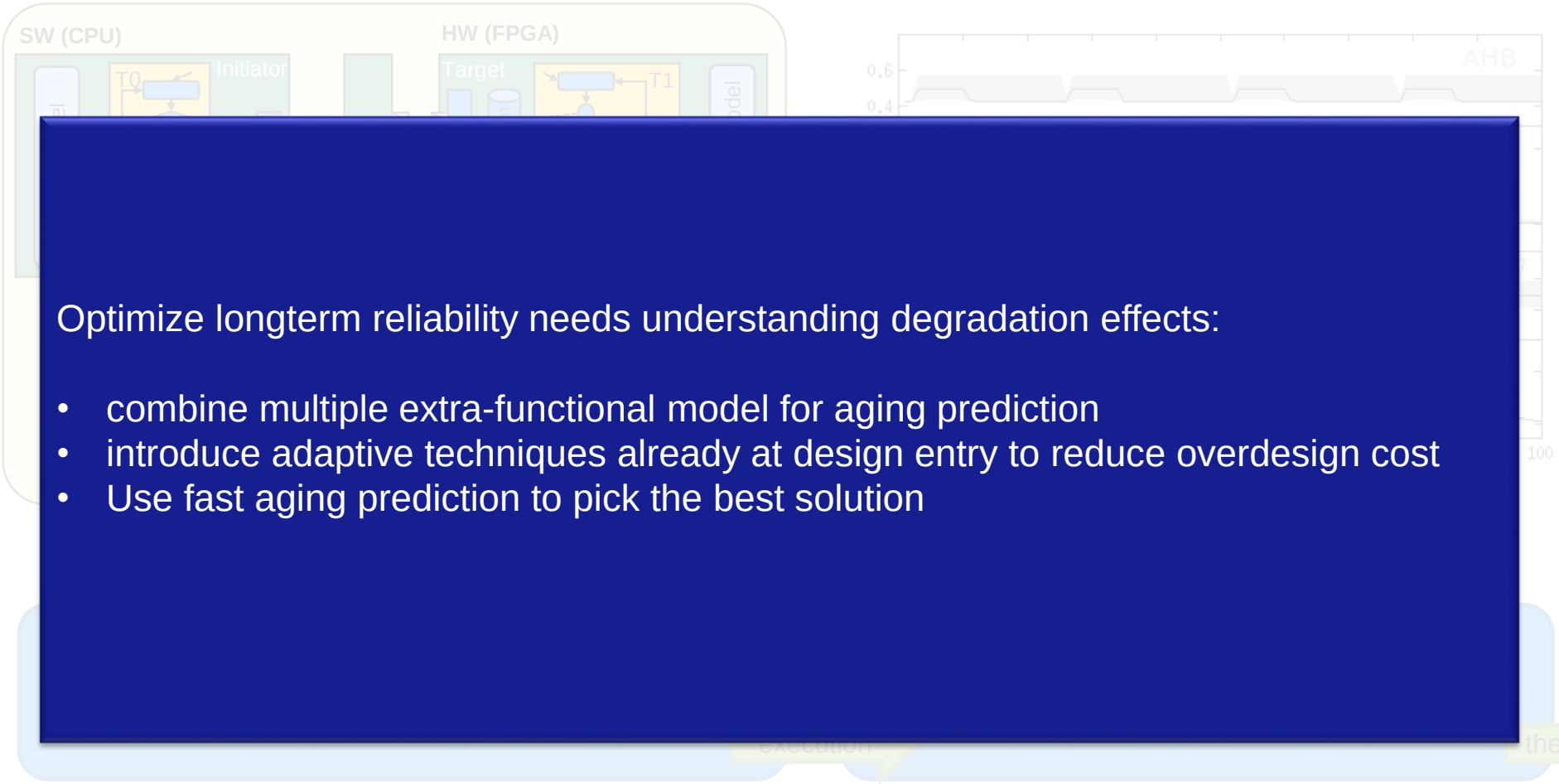


With PTV + aging prediction, regarding adaptive techniques (as DVFS) and redundancies:



13 System level reliability modeling

putting it all together

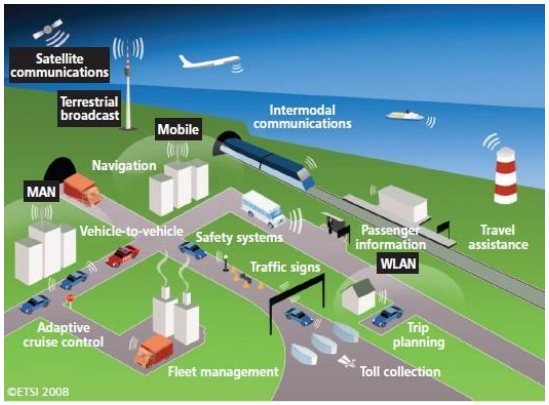


Optimize longterm reliability needs understanding degradation effects:

- combine multiple extra-functional model for aging prediction
- introduce adaptive techniques already at design entry to reduce overdesign cost
- Use fast aging prediction to pick the best solution

14 Challenge III: Integrated Mobility - Smart and Safe

Overview



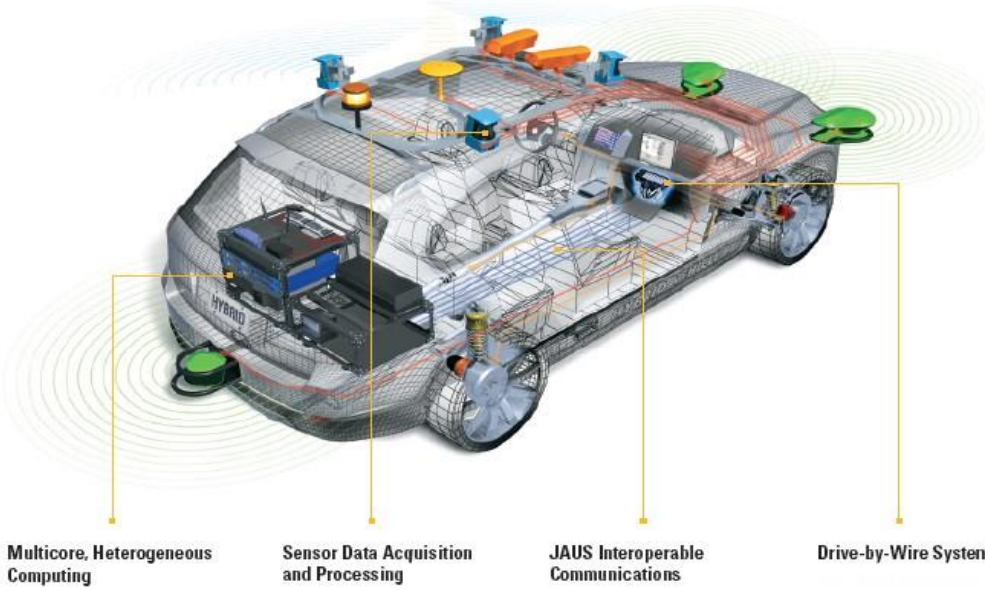
Smart mobility

Source: http://www.openpr.de/images/articles/l/6/l62112789_g.jpg

15 Autonomous mobility

Then and now

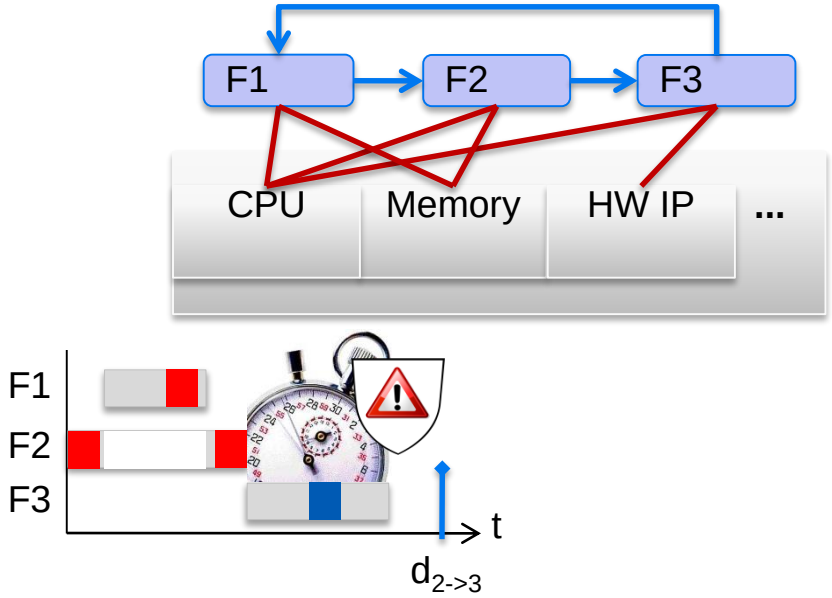
Source: Universität der Bundeswehr, Munich



Source: Team *V*ictor *T*ango (Virginia Tech and TORC Technologies)

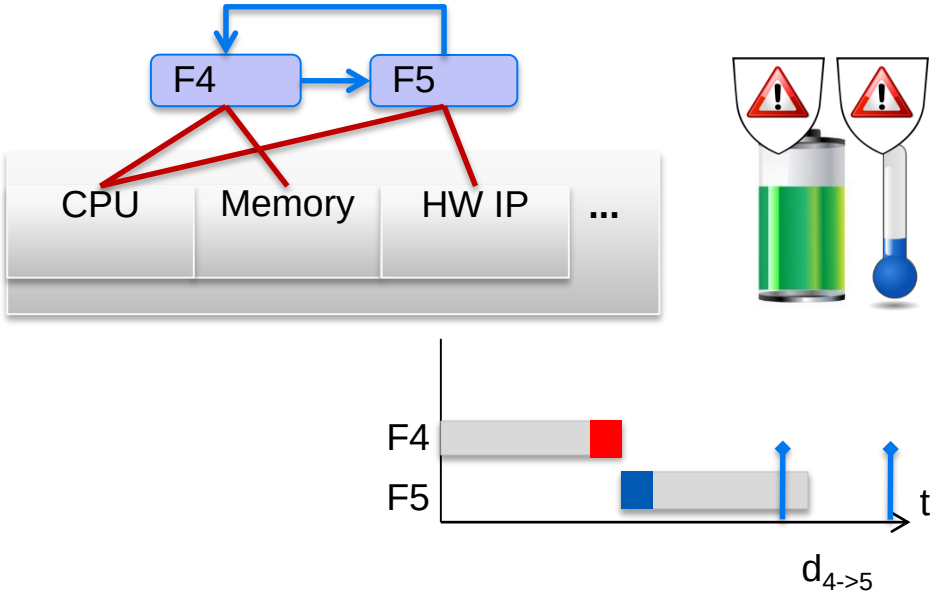
16 State-of-the-art in mixed-critical system design

Fully distributed with dedicated HW/SW platforms for different criticalities



(Safety-critical) Embedded Application

- Hard deadline $d_{2->3}$
- Soft power constraints
- Soft temperature constraints

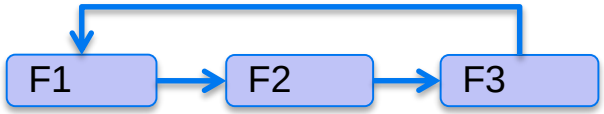


Mobile Multimedia Application

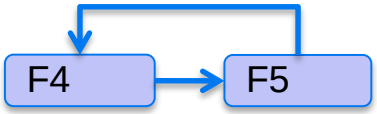
- Soft deadline $d_{4->5}$
- Hard power constraints
- Hard temperature constraints

17 Segregation on shared computation platforms

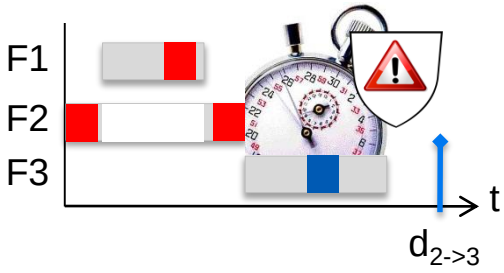
Guarantee extra-functional properties per application on shared platform resources

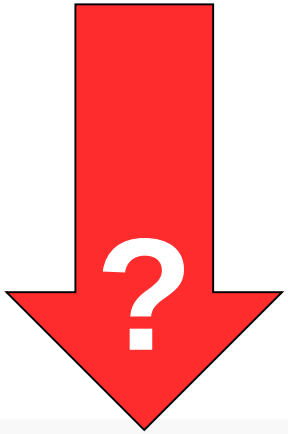


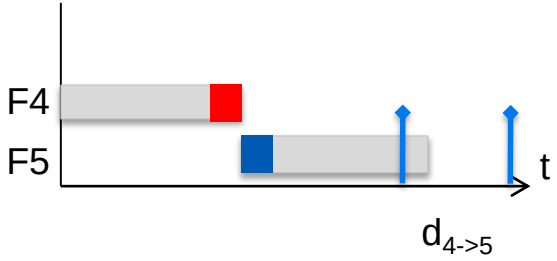
(Safety-critical) Embedded Application

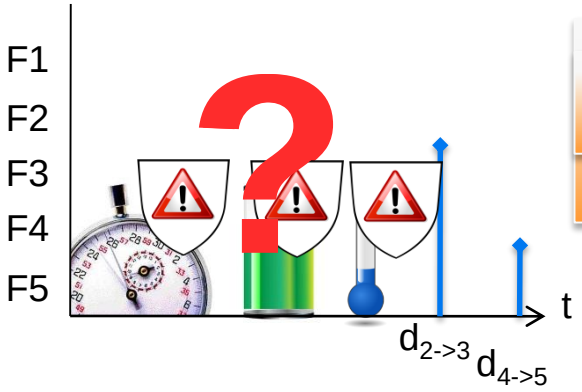


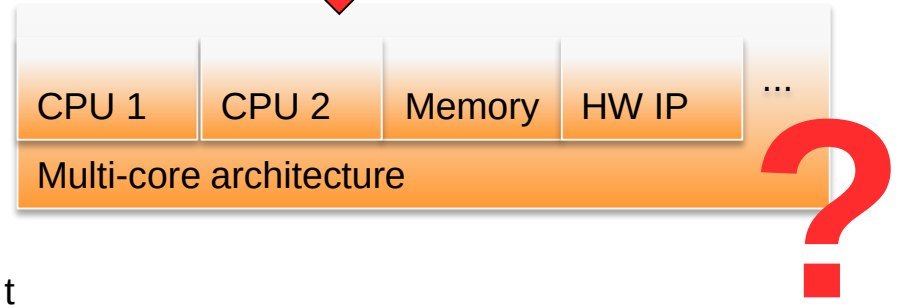
Mobile Multimedia Application











18 Segregation on shared computation platforms

Guarantee extra-functional properties per application on shared platform resources

Multimedia Environments

Safety-Critical Applications

Infotainment

GENIVI

OEM App Store

ANDROID

ADAS

Rear-View Video

Real-Time Cluster

Multicore CPU | 3D GPU | Radio | USB | CAN | WiFi

Source: http://rtcmagazine.com/articles/view/102791

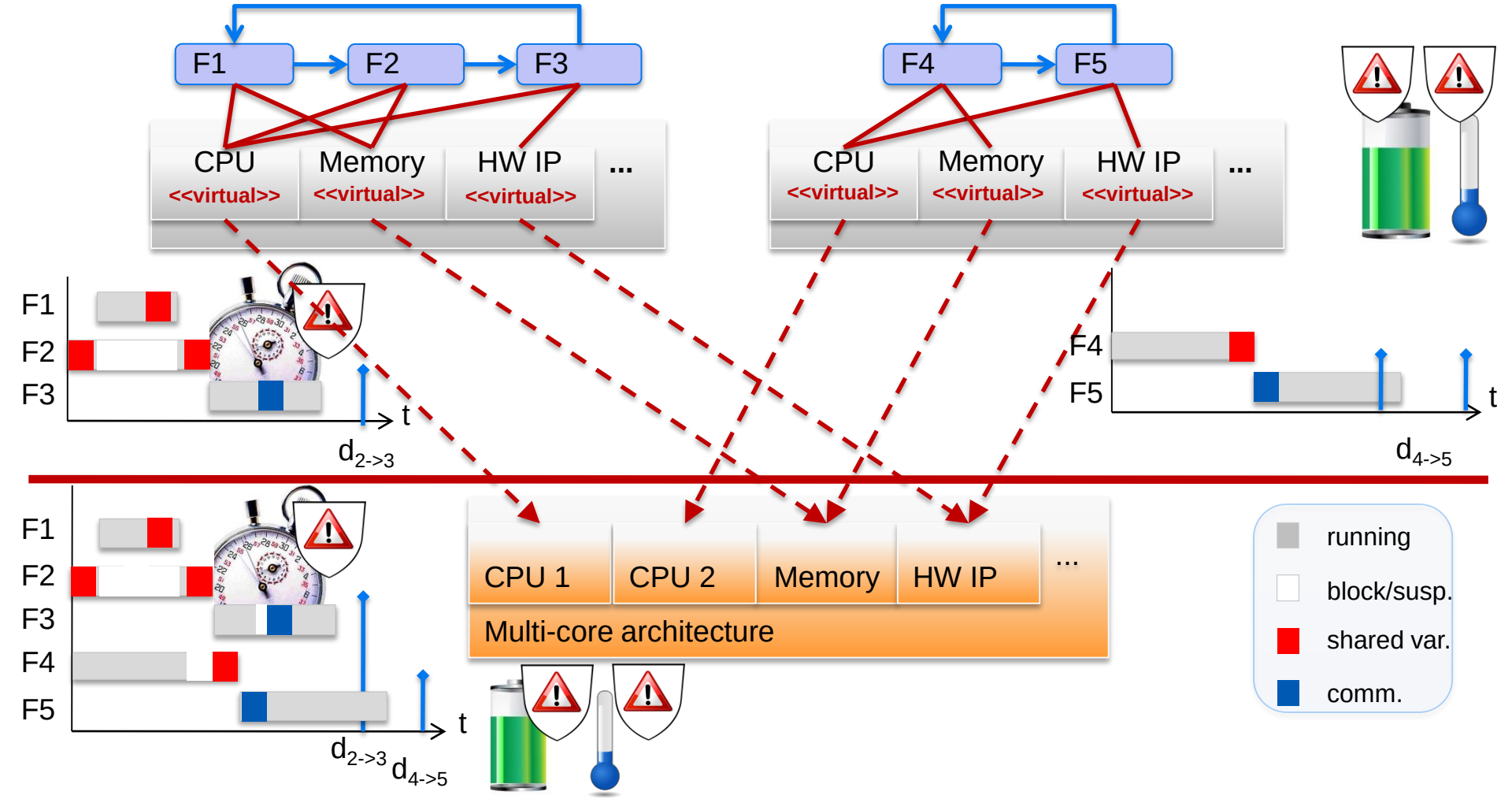
19 Goal: Compositional analysis of power and temperature in mixed-critical systems

Contrex

COOPERATION

Source: http://rtcmagazine.com/articles/view/102791

20 Goal: Compositional analysis of power and temperature in mixed-critical systems



21 Goal: Compositional analysis of power and temperature in mixed-critical systems

Contrex

COOPERATION

Necessary increase in the function density (= more functions in less ECUs) due to

- limited space
- weight requirements
- energy efficiency
- cost
- availability

promotes the use of multi-core processors.

Management of multi-core's shared resources to guarantee **temporal and spatial segregation** of safety-critical applications. But at the same time **enabling compositional power and temperature analysis and management**.

22 Driving Challenges

Summary

I) **Communication - Mobile and Green:**

- 10+ billion mobile communication devices
- Power consumption/heat of infrastructure limits bandwidth and QoS
- Power consumption of mobile devices limits service usability, functionality and availability (-> battery lifetime)

II) **Aging and reliability:**

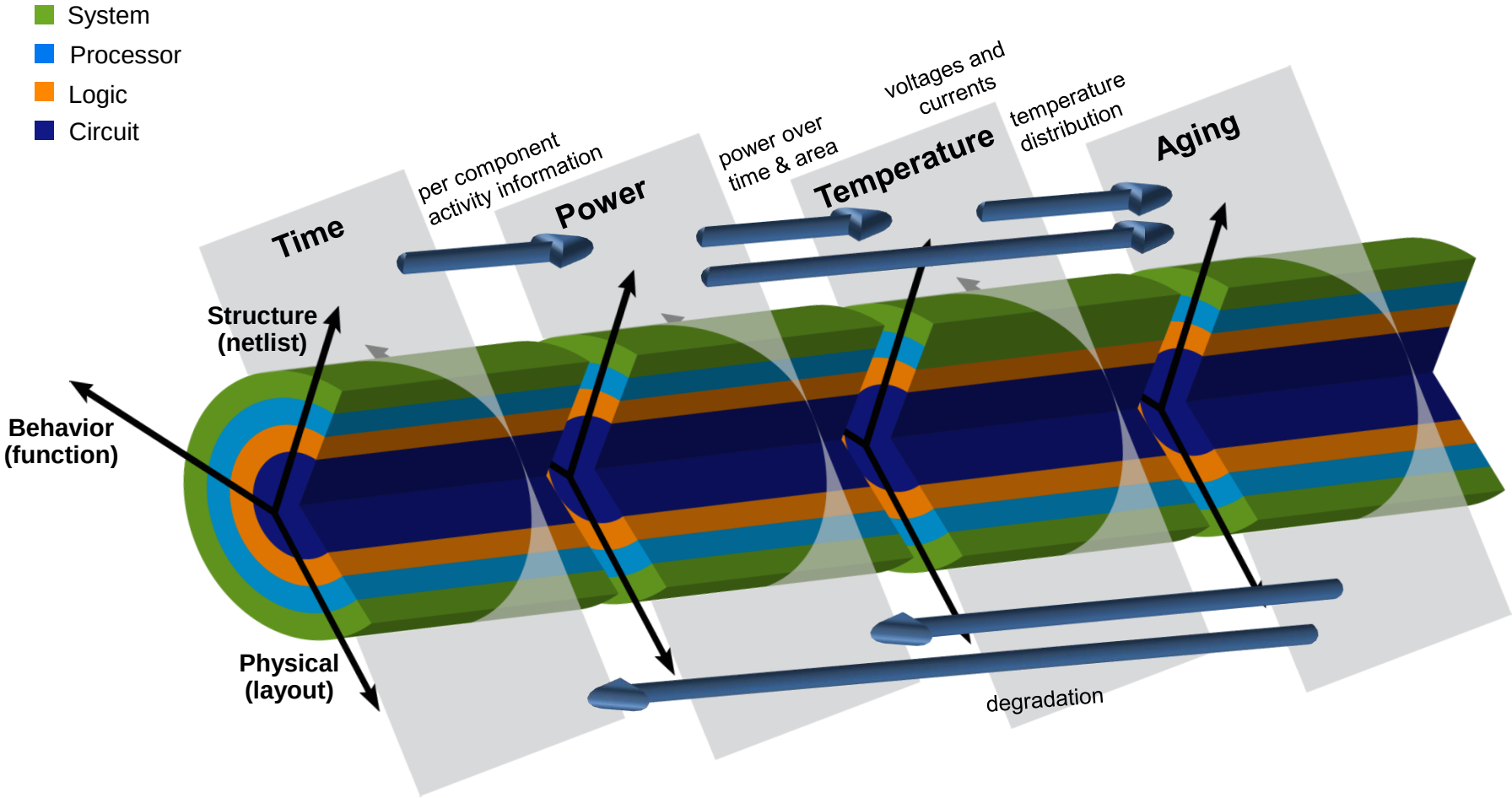
- Shrinking feature size increase variation and degradation
- Aging and reliability become the next limiting extra-functional property.

III) **Mobility - Smart and Safe:**

- Combination of mobile, multimedia and (safety-critical) embedded services on the same device.
- Multi-cores enable higher functional density but cost predictability

23 Y-chart 2.0

An EDA coordinate system for extra-functional properties



Contact information

OFFIS Transportation
INSTITUTE FOR INFORMATION TECHNOLOGY

Prof. Dr.-Ing. Wolfgang Nebel
Chairman of the Board
Mail: nebel@offis.de
Tel: +49 441 9722 - 280

Dr. Frank Oppenheimer
Director R&D Division Transportation
Mail: oppenheimer@offis.de
Tel: +49 441 9722 - 285