

Immortalizing Many-Core Based Cyber-Physical Systems

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Immortalizing Many-Core Based CPSs

- Facts and figures
- Concept and objectives
- Cross-layer fault management
- In-depth: SMT-Based Parameter Synthesis for CPS

About the Funding Scheme

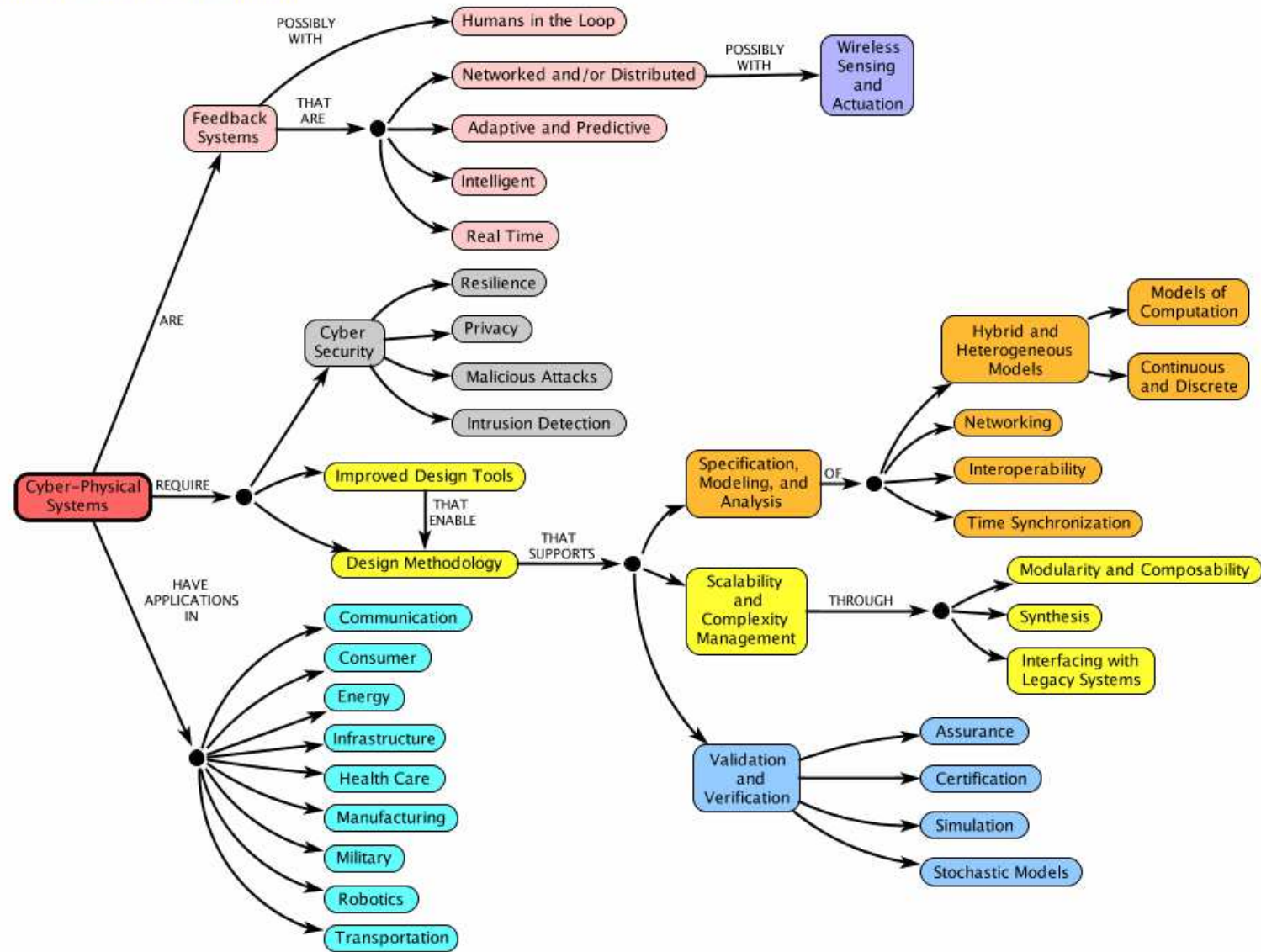
- **Research and Innovation Actions (RIA):** Funding for research projects tackling clearly defined challenges, which can lead to the development of new knowledge or a new technology.
- H2020 call1 2014 - topic ICT1 "Smart Cyber-Physical Systems":
 - Modelling and integration frameworks
 - Smart, cooperative and open CPS
- From 140 submissions 8 RIAs selected (acceptance rate 5.7%!)

Cyber-Physical Systems – a Concept Map

See authors and contributors.

<http://CyberPhysicalSystems.org>

Dependability
and automated
debug largely
overlooked by
previous CPS
frameworks!



IMMORTAL: Facts and Figures

- IMMORTAL - Integrated Modelling, Fault Management, Verification and Reliable Design Environment for Cyber-Physical Systems
- 3 years: 2015-2018, 4MEUR
- Partners: Tallinn University of Technology (coordinator), IBM, German Aerospace Center DLR, Recore Systems, Testonica Lab OÜ, Graz University of Technology, University of Twente



RECORE



UNIVERSITY OF TWENTE.

Synergy of competences

- **DLR:** Space applications, CPS modeling, automated debug
- **TU Graz:** Modeling, automated debug
- **Recore:** Dependable many-core architecture, run-time
- **Testonica:** Instrument network for fault reporting, fault management
- **Tallinn:** Qualification/minimization of fault monitors, fault management
- **IBM:** Fault monitors, automated reliability sign-off
- **Twente:** Fault models for analog/mixed-signal



IMMORTAL Objectives

- CAD framework for designing reliable CPS
- Cross-layer holistic fault modeling of CPS
- Fault management enabling rapid fault recovery and life-time extension for many-core based CPS
- Automated localization and correction of bugs in CPS models

Why a holistic fault model?

The screenshot shows the Federal Computer Week website. The header features the title "Federal Computer WEEK" with the subtitle "Strategy and business management for government leaders". Navigation links include Magazine, Events, Blogs, Community Awards, Subscribe, Webcasts, and Content Libraries. A sidebar on the left promotes a "RESEARCH REPORT CLOUD COMPUTING" with the tagline "THE FUTURE IS HERE. LEARN MORE NOW >" and mentions it is sponsored by Brocade. The main content area includes a "HOT TOPICS" section with a "Joint Special Report: IT consolidation". A news article titled "NASA engineers join Toyota investigation" is dated March 31, 2010, by Alice Lipowicz. The article text states: "Transportation Secretary Ray LaHood is bringing in a team of nine NASA engineers who specialize in computer-controlled electronic systems, electromagnetic interference, software integrity and hardware to help his department investigate alleged unintended vehicle acceleration in Toyota". Social media sharing options for Google+, Embed, Tweet, Meeldib, and Facebook are visible.

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NASA engineers join Toyota investigation

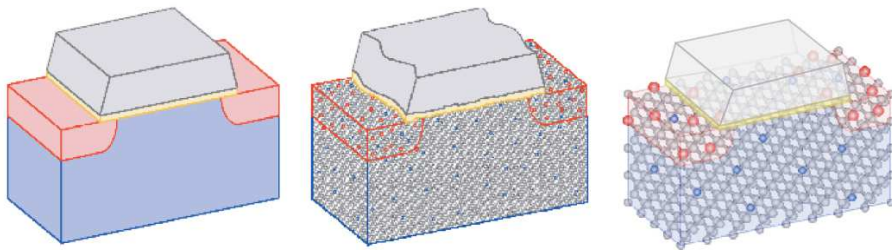
NASA helping with unintended acceleration evaluation

By [Alice Lipowicz](#) Mar 31, 2010

Transportation Secretary Ray LaHood is bringing in a team of nine NASA engineers who specialize in computer-controlled electronic systems, electromagnetic interference, software integrity and hardware to help his department investigate alleged unintended vehicle acceleration in Toyota.

Probability of failures (Bath tub)

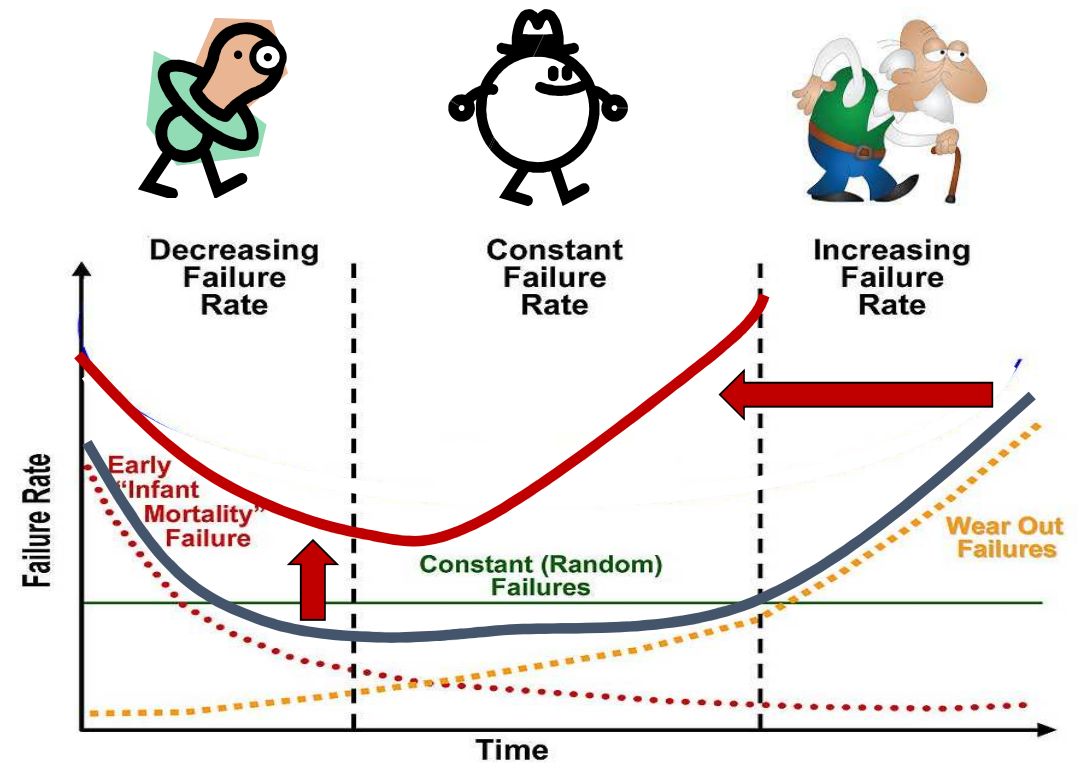
- Process variations
- Soft errors, EMC
- Aging phenomenon
 - NBTI (PBTI), Hot Carrier Injection, Electromigration



Micrometer
technology

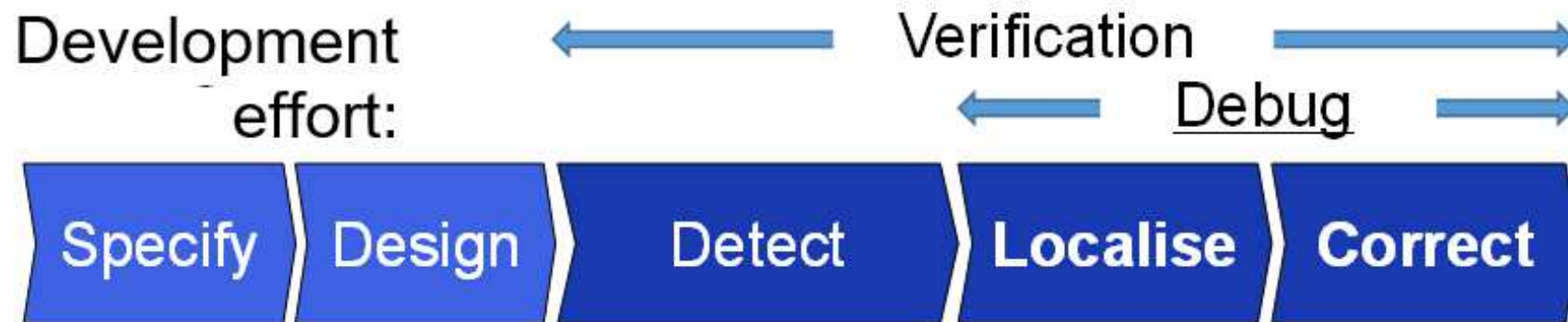
22 nm

Sub-10 nm

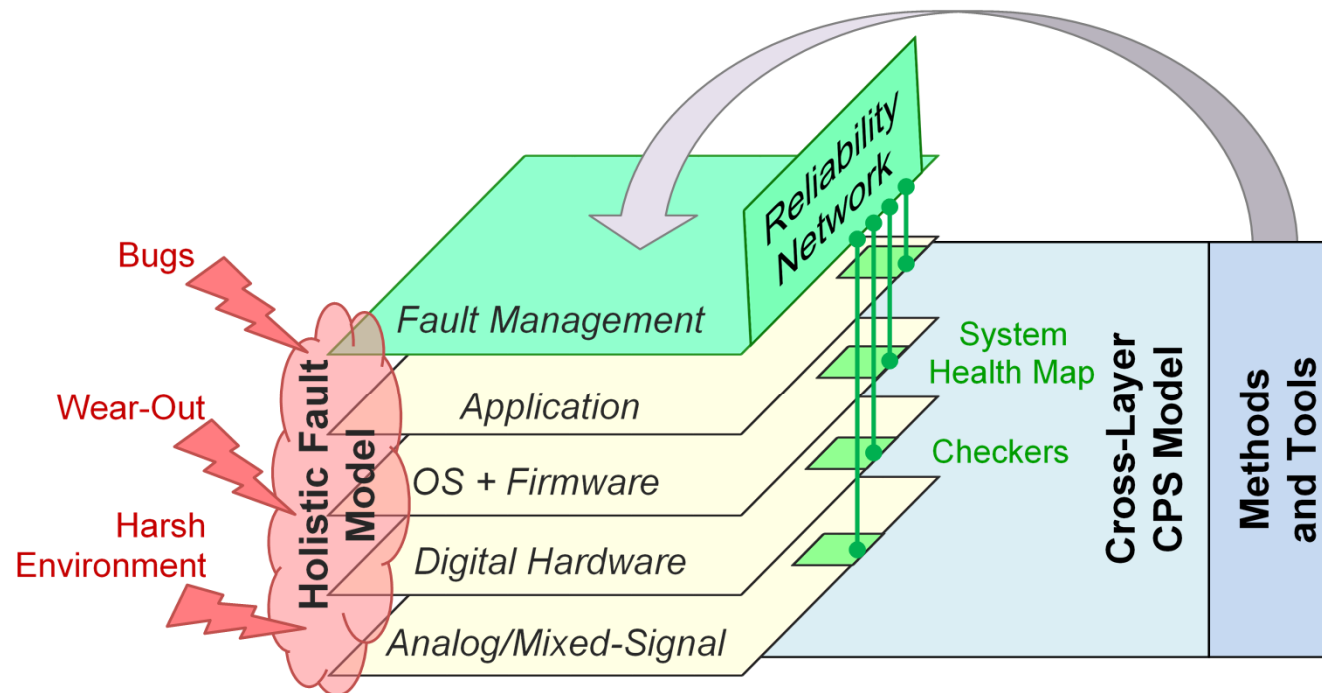


Automated Debug (Localise + Correct)

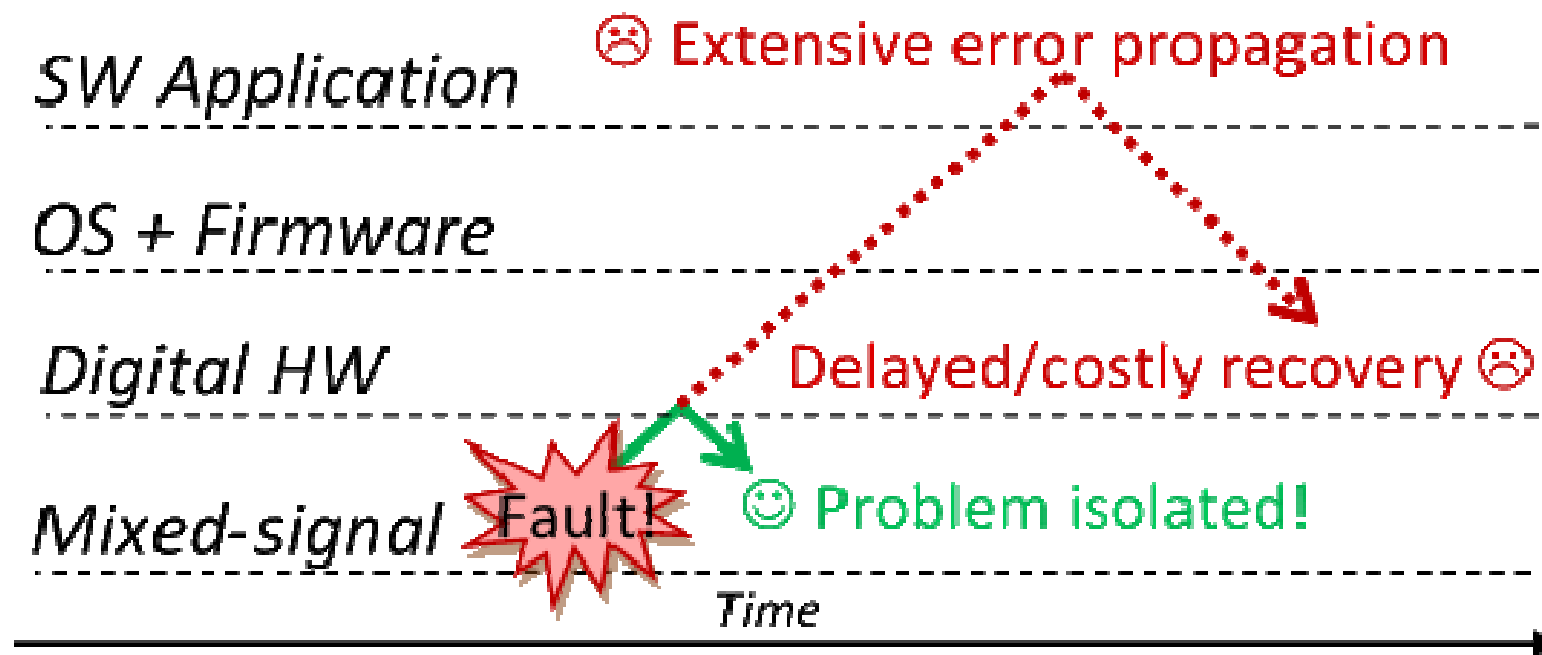
- A major part of the development effort spent on debug
- Automated debug methods for CPS missing



Cross-Layer Fault Management



Fault Detection, Isolation and Recovery



In-depth: SMT-Based Parameter Synthesis for Cyber-Physical Systems

- Sketch a CPS and a specification with open parameters
- Synthesize parameters such that the CPS fulfills the specification
- Example: multi-mode controller synthesis
- Problem: Mixed dynamics, infinite state space
- Our approach: CEGAR-directed search with heuristics to improve performance

(ARCH'16)

Thank you!