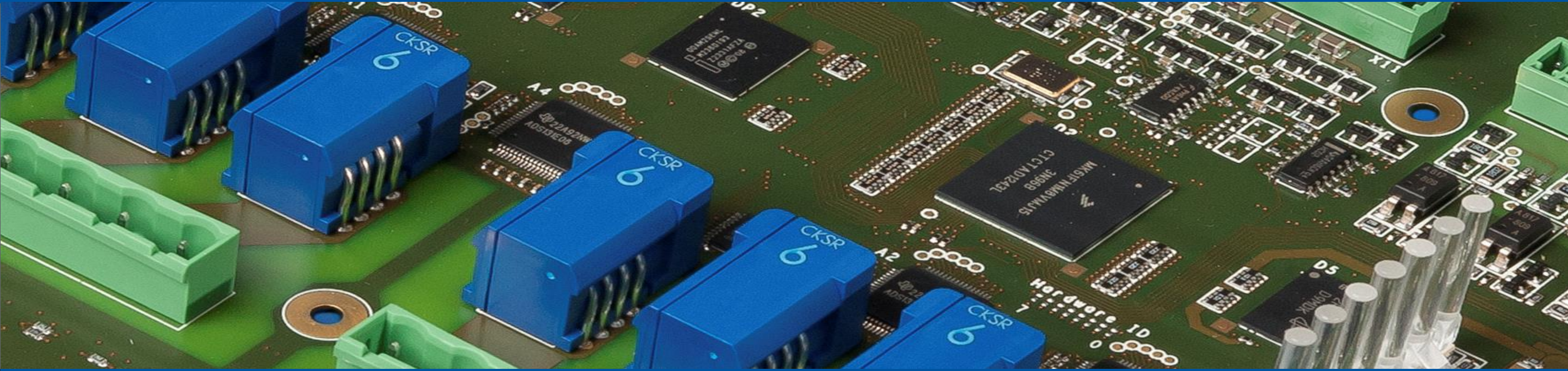
3T electronics & embedded systems

CO-DEVELOPMENT | MANUFACTURING | INNOVATION & SUPPORT



Model-Based Design as an Enabler for Supply Chain Collaboration

Richard Mijnheer, CEO, 3T

Stephan van Beek, Technical Manager, MathWorks

Richard Mijnheer (1970)

- CEO and co-owner of 3T
- Msc. Computer Science from TU Twente (1989-1994)
- Philips (1994, intern), Ericsson (1995-2003), Gemtek Systems (2003), Ascom (2004-2007), ICT Automatisering (2007-2014)
- 3T (2014-now)

3T: leading for more than 30 years

- Founded in 1982, 3T since 1994
- Management buy-out in October 2014
- Development, manufacturing and support of *customer specific electronics and embedded systems*
- ISO 9001:2008 and EN ISO 13485:2012 certified
- 40-45 employees (mainly MSc/BSc)
- Offices in Enschede (HQ) and Eindhoven

Our mission

We continuously invest in our expertise of electronics and embedded systems to enable customers to supply perfect products

Why invest in Model-Based Design?

- Systems are becoming more intelligent, more complex and have more and more electronics and software
- We believe Model-Based Design is a way to deal with this

Why partner with MathWorks?

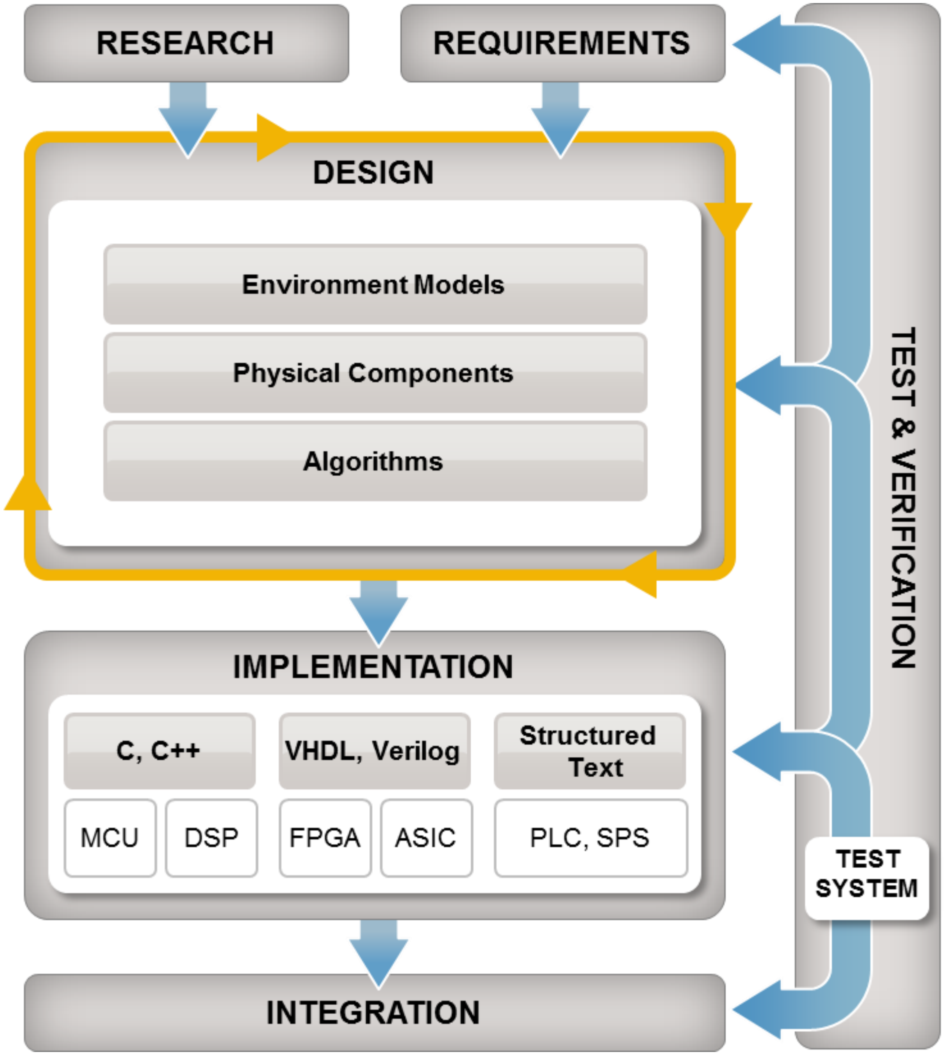
- A lot of companies are already using MATLAB and Simulink e.g.
  - For algorithm development
  - For modeling dynamic mechanical behavior

- Has code generation in place for c/c++ and VHDL

- Is willing to collaborate with us to help our customers become successful

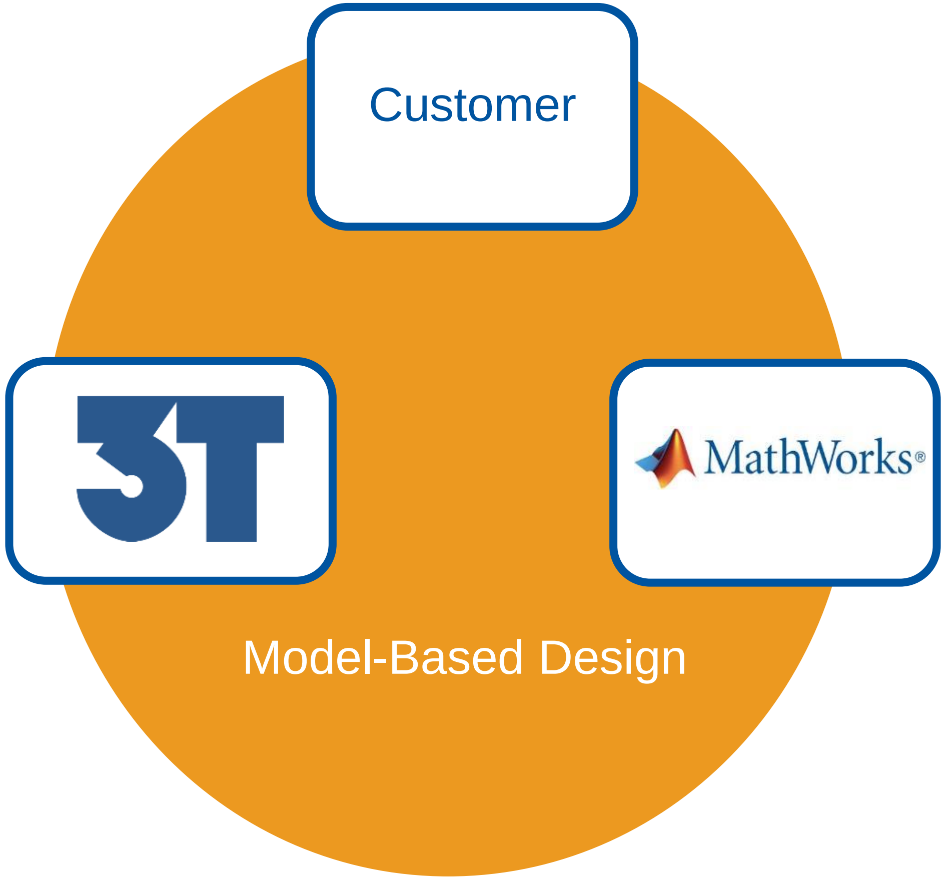
Benefits of Model-Based Design

- Faster innovation
  - Design errors are visible in an early stage
  - Continuous verification in a model-based simulation including hardware-in-the-loop
  - No programming errors due to code generation
  - Hardware choices can be delayed
  - Risk mitigation due to fast iterations
  - Higher quality, flexibility and shorter time-to-market
- Better collaboration
  - The model is the specification
  - Impact of requirements are clear very early
  - Change requests can be implemented quickly



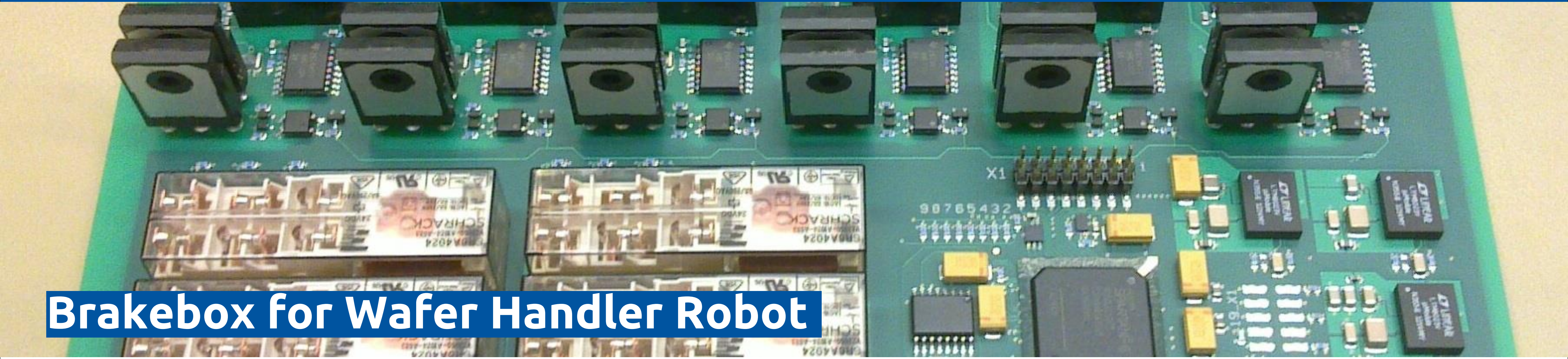
Why collaboration leads to innovation in the supply chain?

- We are not the domain expert: the customer is
- We are not the tooling expert: MathWorks is
- The customer and MathWorks are not the electronics and embedded software expert: we are
- Model-Based Design helps to bridge the gap between these worlds resulting in better collaboration and innovation



Project example

Brake box for wafer handler robot



Brakebox for Wafer Handler Robot

Problem definition:

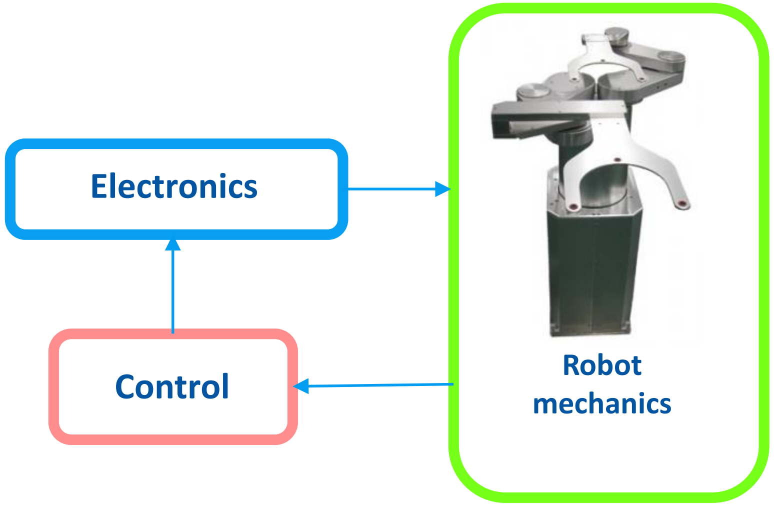
Design a braking system that accurately and safely stops the robot in case ANY of the control components fails to avoid major damage to the machine.

SCARA robot system

- High power robot control
  - 2 high power (>250V hazardous) 3 phase amplifiers
  - Complex motion control platform
  - High resolution encoders
  - A number of low and high voltage power supplies
  - Many interconnects any communication interfaces between these parts
- Any component failure could cause a lot of damage
- Challenge:
  - Design a braking system that accurately and safely stop the robot in case ANY of the control components fails.
  - Within ~mm accuracy (without encoders >> sensor less)
  - At ~m/s speeds
  - Within a < 0.5 s timeframe
  - No external additional support for measurements

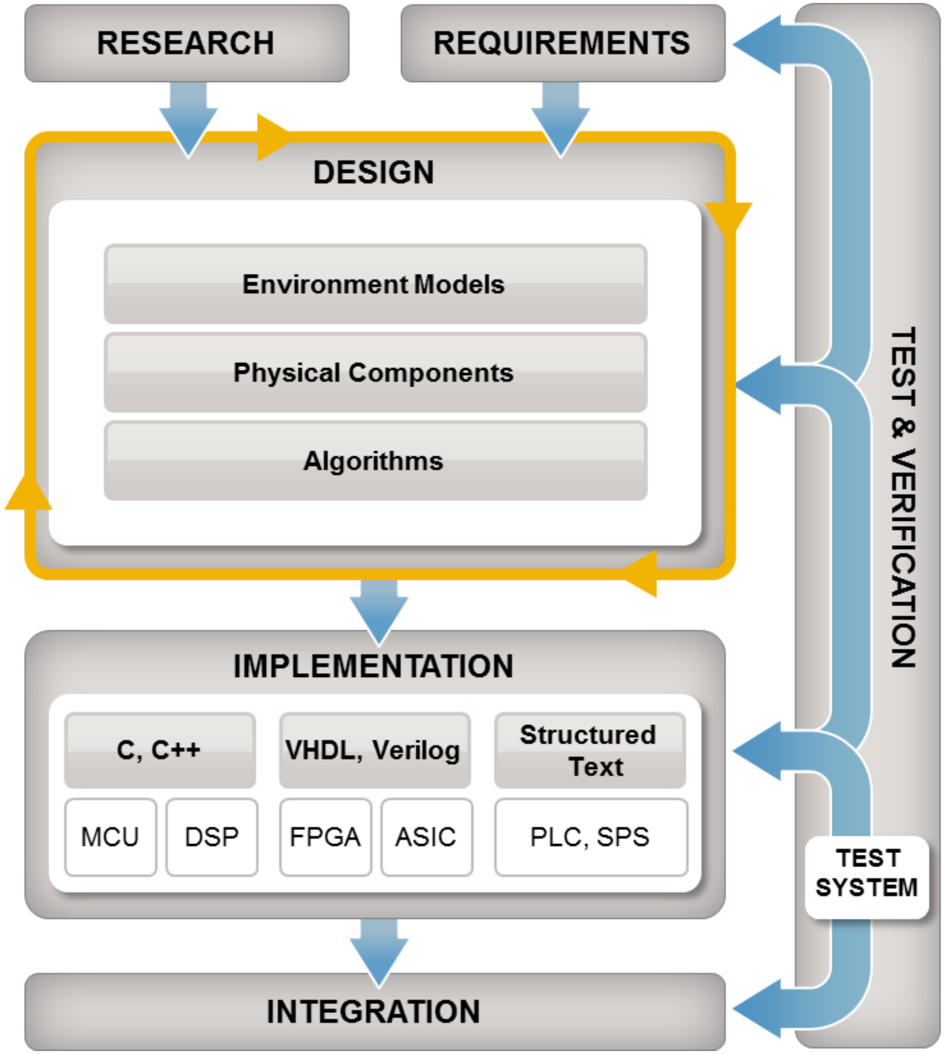
Design approach

- Dynamic robot Simulink model was already available
  - Very complex on the inside
  - Very usable by the other engineers on the outside!
- High level model of electronics added
  - 3 phase motors
  - conceptual actuators and sensors
- Control (closing the loop)
  - Perfect to test different control algorithms
  - Effective control algorithm quickly emerged
- Decided to go for a FPGA solution using HDL code generation for the control



Results

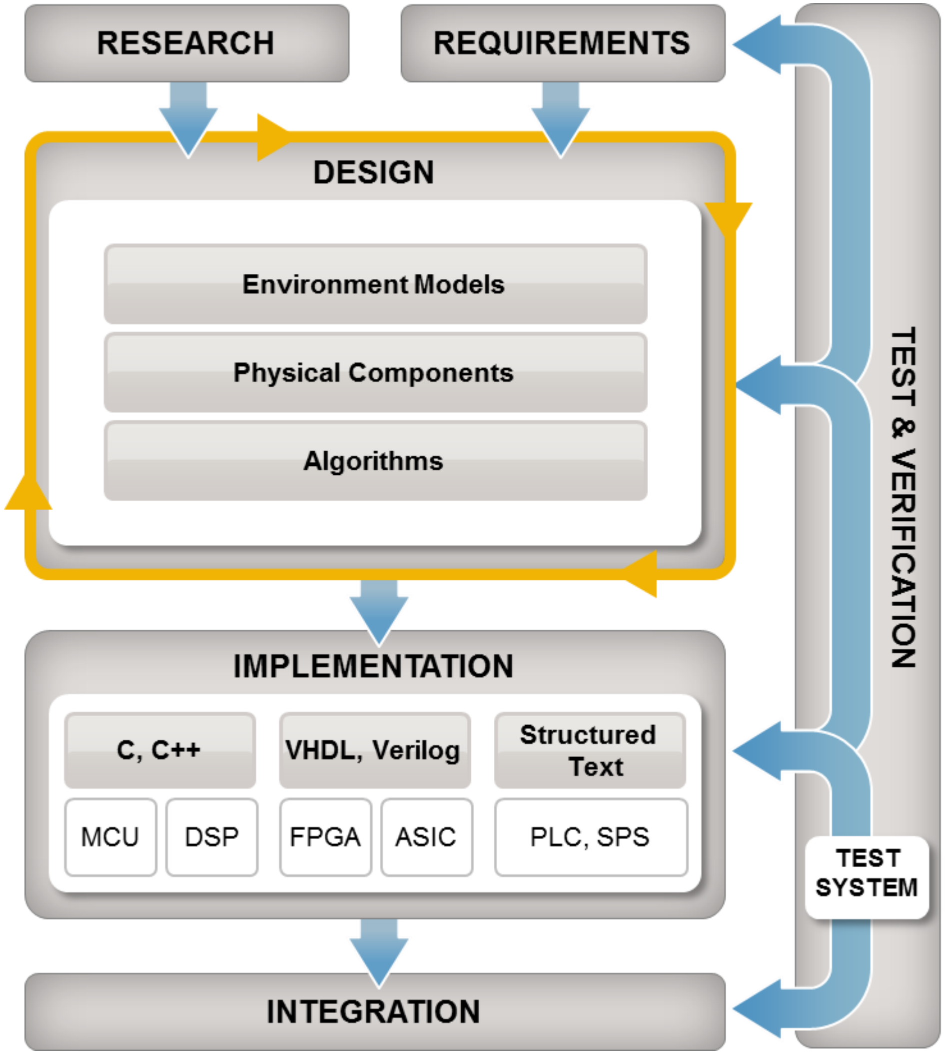
- Final design functions with little tuning needed.
- But……
  - New requirements pops up:
  - Maximum allowed deceleration is dramatically decreased
  - Hardware hits its limits, causing some critical tests to fail. No easy hardware fixes available.
- Now what?
  - After initial cheers project heads towards failure!
  - Hardware redesign is costly in this phase



Results

- PWM style switching was implemented in “golden reference” to mitigate hardware limitation.
- Code generation and testing was highly automated and proceeded very quickly
- The new requirements met by a very fast design iteration of the HDL logic.

Lesson learned:
Fast iterations can be a life safer!



Project example

Radar tracking module

Radar tracking module

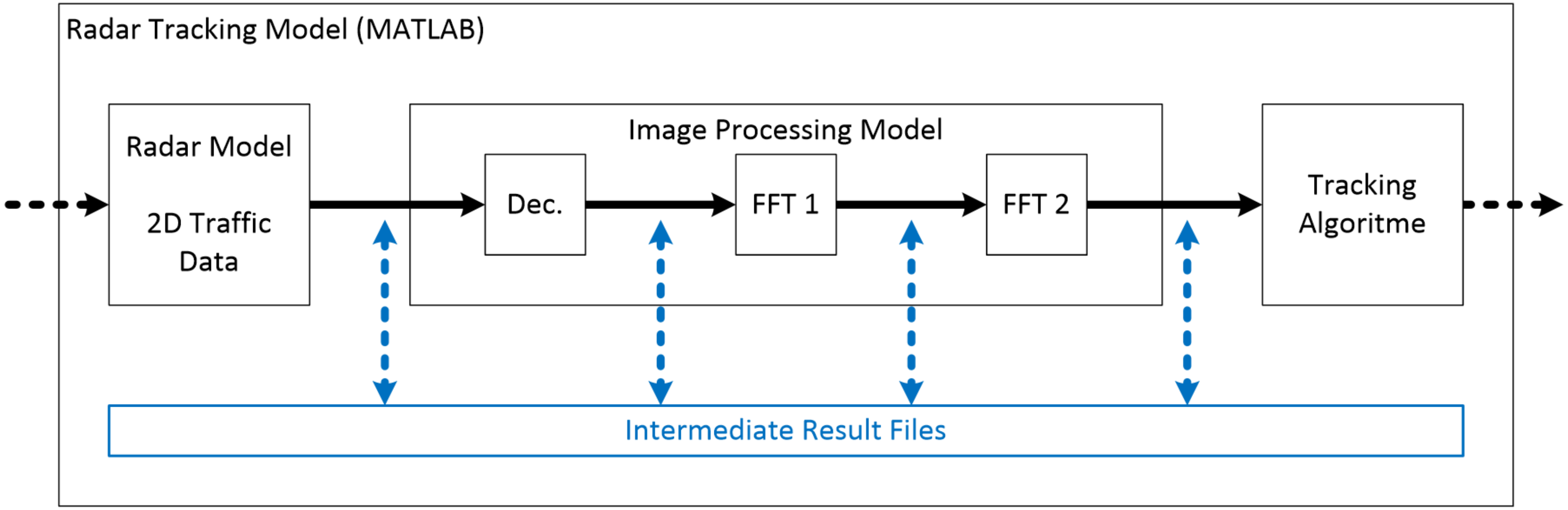
Problem definition:

Develop a new radar tracking module which can

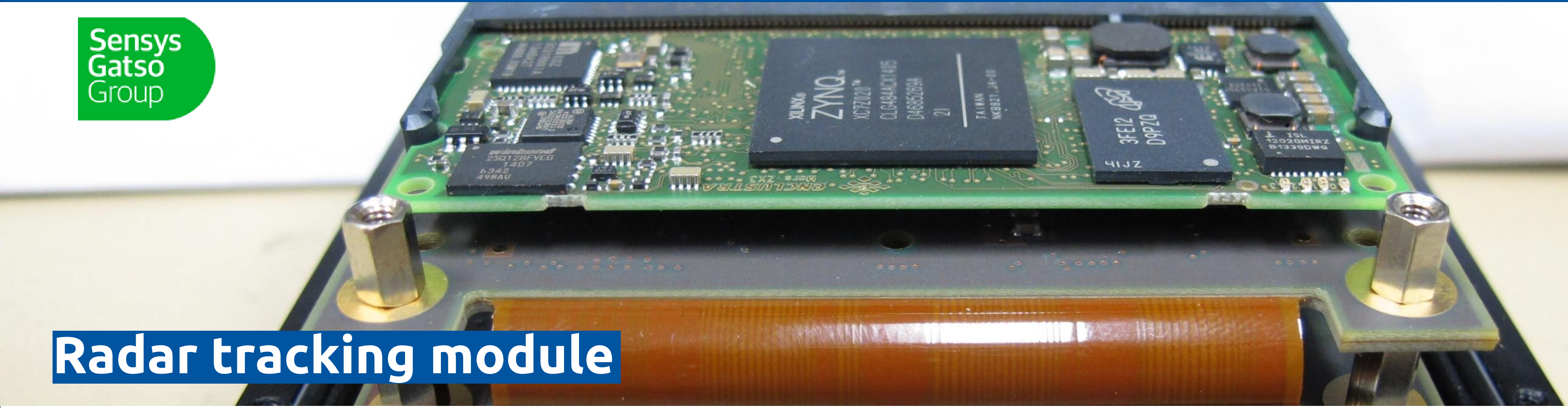
- Track 6 lanes instead of 3
- Discriminate vehicle types better
- Adopt changes in the algorithms due to new circumstances

Design approach

- SensysGatso designed the radar tracking model in MATLAB



- MathWorks helped to optimize model for code generation and advised on decomposition in FPGA vs CPU
- 3T developed the electronics, FPGA firmware and a framework for the generated code



Radar tracking module

- High performance analog front-end for signal conditioning radar signals
- System on Module with Xilinx Zynq Z-7020
- C/C++ code for radar tracking algorithms generated via Model-Based Design using MatLab and Simulink
- Digital Signal Processing in Zynq FPGA fabric
- eCos RTOS on one Zynq ARM core

- See: http://3t.nl/algemeen/soc/

Results

Marco Siebeling, Manager Research, SensysGatso:

- The lead time of the RT4 to a workable product was significantly shorter than with previous radars, roughly 50%
- We have now the possibility to record raw data and to play it back into the model which reduces test time significantly
- From MATLAB algorithm to an integrated RT4 test version takes less than half an hour

- Model based design helps the impact analysis of change requests
- Model bases design helps to efficiently localize problems

Conclusions after using MBD

Conclusions

- The project results show that Model-Based Design helps to

- Enhance innovation:
  - Shortens lead time
  - Helps to adapt to changing requirements through faster iterations
  - Improves the quality by early simulation using hardware-in-the-loop results

- Enhance collaboration
  - Improves communication between different disciplines using the model as the specification
  - Faster impact analysis of changes
  - Helped us to get very satisfied customers

electronics & embedded systems

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