

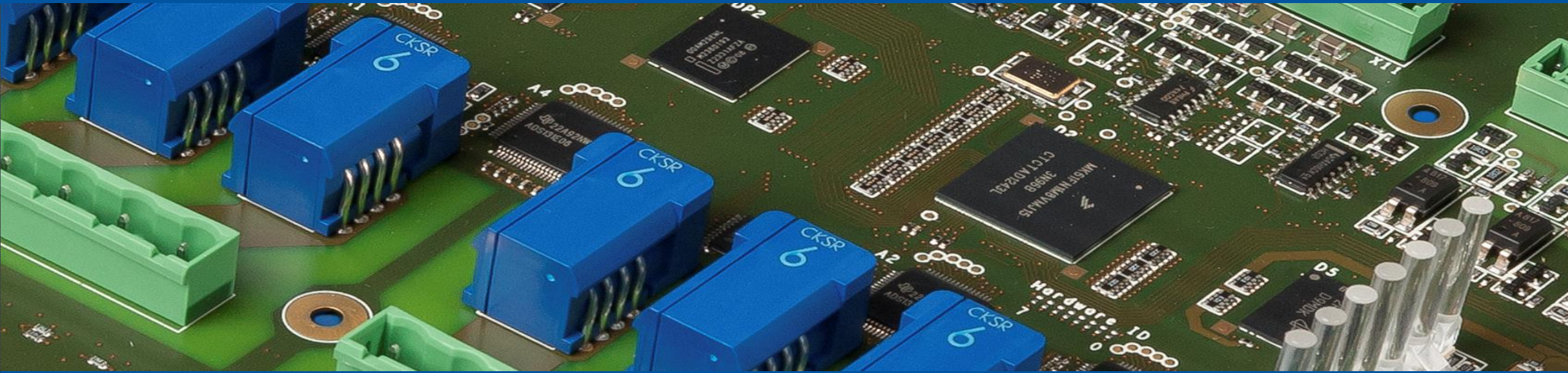


electronics & embedded systems

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

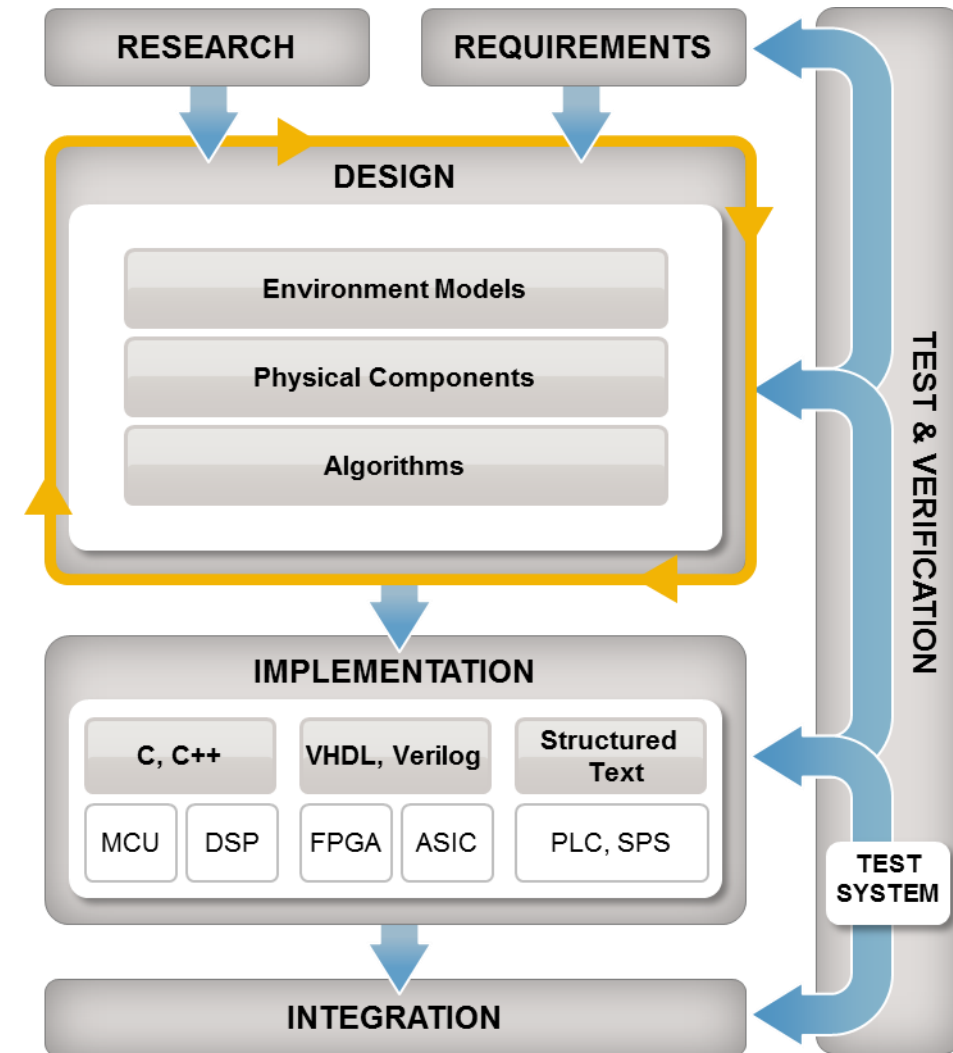
# Why partner with MathWorks?

- 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



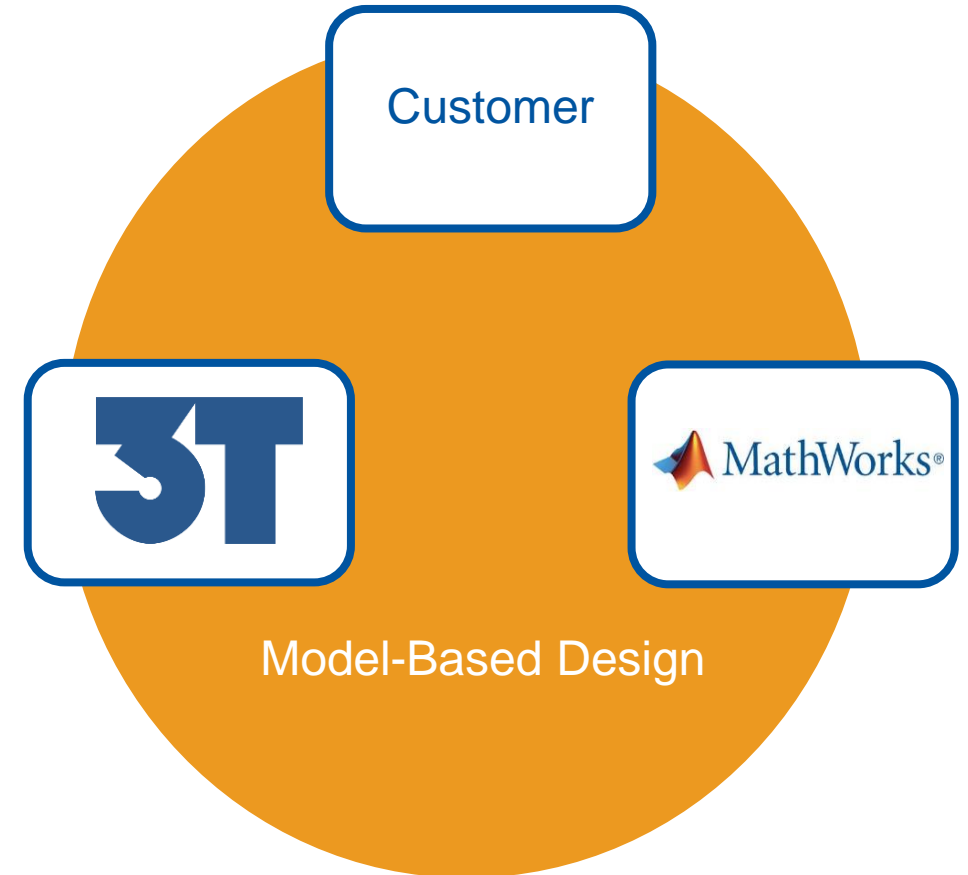
# Benefits of Model-Based Design

- 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

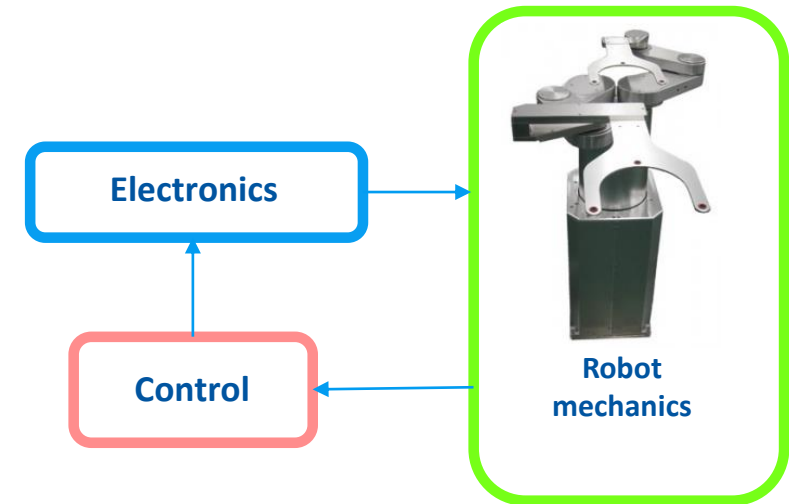
- High power robot control
  - 2 high power (>250V hazardous) 3 phase amplifiers
  - Complex motion control platform
  - High resolution encoders
  - A number of low and high voltage power supplies
  - Many interconnects any communication interfaces between these parts
- Any component failure could cause 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





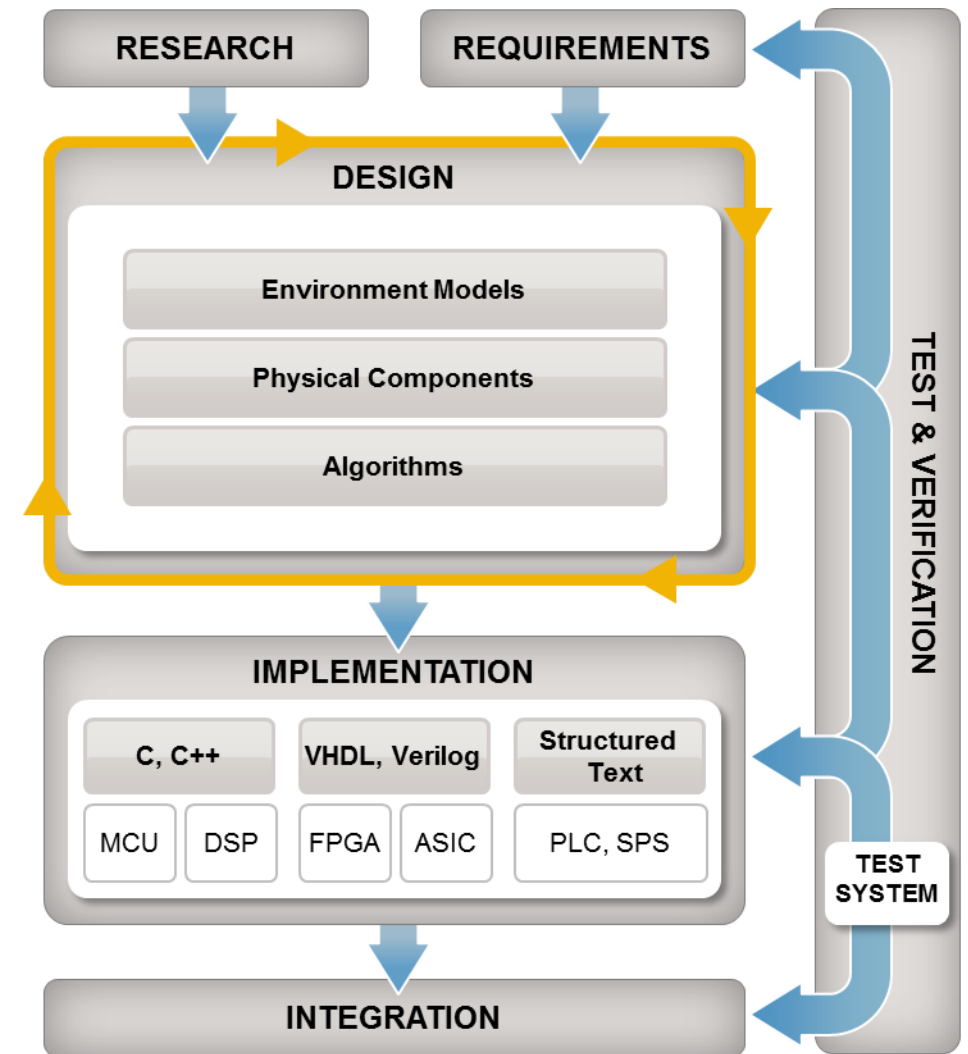
# Design approach

- 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

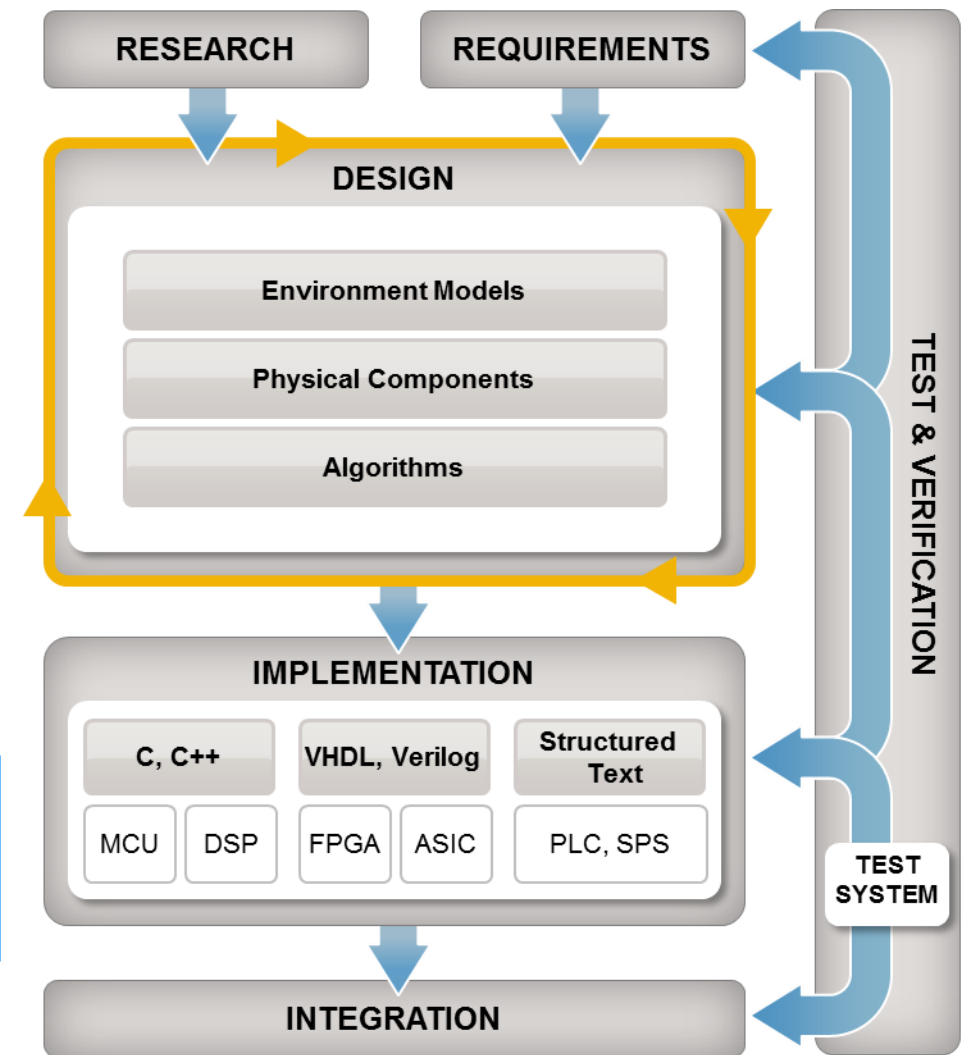
- Final design functions with little tuning needed.
- But.....
  - New requirements pops up:
  - Maximum allowed deceleration is dramatically decreased
  - Hardware hits its limits, causing some critical tests to fail. No easy hardware fixes available.
- Now what?
  - After initial cheers project heads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







# Project example

## Radar tracking module



## Radar tracking module

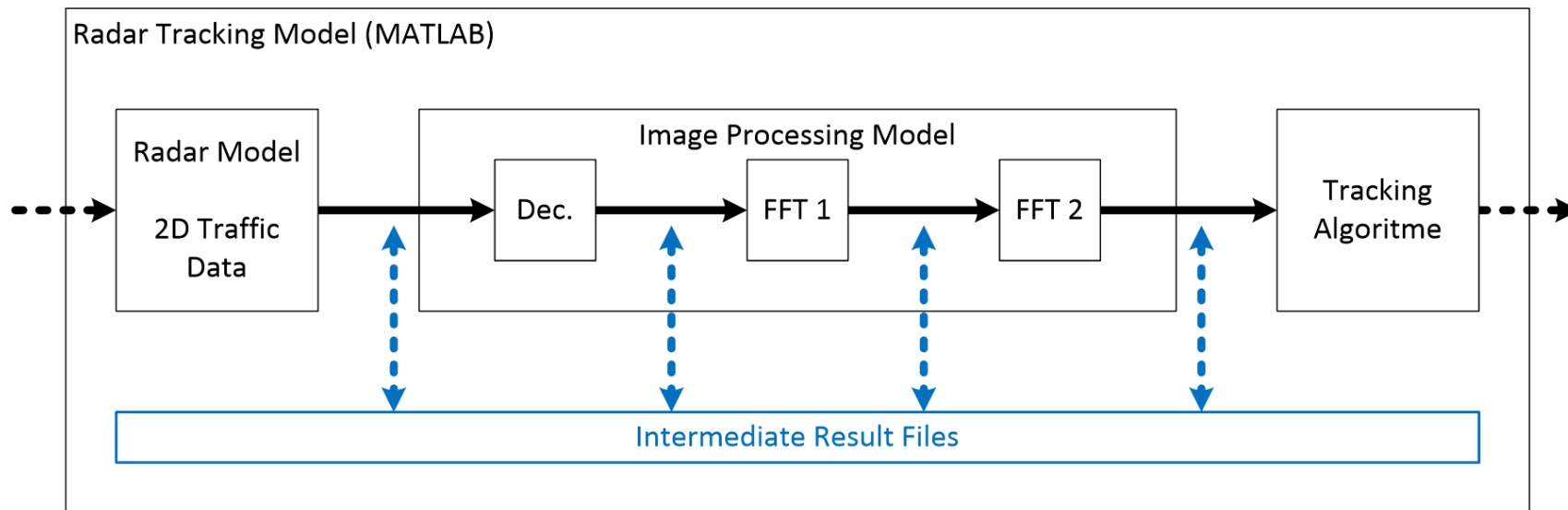
### Problem definition:

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 based 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



**3T B.V.**

Institutenweg 1  
7521 PH Enschede  
The Netherlands

Esp 401  
5633 AJ Eindhoven  
The Netherlands

T. +31 53 4 33 66 33

F. +31 53 4 33 68 69

E. [info@3t.nl](mailto:info@3t.nl)

W. [www.3t.nl](http://www.3t.nl)