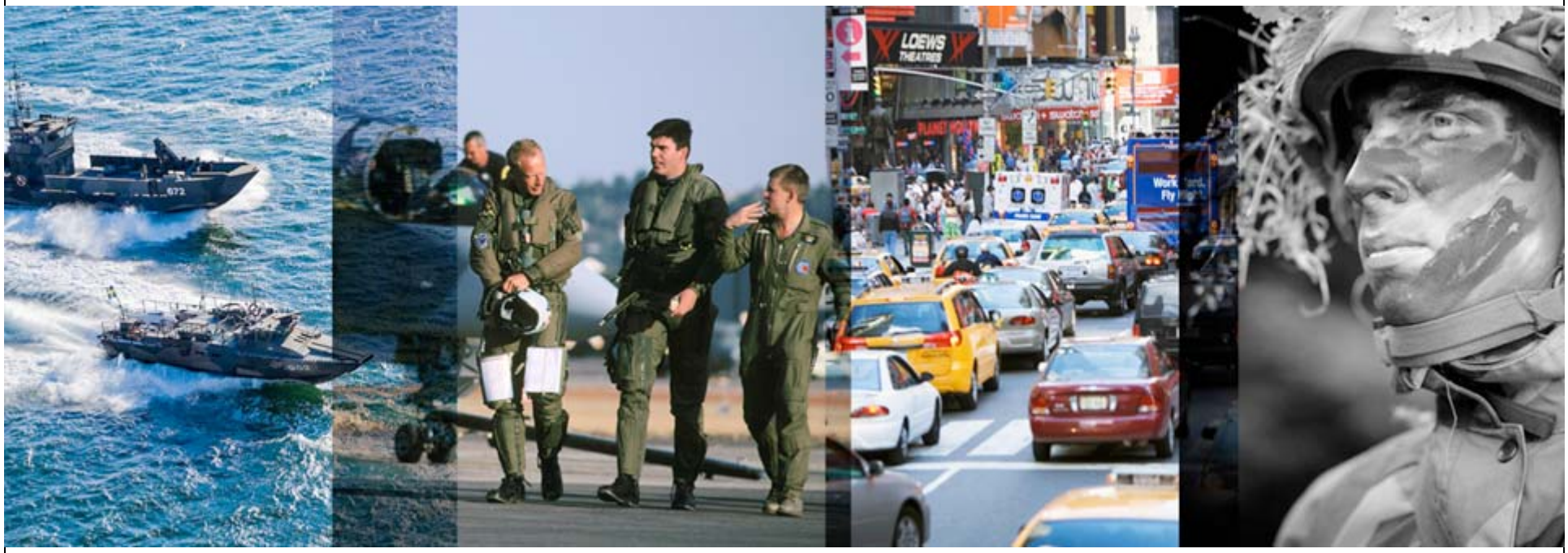
# Contracts based specification

## Results from the SPEEDS project

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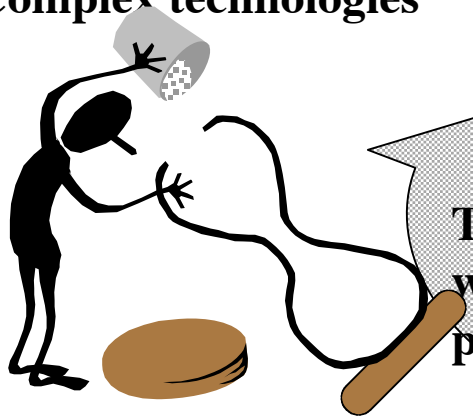
**2008-11-19**

**Sesam**

# Life - It would be trivial if it wasn't for

Complex technologies

Integrated into complex products



Things will be even worse for the next product generation

Change is constant

Developed in complex organisations

# Will things get better with models?

- Modelling allow for exposition of interfaces
- Improved clarity
- But traditional modelling languages does not make a distinction between what is required and what is assumed in terms of interface statics and dynamics

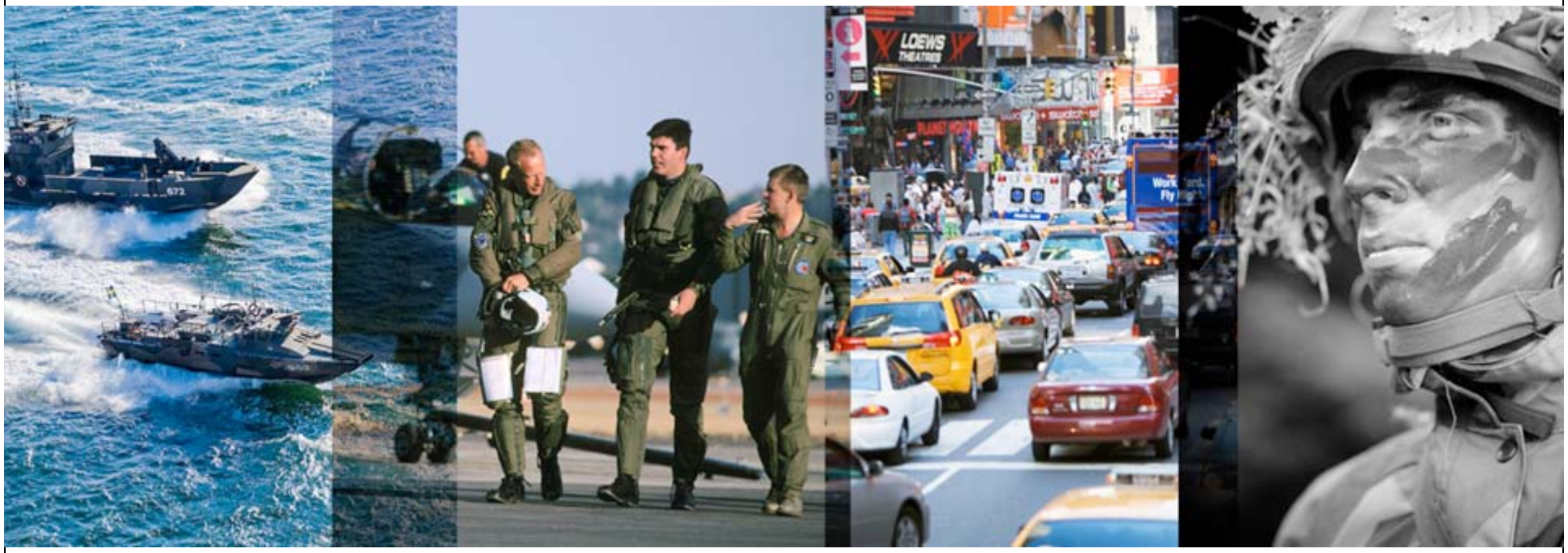
# The challenge

- Concurrent engineering
  - How to document and manage uncertainty
- Efficient coordination between cooperating teams
- Early virtual integration of components
  - Integrate models

# Systems Engineering Strategy

- To master complexity we abstract,
- Partition into components
- Integrate
- Problems
  - We do not know the details when we partition
  - Component development is difficult to coordinate
  - Things never work the first time we integrate

# Improving modelling practise



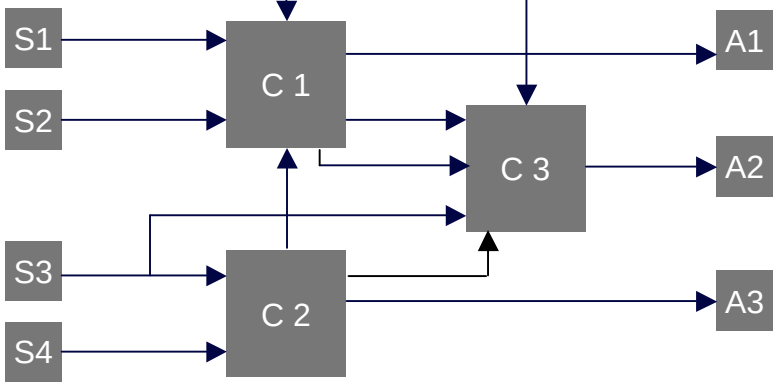
# What about the formal methods

- Formal methods has over and over again demonstrated their strength on small problems
- Any complex system will by nature be costly to formalise
  - Especially considering verification
- Limitations on what can be proven
- For system specification, where the model is an abstraction of the real system, any proof is just valid on that abstraction level
  - Weak connection to the real system

# Initially...

Design was king





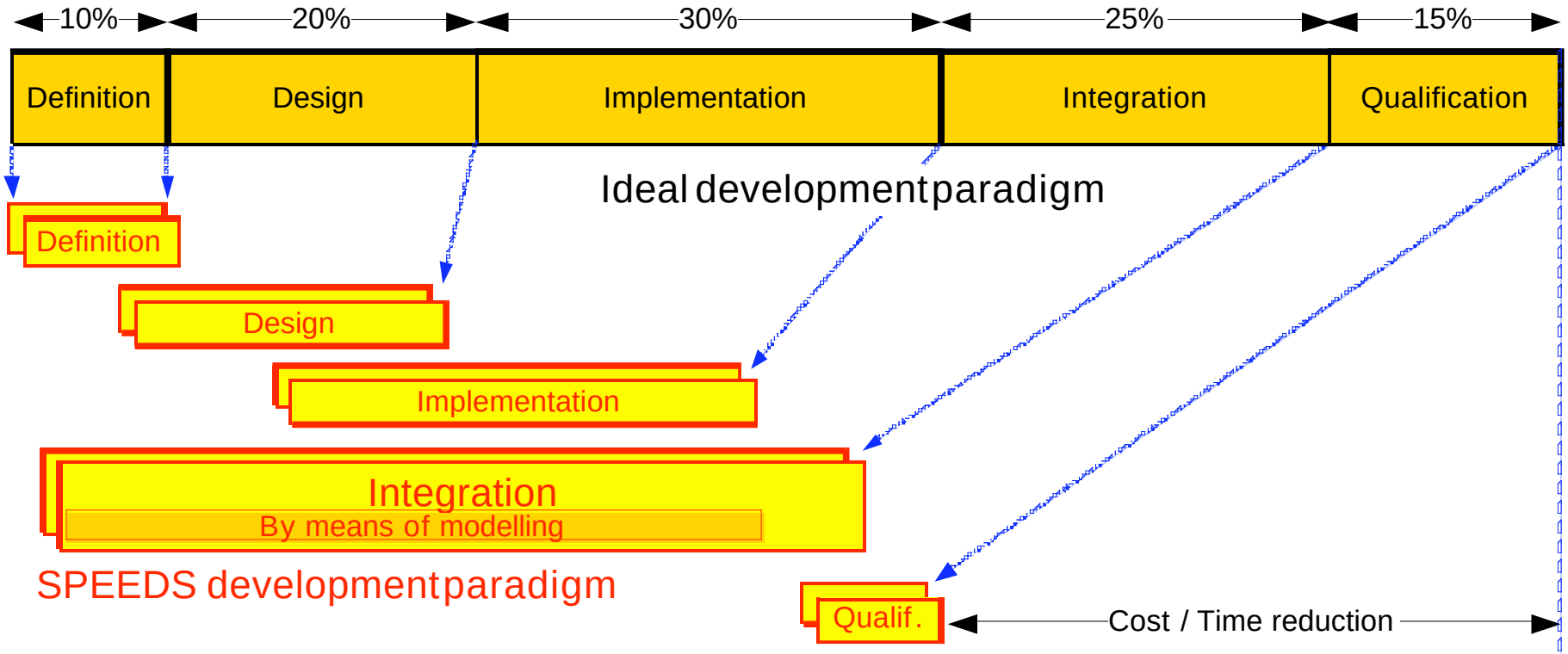

Focus on requirements

One-way communication

Raise Assumptions to the same dignity as requiremetns

Explicit capture of assumptions is important

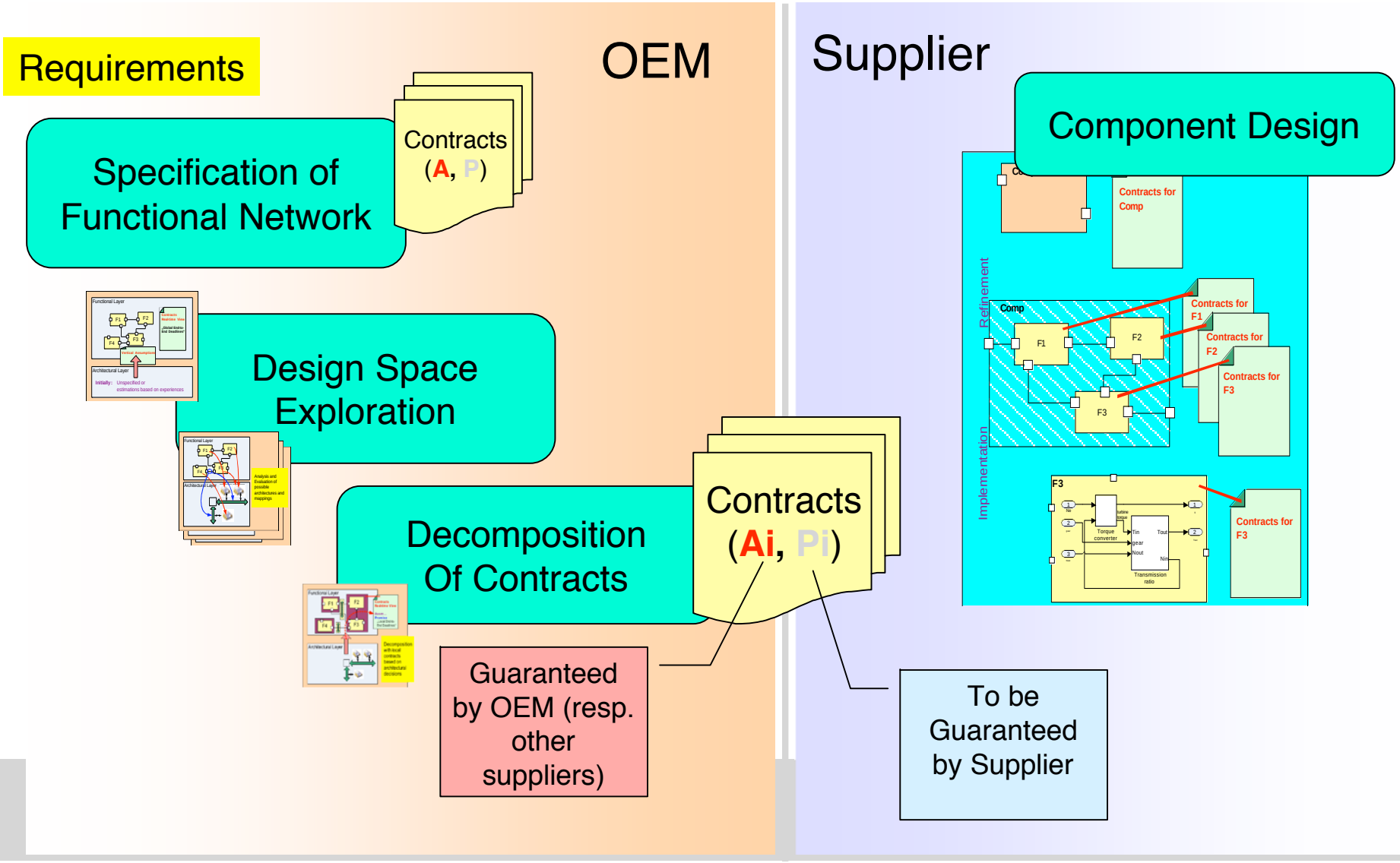
# What do we want to achieve?



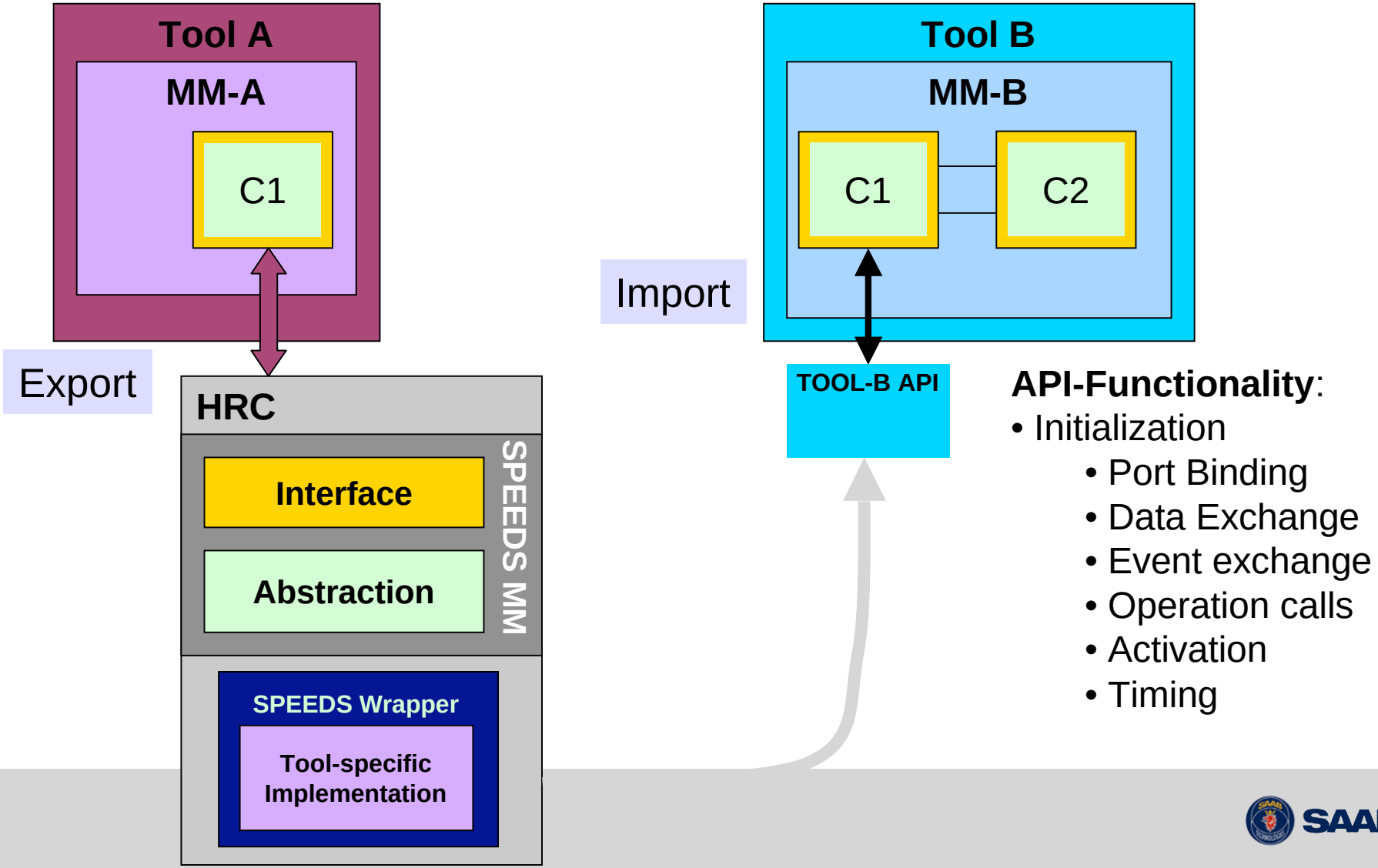
# SPEEDS

- MBSE requires a new approach to really take off
- Focusing of formality, interfaces and requirements
- Define
  - The Component (Component Based Engineering)
  - Requirements (Promises) on the component
  - Prerequisites  (Assumptions) on the environement for requirement fulfillment
  - Group *Assumptions* and *Promises* to *Contracts*
  - Formalise *Assumptions* and *Promises* where desirable
- Integrate
  - Synchronise C*ontracts* to discover integration problems
- Simulate
  - Hosted simulation
- Verify
  - Applying formal analysis

# Contracts in the design process



# Hosted simulation




**API-Functionality**:

- Initialization
  - Port Binding
  - Data Exchange
  - Event exchange
  - Operation calls
  - Activation
  - Timing

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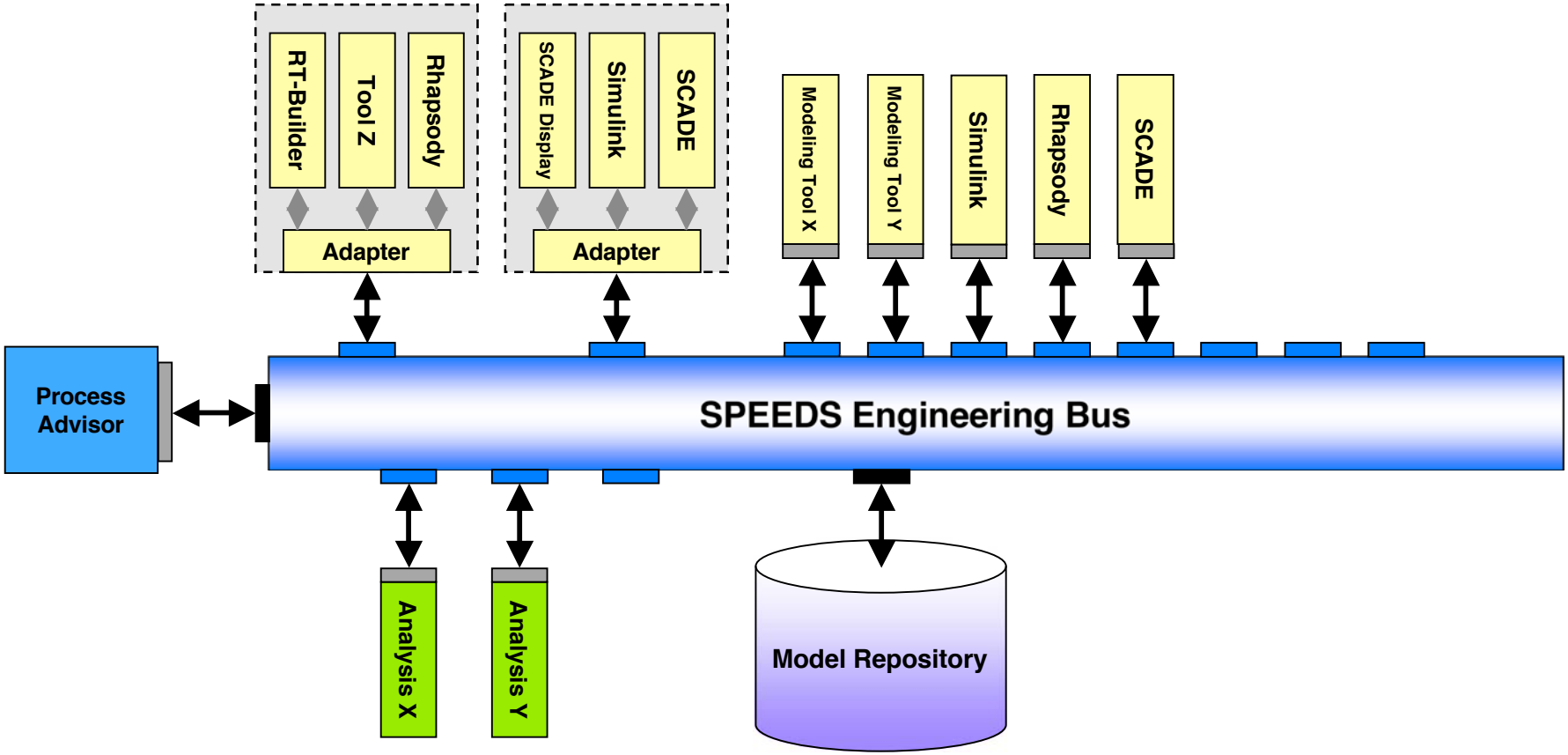
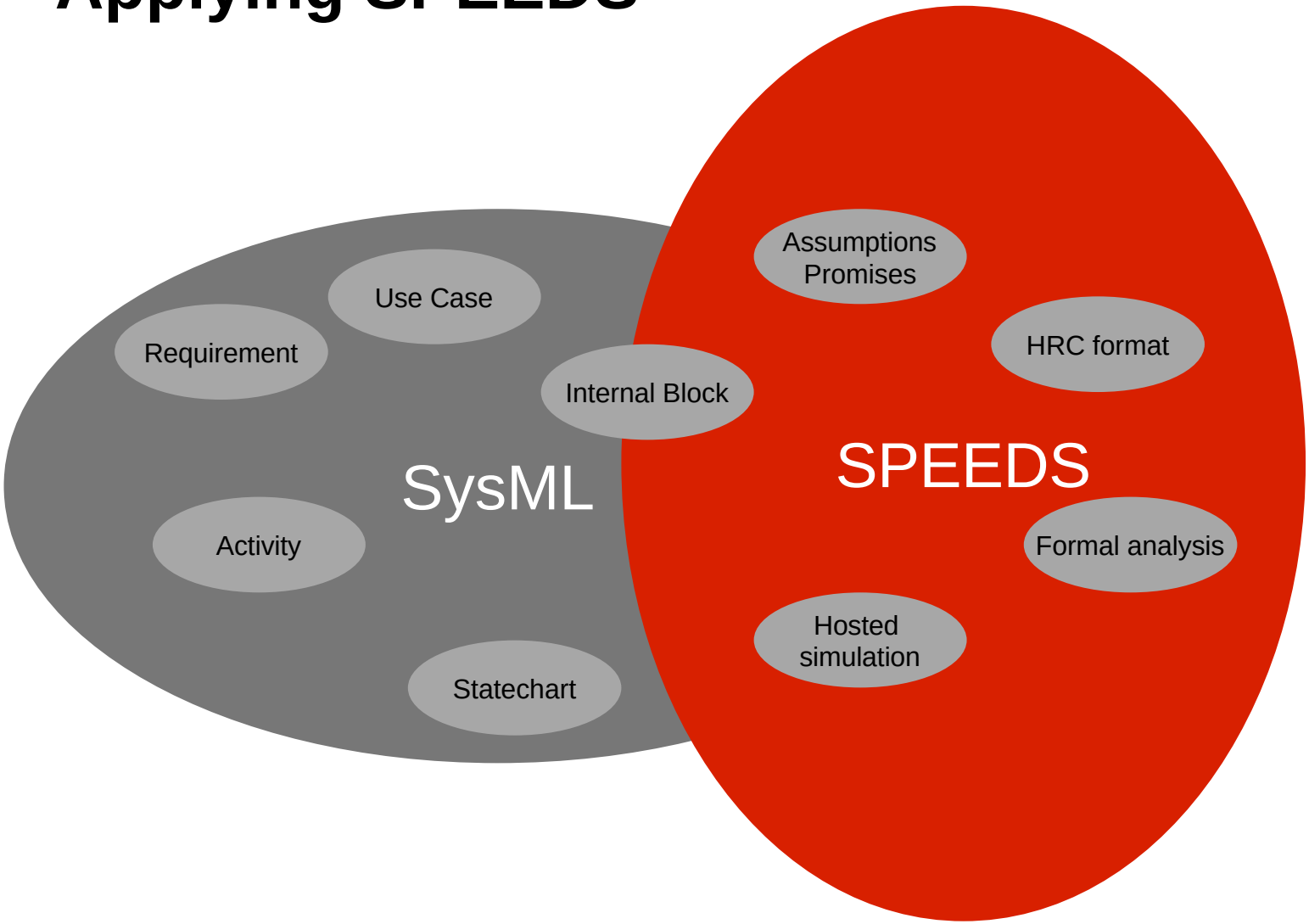
# Tool integration



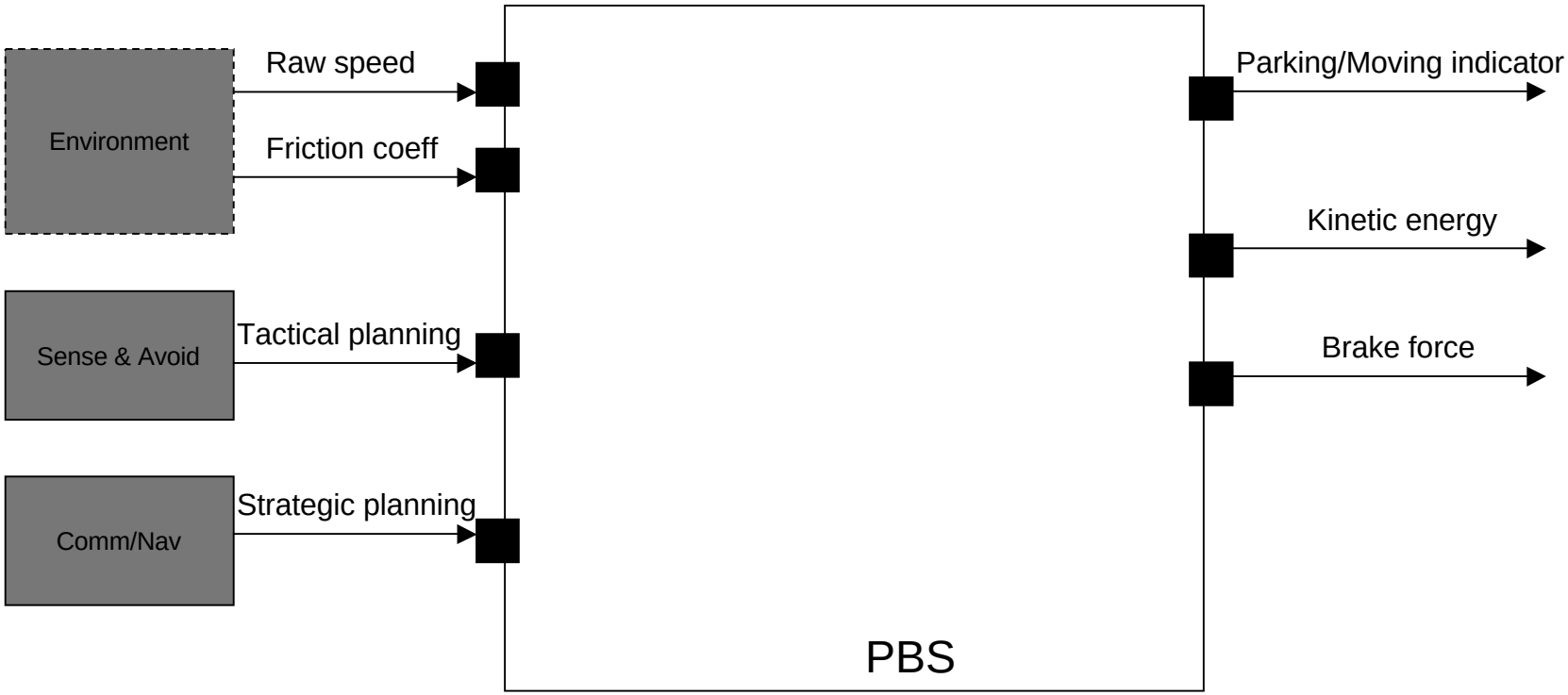
# Applying SPEEDS



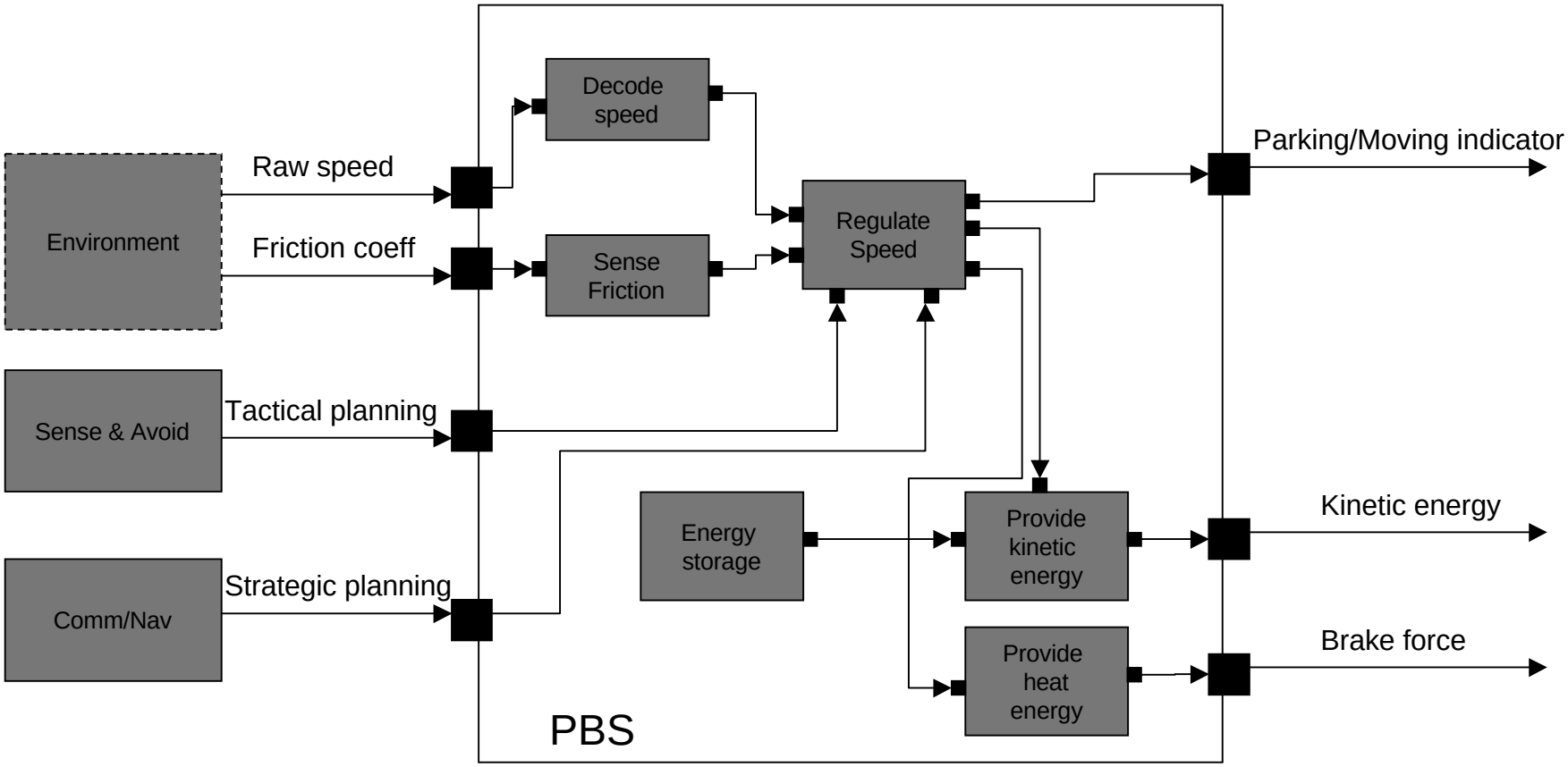
# Approach

- Use standard SysML tool as front-end
  - Telelogic Rhapsody
- Apply normal SysML modelling process
  - Views
  - Use cases
  - Activity diagrams
- Capture system functional (or physical) components and their interfaces
  - Using SysML Internal Block Diagrams used
- Identify requirements (promises) and constraints for individual interfaces
  - Using specific Assumption/Promise editor

# External Interfaces



# Internal functionality



# Assumptions and Promises in u

PBS total cost is less than €1000, specifically:
f(c
f(c
f(c

**Always[**(cost<800 -> f(cost)=1) and ((cost>=800 and cost<1000) -> f(cost)=1-0.005*(cost -800)) and (cost>1000 -> f(cost)=0)**]**

Sense and avoid data is less than 0,2 seconds old (as compared to observation made by ideal sensor) when available at input

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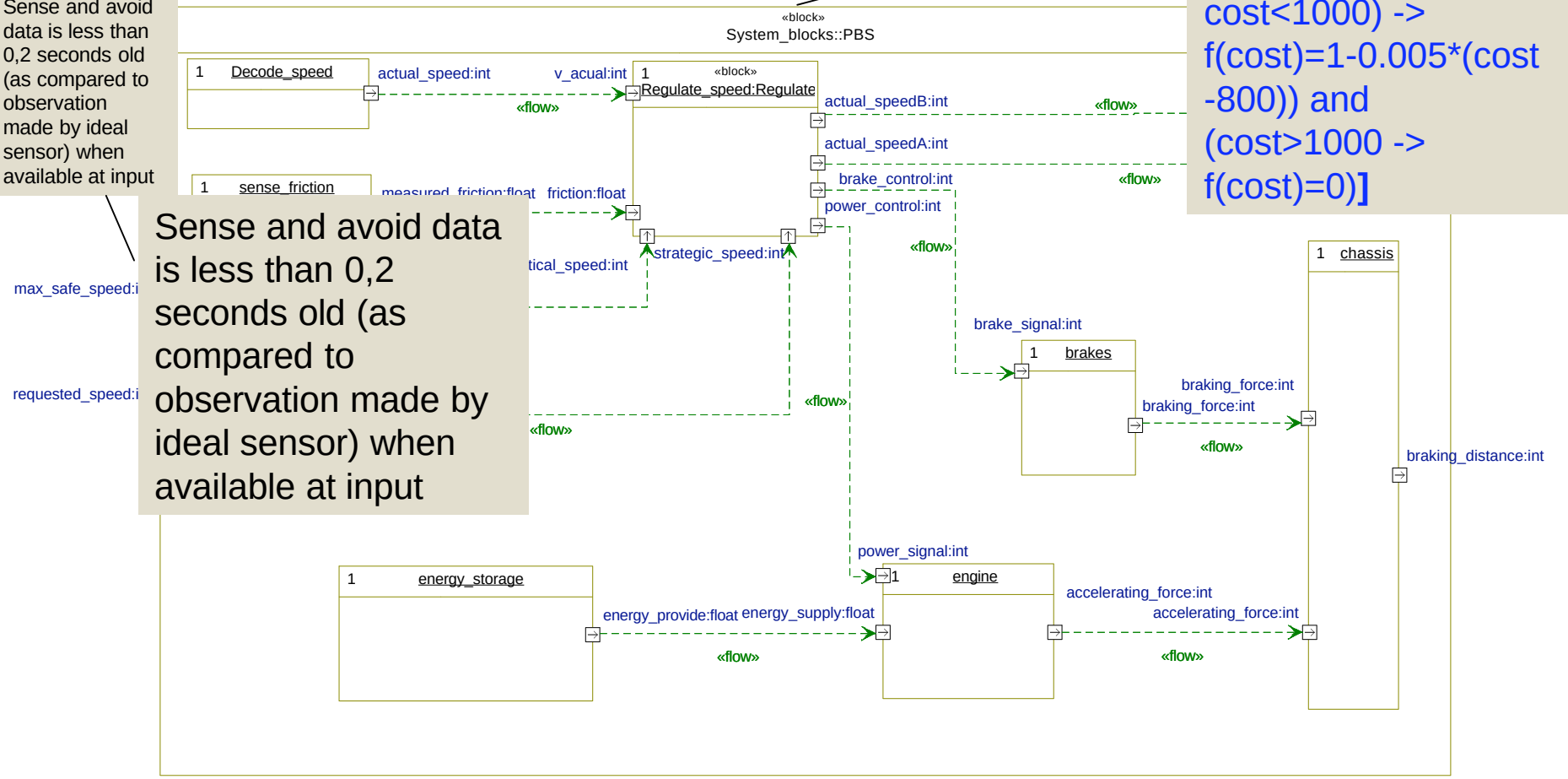

# Experience from early validation

- Strengths
  - Promises couples to functionality or properties that a component is capable of controlling
  - Assumptions is a natural way to capture the constraints identified
    - Seldom done today
    - Prerequisite for concurrent engineering and comprehensive review
  - Coupling of assumptions and promises first step in the integration process
- Weaknesses
  - All assumptions and promises are captured on ports
    - Not natural for component properties
- Observations
  - Time consuming to formalise contracts
  - Extra effort for applying formal analysis may not be economical


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