Comparing Performance Analysis Methods on an Industrial Case Study
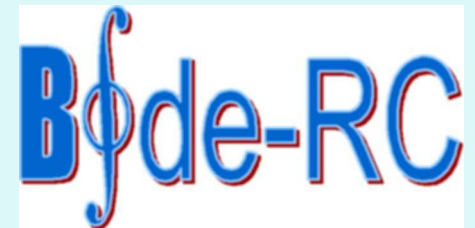
Marcel Verhoef

Chess Information Technology B.V., Haarlem
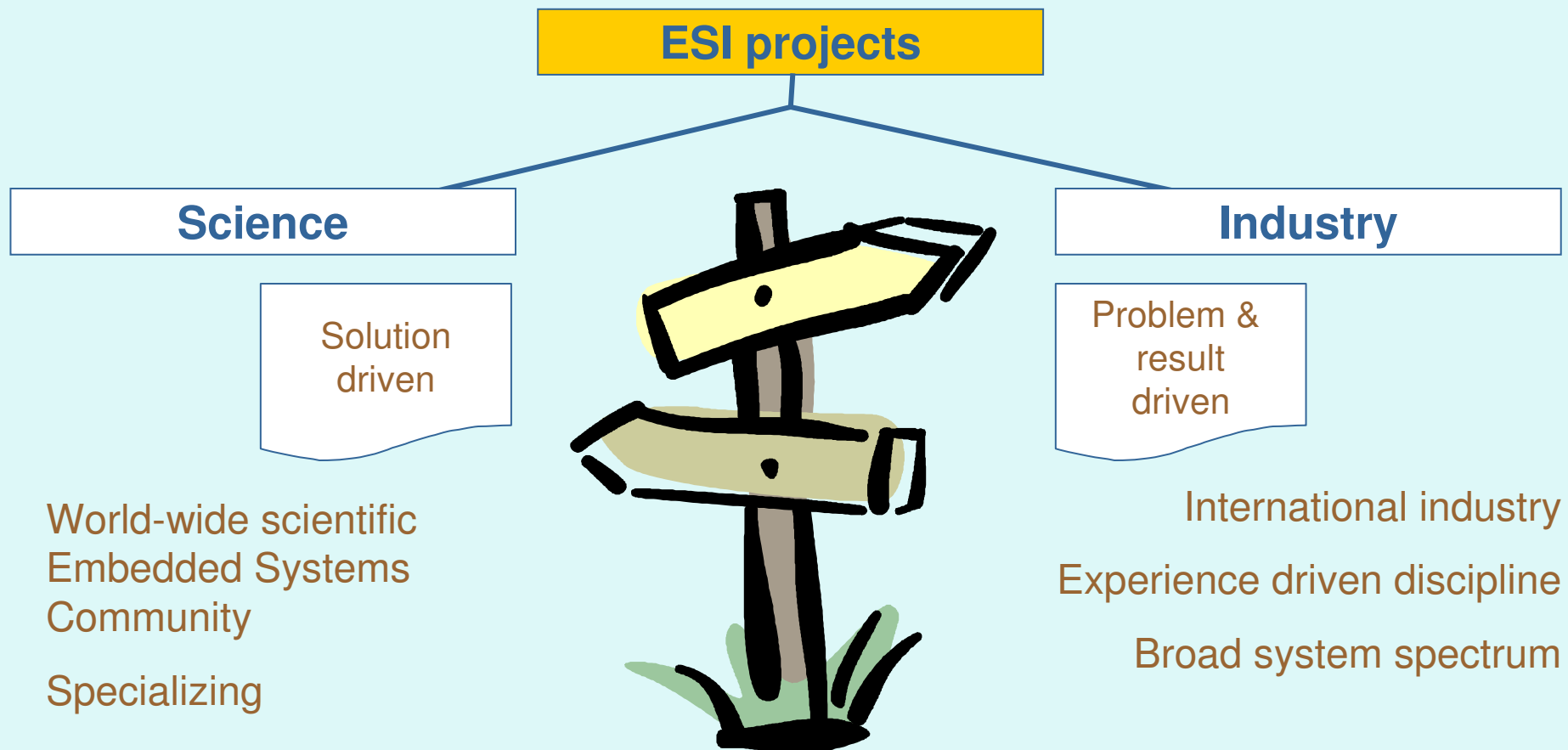**Radboud University Nijmegen**

Jozef Hooman

Embedded Systems Institute, Eindhoven
Radboud University Nijmegen

**Research in context of project Boderc
at the Embedded System Institute**

Aim ESI

Bridge gap between industrial problems and academic solutions

ESI projects

Science

Solution driven

Industry

Problem & result driven

World-wide scientific Embedded Systems Community

Specializing

International industry

Experience driven discipline

Broad system spectrum

2

BODERC Project

Embedded Systems

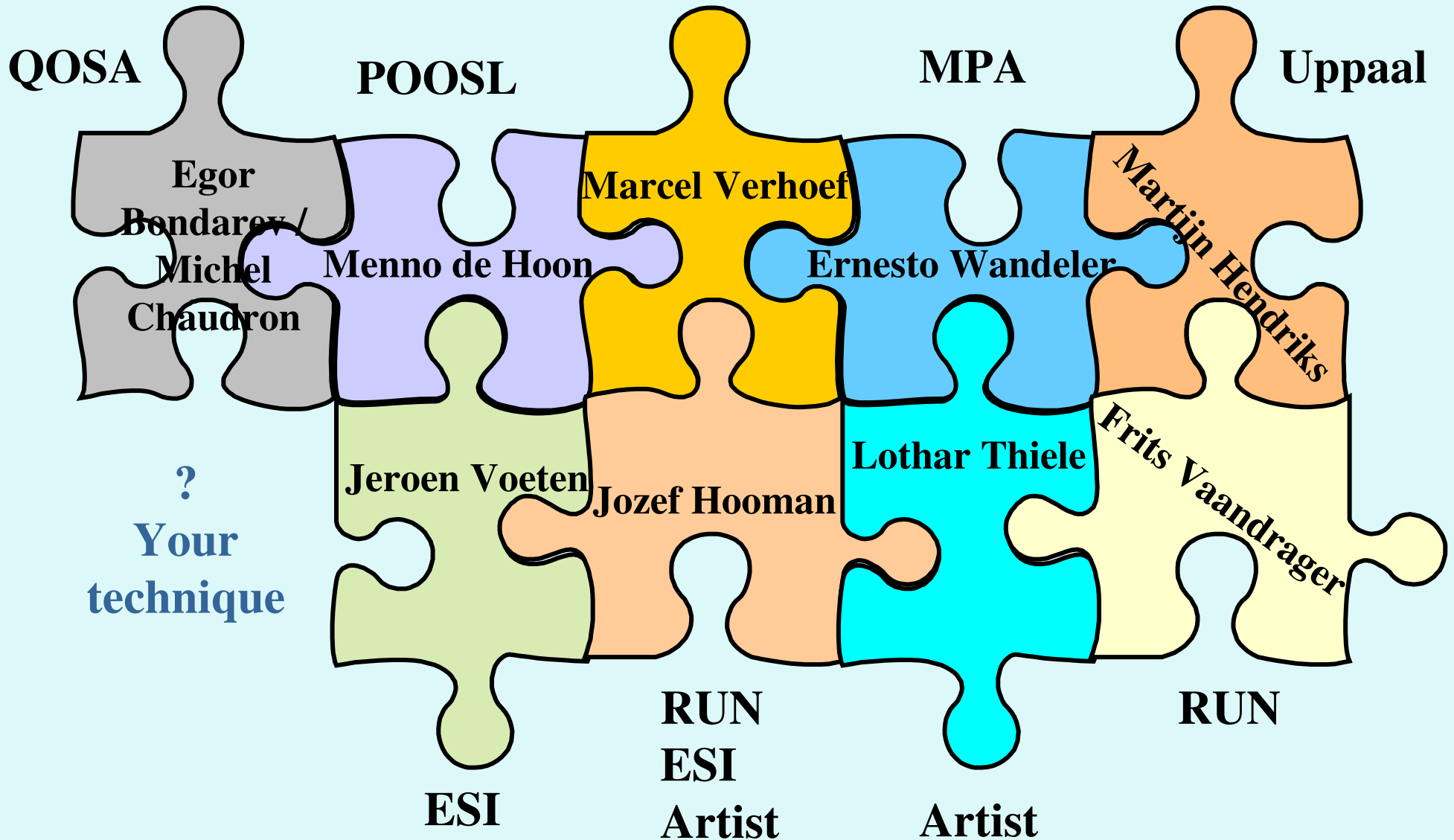Aim: improve high-level design of mechatronic systems

Includes

- multi-disciplinairy design space exploration, focus on performance

- analysis of system-level decisions

- predict consequences of design decisions as early as possible

Carrying Industrial Partner:

océ

CHESS

Imtech
ICT

TU/e technische universiteit eindhoven

PHILIPS

University of Twente
The Netherlands

3

Collaboration on case study

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QOSA

POOSL

MPA

Uppaal

Egor Bondarev / Michel Chaudron

Menno de Hoon

Marcel Verhoef

Ernesto Wandeler

Martijn Hendriks

?
Your technique

Jeroen Voeten

Jozef Hooman

Lothar Thiele

Frits Vaandrager

ESI

RUN
ESI
Artist

Artist

RUN

Comparing Performance Analysis Methods

status and some lessons learnt

Agenda

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- **Why comparison of techniques?**

- **Suitable benchmark**

- **Early results**

- **Lessons learnt**

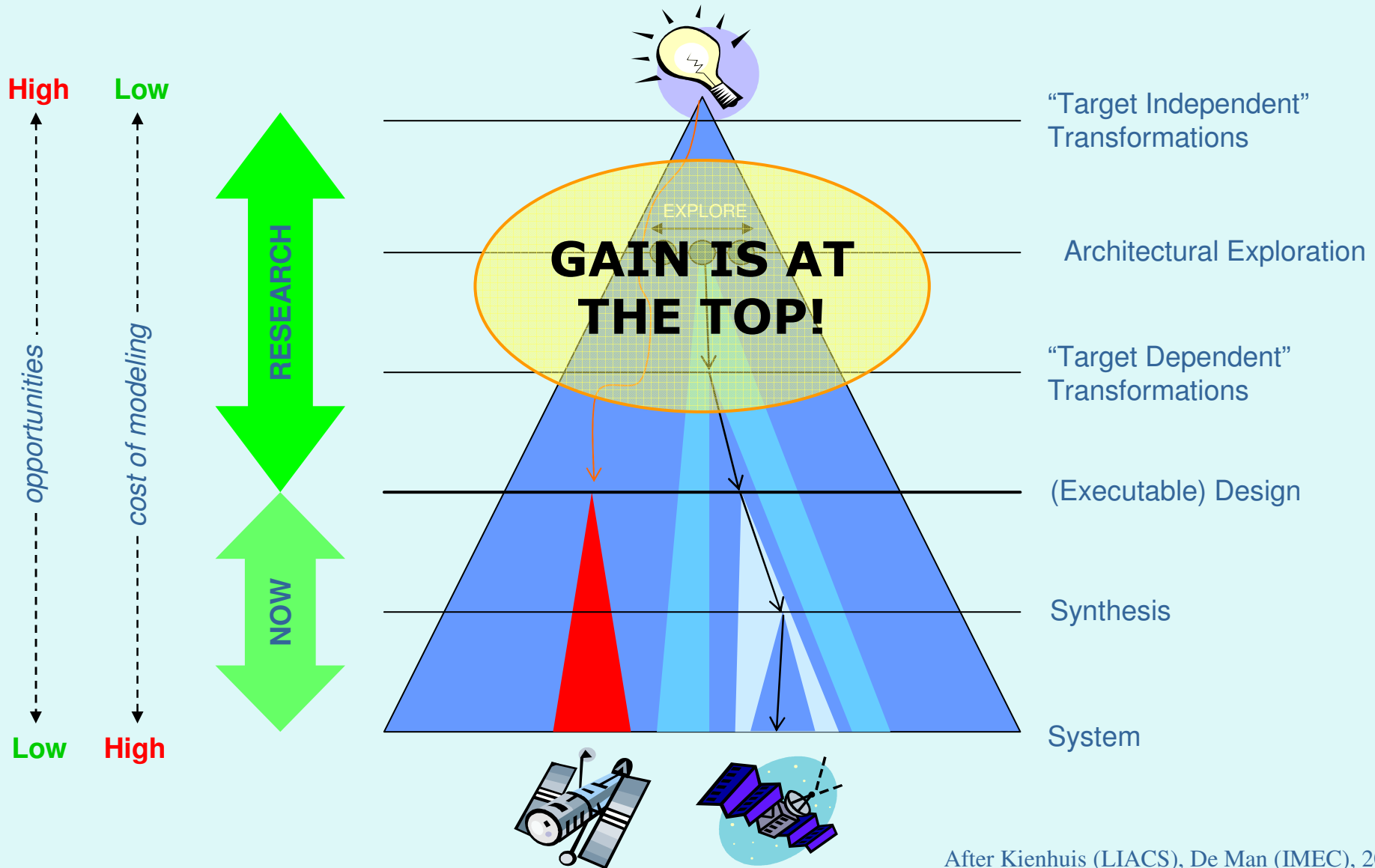Embedded Systems
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- **Why performance analysis?**
  - **continuous increase in functionality demands**
  - **continuous drive to reduce cost price**
  - **tighter time-to-market demands**
  - **rapidly evolving technology**

- **over dimensioning not longer viable ($)**
- **need for <u>early</u> design choice impact analysis**
- **and <u>continuous</u> monitoring over life cycle**

- **still not always recognized in industry!**

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"Does The Product Work?"

SHIFT
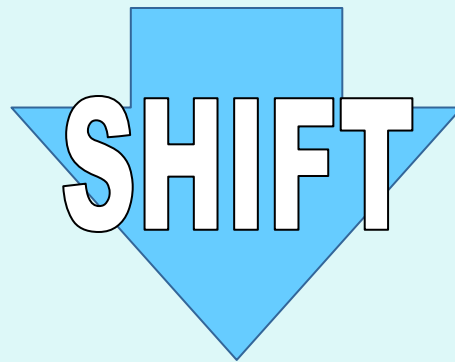
"Does The Product Work Given a Set of
Hard Resource Constraints?"

8

Fighting The Complexity Battle

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High   Low

opportunities   cost of modeling

RESEARCH

NOW

Low   High

EXPLORE

GAIN IS AT THE TOP!

"Target Independent" Transformations

Architectural Exploration

"Target Dependent" Transformations

(Executable) Design

Synthesis

System

After Kienhuis (LIACS), De Man (IMEC), 2002

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- **finding quantitative answers in the early life cycle is <u>very hard</u>, there are <u>many unknowns</u>**

- **"shooting at a moving target"**

- **need for a <u>light-weight approach</u> that can deal with highly interactive nature of the design process**

Why comparison?

- **Trade-off between *effort* and *insight gained* not well understood**
  - Investment: modeling effort
  - Investment: analysis effort
  - Return-on-investment: question answered? what accurracy?
  - Return-on-investment: question answered on time?

- **Problems industry faces**
  - Many techniques available (DES, QN, STOCH); which one fits my problem? How do I select the proper tool?
  - How steep is learning curve; do I need to become an expert?
  - Fit with design cycle; disruptive to current way of working?
  - Sufficient tool support?
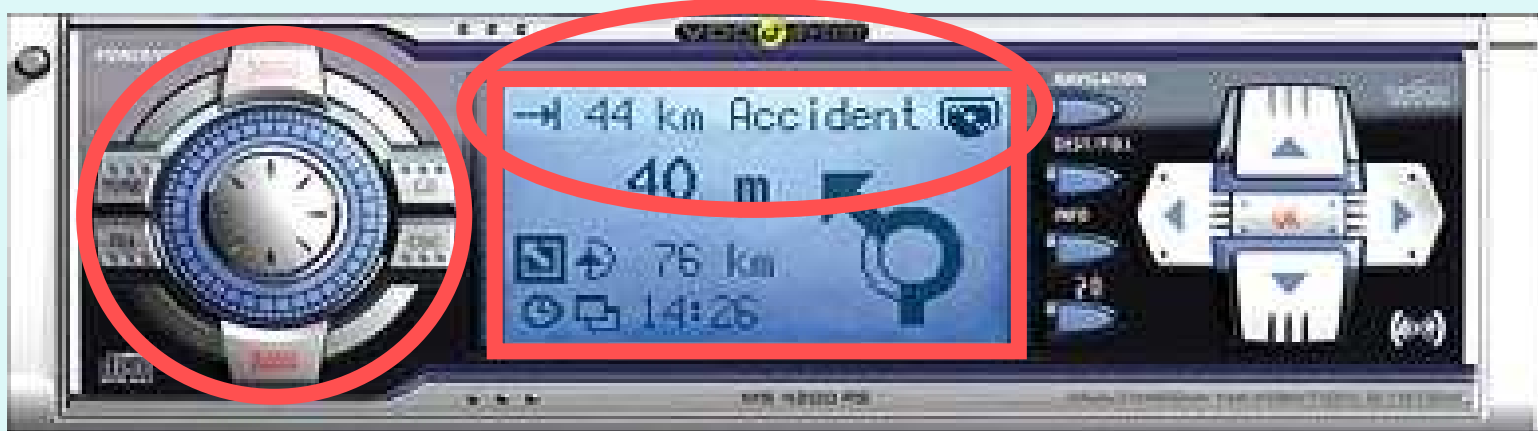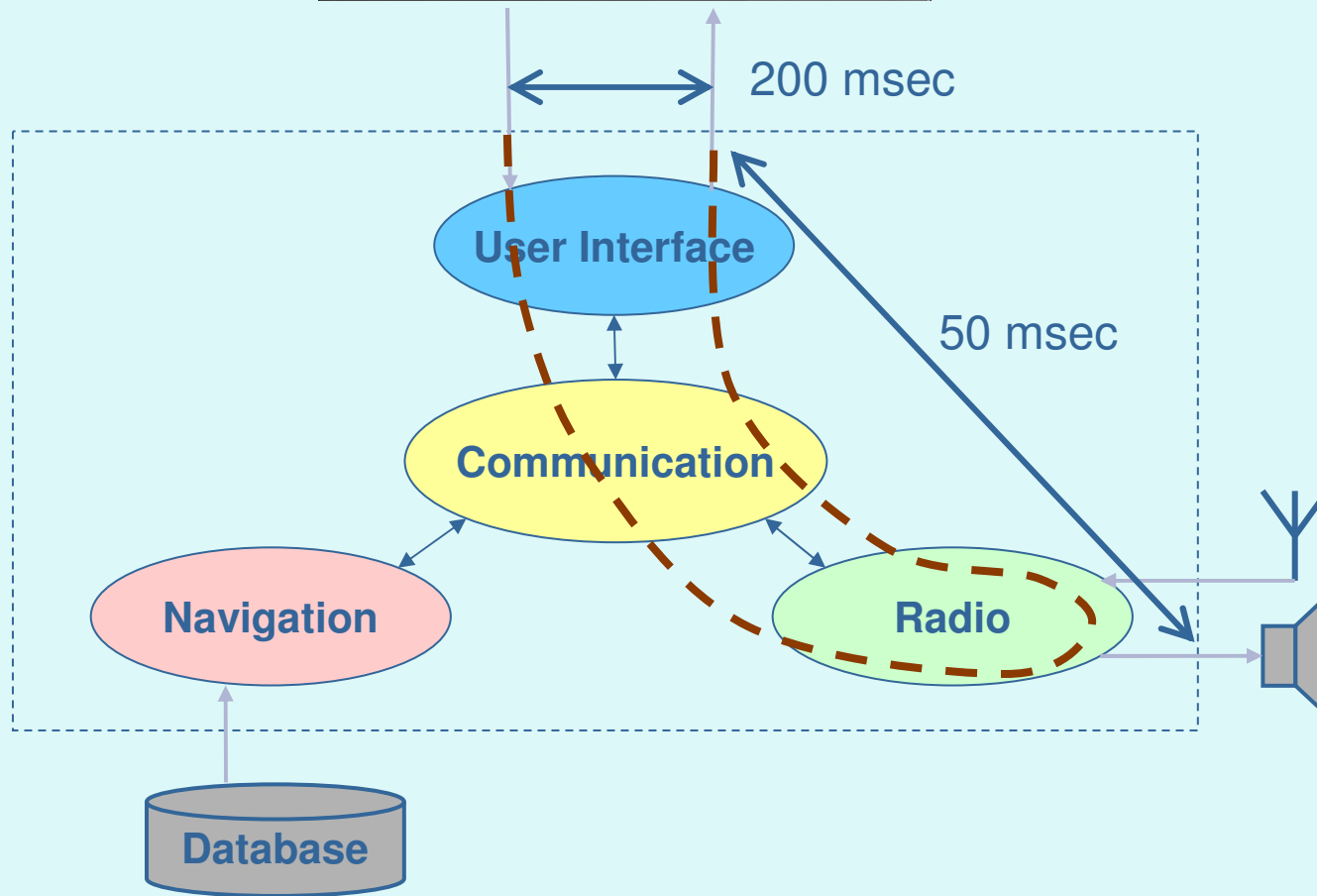
Overview performance models

Aim of our research

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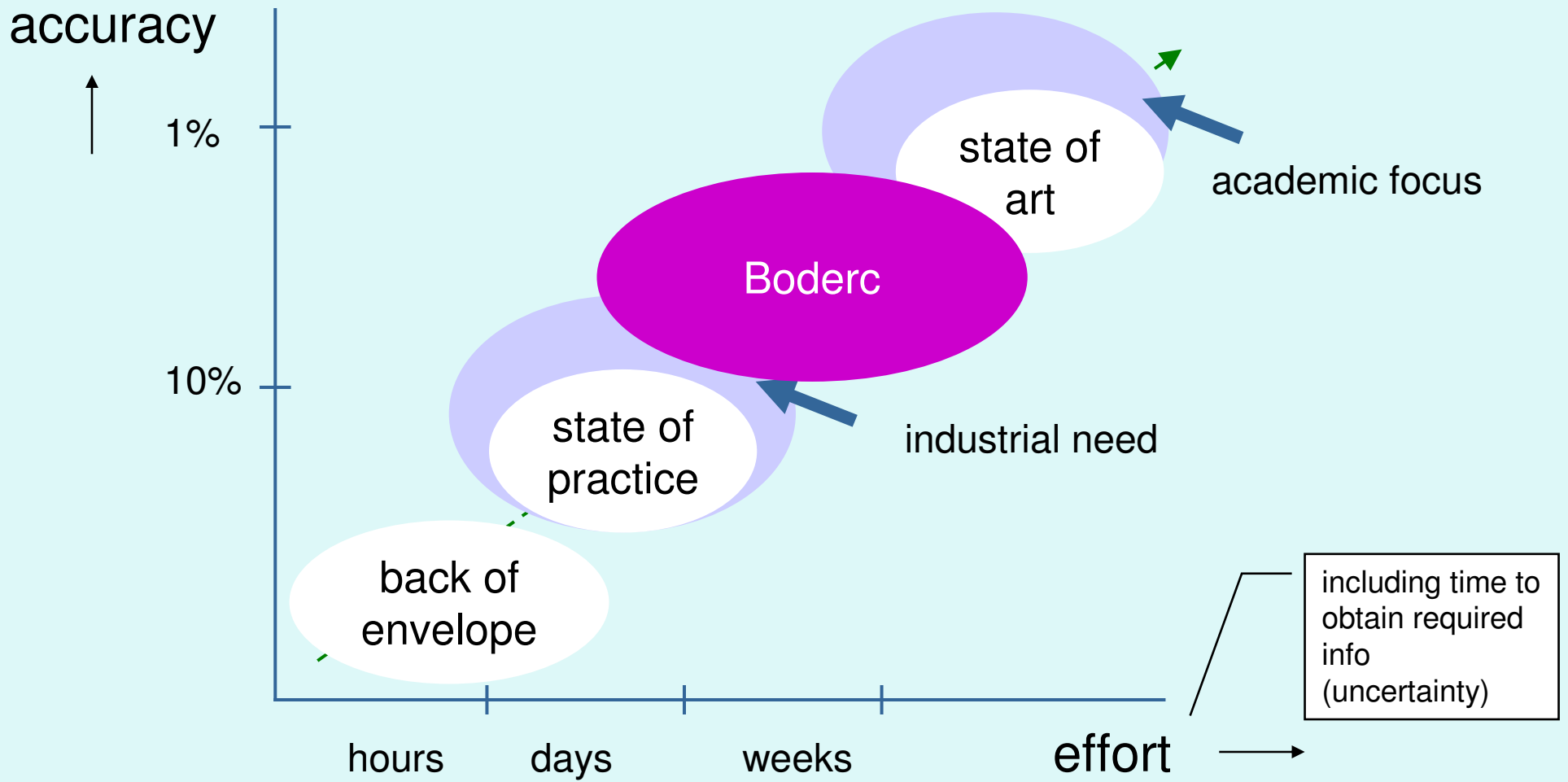
- **Understand pros *and cons* of techniques**

- **Build a taxonomy: problem $\leftrightarrow$ methods**

- **Useful combinations?**

- **Compensate weakness of *'x'* with strength of *'y'* ?**

- **Fit in design cycle: early $\leftrightarrow$ late, throughout?**

- **Fit in design process: how to introduce *'x'***
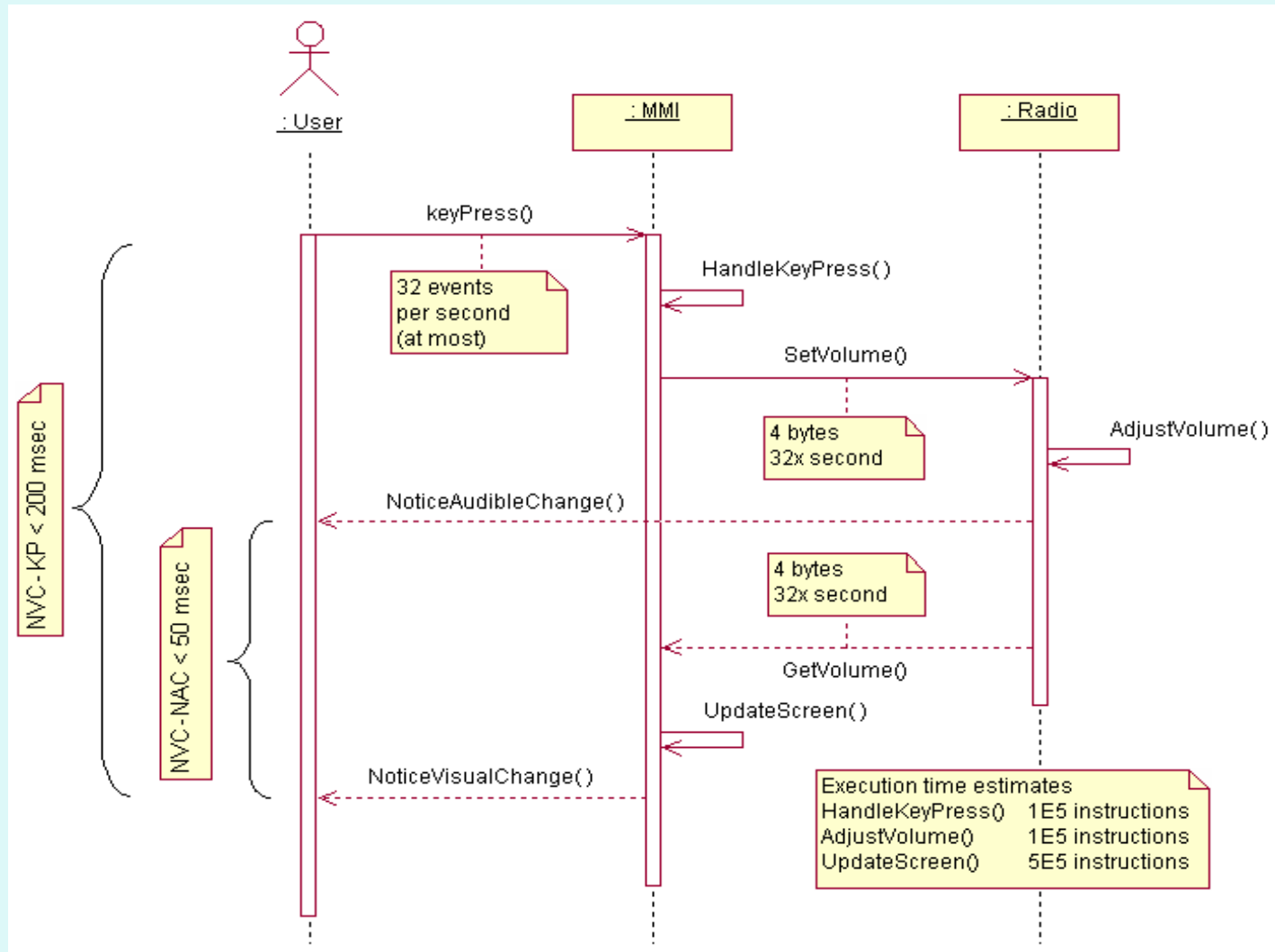
Benchmarking

- **Simple case, such that all techniques can deal with it**

- **Sufficiently complex to provoke problematic issues**

- **Extendable to introduce new "sub-problems"**

- **How to avoid "Lies, True Lies, Statistics" problem?**

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- **Car radio with built-in navigation system**
- **User interface needs to be responsive**
- **Traffic messages must be processed in a timely way**
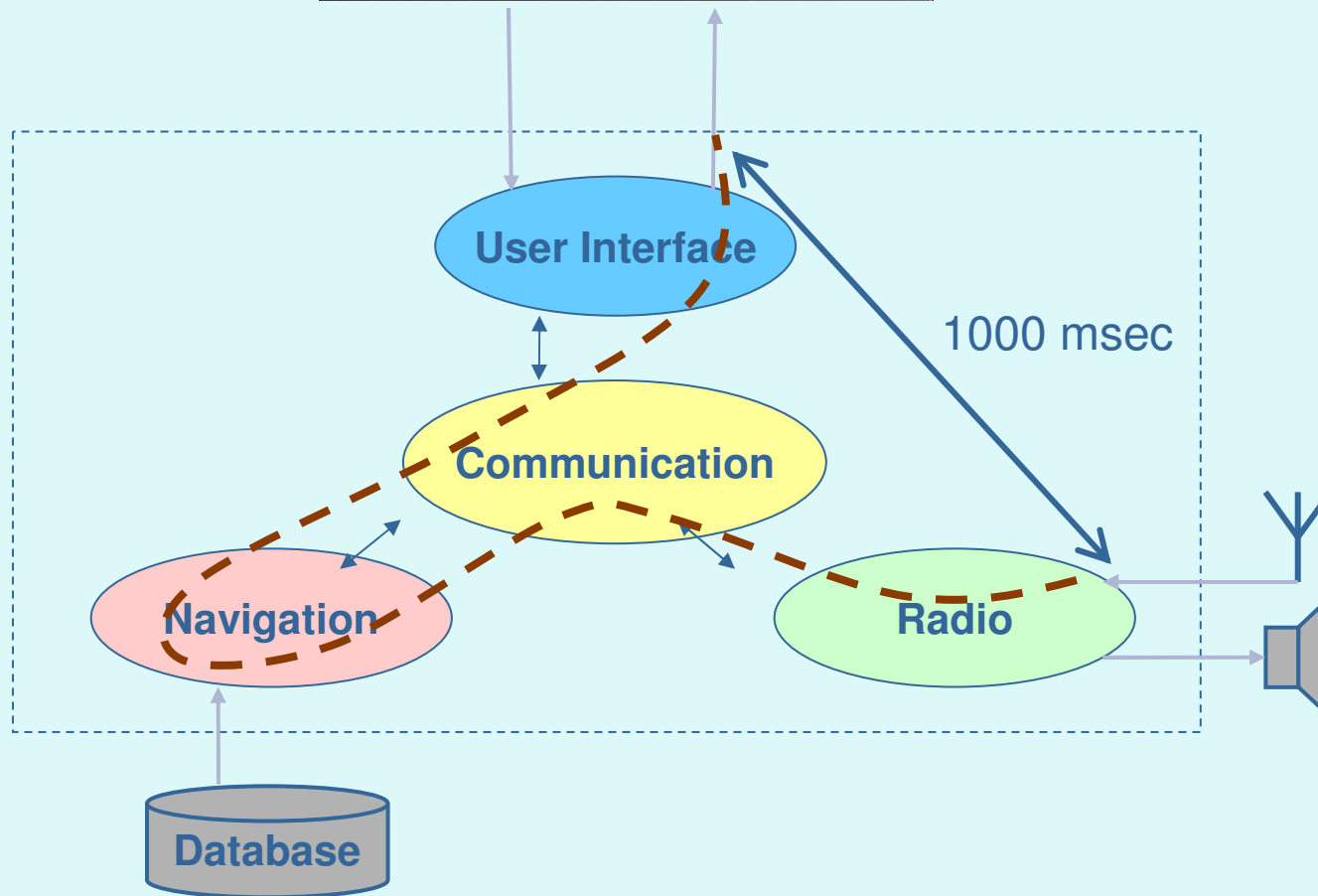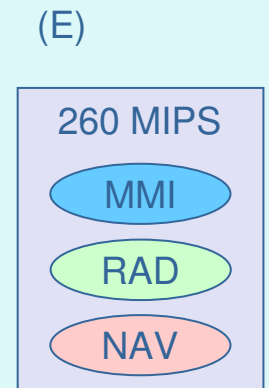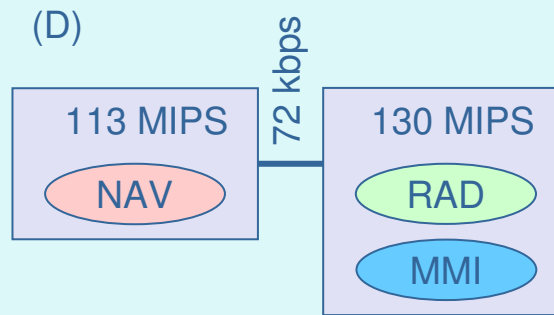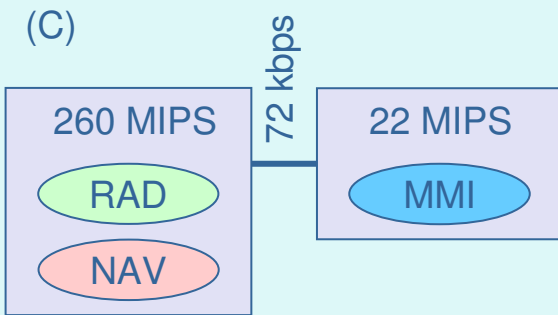- **Several applications may execute concurrently**

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Proposed Architecture Alternatives

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(A)

| 22 MIPS |
| MMI |

| 113 MIPS |
| NAV |

72 kbps

| 11 MIPS |
| RAD |

(B)

72 kbps

| 22 MIPS |
| MMI |

57 kbps

| 113 MIPS |
| NAV |

| 11 MIPS |
| RAD |

(C)

| 260 MIPS |
| RAD |
| NAV |

72 kbps

| 22 MIPS |
| MMI |

(D)

| 113 MIPS |
| NAV |

72 kbps

| 130 MIPS |
| RAD |
| MMI |

(E)

| 260 MIPS |
| MMI |
| RAD |
| NAV |

Analysis questions

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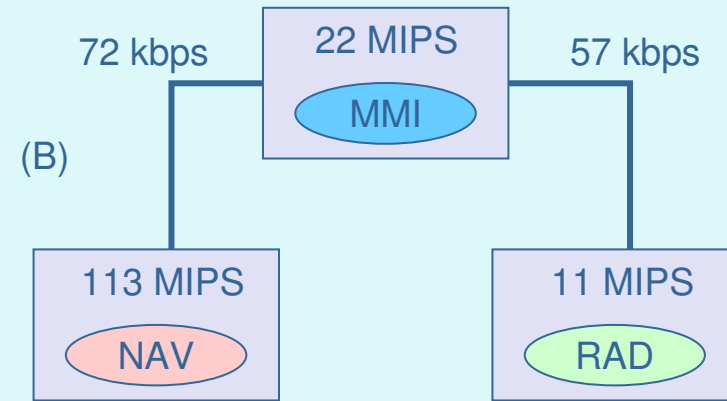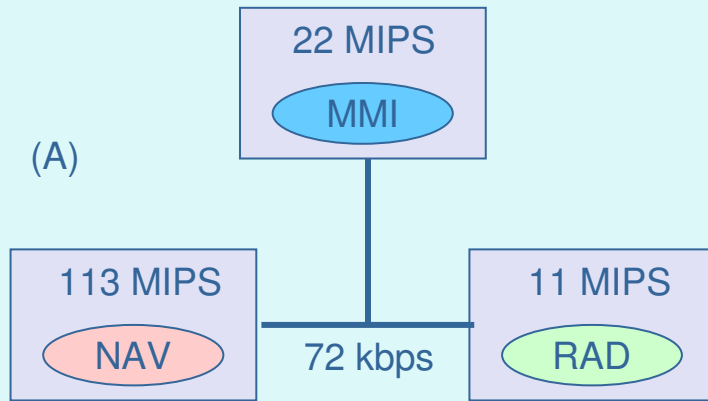
- How do the proposed system architectures compare in respect to end-to-end delays?

- How robust is architecture A? Where is the bottleneck of this architecture?

- Architecture D is chosen for further investigation. How should the processors be dimensioned?

Observations & lessons learnt

- **Comparing results is as hard as getting the results**
  - **Did we *really* model the same thing?**
  - **Simulation / computation effects or true "problem"?**
  - **Interaction with experts is needed to make comparison!**

- **Methods are typically**
  - **Either biased towards application domain; can cause mismatch**
  - **Or very generic; can cause huge modeling effort**

- **Methods can be used complementary**
  - **Provide answers to different types of questions**
  - **Model validation by moving to another paradigm**

- **Input from stochastic domain still missing**

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please contribute to the study!

case study description can be found at
http://www.mpa.ethz.ch

paper can be found at
http://www.esi.nl/boderc

contact: Marcel.Verhoef –at– chess.nl