# Multidisciplinary simulation of mechatronic components in severe environments

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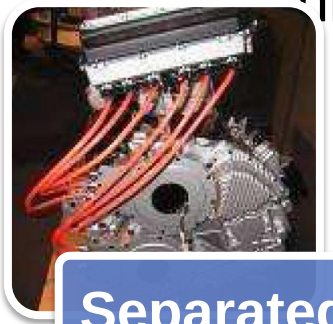
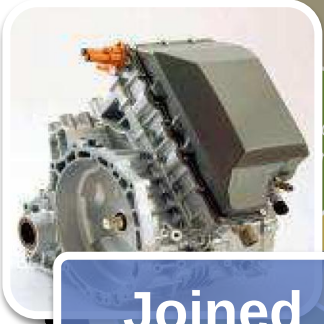
# Context

## Mechatronics

- First time used in Japan 1969 [Mori, 1969]
  - 4 levels for system integration
    - Mechanics
    - Electronics

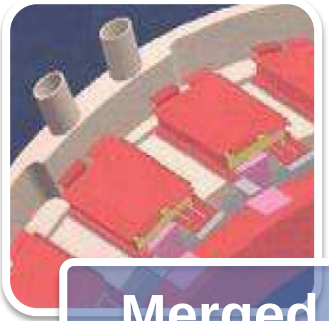
[Choley, 2009]











➔ **Maximum integration**

➔ **4 fields merged**

# Context:

**EXPAMTION :** Expérimentation d'une infrastructure de simulation partagée par tous les acteurs de la chaîne Méca-Mécatronique de conceptION

**Main actors**

**Simulation ISVs**

**Universities**

# Context: EXPAMTION

## Main project targets:

- **Experiment a collaborative design methodology with ALL actors of the supply chain using:**
  - Existing simulation software from the market
  - Expertise, human resources, equipment, and software from all actors to solve problems

- **Meet major technical challenges in the automotive mechatronic design process:**
  - Innovate in the design process
  - Produce results unreachable with current non-collaborative design process

# Context: EXPAMTION

**Project structure: 7 Work Packages**

**WP1: Project Management**

**WP2: Mechanics**

**WP3: Rheologics**

**WP4: Aeroacoustics**

**WP5: Thermomechanics**

**WP6: Vibroacoustics**

**WP7: Business Model**

**Field of study**

**Actor of project**

# Context: EXPAMTION

## Issues of the project

- Unifying of computing resources
- Managing of secured rights
- Simplifying licenses management
- Coupling simulation codes

→ Collaborative simulation platform

➔ **Development time reduced for mechatronic products**

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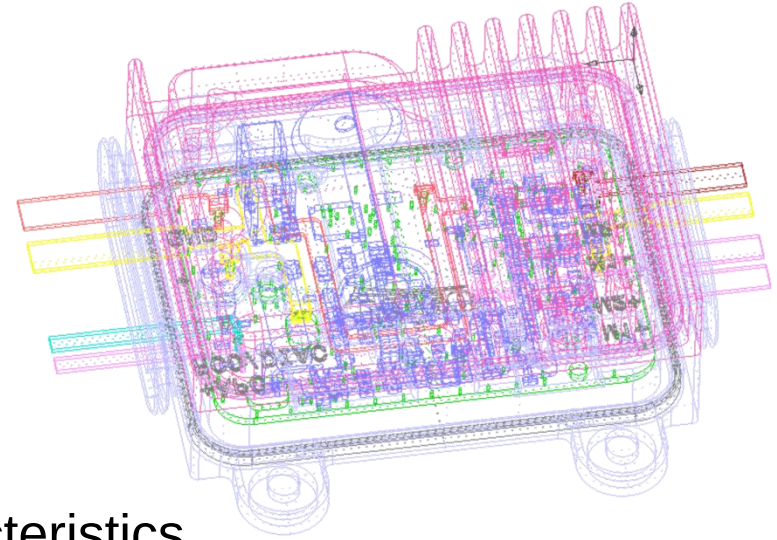
# Context: problem statement

## Mechatronic case study



**Objectives: optimization of:**

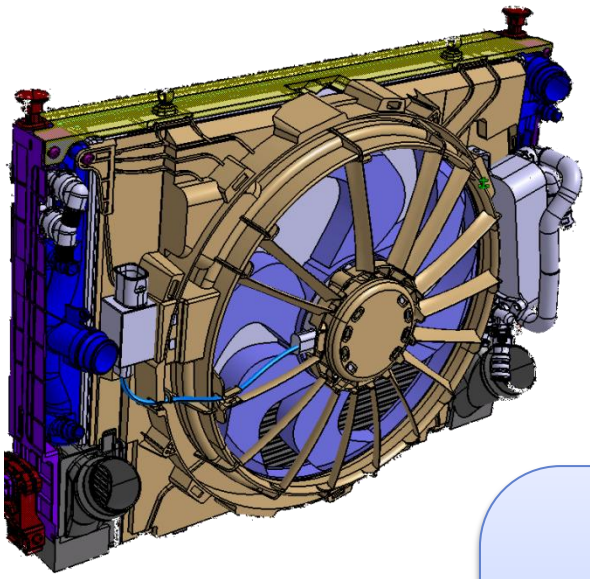
- Reliability
- Compliance of electronic characteristics
- Electrical performance
- Heat dissipation
- Environment interaction

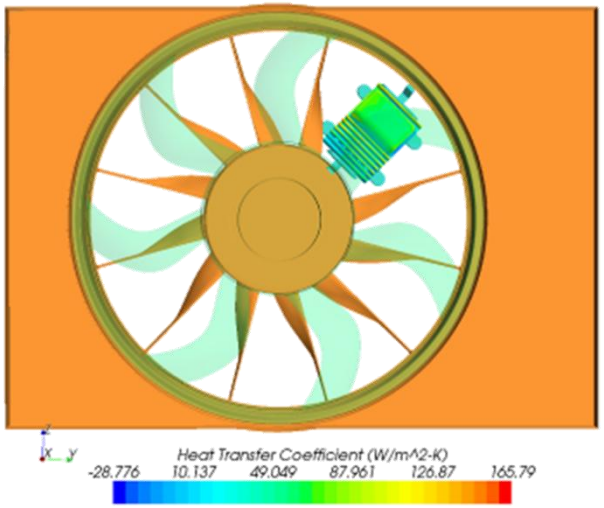
➔ **How can we ensure that the card complies with the specifications ?**

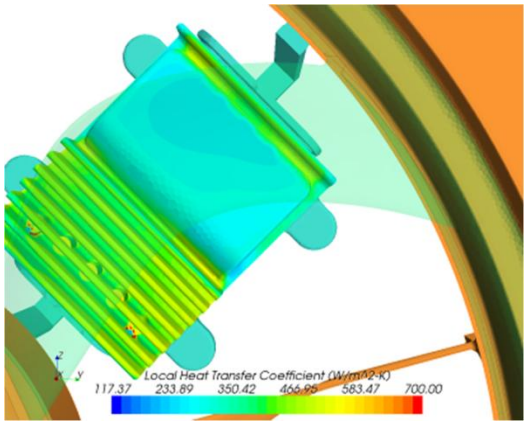
**Proposal: Multidisciplinary simulation**

# Context: problem statement

## Mechatronic case study: approach






**Multidisciplinary simulation**

Define electronic simulation needs → Study dimension ? → Simulation processing → Results analysis and synthesis

# Context: problem statement

## Mechatronic case study: approach

| Requirements | Input data | Environment |
|---|---|---|
| • Operating at 120C at steady state<br>• Transient state analysis<br>• Critical temperature of 145C<br>• Etc. | • Electrical conductivity<br>• Thermal conductivity<br>• Nature of the components<br>• Etc. | • Infinite temperature<br>• Humidity<br>• Cooling<br>• Fluid characteristics<br>• Etc. |

**Multidisciplinary simulation**

Define electronic simulation needs → Study dimension ? → Simulation processing → Results analysis and synthesis

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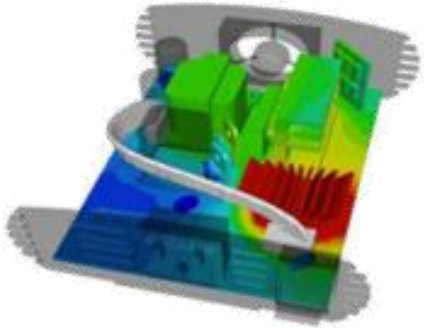
# Proposed solution for integration: used tools

## Some definitions of PLM concept:

| | |
|---|---|
| *[Ameri & Dutta, 2005]* | ➢ **Enterprise solution for Knowledge Management of Product Lifecycle** |
| *[CIMdata, 2002]* | ➢ **Strategic approach involving numerous digital tools** |
| *[Stark, 2004]* | ➢ **A new paradigm for a more effective products along their life cycle** |

- **Collaborative work**
- **Data sharing and management**
- **Business software integration**



➔ **Simulation Lifecycle Management:**
**PLM for simulation**

# Lack of integration between mechatronics and PLM

| | Know how aspect | Technical aspect |
|---|---|---|
| Currently | Mechanics<br>↕<br>Electronics | No PLM link<br>1 or 2 physics |
| Ideally | Mechanics<br>Electronics | PLM linked (SLM)<br>3 and more physics |

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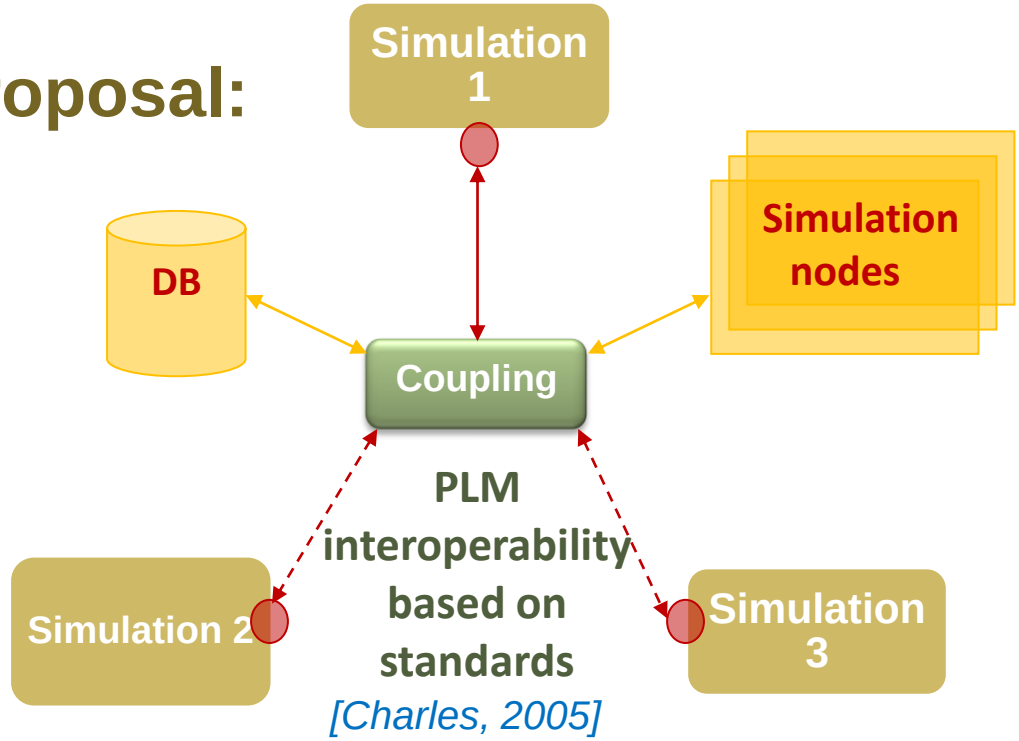
# Proposed solution for integration: architecture

**In the context of multidisciplinary analysis:**

- The lack of interoperability between different simulation software slows products development

➔ **Proposal:**




*[Charles, 2005]*

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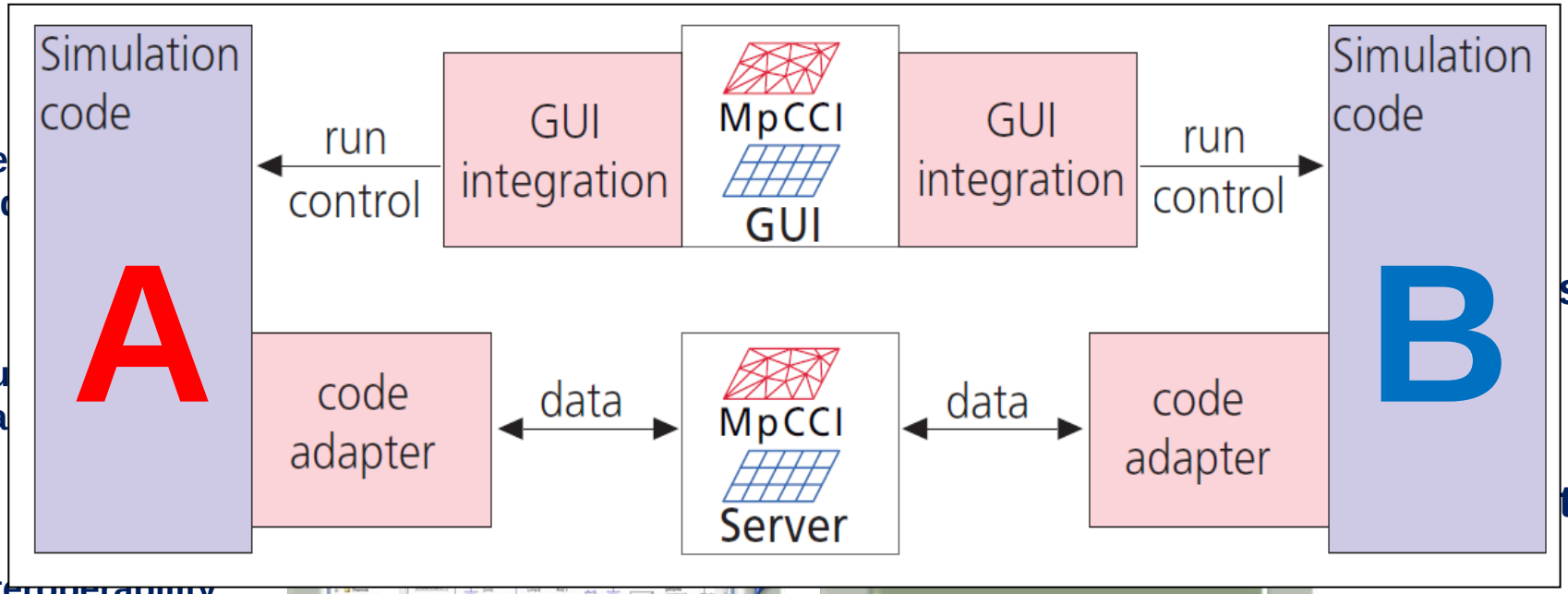
# Proposed solution for integration: used tools

| | | | | | |
|---|---|---|---|---|---|
| Needs | System modeling and meshing | Simulation:<br>•Fluid (CFD)<br>•Thermoelectric | Simulation interoperability | Data exchanges | PLM / SLM |
| Tools | •Modelica<br>*[Fritzson, 2006]*<br>*[Casella, 2009]*<br>•Altair HyperMesh<br>•SysML<br>*[Kadima, 2009]* | •Ansys Fluent<br>•Intes Permas | •MpCCI code coupling<br>*[Fraunhofer, 2009]* | •STEP (APxxx) neutral format<br>*[Charles, 2005]*<br>*[Penas, 2009]* | •PLCS (STEP AP239) |

**Integration in mechatronic approach**

# Proposed solution for integration: architecture

## 1D, 2D and 3D electronic card simulations

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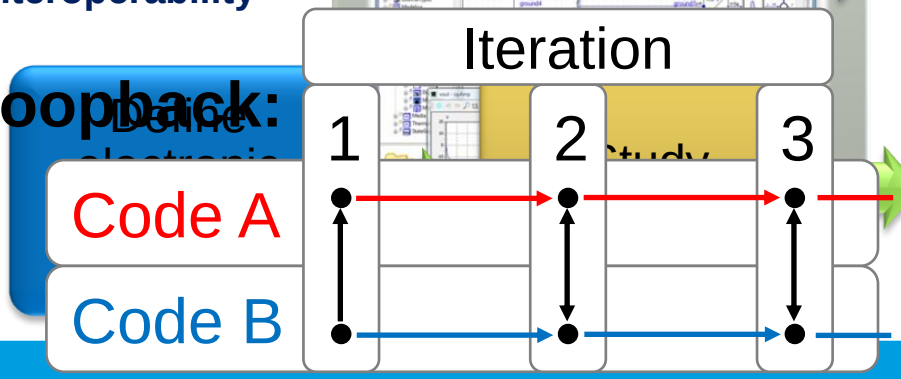
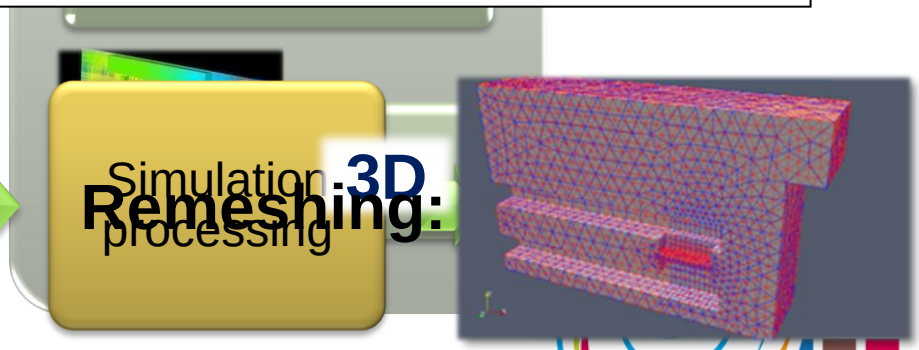
**Loopback:**

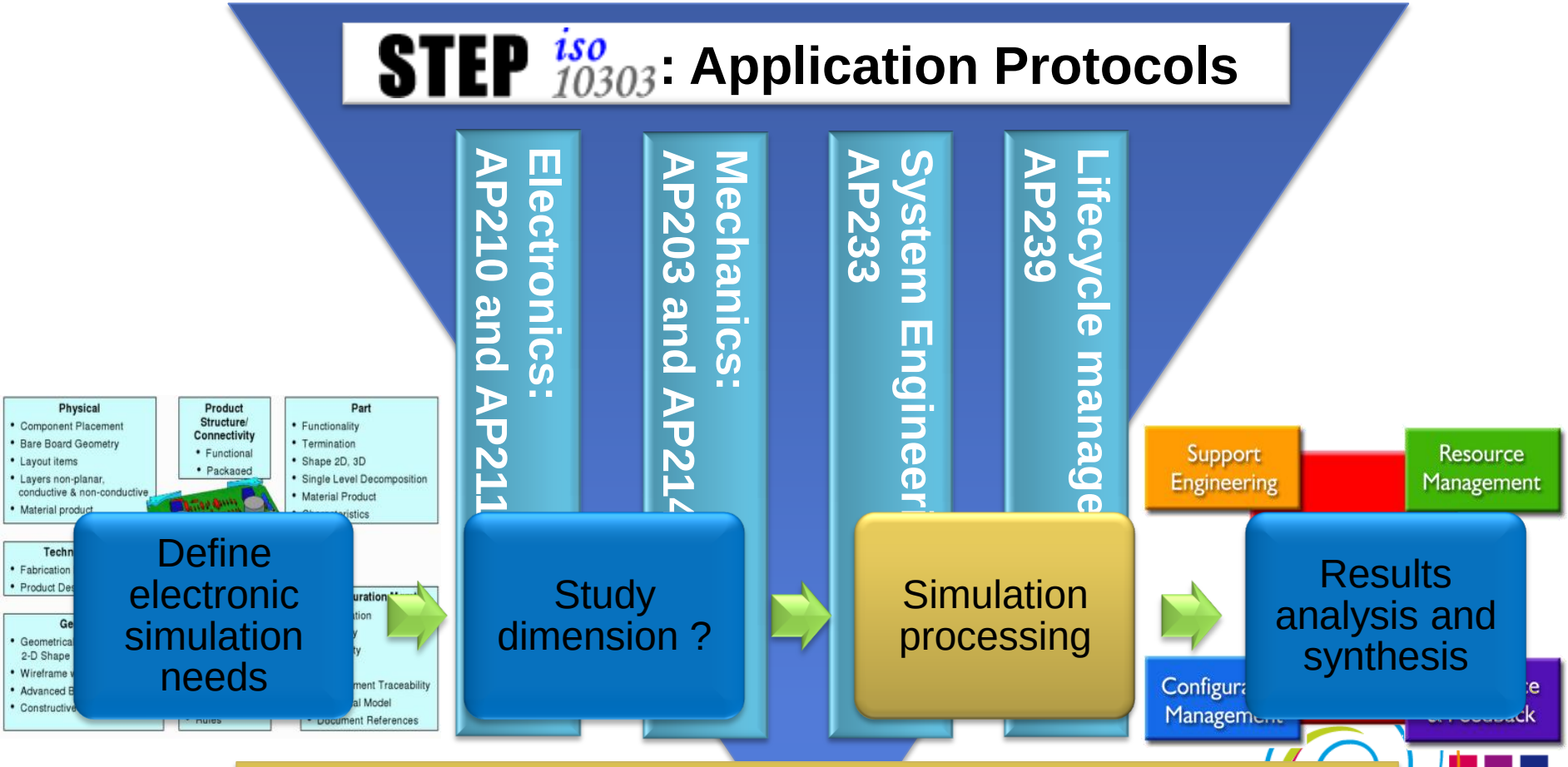



**3D Remeshing:**

# Proposed solution for integration: architecture

## Standard for the Exchange of Product model data




**Integrated resources for mechatronic design**

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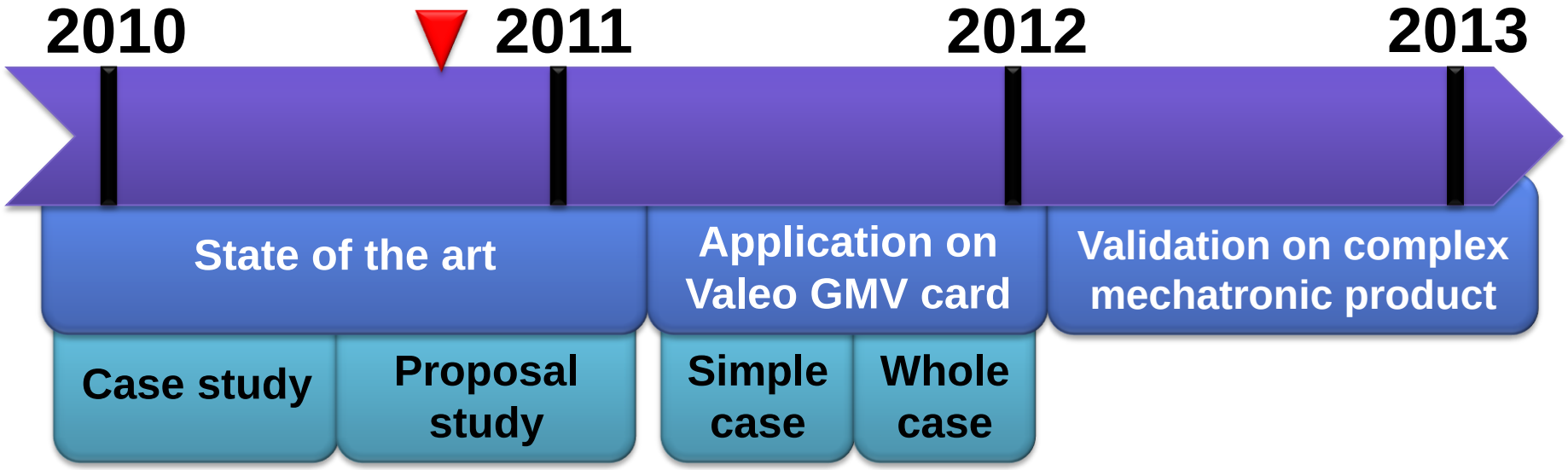
# Conclusion and future works




**Integration of EXPAMTION and O2M methodologies for developing a generic approach from requirements engineering to multidisciplinary simulation dedicated to complex mechatronics systems**

# Questions

## Thanks for your attention

**For more information: http://www.itt-mecatronique.fr**

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