Automotive embedded system redesign

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Presentation plan

- **Introduction and abstract**

- **Research content and impact**

- **Administrative details, and research timeline**

Section 1

Introduction and abstract

Presenting myself first

Jean-Baptiste Laurent

- 1 year teaching
- 3 years in research, static analysis
- 5 years in cyber-security
- 10 years in software development

Current status

- LR-Technology consultant, working for Faurecia
    - First, 6 months on the RAPIDE platform [a]
    - Now, exclusively working on the following research topic

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[a]Generic software platform for car embedded systems

Involved Parties

RICHEFEU Julien

- Faurecia Clarion Electonics, Platform Software Manager
- PhD Director

MENSUEZ Bruno

- ENSTA Paris-Tech, Teacher
- PhD Co-Director

Objective of the presentation

- **Presenting**
  - The **new project** content
  - Who is involved
  - The work I will brought in
- **Precising**
  - How this project could **impact** you in the long run
- Get the time to **exchange** on this

Definitions and wording

EN -> FR

- **ECU**: Unité de controle
- **Socket suppliers**: Fournisseur de micro processeur
- **OEMs**: Les assembleurs
- **Car maker**: Le fabricant
- **The model**: L'ensemble de l'architecture, du microprocesseur à l'application haut niveau.
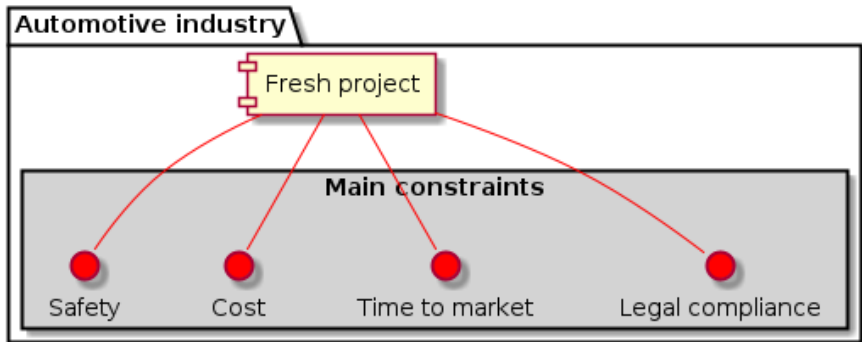
Section 2

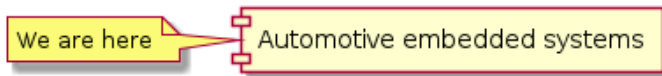## Research content and impact

Subsection 1

Presentation of the current model

Reminder of the main constraints

- We will get back to them next
  - Mostly when comparing **pros** and **cons**
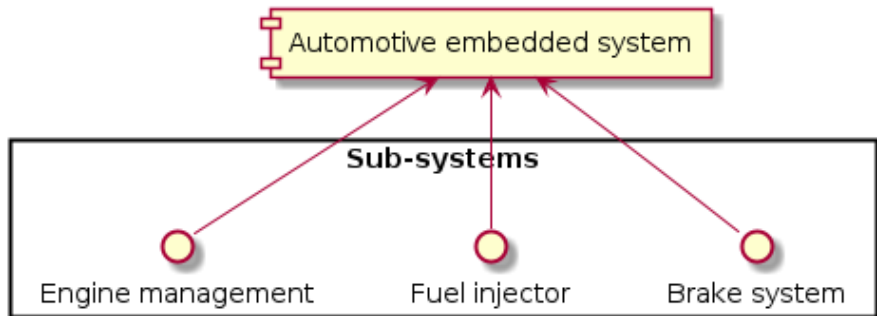 - And also why this project

Model explanation, let's start small

We are here ← Automotive embedded systems

A brief, brief model representation

- **The model** is composed of
  - An **orchestrating component**
  - Individual and isolated **sub-systems**

External parties

- **OEMs**, enhance ships
    - **Handle the commands** with socket suppliers
    - **Communicate** with car makers
    - **Develop** the relevant **functions** for it to be integrated
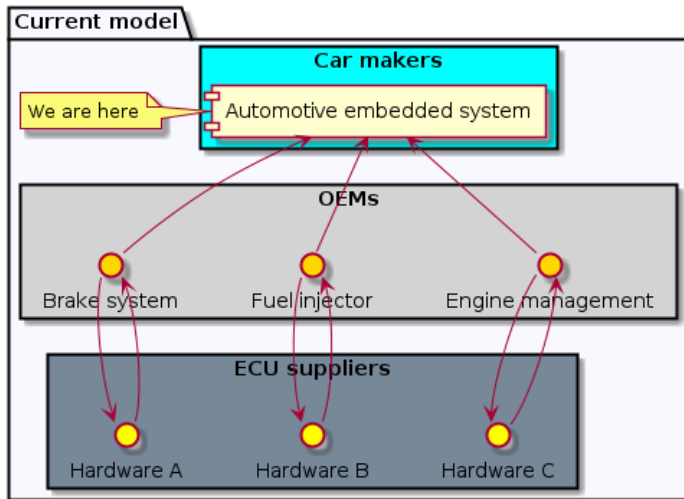- **ECU suppliers**, build ships
    - Pure hardware manufacturers
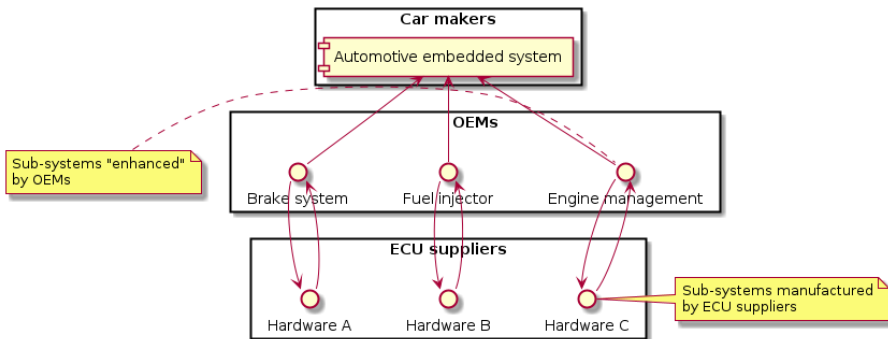
Subsection 2
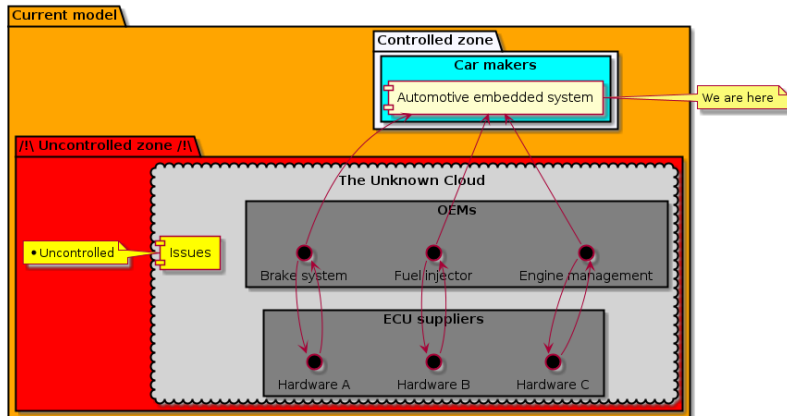
Current model growing issues

Afterthought

- Do we have any **issues** with that model ?

First issues

- **Third parties** involved ?
    - **Proprietary** code
    - Uncontrolled **quality** standard
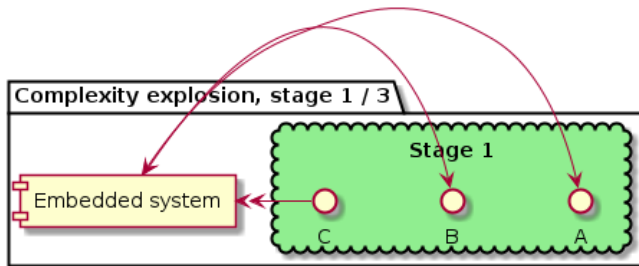   - Uncontrolled **TTM** (Time To Market)

Cars become more and more complex

Let's focus on that for a minute, and see why it's really a problem within the current model

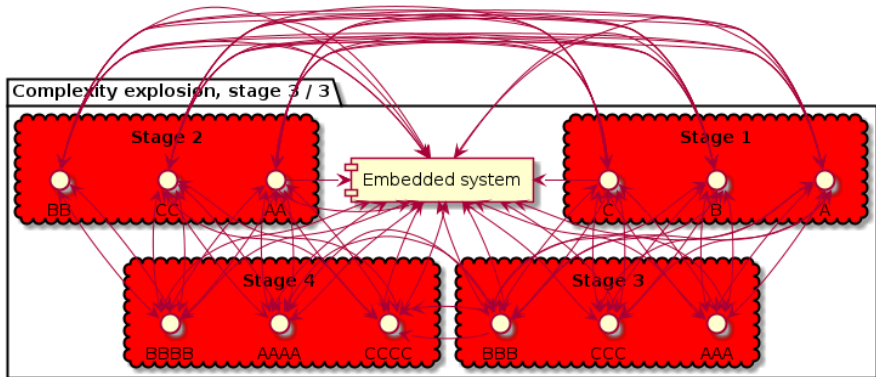# Current model, a complexity issue

Exponential communication complexity, stage 1

- Flat sub-system architecture
  - Good so far

Exponential communication complexity, stage 2

- Flat sub-system architecture
 - Game over

A parenthesis on a published standard

- AUTOSAR relies on
  - A **network of components** (see Simulink$^{\text{tm}}$)
  - Regrouped and abstraction of sub-systems as features
- AUTOSAR is also providing
  - An communication architecture in between ECUs
  - A micro system allowing a normalized API on ECUs
    - Automatic generation of code

Technical solutions do exists, yet

- Potential multiplication of licenses (like AUTOSAR[tm])
- Each OEM has to be dealt with individually still
- Mandatory design coordination between OEMs
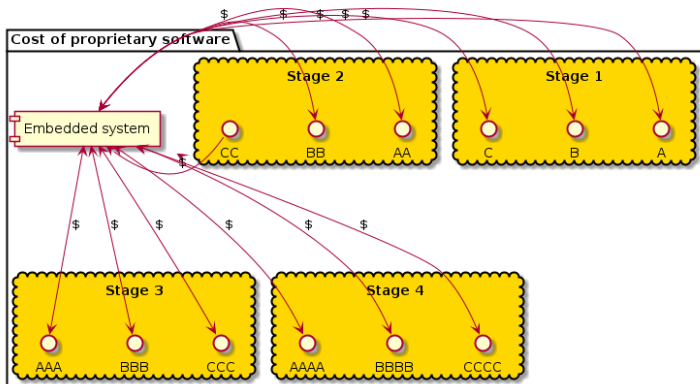
Other limitations do exist

Design wise

- **Lack of dynamism**
  - No easy software redundancy
  - Deep component have to be recompiled in if changed
- **Heavily tied** components
  - Dependencies issues
  - Forces old patchworks to run along new code

Development cycle complexity

- **Difficulties to** build a **replay** environment
  - Increased release cycle, less coverage
- **Difficulties to optimize** the whole system
  - More computing power required
  - Less predictable requirements
- **Difficulties to validate** OEMs deliveries
  - Need to be done by hand, each time
  - Error prone, leads to un-diagnosed issues being brought in

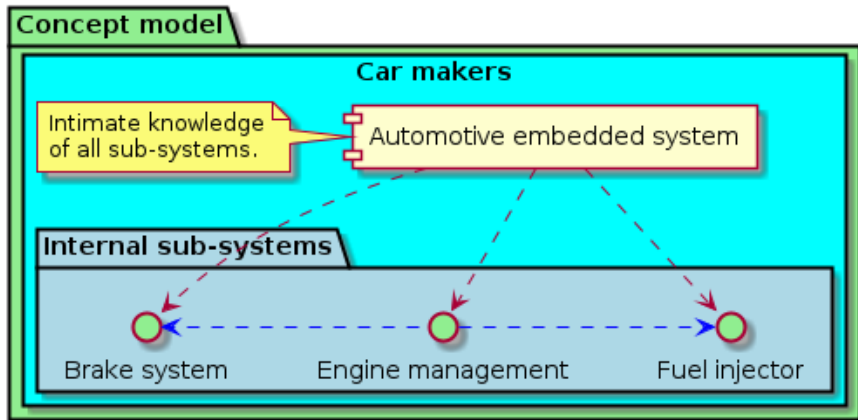# Break n°2, before presenting the new model

Subsection 3

Introduction to the concept model

Incremental list of modifications

1. Appropriation of sub-systems
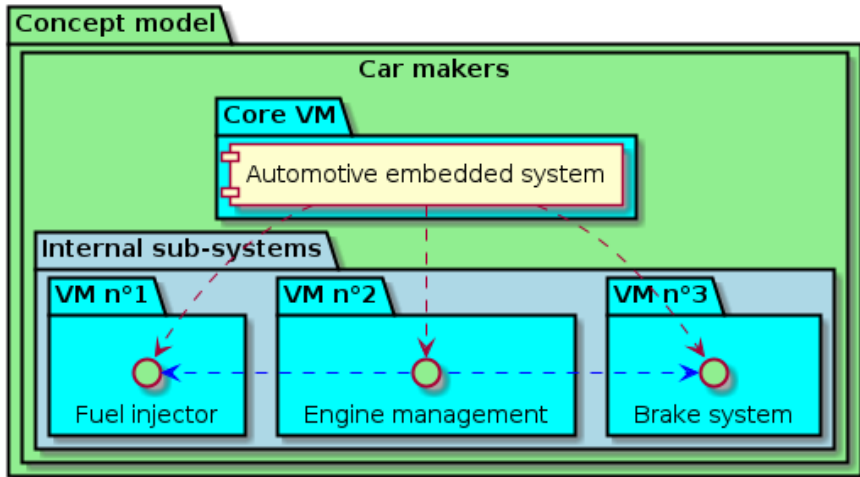
- First, we learn how those sub-components work

2. Isolation of every components

- Then, we build a modular design to gain potential
- It's a start, virtualization brings many other benefits

Concept model

Car makers

Core VM

Automotive embedded system

Internal sub-systems

VM n°1

Fuel injector

VM n°2

Engine management

VM n°3

Brake system

3. Truly exploiting the benefits of the model

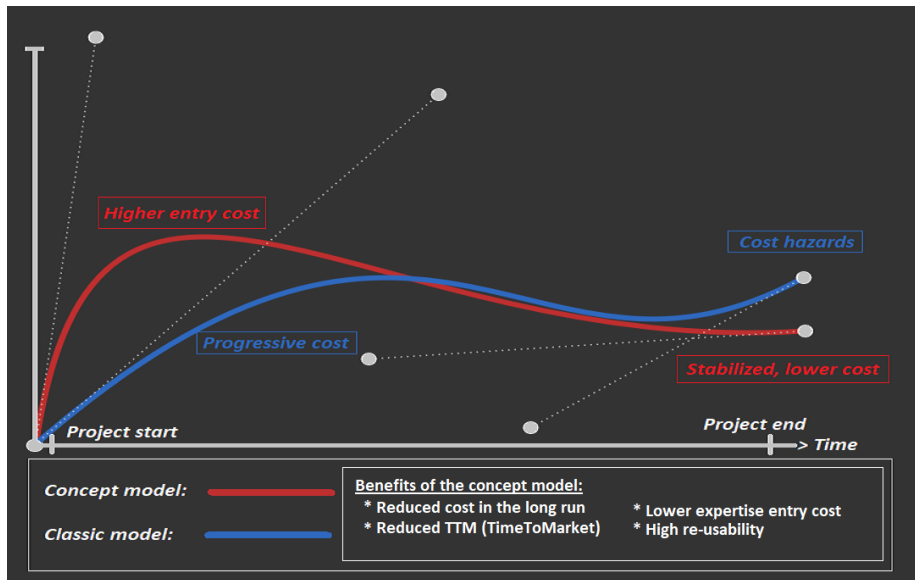- Finally, we capitalize on that and start to do real things

3.1 With technical features like

- Load balancing | Dynamic management | Security
- Static optimizations | A/B benchmarks | Redundancy

3.2 And a motivation boost

- It is always rewarding to work on challenging features

Regarding the project timeline & costs

Investigations to do next on virtualization

Status

- Virtualization is a **mature technology**

Some questions on the subject

1. Is it **compatible** with automotive real-time systems constraints ?
2. How much **does it cost** ? performance wise ?
3. In practice, **does it fit** well ?
4. Is it **easy enough** to manipulate ? debug ? configure ?

[X] **This will have to get analyzed further down the research**

Everyone good so far ?

Any questions before we go to the last part of the presentation ?

- ☒ Part 1/3: Introduction
- ☒ Part 2/3: Research description and models
- ☐ Part 3/3: Administrative details, timeline and future work

Section 3

Administrative details, and research timeline

A research as part of a thesis

- 3 years PhD in the industry
- Publishing and hosting conferences
- Sharing knowledge

Research goals

Short term

- Digging **sub-systems incorporation**
- Introducing **low level virtualization**
- Challenging a **simplification of the hardware** interface
- **Challenging the** existing **model** deeper

Mid term

Macro goals

- Standalone **prototype** realization
- Answering a **client project** call
- Maybe even a **small team** to boost the results

Technical goals

- Extend virtualization
- Incorporate other sub-systems
- **Crushing that complexity issue**

Long term

Macro goals

- Publishing results
- Founding a new project
- Having a production opportunity

Technical goals

- Fleet of VMs
- Development of a VMs orchestrator
- Designing generic ECUs
- Compatibility with other models

Final goal

- Releasing a fully fledged product !
- And validating my PhD :)

A wide, yet focused research

- Milestones are clear
- Possibility to iterate step by step
- Known technologies, less deviation risks
- Expertise do exist on the subject

What's now ?

- Work to be done:
  - Research on the state of the art
  - Bibliographic work
  - Testing the virtualization
  - Validating all the show stoppers
  - Submitting a project proposal

Questions

- Thank you for attending