



Validation de systèmes temps-réel et embarqué à partir d'un modèle MARTE  
06/12/2007

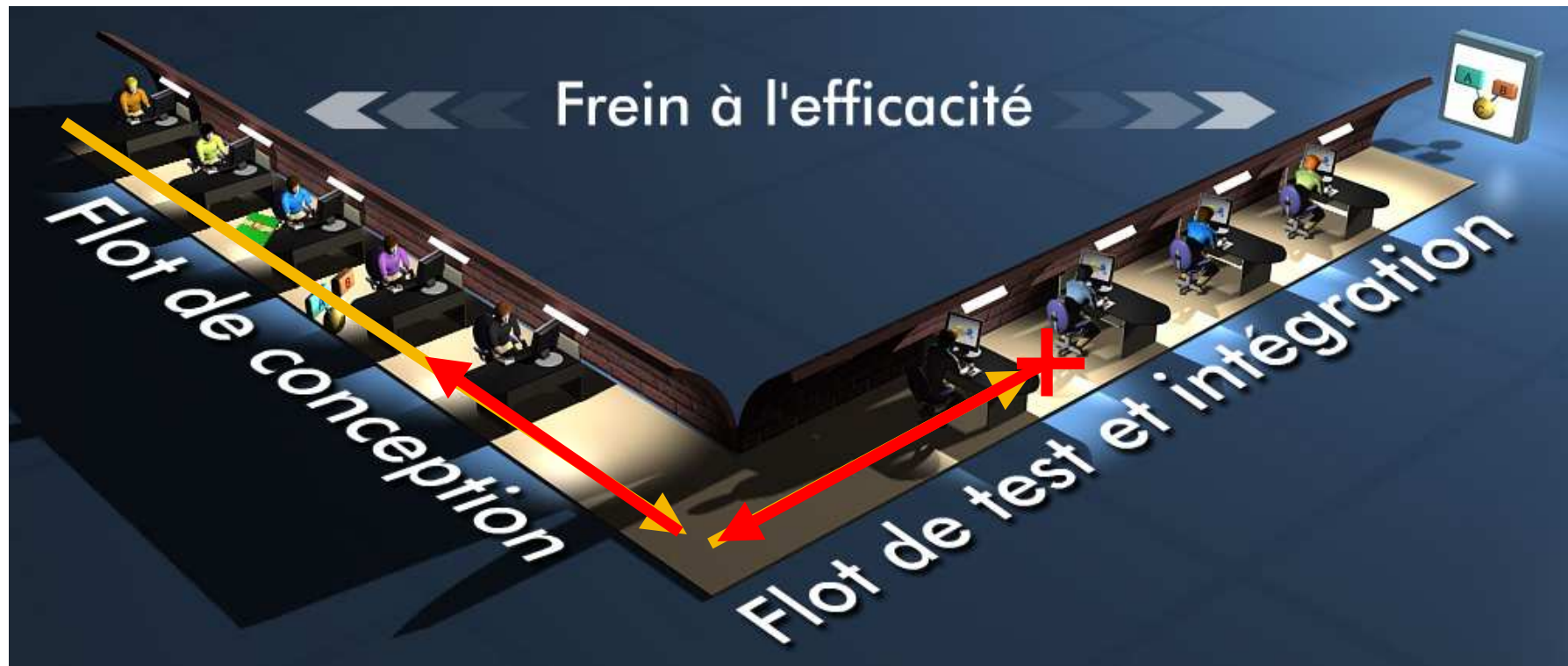
## ➔ Validation de systèmes temps-réel et embarqué à partir d'un modèle MARTE

Thales Research and Technology

Eric MAES ([eric.maes@thalesgroup.com](mailto:eric.maes@thalesgroup.com))

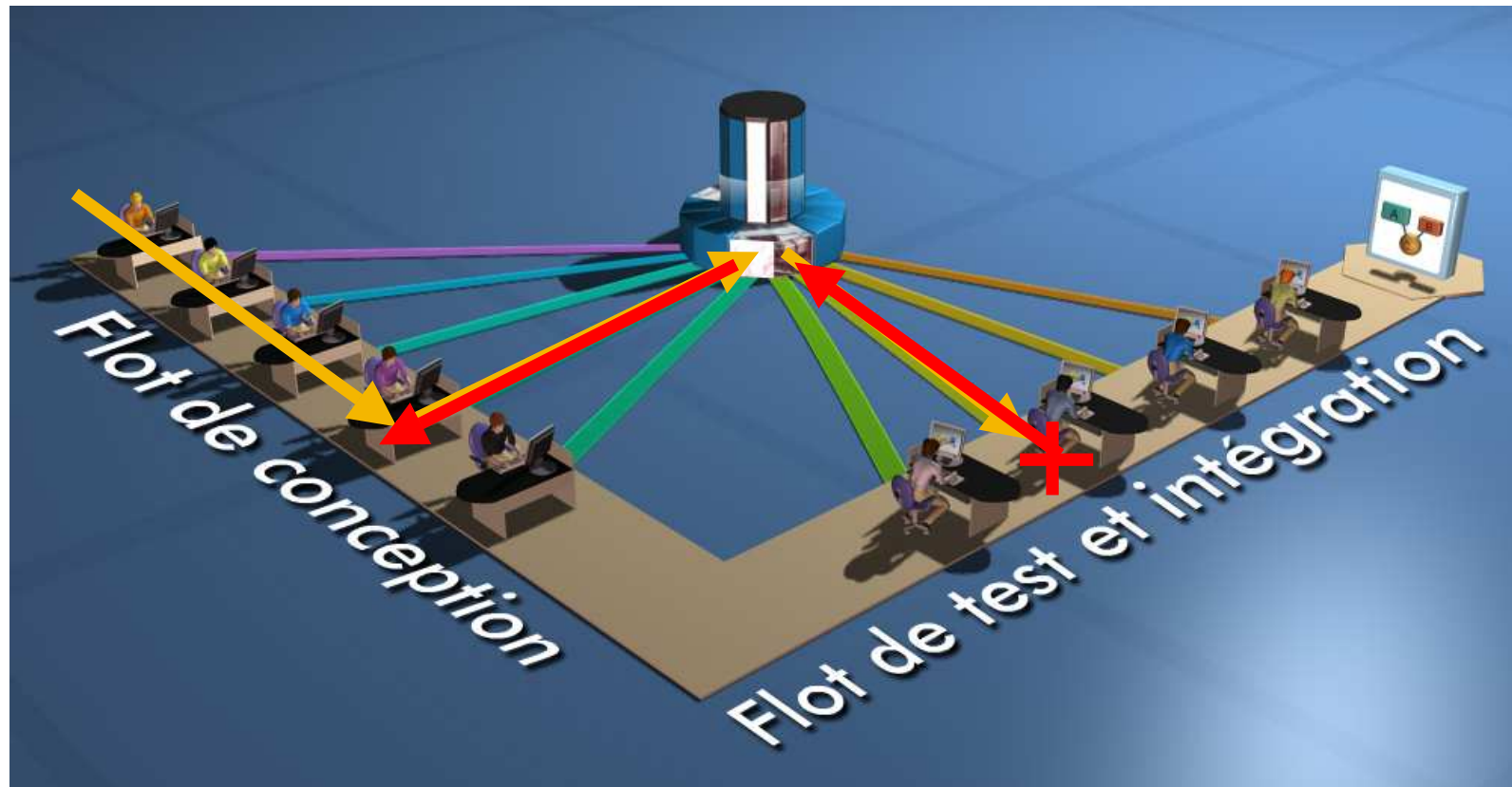
- I - Besoins dans le processus de développement**
- II - MARTE : profil UML standard pour le temps-réel et l'embarqué**
- III – Expérimentation**
  - III.a - Chaîne outillée de l'expérimentation**
  - III.b - Cas d'étude de l'expérimentation**
  - III.c - Modélisation du cas d'étude**
  - III.d - Règles de transformation**
  - III.e - Analyse d'ordonnançabilité pour le cas d'étude**
- VIII - Conclusion**

## Validation de systèmes temps-réel et embarqué

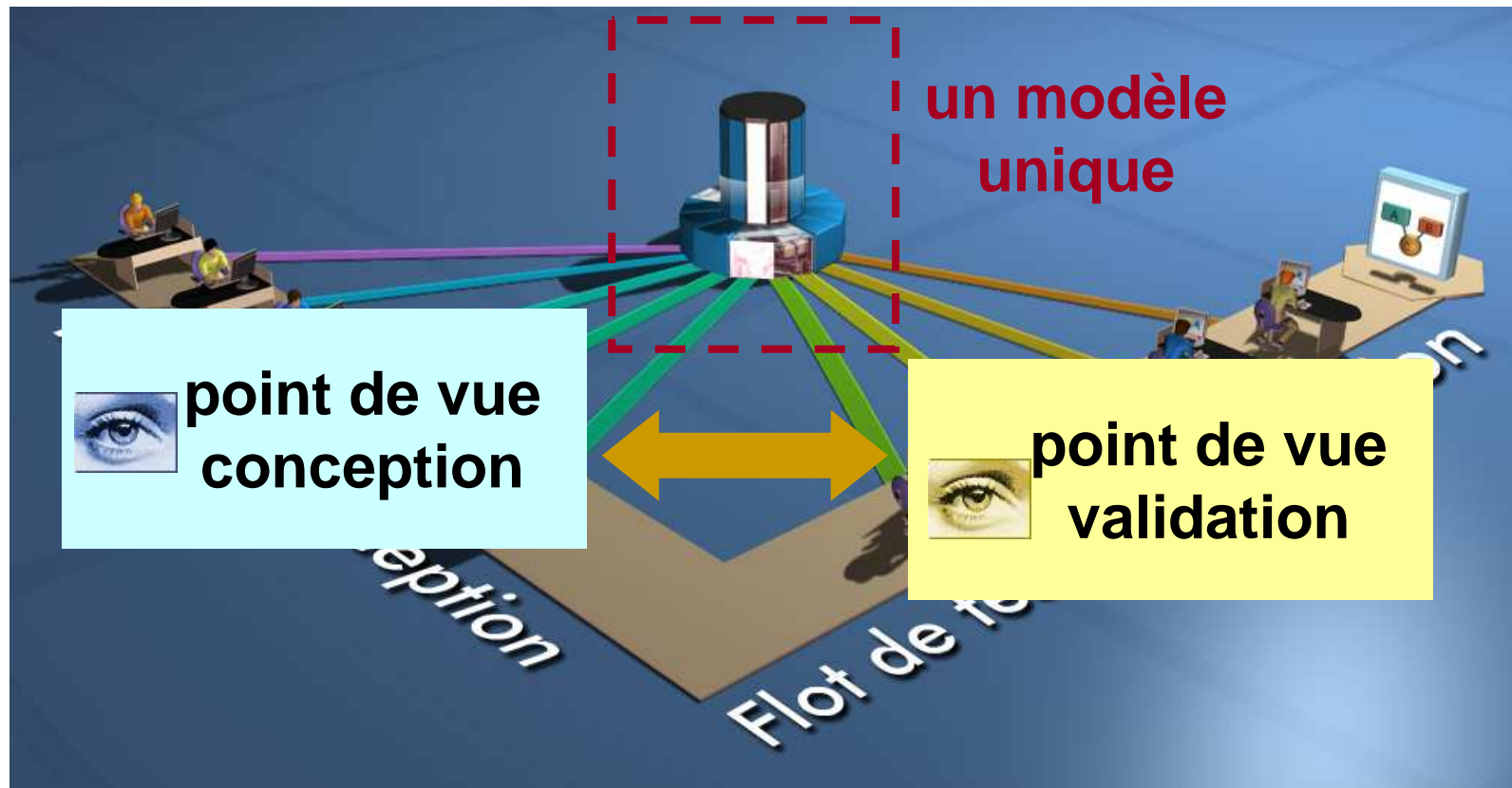


Cycle en V

## Validation de systèmes temps-réel et embarqué



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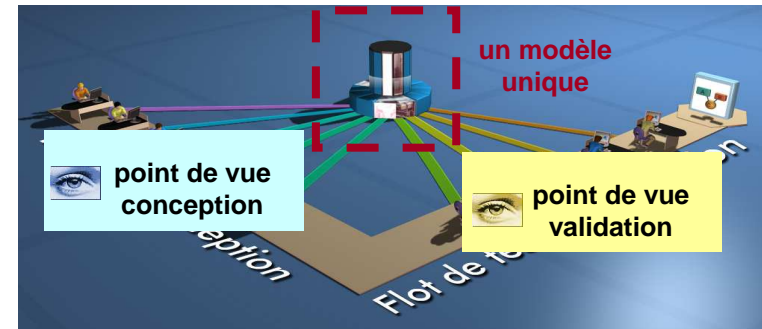
## Validation de systèmes temps-réel et embarqué

## Ingénierie dirigée par les modèles

- UML



Insuffisant



- MARTE



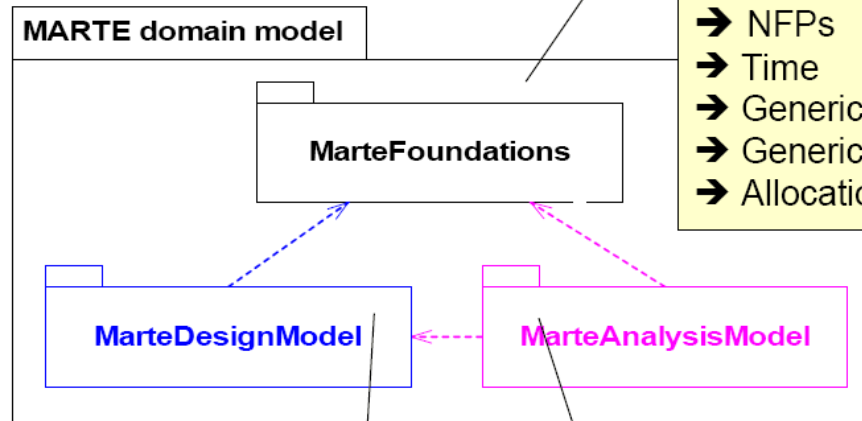
Modeling and Analysis for Real-Time and Embedded systems

Standard OMG : Profil UML pour le développement de systèmes temps-réel et embarqué

[www.omgmarTE.org](http://www.omgmarTE.org)



# MARTE Overview



Foundations for RT/E systems modeling and analysis:

- ➔ CoreElements
- ➔ NFPs
- ➔ Time
- ➔ Generic resource modeling
- ➔ Generic component modeling
- ➔ Allocation

Specialization of MARTE foundations for modeling purpose (specification, design, ...):

- ➔ RTE model of computation and communication
- ➔ Software resource modeling
- ➔ Hardware resource modeling

Specialization of foundations for annotating model for analysis purpose:

- ➔ Generic quantitative analysis
- ➔ Schedulability analysis
- ➔ Performance analysis

Reference MARTE Tutorial – November 2007 – Version 1.1

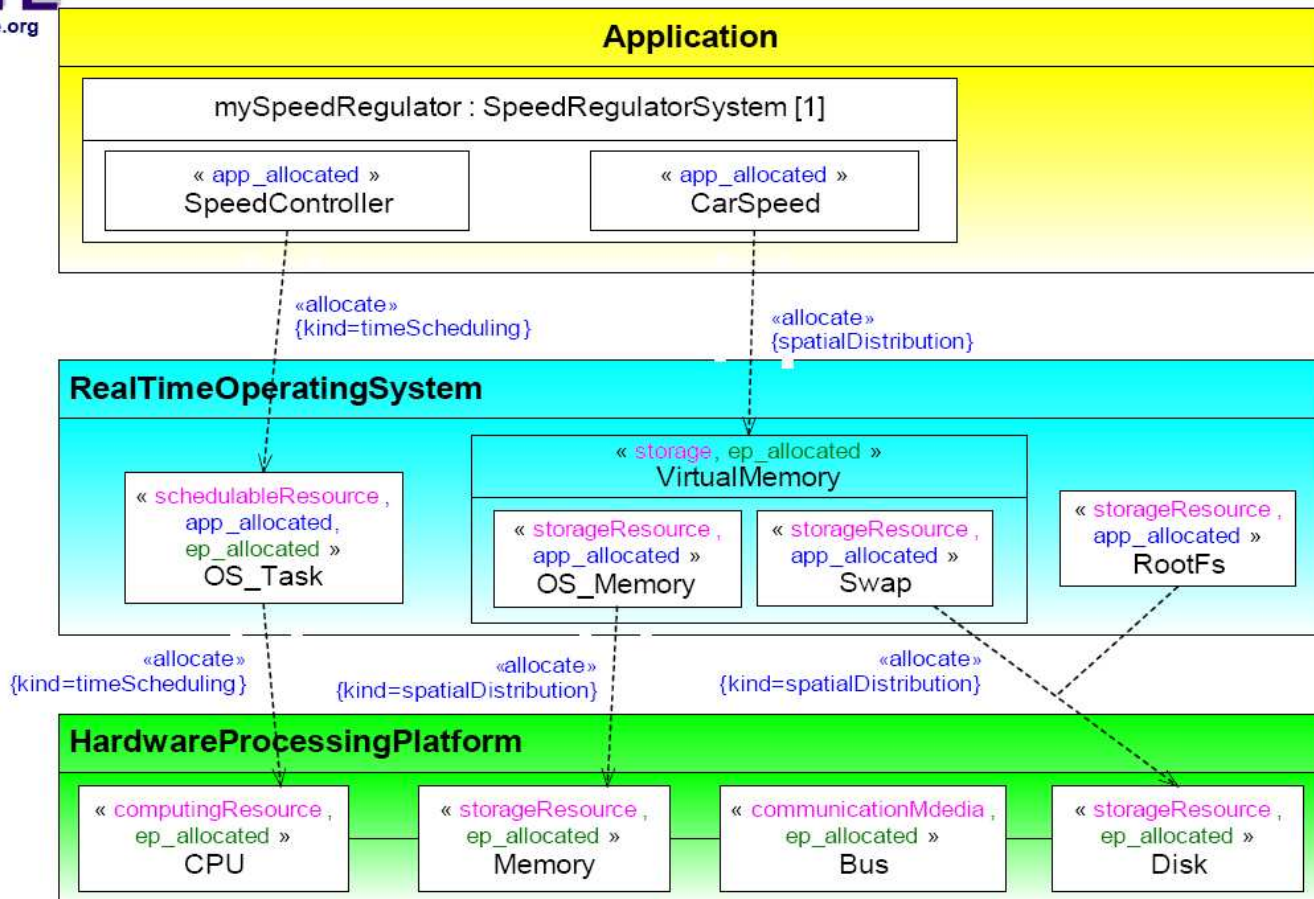
Extracted from S.Gerard (ECRTS07)

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# Allocation example (4)

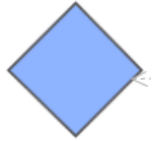


Reference MARTE Tutorial – November 2007 – Version 1.1

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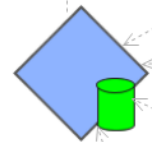




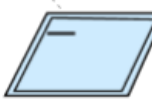
**ComputingResource** : either virtual or physical processing device capable of storing and executing program code



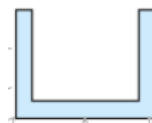
**Scheduler** : kind of ResourceBroker that brings access to its broked ProcessingResource or resources following a certain scheduling policy



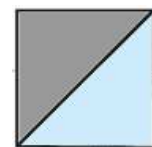
**StorageResource** : different forms of memory



**SwSchedulableResource** : resources which executes concurrently to other concurrent resources



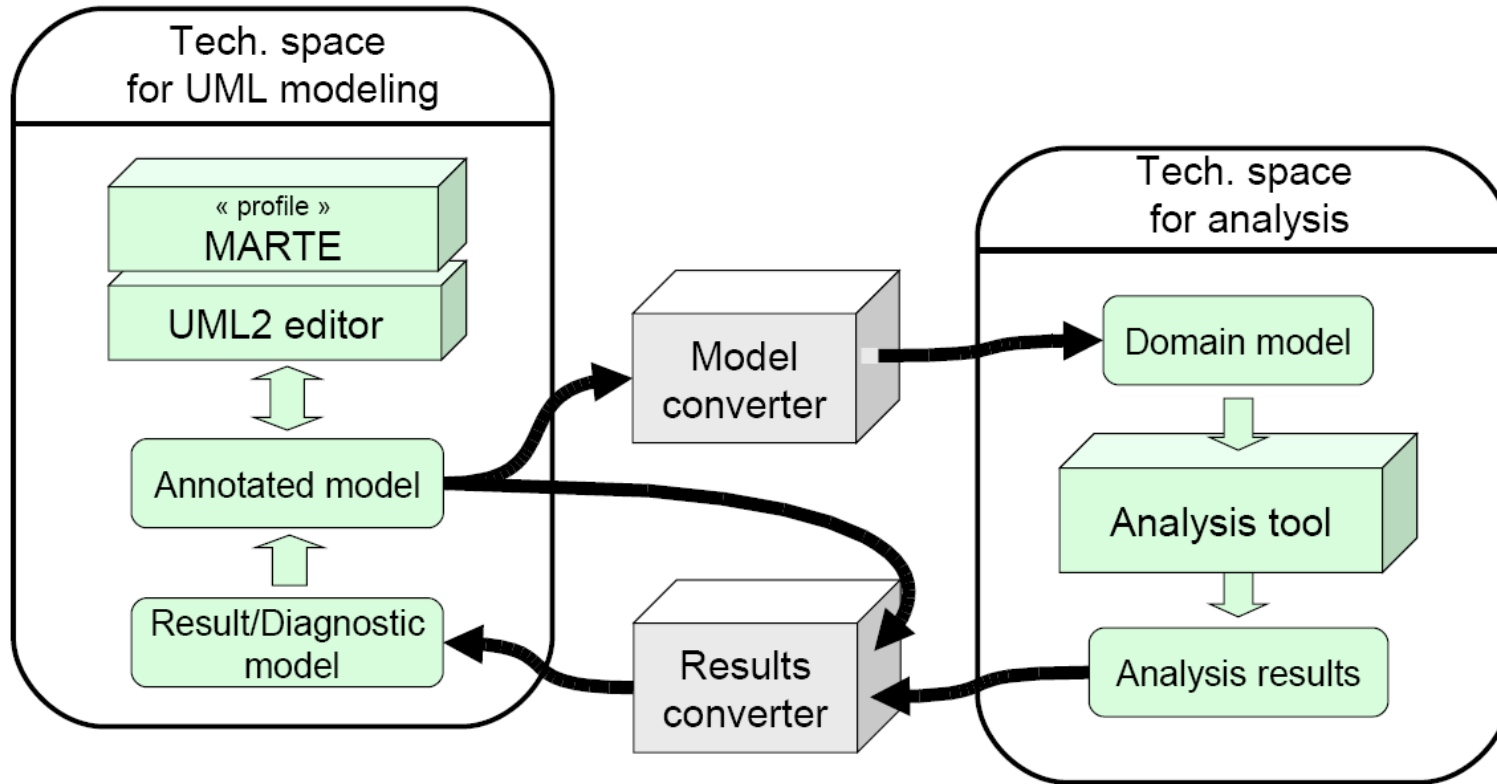
**MemoryPartition** : virtual address space



**SwMutualExclusionResource** : resources commonly used for synchronize access to shared variables



# Processing Schema for Analysis



Reference MARTE Tutorial – November 2007 – Version 1.1

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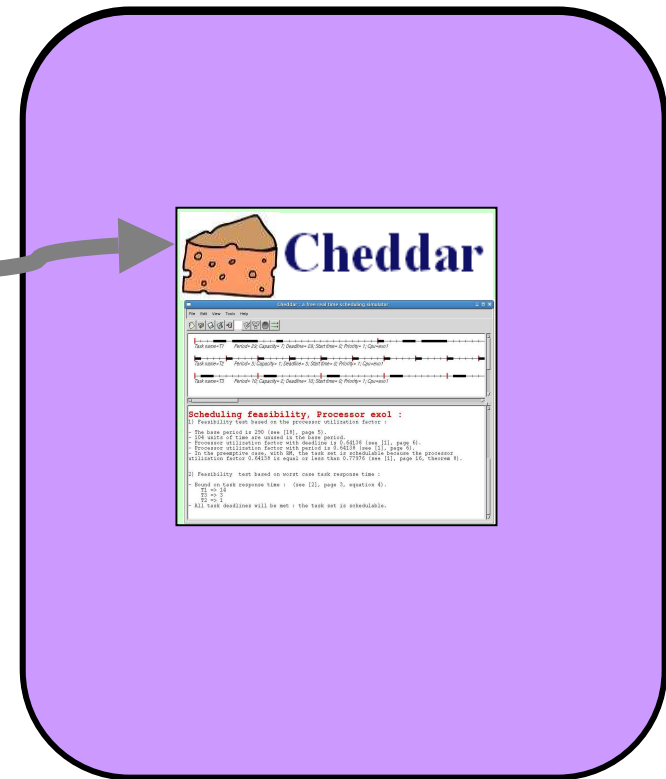




 **point de vue conception**

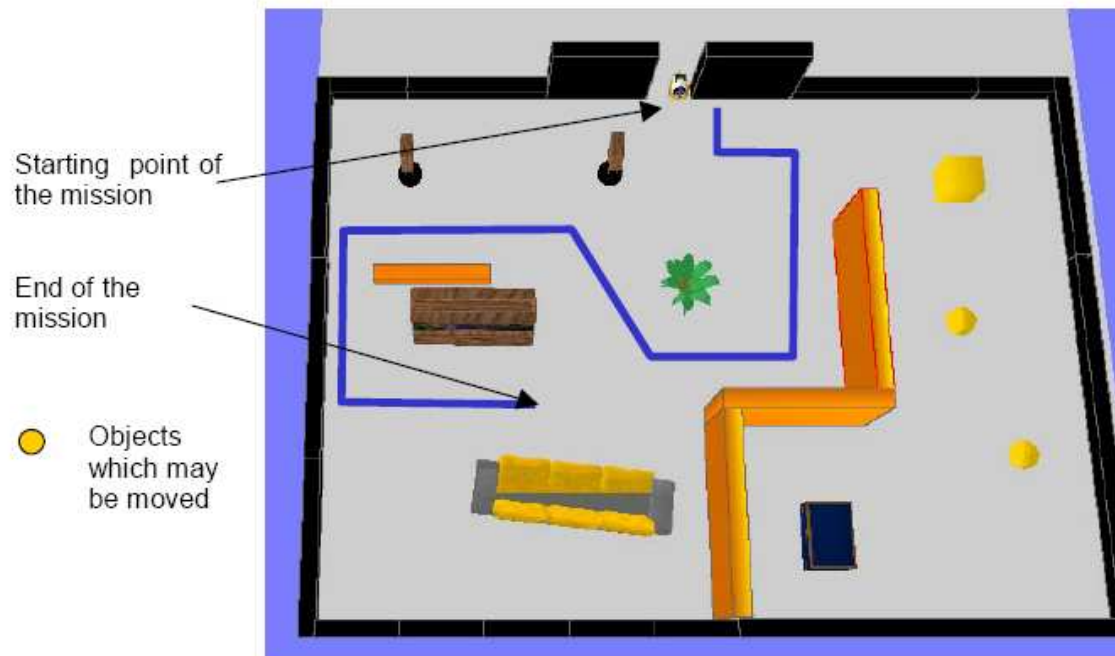


 **point de vue validation**



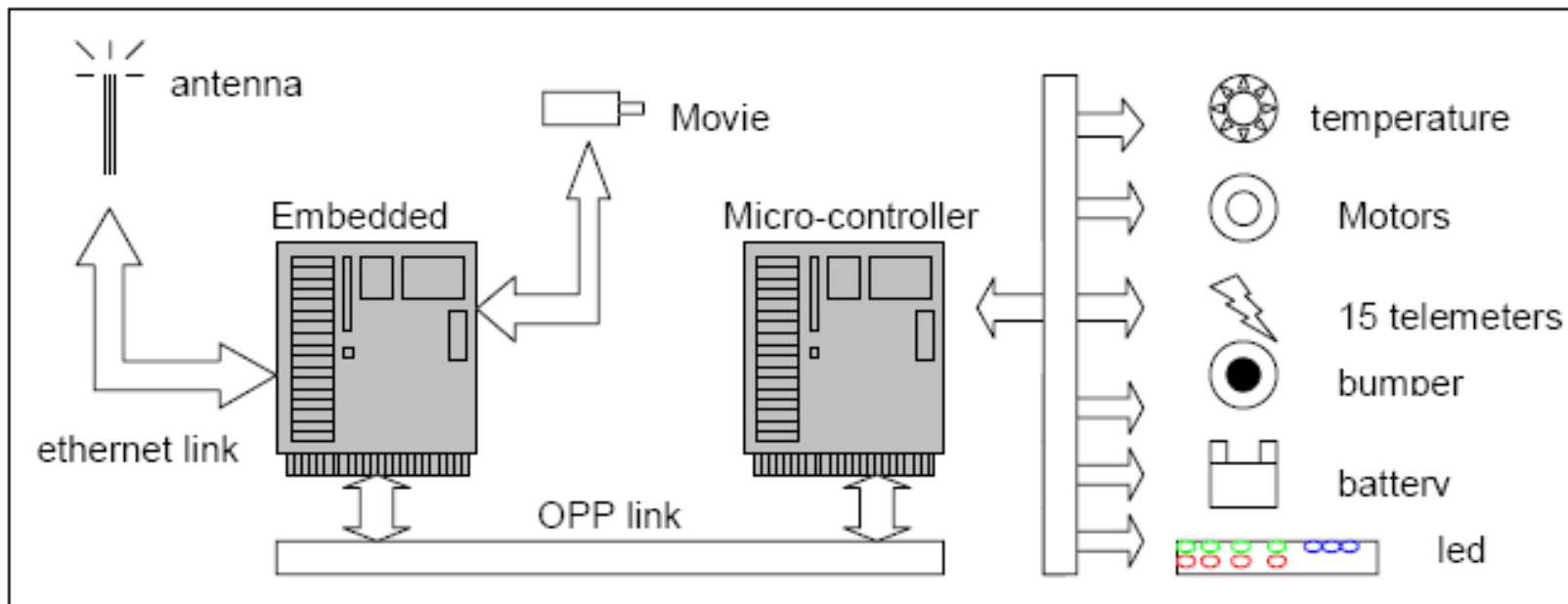
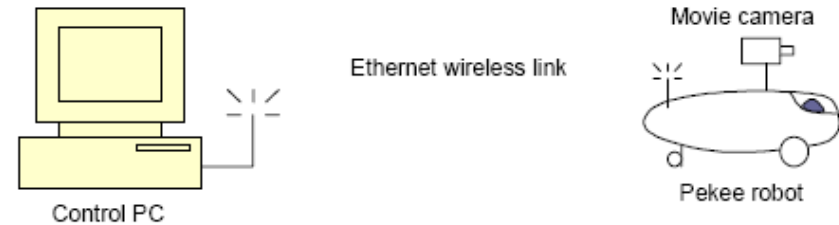
## • Robot

- ▶ Mission : relever la température le long d'un chemin
- ▶ Autonome
- ▶ Contraintes temps réel
  - ▶ Envoi de la position toutes les 50 ms
  - ▶ Envoi de la température toutes les 250 ms



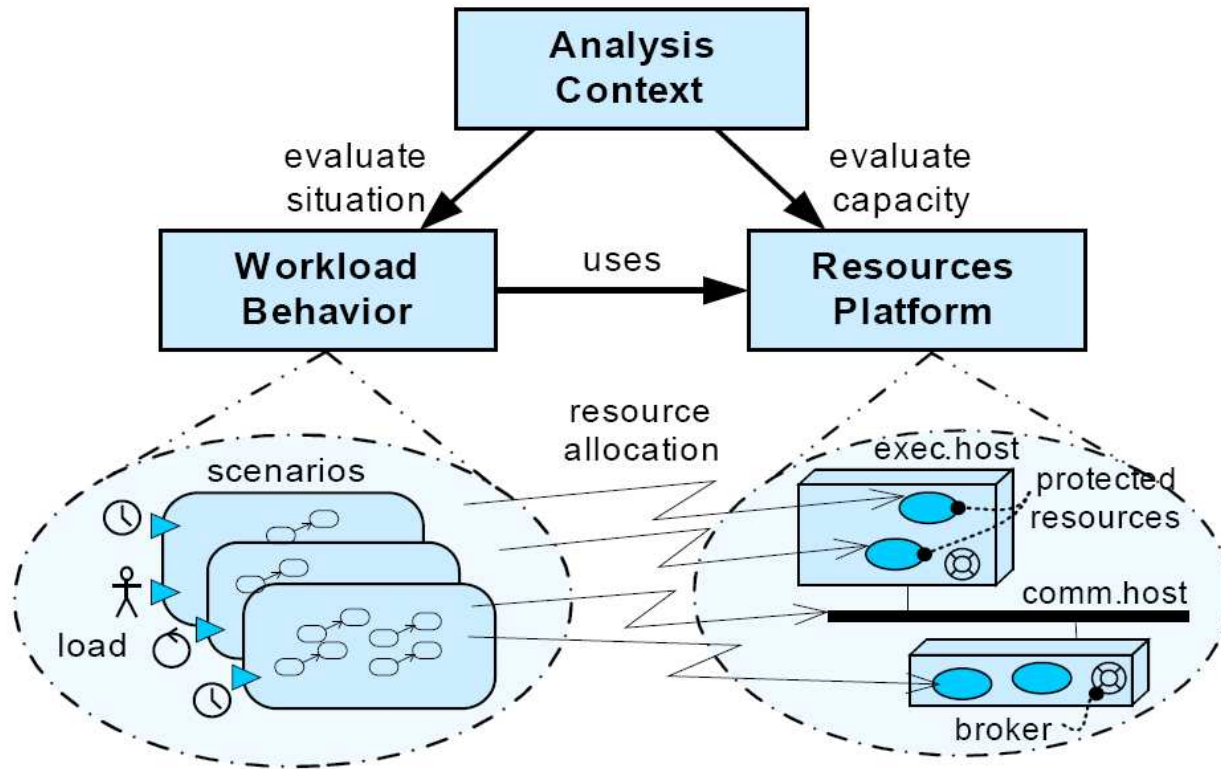
## • Architecture

- ▶ PC de contrôle
- ▶ Microcontrôleur
- ▶ PC embarqué



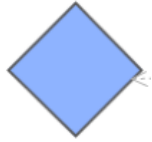


# GQAM: Analysis Modeling Structure



Reference MARTE Tutorial – November 2007 – Version 1.1

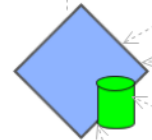
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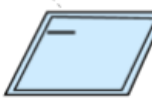
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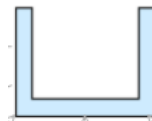
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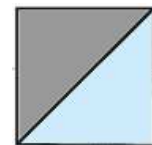
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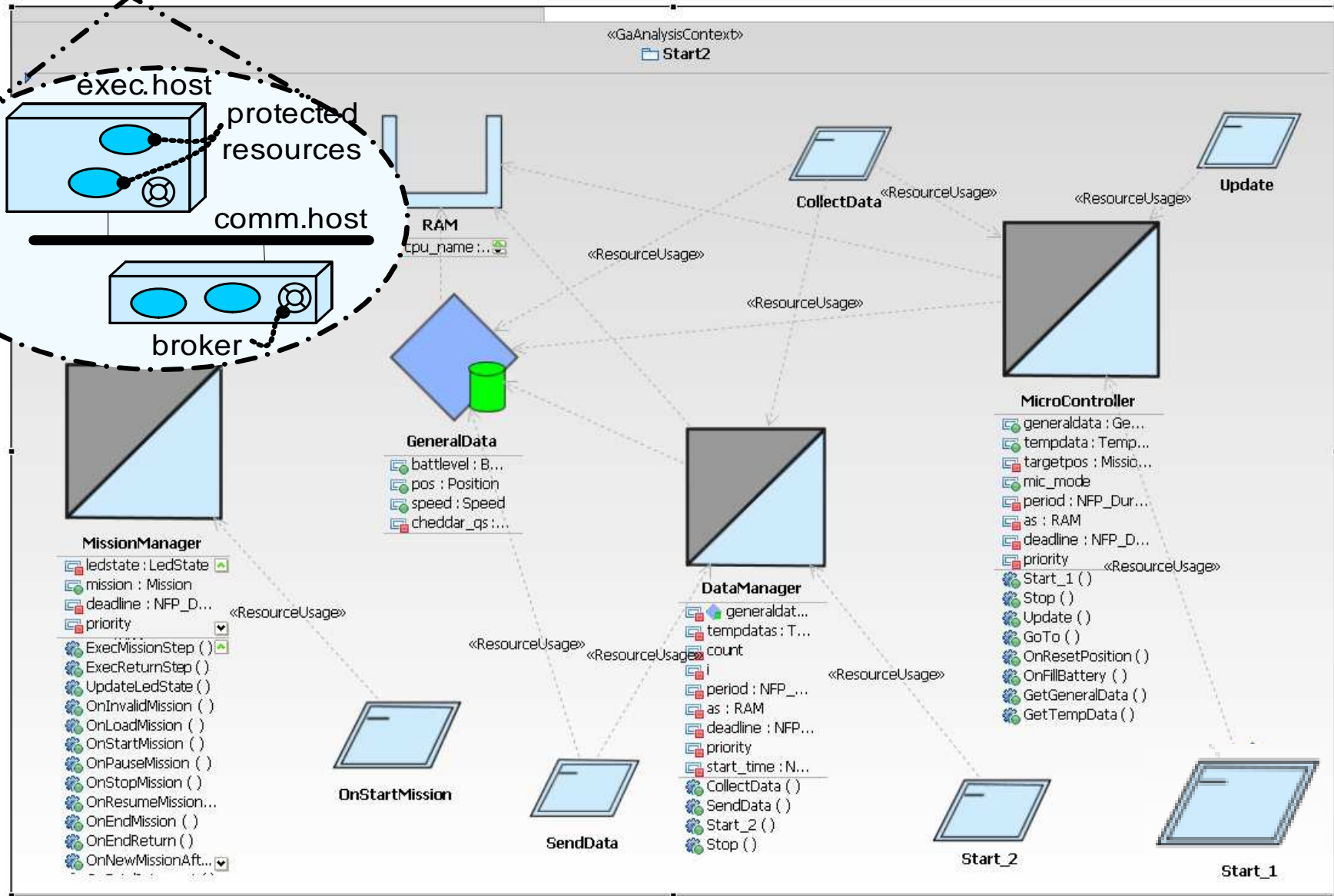


**MemoryPartition** : virtual address space



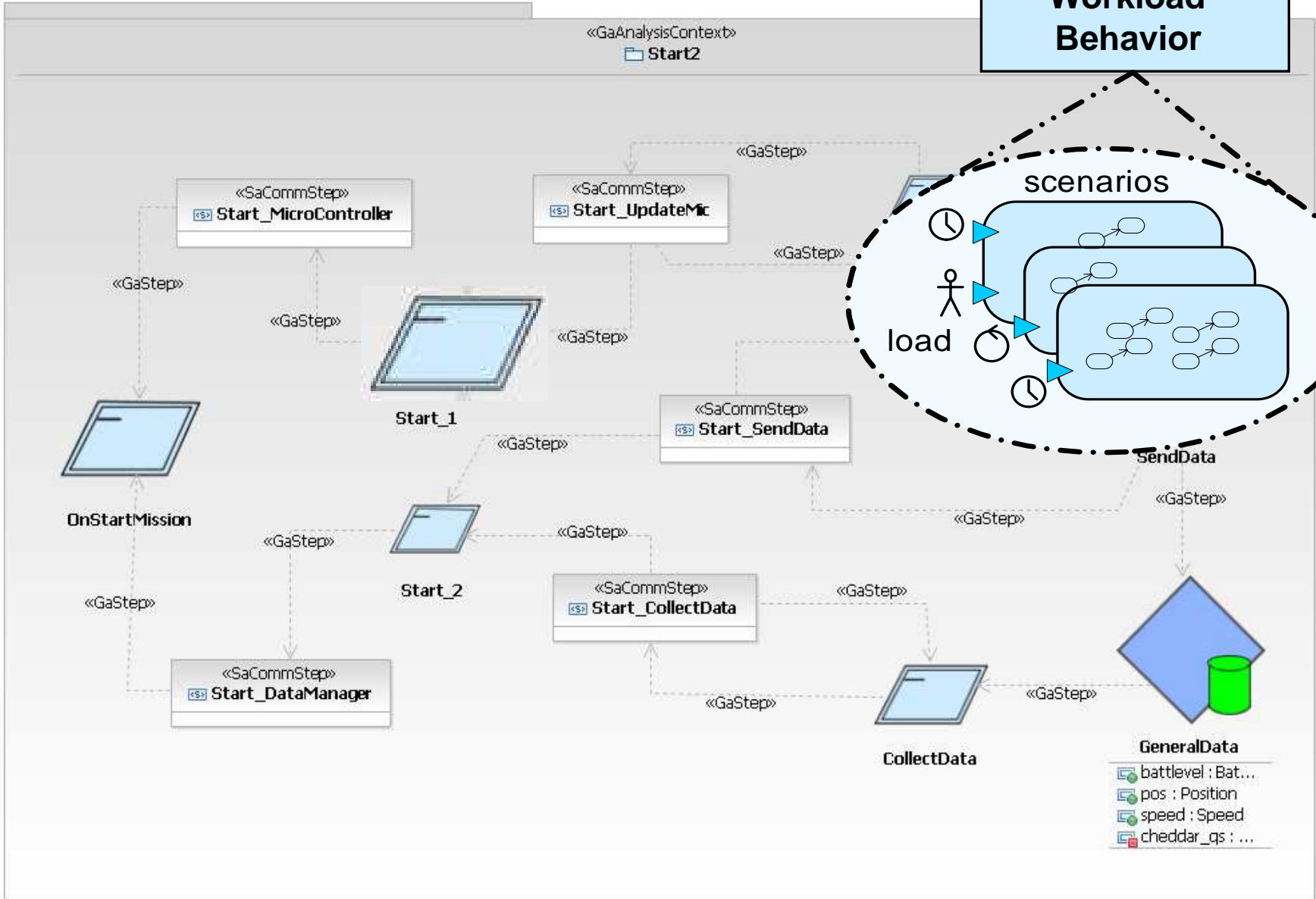
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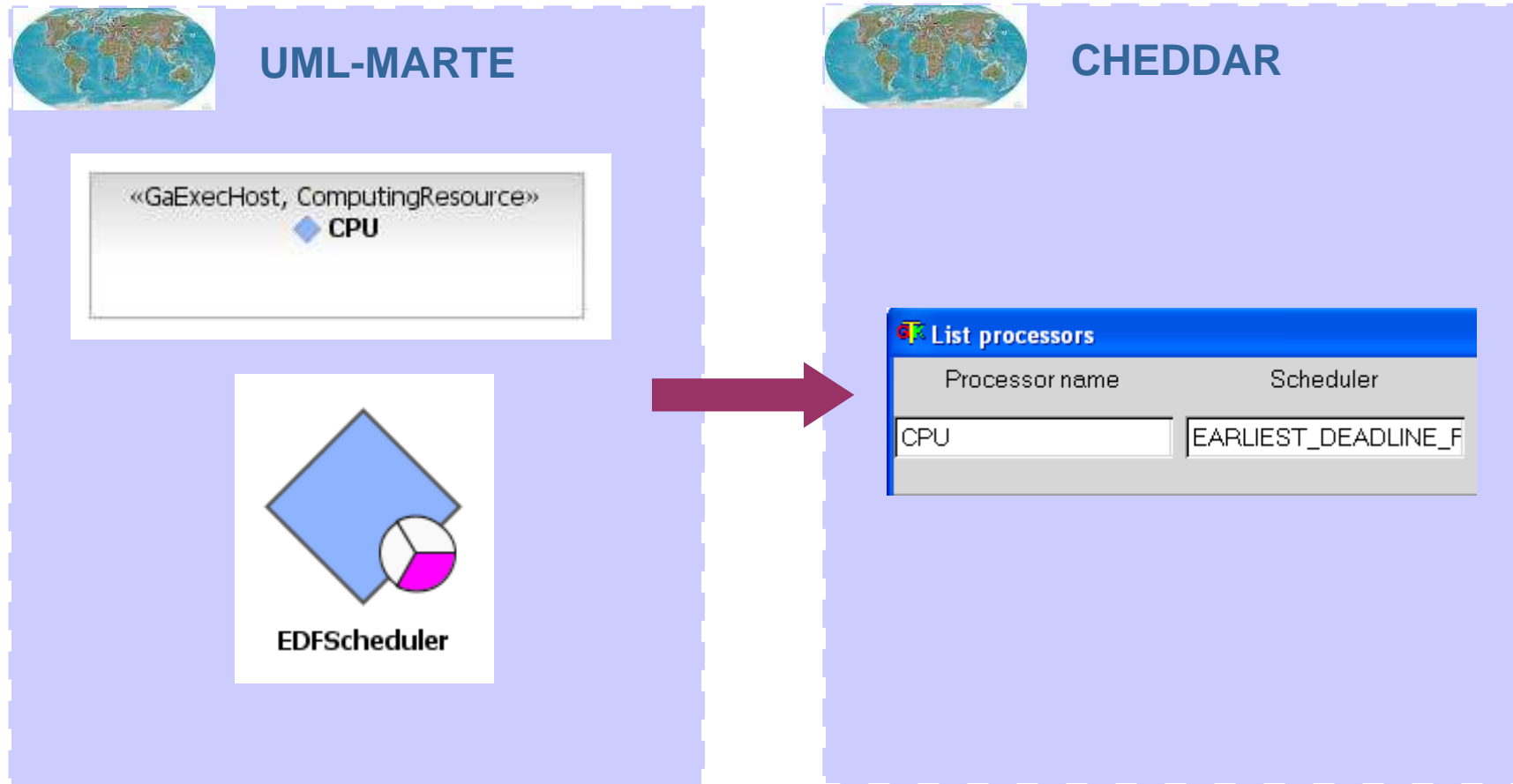


## Workload Behavior

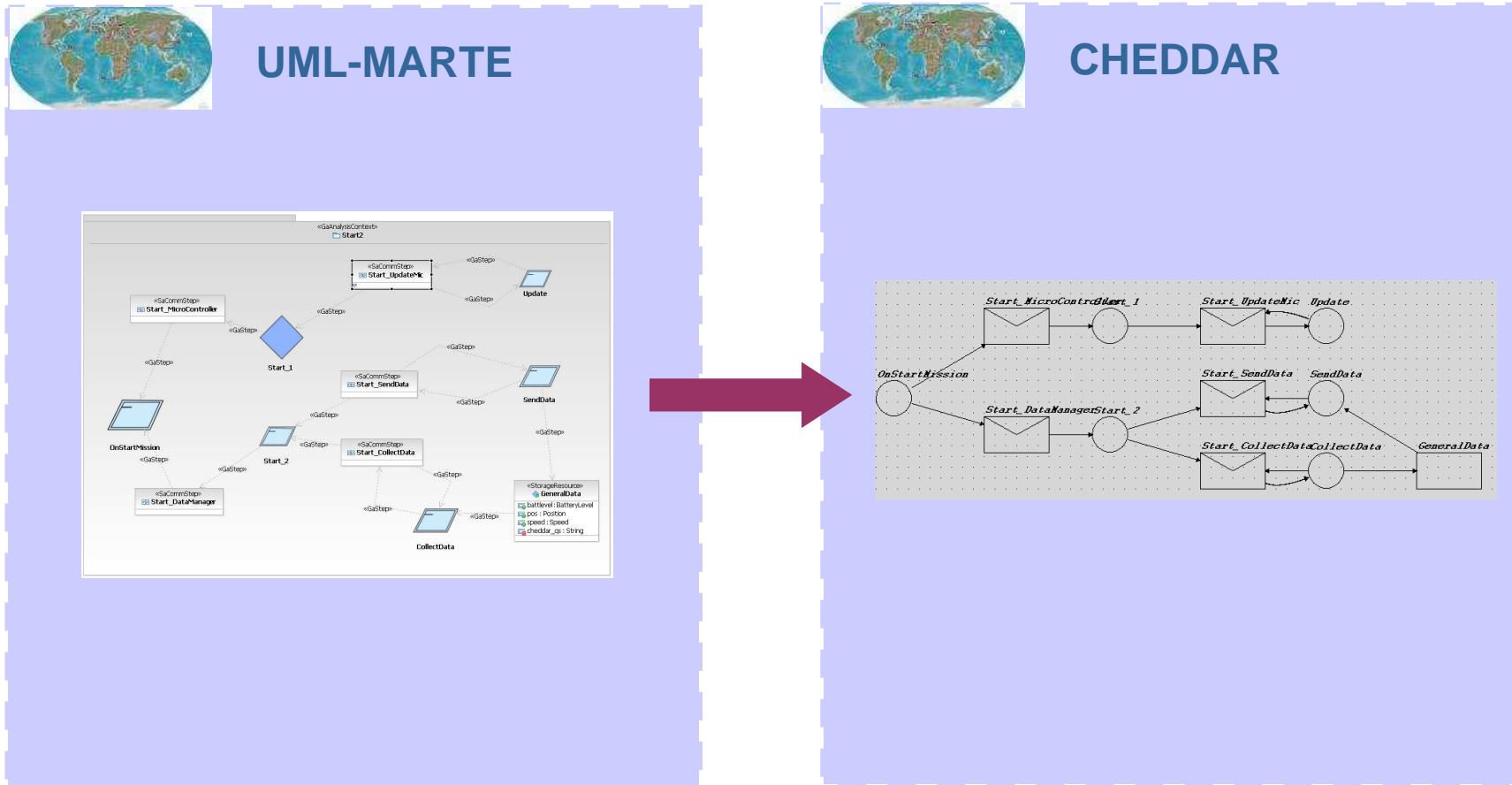


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## Règles de transformation entre concepts des deux mondes



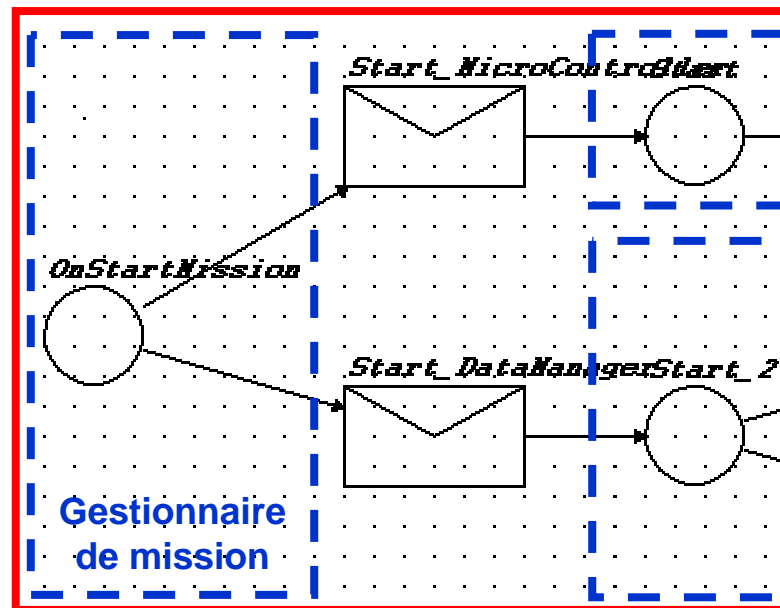
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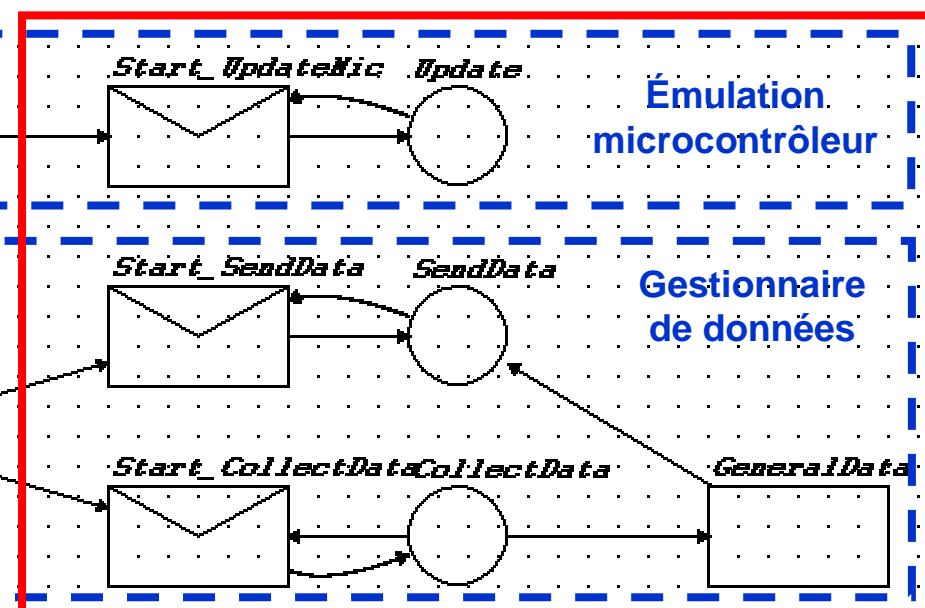
## • Scénario : Démarrage du robot

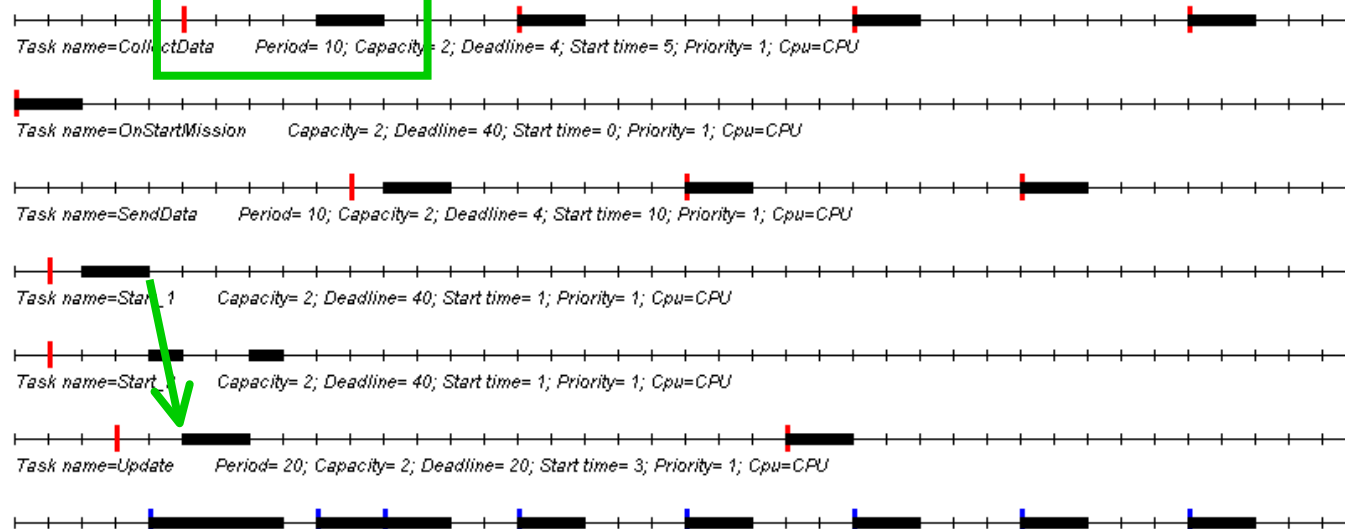
- ▶ Cascade de tâches qui déclenchent les tâches périodiques
- ▶ Retard des messages

### Démarrage



### Fonctionnement général





## Scheduling simulation, Processor CPU :

- Number of context switches : 12
- Number of preemptions : 1
- Task response time computed from simulation :
  - CollectData => 5/worst , missed its deadline (deadline = 9 ; completion time = 11)
  - OnStartMission => 2/worst
  - SendData => 3/worst
  - Start\_1 => 3/worst
  - Start\_2 => 7/worst
  - Update => 4/worst
- Some task deadlines will be missed : the task set is not schedulable.

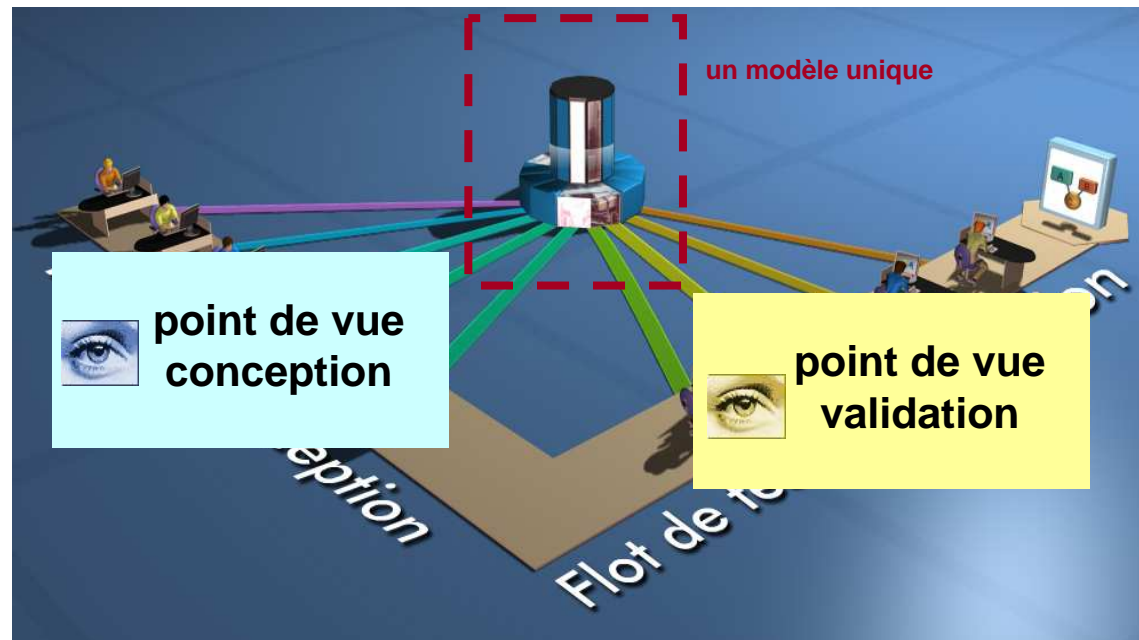
Message name=Start\_MicroController ;Pe=0 ; Delay=0 ; Size = 1

Buffer name=GeneralData Size = 1 ; Cpu = CPU

## - Chaîne outillée centrée sur un modèle unique

- Conception
- Validation intégralement automatisée

⇒ possibilités de correction en amont





**THALES**

## - **MARTE to Cheddar** OpenSource

**Eric MAES** (eric.maes@thalesgroup.com)

**Nicolas VIENNE**

## - **MARTE**

- website : <http://www.omgmarTE.org>
- tutorial : <http://www.omgmarTE.org/Tutorial.htm>
- MARTE for RSA : <http://www.omgmarTE.org/Tools.htm>

OpenSource  
**THALES**

## - **Cheddar**

- <http://beru.univ-brest.fr/~singhoff/cheddar/index-fr.html>

## - **Josefil**

- <http://www.cs.unibo.it/~cianca/wwwpages/sfida.pdf>



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