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Towards Correct Transformation: From High-Level Models to Time-Triggered Implementations

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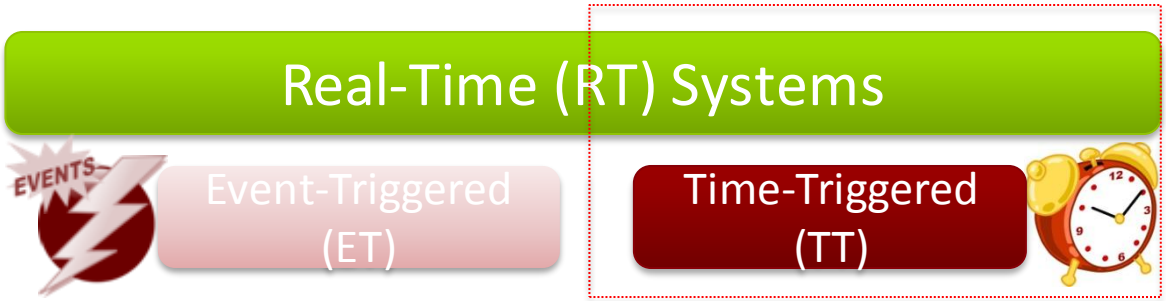
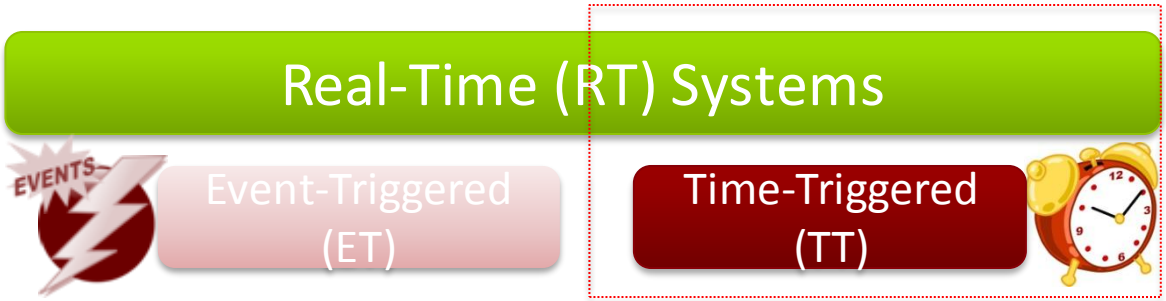
Introduction



How to build Embedded RT systems of guaranteed quality, in a cost-effective manner??

Introduction



How to build Embedded RT systems of guaranteed quality, in a cost-effective manner??

Component-based design framework

- ✔ Abstracts away implementation details
- ✔ Validates the model through different techniques such as formal verification, simulation, and testing
- ✖ Targets generic execution model

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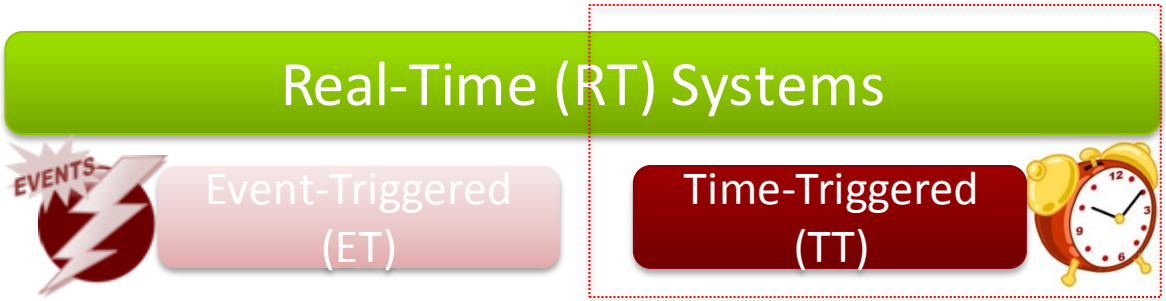

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- ✓ Validates the model through different techniques such as formal verification, simulation, and testing
- ✗ Targets generic execution model

RTOS-based implementation + TT approach

- ✗ No high-level programming models to tackle complexity
- ✓ Implement TT execution model

Introduction

Real-Time (RT) Systems

Event-Triggered (ET)

Time-Triggered (TT)

How to build Embedded RT systems of guaranteed quality, in a cost-effective manner??

Component-based design framework

RTOS-based implementation + TT approach

- ✔ Abstracts away implementation details
- ✔ Validates the model through different techniques such as formal verification, simulation, and testing
- ✖ Targets generic execution model

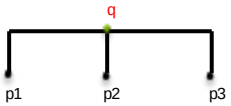
- ✖ No high-level programming models to tackle complexity
- ✔ Implement TT execution model

Background Concepts

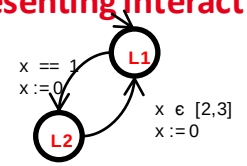
- RT-BIP Framework [1]:
  - Structure of a real-time BIP model:

→ **Mechanism for Conflict resolution between interactions**

→ **Connectors representing interactions**



→ **Timed automata**



Background Concepts

- RT-BIP Framework [1]:
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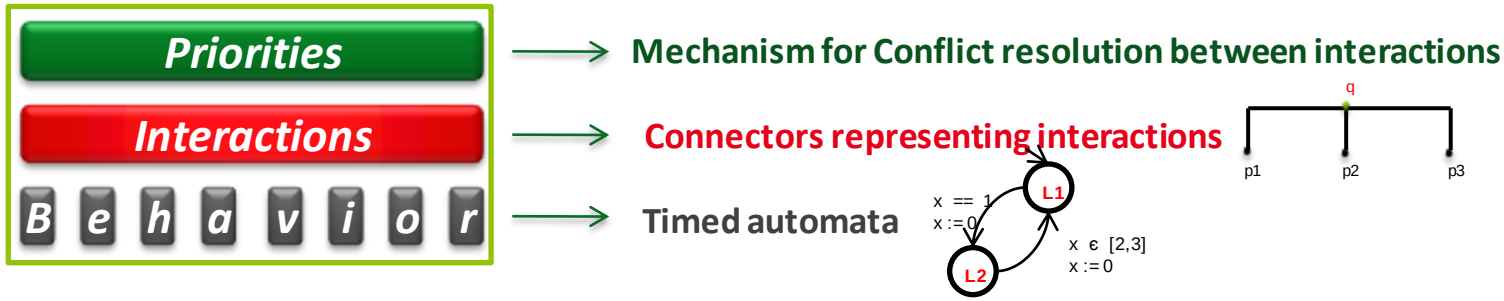
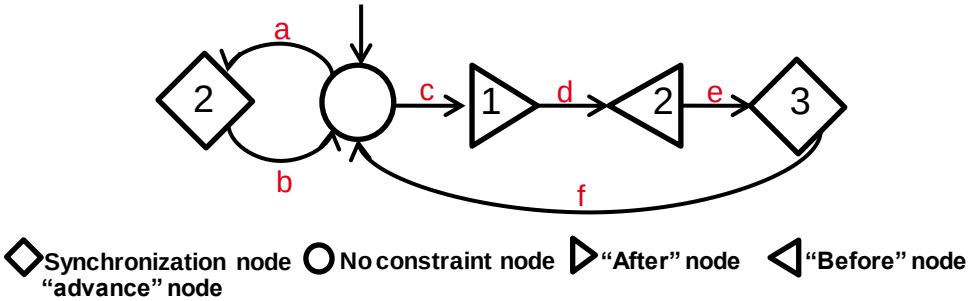
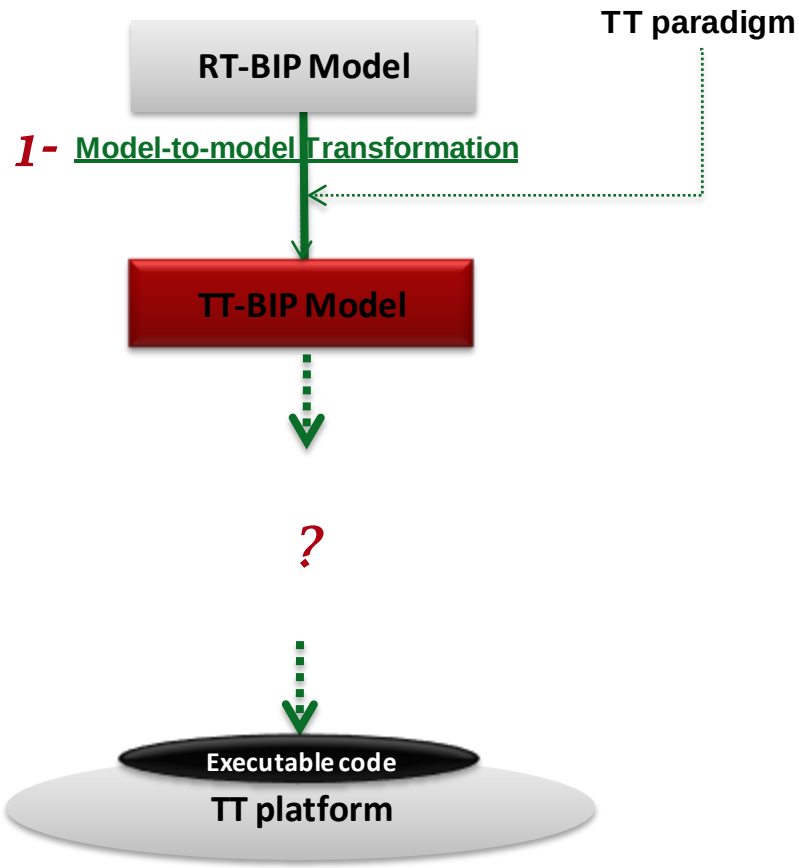


- TCA: Computation model of TT tasks in PharOS [2][5]:
  - The temporal behavior of a task is specified using a directed graph



Approach

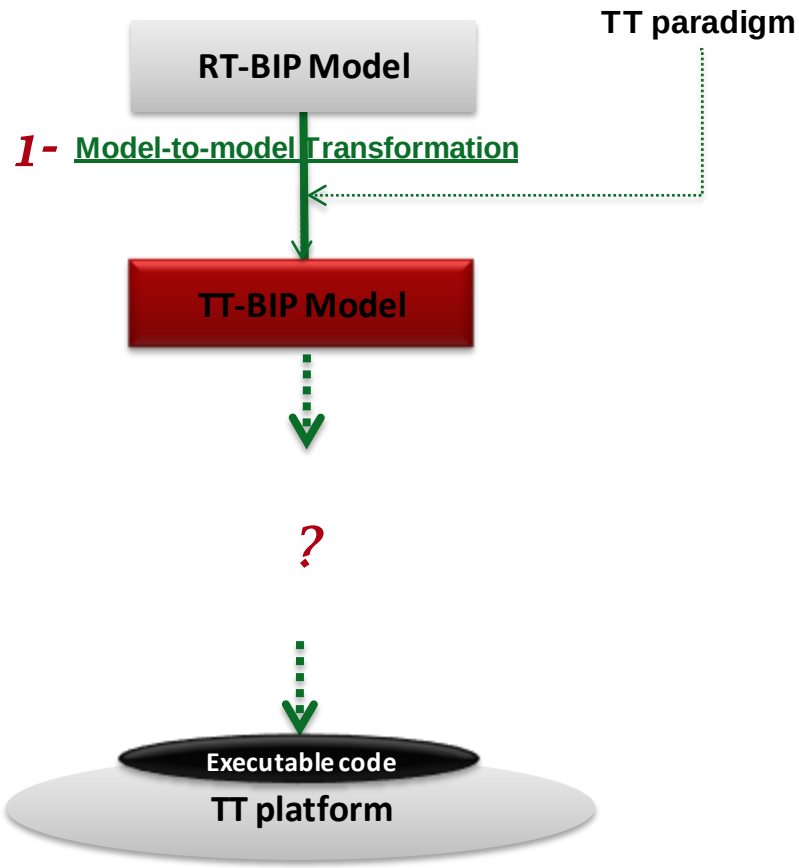
- 1/ Step1 [3]
  - TT-BIP = tasks components + communication components + unidirectional interactions.



Approach

- 1/ Step1 [3]
  - TT-BIP = tasks components + communication components + unidirectional interactions.

TT-BIP is not easily translated to an executable



Approach

- 1/ Step1 [3]
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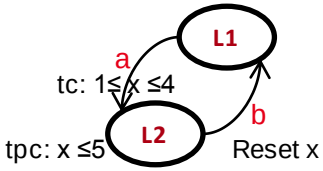
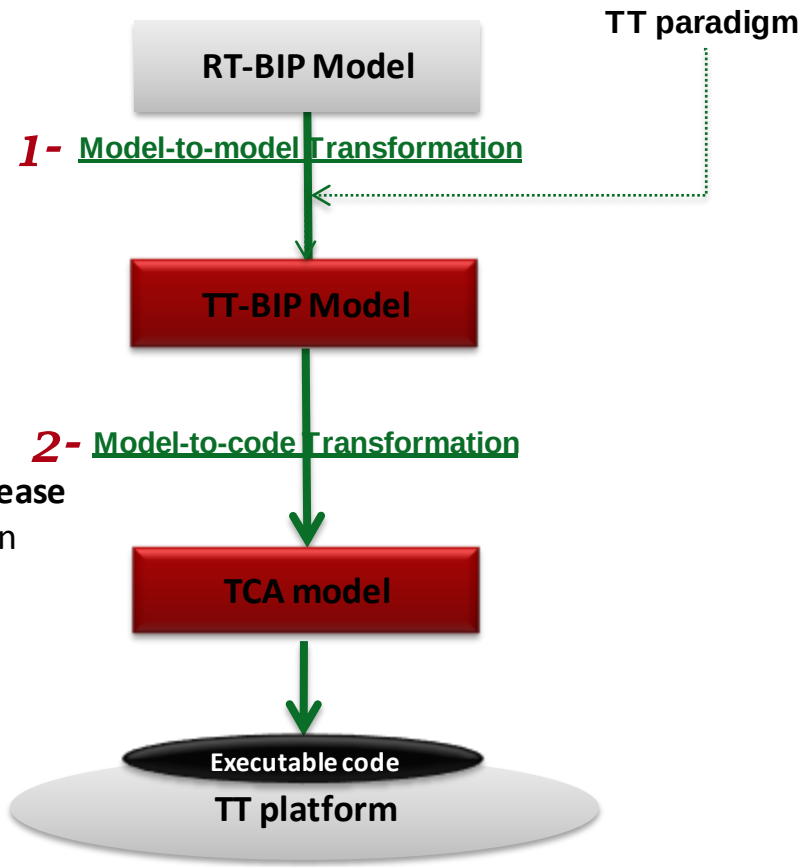
- 2/ Step2:
  - Challenges:

1 Constraints only on the **start** instant of an action



Can be constrained both the **release** and **deadline** instants of an action



Approach

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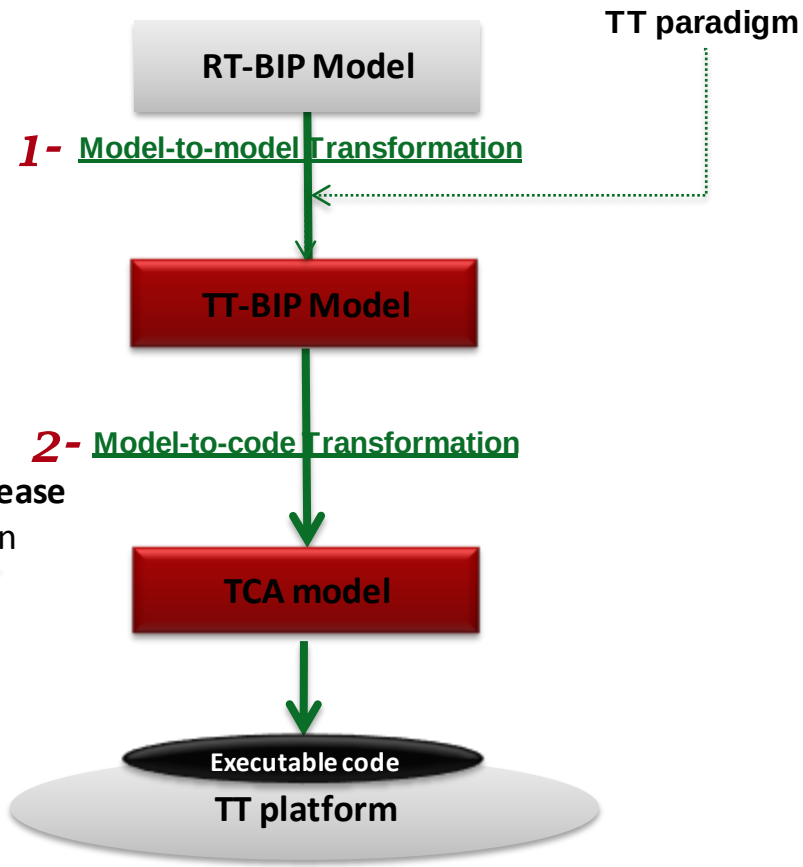
- 2/ Step2:
  - Challenges:

1	Constraints only on the **start** instant of an action	Can be constrained both the **release** and **deadline** instants of an action
2	**Absolute** labeling of constraints	**Relative** labeling of constraints



Approach

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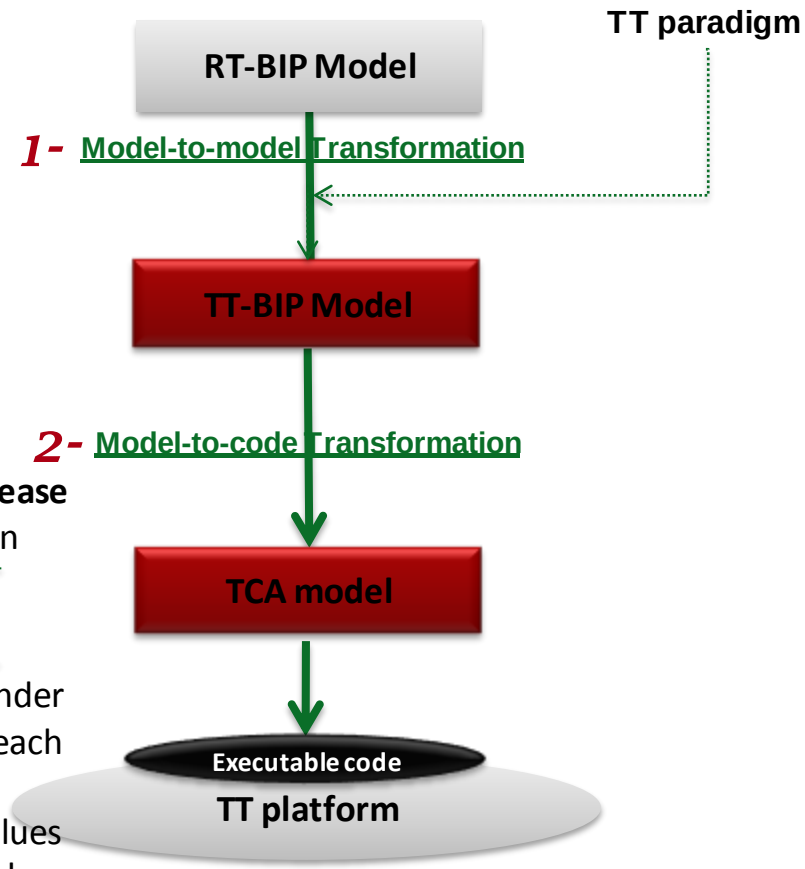
  - Challenges:

1 Constraints only on the **start** instant of an action	Can be constrained both the **release** and **deadline** instants of an action
2 **Absolute** labeling of constraints	**Relative** labeling of constraints
3 Interactions = data transfer + **synchronization** between sending and receiving actions	**Desynchronized** interaction= sender provides new values at each synchronization point + Receivers can consult these values when their current time is equal or higher to the defined visibility dates.



Approach

- 1/ Step1 [3]
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- 2/ Step2:
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1. Constraints only on the **start** instant of an action — Can be constrained both the **release** and **deadlin**[illegible]ants of an action
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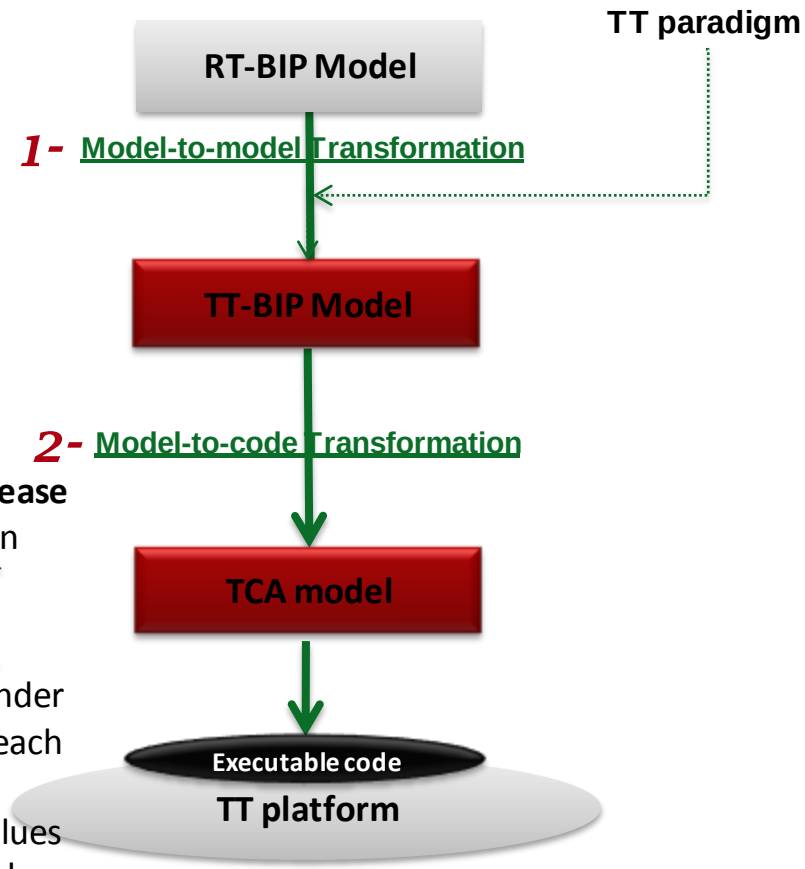
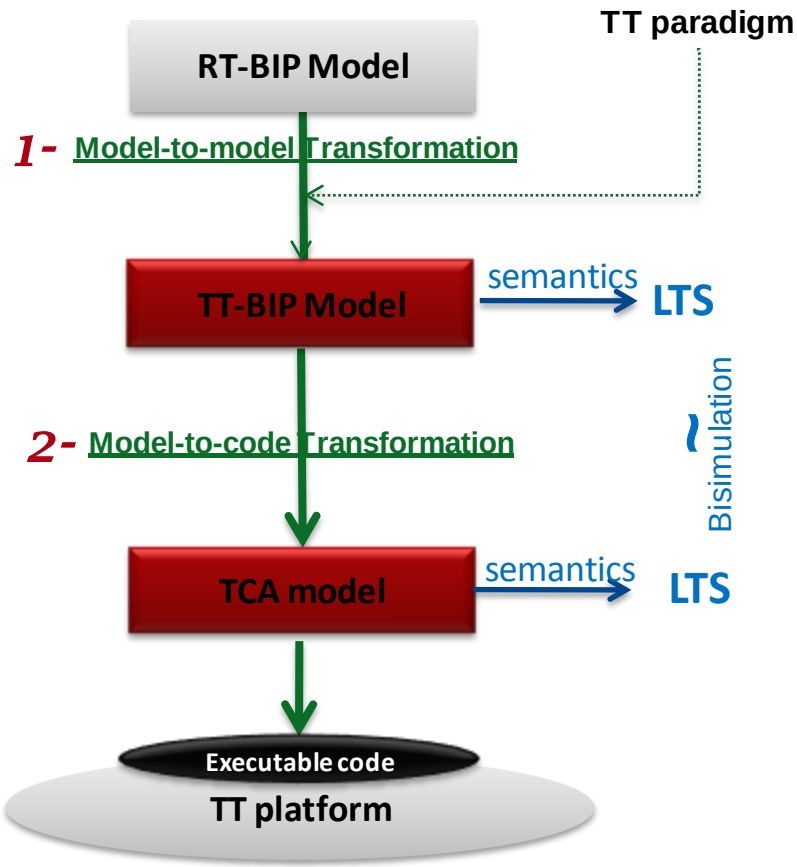
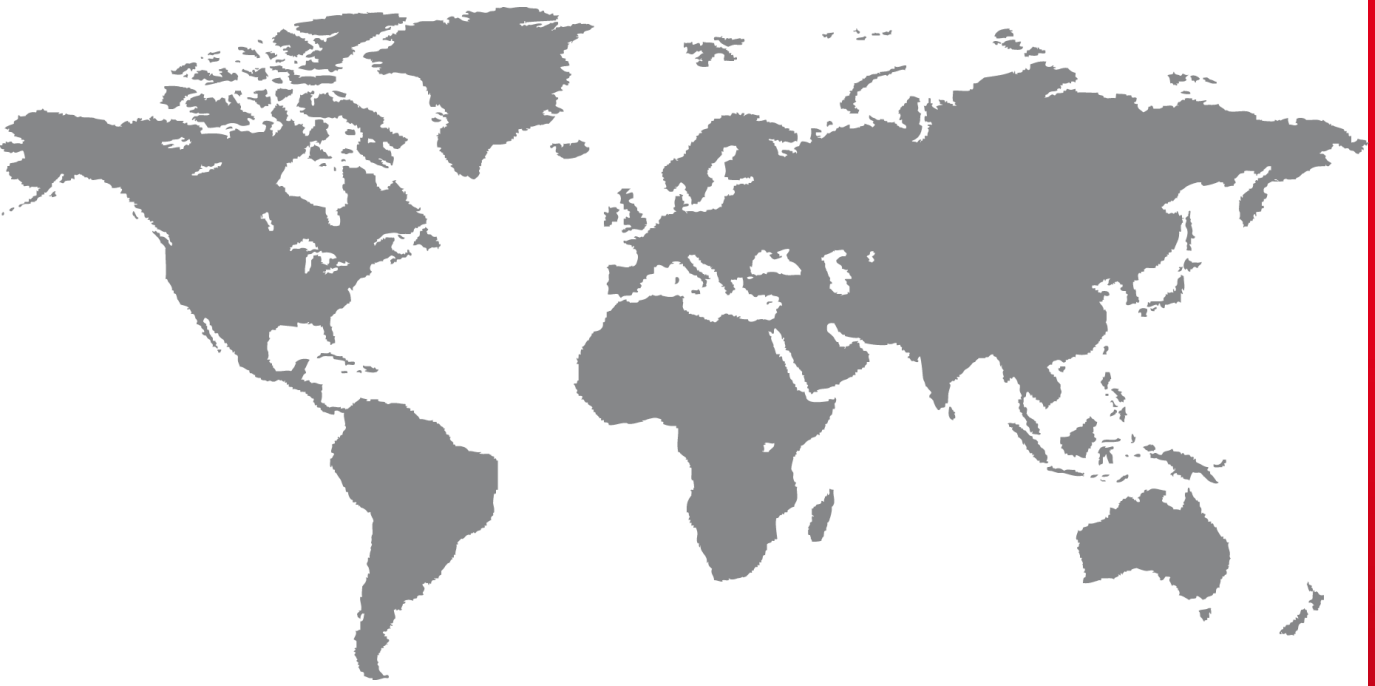
Algorithm details are given in the poster



Approach

- 1/ Step1 [3]
  - TT-BIP = tasks components + communication components + unidirectional interactions.
- 2/ Step2:
  - Challenges:
  - Correctness proof:
    - Expressing semantics of each model in terms of Labelled Transition system (LTS).
    - Proving equivalence between two LTSs by using bisimulation technique.
      → trace equivalence





Thank you!

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[4] Robert Kaiser and Stephan Wagner. Evolution of the PikeOS microkernel. In Proceedings of the 1st International Workshop on Microkernels for Embedded Systems, pages 50–57, 2007.

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