Some Challenges in Adaptive Fault Tolerant Computing

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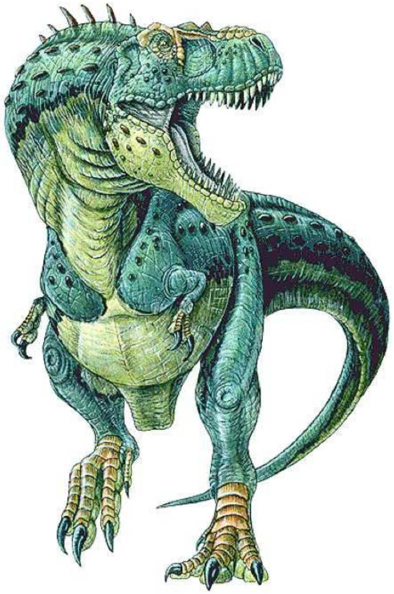
The Problem

- Evolution implies **adaptation**, e.g.
  - ➔ rapidly changing operational conditions
  - ➔ evolving requirements
  - ➔ evolving threats



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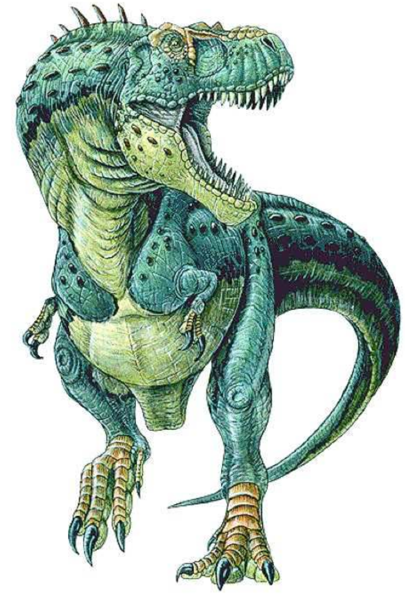

- **Dependability** mechanisms must evolve:
  - ➔ to meet new user requirements.
  - ➔ to provide same level of dependability under different conditions

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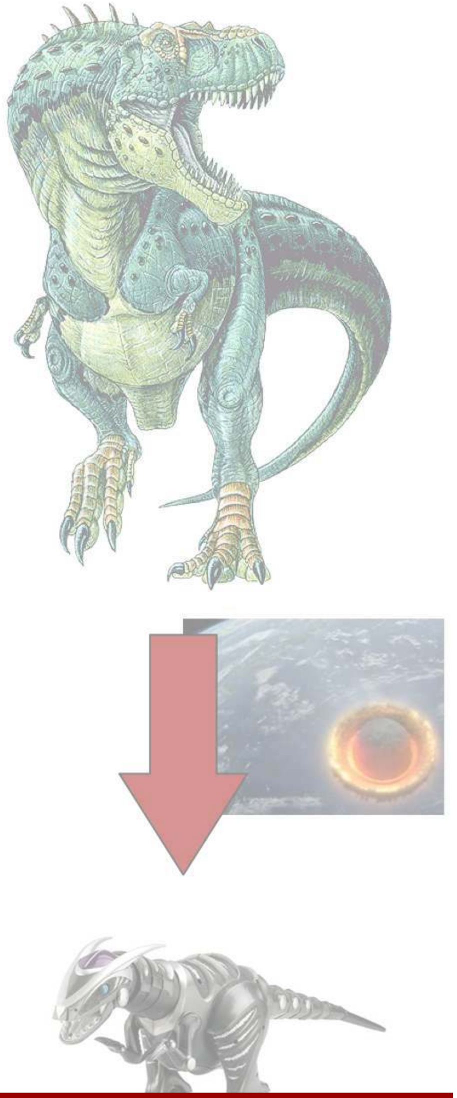

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Our goal: **facilitate** the *design*, *analysis* and *implementation* of adaptable fault-tolerants systems

Requirements and properties

- **Design-level** requirements for adaptation
  - ➔ separation b. functional / non-functional concern
  - ➔ adaptable software structures
  - ➔ appropriate runtime modelling
  - ➔ on-line assessment of execution & dependability

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- **Adaptation mechanisms**: ideal properties
  - ➔ minimal impact on system execution (isolation)
  - ➔ consistent w/ (i) past activity (ii) new requirements
  - ➔ ensure dependability of:
    - new software configuration
    - adaptation process itself

Our (advocated) Strategy

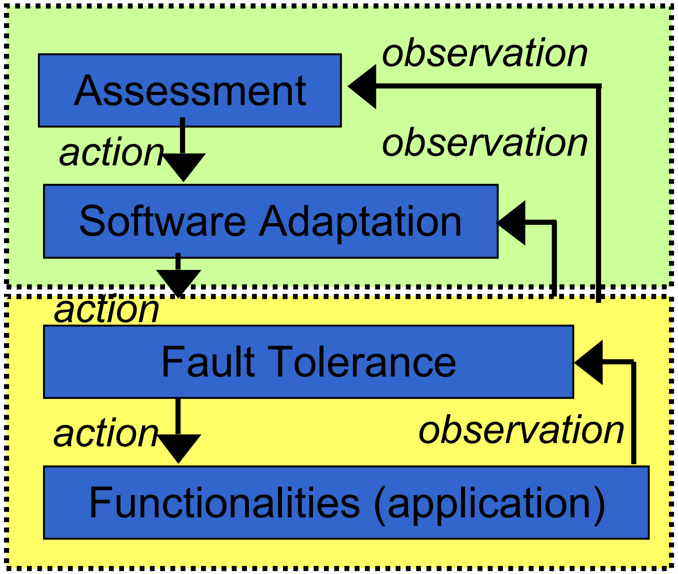
- **Reflection** for separation of concerns between
  - the functional level
  - fault-tolerance
  - adaptation itself.
- **Components** for programmability
  - framework rather than specific / on-dimensional scenario
  - principled high-level abstractions
  - encapsulate best practices adaptation and fault tolerance
- Scope control using **fine-grained decomposition**
  - simple tasks only incur simple costs

Example of recent work

ASAP Framework

LAAS
Lancaster Univ.
City Univ. London
Kaunas Univ

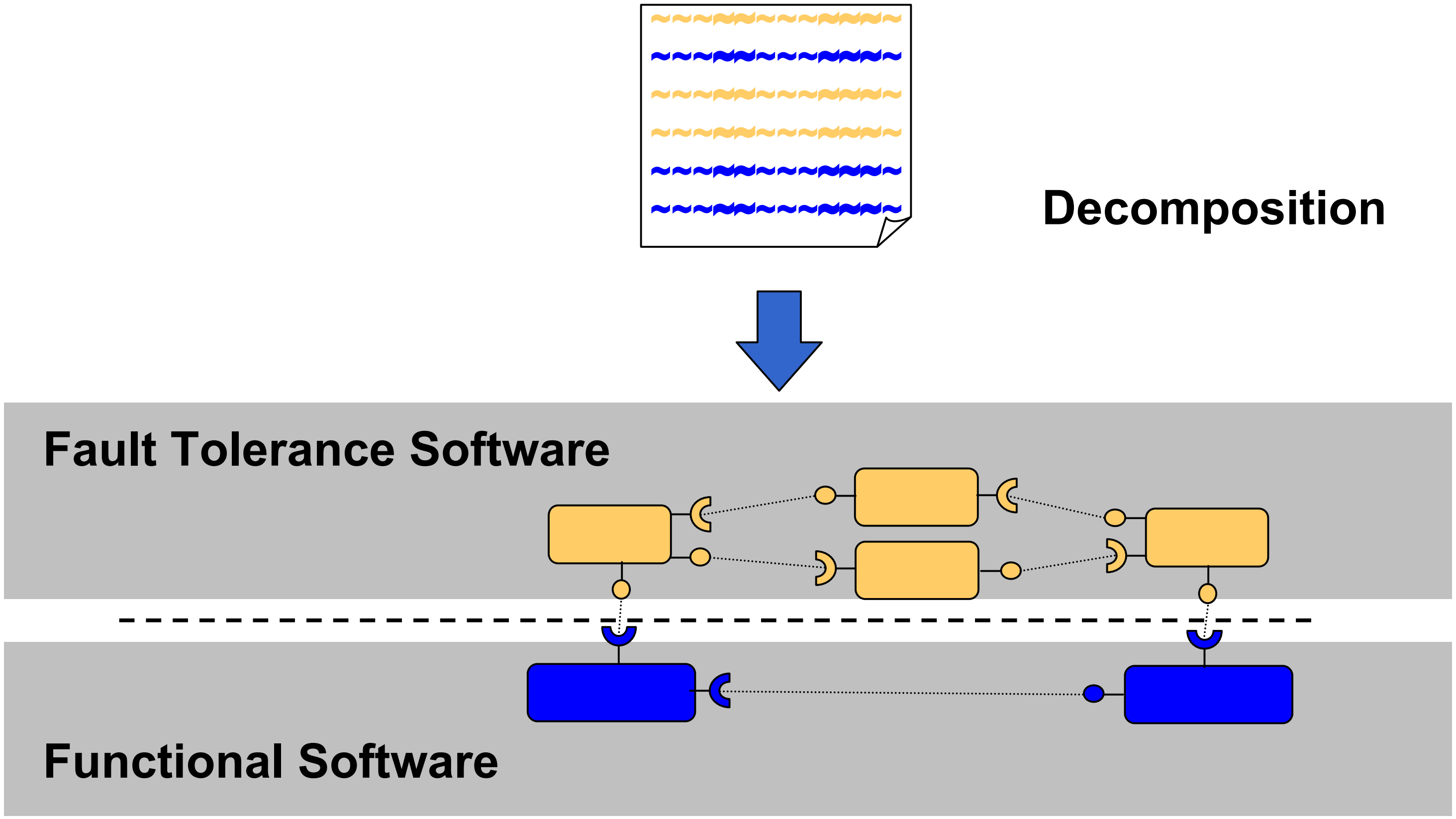
- A Reflective architecture separating:
  - ➔ Fault tolerance mechanisms
  - ➔ Adaptation of FT application
  - ➔ System attributes assessment



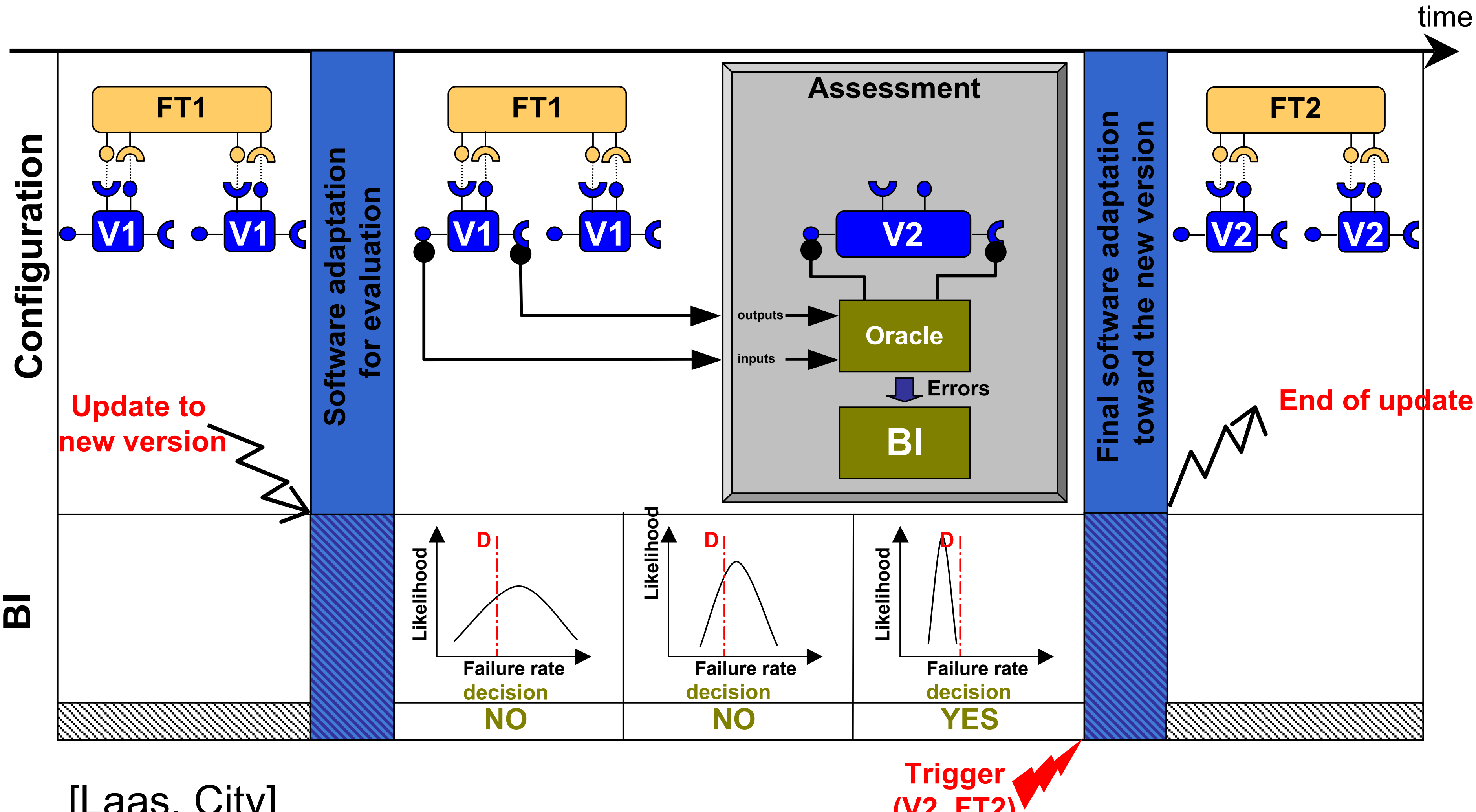
- Architectural principles
  - ➔ Fine-grain decomposition to minimize adaptation cost
  - ➔ Adaptation Triggers ⇔ (i) Adverse operational context, (ii) Side effects of application software modifications

Fault tolerance software design

- Decomposition for adaptation of the fault tolerant Software using CBSE



A Smart update example



[Laas, City]

SWOT Analysis

- Strengths
  - ➔ reflective computing and component technologies
- Weaknesses (so far)
  - ➔ statically defined set of configurations (closed world)
- Opportunities
  - ➔ novel software technologies (CBSE, AOP)….
- Threats
  - ➔ on-line assessment & validation of dynamic systems
  - ➔ performance overheads

What the next step?

- Qualitative sensitivity analysis of approach features
  - ➔ complexity of runtime modelling, performances, etc.
- Better model-based control of execution
  - ➔ automation of model construction [Pareaud 2009]
  - ➔ more powerful in particular considering timing issues
  - ➔ hierarchical models to master complexity
- State
  - ➔ adaptable state wrt to liveness and safety properties?
  - ➔ mastering and handling the capture/ recovery of state of the computation

To Conclude: Challenges (1/2)

- 1. Design for adaptation
  - → Fine grain components
- 2. Synchronisation of modifications
  - → Runtime modelling of execution
- 3. Mastering distributed state
  - → How to capture semantic?
- 4. On-line assessment
  - → How to assess impact of adaptation on dependability?
- 5. On-line adaptation
  - → Reactive (traditional)
  - → Or proactive (much harder)

Thanks

Question?