Architectural Reconfiguration using Coordinated Atomic Actions

Rogério de Lemos
University of Kent, UK

- Motivation;
- Coordinated atomic actions (CA actions);
- CA actions applied to reconfiguration;
- Conclusions;

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Motivation

- System reconfiguration is not that simple:
  - it's hard!
- In dependable system where assurances are necessary:
  - it's even harder!!
- What happens if something goes wrong?
  - atomic actions applied to reconfiguration – nothing new!
    - ensures consistency in the presence of failures and concurrent access;
  - coordinated atomic actions (CA actions);
    - Newcastle Univ. (B. Randell group), 15 years ago;

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Motivation

- Where are the 'self' properties?
  - a general mechanism that can be used in self-reconfigurable systems;
  - systems react to "unexpected" situations through "predictable" means;

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Architectural Reconfiguration

In the context of fault tolerance:

- fault handling during system recovery:
  - addition, removal, or replacement of components and connectors;
  - modifications to the configuration or parameters of components and connectors;
  - alterations in the component/connector network's topology.
- the outcome of reconfiguration should be a safe (stable and useful) state in the system configuration:
  - sequence of atomic actions has been widely advocated:

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Coordinated Atomic Actions (CA Actions)

CA actions is a unified approach that deals with both competitive and cooperative concurrency:

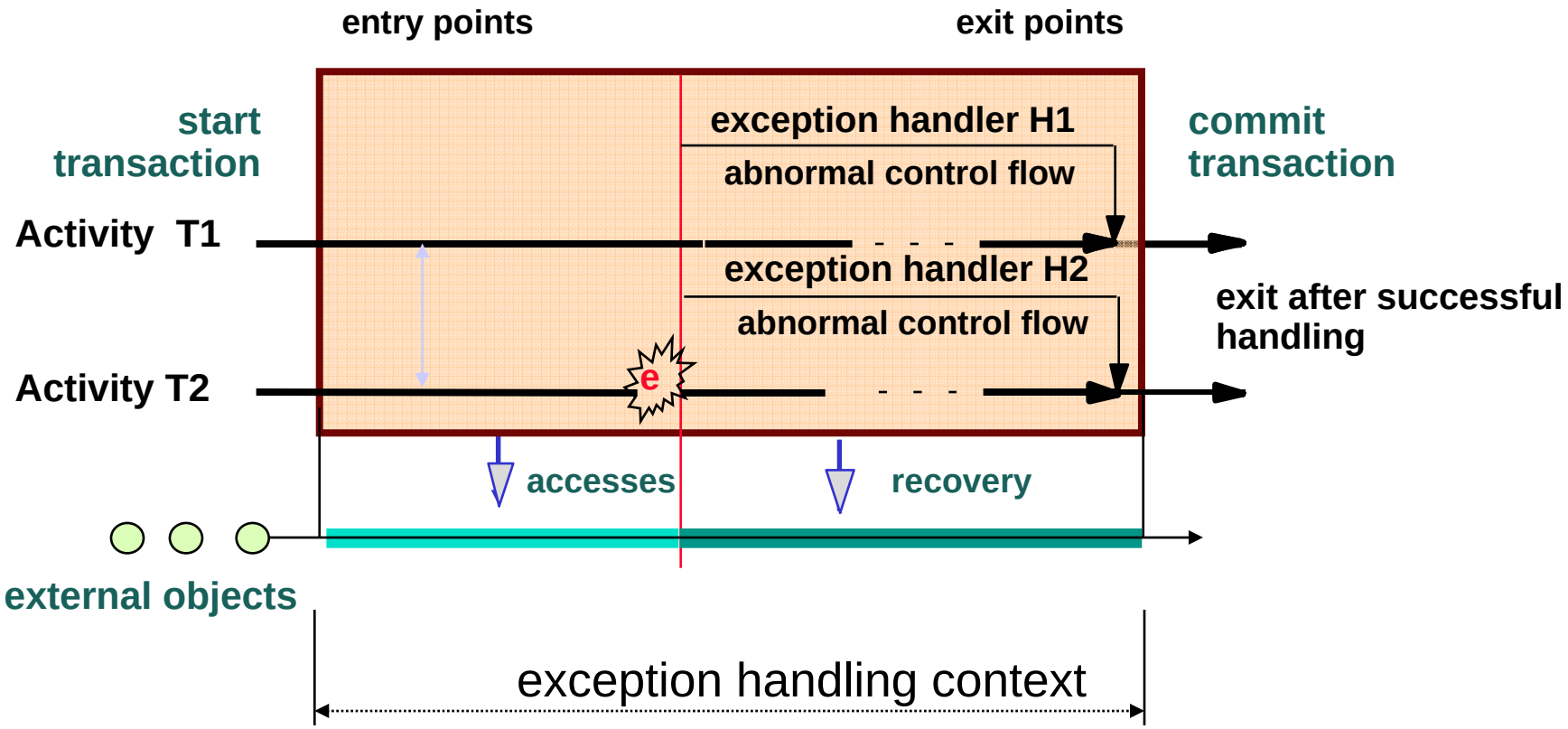
- *transactions* - maintain the consistency of shared resources in the presence of failures and concurrency;
- *conversations* - control cooperative concurrency, and implement coordinated and disciplined error recovery;

CA actions have applied to:

- structuring complex and concurrent activities for error confinement;
- supporting the provision of error detection and handling.

Coordinated Atomic Actions (CA Actions)

CA Action



Borrowed from A. Romanovsky

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Coordinated Atomic Actions (CA Actions)

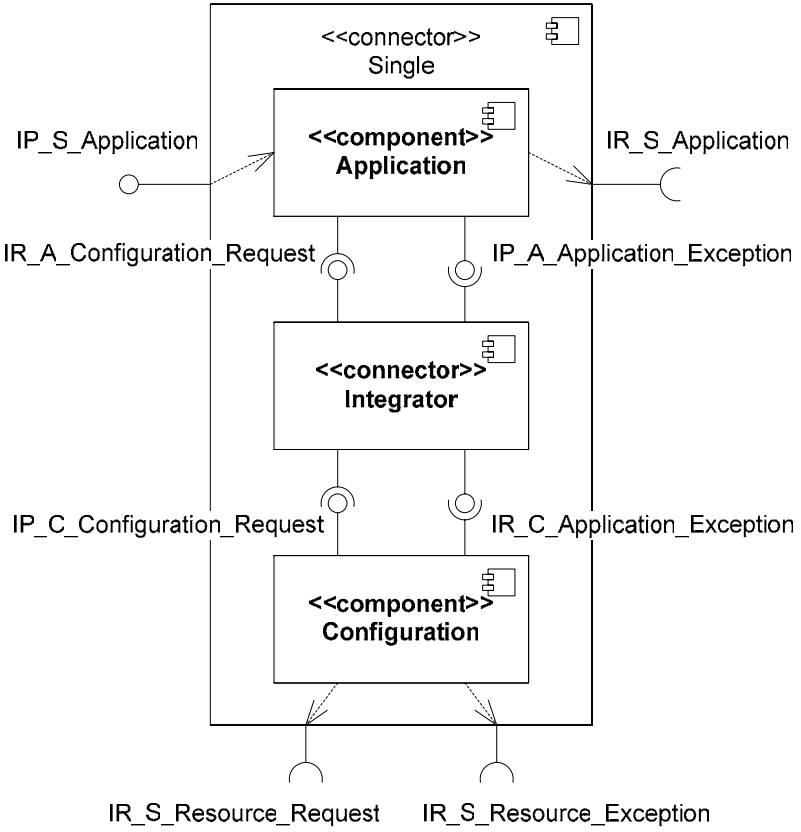
Existing applications of CA actions:

- it has focused on error handling – application dependent;
- fault handling are considered in the context of the application;
- there is no explicit separation of concerns between application and reconfiguration services;

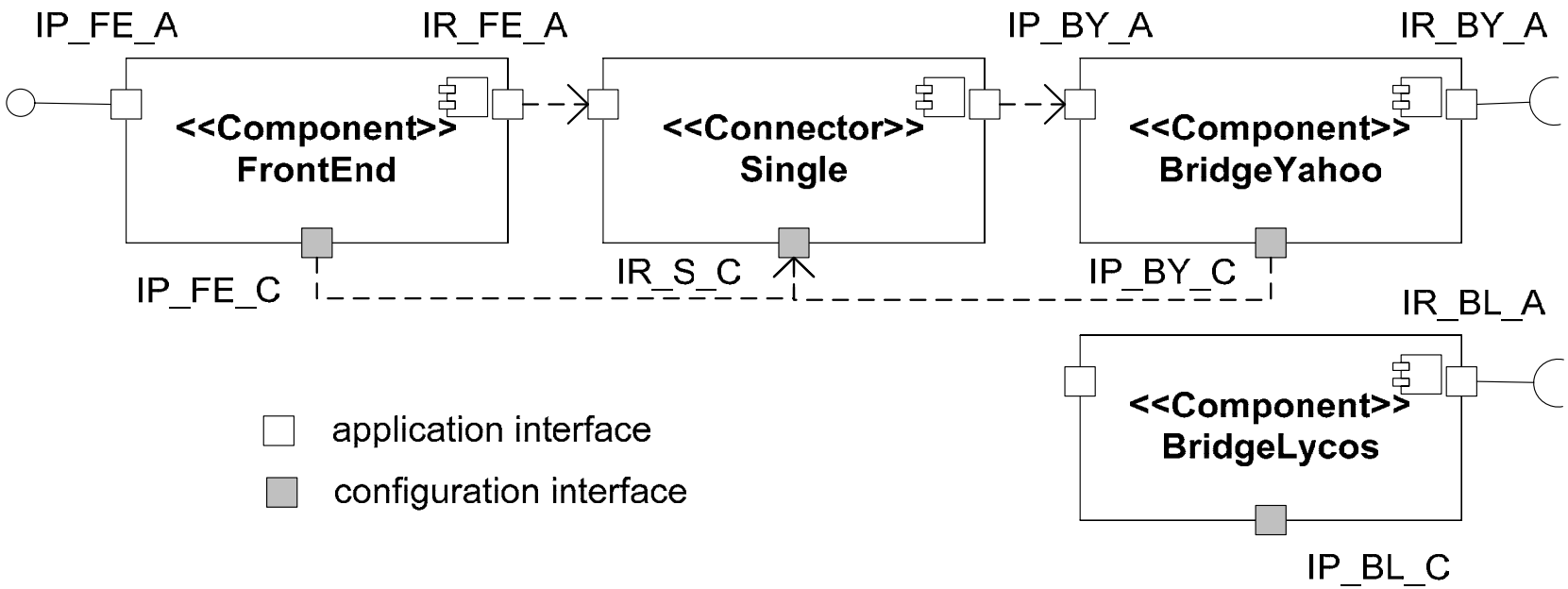
Separation of Concerns

At the level of the architectural element:

- internal structuring for the purpose of error confinement;
- more attention to each part, and their interaction;
- promotes reuse on configuration services since they are similar across architectural elements.

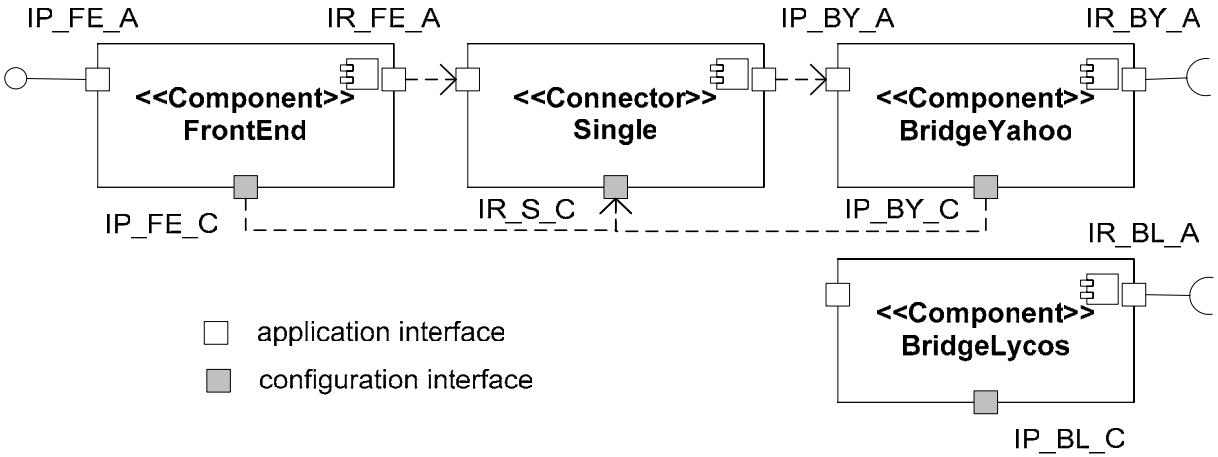


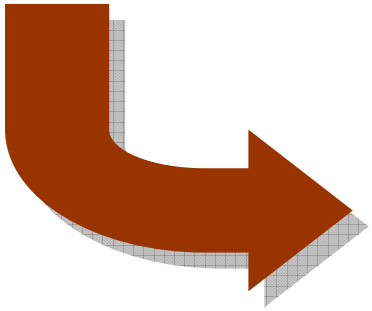
Reliable Stock Quotes

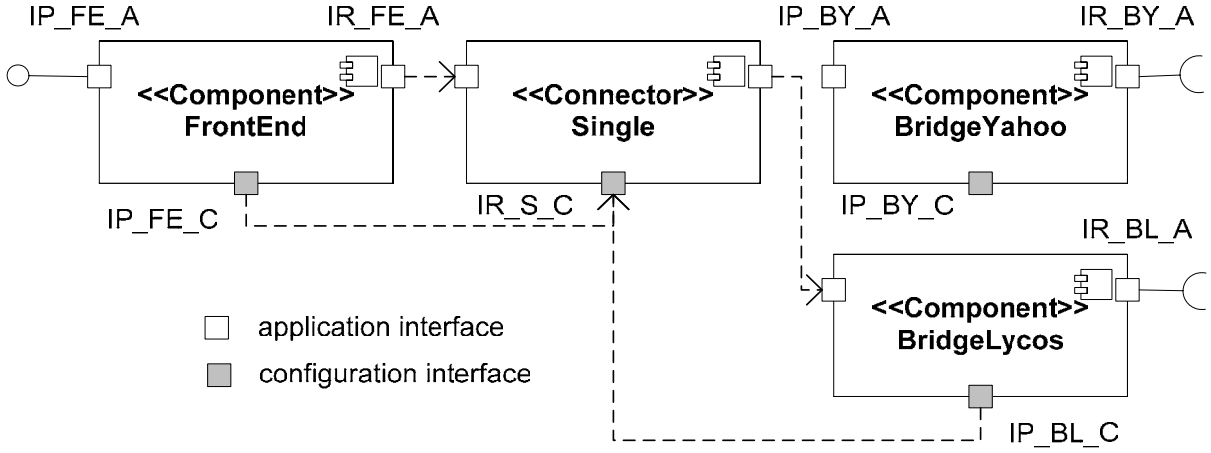


- Peer-to-peer architectural style;
- Architectural elements:
  - stereotyped UML2.0 components;
  - Provided and required interfaces;

Replacing Components







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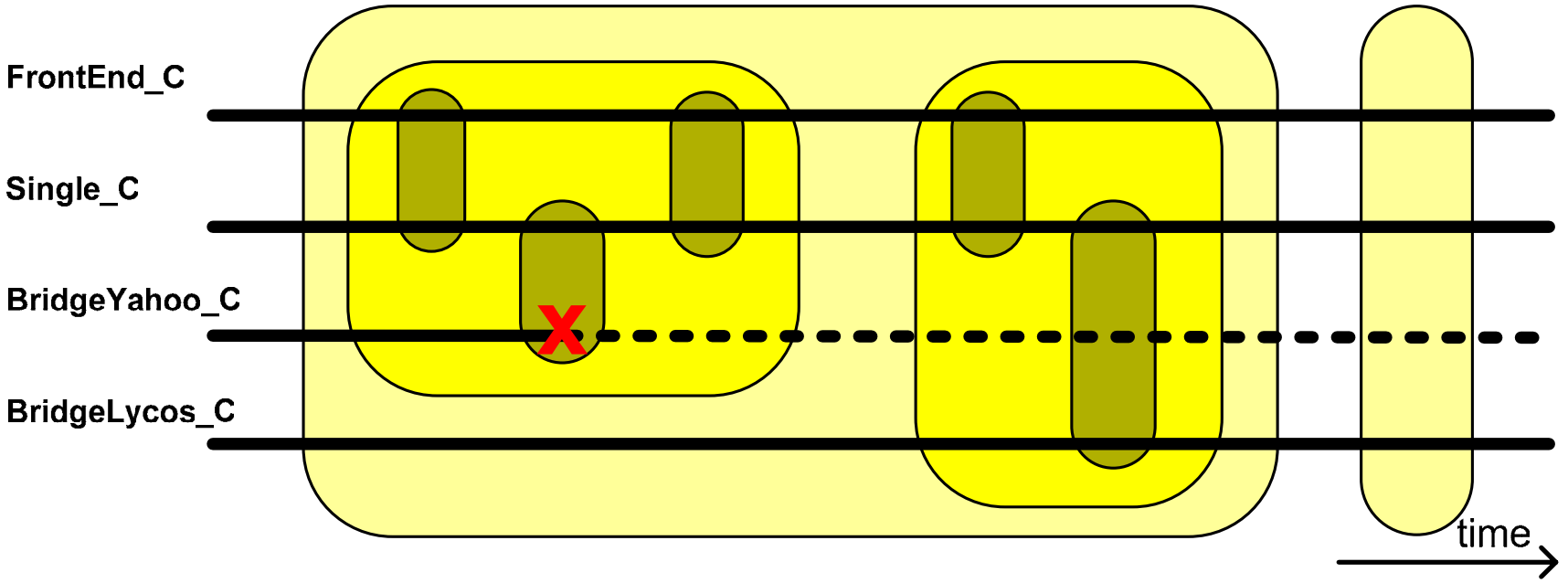
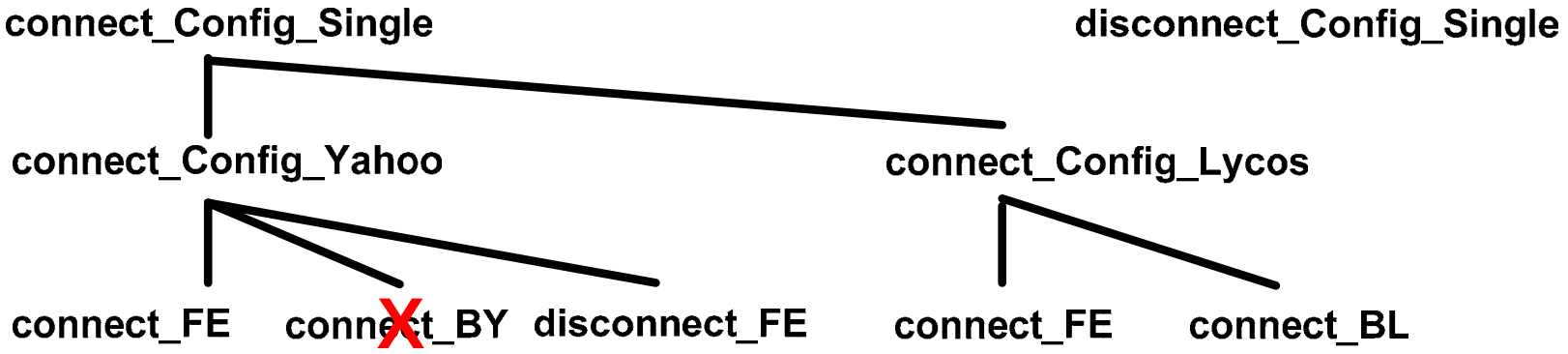
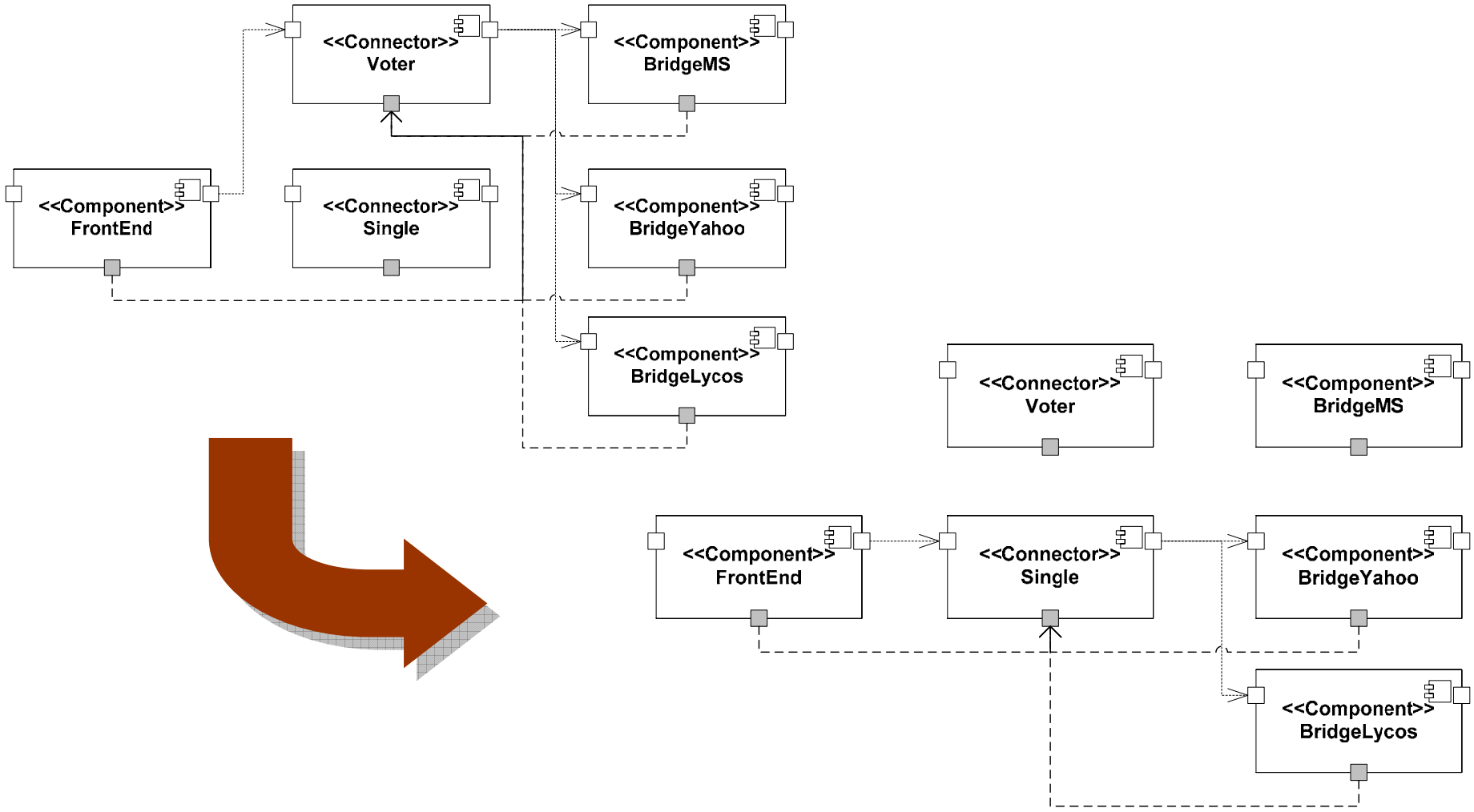
Replacing Components

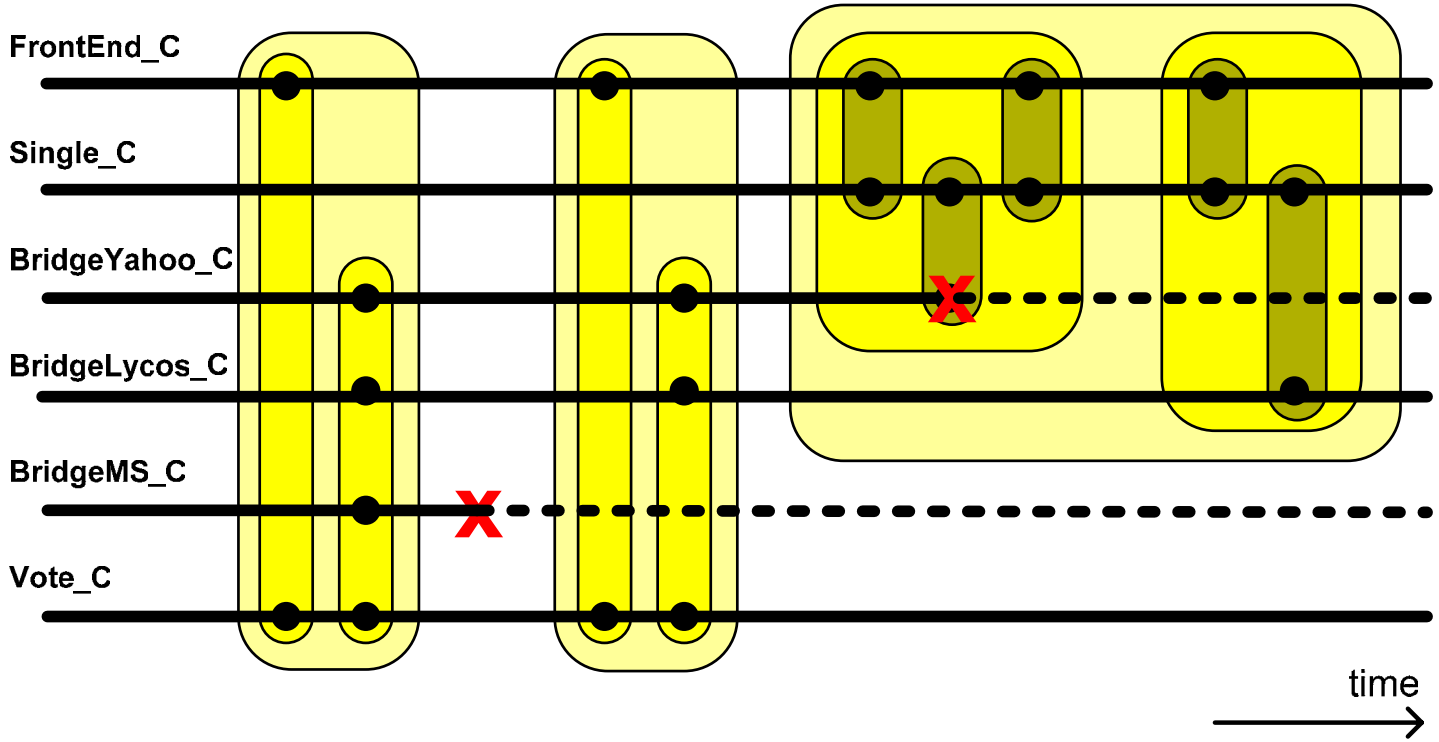


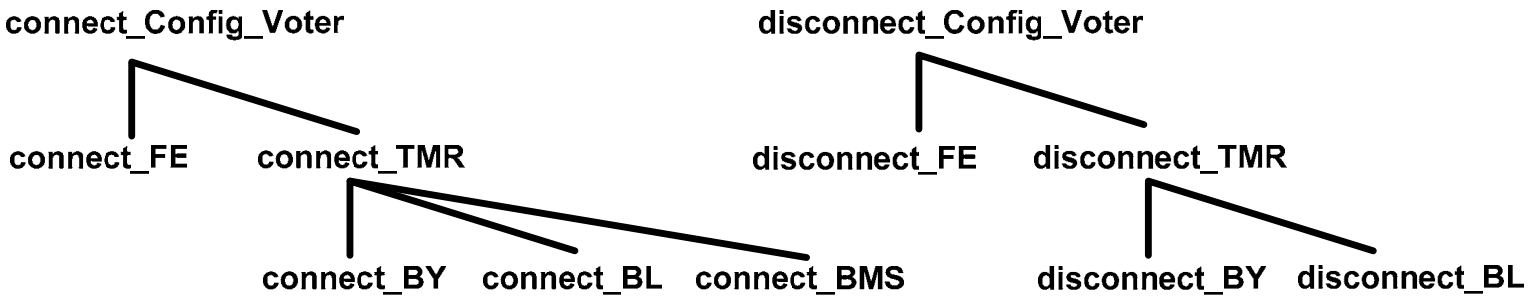


Replacing Connectors



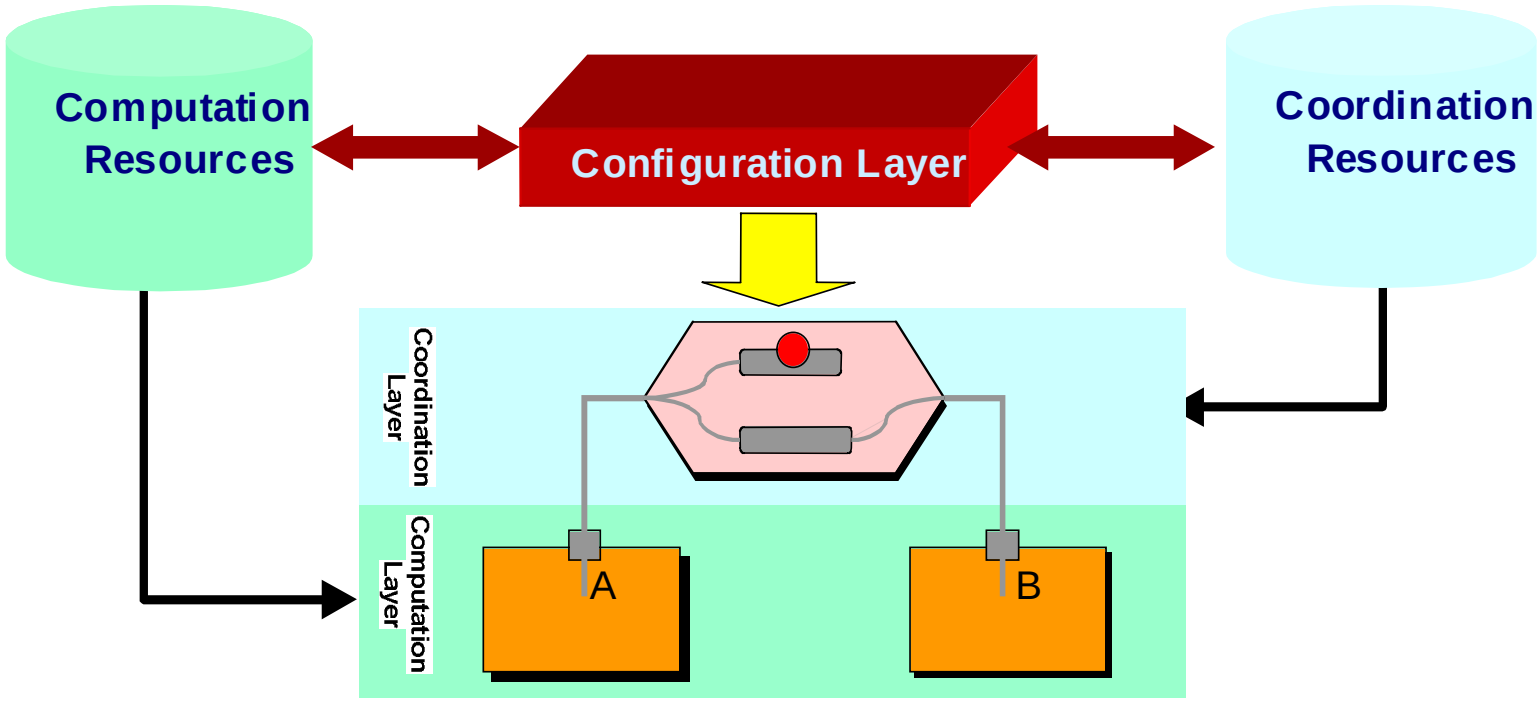
Replacing Connectors





Separation of Concerns

Computation, *coordination* and *configuration* (CCC) system architecture [Fiadeiro, Wermelinger, Andrade, etc.]



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Conclusions

- Applying CA actions as a mechanism for supporting dynamic architectural configuration;
- Separation of concerns between:
  - error detection and recovery, which is application dependent;
  - fault handling, which can be incorporated into the middleware;
- For self-adaptive systems, structural flexibility is obtained by:
  - small increments in the system configuration that can be undone in case of failure;

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Conclusions

- Fault tolerance at the architectural level
  - error detection and handling:
    - application dependent;
    - idealised Fault Tolerant Architectural Elements (iFTE);
  - fault handling:
    - not application dependent;
    - reconfiguration support by CA action;