Using Component Redundancy for adaptive, self-optimising and self-healing Component-Based Systems

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Main Topics

- Targeted domain
- Motivation
- Our approach – component redundancy
  - What is component redundancy ?
  - Example
  - How does component redundancy work ?
  - Framework implementation
- Conclusions & future work

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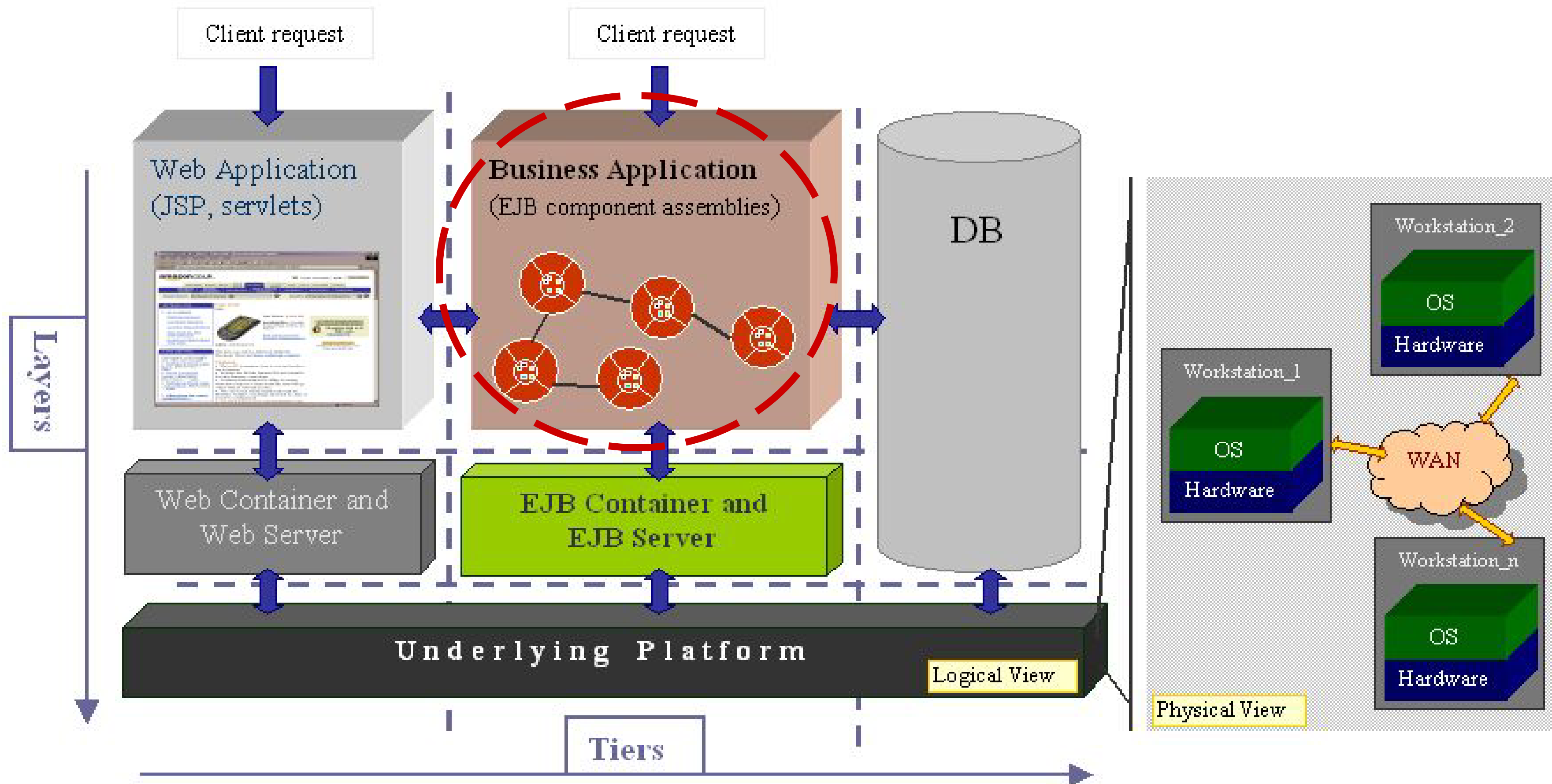
Targeted domain – Enterprise software applications



•We are targeting the business logic tier of enterprise software applications

•Quality characteristics - influenced by all tiers and layers involved

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Motivation

- Enterprise software applications - Characteristics:
  - Complex, large-scale
  - Highly distributed and parallel
  - Non-real time, Soft quality requirements (performance, reliability)

  ⇒ Complicated & expensive design, testing, management processes

  ⇒ Reduced flexibility

  ⇒ Quality characteristics hard to control
- Component-Based Software Development (CBSD):
  - Benefits: modularity, reuse, shorter development time, lower costs
  - New challenges: **lack of information**
    - At component development: ?overall system, platform, resources?
    - At system integration: ?component insight information, changing resources/ requirements at runtime?
- Impossible to exhaustively test such software apps. offline

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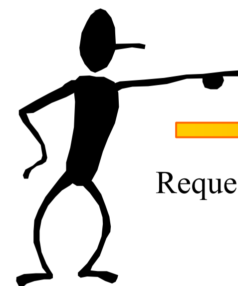
Component redundancy – what is ?

- Multiple Software Component Variants, with:
  - Identical interfaces, Equivalent functionalities (i.e. offered services) and
  - Different design and/or implementation strategies

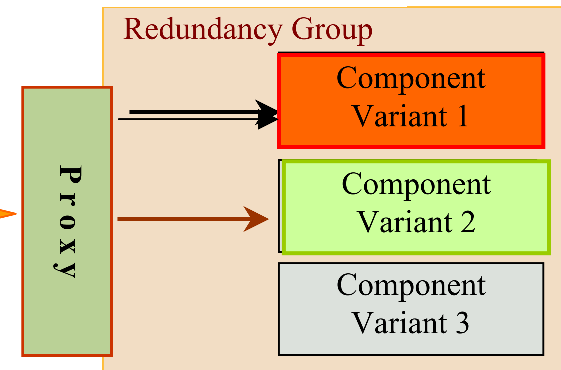
  are available at run-time
- Only one component variant is *active* at all times

  - instantiated for handling client requests -
- Variants are used alternatively, ‘complementing’ each other
- Variants are replaced in case of:
  - Poor/ non-optimal performance
  - Fault detection
  - Changing requirements, or running-context

Improved Performance / Poor Performance



Request Service



Redirect Requests to Component Variant 2

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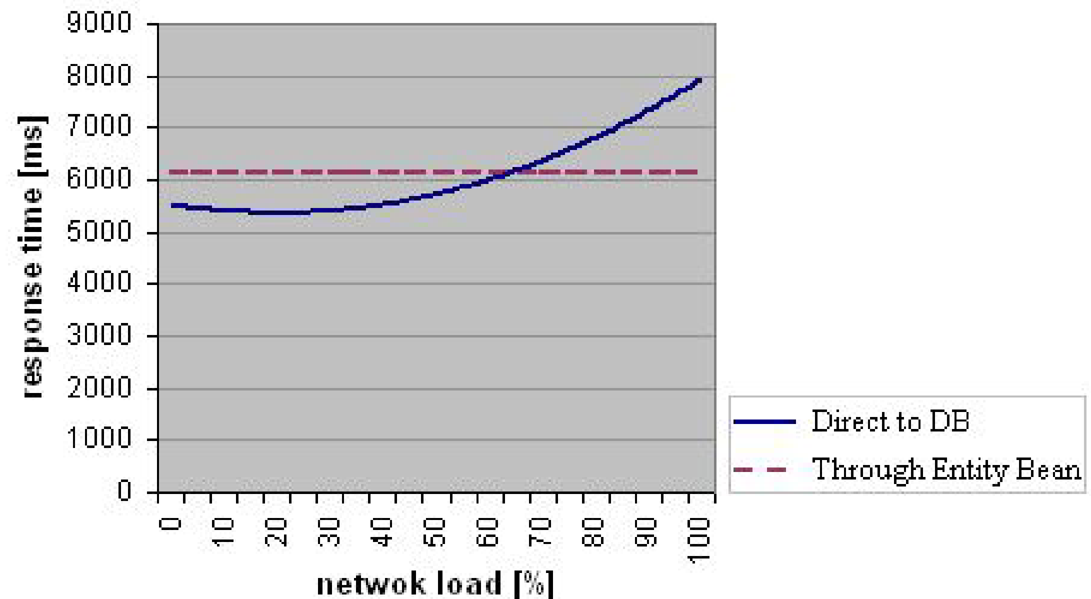
Example

- Used EJB component technology
- Two component implementations:
  - Same functionality: retrieve information from a remote DB
  - Different design: Direct DB vs. Using Entity Bean

Response-time
variations with
Network load
on the link to the DB

⇒Alternating variants yields better performance, at all times



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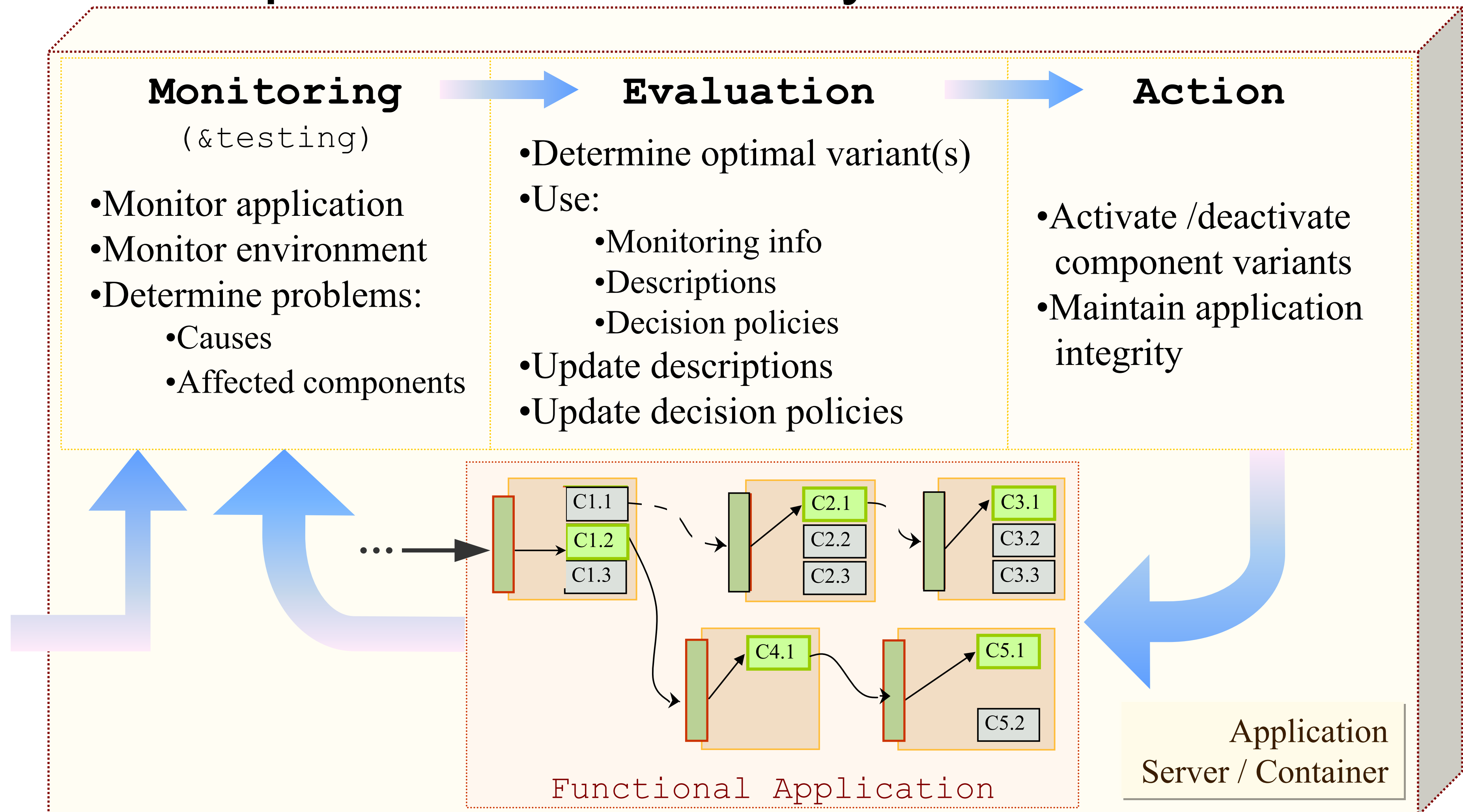
Component redundancy – how it works



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Distributed adaptation mechanism

- Motivation: centralised adaptation mechanisms might:
  - Introduce unnecessary overhead
  - Not scale well
- Adaptation mechanisms with different scopes:
  - Component
  - Group of components
  - Entire application
- Hierarchical organisation
- Local problems:
  - Initially dealt with locally
  - Signalled to higher level adaptation mechanisms (if necessary)
- Periodic global optimisations

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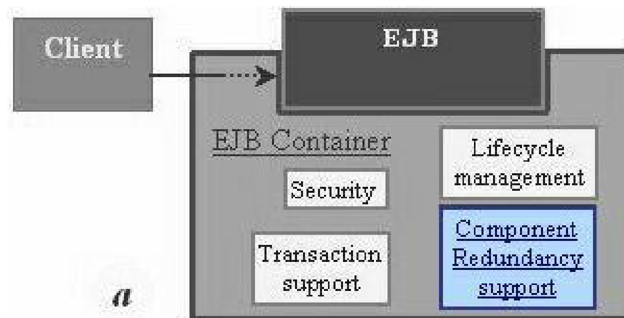
Framework Implementation

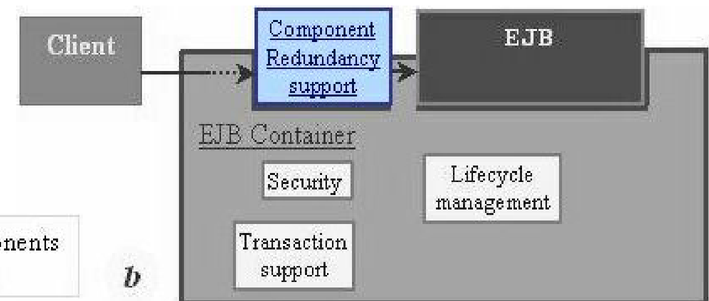
- Independent of specific applications
- Two options:

a) Distributed platform level



All client calls to EJB components go through an EJB container

b) Software application level



- Maintain application integrity:
  - Component swapping implemented by means of client call indirection
    - No state transfer
    - Keep client references consistent using the proxy pattern

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Conclusions & future work

- Component-based enterprise software
- Difficult to provide and maintain performance and dependability:
  - Lack of information
  - Changing requirements and execution contexts
- Our approach: using component redundancy (overview, general framework)
- Expected benefits:
  - Automatic performance optimisation
  - Recover from and avoid integration faults
  - Adapt to changing requirements, resources, workloads
- Future work:
  - Identify and implement relevant examples
  - Design and implement proof-of-concept framework
  - Identify and integrate work on monitoring, component descriptions, knowledge based management,…

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