Combined Error Propagation Analysis and Runtime Event Detection in Process-driven Systems

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- Motivation and our contributions
- Approach
- Motivational example
- Design time analysis
- Runtime analysis
- Future work and conclusion

Motivation

- Analyse complex IT system
  - During development
  - During integration
  - At runtime
  - Based on system models
- Generate analysis for huge systems
- Extendable

Process modelling

- Business process:
  - Directly executed models (e.g. BPMN)
- In a complex systems there are many supporting resources
  - We present a method for business process and supporting resources together
  - Only general tools:
    - Markov chains, Event trees
    - Too general, modelling could be hard
  - Development tools
    - Basic performance analysis
    - Business activity monitoring

Contributions

- Multi aspect modelling of complex (IT) systems
  - Custom, general process and resource model
- Qualitative error propagation analysis
  - Root cause and sensitivity analysis
  - Using finite domain constraint satisfaction problem
- Runtime process monitoring

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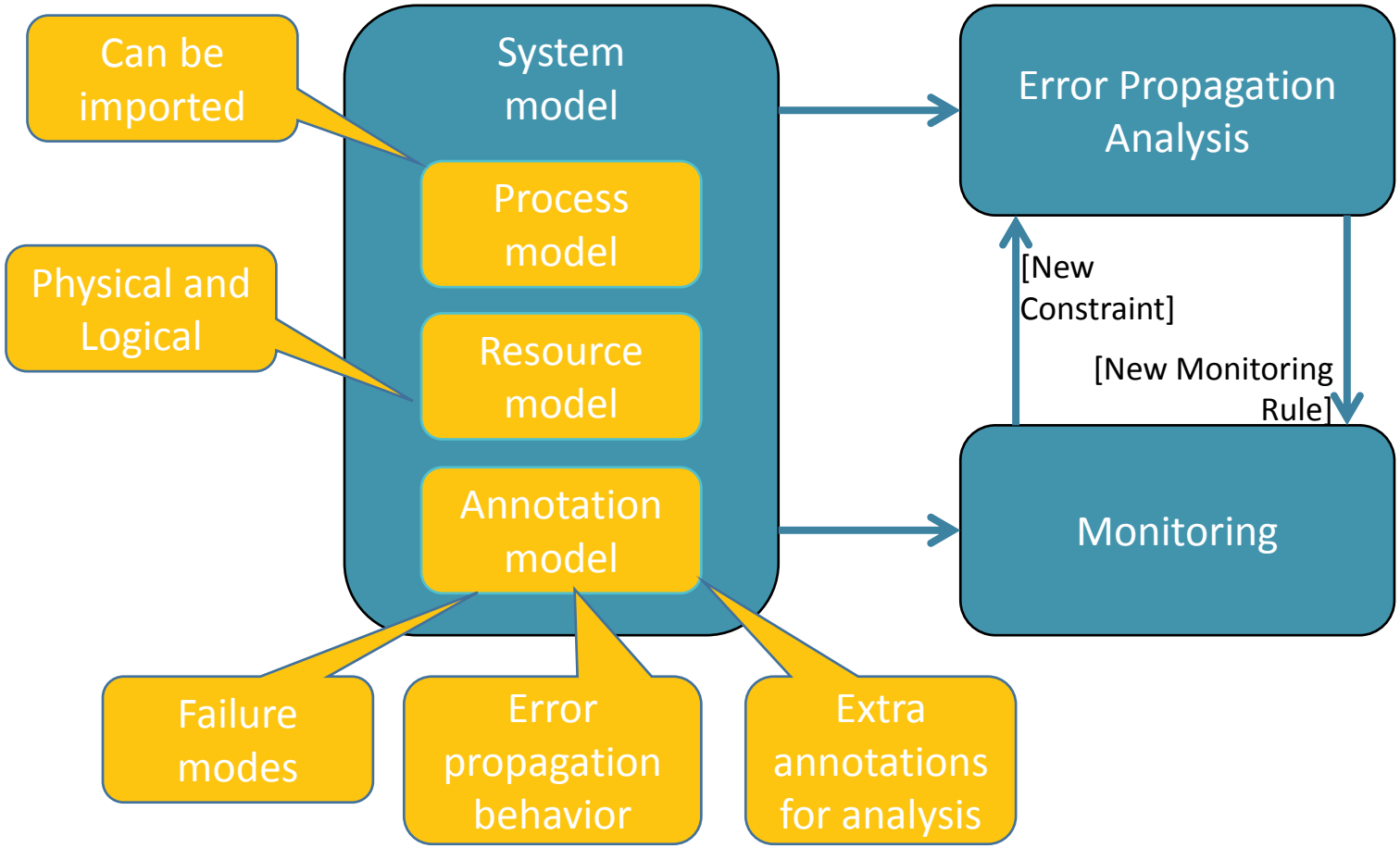
Approach


Can be imported
System model
Process model
Physical and Logical
Resource model
Annotation model
Failure modes
Error propagation behavior
Extra annotations for analysis
Error Propagation Analysis
[New Constraint]
[New Monitoring Rule]
Monitoring

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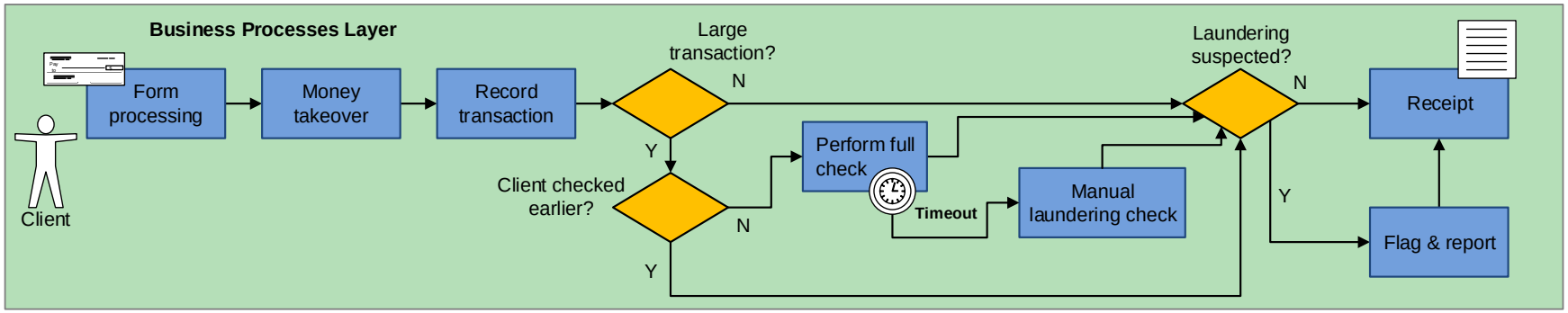
Motivational example

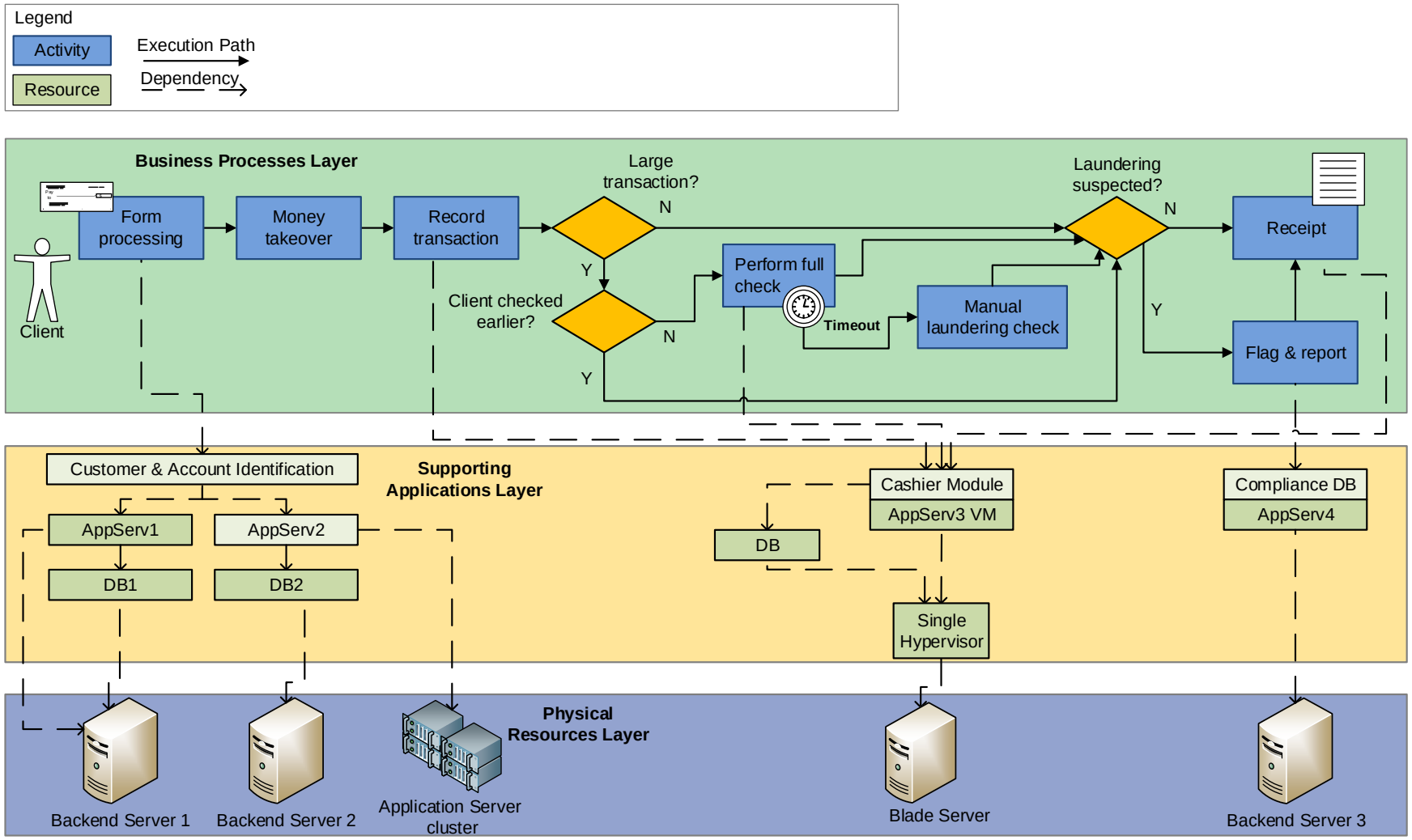
- Design time analysis capabilities
  - SPOF analysis
  - Process-level effects of resource faults
  - Propagating resource errors to the resource layer

Case study

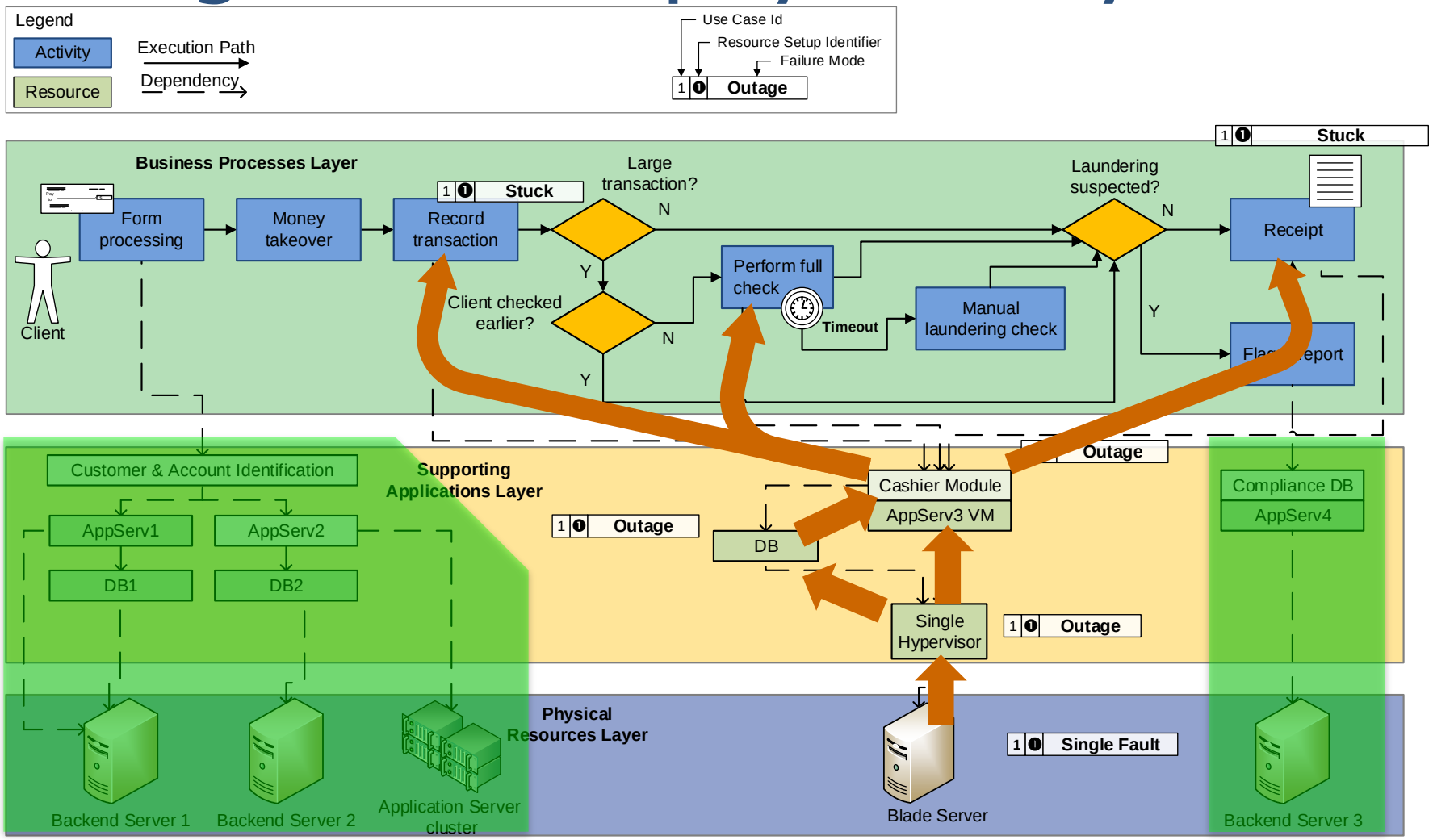

Legend
Activity
Execution Path


Business Processes Layer
Client
Form processing
Money takeover
Record transaction
Large transaction?
N
Y
Client checked earlier?
N
Y
Perform full check
Timeout
Manual laundering check
Laundering suspected?
N
Y
Receipt
Flag & report

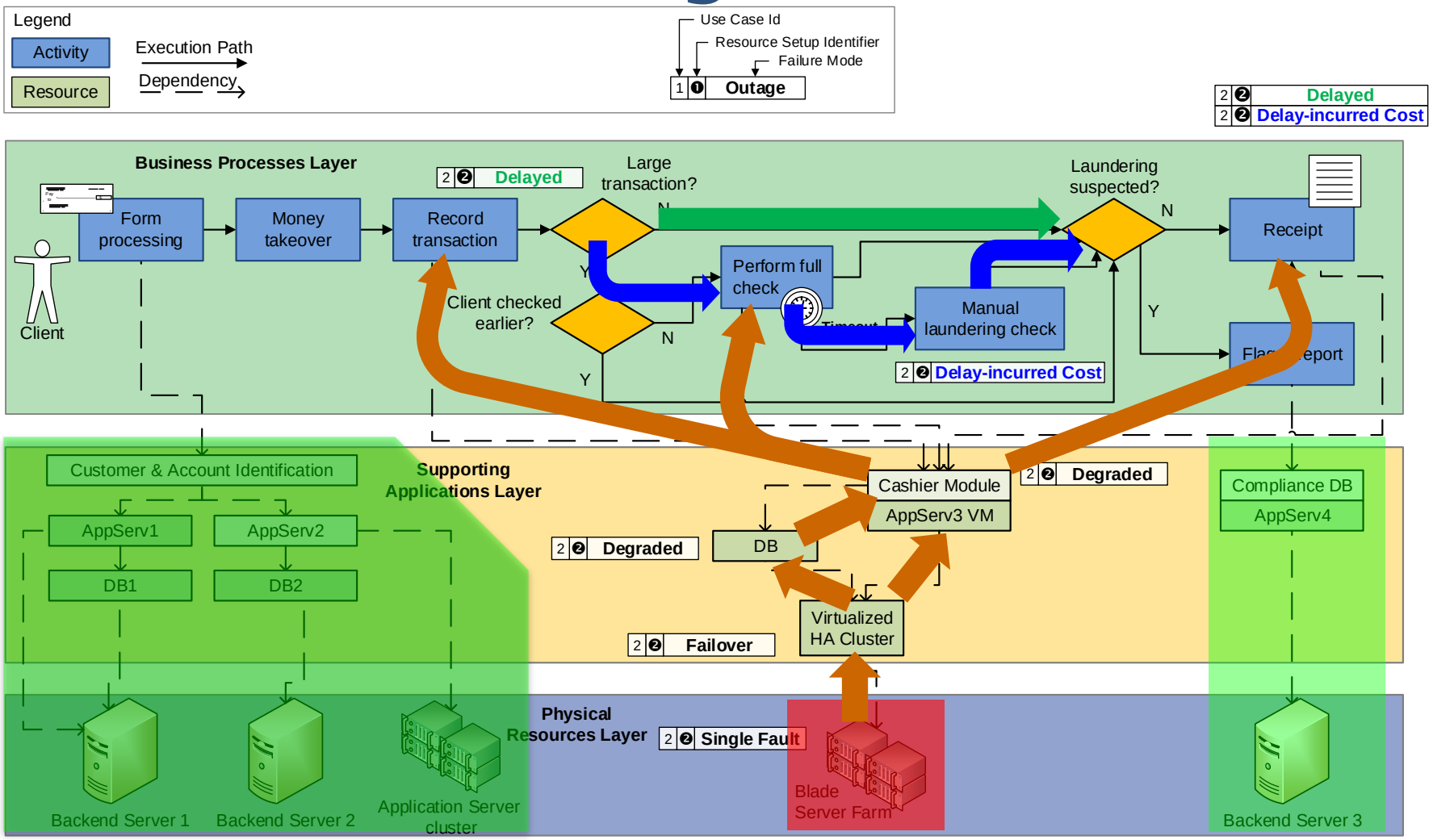
Process with resources



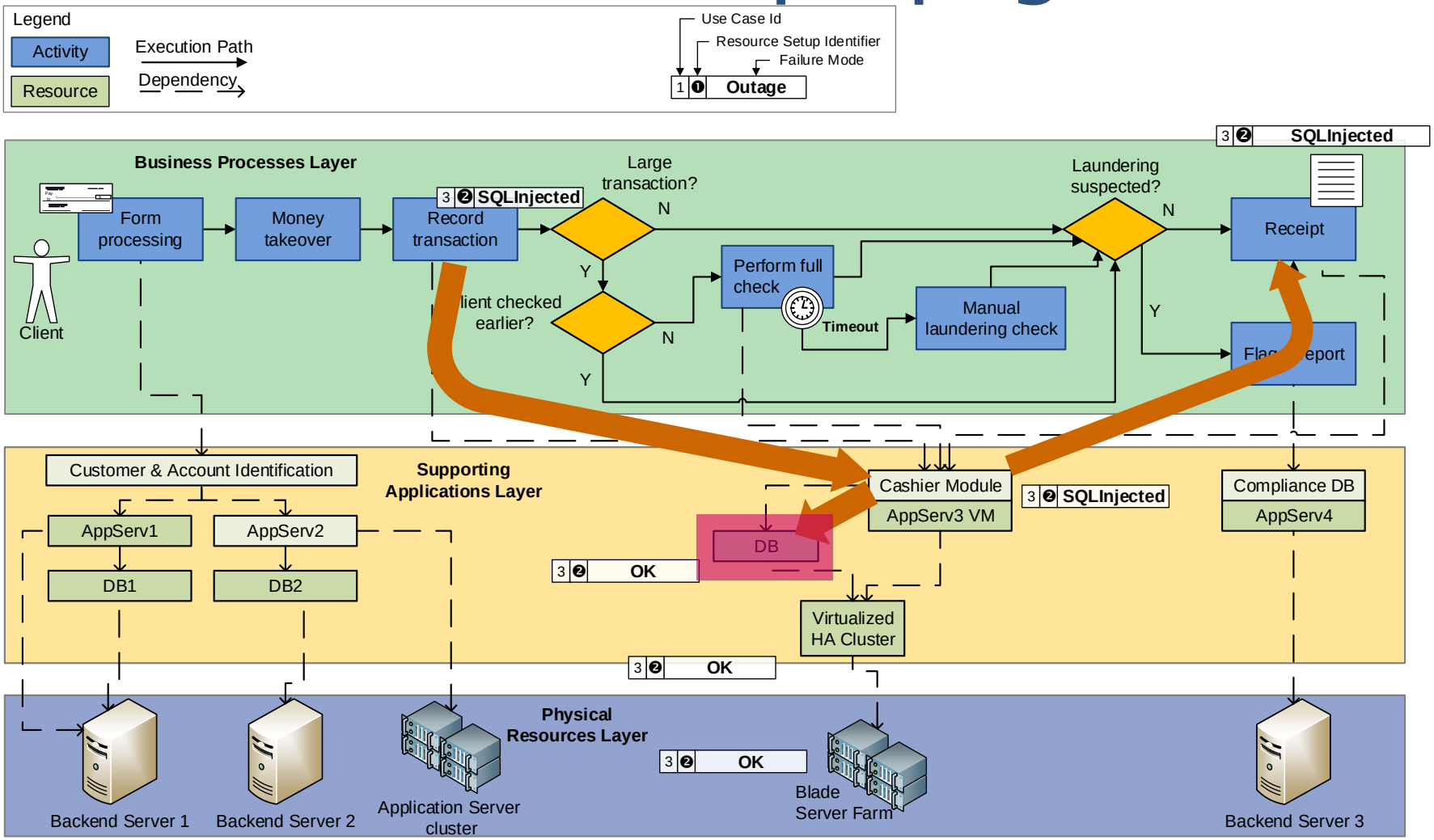
Single fault in physical layer



Effects of a single fault



Backwards error propagation



Motivational example

- Design time analysis capabilities
  - SPOF analysis
  - Process-level effects of resource faults
  - Propagating process errors to the resource layer

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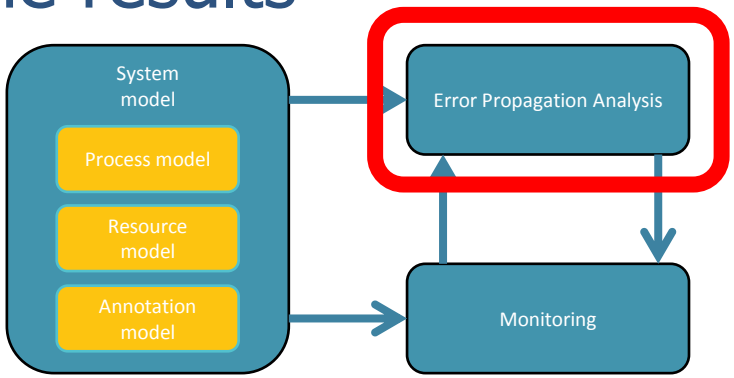
Design time analysis

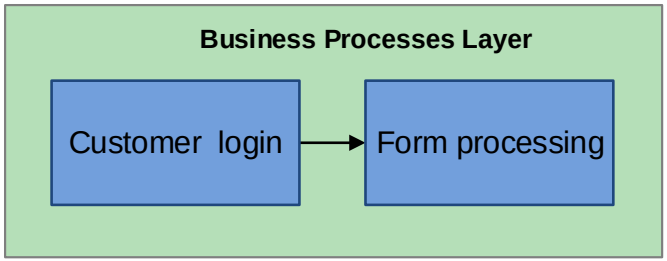
- Error propagation rules
  - Through the process' execution path
  - Through dependencies
- Translate model to constraint satisfaction problem (CSP)
- Solution of the CSP provide the results
  - Of root cause analysis
  - Sensitivity analysis



What is CSP?

- Constraint satisfaction problem
  - Problems defined mathematically
    - A set of variables
    - Constraints between them
- A general solver can find the solution
  - A single or a list of variable layouts
  - All constraints satisfied

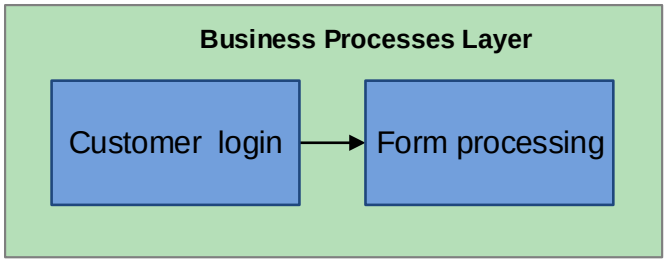
Sample mapping to CSP



(Customer_login_run)

(Form_processing_run)

Sample mapping to CSP



(Customer_login_delay & Customer_login_run)

(Form_processing_delay)

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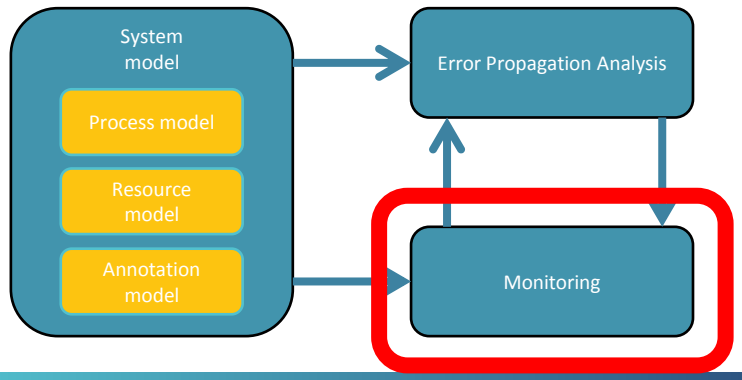
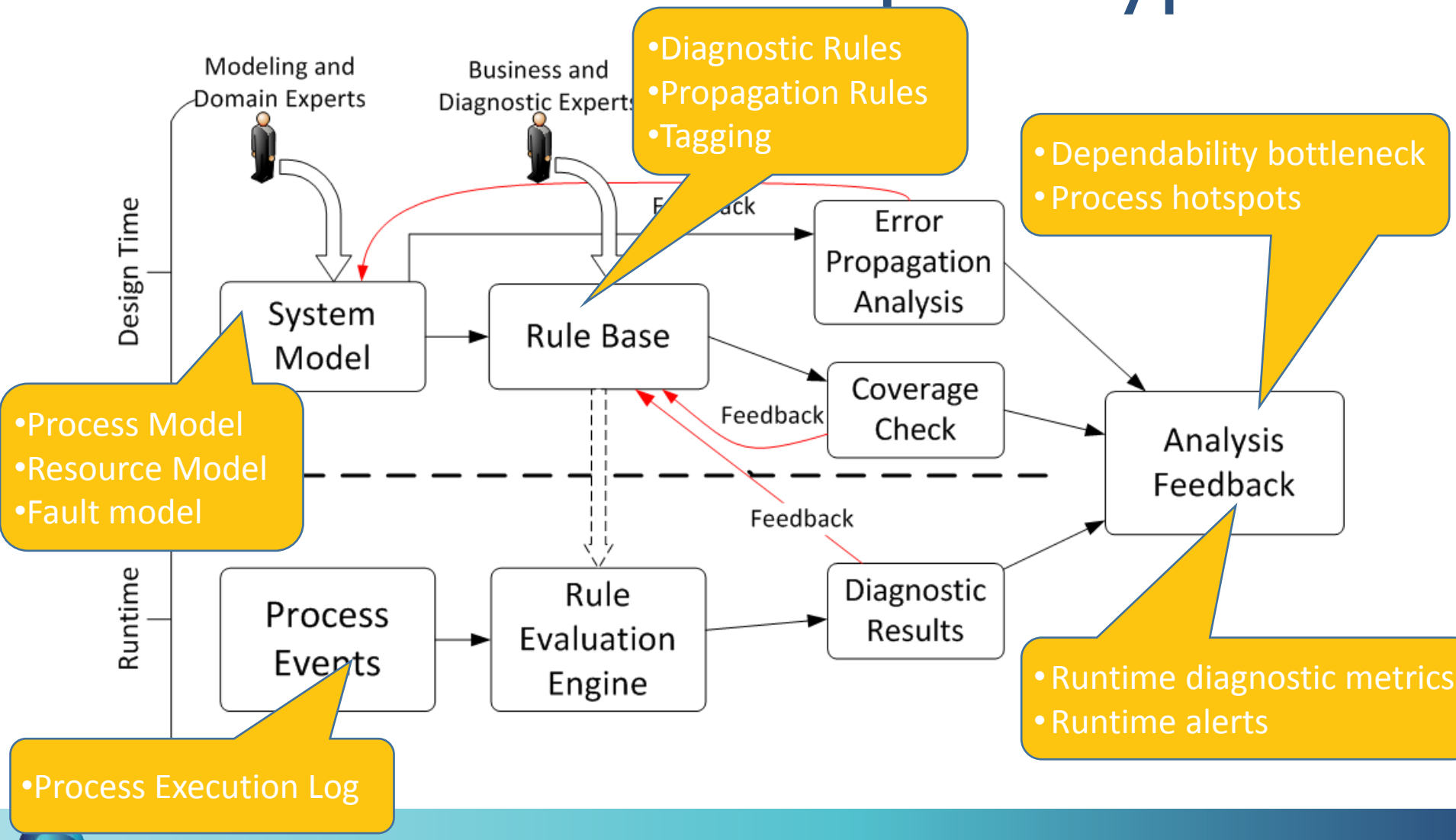
Runtime process monitoring

- Runtime monitoring based on the same model
- Rule based online event processing
  - Events captured during the execution
  - Each time a rule satisfied
    - Notification can be recorded
    - Update of rule-specific process metrics
- Coverage checks
- Annotation-based rule synthesis



Architecture of the prototype



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Future work

- System model and fault model „libraries”
- Hierarchical modelling
- Hierarchical/Incremental CSP evaluation
- Uncertain failure modes
- Back annotation of monitoring results
  - Qualitative abstraction
- Precise modelling frontend
- Connection with optimisation methods

Conclusion

- Design time analysis of business processes
  - With the use of a resource model
  - Root cause analysis
  - Determine weak points
- Rule based runtime diagnostic
  - Process monitoring based on event processing
  - Rule synthesis
  - Coverage test