An automated interference identification approach

Towards INFoRMED - INterFerence Removal MEthoD

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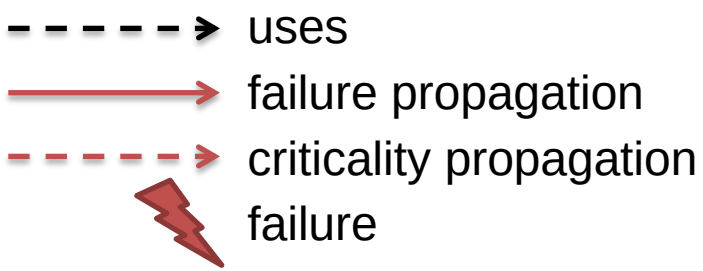
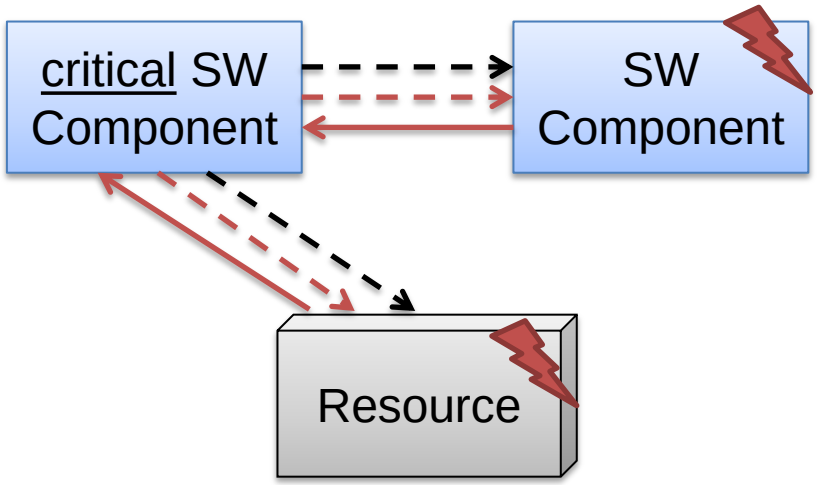
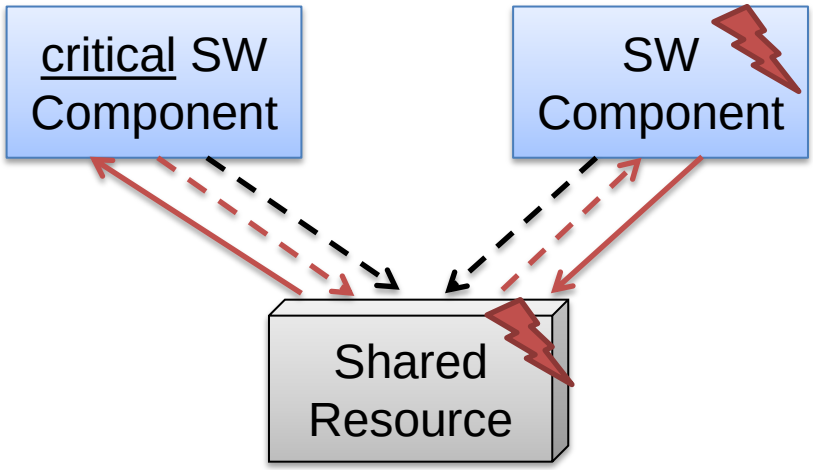
Introduction



traditional fault propagation



“interference“ fault propagation

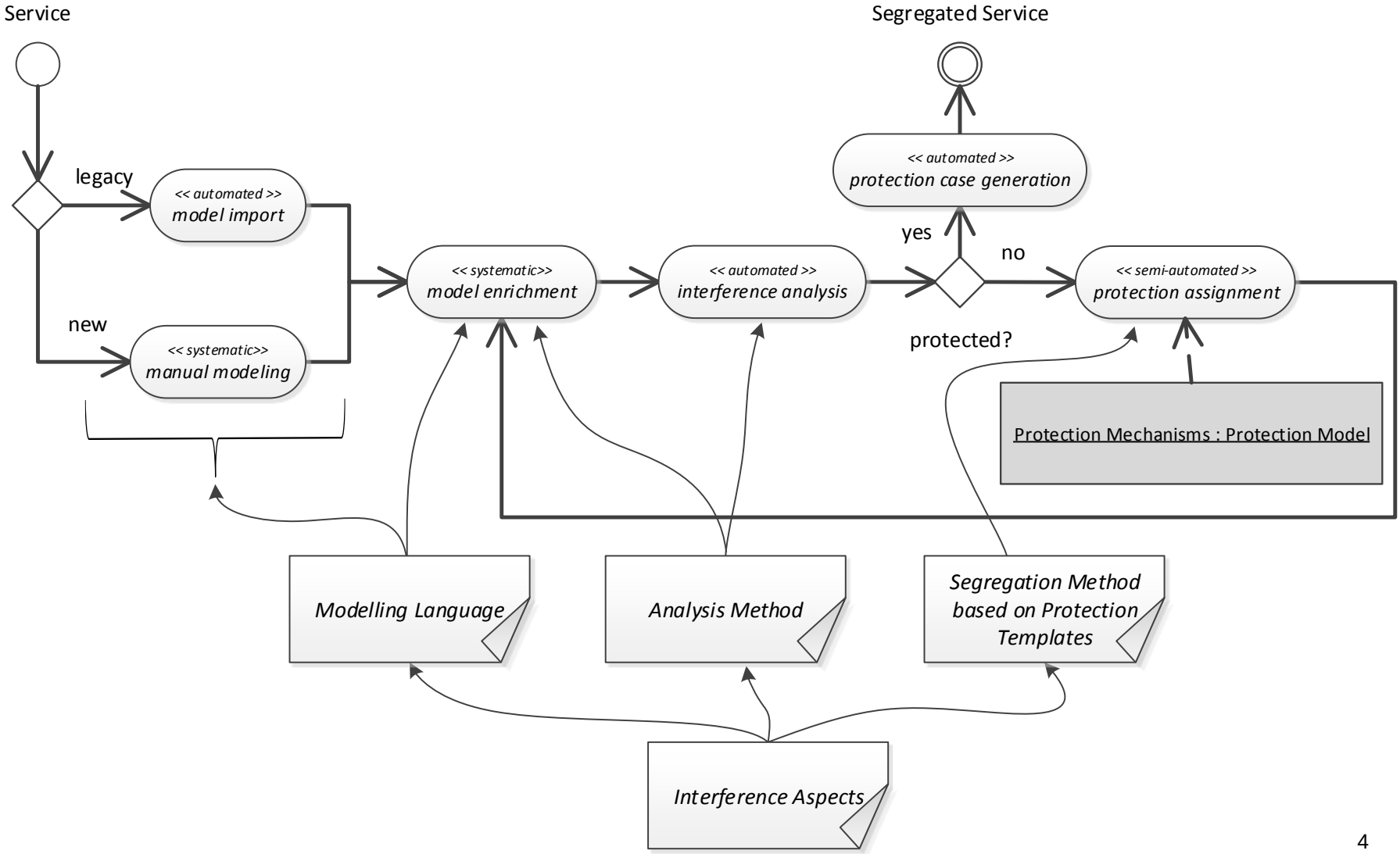


- We define an interference as a cascading failure via a shared resource
- Typical example: Memory corruption, CPU monopolization
- Threat to an integrated system (see AUTOSAR or IMA)
  - Can lead to undesired criticality inheritance

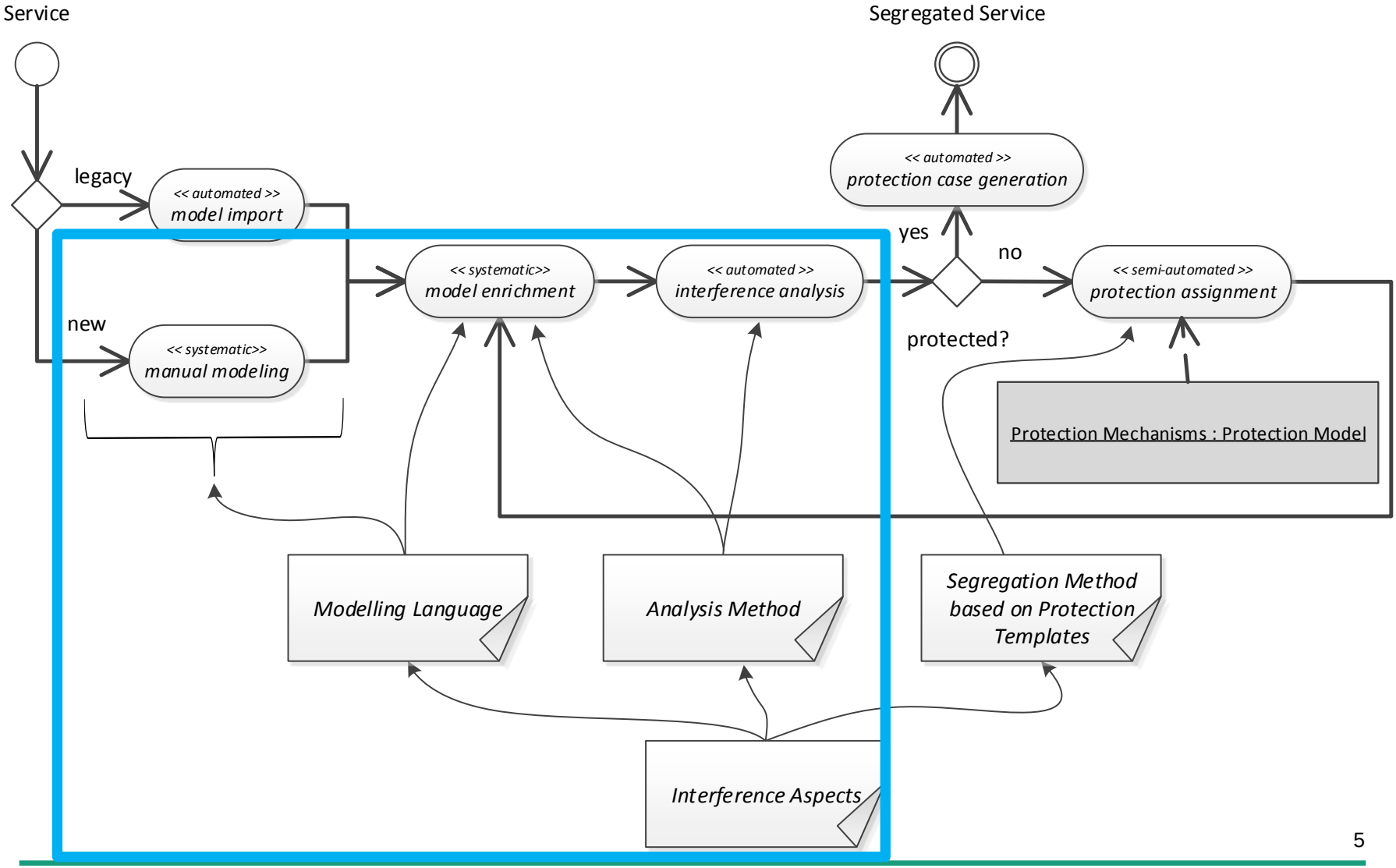
Motivation

- Current situation
  - Movement towards mixed critical systems and more complex platforms
  - Methods and techniques deal with interferences caused by:
    - Dependencies via Scheduling & Memory
    - Physical resource connections (power and temperature)
- Problem
  - Complex computation platforms contain heterogeneous services
  - Little guidance for interferences caused by
    - Logical dependencies within a service?
- Our Solution Idea
  - Provide an automated approach for interference analysis of services
  - Increases confidence in the completeness of the analysis and
  - reduces the impact of human skill and judgment on the analysis quality

Solution Overview - INFoRMED



Solution Overview - INFoRMED



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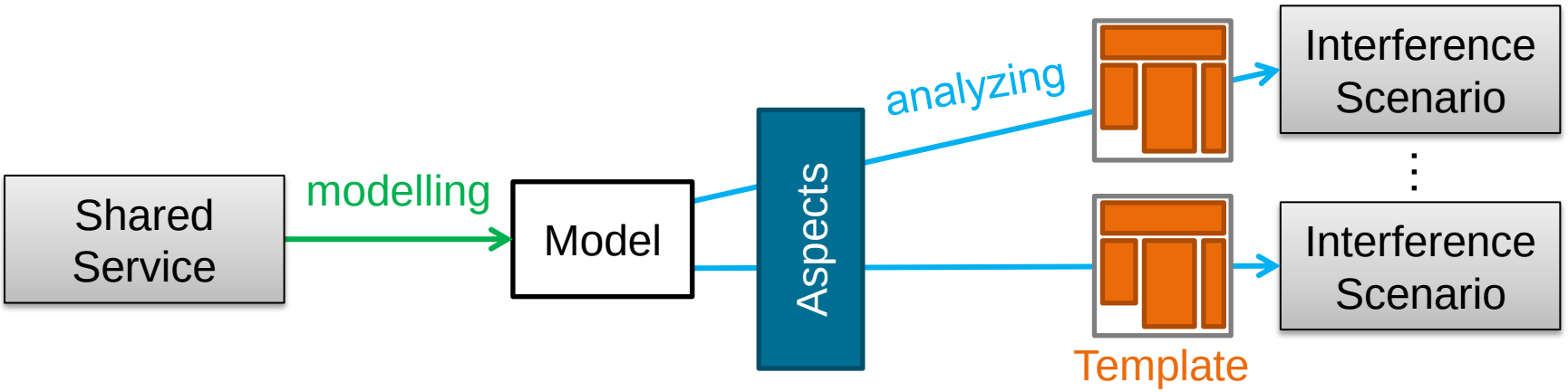
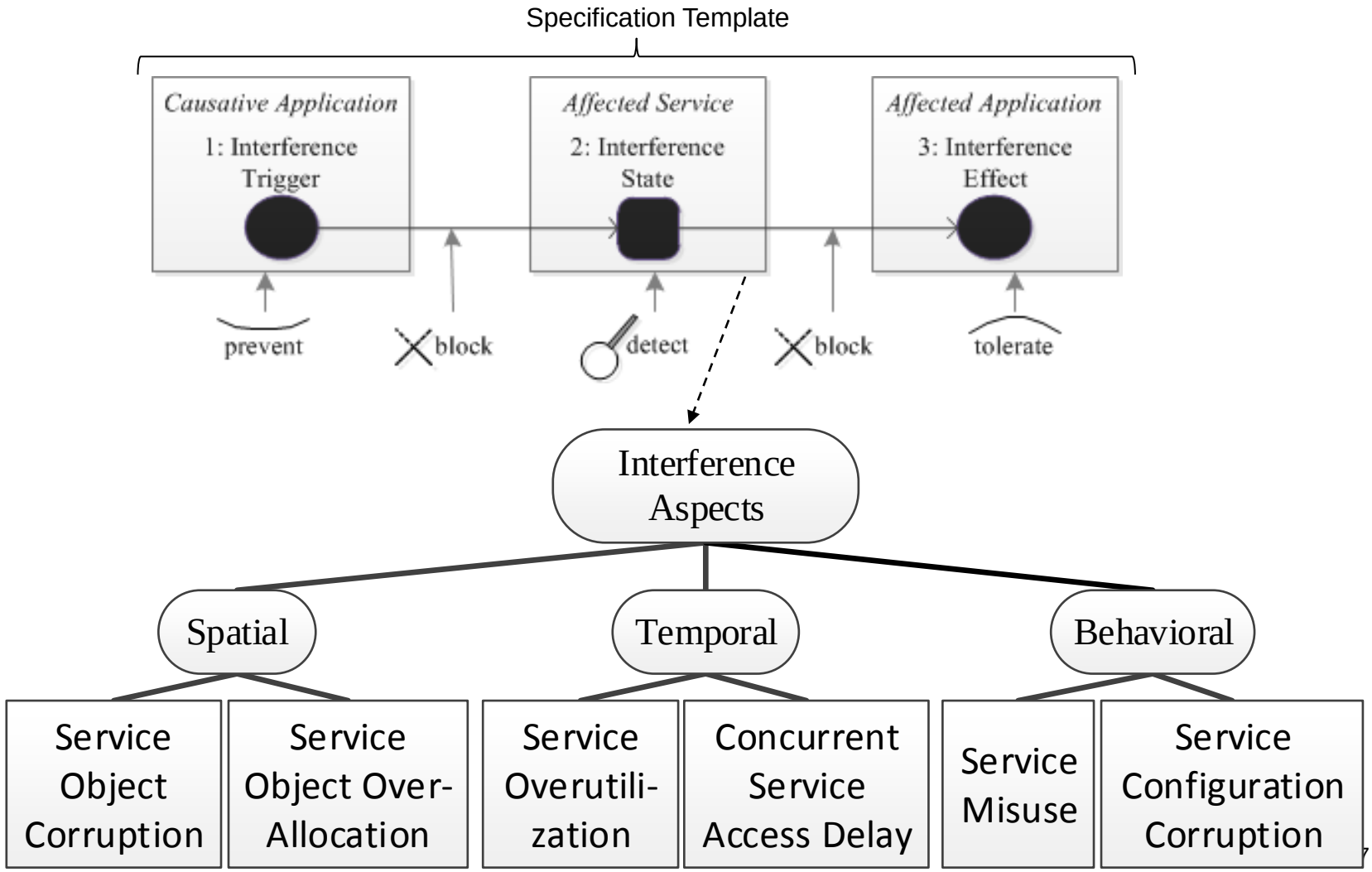
Solution – Service Interference Identification (1)

- Interference scenarios are analyzed for a shared service (e.g. a platform service for redundant execution or a memory management service, …)
- The interference identification bases on:
  - An interference specification template that allows a structured description
  - The interference aspects that defines different, independent classes of interference
  - The modeling language that allows an automated analysis
  - The analysis algorithm to extract the interference scenarios



Solution – Service Interference Identification (2)



Interference Aspects - Spatial

- Sharing Preconditions / Intention
  - The service or parts of it are not supposed to be shared
  - I.e.: Access to the service, or service part is limited to one, or a set of service users

- A Service Object Corruption occurs if
  - *“ … an unauthorized service user accesses or manipulates a service or service object”*
  - Example: Corruption of a data block of a memory management service …
- An Service Object Over-Allocation occurs if
  - *“… a service user allocates more service objects than specified”*
  - Requires that service objects can be allocated during run-time
  - Example: Over-Allocation of memory (e.g. via `malloc`), queue entries, …

Interference Aspects - Temporal

- Sharing Preconditions / Intention
  - The service is shared over time
  - I.e.: At any point in time, only one user can access the service

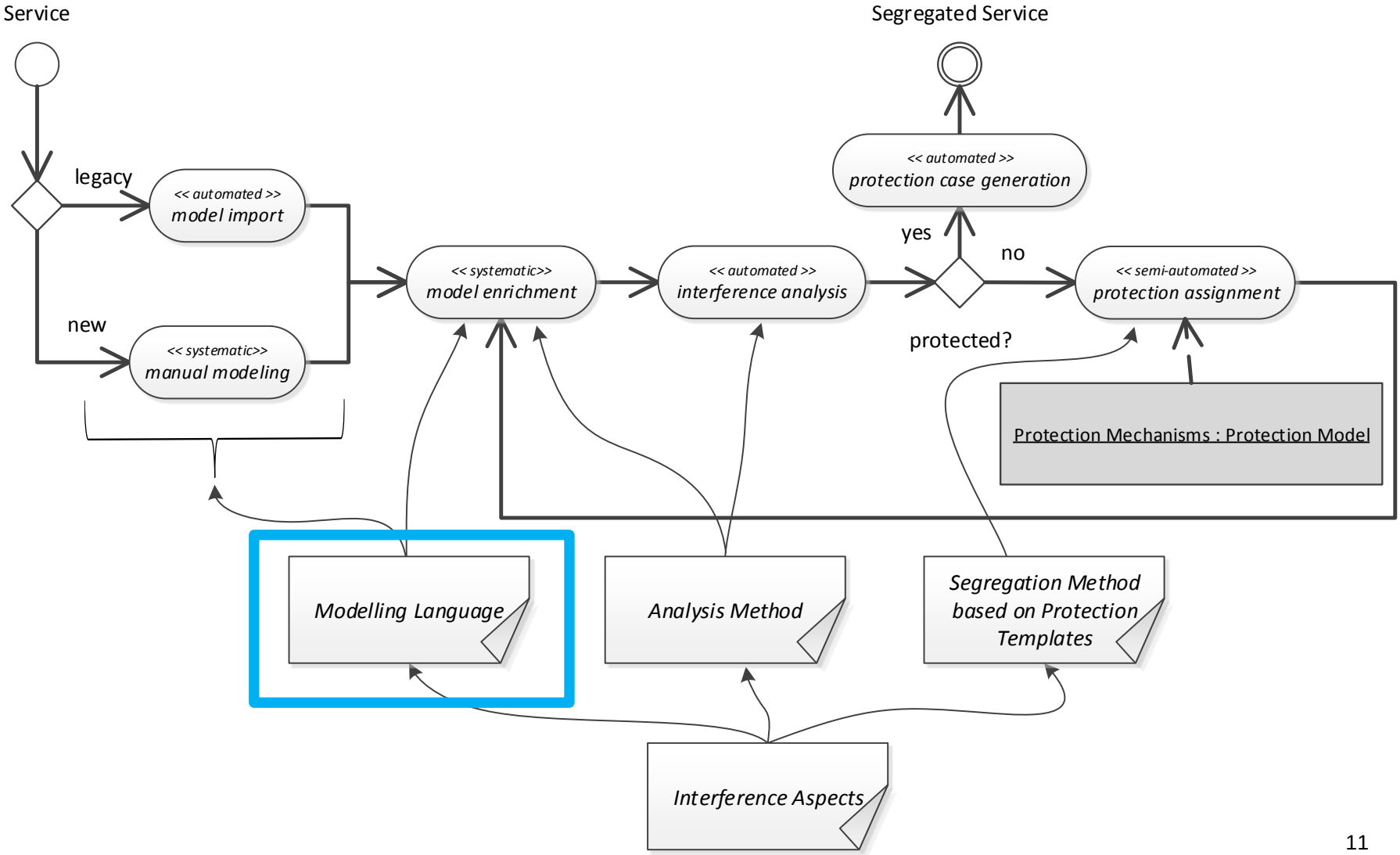
- A Concurrent Service Access Delay occurs if
  - *“ … a service user access a synchronization mechanisms of a service more often than expected*
  - Requires that the service can be accessed from applications in parallel. As a result the execution time of the waiting/ effected service user increases
  - Examples: Using spinlocks in a service implementation, …
- A Service Overutilization occurs if
  - *“ ... a service user’s maximum contention delay is exceeded”*
  - Requires that service accesses are arbitrated dynamically. As a result response time of affected service users increases
  - Examples: Overutilization of a service’s job queue

Interference Aspects - Behavioral

- Sharing Preconditions
  - The service, or parts of it are shared
  - I.e.: Different users are allowed to access the service

- A Service Misuse occurs if
  - *"… a service user erroneously changes implicit the functional behavior of a shared service"*
  - Requires that a service is capable of performing actions that have a service-wide or even system-wide effect
  - Example: an application termination leads to an undefined service sate
- A Service Configuration Corruption occurs if
  - *"… a service user erroneously changes the configuration of a shared service"*
  - Requires that *a service has configuration parameters changeable at runtime*
  - Example: Reconfiguration of a device driver service

Solution Overview - INFoRMED



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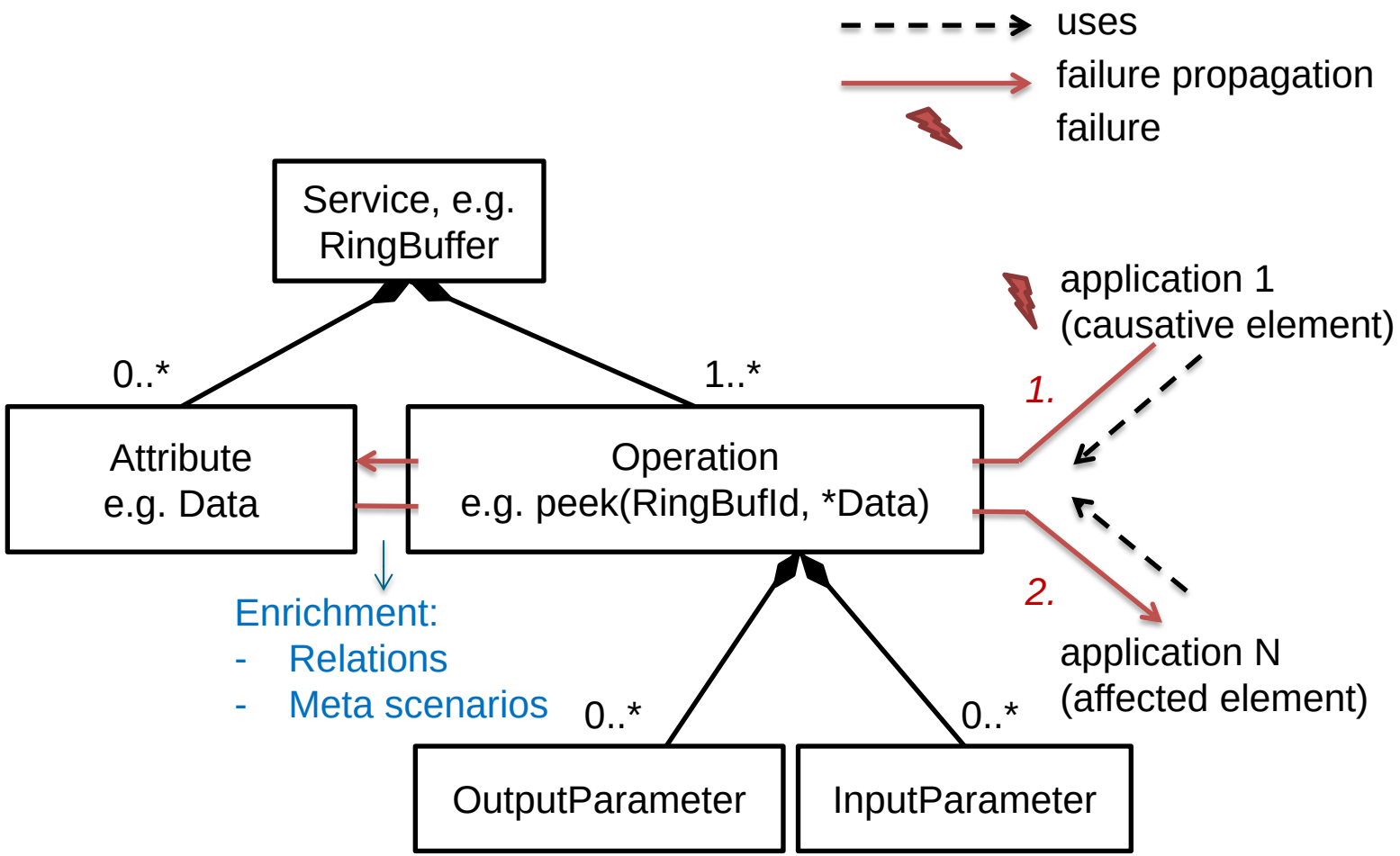
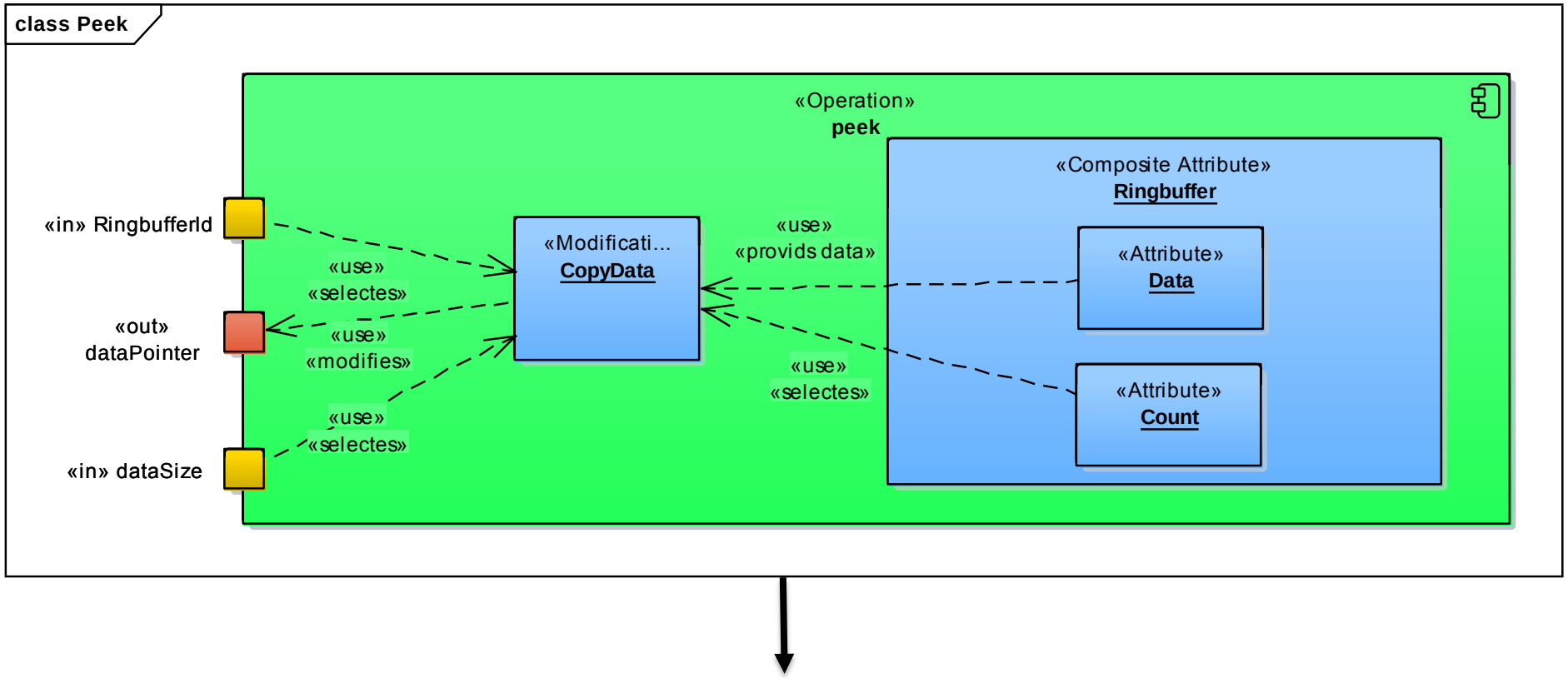
Solution– Modelling Language Basic Idea (1)

UML class model of a service:



Solution– Modelling Language Basic Idea (2)



Interference Channels

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Summary, Limitations and Future Work

- Summary
  - We present an automated service interference analysis approach
  - Proposed benefits are efficient service segregation and reduction of human skill- and judgment
- Limitations
  - Functional dependencies between service users are currently not considered (synchronization issues)
  - Correctness of a service model depends on human skills
- Future Work
  - Completion of the modelling language
  - evaluate the analysis with different services
  - Integration of protection strategies