AspectOPTIMA
Part 2

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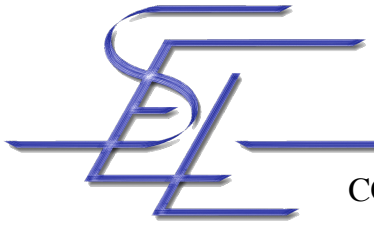

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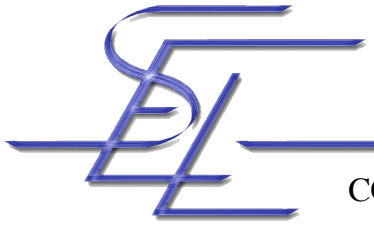
Reusable Aspect Models (RAM)

- Aspect-oriented modeling approach integrating class diagrams, state diagrams and sequence diagrams
  - Aspect models can specify structure and behavior
  - Based on existing class diagram weaving technology [France et al.]
  - Based on existing sequence diagram weaving technology [Klein et al.]
  - Template parameters borrowed from Theme-UML [Clarke et al.]
- Reusable
  - Modular packaging
  - Dependencies encapsulated and automatically resolved



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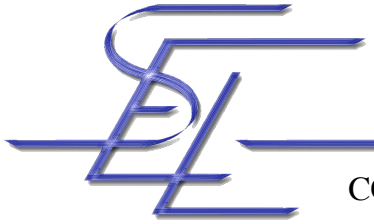
Multi-View Modeling

- Allows developers to describe a (software) system from multiple points of view
  - Structural views vs. behavioral views
- Allows developers to use multiple modeling notations / formalisms
  - Makes it possible for a modeler to use the most appropriate formalism to express the facet of the system in focus
- Challenges
  - Scalability
  - Consistency



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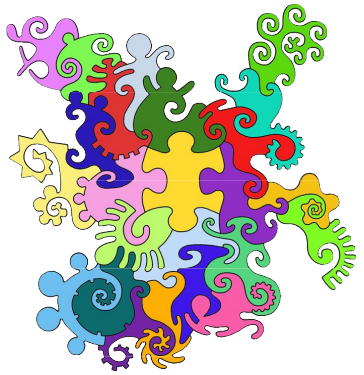
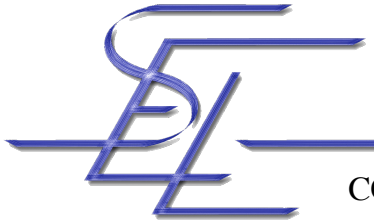
Aspect-Oriented Modeling



- Aspect-oriented Modeling
  - Current weaving techniques based on *one* modeling notation only
  - Can address scalability within one modeling notation
- Aspect-oriented Multi-View Modeling
  - Compatible composition techniques and weaving algorithms must be defined to ensure that the consistency of individual aspects is preserved in woven model



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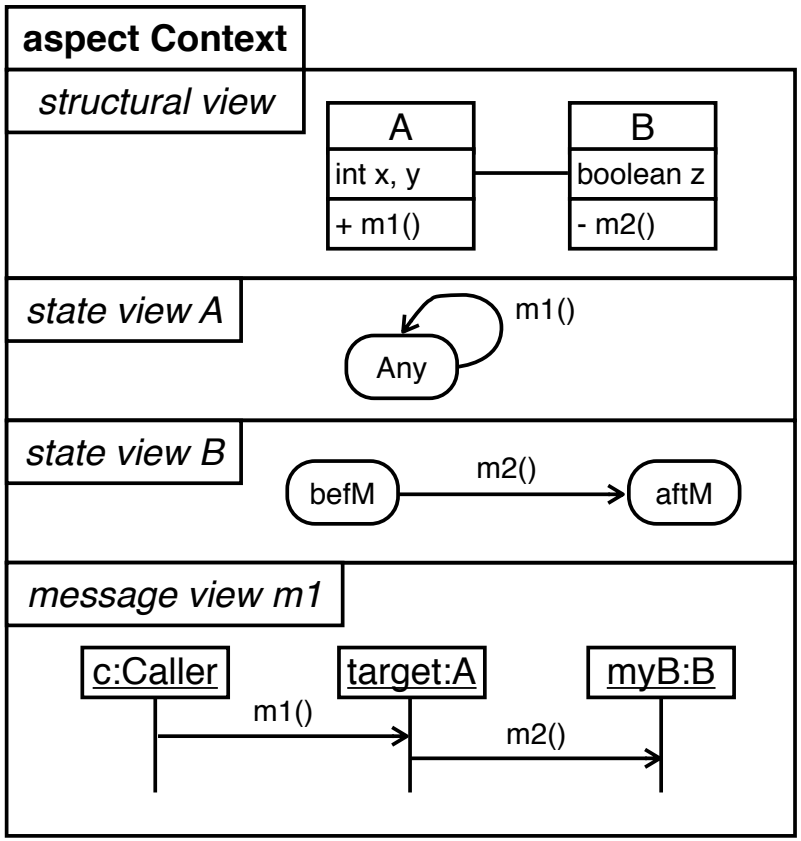
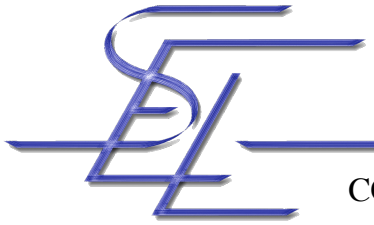
RAM Aspect Models

- Aspect package groups structure and behavioral models related to a concern
  - One structural view
  - One state view for each class defined in structural view
  - At least one message view for each public method defined in structural view





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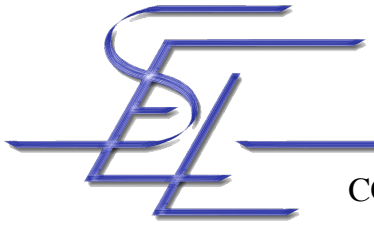
Case Study: AspectOPTIMA

- Aspect-oriented framework implementing (different kinds of) transactions
  - Flat / nested / MTT / OMTT / CAA
  - Pessimistic / optimistic concurrency control
  - Undo / Redo recovery
  - In-place / deferred update
- Implemented in AspectJ
- Currently the functionalities of 29 aspects are modelled in RAM
  - Individually reusable
  - Complex aspect dependencies and interactions



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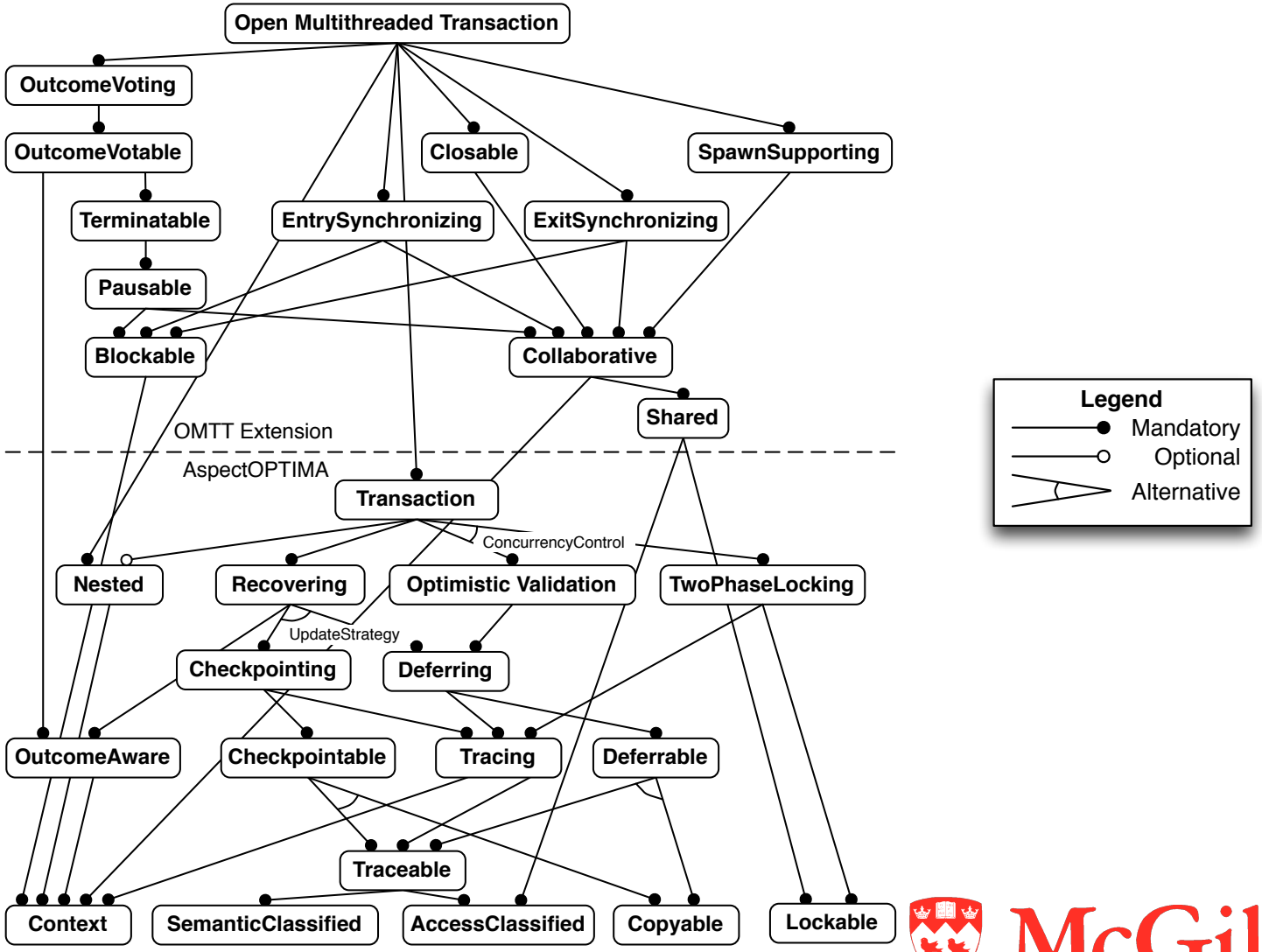
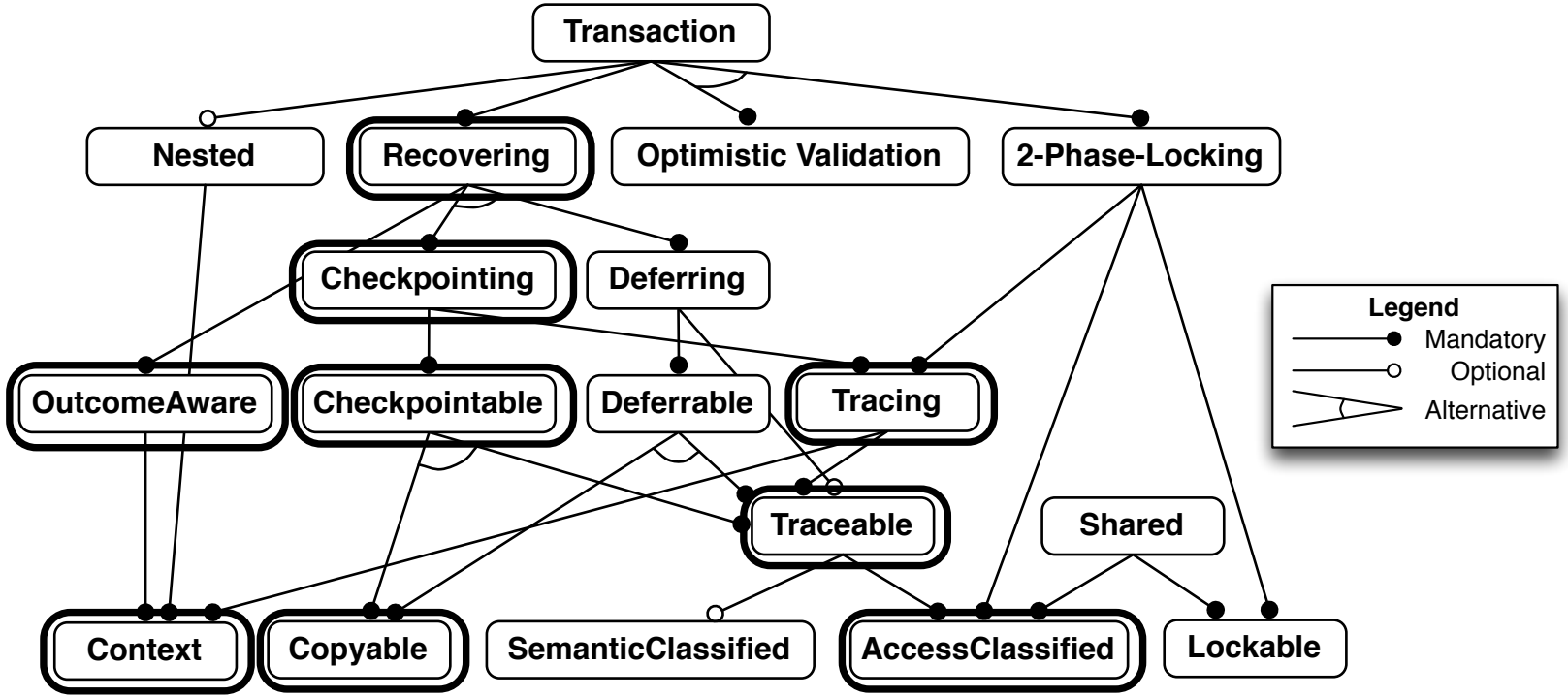
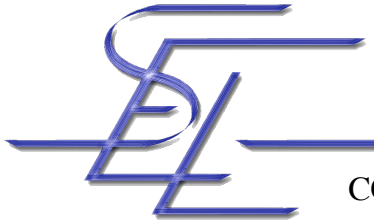
AspectOPTIMA Feature Diagram



AspectOPTIMA Feature Diagram

- Feature diagram allows users of the framework to choose desired transaction configuration





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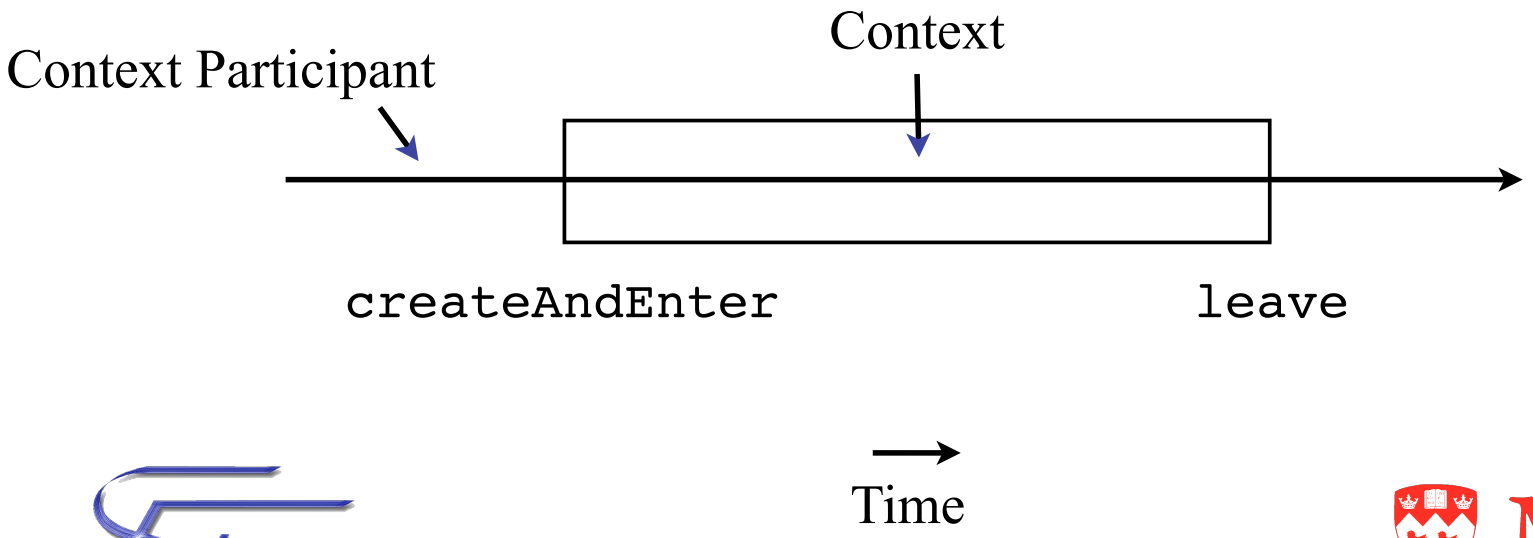
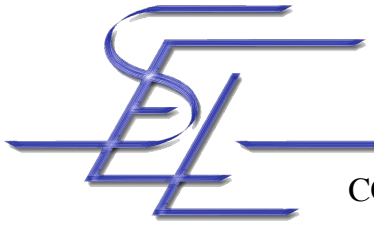
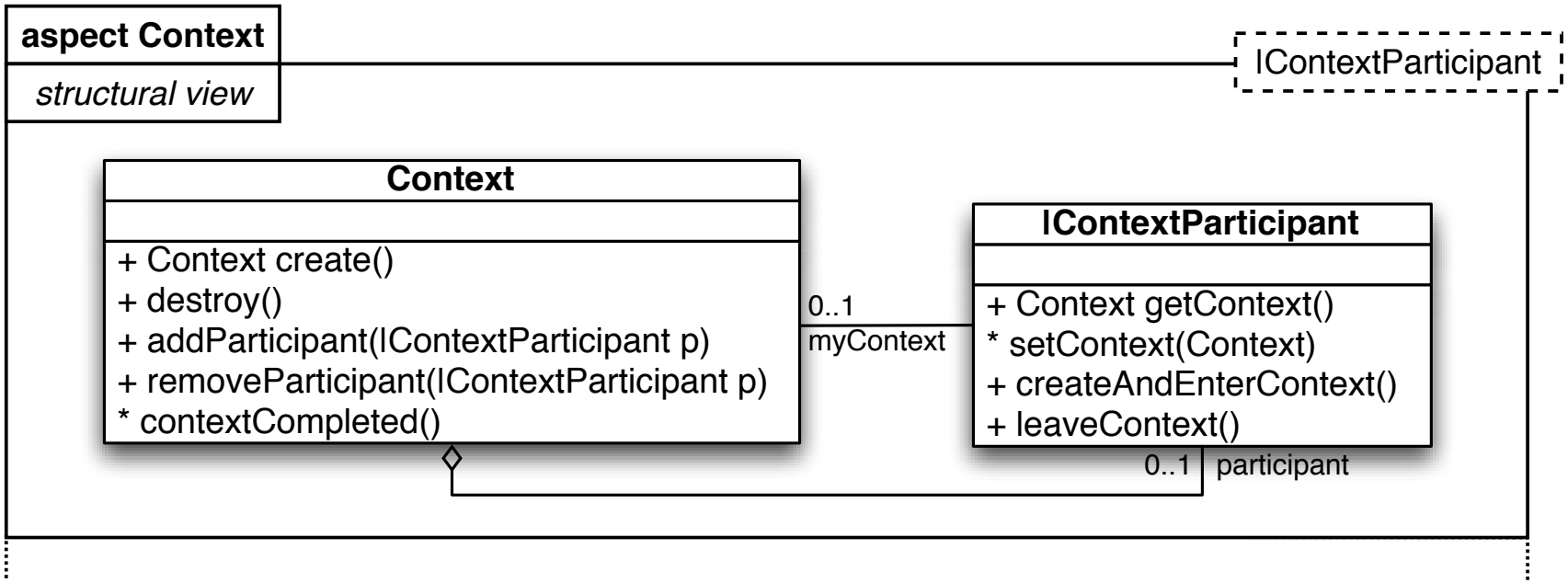
The *Context* Aspect

- A process / thread of computation can *create and enter* a *context*
- Once it is inside, the thread is a *context participant*
- A context participant can *leave* the context at any time

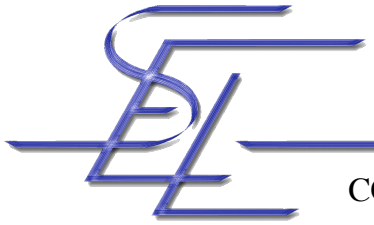




1st View: Structural View



- One structural view
  - Classes (partial or complete) with methods, associations between classes
- Partial classes are mandatory instantiation parameters of the model, shown as UML template parameters to the view



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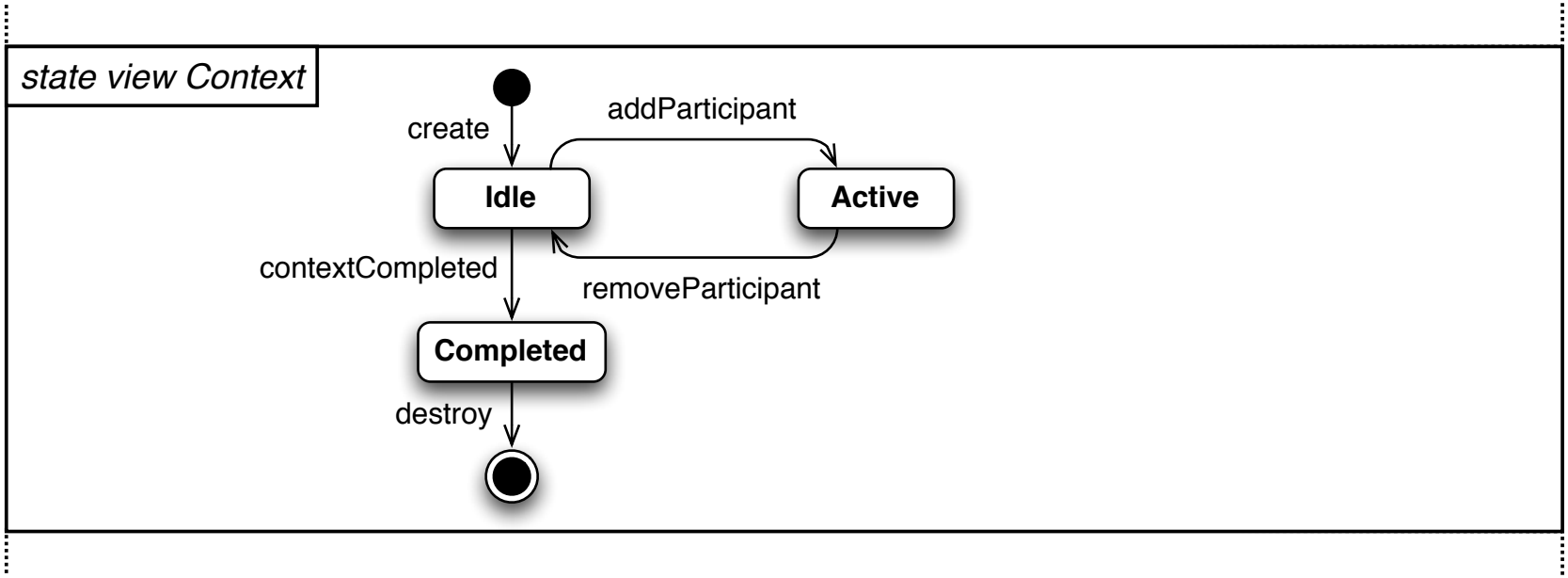
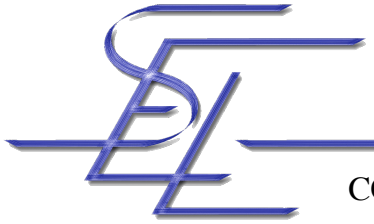
2nd View: State View (1)



- One state view for each class (partial or complete) defined in structural view
- Describes interaction protocol of instances
  - Each method must have at least one corresponding transition



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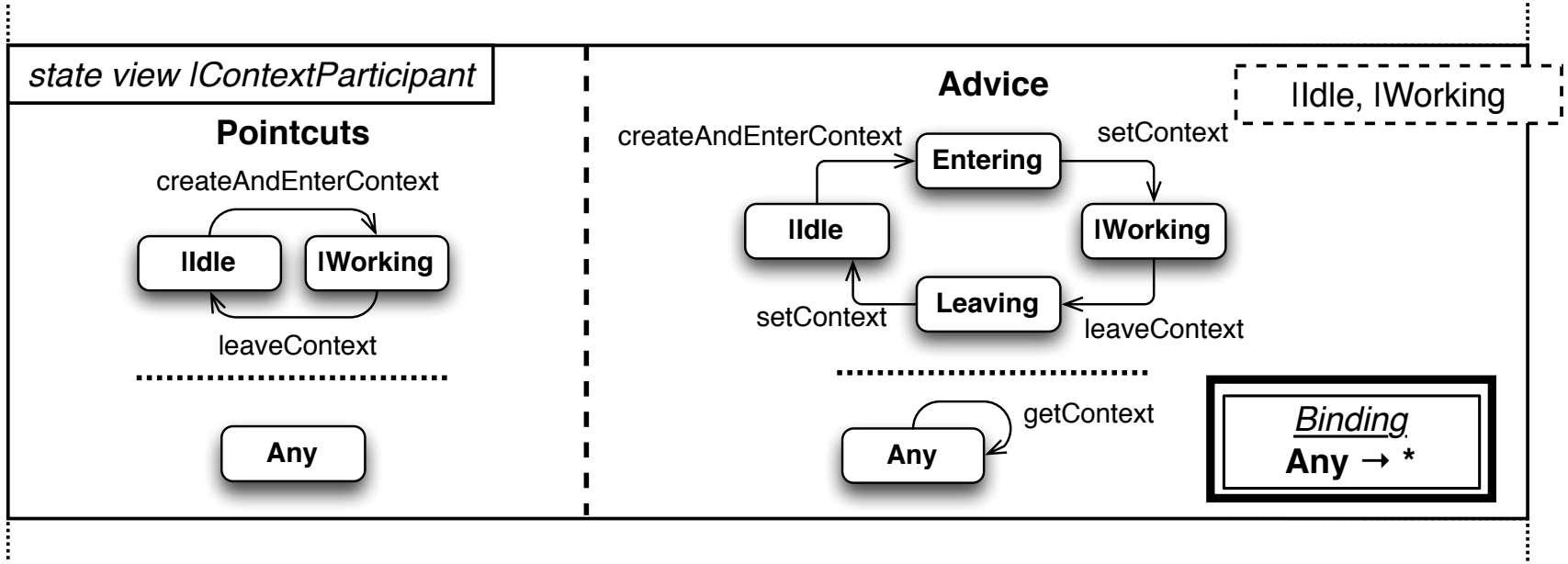
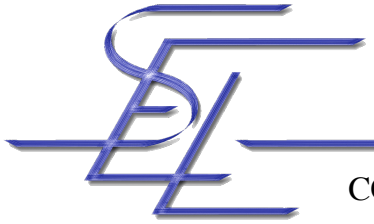
2nd View: State View (2)



- State views of partial classes declare the behavior they assume (pointcut), and how they extend the behavior (advice)
- Placeholder states are mandatory instantiation parameters, and shown as UML template parameters to the view



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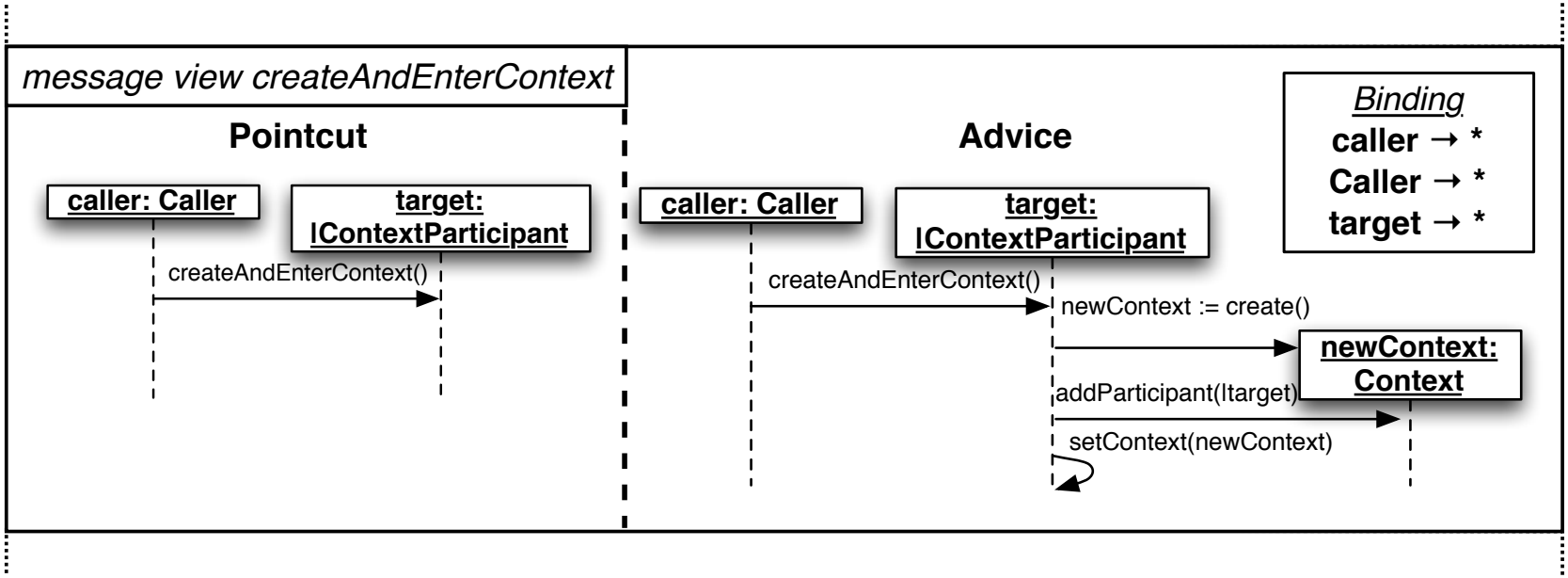
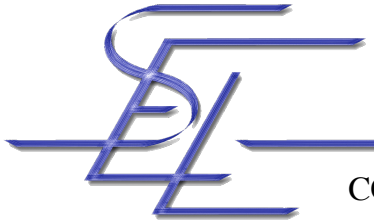
3rd View: Message View



- At least one message view for each public method declared in the structural view
- Describes message exchange between objects of the aspect that implements desired behavior



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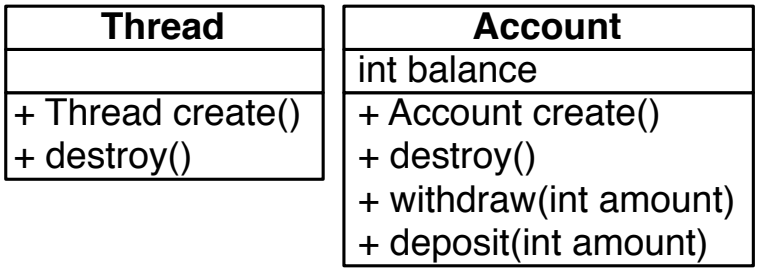
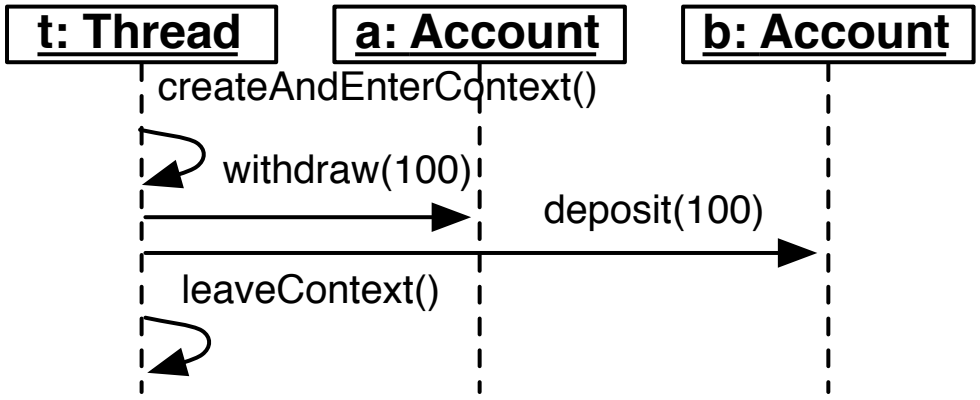
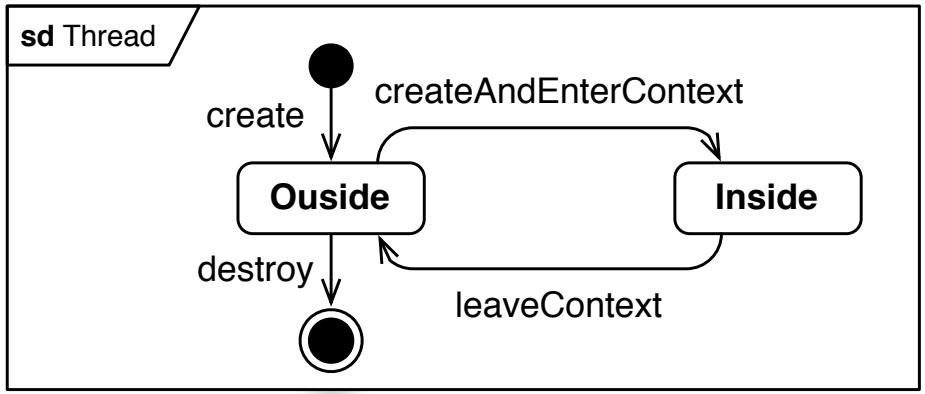
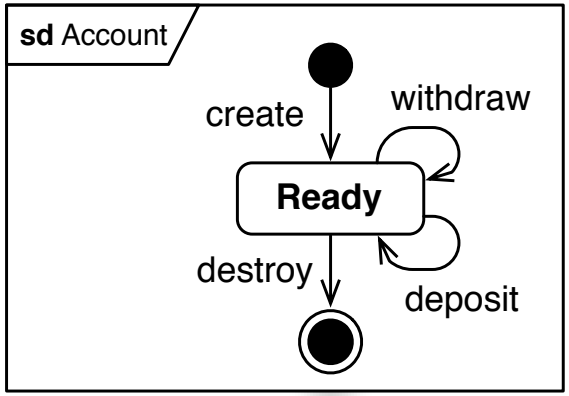
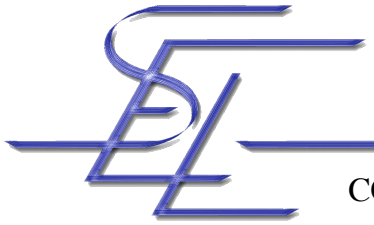
Base Model: A Banking Application











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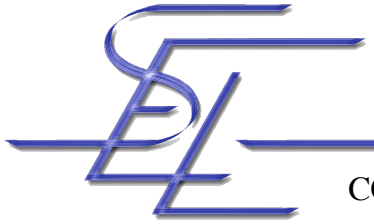
Reuse by Instantiation / Binding

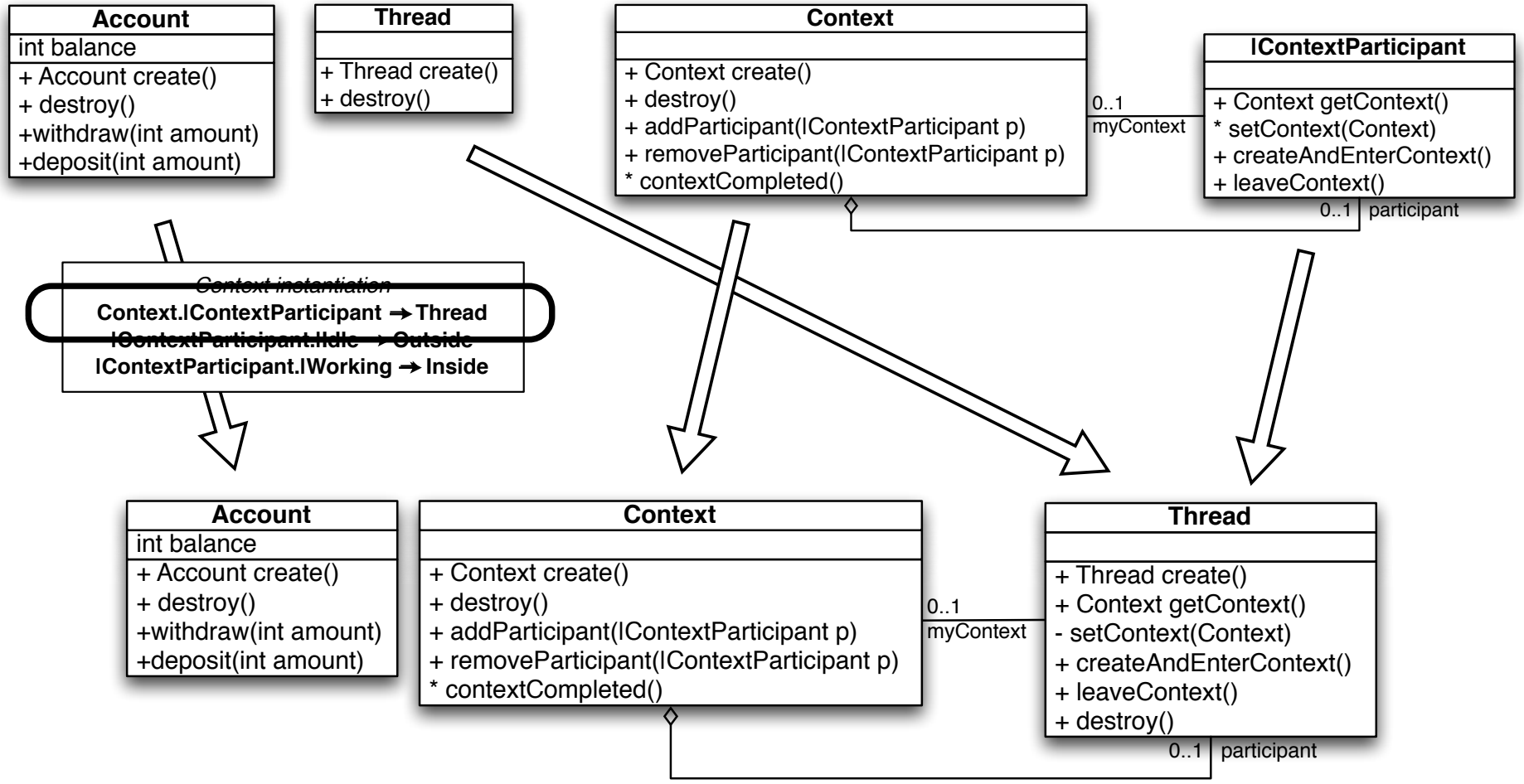
- To reuse the aspect *Context*, the base model must instantiate it explicitly
  - An instantiation directive maps all mandatory instantiation parameters to base model elements

Context instantiation
Context.IContextParticipant ➔ Thread
IContextParticipant.IIdle ➔ Outside
IContextParticipant.IWorking ➔ Inside

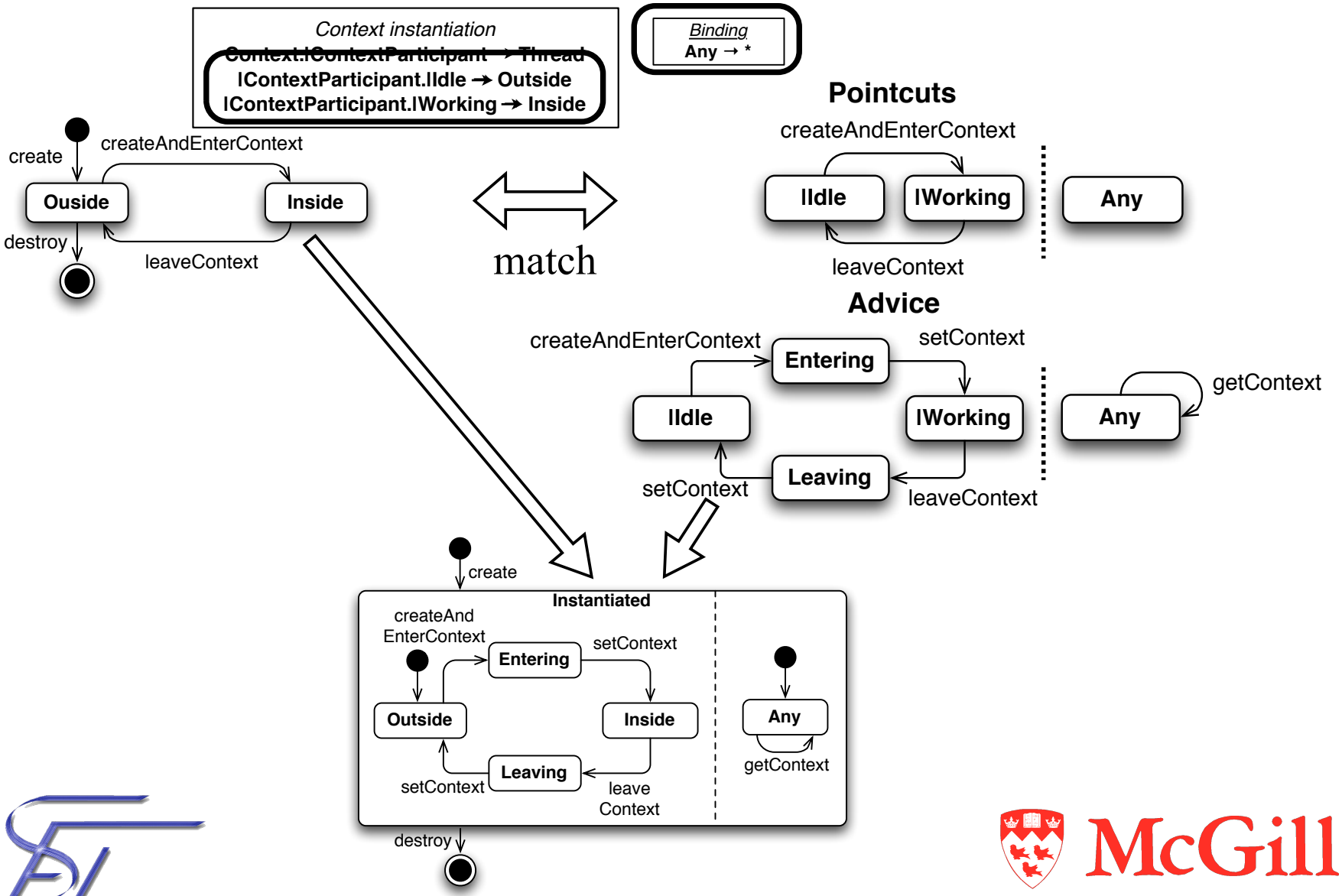
  - When a model A instantiates an aspect model B, A reuses the structure and behavior modeled by B.
  - Reuse of B might require A to extend the structure and behavior of B, in which case A must additionally define a binding to B



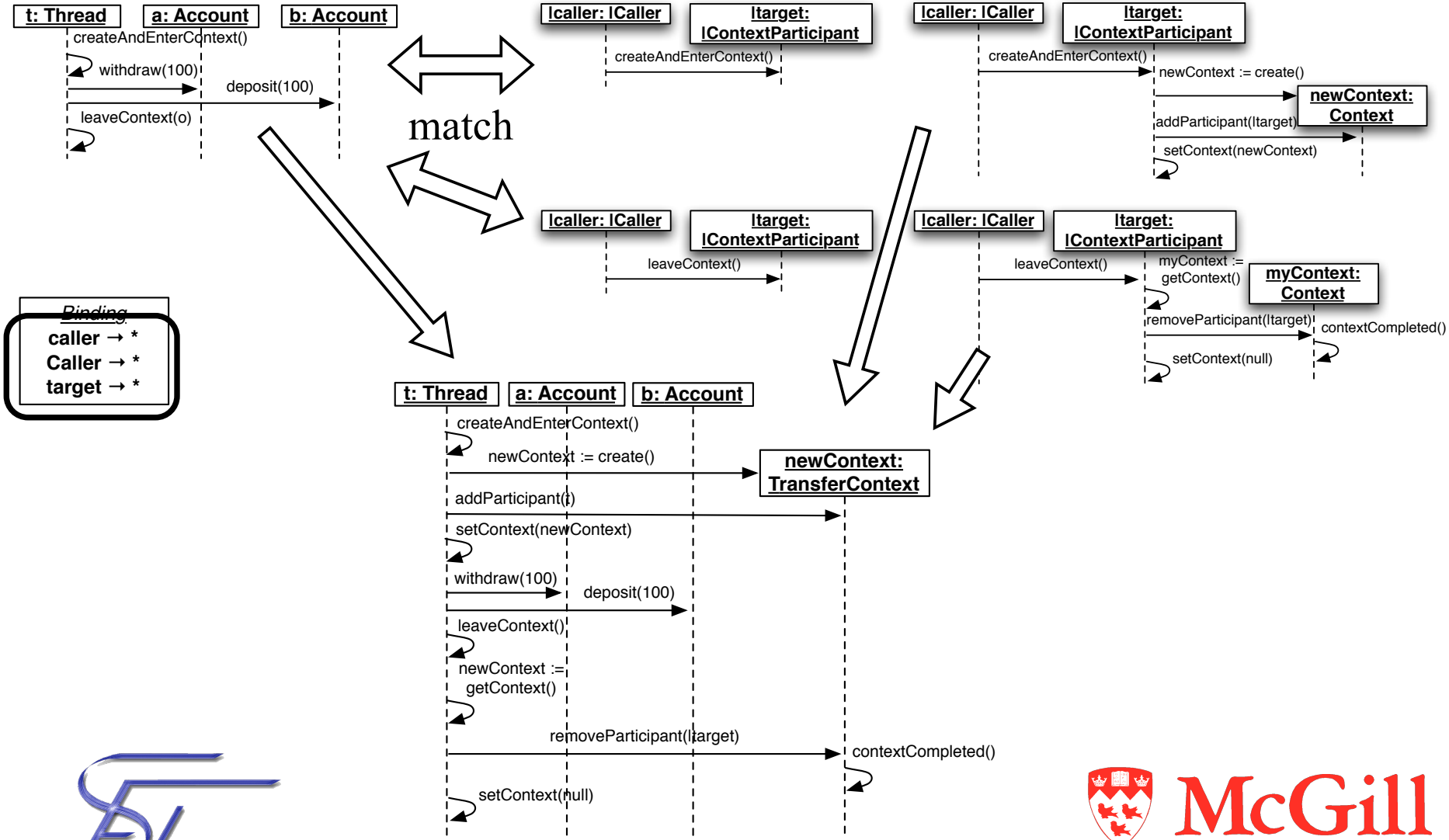
Structural View Weaving



State View Weaving

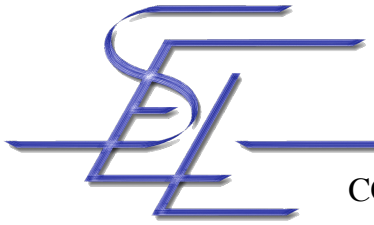


Message View Weaving

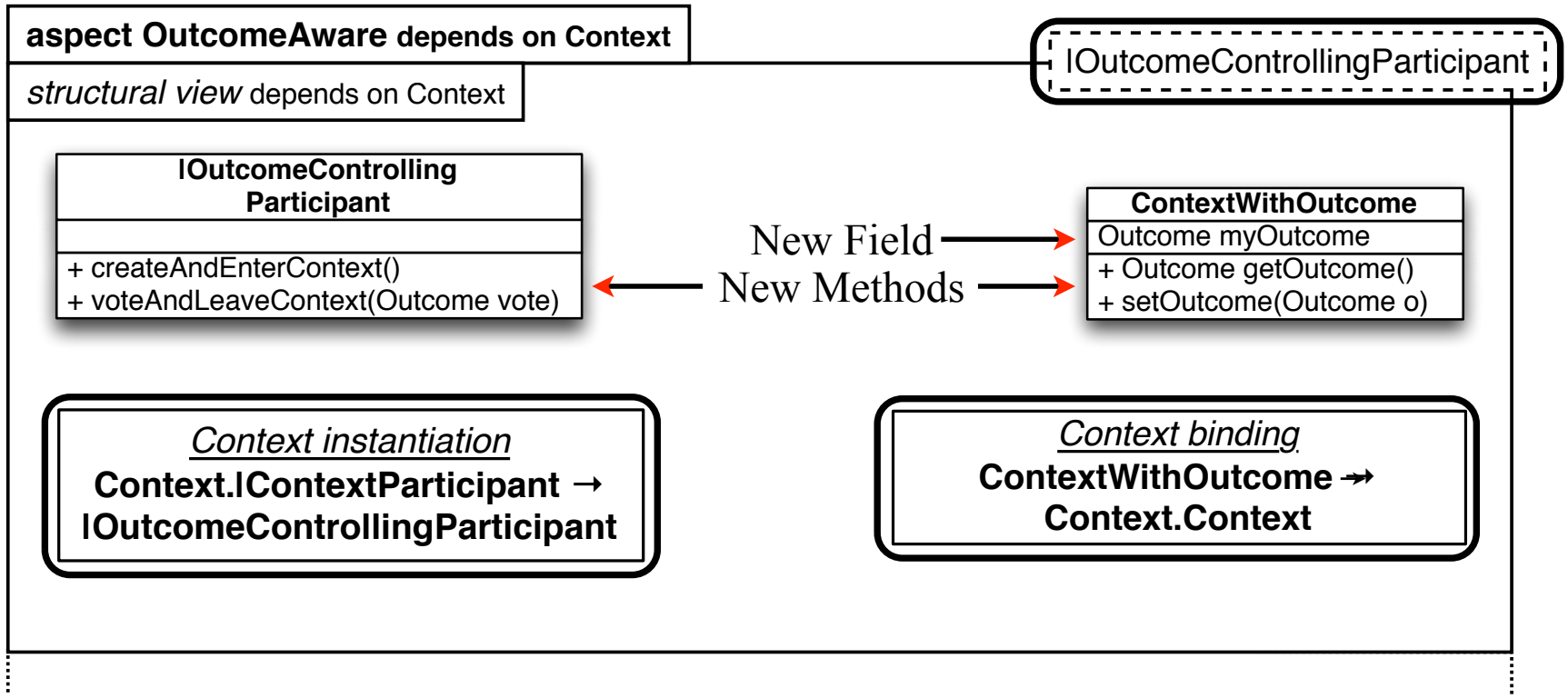


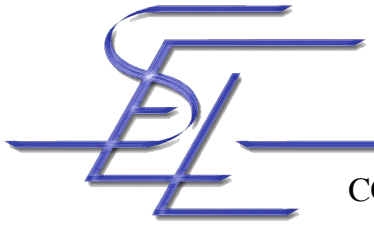
Aspect Dependencies

- RAM makes it very easy to build aspect frameworks
  - Aspects providing complex functionality can reuse aspects providing lower-level functionality
  - Example
    - *OutcomeAware* depends on *Context*
    - Adds the notion of successful completion or unsuccessful completion of a context



OutcomeAware Structural View





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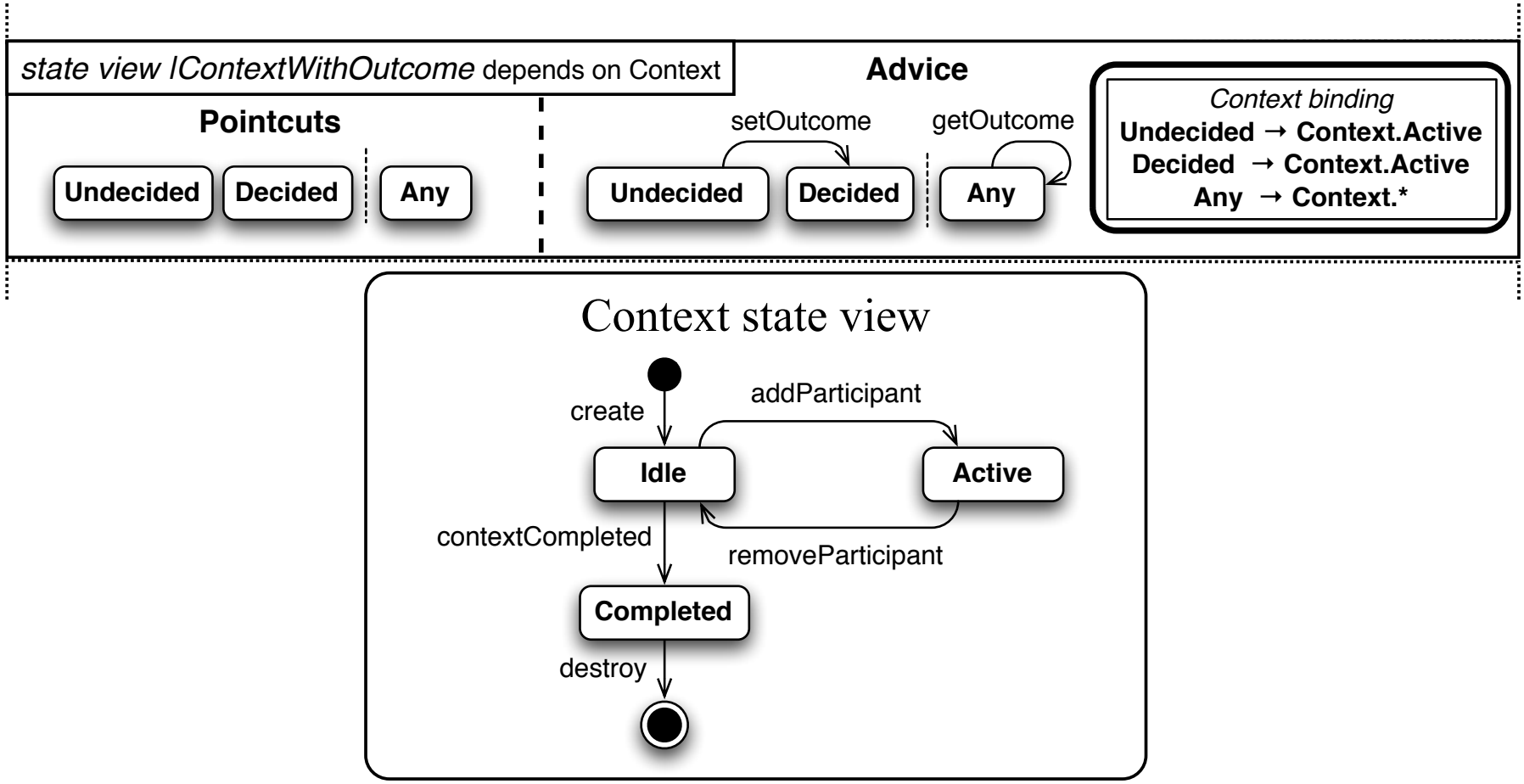
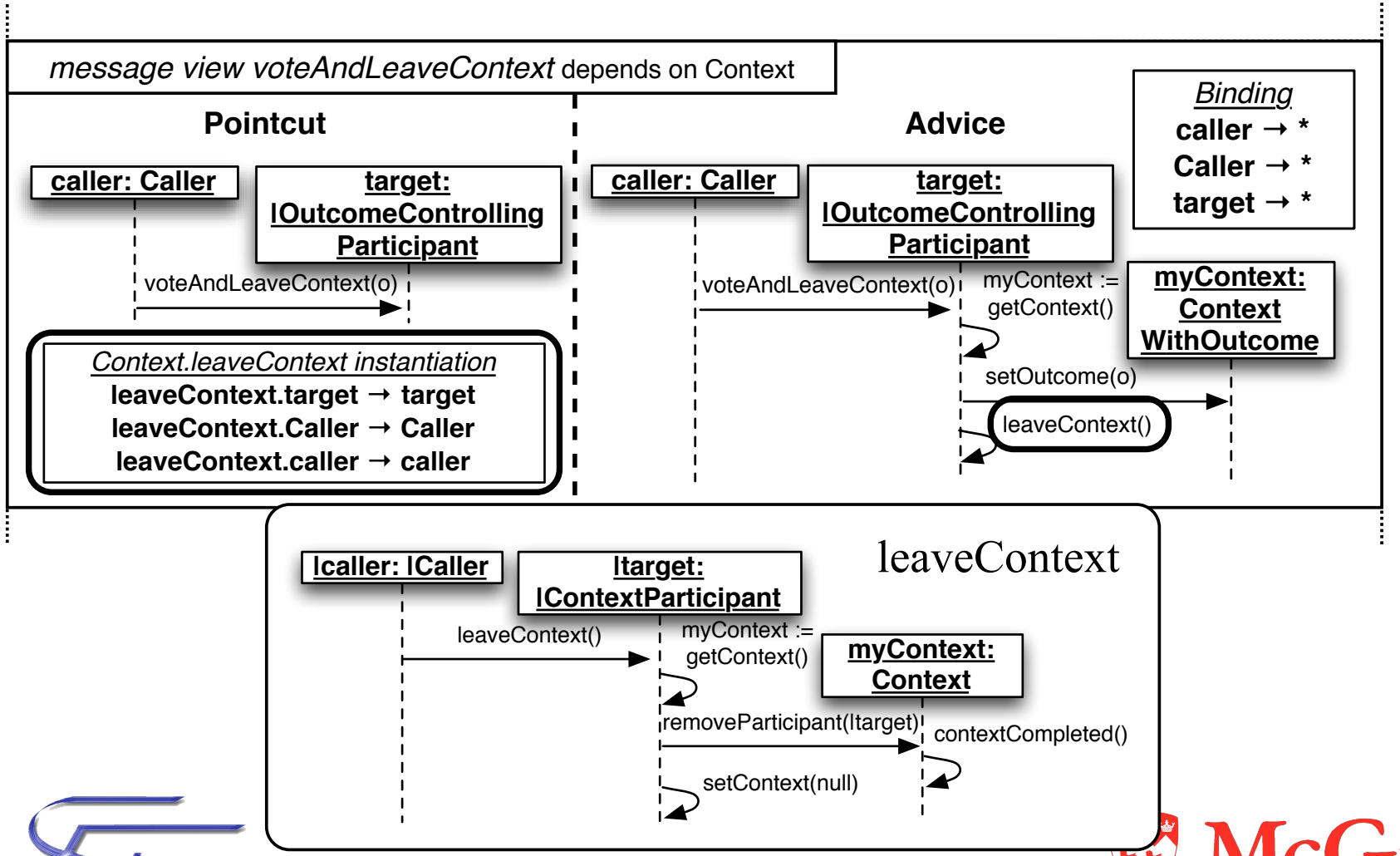
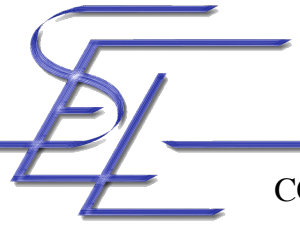
OutcomeAware State Views



OutcomeAware Message View





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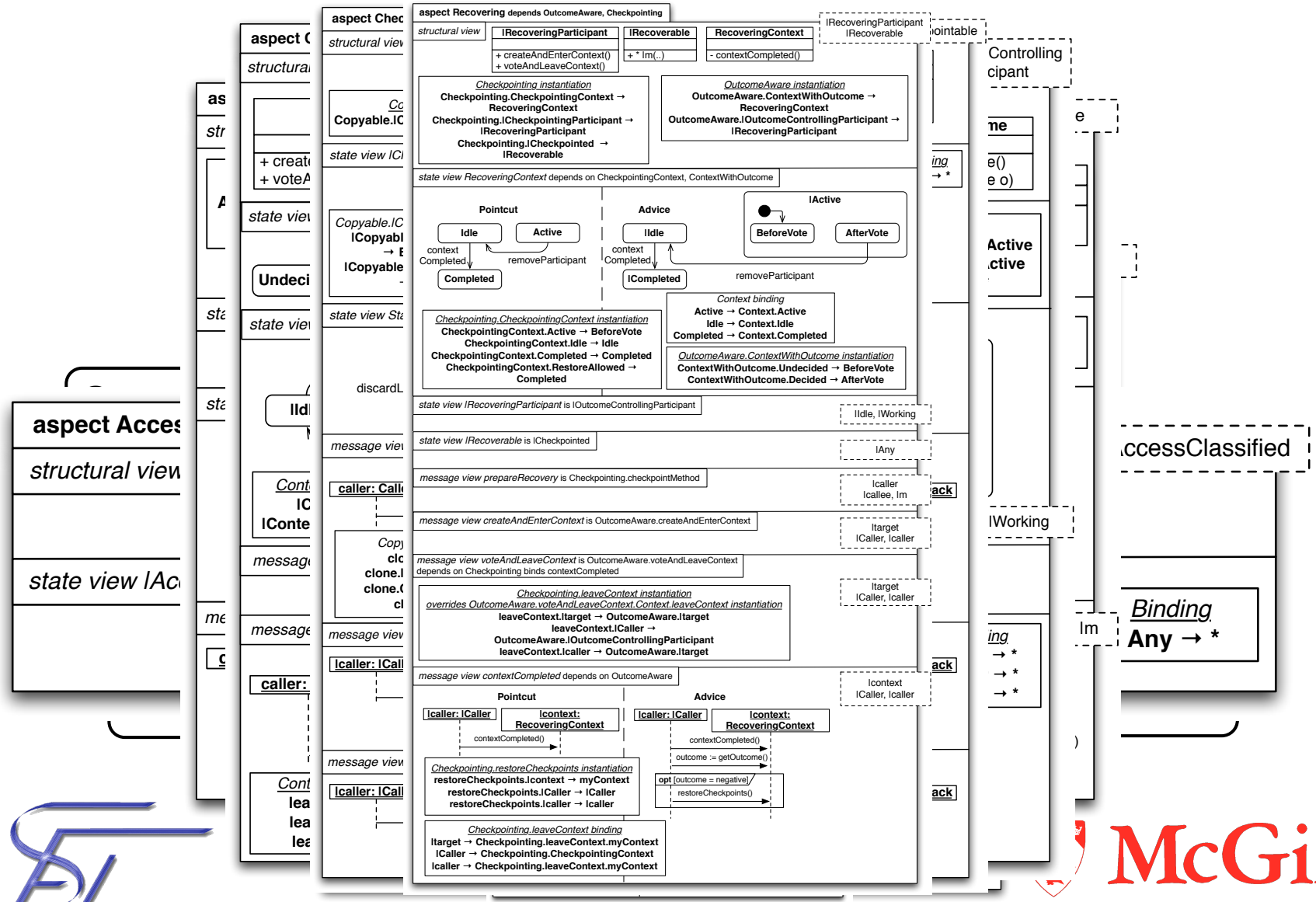
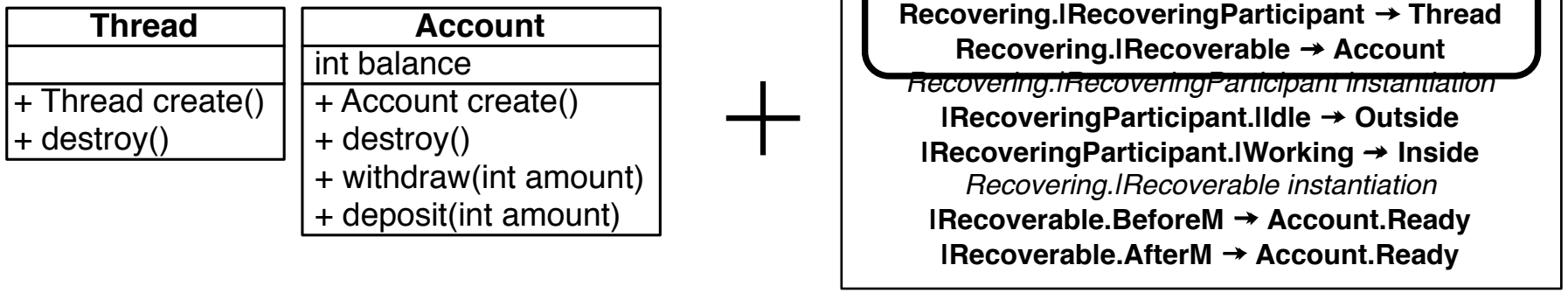
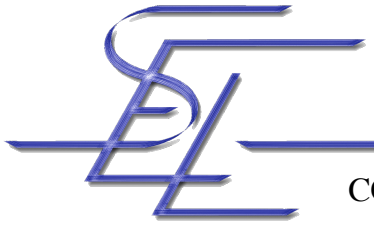
Complex Example: Recovering



Base Model: Structure View





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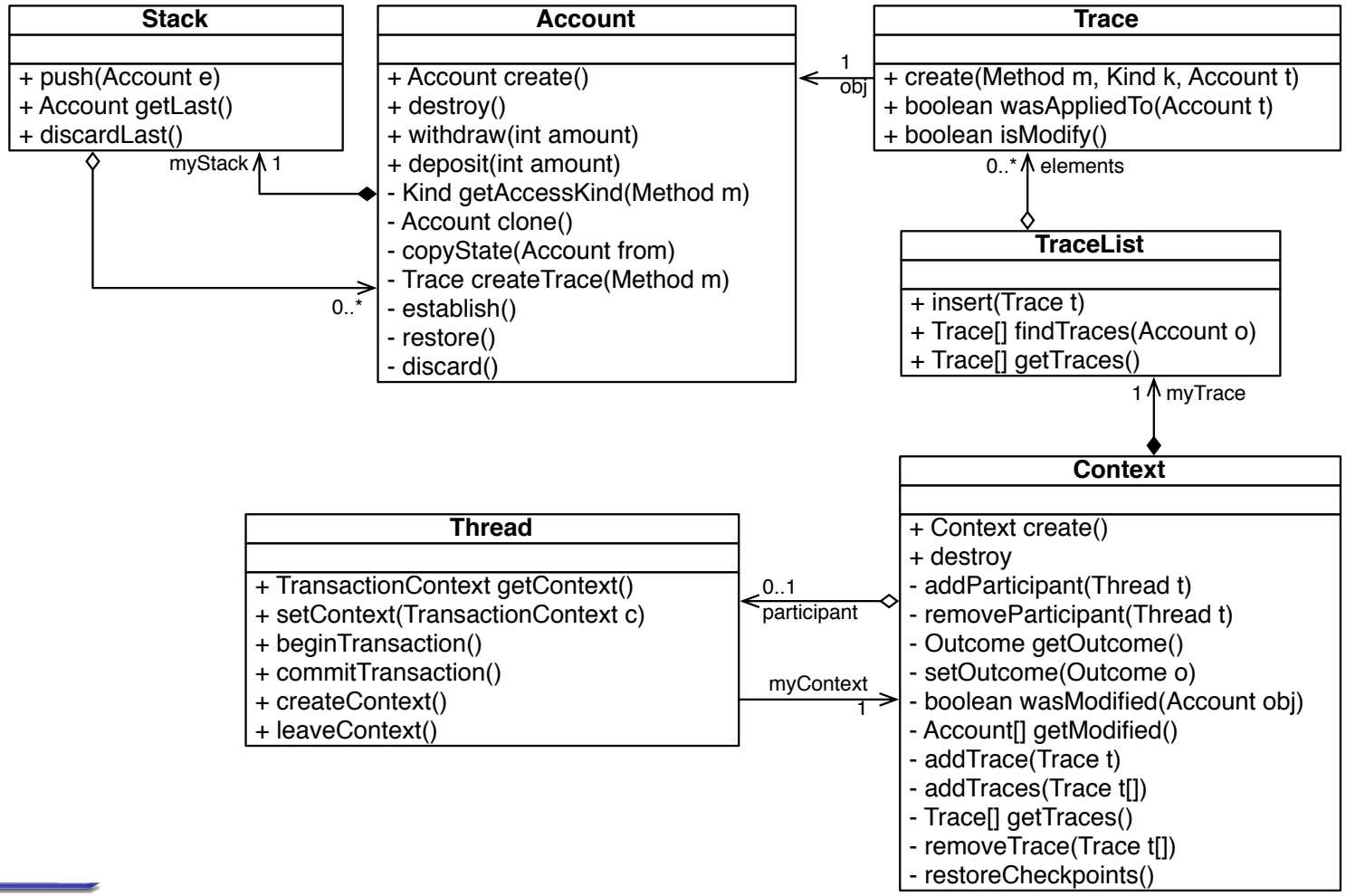
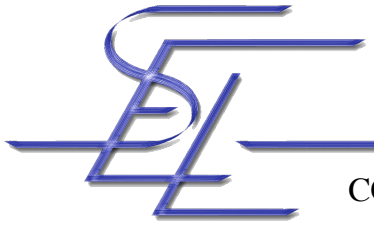
Woven Model: Structure View





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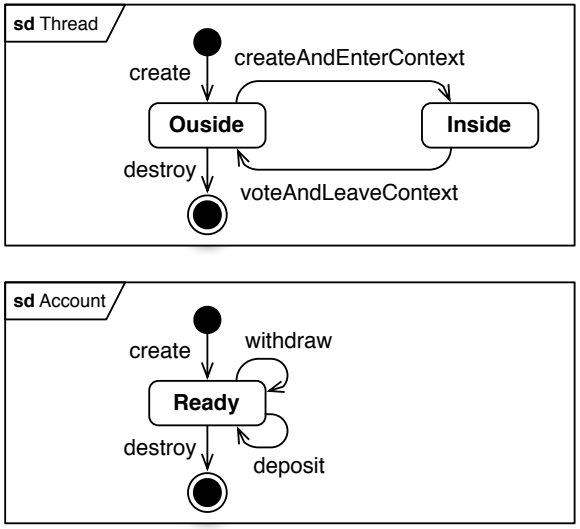
Base Model: State View



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Recovering instantiation

Recovering.IRecoveringParticipant ➝ Thread

Recovering.IRecoverable ➝ Account

Recovering.IRecoveringParticipant instantiation

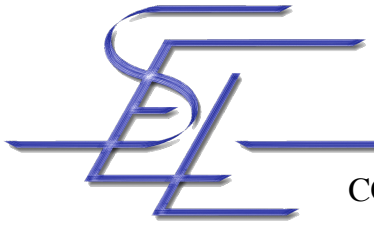
IRecoveringParticipant.IIdle ➝ Outside

IRecoveringParticipant.IWorking ➝ Inside

Recovering.IRecoverable instantiation

IRecoverable.BeforeM ➝ Account.Ready

IRecoverable.AfterM ➝ Account.Ready



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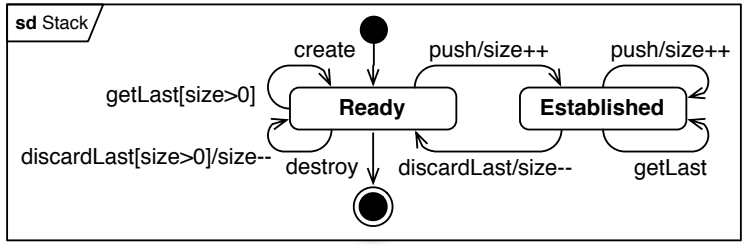
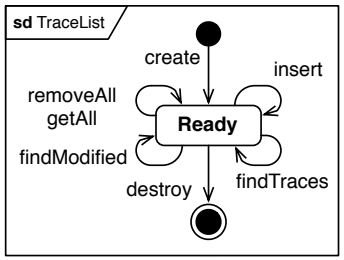
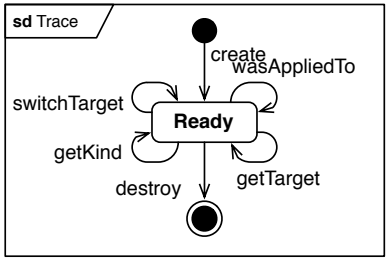
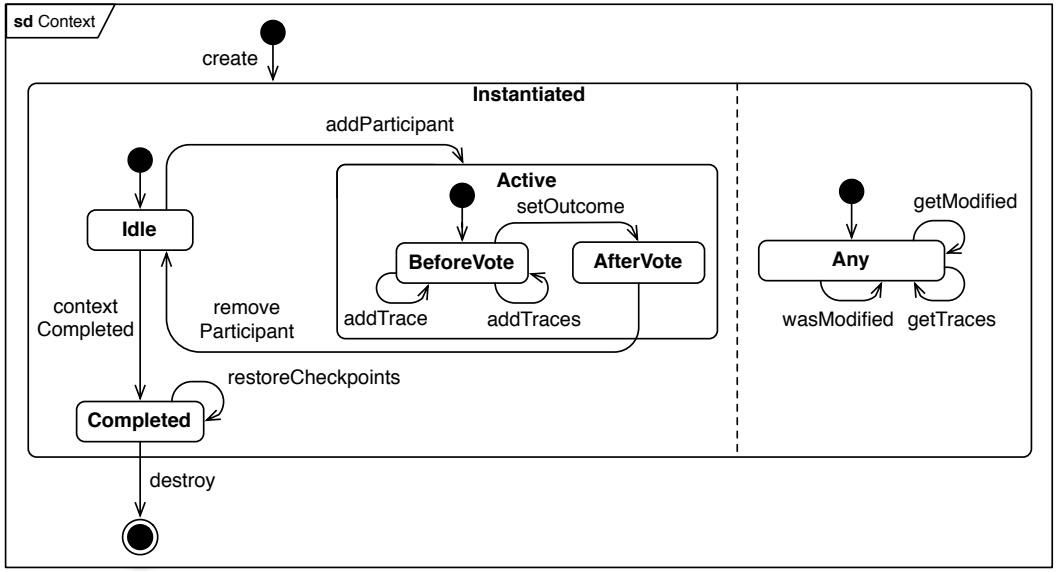
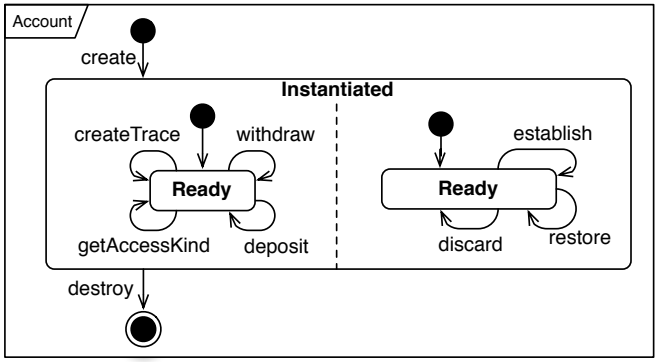
Woven Model: State View

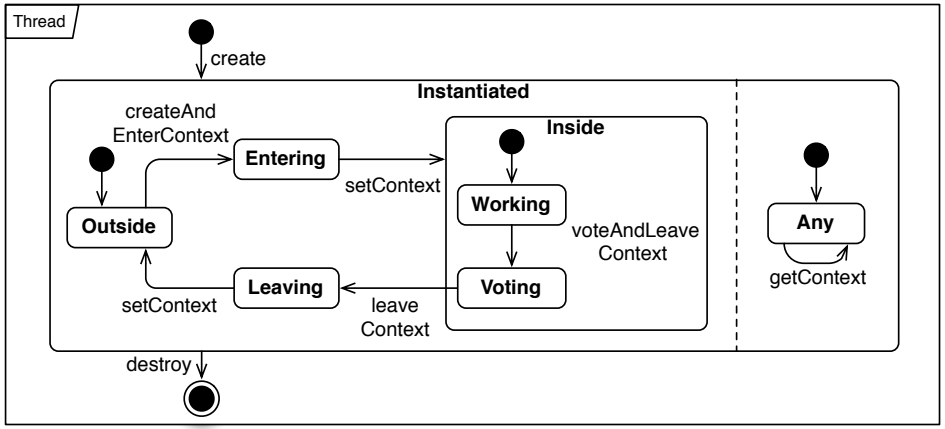


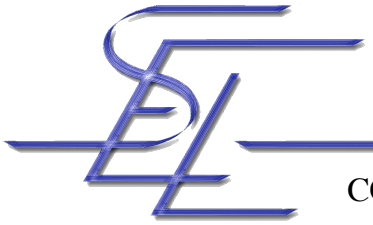












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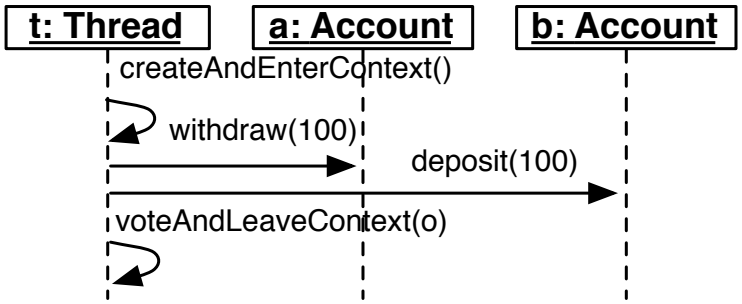
Base Model: Message View



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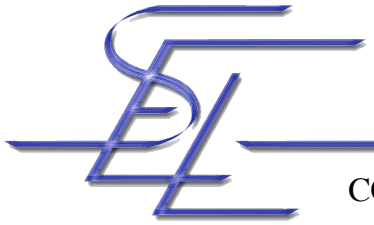
Recovering instantiation
Recovering.IRecoveringParticipant ➝ Thread
Recovering.IRecoverable ➝ Account
Recovering.IRecoveringParticipant instantiation
IRecoveringParticipant.IIdle ➝ Outside
IRecoveringParticipant.IWorking ➝ Inside
Recovering.IRecoverable instantiation
IRecoverable.BeforeM ➝ Account.Ready
IRecoverable.AfterM ➝ Account.Ready



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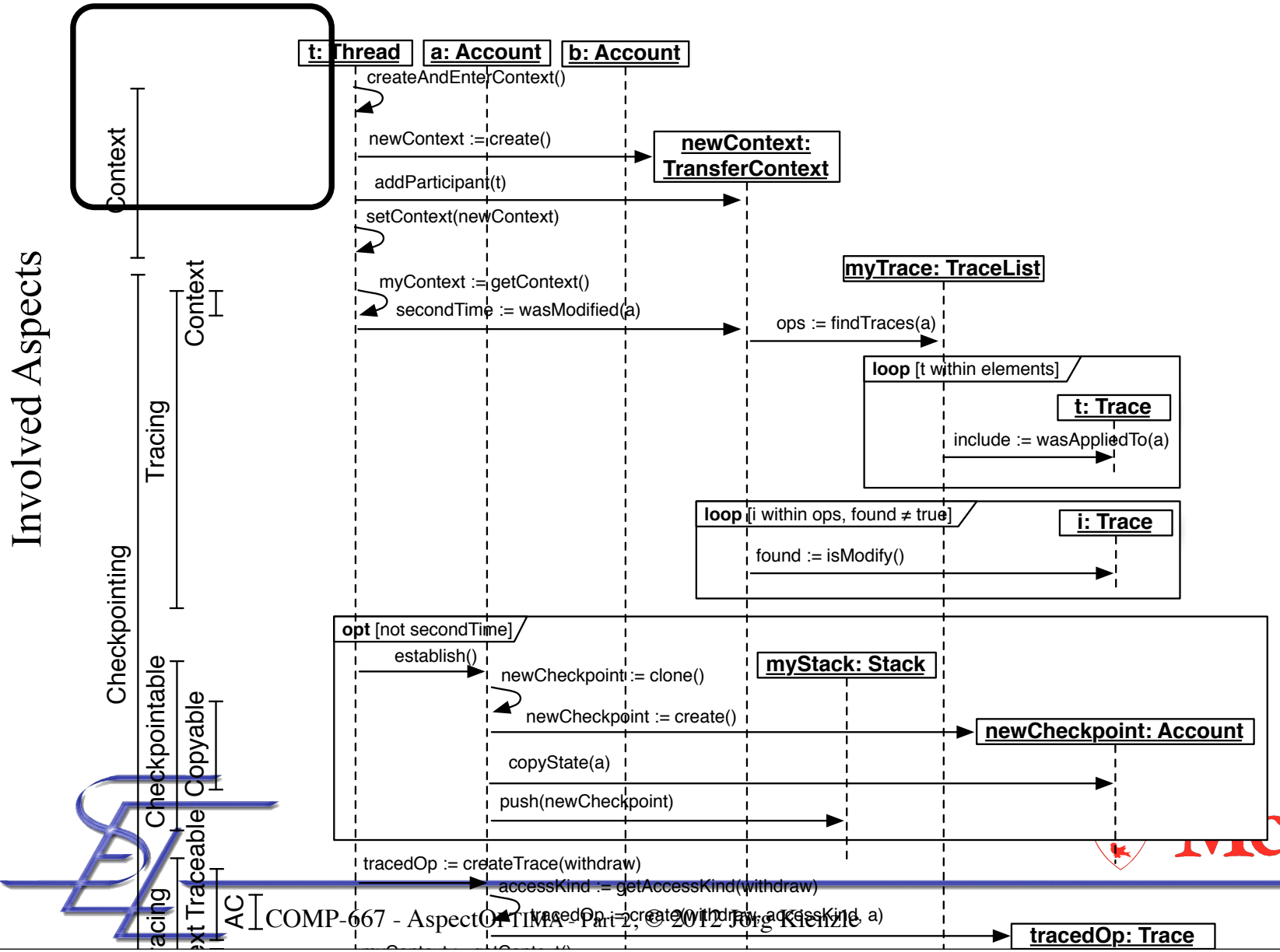
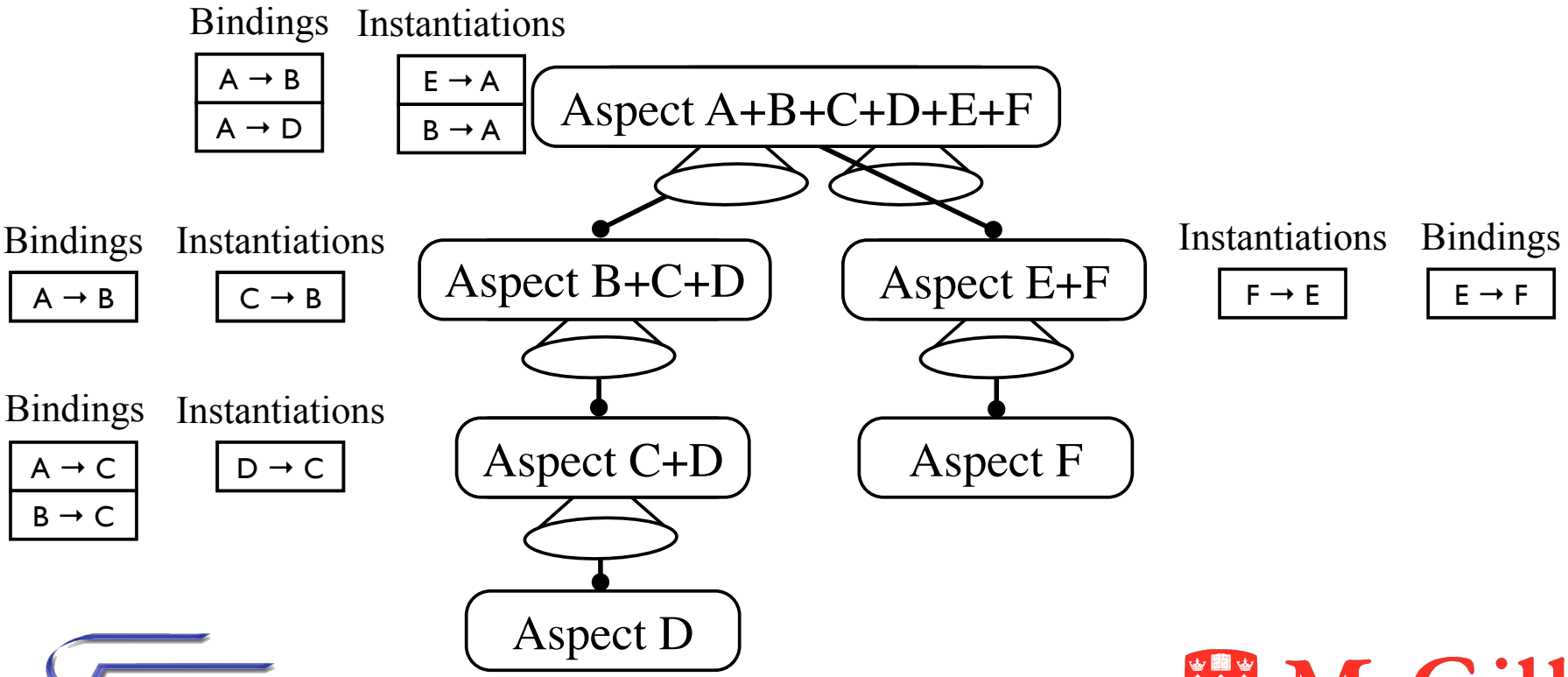
Woven Model: Message View



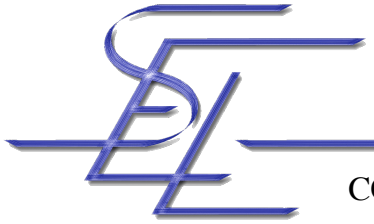
Recursive Weaving Algorithm

- Depth-first recursion through aspect tree, weaving lower-level aspects into higher-level aspects according to instantiation and binding directives
- Details in one of our papers



Consistency Checks

- When creating the aspect model, consistency checks are performed among views
  - Standard consistency checks
  - Conformance between the message views and the state views (model checking).
- Before (during) the weaving, consistency checks are performed among the directives defined at different levels
  - For structural views, bindings and instantiations defining mappings of the same structural entity must be consistent.
  - For state views, bindings and instantiations at a “higher” level must designate the same state or substates of the bindings of the “lower” level.
  - For message views, bindings at a “higher” level must match a subset of messages of the bindings of the “lower” level.
- After executing the weaving, consistency checks are performed among the woven views
  - Conformance of the partial sequences of messages defined for each object instance in the woven sequence diagram with the protocol defined in the state view of the corresponding class (model checking)



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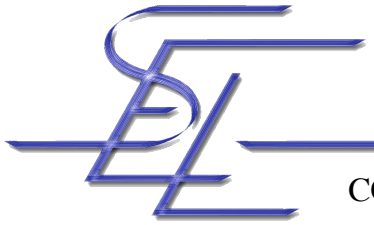
Conclusion

- Reusable Aspect Models (RAM)
  - Aspect-oriented modeling approach integrating class diagrams, state diagrams and sequence diagrams
  - Reuse is safe (mandatory instantiation parameters) and flexible (optional bindings)
  - Support for elaborate dependency chains
- Weaving algorithm recursively resolves dependencies to create independent final model
- Elaborate consistency checks
  - Model-checking of conformance of sequence diagram and state diagrams



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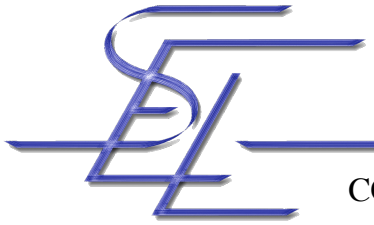
Other Work

- RAM also provides
  - Conflict resolution aspects
  - Feature diagrams to select variations
- Prototype tool
  - Implemented in Eclipse/Kermeta

To download papers, the AspectJ implementation or the RAM models of AspectOPTIMA

http://www.cs.mcgill.ca/~joerg/AspectOPTIMA/AspectOPTIMA.html

(or just google AspectOPTIMA)



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