Experiment result for applying ADManager tool in documenting Architectural Decisions, Version 1.0

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Abstract. As part of an empirical study we did to evaluate our approach with ADManager tool, this report introduces the experimental materials as well as the experimental results. The experiment consists in seeding deletions and additions of elements in the architectural models to see whether the architectural decisions are preserved using mapping models and pattern models. 8 architectural models are chosen to be applied with ADManager. For each of these models, we show the general results for deletion, addition operation and detailed results for each extracted pattern view.

1   Introduction

This document reports the results of applying ADManager tool in formalizing SOA pattern, CBA pattern and documenting AD in and 8 architectural models. We first synthetize the formalized patterns using our pattern language. Next, in each model, we show i) the source where we take the architecture, ii) how we model it using ADManager, iii) for all possible violated deletion operations, how many of them are detected by mapping models and pattern models respectively, iv) for all possible violated addition operations, how many of them are detected by mapping models and pattern models respectively.

This document is organized as follows: Section 2 introduces formalized patterns in two paradigms: SOA and CBA. Section 3 to Section 10 introduces 8 architectural models respectively. For each model, the results for deletion and addition operation as well as the results for each pattern view are presented.

1 Formalized SOA and CBA patterns

Table 1 and Table 2 show the list of formalized SOA and CBA patterns along with the number of architectural elements, the involved roles and the number of multiplicity elements.

Pattern category	Pattern name	Nb of elements	Roles	Nb of multiplicities
Service inventory design patterns	Rules Centralization	2	Service, Rule service	1
	Dual Protocols	1	Protocol	1
	Service Grid	1	Service	1
	Inventory Endpoint	3	Internal inventory service, Inventory endpoint, External consumer	2
	State Repository	2	Service, State repository	1
Service design patterns	Service Façade	3	Service, façade, consumer	0
	Service Data Replication	2	Service, replicated database	1
	Partial State Deferral	2	Service, Deferral state repository	0
	Partial Validation	2	Service, Data validator	0
	Decoupled Contract	2	Service, Service contract repository	0
	Legacy Wrapper	2	Legacy Component, Wrapper Component	1
	Exception Shielding	2	Service, Exception Shield	0
	Message Screening	2	Service, Message screener	0
	Trusted Subsystem	1	Service, Trusted Subsystem	0
	Service Perimeter guard	2	Internal service, Perimeter service	1
	Proxy Capability	2	Service, Proxy	0
	Decomposed Capacity	2	Service, Decomposed proxy	1
	Canonical Protocol	1	Service with uniform protocol	0
	Redundant Implementation	1	Redundant service	1
Service composition	Intermediate Routing	2	Service, Intermediate logic router	0

	Asynchronous Queuing	3	Service, Intermediary buffer, Consumer	0
design patterns	Brokered Authentication	3	Service, Broker, Consumer	1
	Data Format Transformation	3	Service, Intermediary data formatter, legacy component	1
	Service Agent	1	Service Agent	0
	Agnostic Sub-controller	2	Service, Sub-controller	0

Table 1. List of formalized SOA patterns

Pattern category	Pattern name	Nb of elements	Roles	Nb of multiplicities
Layered view	Layers	2	Layer, Layer connector	1
	Indirection Layer	4	Client layer, Indirection layer, Sub-system, Layer connector	0
Data flow view	Pipes and Filters	2	Filter, Pipe	1
Data-centered view	Shared Repository	3	Client, Repository, Data accessor	1
	Active Repository	3	Client, Active repository, Data accessor	1
	Blackboard	3	Blackboard, Knowledge source, Data accessor	1
Adaptation view	Microkernel	5	Client, External server, Micro kernel, Internal server, Layer connector	2
	Interceptor	4	Client layer, Interceptor, Sub-system, Layer connector	0
User interaction view	Model-View-Controller	4	Model, View, Controller, MVC connector	0
	Presentation-Abstraction-Control	2	PAC agent, PAC connector	0
	C2	2	Component, Connector	0
Component interaction view	Client-Server	3	Client, Server, Request/Reply connector	1
	Peer to peer	2	Peer, Peer connector	1
Distribution view	Broker	4	Client, Server, Broker, Broker connector	1

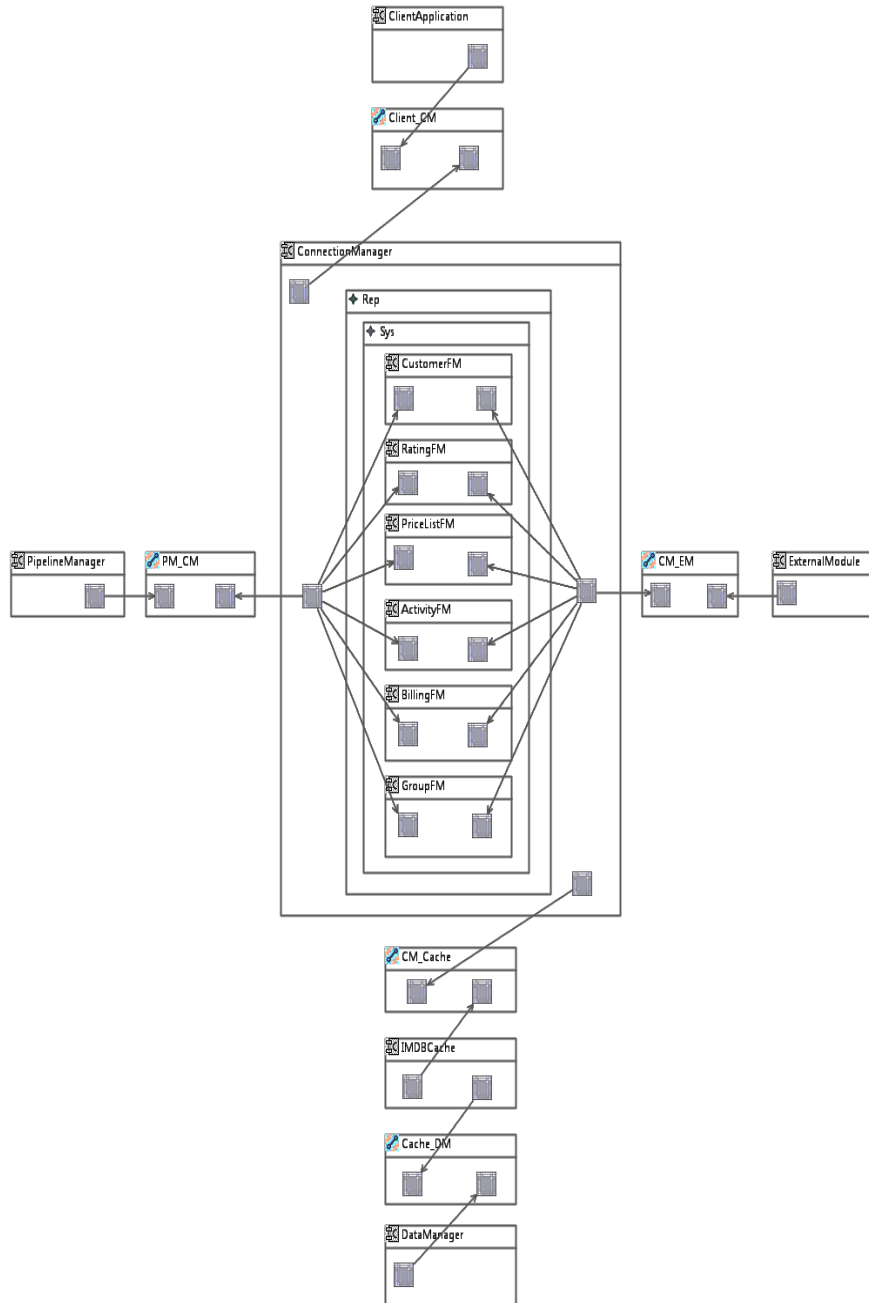**Table 2. List of formalized CBA patterns**

2   BRM [1]

Figure 1. Architecture of BRM

Number of model elements: 73
Number of components: 12
Number of connectors: 5

2.1. Results for deletion operation

Number of possible deletions: 157
Number of pattern-related deletions: 22
Number of total violated deletions (detected by pattern and mapping): 22
Number of violated deletions detected by pattern: 16
Number of violated deletions not detected by pattern: 6

2.2. Results for addition operation

Number of possible additions: 30
Number of pattern-related additions: 6
Number of total violated additions (detected by pattern and mapping): 3
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 3

2.3. Detailed results for each pattern view

2.3.1.   Layer pattern view
Number of mapping elements: 7
Number of pattern view elements: 49
Number of components: 4
Number of connectors: 3

At the granularity of component and connector, the total number of possible deletions of combination of elements: 128

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must also be deleted: 22

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 6
- The case when we delete top or bottom layers and connectors
- The case when we delete both top and bottom layers and connectors
- The case when we delete the entire layers

At the granularity of component and connector, the total number of possible additions of connectors between two components: 6

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3

- The case when we add a connector between two components that are not adjacent
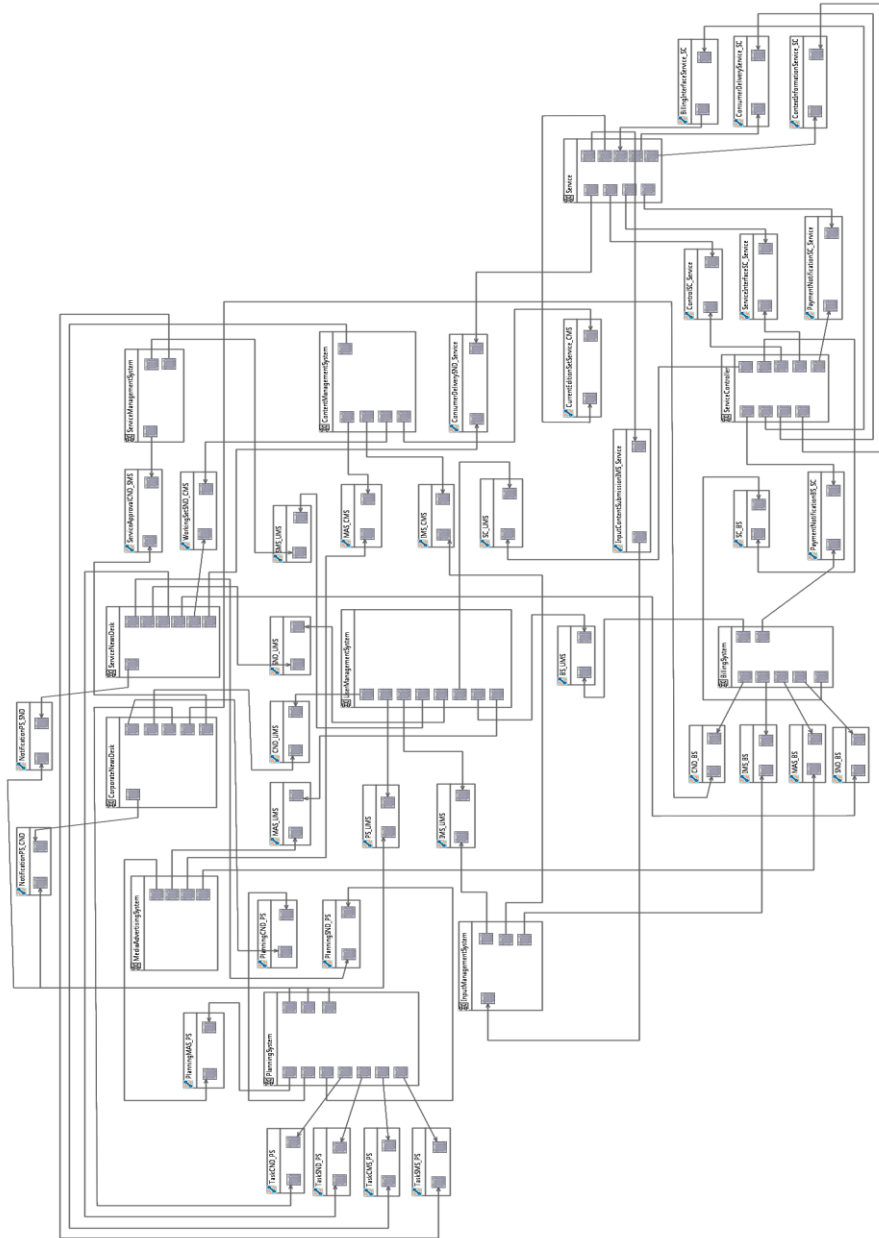
3   Digital publishing system [2]

Figure 2. Architecture of the digital publishing system

Number of model elements: 179
Number of components: 11
Number of connectors: 36

3.1. Results for deletion operation

Number of possible deletions: 68719478782
Number of pattern-related deletions: 776
Number of total violated deletions (detected by pattern and mapping): 776
Number of violated deletions detected by pattern: 518
Number of violated deletions not detected by pattern: 258

3.2. Results for addition operation

Number of possible additions: 55
Number of pattern-related additions: 39
Number of total violated additions (detected by pattern and mapping): 0
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 0

3.3. Detailed results for each pattern view

3.3.1. Content Management System Repository pattern view

Number of mapping elements: 22
Number of pattern view elements: 21
Number of components: 3
Number of connectors: 2

At the granularity of component and connector, the total number of possible deletions of combination of elements: 31

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 10

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 4

- The case when we delete the DataAccessor and its Read/Write connector.
- The case when we delete the entire Repository view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 3

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 0

3.3.2. User Management System Repository pattern view

Number of mapping elements: 17

Number of pattern view elements: 91

Number of components: 9

Number of connectors: 8

At the granularity of component and connector, the total number of possible deletions of combination of elements: 131071

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 766

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 255

- The case when we delete the DataAccessor and its Read/Write connector.
- The case when we delete the entire Repository view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 36

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 0
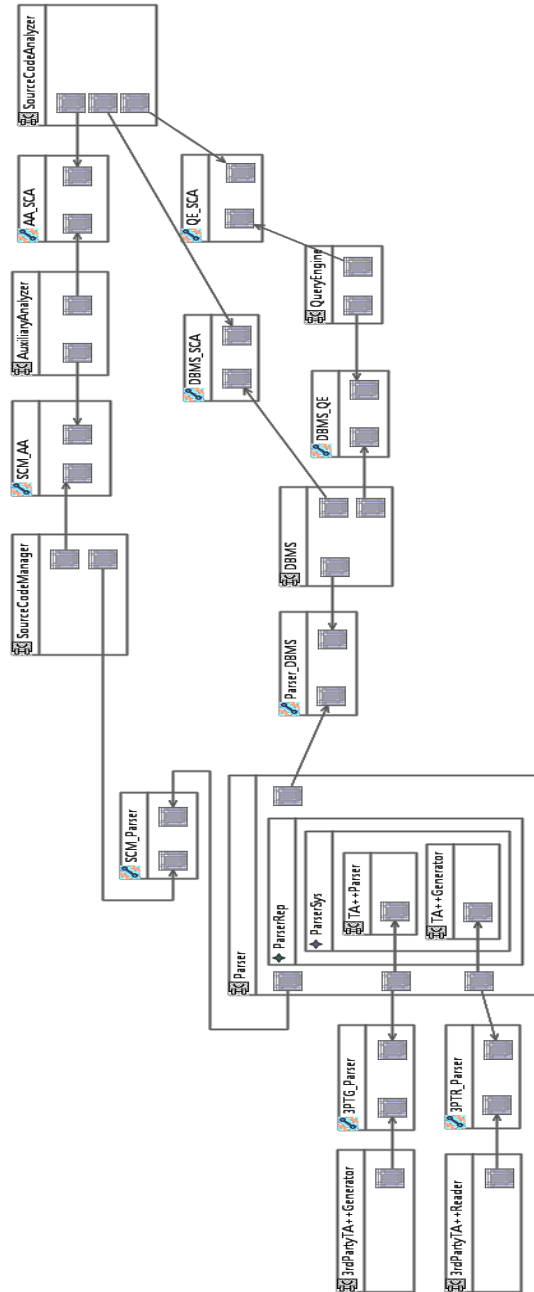
4   JITC [3]

Figure 3. Architecture of JITC

Number of model elements: 79
Number of components: 10
Number of connectors: 9

4.1. Results for deletion operation

Number of possible deletions: 258
Number of pattern-related deletions: 32
Number of total violated deletions (detected by pattern and mapping): 32
Number of violated deletions detected by pattern: 22
Number of violated deletions not detected by pattern: 10

4.2. Results for addition operation

Number of possible additions: 30
Number of pattern-related additions: 9
Number of total violated additions (detected by pattern and mapping): 3
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 3

4.3. Detailed results for each pattern view

4.3.1.   Pipes and Filters pattern view
Number of mapping elements: 5
Number of pattern view elements: 16
Number of components: 3
Number of connectors: 2

At the granularity of component and connector, the total number of possible deletions of combination of elements: 31

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 10

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 3
- The case when we delete the first Filters and their Pipes.
- The case when we delete the entire Pipes And Filters view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 3

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3

- The case when we add a Pipe between two distant Filters to create a cycle
- The case when we add a Pipe between two adjacent Filters that goes in an opposite direction than the other Pipes

4.3.2. Repository pattern view

Number of mapping elements: 7
Number of pattern view elements: 29
Number of components: 4
Number of connectors: 3

At the granularity of component and connector, the total number of possible deletions of combination of elements: 127

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 22

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 7

- The case when we delete the DataAccessor and its Read/Write connector.
- The case when we delete the entire Repository view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 6

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 0

5   Bonding trade system [4]
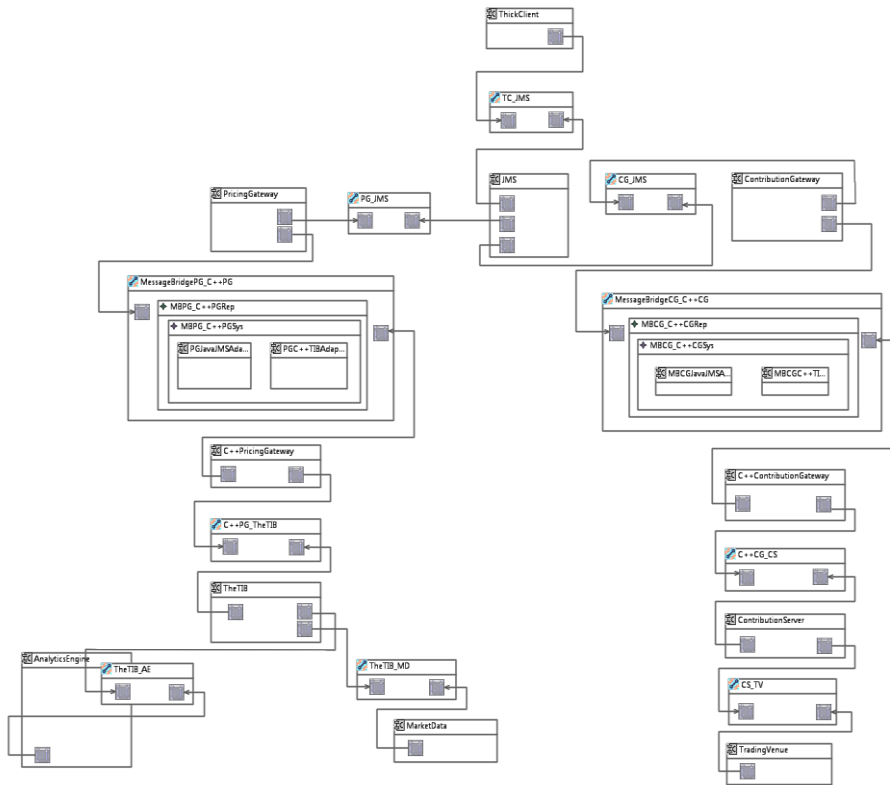
Figure 4. Architecture of the bonding trade system

Number of model elements: 89
Number of components: 15
Number of connectors: 10

5.1. Results for deletion operation

Number of possible deletions: 3076
Number of pattern-related deletions: 30
Number of total violated deletions (detected by pattern and mapping): 30
Number of violated deletions detected by pattern: 21
Number of violated deletions not detected by pattern: 9

5.2. Results for addition operation

Number of possible additions: 57
Number of pattern-related additions: 8
Number of total violated additions (detected by pattern and mapping): 5
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 5

5.1. Detailed results for each pattern view

5.1.1.   Pipes and Filters pattern view
Number of mapping elements: 7
Number of pattern view elements: 21
Number of components: 4
Number of connectors: 3
At the granularity of component and connector, the total number of possible deletions of combination of elements: 127
At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 22
At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 7
- The case when we delete the Application component and its associated Communicator connector
- The case when we delete the entire Message Bus view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 6
At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3
- The case when we add a connector between the Application components

5.1.2.   Pricing Gateway Message Bridge pattern view
Number of mapping elements: 3
Number of pattern view elements: 11
Number of components: 2
Number of connectors: 1
At the granularity of component and connector, the total number of possible deletions of combination of elements: 7
At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 4

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 1

- The case when we delete the entire Pricing Gateway Message Bridge view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 1

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 1

5.1.3. Contribution Gateway Message Bridge pattern view

Number of mapping elements: 3

Number of pattern view elements: 11

Number of components: 2

Number of connectors: 1

At the granularity of component and connector, the total number of possible deletions of combination of elements: 8

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 4

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 1

- The case when we delete the entire Pricing Gateway Message Bridge view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 1

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 1

6 Ginga-CC [5]
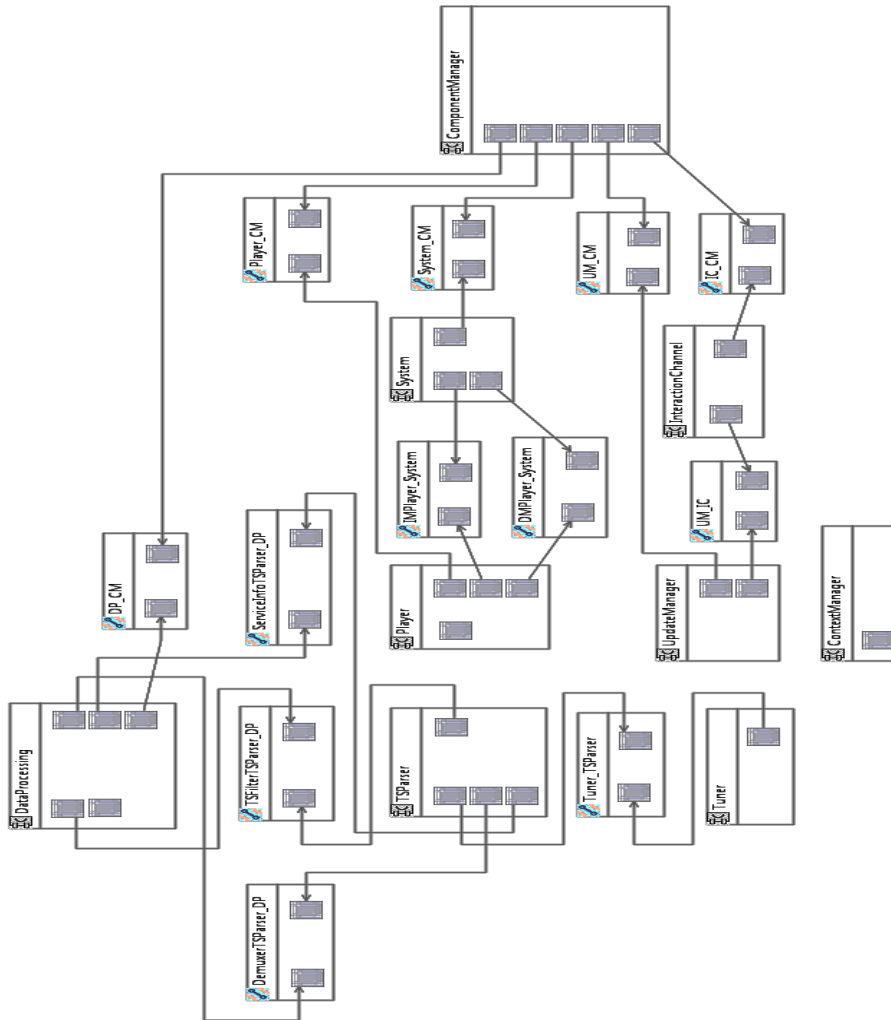
Figure 5. Architecture of Ginga-CC

Number of model elements: 96
Number of components: 9
Number of connectors: 12

6.1. Results for deletion operation

Number of possible deletions: 4606
Number of pattern-related deletions: 10

Number of total violated deletions (detected by pattern and mapping): 10
Number of violated deletions detected by pattern: 7
Number of violated deletions not detected by pattern: 3

6.2. Results for addition operation

Number of possible additions: 36
Number of pattern-related additions: 3
Number of total violated additions (detected by pattern and mapping): 3
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 3

6.3. Detailed results for each pattern view

6.3.1.   Pipes and Filters pattern view
Number of mapping elements: 5
Number of pattern view elements: 19
Number of components: 3
Number of connectors: 2
At the granularity of component and connector, the total number of possible deletions of combination of elements: 31
At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 10
At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 3
-    The case when we delete the first Filters and their Pipes.
-    The case when we delete the entire Pipes And Filters view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 3
At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3
-    The case when we add a Pipe between two distant Filters to create a cycle
-    The case when we add a Pipe between two adjacent Filters that goes in an opposite direction than the other Pipes
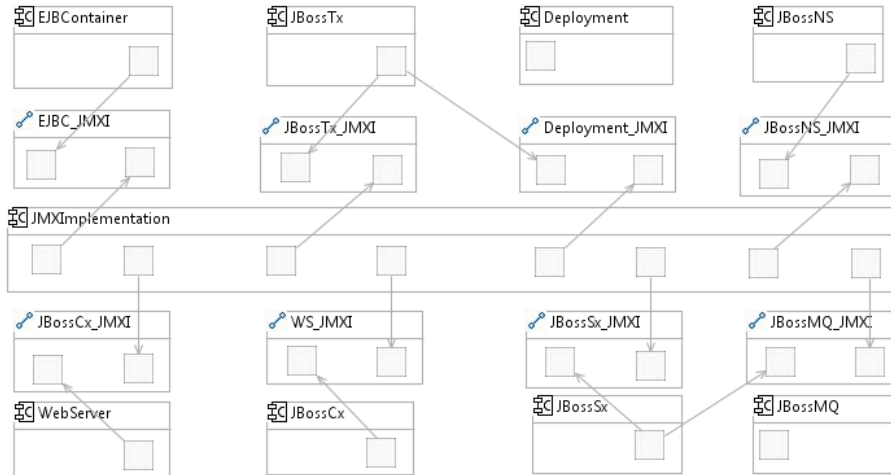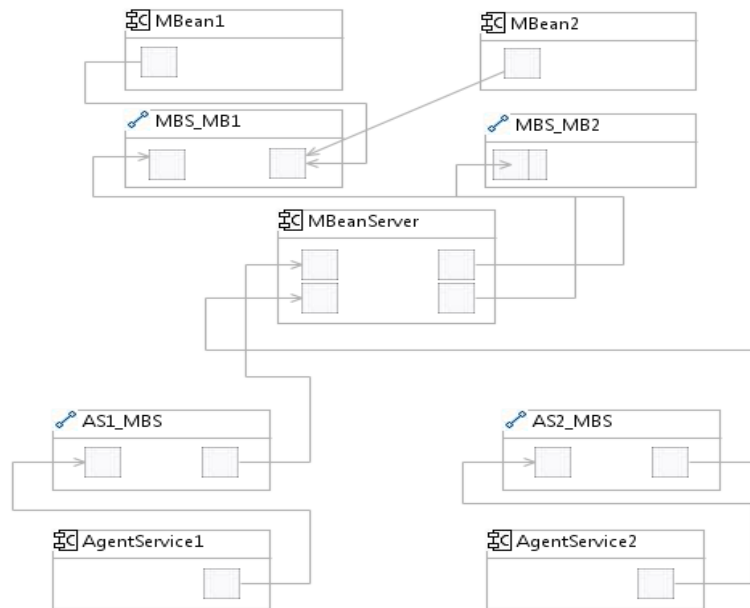
7 JBoss [6]

Figure 6. Architecture of JBoss
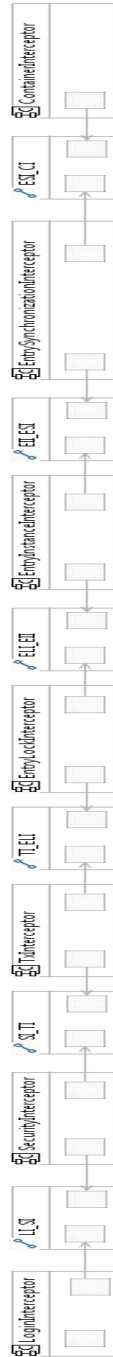

Figure 7. Architecture of JMXImplementation
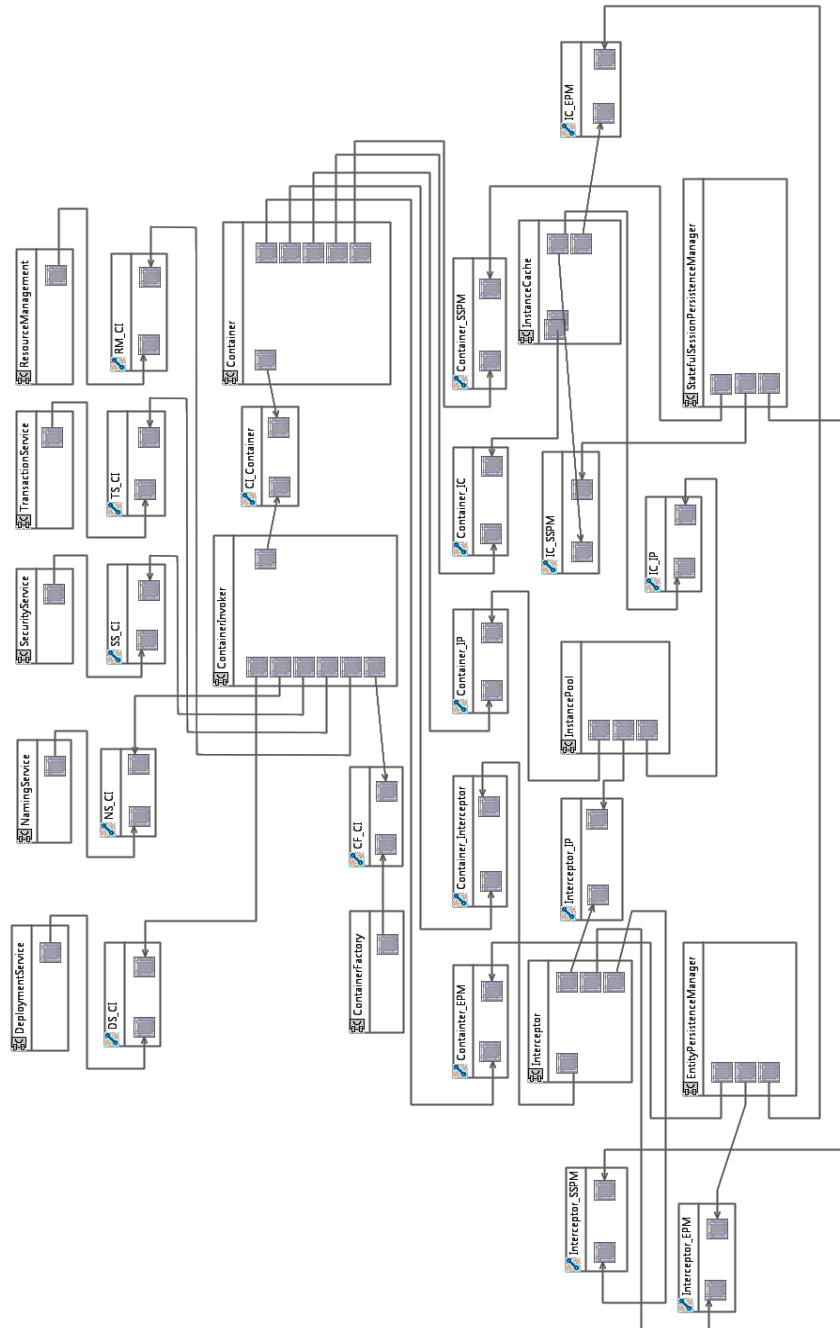
Figure 8. Architecture of Interceptor

Figure 9. Architecture of EJBContainer

Number of model elements: 287
Number of components: 34
Number of connectors: 36

7.1. Results for deletion operation

Number of possible deletions: 271336
Number of pattern-related deletions: 426
Number of total violated deletions (detected by pattern and mapping): 426
Number of violated deletions detected by pattern: 364
Number of violated deletions not detected by pattern: 62

7.2. Results for addition operation

Number of possible additions: 145
Number of pattern-related additions: 52
Number of total violated additions (detected by pattern and mapping): 30
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 30

7.3. Detailed results for each pattern view

7.3.1. Broker pattern view
Number of mapping elements: 13
Number of pattern view elements: 43
Number of components: 7
Number of connectors: 6

At the granularity of component and connector, the total number of possible deletions of combination of elements: 8191

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 190

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 31
- The case when we delete the Client together with its connector to Broker
- The case when we delete the entire Broker view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 21

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 5

- The case when we add a connector between the Remote Object and the Client

7.3.2. Microkernel pattern view

Number of mapping elements: 9

Number of pattern view elements: 25

Number of components: 5

Number of connectors: 4

At the granularity of component and connector, the total number of possible deletions of combination of elements: 511

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 46

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 9

- The case when we delete the External Service together with its connector to Microkernel
- The case when we delete the Internal Service together with its connector to Microkernel
- The case when we delete the entire Microkernel view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 10

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 4

- The case when we add a connector between the External Service and the Internal Service

7.3.3. Pipes and Filters pattern view

Number of mapping elements: 13

Number of pattern view elements: 38

Number of components: 7

Number of connectors: 6

At the granularity of component and connector, the total number of possible deletions of combination of elements: 8191

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 190

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 22

- The case when we delete the first Filters and their Pipes.

- The case when we delete the entire Pipes And Filters view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 21

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 21

- The case when we add a Pipe between two distant Filters to create a cycle
- The case when we add a Pipe between two adjacent Filters that goes in an opposite direction than the other Pipes
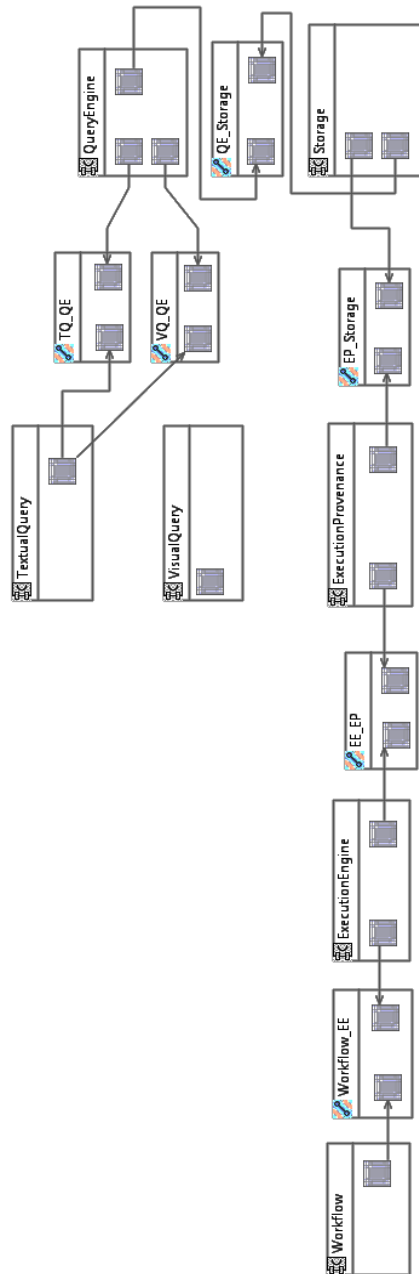
8 VisTrails [7]

Figure 10. Architecture of Vistrails

Number of model elements: 49
Number of components: 7
Number of connectors: 6

8.1. Results for deletion operation

Number of possible deletions: 190
Number of pattern-related deletions: 20
Number of total violated deletions (detected by pattern and mapping): 20
Number of violated deletions detected by pattern: 14
Number of violated deletions not detected by pattern: 6

8.2. Results for addition operation

Number of possible additions: 21
Number of pattern-related additions: 6
Number of total violated additions (detected by pattern and mapping): 3
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 3

8.3. Detailed results for each pattern view

8.3.1.   Pipes and Filters pattern view
Number of mapping elements: 5
Number of pattern view elements: 14
Number of components: 3
Number of connectors: 2

At the granularity of component and connector, the total number of possible deletions of combination of elements: 31

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 10

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 3
-    The case when we delete the first Filters and their Pipes.
-    The case when we delete the entire Pipes And Filters view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 3

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3

- The case when we add a Pipe between two distant Filters to create a cycle
- The case when we add a Pipe between two adjacent Filters that goes in an opposite direction than the other Pipes

8.3.2. Repository pattern view

Number of mapping elements: 5
Number of pattern view elements: 16
Number of components: 3
Number of connectors: 2

At the granularity of component and connector, the total number of possible deletions of combination of elements: 32

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 10

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 3

- The case when we delete the DataAccessor and its Read/Write connector.
- The case when we delete the entire Repository view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 3

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 0
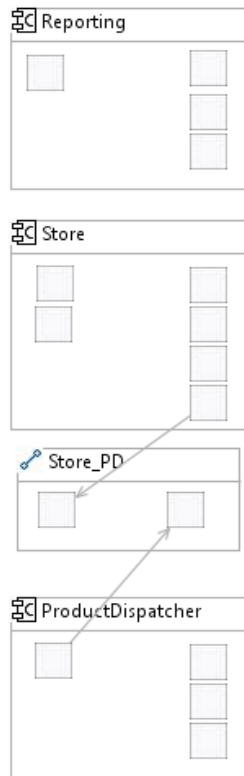
9 CoCoME [8]

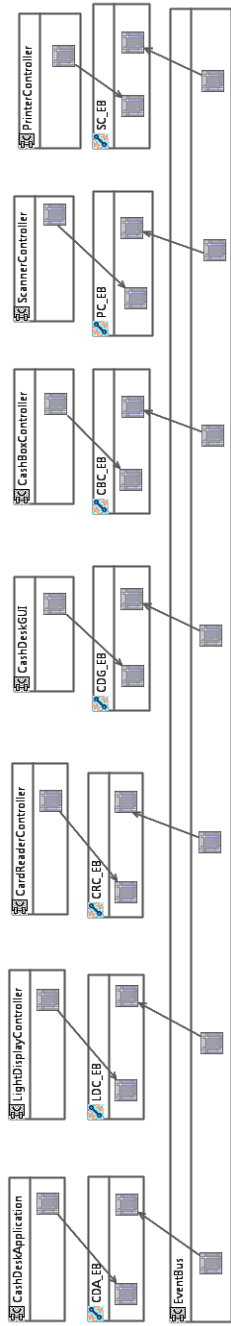
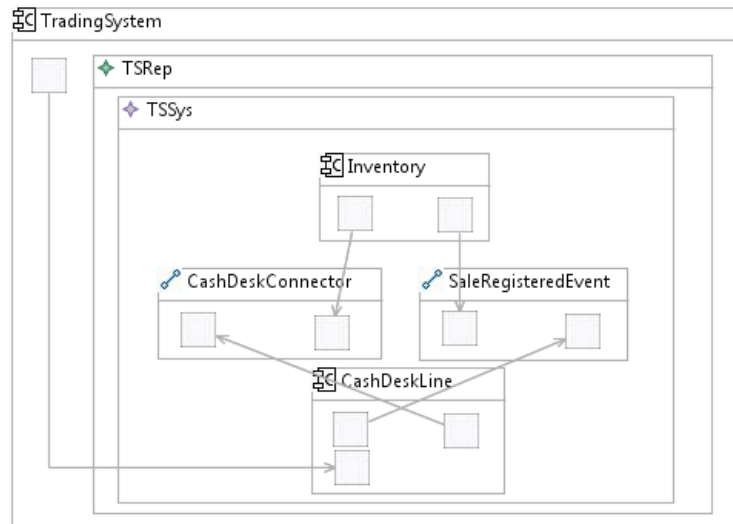**Figure 11. Architecture of Application component**

Figure 12. Architecture of CashDeskLine component

Figure 13. Architecture of CoCoME

Figure 14. Architecture of Data component
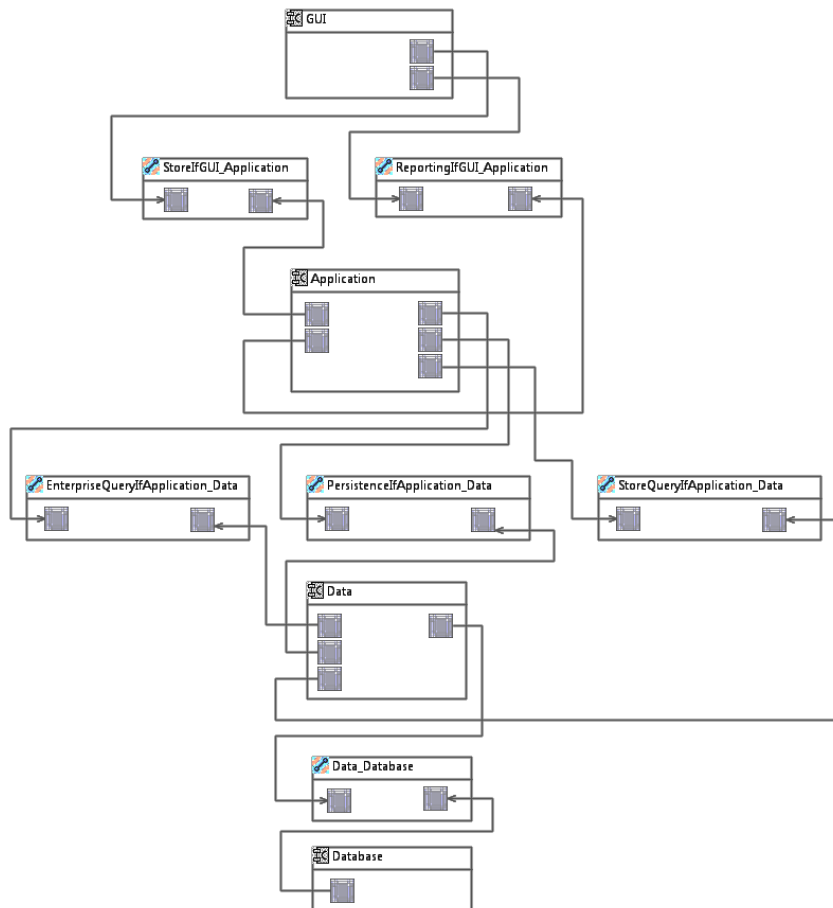
Figure 15. Architecture of GUI component

Figure 16. Architecture of Inventory component

Number of model elements: 157
Number of components: 23
Number of connectors: 16

9.1. Results for deletion operation

Number of possible deletions: 488
Number of pattern-related deletions: 460
Number of total violated deletions (detected by pattern and mapping): 460
Number of violated deletions detected by pattern: 327
Number of violated deletions not detected by pattern: 133

9.2. Results for addition operation

Number of possible additions: 44
Number of pattern-related additions: 6 + 28 = 34
Number of total violated additions (detected by pattern and mapping): 24
Number of violated additions detected by mapping: 0
Number of violated additions not detected by mapping: 24

9.1. Detailed results for each pattern view

9.1.1.   Layers pattern view
Number of mapping elements: 10
Number of pattern view elements: 34
Number of components: 4
Number of connectors: 6
At the granularity of component and connector, the total number of possible deletions of combination of elements: 1023
At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 78
At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 6
- The case when we delete the first or the last Layers and their Connector
- The case when we delete the entire Layers view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 6

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 3

- The case when we add a connector between two components that are not adjacent

9.1.2. Message Bus pattern view

Number of mapping elements: 15

Number of pattern view elements: 43

Number of components: 8

Number of connectors: 7

At the granularity of component and connector, the total number of possible deletions of combination of elements: 32767

At the granularity of component and connector, the total number of possible deletions of combination of elements with the condition that when the component is deleted, its associated connectors must be also deleted: 382

At the granularity of component and connector, the total number of possible deletions of combination of elements that can be detected by mapping models but not by patterns: 127

- The case when we delete the Application component and its associated Communicator connector
- The case when we delete the entire Message Bus view

At the granularity of component and connector, the total number of possible additions of connectors between two components: 28

At the granularity of component and connector, the total number of possible additions of connectors between components that can be detected by pattern models but not by mappings: 21

- The case when we add a connector between the Application components

References

[1] Oracle® Communications Billing and Revenue Management, E23300-05. Technical report, Oracle, March 2013.

[2] D. Van Landuyt, J. Grégoire, S. Michiels, E. Truyen, and W. Joosen, "Architectural design of a digital publishing system," Oct-2006. Available: https://lirias.kuleuven.be/handle/123456789/131455.

[3] T. C. Lethbridge and N. Anquetil, Architecture of a Source Code Exploration Tool: A Software Engineering Case Study. 1997.

[4] Hohpe, G. and Woolf, B.: Enterprise Integration Patterns. Addison Wesley. 2004.

[5] D. Saraiva, L. Pereira, T. Batista, F. C. Delicato, P. F. Pires, U. Kulesza, R. Araújo, T. Freitas, S. Miranda, A. L. Souto, and R. Coelho, "Architecting a Model-Driven Aspect-Oriented Product Line for a Digital TV Middleware: A Refactoring Experience," in Software Architecture, M. A. Babar and I. Gorton, Eds. Springer Berlin Heidelberg, 2010, pp. 166–181.

[6] J. Liu, Research Project: An Analysis of JBoss Architecture. http://www.huihoo.org/jboss/jboss.html, 2002.

[7] A. Brown, The Architecture Of Open Source Applications. lulu.com, 2012.

[8] Andreas Rausch, Ralf Reussner, Raffaela Mirandola, and Frantisek Plasil, editors. The Common Component Modeling Example: Comparing Software Component Models, volume 5153 ofLNCS. Springer, 2008