

**Contributions on development methodologies and
architectures for applying software reuse in
distributed systems**

Abstract

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Content

1. Introduction	6
2. Reuse Concepts and Dimensions	11
2.1 Approach methods	11
2.2 Rationale for applying RDSE	13
2.3 Strategies and processes for reuse	14
2.4 Reuse contexts	15
2.4.1 Application use context	16
2.4.2 Execution context	16
2.4.3 Application structure and architecture	16
2.4.4 Application development	16
2.5 Reuse dimensions	17
2.5.1 Analysis – Knowledge reuse	17
2.5.2 Architecture – Structural reuse	18
2.5.3 Development – Design reuse	19
2.6 Piedici în implementarea cu succes a reutilizării	20
2.7 Conclusions	21
3. Applying knowledge reuse in distributed architectures	23
3.1 Overview	23
3.2 Fundamental design patterns in distributed systems	28
3.2.1 Communication patterns	28
3.2.2 Error handling patterns	32
3.2.3 Security patterns	33
3.3 Architectural models of distributed systems – topologies	36
3.3.1 Architectural layers in distributed systems	37
3.3.2 Distributed systems models	38
3.4 Applying reuse in the design of a distributed system - a distributed monitoring framework (DMF)	47
3.4.1 DMF Specifications	48
3.4.2 DMF Architecture	50
3.4.3 Communication security	54
3.4.4 Adapting to heterogeneous environments	55
3.4.5 Automated communication method change	55
3.4.6 DMF instances - Scaling the architecture	56

3.4.7 A framework instance	57
3.5 Conclusions	62
4. Reuse oriented software architecture	64
4.1 Application family architecture	64
4.1.1 Application Systems	65
4.1.2 Architectural components systems	66
4.1.3 Components systems facades	67
4.1.4 Architectural components variations	68
4.1.5 Component reuse in application systems	69
4.1.6 Reuse-oriented packaging and documenting component systems	70
4.2 Components	71
4.2.1 Analysis and design components reuse	72
4.3 Layered architectures	72
4.3.1 Systematic approach of layered architectures	74
4.3.2 Mapping Use Cases to architecture	76
4.3.3 Embedding legacy systems in the architecture	78
4.3.4 Distributed processes in layered architectures	78
4.4 Architectural patterns	79
4.4.1 Distributed systems patterns	80
4.5 Application frameworks	81
4.6 Reuse oriented architecture of an integrated multimedia messaging system	83
4.6.1 Specifications and domain analysis	83
4.6.2 Application family architecture	89
4.7 Conclusions	99
5. Adapting the OOSE processes for RDSE	100
5.1 Software engineering	100
5.1.1 Software development methodologies	101
5.1.2 Agile methodologies	102
5.1.3 Plan driven methodologies	107
5.1.4 The Unified Process	110
5.1.5 Comparative conclusions of methodologies from the reuse perspective	112
5.2 The components of a successful RDSE	113
5.2.1 Basic principles of reuse	113
5.2.2 Commercial components are a critical success factor	113
5.2.3 A systematic approach allows for a pragmatic reuse	113

5.2.4	Conditions for a successful reuse implementation	115
5.2.5	Adapting the development processes for reuse	115
5.2.6	Organizational changes	116
5.2.7	An iterative and incremental approach on reuse	117
5.3	Commercial aspects of systematic reuse	119
5.4	Conclusions	122
6.	A proposed approach on developing distributed application using RDSE	124
6.1	Applying OO analysis in process analysis	125
6.2	Developing application families	127
6.2.1	Developing application families architectures	127
6.2.2	Planning the development based on use-case priorities	127
6.2.3	Risk management in developing application families	127
6.2.4	Process phases in developing application families	128
6.3	Developing component systems	130
6.3.1	Process phases in developing component systems	130
6.4	Developing application systems	132
6.4.1	Process phases in developing application systems	132
6.5	Contributions on applying the A&D process in RDSE	134
6.5.1	Process description	134
6.5.2	Conclusions on the RDSE processes	143
6.6	Software Analysis adaptation proposal for reuse	144
6.6.1	Artefact and models reuse in software analysis	146
6.6.2	Analysis customization for developing application families	149
6.6.3	Analysis models reuse	153
6.6.4	Conclusions on analysis reuse	157
6.7	Conclusions	157
7.	Measuring reuse	159
7.1	Expected benefits on measuring reuse	160
7.1.1	Development artefacts reuse	160
7.1.2	Components reuse	160
7.1.3	Expected benefits	161
7.1.4	Reuse measurements	161
7.2	The Multidimensional Weighted Analysis Framework	162
7.2.1	Structure	162
7.2.2	Process	162

7.3	Integrated model proposal of multidimensional analysis	163
7.3.1	WBS extension	163
7.3.2	WBS dimensions extension	164
7.3.3	Measurement points attributes	165
7.3.4	Performance indicators structure	166
7.3.5	Performance analysis of Reuse oriented projects	167
7.4	Analysis method	169
7.5	Experimental results	170
7.5.1	Control nodes	171
7.5.2	Numerical results	171
7.6	Conclusions	186
8.	Conclusions and further developments	189
8.1	Contributions	190
8.2	Published papers	192
8.3	Developed projects	193
8.4	Further developments	194
9.	Glossary	195
10.	Figure Index	196
11.	References	199

Abstract

"To change your fate, you must change your attitude."

The main purpose of this thesis is to increase the benefit of reuse in developing distributed systems. We aim at a systematic approach of the reuse problem while identifying the most relevant improvement areas and proposing solutions in the identified areas. The thesis represents the result of our experience in developing distributed systems in the outsourcing domain which is specific to a wide diversity of projects regarding both the dimension and the technology. As a consequence we studied how reuse can be improved during the whole software development lifecycle, starting from the OOSE methodologies and aiming towards RDSE.

The result of our approach is reflected in the structure of this thesis, where the reuse dimensions are first identified and then the problem is analyzed on each of the identified dimensions. Each chapter presents the most promising improvement solutions, the most important threats and the original contribution in the area.

One of the main ideas of the thesis is that the success of reuse oriented approach involves both technological and process-related components. Considering a balance between the importance of the technologies and processes in reuse, we can identify four areas, graphically presented in fig.1.

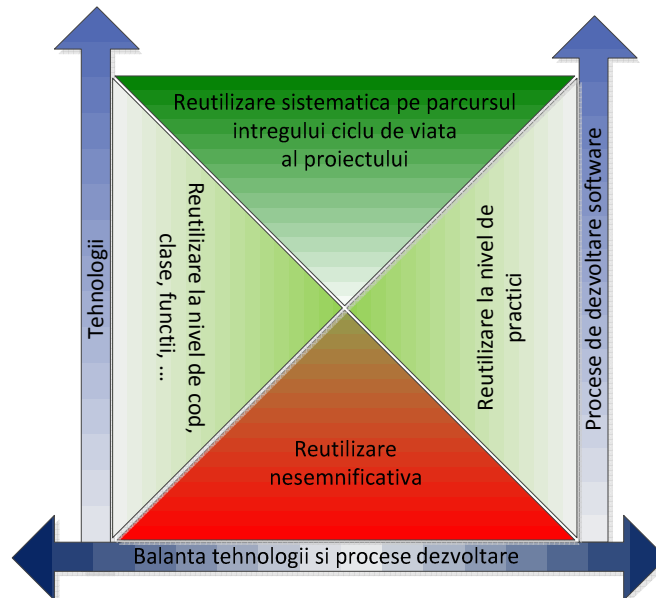


Fig. 1 – Balance between technologies and processes

Considering the contexts where reuse can be applied, we structured the thesis in 7 chapters, each corresponding to one of the following areas: Concepts, Technologies, Processes and Metrics as depicted in Fig.2

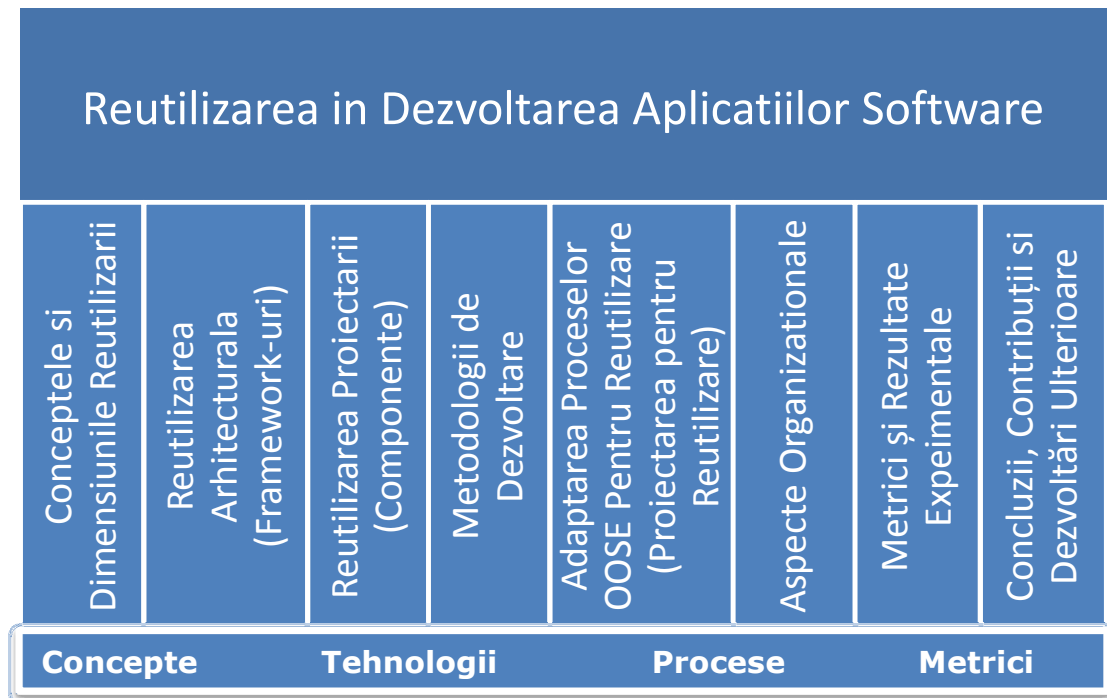


Fig. 2 – Thesis structure

Chapter 2. „Reuse Concepts and Dimensions” contains a brief presentation and a critical analysis of reuse in software engineering, a state of the art of the main methods used and the most promising research and development directions. We present here the disciplines where the highest gain from reuse is expected and also the problems that prevent the expected success of reuse. In Chapter 2 the context in which the proposed improvements to reuse and the proposed performance measurement model will be applied is introduced.

In **Chapter 3** „Applying knowledge reuse in distributed architectures” we are discussing the main principles and problems in the design of distributed systems. We describe the basic principles and architectural models and we present an approach for the design and development of a framework for a remote monitoring distributed system. The approach is reuse driven and involves the reuse of architectural knowledge.

Chapter 4. „Reuse oriented software architecture” goes into further details addressing the problem of domain specific reuse. In this context specific issues related to modeling application families and component systems are addressed. Among these we discuss the design of variation points, facades and packaging components. We also present in this chapter a meta-model for integrating architectural patterns in the design of reuse-driven architectures. Our theoretical proposals are validated by applying them in the design and development of a reuse-driven integrated system for multimedia messaging.

The next **chapters 5.** „Adapting the OOSE Processes for reuse oriented software development” and **și 6.** „A proposed RDSE approach to the development of distributed applications” emphasise the importance of discipline in maintaining the RDSE processes and describe the reuse principles that should be followed in a reuse-oriented process. The chapters start from the OOSE analysis and design processes, the classical plan-driven and agile methodologies and include improvement proposals that facilitate reuse. The focus of the proposed approach is the reuse-driven process for domain specific applications namely application families, component systems and application systems.

In **Chapter 7** "Measuring reuse" we propose an original reuse measurement model. Depending on the types of reuse in focus there are several methods of classification for the metrics and measurements applicable in software reuse. However, a subtle gap is showing up. Because of the underlying metrics the measurements are done mainly at the technical architecture level (class, component, subsystem, etc) while the expected benefits are expressed at management level.

The measurement model we are proposing is based on integrating software reuse specific metrics in the project management measurements. The model can be regarded as part of the reuse cost-benefit analysis and enables the inclusion of software reuse metrics into the project performance indicators. The model is based on the extending the projects' WBS (Work Breakdown Structure) work packages attributes with software reuses metrics and to extend the project performance indicators' calculus methods performed in the CA (Control Account) to include software reuse. The method introduced in this thesis is based on applying the ideas introduced by the Multidimensional Weighted Attribute Framework in calculating software statistics to Earned Value Management. This research extended the project WBS static structure in the multidimensional MWAF fashion and tailoring the calculus method with specific EVM methods instead of statistics.

We extended the WBS from a bi-dimensional structure of work products and resources to a Multidimensional WBS defined as a five-dimensional function obtained by intersecting the methodologies, disciplines and technical architecture (where the reuse metrics are defined) with the control accounts (CA) in the WBS. The obtained MCA are the points where the analysis indicators are calculated by applying familiar project management analysis methods. A brief example of applying the method for including reuse in project predictability indicator was given and the weighted coefficients were calculated for an MCA.

The last **Chapter 8**, "Conclusions and further developments" highlights the conclusions and shows further research directions in the field of reuse in distributed systems.

Main contributions

The contributions of this thesis are both theoretical and practical. The theoretical contributions are validated by the 9 published papers authored by the author of the thesis. The practical contributions are validated by the implementation of the concepts, models and processes in 4 industrial projects managed by the author of this thesis.

A summary of the contributions is presented below:

Theoretical contributions:

- Introducing the dimensional approach as a starting point for the reuse analysis
- Identifying the dimensions that promise the most effective reuse
- Based on the identified dimensions we proposed a tridimensional reuse model using the OOSE disciplines and the abstraction/granularity levels corresponding to the application contexts
- Applying RDSE for the design of a distributed system
- Adapting the architectural modelling methods in the context of application families by introducing the concepts of variation points and superordered models
- Proposal of reuse oriented software development processes
- Organizational changes proposal in companies to support reuse oriented software development processes
- Adapting the Unified Process for developing reuse based applications
- Extending the Unified Process for reuse-driven development of
 - Application families focused on architecture
 - Component Systems focused on design
 - Application Systems focused on component reuse
- Defining an original weighted attributes multidimensional model
- Defining an integrated analysis method and the computational model of performance indicators used in Earned Value Analysis

Practical contributions:

- Design and implementation of a Distributed Monitorin Framework
- Design and implementation of an instance of the framework for environment monitoring
- Architectural modeling of an application family used for the development of multimedia messaging systems.
- Adapting the Analysis and Design discipline for developing application families.
- Applying the multidimensional model and the analysis method on data collected from four closed and current projects.

Published papers

[1] **Mihai Dinsoreanu**, Iosif Ignat, *An Architectural Framework for Distributed Monitoring Systems*, Proceedings of the 8th International Conference on Intelligent Engineering Systems (INES 2004), Cluj-Napoca, Romania.

[2] **Mihai Dinsoreanu**, Iosif Ignat, *An integrated multimedia messaging framework based on architectural patterns*, Proceedings of the IEEE 2nd International Conference on Intelligent Computer Communication and Processing (ICCP 2006), ISSN 973-662-233-9, pp. 135-141.

[3] **Mihai Dinsoreanu**, Iosif Ignat, *Reuse-Oriented Architecture of an Integrated Multimedia Messaging Application*, Proceedings of the 6th Int. Conf. on APPLIED INFORMATICS AND COMMUNICATIONS, pp. 181-188 ISBN 960-8457-51-3 [**ACM Digital Library**]

[4] **Mihai Dinsoreanu**, Iosif Ignat, *Applying software reuse and pattern oriented architectures in a multimedia messaging system*, Transactions on Information Science and Applications. Vol. 3, no. 11, pp. 2223-2230. [**Scopus**]

[5] **Mihai Dinsoreanu**, Iosif Ignat, *A Value Analysis Model for Measuring Software Reuse*, Proceedings of the Second International Conference on Applications of Digital Information and Web Technologies (ICADIWT '09), ISBN: 978-1-4244-4456-4, pp. 846-848 [**Scopus, IEEE Xplore**]

[6] **Mihai Dinsoreanu**, Iosif Ignat, *A Pragmatic Analysis Model for Software Reuse*, Software Engineering Research, Management and Applications 2009, Series: Studies în Computational Intelligence, Springer, Vol. 253, 2010, XVI, ISBN: 978-3-642-05440-2, pp. 217-227 [**DBLP, SpringerLink, Scopus**]

[7] **Mihai Ion Dinsoreanu**, Iosif Ignat, *Measuring Reuse Performance based on an Integrated Multidimensional Analysis Model*, Proceedings of International Conference on Software and Computing Technology (ICST 2010), IEEE Catalog Number: CFP1081K-PRT, ISBN: 978-1-4244-8318-1, pp. 152-157

[8] **Mihai Ion Dinsoreanu**, Iosif Ignat, *Measuring Reuse Performance based on an Integrated Multidimensional Analysis Model*, Proceedings of International Conference on Computer and Electrical Engineering (ICCEE 2010), IEEE Catalog Number: CFP1049I-PRT, ISBN: 978-1-4244-7224-6, pp. 416-421

[9] **Mihai Ion Dinsoreanu**, Iosif Ignat, *An Integrated Multi Dimensional Analysis Model for Software Reuse Performance*, Proceedings of the IEEE 2nd International Conference on IT and Business Intelligence (ITBI 2010), November 12 – 14, 2010, Nagpur India, ISBN No: 978-81-7446-900-7.

Paper [6] was cited in Data Science Journal Vol. 9 (2010) pp.73-92

A PROPOSAL ON USING REUSE READINESS LEVELS TO MEASURE SOFTWARE REUSABILITY

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Selected projects

This thesis was developed based on the experience gained by managing several very large software development projects. We mention below the ones that were directly referred in the thesis:

Project	Client	Status
Multimedia Distribution Platform	RTN US Subsidiary	Completed
Distributed Monitoring Framework	YSI/UK Environmental Agency	Completed
Multimedia Integrated Messaging	Deutsche Telekom Subsidiary	Completed
SmartHome Platform	Microsoft GmbH, Renania Westfalia Energie – RWE	Ongoing