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
      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 heterogenous 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

3.5 Conclusions

4. Reuse oriented software architecture

4.1 Application family architecture

4.1.1 Application Systems

4.1.2 Architectural components systems

4.1.3 Components systems facades

4.1.4 Architectural components variations

4.1.5 Component reuse in application systems

4.1.6 Reuse-oriented packaging and documenting component systems

4.2 Components

4.2.1 Analysis and design components reuse

4.3 Layered architectures

4.3.1 Systematic approach of layered architectures

4.3.2 Mapping Use Cases to architecture

4.3.3 Embedding legacy systems in the architecture

4.3.4 Distributed processes in layered architectures

4.4 Architectural patterns

4.4.1 Distributed systems patterns

4.5 Application frameworks

4.6 Reuse oriented architecture of an integrated multimedia messaging system

4.6.1 Specifications and domain analysis

4.6.2 Application family architecture

4.7 Conclusions

5. Adapting the OOSE processes for RDSE

5.1 Software engineering

5.1.1 Software development methodologies

5.1.2 Agile methodologies

5.1.3 Plan driven methodologies

5.1.4 The Unified Process

5.1.5 Comparative conclusions of methodologies from the reuse perspective

5.2 The components of a successful RDSE

5.2.1 Basic principles of reuse

5.2.2 Commercial components are a critical success factor

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

Practical contributions:

• Design and implementation of a Distributed Monitoring 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


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:

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