

Contents

Foreword	v
Danksagung	vii
Abstract	ix
Zusammenfassung	xi
List of Figures	xvii
List of Tables	xix
1 Introduction	1
1.1 Sample Scenarios of a Peer-to-Peer-Based Content Repository	3
1.1.1 Cross-Enterprise Business Collaboration	3
1.1.2 Intra-Enterprise Knowledge Management	6
1.2 Problem Statement and Research Challenges	10
1.2.1 Research Challenges Regarding the Content Model	11
1.2.2 Research Challenges Regarding the Content Repository Model	11
1.2.3 Research Challenges Regarding the Peer-to-Peer Model	13
1.3 Main Research Contributions of this Thesis	14
1.4 Publications	16
1.5 Outline	17
2 Background	19
2.1 Content Repositories	20
2.1.1 Content versus Data	22
2.1.2 Content Management	23
2.1.3 Content Management Systems	23
2.2 Distributed Systems, Algorithms, and Methods	25
2.2.1 Node Model	26
2.2.2 Communication Models	26
2.2.3 Failure Models	28
2.2.4 Consensus Algorithms	29
2.2.5 Fault-Tolerant State Machines	31
2.2.6 Group Communication	32
2.2.7 Dynamic Code Loading	32
2.3 Peer-to-Peer Systems	33
2.3.1 Centralised Peer-to-Peer Overlays	34
2.3.2 Unstructured Peer-to-Peer Overlays	35
2.3.3 Structured Peer-to-Peer Overlays	36
2.4 Distributed File Systems	37

2.4.1	Client–Server-Based Systems	38
2.4.2	Peer–to–Peer-Based Systems	40
2.5	Distributed Database Systems	42
2.5.1	Client–Server-Based Systems	43
2.5.2	Peer–to–Peer-Based Systems	45
2.6	Summary	46
3	Analysis of Content Repository Requirements in a Peer–to–Peer Case	49
3.1	Methodology of Analysis	49
3.2	Definition of Functional Building Blocks Using the Content Repository API for Java Technology	50
3.2.1	Content Repository Model	51
3.2.2	Content Repository Functions	53
3.2.3	Operational Scope	61
3.3	Dependence Relationships between Functional Building Blocks	62
3.3.1	Service Functionality Dependence	62
3.3.2	Influence Dependence	64
3.4	Suitability of Peer–to–Peer Overlays for Content Repository Functionality . . .	65
3.4.1	Functional Content Repository Requirements for a Peer–to–Peer Approach	66
3.4.2	Non-Functional Content Repository Requirements for a Peer–to–Peer Approach	66
3.5	Summary	68
4	Design of a Generic Peer–to–Peer Content Repository System Architecture	71
4.1	Architectural Model	72
4.1.1	Logical View	72
4.1.2	Process View	72
4.1.3	Development View	73
4.1.4	Physical View	73
4.1.5	Scenarios	73
4.2	Generic Content Repository Architecture	74
4.2.1	Modular Decomposition	74
4.2.2	Persistent Storage Management	77
4.3	Generic Content Mapping	80
4.3.1	Item Naming Concept	80
4.3.2	Flexible Content Item Policies	83
4.4	Generic Peer Architecture	84
4.4.1	Internal Peer Structure	84
4.4.2	Dynamic Service Integration	87
4.5	Related Work	89
4.6	Summary	91
5	Methods for Flexible Content Repository Functions in Structured Peer–to–Peer Overlays	93
5.1	DhtFlex: A Distributed Algorithm for Flexible Atomic Data Management . . .	93
5.2	System Context of DhtFlex	95
5.2.1	System Model	95
5.2.2	System Architecture	96
5.2.3	System Interface	100

5.3	Functionality of DhtFlex	100
5.3.1	Annotated Data Resources	101
5.3.2	Recast Case	101
5.3.3	Put Case	107
5.3.4	Get Case	109
5.3.5	Overlay Breakup Detection	111
5.4	Flexible Content Repository Functions	112
5.4.1	Content Mapping	112
5.4.2	Persistent Content Storage	114
5.5	Related Work	117
5.6	Summary	119
6	Methods for Flexible Content Repository Functions in Hybrid Peer-to-Peer Overlays	121
6.1	Reconfigurable Peer-to-Peer Service Groups	122
6.2	System Context of Peer-to-Peer Service Groups	124
6.2.1	System Model	124
6.2.2	System Architecture	125
6.2.3	System Interface	129
6.3	Functions of Peer-to-Peer Service Groups	130
6.3.1	Lifecycle Management	130
6.3.2	Decentralised Dynamic Code Loading of Service Functions	134
6.3.3	Consensus-Based Peer-to-Peer Group Communication	139
6.4	Flexible Content Repository Functions	148
6.4.1	Content Mapping	148
6.4.2	Persistent Content Storage	150
6.5	Related Work	153
6.6	Summary	156
7	Evaluation	159
7.1	Methodology	159
7.1.1	Architecture Evaluation	159
7.1.2	Method Evaluation	161
7.2	Peer-to-Peer Content Repository System Architecture	162
7.2.1	Architectural Styles	162
7.2.2	Quality Attributes	163
7.2.3	Scenarios	165
7.3	Methods for Flexible Content Repository Functions in Structured Peer-to-Peer Overlays	167
7.3.1	Reliability	167
7.3.2	Consistency	169
7.3.3	Reconfigurability	178
7.3.4	Scalability	178
7.3.5	Performance	182
7.4	Methods for Flexible Content Repository Functions in Hybrid Peer-to-Peer Overlays	187
7.4.1	Reliability	187
7.4.2	Consistency	188
7.4.3	Reconfigurability	189

7.4.4 Scalability	189
7.4.5 Performance	190
7.5 Summary	194
8 Conclusion and Outlook	197
8.1 Conclusion	197
8.2 Future Work	200
Bibliography	205