

Contents

1	Introduction	1
1.1	Background	1
1.2	Contributions and Structure of this Thesis	3
1.3	Related Work	5
1.3.1	Context Awareness	6
1.3.2	Prefetching and Caching in Networks	8
2	Concepts and Theoretical Aspects	11
2.1	Situation Model	11
2.1.1	Situation Space	12
2.1.2	Dynamic Situation Model	18
2.1.3	Symptoms and Consequences	26
2.1.3.1	Symptoms	26
2.1.3.2	Consequences	27
2.1.4	Selection Criteria for Aspects and Components	28
2.1.4.1	Interpretation for Ignorance of Situation as False Probability Assumption	35
2.1.5	Estimation of Model Probabilities	37
2.1.5.1	Frequentist's Estimator	39
2.1.5.2	Laplace's Law of Succession	40
2.1.5.3	Derivation of Maximum Likelihood Estimator for Multinomial Distributions	40
2.1.5.4	Analysis and Comparison of Estimator Errors	42
2.1.5.5	Bayesian Analysis of Estimation for Multinomial Distributions	46
2.1.5.6	Estimation for Ranking and Prefetching Purposes	51
2.2	Situation-Aware Prefetching	55
2.2.1	Analytical Model	57
2.2.2	Influence on Waiting Time	59
2.2.2.1	Two-Document Problem with Known Request Time	59
2.2.2.2	Arbitrary Number of Documents with Unknown Request Time	62
2.2.3	Influence on Transported Volume	72
2.2.4	User Policy and Optimum Probability Threshold	74

3	System Simulation	77
3.1	Network Model	77
3.1.1	Topology and Mobility	78
3.1.2	Resource Sharing and Effective Data Rate	81
3.2	Mobility Model	82
3.2.1	Path Generation	83
3.2.1.1	Diffusion Algorithm	83
3.2.2	Speed Generation	87
3.2.3	Coverage Model Definition	88
3.3	Document and Traffic Model	93
3.4	Simulation Results and Discussion	96
3.4.1	Single User, Classical Mobile Networking Scenario	96
3.4.1.1	Single Trial Experiment	96
3.4.1.2	Multi Trial Experiment	100
3.4.2	Multi User Scenarios	104
3.4.2.1	Influence of Document Probabilities	107
3.4.2.2	Influence of Probability Threshold	107
3.4.2.3	Influence of Number of Access Points	109
4	Implementation Aspects	115
4.1	Relevant Conditions and Constraints in Mobile Networks and Devices	115
4.1.1	Networking Conditions	116
4.1.2	Software Conditions	117
4.2	System Architecture	118
4.2.1	Elements for Situation Awareness	118
4.2.2	Application Layer Proxies	119
4.2.3	Cache Consistency and Dynamic Content	123
4.3	Software Development, Integration and Test	131
4.3.1	Performance Measurements	133
4.4	Deployment and Initial Operational Experiences	139
5	Conclusions and Outlook	143
5.1	Conclusions	143
5.2	Outlook	144
A	Dynamic Pricing for Demand Control	145
B	Fast Generation of High-Dimensional Uniform Probability Vectors	149

C	Memory Management and Data Transfer in Computer Systems	151
C.1	Paging and Swapping	152
C.2	Caching	153
Glossary		161
Bibliography		166