

Contents

1	Introduction	1
1.1	Motivation	1
1.2	Causal Trusted Computing Bases	2
1.3	Challenges and Contributions	3
1.4	Organization	4
2	Related Work	7
2.1	Policy-controlled Operating Systems	7
2.1.1	Flask Security Architecture	7
2.1.2	Rule Set Based Access Control	9
2.1.3	Policy Machine	10
2.1.4	Summary	11
2.2	Reducing the Size and Complexity of TCBs	11
2.2.1	Nizza Security Architecture	11
2.2.2	Other Approaches	13
2.3	Security Models	13
2.3.1	Model-based Security Policy Engineering	14
2.3.2	Access Control Models	15
2.3.3	Information Flow Control Models	16
2.4	Summary	17
3	Security Model Core	19
3.1	Security Model Family Tree	19
3.2	Core Definition	23
3.3	Core Specialization	25
3.4	Model Re-engineering	28
3.4.1	Multilevel Security Models	28
3.4.2	MLS Model for a Web Service Composition System Policy	29
3.4.3	Role-based Access Control Models	31
3.4.4	Use Case RBAC Security Policy	33
3.4.5	RBAC Model for the HIS Policy	34
3.4.6	Attribute-based Access Control Models	36
3.4.7	ABAC Model for an Online Entertainment Store Policy	39
3.4.8	Summary	41
3.5	Model Core Evaluation	41
3.5.1	Expressive Power	41
3.5.2	Model Engineering Costs	46
3.5.3	Summary	48
3.6	Model Core Related Work	48
3.7	Conclusion	50

4	Causal Trusted Computing Bases	53
4.1	Requirements and Prerequisites	53
4.1.1	Security Model Core for TCB Engineering	54
4.1.2	Design Requirements	55
4.1.3	Hardware and Architecture Dependencies	57
4.2	TCB Design	58
4.3	Policy-independent Runtime Environment	64
4.3.1	Security Policy Manager	64
4.3.2	Memory Manager	67
4.3.3	Thread Manager	69
4.3.4	Transaction Manager	72
4.3.5	Inter Thread Communication	75
4.3.6	Trusted Persistent Storage Manager	77
4.3.7	Cryptographer	81
4.3.8	Entity Identification Server	82
4.3.9	Generic Object Manager	83
4.3.10	Authenticator	86
4.3.11	Summary	87
4.4	Policy-dependent Runtime Environment	87
4.4.1	Engineering Approach	88
4.4.2	Abstract Security Model Functionality	90
4.4.3	Abstract Model Instance Functionality	104
4.4.4	Causal Dependencies	106
4.4.5	Summary	119
4.5	Policy-dependent RTE for the RBAC HIS Policy	120
4.5.1	RBAC Security Model Functions	120
4.5.2	Interceptor	137
4.5.3	Executable RBAC HIS Policy	138
4.6	Conclusion	140
5	Specification Engineering	143
5.1	Specification Fundamentals	144
5.2	Requirements for TCB Specifications	145
5.3	TCB Specification Approach	146
5.4	TCB Specification Method	147
5.4.1	Specification of a Core-based Security Model	148
5.4.2	Specification of a Model Instance	152
5.5	Summary	155
6	Evaluation	157
6.1	Evaluation Goals and Methods	158
6.2	Functional Redundancy of the Policy-dependent RTE	159
6.2.1	Redundancy across Multiple Security Model Functions Components	159
6.2.2	Redundancy within a Security Model Functions Component	160
6.2.3	Summary	160
6.3	Expressive Power and Modeling Effort of Core-based Model Engineering	161
6.4	Implementation Effort for Policy Substitution	162
6.4.1	Prototype Implementation of a Policy-dependent RTE	162

6.4.2	Implementation Effort	164
6.5	Formal TCB Specifications	167
6.6	Summary	169
7	Conclusion	171
8	Future Work	173
	Appendix	175
A	Security Models	175
A.1	Notation	175
A.2	MLS Model	175
A.3	RBAC Model	177
A.4	ABAC Model	180
B	Health Information System Model Instance	183
B.1	Initial State and Extension Values	183
B.2	Authorization Scheme	185
C	Formal Rule System	189
C.1	Mapping	189
C.2	Matrix	194
D	TCB Specification for the RBAC HIS Policy	201
D.1	Context rbac_static	201
D.2	Context rbac_state	202
D.3	Context rbac_userhandling	204
D.4	Context rbac_sessionhandling	205
D.5	Context rbac_rolehandling	206
D.6	Context rbac_conditions	208
D.7	Context rbac	210
D.8	Context healthcare_context	210
D.9	Context healthcare_generic	213
D.10	Context healthcare	216
	List of Abbreviations	223
	List of Figures	226
	List of Tables	227
	Bibliography	228