Automated, Ubiquitous Delivery of Generalised Services in an Open Market

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Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

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To my wife, for everything...

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Abstract

Telecommunications networks, and the services delivered over those networks have become an integral part of most people's lives in the developed world. The range and availability of these services is increasing, however the management of services still lags well behind technical capability, providing unnecessary barriers to the adoption of available technology. The work described in this dissertation has a primary goal of enabling flexible, automated delivery of any telecommunication-based service. More specifically, a mechanism to solve the administrative problems in enabling end users to automatically establish service agreements for any available service, from any available provider.

The aims of this work are to:

1. enable the description of service level agreements(SLA) for generalised telecommunication-based services, and
2. provide mechanisms by which those service level agreements may be managed.

The term "generalised services" means that all service types are managed using a common framework and set of processes.

To derive at a suitable service level agreement description language, the characteristics of telecommunication-based services are first analysed, along with considerations in delivering a service, including service quality, resource allocation and configuration, service pricing and service ubiquity. The current art in SLA description is studied and the requirements of an appropriate language are proposed. An ontological approach to SLA description is adopted, and an SLA description language is developed based on semantic web technologies.

To develop the mechanisms for SLA management, the current art is first analysed, and a set of requirements for a suitable SLA management framework are proposed. These requirements are used to guide the design of a multi-agent SLA negotiation framework, including a detailed description of the communication model, framework processes, and social behaviour of the agents involved.

Finally, the SLA description language and the negotiation framework are compared with the closest art, and are assessed against tightly argued criteria. An experimental

framework and use cases are developed to explore an application of the proposed solution, and to validate completeness.

The approach taken has led to the following two key contributions:

1. A set of formal ontologies that may be used to semantically describe secure service level agreements for any application domain.
2. A multi-agent system providing an open market where services can be discovered, participants identified, and negotiation performed using context specific mechanisms.

The conclusions of the work are that an ontology-based SLA description language is appropriate for describing generalised SLAs, and that a distributed, agent based negotiation platform that is based on an open market and uses a minimal set of core processes with an extensible, ontology based communication mechanism is appropriate for managing service level agreements in a generalised, automated and ubiquitous way.

Table of Contents

Chapter 1. Introduction **1**

1.1 A Closer Look 1

1.2 The Desired Scenario 2

1.3 The Problem – Behind the Scenes 3

1.4 Thesis, Contributions and Significance 7

1.5 Outline of the Dissertation 8

1.6 Typographic Conventions 8

1.7 Assumed Knowledge 9

Chapter 2. Background to Services **11**

2.1 What are the Services? 11

2.1.1 The Temporal View 11

2.1.2 The Hierarchical View 16

2.1.3 The Operational View 18

2.2 What is Quality? 19

2.2.1 Quality of Experience 19

2.2.2 Quality of Service (QoS) 20

2.2.2.1 Connectivity Service Quality Parameters 20

2.2.2.1.1 Packet Loss 21

2.2.2.1.2 Packet Delay 21

2.2.2.1.3 Throughput 22

2.2.2.1.4 Jitter 22

2.3 Network Quality of Service Methods 23

2.3.1 Network QoS Techniques 23

2.3.1.1 Bandwidth Over Provisioning 23

2.3.1.2 The Differentiated Services Framework 24

2.3.1.3 The Integrated Services Architecture 25

2.3.1.4 802.1p/d 25

2.3.1.5 Asynchronous Transfer Mode....25
2.3.1.6 (Generalised) Multi-Protocol Label Switching ((G)MPLS)....26
2.3.2 Network Configuration....27
2.3.2.1 Proprietary Methods....27
2.3.2.2 Simple Network Management Protocol (SNMP)....28
2.3.2.3 Policy-Based Network Management (PBNM)....29
2.3.2.4 RSVP....29
2.3.2.5 QBGP....30
2.3.2.6 Agent-Based Approaches....31
2.3.2.7 Active Networks....32
2.4 Resource Allocation....33
2.4.1 Allocation Strategies....33
2.4.1.1 Bulk Allocation....34
2.4.1.2 Exclusive Use....34
2.4.1.3 Differentiated Over-Allocation....35
2.4.2 Allocation Mechanisms....35
2.5 Service Pricing and Charging....38
2.5.1 Flat rate....39
2.5.2 Expected Capacity....40
2.5.3 Usage Based....40
2.5.4 QoS Sensitive....40
2.5.5 Congestion-Based....41
2.6 Ubiquity....41
2.6.1 Mobility....42
2.7 How can we describe the services?....43
2.7.1 The Semantic Web....44
2.7.2 Modelling Ontologies....47
2.7.2.1 OWL....48
2.7.2.2 SWRL....50
2.7.3 Towards an appropriate format....51
2.7.3.1 Web Services....54

2.7.3.1.1 Semantic Web Services....55
2.8 Critique of the Current Art....57
2.8.1 SLA Specifications....57
2.8.2 Negotiation Frameworks....58
2.9 Summary....59
Chapter 3. Managing Future Generation Telecommunications Services 61
3.1 Solution Requirements....61
3.1.1 SLA Description Language....61
3.1.2 Negotiation Framework....63
3.2 The QDINE proposal....65
Chapter 4. The SLA Ontology 67
4.1 Introduction....67
4.1.1 Goals....67
4.1.2 Out of Scope....68
4.2 Semantic Service Level Agreements....68
4.3 A Concrete Formalism....69
4.3.1 Restricting OWL Flexibility....69
4.3.2 Semantic Web Dynamics....70
4.4 Created Ontologies....72
4.4.1 Ontology Diagrams....72
4.4.2 Ontology Hash Ontology....73
4.4.2.1 NonRepudiableThing Class....74
4.4.2.2 Ontology Hash Class....75
4.4.2.3 HashTree Class....76
4.4.2.4 Standard Ontology Tree Hash Layout....78
4.4.2.4.1 Layout Constraints....78
4.4.3 SLA Ontology....79
4.4.3.1 SLA Class....80
4.4.3.2 ServiceObligation Class....80
4.4.3.3 ServiceSpecification Class....81
4.4.3.4 SLA Termination....81

4.4.4 Unit Ontology....82
4.4.4.1 Unit Class....83
4.4.4.2 Comparator Class....86
4.4.4.3 Comparison Class....86
4.4.5 Temporal Ontology....87
4.4.5.1 Event Class....87
4.4.5.1.1 DateTimeEvent....88
4.4.5.2 Interval Class....90
4.4.6 Metrics Ontology....90
4.4.6.1 Metric Class....90
4.4.6.2 Measurement Model Class....91
4.4.6.3 Performance Level Class....91
4.4.7 Time Unit Ontology....91
4.4.8 Network Unit Ontology....93
4.5 Ontology Use....94
4.5.1 Ontology Adoption....94
4.5.2 SLA Individual Creation....95
4.5.3 SLA Validation....95
4.6 Summary....96
Chapter 5. The QDINE Negotiation Framework....97
5.1 Introduction....97
5.1.1 Goals....98
5.1.2 Out of Scope....99
5.2 Communication within QDINE....99
5.2.1 The QDINE Message Payload....100
5.2.1.1 Performative....101
5.2.1.2 Sender and Receiver....102
5.2.1.3 Content....102
5.2.1.3.1 Content Scope....103
5.2.1.4 Language....104
5.2.1.5 Ontology....104

5.2.1.6 Encoding....105
5.2.1.7 Protocol....105
5.2.1.8 Conversation-id, reply-to, reply-with, in-reply-to and reply-by....105
5.2.2 OWL-CL....106
5.2.2.1 MessageContent....108
5.2.2.2 Action....108
5.2.2.2.1 CommunicativeAct....108
5.2.2.3 Proposition....108
5.2.2.3.1 Condition....108
5.2.2.3.2 Statement....108
5.2.2.4 ReferentialExpression....109
5.2.2.5 ACLMessage....109
5.2.3 Protocol Description Language....109
5.2.3.1 Transitions....111
5.2.4 Communication Security....112
5.2.4.1 Authentication....112
5.2.4.1.1 QDINE Proxy Authentication....113
5.2.4.2 Message Privacy....114
5.2.4.3 Accountability....114
5.2.4.4 Integrity....115
5.2.4.5 SLA Signatures....115
5.3 Agent Behaviour....116
5.3.1 Market Norms....117
5.3.2 Violation of Norms....117
5.3.3 Trust and Reputation....118
5.4 The QDINE Market....119
5.4.1 Service Publication....120
5.4.2 Ad-hoc Service Discovery....121
5.4.3 Consumer Authorisation....121
5.4.4 SLA Negotiation....122
5.4.4.1 SLA Binding....123

5.4.4.2 SLA Termination....124
5.4.5 Service Pre-negotiation for Fast Handover....124
5.4.5.1 Handover Capabilities....125
5.4.5.1.1 Provider Handover Capabilities....126
5.4.5.2 The Pre-negotiation Process....127
5.4.5.3 Use Case....129
5.5 QDINE Agent Dialogues....130
5.5.1 Patterns of Interaction....131
5.5.1.1 Request Interaction Pattern....132
5.5.1.2 Inform Interaction Pattern....133
5.5.1.3 Acknowledged Inform Pattern....133
5.5.2 Agent Dialogues....134
5.5.2.1 Consumer Registration....134
5.5.2.1.1 Consumer De-registration....134
5.5.2.1.2 Consumer De-registered....135
5.5.2.2 Provider Registration....135
5.5.2.2.1 Provider De-registration....135
5.5.2.2.2 Provider De-registered....136
5.5.2.3 Service Publication....136
5.5.2.4 Agent Authentication....137
5.5.2.4.1 Agent Authentication Revoked....137
5.5.2.5 Subscriber Registration....137
5.5.2.5.1 Subscription Update....138
5.5.2.5.2 Cancel Subscription....138
5.5.2.5.3 Subscription Cancelled....138
5.5.2.6 Consumer Authorisation....139
5.5.2.6.1 Consumer Authorisation Revoked....139
5.5.2.7 Billing Authorisation....140
5.5.2.7.1 Billing Authorisation Revoked....141
5.5.2.8 Billing Capability Exchange....141
5.5.2.9 Key Validation....142

5.5.2.10 SLA Binding....143
5.5.2.11 Negotiation Mechanisms....143
5.5.2.11.1 Two-Stage Request....143
5.5.2.11.2 Posted Price Purchase....144
5.5.2.11.3 Bilateral Bargaining....144
5.5.2.11.4 Combinatorial Clearing House....145
5.6 QDINE Market Roles....145
5.6.1 Consumer....146
5.6.2 Service Provider....147
5.6.3 Market Agent....148
5.6.4 Subscriber....150
5.6.5 Billing Provider....151
5.7 Operational Market Concerns....152
5.7.1 Knowledge Consistency....152
5.7.2 Stakeholders....153
5.7.2.1 End Users....153
5.7.2.2 Service Providers....154
5.7.2.3 Network Operators....154
5.7.2.4 Billing Providers....155
5.8 Summary....155
Chapter 6. Validating the QDINE Approach 157
6.1 Achieving the Aims....157
6.1.1 A Secure, Flexible Semantic SLA Description Language....158
6.1.2 A Secure, Open, Flexible Negotiation Framework....159
6.2 The QDINE Solution Derivation Process....160
6.2.1 The SLA Ontology....160
6.2.2 The Negotiation Framework....161
6.2.2.1 Communication Mechanisms....161
6.2.2.2 Choosing the Content Language....161
6.2.2.3 Choosing the Protocol Description Language....162
6.3 QDINE vs the Existing Art....163

6.3.1 In comparison with Web Services....164
6.4 The Experimental System....167
6.4.1 The JADE Agent Framework....167
6.4.2 The Jena OWL Application Programming Interface....168
6.4.3 The Agents....169
6.4.4 Experimental Results....170
6.5 The SLA Use Case....171
6.5.1 Example Domain-Specific Ontologies....172
6.5.1.1 QDINE SLA Ontology....172
6.5.1.2 QDINE Charging Ontology....174
6.5.1.3 QDINE Entity Ontology....174
6.5.1.4 QDINE Violation Ontology....175
6.5.2 Currency Ontology....175
6.5.3 The Use Case – An SLA based on the TEQUILA Service Level Specification (SLS)....176
6.5.3.1 The TEQUILA SLS....176
6.5.3.2 The Connectivity Service Offered by a Provider....176
6.5.3.3 The Created Service Level Agreement....179
6.6 Summary....180
Chapter 7. Conclusions....181
7.1 The Key Components....181
7.2 Critical Analysis and Future Development of QDINE....181
7.3 Concluding Remarks....184
Appendix A. Ontology Source Files....187
A.1 The Generic Ontologies....187
A.2 Agent Dialogues....187
A.3 Example Domain Specific Ontologies....187
A.4 OWL Individuals used in Examples....187
Appendix B. QDINE Interaction Ontology....189
B.1 QDINE Actions....189
B.1.1 Action....189

B.1.2 Authenticate Agent....190
B.1.3 Register Consumer....190
B.1.4 Register Provider....190
B.1.5 Update Published Services....190
B.1.6 De-register Agent....190
B.1.7 Provide Service Updates....190
B.1.8 Authorise Consumer....191
B.1.9 Authorise Billing....191
B.1.10 Answer Key Challenge....191
B.1.11 Provide Service....191
B.2 QDINE Propositions....192
B.2.1 Authentication Revoked....192
B.2.2 Consumer Authorisation Revoked....192
B.2.3 Billing Authorisation Revoked....192
B.2.4 Service Changes....192
B.2.5 Billing Capability Statement....192
B.2.6 Overridden Knowledge....193
B.2.7 Action Done....193
B.2.7.1 Provider Registered....193
B.2.7.2 Consumer Registered....193
B.2.7.3 Billing Authorised....194
B.2.7.4 Agent Authenticated....194
B.2.7.5 Subscriber Registered....195
B.2.7.6 Consumer Authorised....195
B.2.7.7 Key Challenge Answered....195
B.2.8 QDINE Reasons....195
B.2.8.1 Unknown Namespace Prefix....195
B.2.8.2 Unsupported Namespace....196
B.2.8.3 Strict OWL Required....196
B.2.8.4 Untrusted Signatory....196
B.2.8.5 Certificate Expired....196

B.2.8.6 Key Challenge Failed....196
B.2.8.7 Authentication Details Required....197
B.2.8.8 Ontology Hash Mismatch....197
B.2.8.9 Unsupported Role....197
B.2.8.10 Message Signature Required....197
B.2.8.11 Consumer Authorisation Required....197
B.2.8.12 Market Authorisation Only....197
B.2.8.13 Rejected Billing Provider....198
B.2.8.14 Unknown RDF Resource....198
B.2.8.15 Consistence Violation....198
B.2.9 FIPA ACL Message Class....198
Associated Publications....201
Bibliography....203

List of Figures

Figure 1: Service Management Components....4
Figure 2: Two basic service layers....12
Figure 3: The Digital Access Layer....13
Figure 4: The Basic Network Service Structure....15
Figure 5: Increased Connection Availability....16
Figure 6: The Service Stack....17
Figure 7: The IP Header DS field [43]....24
Figure 8: ATM Hierarchy....26
Figure 9: RSVP Components (Adapted from [56])....30
Figure 10: Typical resource utilisation profiles for each allocation strategy....35
Figure 11: The Semantic Web Stack....44
Figure 12: The MOF metadata stack....48
Figure 13: Stucture of a WS-Agreement....55
Figure 14. Ontological Diagram Layout....73
Figure 15: The Ontology Hash Ontology....74
Figure 16: The SLA Ontology....80
Figure 17: The Unit Ontology - Part 1....83
Figure 18: Unit Ontology Use....83
Figure 19: The Unit Ontology - Part 2....84
Figure 20: The Temporal Ontology....89
Figure 21: The Metrics Ontology....90
Figure 22: The Time Unit Ontology....92
Figure 23: The Network Unit Ontology....94
Figure 24: QDINE FIPA Message....100
Figure 25: An example QDINE resource namespace....103
Figure 26: OWL-CL class diagram....107
Figure 27: Example ACL Message using OWL-CL....108

Figure 28: Protocol Description Language Class Diagram....110
Figure 29: Internal SLA signature....115
Figure 30: External SLA Signature....116
Figure 31: A QDINE Multiagent System....120
Figure 32: Service Publication and Discovery....121
Figure 33: Consumer Authorisation....122
Figure 34: Two SLA Negotiation and Binding Scenarios....123
Figure 35: SLA Binding Mechanism....124
Figure 36: Components for specifying provider handover capabilities....126
Figure 37: Service Pre-negotiation....129
Figure 38: An example Multi-Service Network....129
Figure 39: Sequence diagram for the Request interaction pattern....132
Figure 40: State-transition diagram for the Request interaction pattern participants....133
Figure 41: Sequence diagram for the Inform interaction pattern....133
Figure 42: State-transition diagram for the Inform interaction pattern....133
Figure 43: Sequence diagram for the Acknowledged Inform interaction pattern....134
Figure 44: State-transition diagram for the Acknowledged Inform interaction pattern 134
Figure 45: Sequence Diagram for the Billing Capability Request....142
Figure 46: Screenshot of Experimental System, showing the Consumer Registration Message....171
Figure 47: The Example QDINE SLA Ontology....173
Figure 48: The Example QDINE Charging Ontology....174
Figure 49: The Example QDINE Entity Ontology....175
Figure 50: The Example QDINE Violation Ontology....175
Figure 51: The Example Currency Ontology....176
Figure 52: The TEQUILA Service Level Specification Ontology....177

List of Tables

Table 1: Example protocols within the OSI Seven Layer Model.....18

Table 2: FIPA-ACL Message Payload Attributes.....100

Table 3: Service Registrations for Figure 38.....130

Table 4: The SLA Ontology vs the current art.....164

Table 5: The QDINE Framework vs the current art.....164

Table 6: Comparison of OWL Java APIs.....169

List of Symbols

α - Agent acting in Market Agent role

β - Agent acting in Service Provider role

γ - Agent acting in Consumer role

δ - Agent acting in Billing Provider role

ϵ - Agent acting in Subscriber role

ζ - A QDINE agent

κ - A service

λ - Message content language

μ - FIPA message payload

π - Agent state in a protocol

ρ - Interaction Protocol

ϱ - An agent role

σ - Message Reply identifier

τ - Message Reply-By time

ϕ - Performative

φ - Root message content individual

χ - Message payload content

ψ - Conversation

ω - Ontology

A - Set of all agents acting in the Market Agent role

B - Set of all agents acting in the Service Provider role

Γ - Set of all agents acting in the Consumer role

E - Set of all agents acting in the Subscriber role

Z - Set of all QDINE agents