
Design Issues for Service Delivery Platforms

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Incorporate User Experience:
A Grounded Theory Study of
Individual User Needs

With a Preface by Prof. Dr. Reinhold Behringer

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Preface

Service delivery platforms (SDPs) play an important role in the evolving ubiquitous online mobile connectivity. Data rates and available bandwidth have increased dramatically with the introduction of new generation mobile networks (4G) and are set to increase further with new developments of 5G networks. This enables new mobile services such as video on demand and cloud-based services such as Software as a Service (SaaS). However, mobile bandwidth will always be limited at any single network node, due to physical limitations of wireless connectivity of simultaneous connections. Therefore, measures need to be taken to ensure efficient use of the available bandwidth.

The SPICE project (Service Platform for Innovative Communication Environment), funded by the European Commission in the Framework Programme 6 during 2006-2008, has addressed several of the issues of such SDPs and has contributed to technological improvements of service platform functionality and security. But this has been done mainly from a technology and engineering perspective. What has not been sufficiently investigated were issues related to users and stakeholders of such SDPs.

This book addresses this gap by investigating the user needs related to SDPs. The author has investigated the user requirements of those stakeholders from developers to end users and has developed guidelines for the development of future SDPs. These guidelines have been validated through scientific methods in real-world scenarios, where significant improvements in usability could be observed. Therefore, this book is a MUST-READ for system architects and software developers who are designing and implementing new SDPs. The content of this book will help improving the usability of future SDPs.

Leeds, Reinhold Behringer
Professor of Creative Technology
Leeds Beckett University

Dedication

I would like to dedicate this dissertation to my family and friends, in gratitude to their collective efforts in providing me with invaluable advice, encouragement and wisdom, whilst allowing me space for my own explorations.

I particularly dedicate this thesis to my parents, who have given me all their love, support and understanding. Without them I could not have accomplished the following. Their knowledge of the value of education is truly beyond my comprehension and I am a lucky beneficiary.

Moreover, I dedicate this work to my deceased best friends Johannes Beiglböck and Harald Hörl, who inspired me with their energy and friendship, and who helped me to learn about life and the knowledge how to live a good one. In memory of the comfort and advice they gave me in the past, whenever I needed them.

Vienna, Martin Bergaus

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Vienna, Martin Bergaus

Table of Contents

Preface V
Dedication VII
Acknowledgement IX
Table of Figures XXI
Table of Tables XXV
Table of Memos XXVII
Index of Abbreviations and Glossary of Terms XXIX

1 Introduction 1
1.1 Background and Scope of this Research 1
1.2 Problem Statement and Motivation for this Study 5
 1.2.1 Problem Statement for this Investigation 6
 1.2.2 Problem Findings and Challenges of SDPs 10
 1.2.3 Motivation for this Research 12
1.3 Aim and Objectives 13
 1.3.1 Aim: Identify challenges and design issues and develop a model / framework from the perspective of users to make everyday tasks easier 14
 1.3.2 Objective 1: Investigate the relationship between users and SDPs to control and operate ICT environments from an individual’s perspective. 16
 1.3.3 Objective 2: Identify the current technological situation regarding user needs and design issues of SDP SPICE in terms of supporting user’s everyday tasks. 17
 1.3.4 Objective 3: Locate and relate user needs and design issues of web-based platforms to support daily user activities. 17
 1.3.5 Objective 4: Offer a coherent explanation of challenges and design issues of web-based platforms and ICT systems to support individual’s everyday activities from an individual’s perspective. 18
1.4 Project Overview 19
1.5 Main Contribution to this Research Study 22
1.6 List of Publications 22
1.7 Outline of Chapters 23

2 Literature Review: ICT, SDPs and System Design for User Needs 27

- 2.1 Introduction..... 27
- 2.2 The Connection of Information and Communication Technology (ICT) to SDPs 31
 - 2.2.1 Basic concepts 31
 - 2.2.2 Convergence and ICT4D 35
 - 2.2.3 Ubiquitous Technologies 38
- 2.3 Service-Delivery-Platforms 39
 - 2.3.1 Mobile Software Applications..... 40
 - 2.3.2 SDPs in Terms of Core Technologies..... 41
 - 2.3.3 SDPs to Drive the Alignment of Web-Platforms and Applications..... 45
 - 2.3.4 A Service Platform for an Innovative Communication Environment (SPICE)..... 47
 - 2.3.4.1 A Technical Overview of SPICE 47
 - 2.3.4.2 The IST SPICE FP6 Project..... 48
 - 2.3.4.3 Definition of the Interview Participant Group of SPICE Experts..... 50
 - 2.3.4.4 Related Research Projects to SPICE 52
 - 2.3.5 Contribution of SPICE and Critical Treatment of SDPs..... 56
 - 2.3.6 Summary..... 59
- 2.4 System Design for User Needs 59
 - 2.4.1 The Importance of Usability is Increasing..... 60
 - 2.4.2 User Centred Design..... 61
 - 2.4.3 Requirement Engineering 62
 - 2.4.3.1 Different Views between Users and Developers..... 64
 - 2.4.3.2 Requirement Engineering Process..... 65
 - 2.4.3.3 Feasibility Studies 66
 - 2.4.3.4 Requirements Elicitation and Analysis 66
 - 2.4.3.5 Requirements Specification..... 68
 - 2.4.3.6 Requirements Validation..... 68
 - 2.4.4 Design for Testability of Software Architectures 69
 - 2.4.5 Related Research in Terms of System Design for User Needs..... 72
 - 2.4.5.1 Related Research - Technical-Oriented Studies 73
 - 2.4.5.2 Related Research - User-Focused Studies 76
 - 2.4.5.3 Related Research done by the Author 78
 - 2.4.6 Summary..... 81

2.5	A Conceptual Framework to Develop SDP-based ICT Systems from a User's Perspective.....	81
2.5.1	Human-Computing Interaction.....	82
2.5.1.1	Main Characteristics for Human to Computer Interaction.....	83
2.5.1.2	Cooperative Partnership between Human and Computer Agents.....	84
2.5.2	A brief introduction to Trick and Weber's Conceptual Framework.....	85
2.5.3	Research Framework.....	86
2.5.3.1	Research Questions.....	86
2.5.3.2	Research Gap.....	91
2.5.4	Summary.....	93
2.6	Chapter Summary and Conclusion.....	93
3	Research Methodology.....	95
3.1	Introduction.....	95
3.2	Underlying Philosophy of the Research Paradigm.....	96
3.3	EMPLIT Research Framework.....	97
3.3.1	Empirical Study.....	99
3.3.2	Literature-based Study.....	99
3.3.3	Theoretical Sampling to Intermediate the Integration between Empirical and Literature-based Study.....	99
3.3.4	Mapping Process.....	100
3.3.5	Overview about the Research Project Process.....	101
3.4	Grounded Theory Methodology (GTM).....	104
3.4.1	Introduction to Grounded Theory.....	105
3.4.2	Characteristics of GTM.....	107
3.4.3	Criteria for GT Studies.....	109
3.4.4	Coding and Analysing Content with GT.....	110
3.4.4.1	Open Coding.....	111
3.4.4.2	Selective Coding.....	112
3.4.4.3	Theoretical Coding.....	112
3.4.5	Theoretical Integration.....	114
3.4.6	The Role of the Researcher.....	115
3.4.7	Limitations of the GTM.....	117
3.4.8	Statement of Reasons for Choosing GTM in this Study.....	117
3.4.9	Alternative Methodology.....	118
3.5	Colour Coding System.....	119
3.5.1	Initial Coding by Using Qualitative Analysis Software.....	120
3.5.2	Fact Finding Tool.....	122

3.6	Mind- and Concept Mapping Techniques.....	123
3.6.1	Mapping Techniques	124
3.6.2	Advantages of the Mapping Techniques and their Functions	124
3.6.3	Use of Mind Maps in this Study	125
3.7	Feedback to Developed Empirical Results	126
3.8	Literature-based Study	127
3.8.1	Literature Review Phase	127
3.8.2	Literature-based Criteria Catalogue.....	127
3.8.3	Phases from the Literature-based Study	127
3.8.4	Visualisation of Literature-based Data via Mind Map Representation	128
3.9	Research Study Setup	130
3.9.1	Pledge of Confidentiality.....	130
3.9.2	Sample and Ethical Consideration.....	130
3.9.3	Background Introduction Information about the Research Project	131
3.9.4	Research Questions for Developing Web-Based Platforms (SDPs) in Terms of ICT Systems of the Future.....	132
3.9.5	Theoretical Sampling and 3-Stage Research Design within this Study.....	132
3.9.6	Interview Participants of this Study.....	133
3.9.6.1	General Information about the Interview Participants.....	133
3.9.6.2	Demographics and Background Information of the Interview Participants.....	134
3.9.6.3	Selection Process of the Interview Participants.....	136
3.9.7	Interview Guideline	137
3.9.7.1	Development of the Interview Guidelines.....	137
3.9.7.2	Critical Incident Technique (CIT).....	138
3.9.7.3	Structure of the Interview Guidelines for the SPICE Experts.....	138
3.9.8	Recording and Transcription Procedure	139
3.10	Application of the EMPLIT Methodology within this Study.....	140
3.10.1	Data Collection and Analysis	140
3.10.2	EMPLIT in Four Phases	140
3.10.3	GTM Colour Coding Procedure within EMPLIT	143
3.10.4	Application of the Literature-Based Study	143
3.10.5	Detailed Research Procedure of this Study.....	144

3.11 Analysis of Data in EMPLIT	151
3.11.1 Analysis of Empirical Data Using Colour Coding System within EMPLIT	151
3.11.2 Overall Coding Process within EMPLIT	155
3.11.3 Analysis of Literature-based Data within EMPLIT	156
3.11.3.1 Development of the Literature-Based Criteria Catalogue.....	158
3.11.3.2 Development of Literature-Based Aspects (Categories)	160
3.11.3.3 Clustering Literature-Based Aspects	161
3.11.4 Third-Party Coding.....	162
3.11.5 Memo Writing	162
3.11.6 Confirmation of Data within EMPLIT.....	163
3.12 Dual-layered Justification Process	164
3.12.1 Justification of Empirical Data During the Research Process	164
3.12.1.1 Third-party Coding.....	164
3.12.1.2 Memo Writing.....	165
3.12.1.3 Compare and Justify Empirical Codes and Categories.....	165
3.12.2 Justification of the Final Research Results	165
3.12.2.1 Thesis in Context.....	166
3.12.2.2 Validate a Number of Research Questions.....	166
3.12.2.3 Validate the Results by Presenting Final Results to the Interview Participants.....	166
3.12.3 Substantial and Methodological Results	166
3.13 Development of the GT Categories.....	167
3.14 Chapter Summary and Conclusion.....	169
4 Presentation of Findings	171
4.1 Findings from the Literature-based Study.....	171
4.1.1 Requirements for an SDP-based ICT infrastructure of the future.....	171
4.1.2 Results of the Grouping and Structuring Procedure	175
4.2 Findings from Phase 1: Pilot Interviews	177
4.2.1 Aims of the Pilot Interviews	177
4.2.2 Summary of the Pilot Interviews	177
4.2.3 Analysis of the Pilot Interview Data	179
4.2.4 Summary of Initial Coding	180
4.2.5 Justification of Initial Codes and Categories	181

4.3	Findings from Phase 2: In-Depth Interviews	182
4.3.1	Aims of the In-Depth Interviews from Phase 2	182
4.3.2	Summary of the In-Depth Interviews from Phase 2	183
4.3.3	Analysis of the Interview Data from Phase 2	185
4.3.4	Summary of Coding of the Data from Phase 2	185
4.3.5	Justification of Further Codes and Categories from Phase 2 by Using Literature-Based Criteria Catalogue and the Mapping Process	187
4.3.6	Development of Categories Based on Initial and Focused Codes	189
4.3.7	Summary of Focused Codes after Phase 2	189
4.4	Findings from Phase 3: In-Depth Interviews	191
4.4.1	Aims of the In-Depth Interviews from Phase 3	192
4.4.2	Summary of the In-Depth Interviews from Phase 3	192
4.4.3	Analysis of the Interview Data from Phase 3	194
4.4.4	Summary of Coding of the Data from Phase 3	194
4.4.5	Justification of Further Codes and Categories from Phase 3 by using Literature-Based Criteria Catalogue and the Mapping Process	196
4.4.6	Further Development of Categories Based on the Focused Codes	197
4.4.7	Summary of Focused Codes after Phase 3	198
4.5	Development of GT Categories Based on Focused Codes	199
4.5.1	Category - Applicability	200
4.5.2	Category - Controllability	205
4.5.3	Category - Interoperability	209
4.5.4	Category - Mobility	213
4.5.5	Category - Security and Reliability	217
4.5.6	Category - Usability	222
4.5.7	Justification of the Categories	226
4.5.8	A Summary of the Final Six Categories and Sub-Categories	228
4.6	Chapter Summary and Conclusions	231
5	Model Development and Discussion of the Results	233
5.1	Introduction	233
5.2	Reflection and Discussion in Terms of the Relevant Literature	234
5.2.1	Context of the Six Final Categories and the Current Literature	235
5.2.2	Summary of the Theoretical Integration	241

5.3	Development of an Exploratory Framework for Design Issues of an SDP-based ICT System.....	242
5.3.1	Development of the Relations between the Categories.....	243
5.3.2	An Exploratory Framework of Design Issues of SDP-based ICT Development from the Perspective of Users	243
5.3.3	Discussion of the Relationships between the GT Categories.....	246
5.3.4	Substantive Theory Diagram of this Investigation.....	249
5.4	Development of Category-based Models for the Empirical and Literature-based Study	251
5.4.1	Preconditions for the Development of both Models	251
5.4.2	GT Categories and the Interview-Based Model.....	251
5.4.3	Literature-based Categories and the Literature-Based Model.....	257
5.4.4	Reflection and Discussion	261
5.4.4.1	Relationship between GT Categories and Literature-Based Categories	261
5.4.4.2	Comparison of GT Categories, their Relations and the Literature-Based Categories	262
5.5	Development of a Generic Framework for a SDP-based ICT System of the Future	263
5.5.1	Functional Requirements of the Generic ICT Systems.....	264
5.5.1.1	General Requirements of an ICT System.....	264
5.5.1.2	Functional Requirements of an ICT System.....	265
5.5.1.3	Functional Requirements of an SDP for an ICT System.....	266
5.5.2	Correlation of GT Categories and Functional Requirements	266
5.6	Interpretation and Discussion of the Empirical Findings	268
5.6.1	Respondents' Perspectives of Challenges and Design Issues on SDPs and ICT environments.....	268
5.6.2	Respondents' Views and the Findings and Outcomes of this Study	270
5.6.3	Reflection and Discussion of the Respondent Views	274
5.6.3.1	Relations between Findings and Objectives.....	274
5.6.3.2	Relations between Findings and Outcomes.....	277
5.6.3.3	Summary of Challenges in SDP development from this Study	278

- 5.7 Individuals’ Perceptions - Parallels and Divergences from the Academic Literature..... 279
 - 5.7.1 Scope of SDP definition 280
 - 5.7.2 SDP influenced by technologies 281
 - 5.7.3 Respondents’ Views Regarding SDP, ICT Systems, Society and Technology 282
 - 5.7.4 Individual and Collective Views of SDPs in the Literature... 283
 - 5.7.5 GT Categories and the Different Notations of Individual and Collective Views of SDPs..... 284
 - 5.7.5.1 Final Six GT Categories 284
 - 5.7.5.2 Four Main Findings..... 285
 - 5.7.6 Respondents Views on the Results Presented and Discussed in the Re-Validation Phase 285
- 5.8 Discussion of User Needs in Terms of SDPs..... 286
 - 5.8.1 Answering the Research Questions of this Investigation..... 286
 - 5.8.2 Relation of the Four Main Findings and the GT Categories to the Requirements from Section 1.1..... 288
 - 5.8.3 Substantive GT to Contribute the Understanding of User Needs..... 289
 - 5.8.4 EMPLIT to Contribute the Understanding of User Needs.... 289
- 5.9 Summary of the Substantive GT of This Study 291
- 5.10 Chapter Summary and Conclusions 292

6 Conclusions.....295

- 6.1 Main Contributions of this Research Study 295
- 6.2 Findings and Outcomes of this Investigation..... 300
 - 6.2.1 Brief Summary 301
 - 6.2.2 Relationship between Aim, Objective, Findings and Outcomes of the Study..... 302
 - 6.2.3 Confirmation, Extensions and Contradictions of Final GT Categories to the Current Literature 303
- 6.3 Meeting Grounded Theory Criteria..... 305
- 6.4 Discussion..... 307
- 6.5 Lessons Learned and Recommendations 311
- 6.6 Further Research 315

7 References.....317

8	Appendix A – Theoretical Background.....	345
8.1	Essentials in Mobile Communication Technologies	345
8.1.1	Aspects of Mobility in relation to OSI Layers	345
8.1.1.1	Physical and Data Link Layer	345
8.1.1.2	Network Layer	346
8.1.1.3	Transport Layer	348
8.1.1.4	Application Layer	349
8.1.1.5	Mobility Modes	350
8.1.2	Mobile Telecommunication Network Systems	351
8.1.2.1	Global System for Mobile Communications (GSM).....	351
8.1.2.2	Universal Mobile Telephone System (UMTS).....	353
8.1.2.3	Next Generation Networks (NGNs)	356
8.1.3	Location-based Systems	358
8.1.3.1	Satellite-based Systems	359
8.1.3.2	Network-based Positioning Systems	361
8.1.3.3	WiFi-based Positioning Method.....	363
8.1.3.4	Near Field Communication (NFC) and Radio Frequency Identification (RFID) Localisation Method.....	364
8.1.4	IP Multimedia Subsystem (IMS)	365
8.1.5	Session Initial Protocol (SIP).....	366
8.1.6	Summary.....	367
8.2	Applications and the ICT Infrastructure of the Future	368
8.2.1	Challenges for Today's Infrastructures	368
8.2.2	Drivers for the Communication Infrastructure based on the User Perspective.....	370
8.2.3	Location-Based Services (LBS).....	372
8.2.4	Possible Solutions for the Development and Availability of Value-Added Services	373
8.2.5	User-Centred/Ubiquitous Services (UbS).....	374
8.2.6	Summary.....	374
8.3	Service Delivery Platforms	374
8.3.1	Fundamentals and the Architecture of SDPs	375
8.3.2	Functional Architecture of SPICE and the Functional Components	378
8.3.3	The SPICE Architecture	380
8.3.4	Service and Information Transfer in SPICE	382
8.3.5	Service Composition with SPICE.....	383
8.3.6	Service Roaming in SPICE.....	384

8.4	General Research Approaches	388
8.4.1	Deductive and Inductive Research Approach.....	388
8.4.2	Abductive (Retroduction) Research Approach.....	391
8.5	Philosophical Position in Terms of the Research Design.....	393
9	Appendix B – Participants Correspondence	395
9.1	Cover Letter/Email to Participants of the Interviews	395
9.2	Pledge of Confidentiality	396
9.3	General Background Information	398
9.4	Interview Guideline	399
10	Appendix C – Empirical and Literature-Based Data.....	409
10.1	Example of Transcribed and Colour-Coded Interview	409
10.2	Fact Finding Tool Result	421
10.3	Literature-Based Criteria Catalogue	424
10.4	List of Mind Maps	436
10.5	Examples of Generated Mind Maps (Intermediate data)	437
10.6	Consolidated Codes	449
11	Appendix D – DVD with Data Sources and Raw Data	453
11.1	Table of Contents.....	453

Table of Figures

Figure 1: Aim of this study 13

Figure 2: Explaining the relation of empirical and literature-based data 15

Figure 3: The four objectives of this investigation 16

Figure 4: Phases of the research procedure applied 20

Figure 5: Phases of subsequent chapters 23

Figure 6: ICT4D cube: interplay between technology, society, and policy
(Hilbert, 2011; source:
<http://www.martinhilbert.net/HilbertCube.pdf>) 36

Figure 7: A framework for requirement engineering process
(Chakraporty *et al.*, 2012) 65

Figure 8: EMPLIT research framework of this research study 98

Figure 9: Validation of empirical data throughout 3 stages 101

Figure 10: Steps in developing a GT (According to Miles and Huberman,
1994; Gorra, 2007, 2008) 110

Figure 11: Steps of the result presentation workshop with respondents 126

Figure 12: Phases from the literature-based study 128

Figure 13: Detailed research methodology used in this study - 1/2 145

Figure 14: Detailed research methodology used in this study - 2/2 149

Figure 15: Excerpt from the analysis tool (Fact Finding tool) 152

Figure 16: Excerpt from a colour-coded interview after the 1st coding step 152

Figure 17: Excerpt from a colour-coded interview after 2 coding steps 153

Figure 18: Excerpt from a colour-coded interview after 2 coding steps
(including the alternation mode for 2 different codes) 154

Figure 19: Excerpt from the Fact Finding tool with text passages from 3
interviews 154

Figure 20: Excerpt from an entirely colour-coded interview 155

Figure 21: Excerpt of the overall coding process with each coding step 156

Figure 22: Phases for the literature-based study 157

Figure 23: Example for the result of the literature-based study 158

Figure 24: Excerpt from a general criteria catalogue with important
aspects of an SDP (Bergaus, 2010b) 159

Figure 25: Excerpt from a detailed criteria catalogue with representations
of the aspects of Beyond 3rd Generation (B3G) system,
with regard to an SDP (Bergaus, 2010b) 160

Figure 26: Requirements on the services and mobile applications from
a user-centred perspective (Bergaus, 2010b) 161

Figure 27: Clustering of aspects into a higher category (Bergaus <i>et al.</i> , 2012).....	162
Figure 28: Confirmation and justification of empirical data.....	163
Figure 29: The dual-layered justification process.....	164
Figure 30: General requirements on an ICT infrastructure.....	172
Figure 31: Requirements for an ICT infrastructure of the future.....	173
Figure 32: Requirements for the creation, provision and execution of services	174
Figure 33: Requirements of services and mobile applications from the user-centred perspective	175
Figure 34: Excerpt of the grouping and structuring procedure	176
Figure 35: Validation of initial and further codes and categories from pilot and in-depth interviews from the second phase by using the Mapping Process.....	188
Figure 36: Validation of initial and further codes and categories from the in-depth interviews from the 3 rd phase undertaken by using the Mapping Process.....	197
Figure 37: Clustering of category “Applicability” with its sub-categories	200
Figure 38: Different areas of “Applicability” and their scale according to participants’ perceptions	203
Figure 39: Clustering of category “Controllability” with its sub-categories ...	205
Figure 40: Clustering of the category “Interoperability” with its sub-categories	210
Figure 41: Clustering of category “Mobility” with its sub-categories	214
Figure 42: Clustering of category “Security and Reliability” with its sub-categories	218
Figure 43: Clustering of category “Usability” with its sub-categories	222
Figure 44: Different areas of “Usability” and the scale of importance according to participants’ perceptions	225
Figure 45: Example: Clustering of the Category "Security" with its sub-categories	228
Figure 46: Theoretical model with final categories and their relations.....	244
Figure 47: Substantive theory diagram of this investigation	250
Figure 48: Interview-based model from this investigation	252
Figure 49: Literature-based model from this investigation.....	258
Figure 50: Final categories, their relations and the connection to literature-based data.....	263
Figure 51: SDP for future-based ICT systems.....	264
Figure 52: Functional requirements of an ICT system of the future, as a result of the literature-based study and the mapping process, and seen from a generic level.....	265

Figure 53: Functional requirements of an SDP for an ICT System of the future as a result of the Mapping Process, and seen from a meta-level.....	266
Figure 54: Objectives and main findings of this study	275
Figure 55: Findings and outcomes of this investigation	278
Figure 56: Interview-based model representing the six GT categories.....	296
Figure 57: The theoretical contribution of this research (6 GT categories and their relations)	298
Figure 58: The methodological contribution of this research (EMPLIT framework).....	299
Figure 59: Substantive theory diagram of this investigation.....	300
Figure 60: Aim, objectives, findings and outcomes of this investigation	303
Figure 61: Recommendation for ‘extended’ design guidelines contributed by this thesis.....	314
Figure 62: Simplified 7 layers of the OSI reference model and dedicated aspects of mobility (Roth, 2005: p. 29).....	345
Figure 63: Architecture of the UMTS network (Roth, 2005: p. 75)	355
Figure 64: 3-layer architecture of ICT infrastructure of the future (Ahson and Ilyas, 2011; Bergaus and Stottok, 2010: p. 6 and 7).....	370
Figure 65: LBS architecture illustrating 2 possibilities for position regulation according to Richter <i>et al.</i> (2010: p. 3)	372
Figure 66: General representation of an SDP (Roland and Hu, 2008: p. 2).....	375
Figure 67: Architecture of a Service Delivery Platform (Trick and Weber, 2009: p. 475).....	376
Figure 68: Functions of an SIP application server (Trick and Weber, 2009: p. 476).....	378
Figure 69: Functional SPICE architecture (Tarkoma <i>et al.</i> , 2007a: p. 2).....	381
Figure 70: Accessing home and local services through service and information transfer	382
Figure 71: Inter-domain service composition	383
Figure 72: Functional architecture for consuming home services in the visited domain (according to the SPICE Project: http://www.ist-spice.org/)	386
Figure 73: Functional architecture for consuming local services in the visited domain (according to the SPICE Project: http://www.ist-spice.org/)	387
Figure 74: Functional architecture for consuming home services using local service components (according to the SPICE Project: http://www.ist-spice.org/)	388
Figure 75: Phases of the deductive research approach.....	389
Figure 76: Phases of the inductive research approach	389

Figure 77: Phases of the abductive research approach	392
Figure 78: Excerpts of the Fact Finding tool for participants p11_u, p12_d, p13_u and p14_d and the colour-coded text of the interviews	423
Figure 79: Excerpt of a detailed criteria catalogue in bullet point form	427
Figure 80: Excerpt of a criteria catalogue in mind map form	428
Figure 81: Excerpt of a general CIT-analysed criteria catalogue in mind map form (main objectives).....	429
Figure 82: Excerpt of a general CIT-analysed criteria catalogue in mind map form (objectives from second hierarchy).....	432
Figure 83: Excerpt of a detailed CIT-analysed criteria catalogue in mind map form (main objectives).....	433
Figure 84: Excerpt of a detailed CIT-analysed criteria catalogue in mind map form (objectives from second hierarchy).....	436

Table of Tables

Table 1: SPICE attributes cross-referenced to current SDP literature	57
Table 2: Data collection and analysis phases	103
Table 3: Example of a comparison between numerical and colour coding	119
Table 4: List of interview participants and some information	135
Table 5: List of interview and timeline	136
Table 6: Overview of data collection and analysis phases	141
Table 7: The development process of the GT categories	168
Table 8: Extract of the Fact Finding tool taken from empirical data of the pilot interviews (translated by the author).....	178
Table 9: List of initial (preliminary) codes for pilot interviews.....	180
Table 10: Some initial attributes from the pilot interviews.....	181
Table 11: Extract of empirical data from the in-depth interviews of phase 2 from the Fact Finding tool (translated by the author.....	184
Table 12: Lists of further codes for the in-depth interviews from the 2 nd interview phase	186
Table 13: Some initial and further developed attributes for pilot- and in-depth interviews relating to challenges and design aspects of SDPs and ICT systems	187
Table 14: List of focused codes developed from the pilot and the in-depth interviews from the 2 nd phase.....	190
Table 15: List of grouped focused codes and their description.....	191
Table 16: Extract taken from the empirical data from the in-depth interviews f phase 3 from Fact Finding tool (translated by the author)	194
Table 17: Lists of further codes for the in-depth interviews from the 3 rd interview phase	195
Table 18: Some initial and further attributes for pilot- and in-depth interviews, relating to challenges and design aspects of SDPs and ICT systems.....	196
Table 19: List of focused codes developed from the pilot and in-depth interviews from the 3 rd phase	198
Table 20: List of grouped focused codes and their description.....	199
Table 21: Areas of “Applicability”	203
Table 22: Areas of “Controllability”	207
Table 23: Category “Controllability” and its properties and dimensions	207
Table 24: Areas of “Interoperability”	212
Table 25: Areas of “Security and Reliability”	219

Table 26: Category “Security and Reliability”, and its properties and dimensions	220
Table 27: Areas of “Usability”	225
Table 28: Detailed validation and classification of categories developed from interview- and literature-based data	227
Table 29: Summary of final categories and sub-categories	229
Table 30: Chain of evidence of attributes and codes (inspired by Urquhart, 2001).....	230
Table 31: Summary of the theoretical integration	242
Table 32: Categories and relations amongst them	245
Table 33: Comparison of categories developed from interview and literature-based data.....	262
Table 34: Correlation of the aspects (developed categories), with the functional requirements of future-oriented ICT systems	267
Table 35: List of six final categories, and their relation to codes and theoretical memos	291
Table 36: Presentation how research findings confirm, extend or contradict current literature.....	305
Table 37: List of Mind Maps generated and presented in this thesis.....	436
Table 38: List of Mind Maps generated as intermediate data within the study (presented in the original language created, in German)	437

Table of Memos

Memo 1: Visual memo on the relationship between “Applicability” and users’ needs, in terms of using an SDP 204

Memo 2: Memo about “Controllability” and its properties and dimensions..... 208

Memo 3: Visual memo on the relationship between compatible environments and users, in terms of using an SDP 212

Memo 4: Visual memo on the respondents’ views of “Mobility” 216

Memo 5: Memo about “Security and Reliability” and the properties and dimensions 221

Memo 6: Visual memo on the relationship between “Usability” and its related environments 226

Index of Abbreviations and Glossary of Terms

Abbreviation	Explanation
1G	First generation of wireless telephone technology; an analogue telecommunication standard using analogue radio signals.
2G	Second generation of wireless telephone technology; a digital telecommunication standard using digital radio signals; Global System for Mobile Communications (GSM) standard, with introduced data services.
2.5G	Second generation of enhanced wireless telephone technology; enables high speed data transfer over upgraded existing 2G networks; High-Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS) or Code Division Multiple Access (CDMA) technology.
3G	Third generation of wireless telephone technology; IMT-2000 family – a generation of standards for mobile telecommunication services, that must allow the simultaneous use of speech and data services; provide peak data rates of at least 200 kbit/s according to IMT-2000 specification; for example mobile internet access, video calls and mobile TV; W-CDMA technology.
3GPP	3rd Generation Partnership Project, worldwide cooperation of standard setting bodies, for the standardising of UMTS (Universal Mobile Telecommunication System) and GSM (Global System for Mobile Communications) technology.
4G	Fourth generation of wireless telephone technology; includes all-IP packet-switched networks, mobile broadband access, and multi-carrier transmission; mobile Worldwide Interoperability for Microwave Access (WiMAX) and Long-Term Evolution (LTE).
AAA	Authentication, Authorisation, Accounting, network service for recognising users, awarding access rights and charging features.
AD-HOC ROUTING	Term for the radio networks, which connect several terminals to an interconnected network, which can be configured by a mobile ad-hoc network. Special routing procedures provide for the fact, that the existing ad-hoc network continuously adapts itself if nodes (end devices) move, appear or fall out.

API	Application Programme Interface is a specification, intended to be used as an interface, by software components to communicate with each other. An API includes different specifications for routines, data structures, object classes and variables.
AMBIENT INTELLIGENCE	Highly specified sensors for radio networks and mini computers in used applications and services. These objects around communication ability serve to enhance people's everyday lives. A sensor in the office ascertains when the temperature is too high (air-conditioning is switched on), or too low (heating is switched on).
AUC	Authentication Centre is a function to authenticate each Subscriber Identity Module (SIM) that attempts to connect to the GSM core network when the mobile phone is switched on.
B3G	Beyond 3rd Generation, is the fourth generation (4G) of cell phone mobile communications standards; provides mobile ultra-broadband internet access; conceivable applications include amended mobile web access, IT telephony, gaming services, high-definition mobile TV, video conferencing and 3D television.
BLUE-TOOTH	An open wireless technology standard, which facilitates the exchange of data over short distances, from wired and mobile devices, creating personal area networks with high levels of security.
BSC	Base Station Controller is part of a traditional cellular telephone network that is responsible for handling traffic and signalling between a mobile phone and the network switching subsystem.
BSS	Business Support Systems; support business processes within a company; used to manage contract relations with customers easier, suppliers and partners as well as the management of products and resources.
BTS	Base Transceiver Station is a piece of equipment that facilitates wireless communication between user end devices and a network.
CAMEL	Customised Applications for Mobile Network Enhanced Logic, a standard for mobile communication networks, initiated by the European Institute for Telecommunication norms, expanded service offers in UMTS.
CDM	Code Division Multiplexing is a channel access method used by various radio communication technologies (see also CDMA2000).

CDMA2000	Mobile technology standard developed in the mid 1990s; is the competitor of UMTS. This is not represented in Europe, but in America (the USA, South America), parts of Asia (Japan, Korea) and also parts of Africa. CDMA2000 standard also based on the CDMA procedure (Code Division Multiple Access), but not compatible with it.
CELLULAR IP	This is a network protocol standard, makes routing functionality available for mobile participants in IP networks.
CIT	Critical Incident Technique is a procedure that was developed originally as an observation method to uncover critical incidents concerning situative conditions and involved or following reactions. Besides this, there are data from observations to uncover relevant or critical incidents.
CLOUD COMPUTING	Cloud Computing allows suppliers to provide computer performance, storage space and software licences for abstracted, highly scalable and administered IT infrastructure. This will enable users in the future, whether private or commercial, to operate anywhere from low-performance, low-storage-capacity machines, providing they have a reliable internet connection.
CONTEXT AWARENESS	Software technology concept; can change its structure, functionality and behaviour to adapt itself to different situations according to the end device being used. Context-Awareness uses information to tune the behaviour to it. Nowadays context adaptation has to be discussed, as a key requirement for future mobile and ubiquitous systems.
DCSM	Distributed Communication Sphere: communication working field in SPICE.
DIAMETER	Diameter is an authentication, authorisation and accounting protocol, for the authentication of communication partners on a network. The diameter protocol is defined in the RFC 3588, and fulfils the requirements of the AAA transport profile "Authentication, Authorisation, Accounting", from RFC 3539. Diameter is used in the IP Multimedia Subsystem.
DHCP	Dynamic Host Configuration Protocol is a network protocol that is used, to configure network devices for communicating within IP networks: A DHCP client acquires an IP address, a default route and one or more DNS server addresses from a DHCP server. This information is used for configuring its host. The host is able to communicate on the internet.

DNS	Domain Name Server is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet, or a private network.
DSP	Digital Signal Processing is the manipulation of an information signal in order to modify it mathematically in a certain way; it is characterised by the representation of discrete time and discrete frequency.
EDGE	Enhanced Data Rates for GSM Evolution; further development of GPRS or HSCSD, developed to increase data transfer rates by means of new modulation procedures; in comparison to GSM (GMSK), EDGE uses 8-phase Shift Keying (8-PSK) modulation; data rate of 59.2 kBit/s possible, maximum theoretical transfer rate 473 kBit/s, in practice maximum 220 kBit/s download and 110 kBit/s upload.
EIR	Equipment Identifier Register maintains a list of mobile phones that are identified by their International Mobile Equipment Identity (IMEI) which are to be banned from the network or monitored. It is often integrated in the Home Location Register (HLR).
EPC	Evolved Packet Core is the main component of the System Architecture Evolution (SAE). EPC serves as equivalent of GPRS networks via the Mobility Management Entity, Serving Gateway and PDN Gateway subcomponents.
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network, a mobile radio standard, which was defined as UMTS's UTRAN successor, within the scope of 3GPP.
FDD	Frequency Division Duplexing means that the transmitter and receiver operate at different carrier frequencies. The station must be able to send and receive a transmission at the same time, and does so by slightly altering the frequency at which it sends and receives.
FDM	Frequency Division Multiplexing is a technique in which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal.
GALILEO	European, open, global, and independent positioning system, which is intended to be compatible with other navigation systems such as GPS.
GERAN	GSM EDGE Radio Access Network, Radio Access Network for GSM/EDGE Standard.

GGSN	Gateway GPRS Support Node, Crossing of the GPRS net in a public Data Network (PDN) or Packing Data Network.
GMSC	Gateway Mobile Switching Centre, Interfaces with other telephone networks.
GPS	Global Positioning System (NAVSTAR GPS); is a space-based worldwide navigation satellite system, which provides reliable location and time information, regardless of weather conditions, at all times and anywhere on or near the earth; developed in the 1980s; initially launched by the United States Department of Defense. It orbits the Earth and makes it possible to pinpoint geographic location - location accuracy ranges from 10m to 100m - nowadays it is both a military and commercial programme.
GPRS	General Packet Radio Service is a packet-oriented mobile data service, developed around higher data rates. It is packet-oriented and uses the same channels as GSM, with theoretical data rate of maximum 171.2 kBit/s - all 8 channels are bundled up. Maximum practical speed 115 kBit/s; available to users of 2G cellular communication systems, GSM as well as 3G systems; a 2.5G mobile standard, typically adopted by GSM operators as a migration step towards 3G.
GSM	Global System for Mobile Communications is, a European-developed digital mobile cellular standard which allows for international roaming arrangements between mobile operators, whilst providing subscribers with the possibility of using their phones in many parts of the world. It is used primarily for telephony, for management-provided and package-provided data transfer, as well as short communication, and was developed at the beginning of the 1980s. It is used in more than 200 countries and has approximately 3.4 billion users. It is compatible with ISDN or other analogue telephone networks and uses frequency carriers of 900 MHz to 1800 MHz; low speed rate of 9.6 kBit/s to 14.4 kBit/s.
GTM	Grounded Theory Methodology: research methodology focusing on an inductive research approach.

HANDOVER	The process of transferring an ongoing call or data session from one channel, connected to the core network, to another channel. It is a process with which the Mobile Switching Centre (MSC) passes a mobile phone conversation from a radio frequency in one cell to another radio frequency in another, as a subscriber crosses the boundary of a cell. For example - the mobile station changes its radio cell from GSM to UMTS base stations during a conversation, or a data connection, without interruption to the connection.
HCI	Human Computer Interaction involves the study, planning, and design of the interaction between people and computers.
HDTV	High-definition Television provides a resolution that is substantially higher than that of standard-definition television.
HFC	Hybrid Fibre Coax is a telecommunication industry term, for a broadband network, that combines optical fibre and coaxial cable.
HLR	Home Location Register is a central database that contains details of each mobile phone subscriber that is authorised to use the GSM core network.
HSCSD	High-Speed Circuit Switched Data is an enlargement of the GSM standard, used to speed up data transfer by the grouping together of several data channels. Besides this, data transfer rates, up to about 115.2 kbit/s (8×14.4 kbit/s), can be theoretically reached; through changes in the existing GSM infrastructure it is possible for the data rate to be increased by interference.
HSPA	High-Speed Packet Access, further development of (3.5G) UMTS, which is separated in HSDPA (High-Speed Downlink Packet Access) and HSUPA (High-Speed Upload Packet Access). Purpose: higher download speeds (2 MBit/s).
HSDPA	High-Speed Downlink Packing Access, data transfer procedures of the mobile radio standard UMTS, protocol allows for the increase of the data rates in a UMTS network.
HSUPA	High Speed Uplink Packing Access, data transfer procedures of the mobile radio standard UMTS. Protocol allows for an increase of the data rates in a UMTS network.
HTTP	Hypertext Transfer Protocol: a standard transport protocol for transferring 'web pages' from one machine to another.

ICT	Information and Communications Technology: ICT consists of IT, as well as telecommunication, broadcast media (all types of audio and video processing and transmission) and network based control and monitoring functions; often used as extended synonym for IT, but also to stress the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers, middleware and software, storage, and audio-visual systems, which enables users to create, access, store, transmit, and manipulate information.
IP	Internet Protocol Address. A numeric value that serves to identify an interface that is connected to the Internet, in a unique way.
IMEI	International Mobile Equipment Identity. Unique serial number used for mobile phones, typically those connected to the GSM network.
IMS	IP (Internet Protocol) Multimedia Subsystem, collection of specifications of 3rd generation Partnership Project (3GPP), the aim of IMS is to enable access to the services of different networks.
IMSI	International Mobile Subscriber Identity, a unique number that is associated with all GSM and Universal Mobile Telecommunications System network mobile phone users. The number is stored in the Subscriber Identity Module (SIM).
ISC	International Switching Centre is a 3G core network element such as a Mobile Switching Centre (MSC) that controls the network switching subsystem elements on an international level.
ISDN	Integrated Services Digital Network. A digital switched network, which supports the transmission of voice, data and images, over conventional telephone lines.
IST FP6	Information Society Technologies aims to increase innovation and competitiveness in European businesses and industry; Framework Programme six.
ITU	International Telecommunication Union; the United Nations specialised agency for telecommunications. http://www.itu.int/
LBS	Location-based Services are mobile services that can provide information to the end user, by aid of data, dependent on position (e.g., data from the GPS-position regulation), and produce services of other kinds, for example, advertising services.

LDAP	Lightweight Directory Access Protocol is an application protocol for the access and the maintenance of distributed directory information services over an IP network.
LTE	Long Term Evolution, is a standard for wireless communication of high-speed data for mobile phones and end devices developed by 3GPP; based on GSM/EDGE and UMTS/HSPA network technologies with increased capacity and speed, using new modulation techniques.
M-COMMERCE	Mobile Commerce is similar to e-commerce, however the term is usually applied to the emerging transaction activity in mobile networks.
MGW	Media Gateway, Benefit data-transferring Authority on a UMTS network.
MMS	Multimedia Messaging Service provides more sophisticated mobile messaging than SMS. A global standard for messaging, MMS enables users to send and receive messages with formatted text, graphics, audio and video clips. Unlike SMS, it is not limited to 160 characters per message.
MOBILE IP	A network protocol standard that allows the change of a computer network to another network, whereby users of mobile terminals keep a firm IP address alongside, at the same time.
MS	Mobile Station or mobile telephone.
MSC	Mobile Switching Centre, mobile full-digital agency on the mobile radio network, component of GSM, UMTS or Long-Term Evolution (LTE) of mobile radio networks.
NFC	Near Field Communication: a set of standards for Smartphones and end devices for establishing radio communication with each other by linking them together, usually no more than a few centimetres; present and anticipated applications include contactless transactions, data exchange, and simplified setup of more complex communications such as Wi-Fi.
NGN	Next Generation Networks: one telecommunication network that transports all information and services (voice, data, media and video) by encapsulating these into IP packets.
NUDIST	Non Numerical Unstructured Data Indexing Searching and Theorizing: software product from QSR international which helps with the undertaking of qualitative research and is especially useful when a researcher is working with large amounts of data. It helps to structure the researchers' data in order to interpret it.

NVIVO	Is a data analysis software product from QSR international, designed for qualitative research by working on very rich text-based and/or multimedia information where deep levels of analysis of small, or large, volumes of data is required.
OMC	Operation and Maintenance Centre; company and servicing headquarters for telecommunication networks.
OMSS	Operation and Maintenance Sub-System, part of the Mobile Switching Centre.
OSI	Open Systems Interconnection, is an effort to standardize networking; started in 1977.
OSS	Operations Support System, Company Support System, Network Management System that supports automated service processes.
PAM	Pluggable Authentication of Module, is a mechanism for integrating multiple low-level authentication schemes into a high-level application-programming interface (API). It allows programs that rely on authentication to be written independently of the underlying authentication scheme.
PAN	Personal Area Network is a computer network implemented for the communication among computers and mobile end devices.
PDA	Personal Digital Assistant is a generic term for handheld devices that combine computing and communication functions.
PSTN	Public Switched Telephone Network, totality of all public management-engaged telephone networks.
QoS	Quality of Services refers to network traffic resource reservations and control mechanisms in computer environments.
RFID	Radio-frequency Identification is used for wireless non-contact systems, that use electromagnetic fields to transfer data from a tag, attached to an object, for the purpose of automatic identification and tracking.
RTP	Real-Time Transport Protocol, a protocol for the continuous transference of audio-visual data streams in IP based networks.
SAE	System Architecture Evolution is the core network architecture of 3GGG's Long Term Evolution (LTE) wireless communication standard.
SCE	Service Creation Environment in SPICE - Service Creation Environment on a Service-Delivery-Platform (SPICE).

SCTP	Stream Control Transmission Protocol, Session Initial Protocol (SIP) Transport Protocol is a reliable, connection-oriented transport protocol, which touches on a potentially unreliable package service without connection.
SDM	Space Division Multiplex, Space multiplex procedures, transference canals are bundled up in order to enable parallel, but exclusive use, by several transmitters and receivers.
SDL	Service Description Language: is a platform, programme and protocol independent description language for network services, for the exchange of messages, on the basis of XML.
SDP	Service-Delivery-Platform, Official development and execution platform, makes available services as a uniform program interface and shows a sub range of NGNs.
SGSN	Serving GPRS Support Node, SGSN has a similar function to a Mobile Switching Centre (MSC) for linguistic communication for GPRS data communication.
SIM	Subscriber Identity Module is a small printed circuit board that is inserted into a GSM-based mobile phone. It includes subscriber details, security information and memory for the personal directory of numbers. This information can be maintained by subscribers when changing handsets.
SIP	Session Initial Protocol, special net protocol from the Internet-protocol family for the construction, control, and dismantling of a communication meeting between two or more participants.
SLA	Service Level Agreement, agreement about the quality and price of a service contract.
SMS	Short Message Service; is a service available on digital networks, typically enabling messages with up to 160 characters, to be sent from, or received on, a subscriber's mobile phone via the message centre of a network operator.
SMSS	Switching and Management Sub-System: Mediation subsystem in a telecommunication system.
SOA	Service Oriented Architecture, architecture oriented structuring of services of IT systems; is a set of principles for designing and developing software in terms of interoperable services.
SON	Self-Organising Networks, self-curative/-optimising networks.

SPATEL	SPICE advanced service description language for telecommunication services, Enlarged, official description language for telecommunication services, a platform which simply allows the definitions of official parameters according to a standardised action.
SPICE	Service Platform for an Innovative Communication Environment, Collection of specifications with particular adjustment for user-centred, IP based services.
SSL	Secure Sockets Layer, is a cryptographic protocol that provides communication security over the internet and that encrypts the segments of network connections at the applications layer.
TCP	Transmission Control Protocol, Protocol for arranging which way data should be exchanged between computers, a reliable, connection-oriented, package-intermediary transport protocol in computer networks.
TDD	Time Division Duplexing is the application of Time Division Multiplexing (TDM) to separate outward and return signals.
TDM	Time Division Multiplexing is a type of multiplexing in which two or more bit streams or signals are transferred apparently simultaneously as sub-channels in one communication channel, but are physically taking turns on the channel.
UBIQUITOUS COMPUTING	The English term "Ubiquitous" means "everywhere". It refers to the development that computers are to be seen everywhere in our lives (from the modern pocket calculator to the Smartphone). Computers have played a role of increasing responsibility since the 1990s, with a trend towards Ubiquitous Computing. This means "completely piercingly"; it is difficult to separate either concept from another, therefore, they are summarised under "Ubiquitous Computing".
UBS	Ubiquitous Services are services that support human computer interaction in which information processing has been thoroughly integrated into everyday objects and activities.
UDP	User Datagram Protocol is a network protocol without connection.
UMTS	Universal Mobile Telecommunication System is the European term for third generation mobile cellular systems or IMT-2000 based on the W-CDMA standard. It is a third generation mobile radio standard; with clearly higher data transfer rates (up to 7.2 MBit/s with HSDPA; without maximum 384 kbit/s).

URL	Unique/Uniform Resource Locator. A naming system for web resources.
USIM	Universal Subscriber Identity Module (card). A printed circuit board (similar to a SIM) that is inserted into a mobile phone. Adopted by W-CDMA operators for 3G mobile. Capable of storing information, with sophisticated security functions, in comparison to SIMs. Also referred to as User Identity Module, or USIM.
UTRAN	UMTS Terrestrial Radio Access Network is a hierarchically built up radio access network in a mobile radio network according to the UMTS standard.
VLAN	Virtual Local Area Network is the concept of partitioning a physical network, so that distinct broadcast domains (is a logical division of a computer network, in which all nodes can reach each other by broadcast at the data link layer) are created.
VLR	Visited Location Register is a database of the subscribers who have roamed into the jurisdiction of the MSC (Mobile Switching Centre) that it serves.
VoIP	Voice over IP: phoning in computer networks that are built up according to internet standards.
VHE	Virtual Home Environments is a system to support GSM roaming.
WAP	Wireless Application Protocol - A licence-free protocol for wireless communication, which enables the creation of mobile telephone services, and the representation of internet pages on a mobile phone, and is therefore the mobile equivalent of HTTP (Hypertext Transfer Protocol).
WEARABLE COMPUTING	Computer or electronic components one carries directly on the body.
WIDGET	Component of a graphic window system: Widgets are always integrated into a certain window system and use this for interaction with the user, or other windows system Widgets.
WLAN	Wireless Local Area Network: local radio network according to the standard of the IEEE-802.11 family.

Wi-Fi	Wireless Fidelity: wireless systems that provide internet connectivity, this refers to Wireless Fidelity, the 802.11b specification for Wireless LANs, laid out by the Institute of Electrical and Electronics Engineers (IEEE). It is part of a series of wireless specifications that also includes 802.11a, and 802.11g. Sources: International Telecommunication Union (2003) and Home Office (2003b).
WPAN	Wireless Personal Area Network is a personal area network for interconnecting devices centred around an individual person's workspace, in which the connections are wireless.
XML	Extensible Mark-up Language of structured records, in the form of text data.