

Frank Oemig · Robert Snelick

Healthcare Interoperability Standards Compliance Handbook

 Springer

Healthcare Interoperability Standards Compliance Handbook

Frank Oemig · Robert Snelick

Healthcare Interoperability Standards Compliance Handbook

Conformance and Testing of Healthcare Data
Exchange Standards

 Springer

Frank Oemig
Deutsche Telekom Healthcare
and Security Solutions GmbH
Mülheim
Germany

Robert Snelick
National Institute of Standards
and Technology (NIST)
Gaithersburg, MD
USA

ISBN 978-3-319-44837-4 ISBN 978-3-319-44839-8 (eBook)
DOI 10.1007/978-3-319-44839-8

Library of Congress Control Number: 2016949613

© Springer International Publishing Switzerland (outside the USA) 2016

Mr. Snelick's work was completed within the capacity of US governmental employment. US copyright protection does not apply. HL7[®], HL7 CDA[®] and FHIR[®] and are registered trademarks of Health Level Seven International, Inc. and are used with permission. HL7[®] Version 2.x, HL7 Version 3.0, HL7[®] CTS2 is copyrighted material owned by HL7[®] International and are used with permission. Use of these trademarks and material does not represent endorsement of HL7[®] International of this text. DICOM[®] is the registered trademark of the National Electrical Manufacturers Association for its standards publications relating to digital communication of medical information.

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

Interoperability is essential for information to flow freely, accurately, efficiently, and securely between health information technology (HIT) systems and across healthcare networks—systems and networks that support hospitals and clinicians in the delivery of patient care. This information flow can enable the healthcare industry to achieve its goals related to preventive care, population health management, cost-effectiveness, and, that particularly elusive factor, patient safety.

Actually achieving interoperability through use of HIT has been compared, as far as the difficulty involved and the likelihood of it happening, to traveling to another planet; however, the initial building blocks needed for successfully realizing the information flow envisioned with true interoperability are identifiable today, including well-designed and clearly articulated data exchange standards and the test tools that evaluate conformance of HIT systems to those standards.

In *Healthcare Interoperability Standards Compliance Handbook: Conformance and Testing of Healthcare Data Exchange Standards*, Mr. Oemig and Mr. Snelick explain the challenges, methodologies, and mechanisms related to developing the standards and measuring the conformance of HIT systems. Having been co-chairs of the *HL7 Conformance and Guidance for Implementation/Testing Working Group* for numerous years, these authors are able to impart knowledge gleaned from real-world experience in development of conformance tools as well as from detailed discussions with clinical informatics experts in development of official standards that are in use today. With their in-depth understanding and their international perspective about the subject matter, the authors convey valuable information about the different families of data exchange standards—HL7 version 2.x, HL7 V3, and others—and about the need for an underlying system architecture and standards that provide the foundation for electronic communication of healthcare data at the national level in various countries and that also are flexible enough to allow for local adaptations and enhancements.

The format of interoperability standards documents themselves does not provide the means to disclose the details of the discussions that occur among the standards developers. In this book, however, the authors are able to give the readers insight

into the topics that are discussed as well as how the conclusions included in the standards were reached.

Using the basic interoperability guidelines, the foundation for which is provided in this book, the readers should be able to participate actively in efforts toward achieving the goals of compatible and interoperable implementations when applying the standards that are discussed herein. Furthermore, as the various concepts described are independent of these standards, the interoperability guidelines can be utilized with standards other than the ones highlighted in this text.

By providing this book as a source of up-to-date information about conformance testing and the development of testable data exchange standards, the authors are facilitating the healthcare industry's progress toward achieving HIT interoperability and reaching the goal of safer and more cost-effective patient care.

Gaithersburg, Maryland, USA

Sheryl L. Taylor, BSN, RN
IT Specialist, NIST

Preface

This book is organized into three parts. Part I, *Healthcare Information Technology*, outlines the motivation for writing the book, the background for the discussions, and the foundation upon which the subsequent parts of the book are based, and establishes the context for descriptions of the included conformance, interoperability, and testing concepts. Chapter 1, *Introduction*, gives an overview of the concepts, the targeted issues, and how the concepts are interrelated. This chapter describes a complete conformance testing process lifecycle from the development of standards to the certification of products. Chapter 2, *Architecture*, describes common architectures for distributed healthcare systems. The remaining concepts of the book are discussed against the backdrop of this context. Chapter 3, *Healthcare Data Exchange Landscape*, provides an overview of the Standards Development Organizations (SDO) and Standards Profiling Enforcement Organizations (PEO). In general, SDOs create the standards and PEOs apply the standards to address various workflows. Chapter 4, *Healthcare Data Exchange Standards*, provides a survey of the most relevant standards in use for healthcare data exchange today, while giving the reader a perspective on the standards-related technologies that are available along with the means to compare and contrast them at a high level. To explain the various data exchange concepts, case studies using specific standards are presented extensively throughout this book. Although any standard could have been used in the case studies, the HL7 v2.x standard is used for the most part since it is the most widely deployed standard, and the authors have extensive experience with it.

Part II, *Conformance*, focuses on the definition and explanation of conformance concepts and techniques for unambiguously specifying requirements, including applying the concepts of profiling. In the opinion of the authors, the lack of quality standard specifications is the biggest impediment to achieving interoperability among healthcare information systems. We encourage all standards developers to employ the concepts presented in Part II. Chapter 5, *Conformance Constructs*, provides a detailed explanation of conformance concepts that are applicable in a standard-agnostic manner to most standard specifications. This explanation sets the foundation for much of the discussion in later chapters, and the reader's

understanding of the information provided in this chapter is essential. Chapter 6, *Principles of Specifying Conformance*, describes how specifications should state requirements (conformance) in a general sense. This discussion includes the necessary conformance components and what they mean. A list of principles is given with explicit examples. Chapter 7, *Principles of Effective Profiling*, introduces the concept of profiling and how to use profiles effectively for managing standard specifications and for developing implementations. Chapter 8, *Profile Relationships*, gives an in-depth analysis of how profiles relate to each other in multiple dimensions (e.g., profile hierarchy and sender/receiver perspectives). A set of rules for creating and determining profile compliance and compatibility is given. Chapter 9, *Tools for Conformance Profiling*, provides a survey of the tools that help in effective application of the profiling mechanisms.

Part III, *Testing and Tools*, focuses on the concepts and techniques of conformance and interoperability testing. Principles of testing are discussed along with application of those principles via testing models, frameworks, architecture, tools, and testing programs. Parts I and II laid the foundation for a clear understanding of what conformance means, why it is necessary, and its benefits. Given that information as the background, how does anyone verify that implementers and users are applying the concepts appropriately in practice? *Testing and Tools* examines this topic by exploring the process, strategy, assessment, and instantiation of conformance and interoperability testing. A foundational chapter, Chap. 10, *Testing Models*, begins this part of the book by defining, in an abstract manner, the various testing models and describing the types of testing that can be performed within the models. Chapter 11, *Principles of Conformance Testing*, explains how to conduct conformance testing, including the creation and execution of test plans. Various types of conformance testing are examined. Chapter 12, *Conformity Assessment*, presents the assessment tables and interpretation of conformance for the conformance constructs presented in Chap. 5. The assessments provide the requirements for building validation tools to evaluate conformance. Through use of concrete examples, Chap. 13, *Testing Architectures*, provides a realization of the concepts and methodologies described in Chaps. 10 and 11. This realization includes a description of a testing infrastructure, testing framework, and an interoperability test bed. Case studies are provided to emphasize the utility of the modular approach. Chapter 14 builds upon this theme by providing a sampling of test tools created from the ideas (framework) explained in Chap. 13. Finally, Chap. 15 describes how testing programs operate and how they utilize the testing tools. An overview is given of the most prevalent testing and certification programs, such as the IHE Connect-a-thon and the ONC Health IT Certification Program that supports the CMS EHR Meaningful Use Programs.

Finally, Appendix, *Additional Healthcare Data Exchange Standards*, provides additional background information about some of the data exchange standards that are in use worldwide.

Trademarks and Disclaimer

Use of trademarks and referenced materials does not represent endorsement by these organizations for the text provided with this book. Trademark information can be found on page iii.

The information in this book was compiled with great care. However, mistakes cannot be completely ruled out. Authors assume no legal responsibility or liability of possible errors, incorrect data or the resulting consequences thereof.

All product names are used without guarantee of their unrestricted applicability and are possibly registered trademarks.

Certain commercial products or materials are identified in this book in order to explain a concept or to provide realistic examples adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the products or materials identified are necessarily the best available for the purpose.

Copy-Editor

We can't thank Sheryl Taylor (NIST) enough for the detailed edits she made in multiple drafts of the book, improving the readability and content immensely.

Contributors

The section "EHR Certification and Meaningful Use Programs" in Chap. 15 was contributed by Sheryl Taylor of NIST. We are delighted that Sheryl shared her knowledge about the CMS Meaningful Use and ONC Health IT Certification Programs and the associated testing efforts. Another special thank you goes to those persons and institutions/organizations that have provided us with supportive material which we are allowed to use to underline our statements and explanations: Bernd Blobel, Kai Heitmann, Ioana Singureanu, Pete Rontey, Sheryl Taylor, Ted Klein, Friedemann Schulz von Thun, HL7 International, National Electrical Manufacturers Association (NEMA), IHE-Integrating the Healthcare Enterprise, International Standardization Organization (ISO), Deutsches Institut für Normung (DIN), ASTM, OASIS, IETF, United Nations, DVTK, Hprim Santé, Phast, ART-DECOR Experts Group, Lantana Consulting Group, Furore, Qualitätsring Medizinische Software, and finally Australian Healthcare Messaging Laboratory (AHML).

Reviewers

We would like to thank Craig Newman, who was the technical reviewer for the book. Craig provided thoughtful and detailed comments that led to many clarifications, improvements, and additional content.

We would like to thank other reviewers who also provided comments that led to many quality improvements in one or more chapters: Bernd Blobel, Peter Geibel, Ted Klein (contributed to, and reviewed various sections in vocabulary), Riki Merrick, Nathan Bunker, John Garguilo and Marek Vačlavik.

Finally, we would like to thank those who partially reviewed specific sections for their correctness: Francois Macary/Franck Gener/Olivier Boux (InteropSante, ASIP.SANTE, Hprim Santé, PN13), Michel Rutten (Forge profile editing tool), Kai Heitmann (ART-DECOR), Reinhold Mainz (xDT standards family), Nicolas Canu (PN13), Ewout Kramer (FHIR), Liora Alschuler/Rick Geimer/Sean P. McIlvenna (Trifolia), and Andreas Schultz (EDIFACT).

HL7 Conformance Working Group

We would like to thank the members of the HL7 Conformance, Vocabulary, and Order and Observations Working Groups for the many fruitful and insightful conversations through the years that helped formulate many of the concepts and principles documented in this book.

Robert Snelick Acknowledgments

I would like to thank the numerous colleagues with whom I have worked at NIST. Many of the concepts explained in this book were generated from our projects. Caroline Rosin is the senior developer for the suite of laboratory conformance HL7 v2 testing tools. Harold Affo is the architect and senior developer of the NIST HL7 v2 testing framework. He is also the project lead and architect of the NIST Implementation Guide Authoring and Management Tool (IGAMT). Woo Jungyub is the architect and senior developer of the NIST Test Case Authoring and Management Tool (TCAMT). Sydney Henrard, Salifou Malick, and Hossam Tamri have developed and refined the validation engine over many years. Sandra Martinez is the tool analyst for the Immunization and Vital Records domains. I would like to thank Sheryl Taylor for her unyielding work ethic and for sharing her knowledge of clinical informatics as we developed the three iterations of ONC certification test procedures and test tools. Others who also contributed as tool analysts or

developers include Len Gebase, Sheryl Taylor, Roch Bertucat, Nico Couzier, and Mike Indovina. NIST management, past and present, must be thanked for their forward-thinking vision in establishing the conformance testing project and for providing a first-class working environment.

I would also like to thank the NIST contractors, associates, and collaborators, of whom there are too many to name. I would especially like to thank the subject matter experts who provided domain expertise, test data, and feedback during the process of the tool development: Rob Savage, Craig Newman, Nathan Bunker, and Eric Larson (Immunization); Riki Merrick, Eric Haas, and Bob Dieterle (Laboratory); and others in the various domains. I am appreciative of the efforts of the S&I Framework Laboratory Work Group, through which many of the profiling ideas and concepts were proposed, applied, vetted, and refined. I would also like to thank my colleagues at the CDC, HL7, and IHE.

And, finally, I would like to thank my wife Donna for always being there for me and to thank my children Victoria, Austin, and Connor for their support and patience; it is finally finished!

Frank Oemig Acknowledgments

I would like to thank my mentor and long-time friend Bernd Blobel for an uncountable number of discussions in this domain. Without his outstanding support I wouldn't be in the position I am in today.

A lot of my work is supported not only by my employer, but also HL7 Germany. Here I would like to say thank you to my friends and colleagues Kai, Christof, Sylvia, Bernd (2x), Alex, Markus, Mathias, Daniel, Peter (2x), Marek, Simone, Ralf and Tarik. I am sorry if I missed anyone here.

Furthermore, I appreciate the discussions with my friends from the international and national community and would like to thank them for their patience with me. I know it is not that easy.

Another special thank you goes to Sheryl, who has done an incredible job in taking care of my English. As a non-native speaker it was a great exercise for me, and I have learned a lot.

Finally, I would like to thank my wife Anja and our children Alina and Fabian for their continuous support and encouragement, especially when I have to start a new trip to USA.

After several years of work and huge amount of intermediate versions of the individual chapters the first release of our book is ready.

Dedication

The authors would like to dedicate this book to friend and colleague Pete Rontey. Pete was a leader in establishing conformance principles and implemented those principles in his development of the highly successful messaging workbench (MWB). We recall fond memories of Pete at the HL7 working group meetings discussing conformance issues over a cold beer (or two...). This one is for you Pete!

Mülheim, Germany
Gaithersburg, USA

Frank Oemig
Robert Snelick

Contents

Part I Healthcare Information Technology

| | | |
|----------|---|----|
| 1 | Introduction | 3 |
| 1.1 | The Case for Common Understanding | 5 |
| 1.1.1 | The Need for Consistency | 6 |
| 1.2 | Information Cycle | 7 |
| 1.3 | Motivation for Cooperation | 8 |
| 1.4 | Definition of Key Terms and Concepts | 9 |
| 1.4.1 | Conformance | 9 |
| 1.4.2 | Interoperability | 10 |
| 1.5 | Interoperability Levels | 12 |
| 1.6 | Standards Development Life-Cycle | 13 |
| 1.7 | ISO/OSI Stack | 15 |
| 1.8 | Reference Model for Open Distributed Processing (RM-ODP) | 17 |
| 1.9 | Concept Relationships | 19 |
| 1.10 | Approaches to Standards Development | 20 |
| 1.11 | Testing | 22 |
| 1.12 | Scope and Purpose | 23 |
| 1.13 | Commonly Used Terms and Definitions | 25 |
| 1.14 | Intended Audience | 27 |
| 1.15 | Keywords for Use | 28 |
| 1.16 | Summary | 28 |
| | References | 29 |
| 2 | Architecture | 31 |
| 2.1 | Interface | 31 |
| 2.1.1 | Types of Interfaces | 32 |
| 2.1.2 | Communication Paradigms | 35 |
| 2.1.3 | Protocol Layer | 36 |
| 2.1.4 | Levels for Interoperability | 36 |

- 2.2 Interfacing. 37
 - 2.2.1 Impact on Interfaces 38
- 2.3 Serving Interfaces with Data. 39
 - 2.3.1 General “Capability” of a System 39
 - 2.3.2 Relevance for Interfaces. 41
- 2.4 Dynamic Behavior 42
 - 2.4.1 Message Pairs 42
 - 2.4.2 Timing. 43
 - 2.4.3 Message Identification 43
 - 2.4.4 Routing to Multiple Destinations. 45
 - 2.4.5 Responsibility of a System 46
 - 2.4.6 Event Handling 47
 - 2.4.7 Delayed Message Handling (Sender) 48
 - 2.4.8 Handling of Outdated Data (Receiver). 49
- 2.5 Intermediate Message Handling 50
- 2.6 Message Population 51
- 2.7 Information Transmission 52
- 2.8 Delete Indication. 53
 - 2.8.1 Legal Requirements for Data Persistence. 56
 - 2.8.2 Receiver Responsibility 56
 - 2.8.3 Data Granularity 57
 - 2.8.4 Impact of Order of Messages. 57
 - 2.8.5 Sender Responsibility: Impact to System Design. 58
- 2.9 Null Flavors 59
- 2.10 Snapshot Mode Versus Update Mode. 61
- 2.11 Considerations in Application Development 64
 - 2.11.1 Introducing Functional Requirements. 64
 - 2.11.2 Conformance Discussion 69
- 2.12 Summary 72
- References. 73
- 3 Healthcare Standards Landscape 75**
 - 3.1 Introduction 75
 - 3.2 Standards Developing Organizations. 76
 - 3.2.1 UNECE. 76
 - 3.2.2 ASC (US) 77
 - 3.2.3 ASTM (US). 78
 - 3.2.4 HL7 78
 - 3.2.5 DICOM 79
 - 3.2.6 KBV, ZI and QMS (Germany) 80
 - 3.2.7 KV-Telematik (Germany) 80
 - 3.2.8 NCPDP (USA) 81
 - 3.2.9 OASIS. 82

| | | |
|----------|---|------------|
| 3.3 | Profile Development Organizations | 83 |
| 3.3.1 | IHE | 83 |
| 3.3.2 | ELGA (Austria) | 86 |
| 3.3.3 | eHealth Suisse (Switzerland) | 87 |
| 3.3.4 | HITSP (US) | 88 |
| 3.3.5 | S&I Framework (US) | 89 |
| 3.3.6 | Standards Collaborative (Canada) | 90 |
| 3.3.7 | Interop’ Santé (France) | 91 |
| 3.3.8 | ASIP Santé (France) | 92 |
| 3.3.9 | Phast (France) | 92 |
| 3.3.10 | eSanté (Luxembourg) | 93 |
| 3.3.11 | Interoperability Forum (Germany) | 93 |
| 3.3.12 | NHS (UK) | 95 |
| 3.3.13 | SMART Health IT on FHIR® (US) | 96 |
| 3.4 | Overview of Widely Used Standards | 97 |
| 3.4.1 | HL7 | 97 |
| 3.4.2 | Other Standards | 100 |
| 3.5 | Summary | 101 |
| | References | 101 |
| 4 | Healthcare Data Exchange Standards | 105 |
| 4.1 | Introduction | 106 |
| 4.2 | HL7 Version 2.X | 106 |
| 4.2.1 | Versions | 107 |
| 4.2.2 | Information Model | 109 |
| 4.2.3 | Message Structure | 109 |
| 4.2.4 | Optionality | 111 |
| 4.2.5 | Encoding | 112 |
| 4.2.6 | Delimiters | 114 |
| 4.2.7 | Delete Requests | 114 |
| 4.2.8 | Null-Flavors | 115 |
| 4.2.9 | Data Types | 115 |
| 4.2.10 | Events | 117 |
| 4.2.11 | Dynamic Behavior | 119 |
| 4.2.12 | Transmission Protocols | 121 |
| 4.2.13 | Tables and Table Values | 121 |
| 4.2.14 | Conformance Methodology | 123 |
| 4.3 | FHIR (HL7) | 123 |
| 4.3.1 | Introduction and Overview | 123 |
| 4.3.2 | Element Hierarchy | 126 |
| 4.3.3 | References | 128 |
| 4.3.4 | Bundling | 129 |
| 4.3.5 | Retrieval and Queries | 129 |
| 4.3.6 | Extensibility | 130 |
| 4.3.7 | Use of Vocabulary | 130 |

- 4.3.8 Data Types 131
- 4.3.9 Representation/Encoding 133
- 4.3.10 Maturity Model 133
- 4.3.11 Versions. 134
- 4.3.12 Profiling by “Slicing” 135
- 4.3.13 Conformance 135
- 4.3.14 Conformance Methodology 139
- 4.4 UN/EDIFACT 140
 - 4.4.1 Introduction and Overview 140
 - 4.4.2 Message Structure 140
 - 4.4.3 Delimiter 141
 - 4.4.4 Data Types Format Notation 143
 - 4.4.5 Tables 144
 - 4.4.6 Conformance Methodology 145
- 4.5 ebXML 145
 - 4.5.1 ebRIM 145
 - 4.5.2 Data Types 146
 - 4.5.3 Classes and Attributes 147
 - 4.5.4 Methods. 147
 - 4.5.5 Conformance Methodology 148
- 4.6 CTS2 (HL7) 148
 - 4.6.1 Information Model. 149
 - 4.6.2 Conformance Methodology 150
- 4.7 ClaML (ISO) 150
 - 4.7.1 Information Model. 150
 - 4.7.2 Conformance Methodology 151
- 4.8 Technical Compatibility Matrix 152
- 4.9 Summary 152
- References. 155

Part II Conformance (and Tools)

- 5 Conformance Constructs. 159**
 - 5.1 Overview 159
 - 5.1.1 Conformance Constructs Overview 160
 - 5.1.2 Related Conformance Concepts 163
 - 5.1.3 Example Specifications 164
 - 5.1.4 Summary 165
 - 5.2 Data Structures and Data Types 166
 - 5.2.1 Binding to Elements 166
 - 5.2.2 Atomic Versus Complex Information 167
 - 5.2.3 Representation/Formats 168
 - 5.2.4 Precision in Representation 169

- 5.2.5 Precision in Meaning 170
- 5.2.6 Collections of Data Types 170
- 5.2.7 Promotion/Demotion (in HL7 V3). 171
- 5.3 Usage (Optionality). 172
 - 5.3.1 Example Application Discussion 173
 - 5.3.2 Support for an Element 175
 - 5.3.3 Implementation Support Versus Presence
in Instances 176
 - 5.3.4 Conditional Usage 177
 - 5.3.5 Case Study: HL7 v2.x Conditional Usage 178
 - 5.3.6 “Required” Versus “Mandatory” 179
 - 5.3.7 Binding of Elements 181
 - 5.3.8 Interface Design Choices 181
 - 5.3.9 Sender and Receiver Perspectives 182
- 5.4 Cardinality 182
 - 5.4.1 Limitations. 183
 - 5.4.2 Delimiters 184
 - 5.4.3 Alternate Terms for Cardinality 184
 - 5.4.4 Notation for Cardinality. 184
 - 5.4.5 Use of Cardinality 184
 - 5.4.6 Relationship of Optionality and Cardinality. 185
- 5.5 Length 186
 - 5.5.1 Sender/Receiver Role. 187
 - 5.5.2 Truncation 187
 - 5.5.3 Padding 188
 - 5.5.4 Conformance Length 189
- 5.6 Content 189
 - 5.6.1 Vocabulary 190
 - 5.6.2 Null Flavors (Values) 201
 - 5.6.3 Fixed Value (Constant) 202
 - 5.6.4 Default Values. 203
 - 5.6.5 Placeholder Values 204
- 5.7 Conformance Statements. 204
- 5.8 Data Semantics 205
 - 5.8.1 Models. 205
- 5.9 Encoding. 205
 - 5.9.1 Display-Oriented Encoding Concepts. 206
 - 5.9.2 Presence/Absence of an Element 213
 - 5.9.3 Parsing. 216
- 5.10 Summary 220
- References. 220
- 6 Principles of Specifying Conformance 223**
 - 6.1 Introduction 223
 - 6.2 Overloaded Terms. 225

- 6.2.1 Declaring Requirements and Conformance 225
- 6.2.2 Requirement Documents 226
- 6.3 Conformance Keywords 226
 - 6.3.1 Impact of Keywords on Requirements. 228
 - 6.3.2 Nested Requirements 229
 - 6.3.3 Normative and Informative Statements 230
- 6.4 Conformance Clause. 230
 - 6.4.1 Conformance Claim. 231
- 6.5 Specifying Conformance Requirements. 232
 - 6.5.1 Implicit Definitions with Conformance
Constructs 232
 - 6.5.2 Explicit Definition with Normative Statements 236
 - 6.5.3 Principles for Writing Conformance
Requirements. 236
- 6.6 Scope of Conformance Specifications 239
- 6.7 Summary 241
- References. 241
- 7 Principles of Effective Profiling 243**
 - 7.1 Introduction 243
 - 7.2 Profiling: Definition of Terms. 244
 - 7.2.1 Profile Components 249
 - 7.2.2 Annotations 249
 - 7.3 Refinement of a Standard 250
 - 7.3.1 Profiling Methodology Summary. 251
 - 7.3.2 Constraints. 251
 - 7.3.3 Allowable Constraints 257
 - 7.3.4 Extensions 257
 - 7.3.5 Conformance Approaches: Constraints Versus
Extensions 258
 - 7.4 Profile Hierarchy. 258
 - 7.4.1 Profile Hierarchy in Use 260
 - 7.4.2 Profile Hierarchies for Standard Specifications 261
 - 7.4.3 Non-compliant Profiles 263
 - 7.5 Profiling Case Study: HL7 v2. 264
 - 7.5.1 HL7 v2.x Profiles: Background and Motivation. 264
 - 7.5.2 HL7 v2 Conformance Profile Defined 266
 - 7.5.3 Message Profile Components Defined 267
 - 7.6 Vocabulary Profiling. 269
 - 7.6.1 Vocabulary Binding and Profiling 270
 - 7.6.2 Use of Extensibility and Stability 273
 - 7.6.3 Profiling at the Code Level 275
 - 7.6.4 Summary 283

- 7.7 Vocabulary Management 283
 - 7.7.1 Managing Code Systems 284
 - 7.7.2 Value Set Definition and Expansion 285
 - 7.7.3 Managing Dynamic Value Sets 286
- 7.8 Uses of Conformance Profiles. 288
- 7.9 Profile Design and Management. 289
 - 7.9.1 Profile Identification Management 292
 - 7.9.2 Publishing the Specification. 292
- 7.10 Pairing Sender and Receiver Profiles for Use 293
 - 7.10.1 One-to-One Profile Pairing 294
 - 7.10.2 One-to-Many Profile Pairing 294
 - 7.10.3 Many-to-One Profile Pairing 296
 - 7.10.4 Design Considerations: Profiling Pairing 299
- 7.11 Case Studies 299
 - 7.11.1 Localization Using Profile Components 299
 - 7.11.2 IHE Integration Profile. 301
 - 7.11.3 Laboratory Orders, Results, and Public Health 301
 - 7.11.4 HL7 v2.x Message Profiles (in Germany) 304
- 7.12 Documenting Interfaces 306
 - 7.12.1 Profile and Implementation Relationships 307
 - 7.12.2 Documentation Quality 310
- 7.13 Summary 310
- References. 312
- 8 Profile Relationships 315**
 - 8.1 Introduction 315
 - 8.2 Specialization of Profiles. 319
 - 8.2.1 Usage (Optionality) Compliance Rules 320
 - 8.2.2 Cardinality Compliance Rules 324
 - 8.2.3 Length Compliance Rules 325
 - 8.2.4 Vocabulary Compliance Rules. 327
 - 8.3 Versioning of Profiles. 328
 - 8.3.1 Example. 330
 - 8.4 Creating New Profiles. 332
 - 8.5 Compatibility of (Sender and Receiver) Profiles 332
 - 8.5.1 Usage. 333
 - 8.5.2 Cardinality. 335
 - 8.5.3 Length 335
 - 8.5.4 Vocabulary 336
 - 8.6 Summary 337
 - References. 338
- 9 Conformance Profiling Tools 339**
 - 9.1 Introduction 339
 - 9.2 Messaging Workbench 340

| | | |
|-----|---|-----|
| 9.3 | IGAMT | 343 |
| 9.4 | MDHT | 345 |
| 9.5 | ART-DECOR | 346 |
| 9.6 | Lantana Template Repository: Trifolia | 352 |
| 9.7 | Forge | 358 |
| 9.8 | Summary | 360 |
| | References. | 360 |

Part III Testing (and Tools)

| | | |
|-----------|--|------------|
| 10 | Testing Models | 365 |
| 10.1 | Introduction | 365 |
| 10.2 | Testing Objectives | 366 |
| 10.3 | Definition of Terms | 367 |
| 10.4 | Test Organization Hierarchy | 368 |
| 10.5 | Test Evaluation Types | 372 |
| 10.6 | Testing Models | 374 |
| | 10.6.1 Data Instance Testing Model | 375 |
| | 10.6.2 Isolated System Testing Model | 376 |
| | 10.6.3 Peer-to-Peer System Testing Model | 378 |
| 10.7 | Additional Testing Considerations | 379 |
| 10.8 | Summary | 380 |
| | References. | 381 |
| 11 | Principles of Conformance Testing | 383 |
| 11.1 | Overview | 383 |
| 11.2 | Conformance and Interoperability Testing | 384 |
| | 11.2.1 Conformance Testing. | 384 |
| | 11.2.2 Interoperability Testing | 384 |
| | 11.2.3 Conformance and Interoperability Testing Relationship. | 385 |
| | 11.2.4 Periodic Testing | 387 |
| | 11.2.5 Conformance Testing in Operational Environments. | 387 |
| 11.3 | Standards Development Life-Cycle. | 388 |
| 11.4 | Test Methodology Framework | 390 |
| | 11.4.1 System-Under-Test (SUT) | 392 |
| | 11.4.2 Anatomy of a Test Suite | 392 |
| | 11.4.3 Anatomy of a Test Plan. | 392 |
| | 11.4.4 Anatomy of a Test Case | 393 |
| | 11.4.5 Anatomy of a Test Step. | 393 |
| | 11.4.6 Test Data | 394 |
| | 11.4.7 Test Script. | 394 |
| | 11.4.8 Inspection Documents | 395 |
| | 11.4.9 Test Artifact. | 395 |

- 11.4.10 Test Assertion 396
- 11.4.11 Test Tool 396
- 11.4.12 Configuration Information 396
- 11.4.13 Test Report 397
- 11.5 Testing in Practice 397
 - 11.5.1 Testing Sending Applications 397
 - 11.5.2 Case Study: Laboratory Results 401
 - 11.5.3 Testing Receiving Applications 407
 - 11.5.4 Case Study: Incorporation of Laboratory Results 413
- 11.6 Context-Based Test Data Categorizations 418
 - 11.6.1 Data Content Conformity Assessment Examples 424
 - 11.6.2 Testing Cardinality and Other Conformance
Constructs 426
- 11.7 Strategies and Best Practices for Test Case Development 426
- 11.8 Capability, Site, and Interoperability Testing 430
- 11.9 Negative Testing 432
 - 11.9.1 Message and Document Incorporation 433
 - 11.9.2 Boundary Testing 435
 - 11.9.3 False Positive and False Negative Test Results 435
- 11.10 Other Types of Testing 436
 - 11.10.1 Smoke Testing 437
 - 11.10.2 Communication Testing 437
 - 11.10.3 Application Functional Testing 438
 - 11.10.4 Data Quality Testing 439
 - 11.10.5 Usability Testing 440
 - 11.10.6 Load Testing 441
- 11.11 Summary 441
- References 443
- 12 Conformity Assessment 445**
 - 12.1 Overview 445
 - 12.2 Processing Aspects (for Receiving Applications) 448
 - 12.3 Usage/Optionality 448
 - 12.3.1 Sender Usage Conformity Assessments 449
 - 12.3.2 Receiver Usage Conformity Assessment 451
 - 12.4 Cardinality 457
 - 12.4.1 Sender Cardinality Conformity Assessment 458
 - 12.4.2 Receiver Cardinality Conformance Assessment 464
 - 12.5 Vocabulary Conformance and Assessment 475
 - 12.5.1 Vocabulary Conformance 475
 - 12.5.2 Vocabulary Conformity Assessment 477
 - 12.6 Summary 480
 - References 480

- 13 Testing Architectures** 481
 - 13.1 Introduction 481
 - 13.2 Testing Infrastructure 482
 - 13.2.1 Key Objectives of a Testing Infrastructure. 485
 - 13.2.2 Resource Repository 485
 - 13.2.3 Test Harness 486
 - 13.2.4 Services 487
 - 13.2.5 Infrastructure Components 496
 - 13.2.6 Testing Infrastructure—A Broader Context 496
 - 13.2.7 Testing Infrastructure Observations 499
 - 13.3 A Test Scenario 499
 - 13.4 Testing Frameworks 503
 - 13.4.1 Data Instance Test Framework. 503
 - 13.4.2 Isolated System Test Framework. 505
 - 13.4.3 Peer-to-Peer Testing Framework 506
 - 13.5 Instantiation of Test Tools 508
 - 13.5.1 Data Instance Testing Test Tool 508
 - 13.5.2 Isolated System Testing Test Tool. 509
 - 13.5.3 Interoperability Test Bed 513
 - 13.6 Summary 523
 - References. 523

- 14 Testing Tools** 525
 - 14.1 Introduction 525
 - 14.2 NIST HL7 v2.x Test Tools 526
 - 14.2.1 NIST Immunization Test Suite 527
 - 14.2.2 Testing Functional Requirements with the Tool. 534
 - 14.2.3 NIST HL7 v2.x Testing Web Services API. 536
 - 14.3 Message Workbench (MWB) 536
 - 14.3.1 Message Instance Validation 536
 - 14.3.2 Message Validation via a Proxy-Server 537
 - 14.3.3 MWB Validation Server 537
 - 14.4 CDC Message Quality Framework 539
 - 14.5 AHML-Australian Healthcare Messaging Laboratory 540
 - 14.5.1 Message Testing Process 541
 - 14.5.2 Reporting. 543
 - 14.6 CDA Test Tools 543
 - 14.6.1 ART-DECOR 543
 - 14.6.2 Lantana Trifolia 544
 - 14.6.3 NIST CDA Testing 545
 - 14.6.4 eHealth Suisse 547
 - 14.6.5 IHE Gazelle Object Checker 548
 - 14.7 IHE Conformance and Interoperability Test Tools 548

- 14.8 e-Prescribing (e-Rx) Tools 550
 - 14.8.1 NIST e-Prescribing Test Tool 551
- 14.9 DVTK—DICOM Validation Toolkit 552
 - 14.9.1 History. 552
 - 14.9.2 Functionality 552
- 14.10 Related Tools 554
 - 14.10.1 HAPI. 554
 - 14.10.2 MDHT. 555
 - 14.10.3 IPF (by Open eHealth Foundation) 556
 - 14.10.4 eHealth Connector (by eHealth Suisse) 556
- 14.11 Table of Tools and Access Points. 557
- 14.12 Summary 557
- References. 557
- 15 Testing and Certification Programs 559**
 - 15.1 Introduction 559
 - 15.2 Certification Perspectives 560
 - 15.3 IHE Testing Programs. 562
 - 15.3.1 IHE Technical Framework Overview. 562
 - 15.3.2 IHE Testing Process 562
 - 15.3.3 IHE Product Registry. 566
 - 15.3.4 Gazelle 567
 - 15.4 EHR Certification and Meaningful Use Programs. 568
 - 15.4.1 Patient Safety and Federal EHR
Technology Programs 568
 - 15.4.2 The Federal HIT Certification Program 569
 - 15.4.3 The Role of NIST 574
 - 15.4.4 Reaction in the Market to the Federal
EHR Programs. 577
 - 15.4.5 The Interoperability Factor 582
 - 15.4.6 Summary and Conclusions 583
 - 15.5 Other Programs. 584
 - 15.5.1 Surescripts. 584
 - 15.5.2 Certification in Australia 584
 - 15.5.3 Certification in Germany 585
 - 15.6 Scope of Certification Testing. 586
 - 15.7 Summary 588
 - References. 588
- Appendix A: Additional Healthcare Data Exchange Standards. 591**
- Appendix B: Trademark Information 649**
- Index 651**

About the Authors



Frank Oemig, Ph.D., FHL7 has studied computer science and theoretical medicine at the Universities in Dortmund and Bochum (both located in Germany) in the mid-eighties. Although he concentrated on artificial intelligence (AI) he also worked for a software company developing programs for radiology departments, diagnosis coding and other healthcare related problems. Having said that, Mr. Oemig has been active in the healthcare domain for more than 30 years.

Immediately after finalizing his diploma thesis and leaving his first employment in a research department he started concentrating on ICT—information communication technology—in healthcare. One of his first topics was enabling a subsystem to receive patient related data. During that time (1993) he started a more intensive work with HL7 v2.1 in Germany. When joining the internal HL7 community in 1998 he became one of the first international co-chairs for the Personnel Management Work Group which he led together with Bernd Blobel till 2003. Since 2005 Frank is one of the co-chairs to the Conformance and Guidance for Implementation and Testing Work Group (CGIT, formerly known as Conformance WG).

Frank is also co-founder of IHE in Germany, initiator of HL7 Switzerland, HL7 Austria, HL7 Luxembourg and HL7 Bosnia & Herzegovina.

For more than 9 years Frank has worked for Agfa Healthcare GmbH, Bonn, Germany, a vendor company being the HIS leader in Germany. Now he is employed by Deutsche Telekom Healthcare and Security Solutions GmbH, a subsidiary of T-System International.

Using all that knowledge, Frank could intensify his engagement with HL7 by writing a Ph.D. thesis about knowledge representation in healthcare using formal ontologies. The most important result was the development of a communication standards ontology (CSO) formally allowing to bridge different communication standards like HL7 v2.x and Version 3.

Mr. Oemig has published approximately 180 of his works, including articles in journals, papers for conferences, and chapters for technical books.



Robert Snelick, M.Sc. has a B.S. (Computer Science) from Clarion University of Pennsylvania (1986) and a M.S. (Computer Science) from the Johns Hopkins University (1991). Mr. Snelick has been employed at the National Institute of Standards and Technology (NIST) since 1986. He began working in the healthcare technology domain in 2004. Mr. Snelick is currently the project lead and chief architect for the NIST HL7 v2 Testing Framework and Tools, the Implementation Guide Authoring and Management Tool (IGAMT), and the Test Case Authoring and Management Tool (TCAMT).

Mr. Snelick is active in standards development organizations such as HL7, IHE, and ONC S&I Framework. He has served as a co-chair for HL7 Conformance working group for the past eight years, is a member of the IHE Testing and Tooling Committee, and is the S&I Framework Validation Suite Chair for the Laboratory domain. His technical focus is on improving the specification of conformance requirements and the testing of implementations for conformance and interoperability. Mr. Snelick's proposals have led to numerous improvements to the HL7 v2 conformance model and to the increased efficiency and rigor in conformance and interoperability testing.

Mr. Snelick has lead the development of the test procedures and test tools to support the ONC 2012, 2014, and 2015 Edition Health IT Certification measures that included HL7 v2 standards. He has also led tool development efforts to support testing activities at the CDC, IHE, AIRA, HL7, HITSP, and CCHIT.

Prior to working in the healthcare information technology domain, Mr. Snelick conducted research and development in performance evaluation of parallel and supercomputing, cluster computing, interactive digital television, biometrics, and multi-model biometrics methods and testing.

Mr. Snelick has published over 30 of his works, including articles in journals, papers for conferences, and chapters for technical books.

Acronyms

| | |
|---------|--|
| ACB | Authorized Certification Body |
| ACK | Acknowledgement |
| ACR | American College of Radiology |
| ACRNEMA | American College of Radiology—National Electrical Manufacturers Association predecessor of the DICOM standard defined by ACR and NEMA |
| ADT | Abrechnungsdatentransfer (xDT)—aka financial transaction ⇒ QMS |
| ADT | Admission, Discharge and Transfer ⇒ HL7 |
| AHIC | American Health Information Community |
| AHML | Australian Healthcare Messaging Laboratory, University of Ballarat, Australia, www.ahml.com.au |
| AMS | Abstract Message Syntax ⇒ HL7 v2.x |
| ANSI | American National Standards Institute |
| API | Application Programming Interface |
| ART | Advanced Requirement tooling ⇒ ART-DECOR |
| ASC | Accredited Standards Committee |
| ASCII | American Standard Code for Information Interchange |
| ASIP | Agence des systèmes d'information partagés de santé ⇒ ASIP Santé |
| ASTM | American Society for Testing and Materials |
| ATL | Accredited Testing Laboratory |
| ATL | Archetype Type Library |
| B2B | Business to Business |
| BDT | Behandlungsdatentransfer (xDT)—aka administrative data transfer ⇒ QMS |
| BNF | Backus Naur Form |
| BOM | Byte Order Mark |
| BPEL | Business Process Execution Language |

| | |
|---------|--|
| CCOW | Clinical Context Object Working Group ⇒ HL7 |
| CDA | Clinical Document Architecture ⇒ HL7 |
| CDC | Center for Disease Control and Prevention |
| CEHRT | Certified EHR Technology |
| CEN | Comité Européen de Normalisation, http://www.cen.org |
| CGIT | Conformance and Guidance for Implementation/Testing, an HL7 Work group, www.hl7.org |
| CHI | Canada Health Infoway |
| ClAML | Classification Markup Language ⇒ ISO |
| CLIA | Clinical Laboratory Improvement Amendments |
| CMET | Common Message Element Types ⇒ HL7 V3 |
| CMS | Centers for Medicare and Medicaid Services |
| CORBA | Common Object Request Broker Architecture |
| CT | Computer Tomography |
| CTS | Common Terminology Services ⇒ HL7, OMG |
| CTS2 | Common Terminology Services, Release 2 ⇒ HL7, OMG |
| D2D | Doctor-to-Doctor Communication |
| DECOR | Data Elements, Codes, OIDs and Rules ⇒ ART-DECOR |
| DICOM | Digital Imaging and COmmunication in Medicine, www.rsna.org |
| DIMSE | DICOM Message Service Element |
| DIN | Deutsches Institut für Normung, German branch of CEN |
| DITA | Darwin Information Typing Architecture ⇒ OASIS |
| D-MIM | Domain Message Information Model ⇒ HL7 V3 |
| DMP | Dossier Médical Personnel ⇒ ASIP Santé |
| DQA | Data Quality Assurance |
| DRG | Diagnosis Related Group |
| DSTU | Draft Standard for Trial Use ⇒ HL7, IHE, now replaced by STU |
| EBCDIC | Extended Binary Coded Decimal Interchange Code |
| ebRIM | Electronic business Registry Information Model ⇒ OASIS |
| ebXML | Electronic business XML ⇒ OASIS |
| ECCF | Enterprise Compliance and Conformance Framework ⇒ HL7, SAIF |
| EDI | Electronic Data Interchange |
| EDIFACT | Electronic Data Interchange For Administration, Commerce and Transport |
| EHR | Electronic Health Record |
| EHR-S | Electronic Health Record System |
| ELR | Electronic Laboratory Reports |
| ER7 | Encoding Rules 7, the standard encoding format for HL7 v2 messaging ⇒ HL7 |
| ESB | Enterprise Service Bus |
| EU | European Union |
| EUP | EHR Usability Protocol, www.nist.gov |

| | |
|-------------|---|
| FHIR | Fast Healthcare Interoperability Resources ⇒ HL7 |
| GCM | Generic Component Model |
| GDT | Gerätedatentransfer (xDT), aka of device data transfer ⇒ KBV |
| GELLO | An OCL-Like Common Expression Language ⇒ HL7 |
| Gematik | “Gesellschaft für Telematik im Gesundheitswesen”, http://www.gematik.de |
| GLIF | Guideline Interchange Format ⇒ HL7 |
| GMSIH | Groupement pour la Modernisation du Système s’Information Hospitalier |
| GP | General Practitioner |
| H.PR.I.M. | Harmonie et Promotion de l’Information Médicale |
| HAPI | HL7 API, a Java-based toolkit |
| HDF | HL7 Development Framework ⇒ HL7 |
| HIMSS | Healthcare Information and Management Systems Society |
| HIS | Hospital Information System |
| HISSP | Health Information System Strategic Plan |
| HIT | Health(care) Information Technology |
| HITSP | Health(care) Information Technology Standards Panel |
| HL7 | Health Level Seven, Inc., www.hl7.org |
| HL7v2.6 | HL7 Version 2.6 ⇒ HL7 |
| HL7v2.7 | HL7 Version 2.7 ⇒ HL7 |
| HL7V3NE2008 | HL7 Version 3 Normative Edition 2008 ⇒ HL7 |
| HLLP | Hybrid Lower Layer Protocol |
| HPC | Health Professional Card |
| HTML | Hyper Text Markup Language |
| IATM | International Association for Testing and Materials |
| ICT | Information and Communication Technology |
| IE | Information Entity ⇒ DICOM |
| IEEE | Institute of Electrical and Electronics Engineers |
| IG | Implementation Guide |
| IHE | Integrating the Healthcare Enterprise, www.ihe.net |
| IHTSDO | International Health Terminology Standards Development Organization, www.ihtsdo.org |
| IOM | Institute of Medicine’s |
| IP | Internet Protocol |
| ISO | International Standardisation Organisation, http://www.iso.org |
| IT | Information Technology |
| ITB | Interoperability Test Bed |
| ITI | IT-Infrastructure: IHE Domain, ⇒ IHE, www.ihe.net |
| ITS | Implementation Technology Specification ⇒ HL7 V3 |
| JSON | Java Script Object Notation |
| KADT | Kurärztliche Abrechnungsdaten (xDT) |
| KBV | “Kassenärztliche Bundesvereinigung”, a German institution being responsible for handling the reimbursement of general practitioners, www.kbv.de |

| | |
|--------|---|
| KdÖR | www.kbv.de/html/ita.php |
| KH-IT | Bundesverband der Krankenhaus-IT-Leiterinnen/Leiter e.V., professional association of head of IT departments in hospitals, www.kh-it.de |
| KV | “Kassenärztliche Vereinigung”, diverse branches of the KBV in the different German federal states |
| LDT | Labordatentransfer (xDT)—aka laboratory data transfer ⇒ KBV |
| LIS | Laboratory Information System |
| LOI | Laboratory Order Interface, www.healthit.gov |
| LOINC | Logical Observation Identifier Names and Codes, www.loinc.org , www.regenstrief.org |
| LRI | Laboratory Results Interface, www.healthit.gov |
| LTPAC | Long Term and Past Acute Care |
| MDF | Message Development Framework, 1999 ⇒ HL7 |
| MDHT | Model Driven Health Tool ⇒ HL7 V3 |
| MIF | Model Interchange Format ⇒ HL7 V3 |
| MLLP | Minimal Lower Layer Protocol ⇒ HL7 v2 |
| MR | Magnetic Resonance |
| MSH | Message Header ⇒ HL7 v2 |
| MU | Meaningful Use ⇒ CMS |
| NATA | National Association of Testing Authorities |
| NCPDP | National Council for Prescription Drug Programs |
| NEMA | National Electrical Manufacturing Association, a US trade organization |
| NHS | National Health Service (UK) |
| NICTIZ | Nationaal ICT Instituut in der Zorg, www.nictiz.nl |
| NIST | National Institute of Standards and Technology, www.nist.gov |
| OASIS | Organization for the Advancement of Structured Information Standards, www.oasis-open.org |
| OCL | Object Constraint Language |
| OHT | Open Health Tools |
| OMG | Object Management Group, www.omg.org |
| ONC | Office of the National Coordinator |
| OSI | Open Systems Interconnection |
| PACS | Picture Archiving and Communication System |
| PAM | Patient Administration Management ⇒ IHE IT-Infrastructure |
| PCC | Patient Care Coordination: Domain ⇒ IHE |
| PCD | Patient Care Devices: Domain ⇒ IHE |
| PDF | Portable Document Format, http://www.pdfassociation.org |
| PDF/A | PDF Archive |
| PDO | Profile Development Organization |
| PDQ | Patient Demographics Query ⇒ IHE IT-Infrastructure |
| PET | Positron Emission Tomography |

| | |
|------------|--|
| PHAST | Association Réseau Phast, L'Information de santé Standardisée, http://www.phast.fr |
| PIF | Patient Identity Feed ⇒ IHE ITI XDS |
| PIX | Patient Information Cross Referencing ⇒ IHE IT-Infrastructure |
| QMS | Qualitätsring Medizinische Software, www.qms-standards.de |
| QRPH | Quality, Research and Public Health ⇒ IHE |
| REST | Representational State Transfer |
| RIM | Reference Information Model |
| RM-ODP | Reference Model for Open Distributed Processing |
| RSNA | Radiological Society of North America, www.rsna.org |
| RTF | Rich Text Format |
| RTM | Rosetta Terminology Mapping ⇒ IHE PCD |
| SAEAF | Services Aware Enterprise Architecture Framework (old term ⇒ SAIF) |
| SAIF | Services Aware Interoperability Framework (new term ⇐ SAEAF) |
| SAML | Security Assertion Markup Language ⇒ OASIS |
| SCIPHOX | Standardized Communication in Physician Offices and Hospitals using XML, www.sciphox.de , relinked to www.hl7.de |
| SCP | Service Class Provider ⇒ DICOM |
| SCU | Service Class User ⇒ DICOM |
| SDA | Structured Document Architecture ⇒ HL7 |
| SDO | Standards Developing Organisation |
| SFM | Service functional model |
| SGML | Standard Generalized Markup Language ⇒ OASIS |
| Snomed CT | Snomed Clinical Terms ⇒ IHTSDO |
| SNOMED | Systemized Nomenclature in MEDicine ⇒ IHTSDO |
| SOAP | Service oriented access protocol |
| SOP | Service Object Pair ⇒ DICOM |
| SPL | Structured Product Labeling |
| STU | Standard for Trial Use ⇒ HL7 |
| SUT | System under test |
| SWF | Scheduled Workflow ⇒ IHE Radiology |
| TCP/IP | Transmission Control Program/Internet Protocol |
| TeveGe | “Telematikgesellschaft für ein vernetztes Gesundheitswesen”, www.tevege.de |
| UCS | Universal Multiple-Octet Coded Character Set |
| UCUM | Unified Code for Units of Measure |
| UDDI | Universal Description, Discovery and Integration ⇒ OASIS |
| UDP/IP | User Datagram Protocol/Internet Protocol |
| UID | Unique Identifier |
| UML | Unified Modeling Language, www.omg.org |
| UN/EDIFACT | United Nations Electronic Data Interchange for Administration, Commerce and Transport |