

## THE FORMAL SPECIFICATION FOR THE INVENTORY SYSTEM USING Z LANGUAGE

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**ABSTRACT:** Formal methods use mathematical notations to precisely express requirements specification. The formal specification removes ambiguity which is inherently present in natural language specification. Formal specification also addresses the software reliability. In this paper, we present the formal specification for the inventory system by using Z language. Based from the scenario of the inventory system, we present the Unified Modeling Language (UML) specification by means of use case diagram and class diagram. We then present the Z schema based from the UML specification. We also show the consistency between UML specification and Z schema for this inventory system. The Z schema can effectively improve system reliability and reduce defect in developing the system.

**Keywords:** formal method, formal specification, Z language, inventory system, UML diagram

### INTRODUCTION

Z is a formal specification language, which is a set of conventions for presenting mathematical text, used for describing and modeling computing systems (Spivey, 1992). Z language is one of the widely used formal specification languages since people are already familiar with its syntax and semantics (Jonathan, 1996).

This paper defines requirements to establish a formal model of checking the inventory system, to deliver the item and invoice to the customer project. The project named as Stock System and Z language is used to describe the notation of every function from the UML class diagram. The rest of the paper is organized as follows. Section 2 presents the related work and Section 3 demonstrates the case study of inventory system. Section 4 proposed the Z schema based from the UML class diagram and finally Section 5 concludes the paper.

### RELATED WORK

Yusufu and Yusufu (Yusufu and Yusufu, 2012) discussed and compared the properties of five formal specification methods (Z language, B method, UML, LOTOS, SDL) by designing a particular part of the ABM system for each method. They also discussed the two formal specification methods, SDL and LOTOS, by emphasizing some similarities among them and address their differences based on a particular part of the ABM system, and further compare these methods by analysing their strengths and weaknesses.

Latif et al. (Latif et al., 2007) used Z specification language to specify multimedia content in safety critical systems. The extensions in Z specification language are suggested to add

# Formal Specification Using Z

**Allen Tucker, Teofilo Gonzalez, Heikki  
Topi, Jorge Diaz-Herrera**



## Formal Specification Using Z:

**Formal Specification Using Z** David Lightfoot, 2001 Formal Specification Using Z is an introductory book intended for the many software engineers and students who will benefit from learning about this important topic in software engineering

**Formal Specification and Documentation Using Z** Jonathan Peter Bowen, 1996 *Formal Specification Using Z* Leon Bottaci, Leonardo Bottaci, John Jones, 1995 This text is about the use of mathematically based techniques for specifying software systems and is designed for computer science or software engineering students studying an introductory course in formal specification The text focuses on the Z notation The level of maths required to profit from this text is not very high the emphasis is on the applications rather than the math itself **Z** Antoni Diller, 1990-07-19 This text is about the formal specification language Z suitable for courses on Z and formal methods at first and second year undergraduate level The book includes a tutorial introduction covering the basic mathematics of Z and provides four specification case studies ZUM '95: The Z Formal Specification Notation Jonathan P. Bowen, 1995-08-23 This book presents the proceedings of the 9th International Conference of Z Users ZUM 95 held in Limerick Ireland in September 1995 The book contains 34 carefully selected papers on Z using Z applications of Z proof testing industrial usage object orientation animation of specification method integration and teaching formal methods Of particular interest is the inclusion of an annotated Z bibliography listing 544 entries While focussing on Z by far the most commonly used formal method both in industry and application the volume is of high relevance for the whole formal methods community *Introducing Specification Using Z* Bryan Ratcliff, 1994 Offering an introduction to formal specification using the Z notation this practical text makes use of a series of case studies of varying complexity to illustrate the construction of good specifications in Z These case studies serve to describe the most frequently used features of Z the relevant discrete mathematics and the various techniques used The text also includes an introduction to specification validation theorem proving and refinement The importance of formal methods within software engineering is stressed throughout and there are a large number of exercises with solutions ZUM '98: The Z Formal Specification Notation Jonathan P. Bowen, Andreas Fett, Michael G. Hinchey, 1998-09-16 1 In a number of recent presentations most notably at FME 96 one of the foremost scientists in the field of formal methods C A R Hoare has highlighted the fact that formal methods are not the only technique for producing reliable software This seems to have caused some controversy not least amongst formal methods practitioners How can one of the founding fathers of formal methods seemingly denounce the field of research after over a quarter of a century of support This is a question that has been posed recently by some formal methods skeptics However Prof Hoare has not abandoned formal methods He is reiterating 2 albeit more radically his 1987 view that more than one tool and notation will be required in the practical industrial development of large scale complex computer systems and not all of these tools and notations will be or even need be formal in nature Formal methods are not a solution but rather one of a selection of techniques that have proven to be useful in the development of

reliable complex systems and to result in hardware and software systems that can be produced on time and within a budget while satisfying the stated requirements After almost three decades the time has come to view formal methods in the context of overall industrial scale system development and their relationship to other techniques and methods

We should no longer consider the issue of whether we are pro formal or anti formal but rather the degree of formality if any that we need to support in system development This is a goal of ZUM 98 the 11th International Conference of Z Users held for the first time within continental Europe in the city of Berlin Germany

**Formal Specification Using Z** David Lightfoot, 1991  
Covers the main areas of formal specification in Z at an introductory level The explanations of the mathematics of Z are interleaved with the development of an example specification Exercises are included throughout and sample solutions are provided

**ZUM'97: The Z Formal Specification Notation** Jonathan P. Bowen, Michael G. Hinchey, David Till, 1997-03-20  
This book constitutes the refereed proceedings of the 10th International Conference of Z Users ZUM 97 held in Reading UK in April 1997 The volume presents 18 revised full papers together with three invited presentations by internationally leading experts The papers are organized into topical sections on real time systems tools logic system development reactive systems refinement and applications Also a select Z bibliography by Jonathan Bowen is added All in all the book competently reports the state of the art in research and advanced applications of the Z notation

An Introduction to Formal Specification and Z Ben Potter, Jane Sinclair, David Till, 1996 Following the success of the first edition the authors have updated and revised this bestselling textbook to take into account the changes in the subject over the past 5 years

**An Introduction to Formal Specification with Z and VDM** Deri Sheppard, 1995 Formal methods emphasize the correct and efficient development of software This text puts formal specification in the context of traditional methods of software development including object orientation introducing these concepts and the necessary discrete maths before moving on to look at both Z and VDM in depth using the case study of a drinks dispensing machine

ZUM ... the Z Formal Specification Notation, 1995

*ZB 2005: Formal Specification and Development in Z and B* Helen Treharne, Steve King, Martin Henson, Steve Schneider, 2005-04-07 This book constitutes the refereed proceedings of the 4th International Conference of Z and B users ZB 2005 held in Guildford UK in April 2005 The 25 revised full papers presented together with extended abstracts of 2 invited papers were carefully reviewed and selected for inclusion in the book The papers document the recent advances for the Z formal specification notation and for the B method ranging from foundational theoretical and methodological issues to advanced applications tools and case studies

Coordination Models and Languages Amy L. Murphy, Jan Vitek, 2007-06-26  
This book constitutes the refereed proceedings of the 9th International Conference on Coordination Models and Languages COORDINATION 2007 held in Paphos Cyprus June 2007 as one of the federated conferences on Distributed Computing Techniques It examines how to increase modularity simplify reasoning and ultimately enhance today's software development by exploring the spectrum of languages middleware services and algorithms

*The Object-Z Specification Language*

Graeme Smith,2012-12-06 Object Z is an object oriented extension of the formal specification language Z It adds to Z notions of classes and objects and inheritance and polymorphism By extending Z s semantic basis it enables the specification of systems as collections of independent objects in which self and mutual referencing are possible The Object Z Specification Language presents a comprehensive description of Object Z including discussions of semantic issues definitions of all language constructs type rules and other rules of usage specification guidelines and a full concrete syntax It will enable you to confidently construct Object Z specifications and is intended as a reference manual to keep by your side as you use and learn to use Object Z The Object Z Specification Language is suitable as a textbook or as a secondary text for a graduate level course and as a reference for researchers and practitioners in industry      **Computing Handbook** Allen Tucker,Teofilo Gonzalez,Heikki Topi,Jorge Diaz-Herrera,2022-05-29 This two volume set of the Computing Handbook Third Edition previously theComputer Science Handbook provides up to date information on a wide range of topics in computer science information systems IS information technology IT and software engineering The third edition of this popular handbook addresses not only the dramatic growth of computing as a discipline but also the relatively new delineation of computing as a family of separate disciplines as described by the Association for Computing Machinery ACM the IEEE Computer Society IEEE CS and the Association for Information Systems AIS Both volumes in the set describe what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today s world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century Chapters are organized with minimal interdependence so that they can be read in any order and each volume contains a table of contents and subject index offering easy access to specific topics The first volume of this popular handbook mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers it examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals The second volume of this popular handbook demonstrates the richness and breadth of the IS and IT disciplines The book explores their close links to the practice of using managing and developing IT based solutions to advance the goals of modern organizational environments Established leading experts and influential young researchers present introductions to the current status and future directions of research and give in depth perspectives on the contributions of academic research to the practice of IS and IT development use and management      **Computing Handbook, Third Edition** Teofilo Gonzalez,Jorge Diaz-Herrera,Allen Tucker,2014-05-07 Computing Handbook Third Edition Computer Science and Software

Engineering mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers the first volume of this popular handbook examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals Like the second volume this first volume describes what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today s world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century

**High-Integrity Software** C.T. Sennett,2012-12-06 4 3 The Gypsy language 72 4 4 The Gypsy Verification Environment 73 4 5 A simple example 81 4 6 Specification data types 91 4 7 Future directions 95 100 4 8 Conclusions 5 Reliable programming in standard languages 102 Bernard Carre Program Validation Ltd 5 1 Introduction 102 5 2 Language requirements for high integrity programming 103 5 3 The use of standard languages 108 5 4 Programming in Pascal and Ada 110 1 19 5 5 Practical experiences NewSpeak a reliable programming language 6 122 I F Currie Royal Signals and Radar Establishment 6 1 Introduction 122 6 2 Types and values 127 6 3 Declarations and variables 132 6 4 Guarded declarations 134 6 5 Cases and conditionals 136 6 6 Loops 138 6 7 Procedures 140 6 8 Assertions 145 6 9 Timing 147 6 10 Conclusion 149 6 11 Appendix 1 summary of syntax 150 6 12 Appendix 2 type lattice and widening 156 7 Program analysis and systematic testing 159 M A Hennell University of Liverpool and D Hedley and I J Riddell Liverpool Data Research Associates Ltd 7 1 Introduction 159 7 2 The basic requirement 160 7 3 The Liverpool experience 161 7 4 The Liverpool experiments 162 7 5 The LDRA Testbeds 163 Interpretation 169 7 6 7 7 Applicability and benefits 171 7 8 Safety critical systems 173 VI 8 Program analysis and verification 176 Bernard Carre Program Validation Ltd 8 1 Introduction 176 8 Formal Aspects in Security and Trust Theo Dimitrakos,Fabio Martinelli,2005-10-04 Second International Workshop on Formal Aspects in Security and Trust is an essential reference for both academic and professional researchers in the field of security and trust Because of the complexity and scale of deployment of emerging ICT systems based on web service and grid computing concepts we also need to develop new scalable and more flexible foundational models of pervasive security enforcement across organizational borders and in situations where there is high uncertainty about the identity and trustworthiness of the participating networked entites On the other hand the increasingly complex set of building activities sharing different resources but managed with different policies calls for new and business enabling models of trust between members of virtual organizations and communities that span the boundaries of physical enterprises and loosely structured groups of individuals The papers presented in this volume address the challenges posed by ambient intelligence space as a future paradigm and

the need for a set of concepts tools and methodologies to enable the user's trust and confidence in the underlying computing infrastructure This state of the art volume presents selected papers from the 2nd International Workshop on Formal Aspects in Security and Trust held in conjunction with the 18th IFIP World Computer Congress August 2004 in Toulouse France The collection will be important not only for computer security experts and researchers but also for teachers and administrators interested in security methodologies and research

**Z User Workshop, Cambridge 1994** J.P. Bowen, J.A. Hall, 2012-12-06

This volume contains papers from the Eighth Z User Meeting to be held at the University of Cambridge from 29-30 June 1994 The papers cover a wide range of issues associated with Z and formal methods with particular reference to practical application These issues include education standards tool support and interaction with other design paradigms such as consideration of real time and object oriented approaches to development Among the actual topics covered are the formal specification in Z of Defence Standard 00 56 formal specification of telephone features specifying and interpreting class hierarchies in Z and software quality assurance using the SAZ method Z User Workshop Cambridge 1994 provides an important overview of current research into industrial applications of Z and will provide invaluable reading for researchers postgraduate students and also potential industrial users of Z

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