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Jarosław Sugier · Tomasz Walkowiak
Janusz Kacprzyk *Editors*

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Preface

We are pleased to present the proceedings of the Ninth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX, which took place in a beautiful Brunów Palace, Poland, from 30th June to 4th July, 2014.

Started in 2006, DepCoS – RELCOMEX is a conference organized annually by the Institute of Computer Engineering, Control and Robotics (CECR) from Wrocław University of Technology. Its roots go nearly 40 years back to the heritage of the other two cycles of events: RELCOMEX (1977 – 89) and Microcomputer Schools (1985 – 95) which were organized by the Institute of Engineering Cybernetics (the previous name of CECR) under the leadership of prof. Wojciech Zamojski, now also the DepCoS chairman. In this volume of “Advances in Intelligent and Soft Computing” we would like to present results of research on selected problems of complex systems and their dependability. Effects of the previous DepCoS events were published in volumes 97, 170 and 224 of this series.

Today’s complex systems are integrated unities of technical, information, organization, software and human (users, administrators and management) resources. Complexity of such systems comes not only from their involved technical and organizational structures built on hardware and software resources but mainly from complexity of information processes (processing, monitoring, management, etc.) realized in their specific environment. In operation of such wide-ranging and diverse systems their resources are dynamically allocated to ongoing tasks and the rhythm of system events (incoming and/or ongoing tasks, decisions of a management subsystem, system faults, “defense” system reactions, etc.) may be considered as deterministic or/and probabilistic event stream. Security and confidentiality of information processing introduce further complications into the modelling and evaluation methods. Diversity of the processes being realized, their concurrency and their reliance on in-system intelligence often significantly impedes construction of strict mathematical models and calls for application of intelligent and soft computing methods.

Dependability is the modern approach to reliability problems of contemporary complex systems. It is worth to underline the difference between the two terms: system dependability and system reliability. Dependability of systems, especially

computer systems and networks, is based on multi-disciplinary approach to theory, technology, and maintenance of the systems working in a real (and very often unfriendly) environment. Dependability concentrates on efficient realization of tasks, services and jobs by a system considered as a unity of technical, information and human assets, while “classical” reliability is more restrained to analysis of technical system resources (components and structures built from them).

Presenting our conference proceedings to the broader audience we would like to express the sincerest thanks to all the authors who have chosen to describe their research here. It is our hope that the communicated results will help in further developments in complex systems design and analysis aimed at improving their dependability. We believe that the selected contributions will be interesting to all scientists, researchers, practitioners and students who work in these fields of science.

Concluding this brief introduction we must emphasize the role of all reviewers who took part in the evaluation process and whose contribution helped to refine the contents of this volume. Our thanks go to, in alphabetic order, Salem Abdel-Badeeh, Andrzej Białas, Frank Coolen, Manuel Gil Perez, Zbigniew Huzar, Jacek Jarnicki, Vyacheslav Kharchenko, Mieczysław M. Kokar, Alexey Lastovetsky, Marek Litwin, Jan Magott, István Majzik, Jacek Mazurkiewicz, Katarzyna M. Nowak, Yiannis Papadopoulos, Oksana Pomorova, Krzysztof Sacha, Ruslan Smeliansky, Janusz Sosnowski, Jarosław Sugier, Victor Toporkov, Carsten Trinitis, Tomasz Walkowiak, Max Walter, Bernd E. Wolfinger, Marina Yashina, Irina Yatskiv, Wojciech Zamojski, and Włodzimierz Zuberek.

The Editors

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Brunów Palace, Poland, June 30 – July 4, 2014

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Contents

Framework for the Distributed Computing of the Application Components	1
<i>Razvan-Mihai Aciu, Horia Ciocarlie</i>	
Analysis of Statistical Characteristics of User Arrival Process to the Testing Service	13
<i>Artem Adzhemov, Nikolay Albov, Irina Sineva</i>	
The Role of Enterprise Social Networking (ESN) on Business: Five Effective Recommendations for ESN	23
<i>Saeed M. Alqahtani, Sultan Alanazi, Derek McAuley</i>	
Dependability and Safety Analysis of ETCS Communication for ERTMS Level 3 Using Performance Statecharts and Analytic Estimation	37
<i>Tomasz Babczyński, Jan Magott</i>	
Entropy-Based Internet Traffic Anomaly Detection: A Case Study	47
<i>Przemysław Bereziński, Józef Pawelec, Marek Małowidzki, Rafał Piotrowski</i>	
A Formal Approach for Preventive Maintenance Workload Balancing	59
<i>Ammar Bessam</i>	
Computer Support for the Railway Safety Management System – Requirements Analysis	69
<i>Andrzej Białas</i>	
Computer Support for the Railway Safety Management System – First Validation Results	81
<i>Andrzej Białas</i>	

Reductions of Operators in Java Mutation Testing	93
<i>Ilona Bluemke, Karol Kulesza</i>	
An Approach for Planning and Analysis of the Sewage Sanitary Networks Using Some Calculation Formulas and Computer Simulation	103
<i>Lucyna Bogdan, Grażyna Petriczek, Jan Studziński</i>	
Mathematical Model of Task Scheduling in Educational Cloud	115
<i>Agata Brzozowska, Jerzy Greblicki</i>	
Optimization and Control of Transport Processes in the Distributed Systems	123
<i>Alexander Buslaev, Mikhail Volkov</i>	
On Some Resources Placement Schemes in the 4-Dimensional Soft Degradable Hypercube Processors Network	133
<i>Jan Chudzikiewicz, Zbigniew Zieliński</i>	
Efficient Training of Context-Dependent Neural Nets with Conjugate Gradient Algorithms	145
<i>Piotr Ciskowski</i>	
Analysis of Mutation Operators for the Python Language	155
<i>Anna Derezińska, Konrad Hałas</i>	
Deterministic Schedule of Task in Multiprocessor Computer Systems with Higher Degree of Dependability	165
<i>Mieczysław Drabowski, Edward Wantuch</i>	
Using Simulation to Evaluate Dynamic Systems with Weibull or Lognormal Distributions	177
<i>Ernest Edifor, Neil Gordon, Martin Walker, Yiannis Papadopoulos</i>	
FSM Simulation of Cryptographic Protocols Using Algebraic Processor	189
<i>Alexander Frolov, Alexander Vinnikov</i>	
Disturbance Injection in Dependability Assessment of Android Applications	199
<i>Piotr Gawkowski, Maciej Sulek</i>	
Approximate Algorithm for Fast Capacity Provisioning in WANs with Trade-Off between Performance and Cost under Budget Constraint	211
<i>Mariusz Gola, Adam Czubak</i>	

Evolution of Software Quality Models in Context of the Standard ISO 25010	223
<i>Oleksandr Gordieiev, Vyacheslav Kharchenko, Nataliia Fominykh, Vladimir Sklyar</i>	
Model Checking of UML Activity Diagrams in Logic Controllers Design	233
<i>Iwona Grobelna, Michał Grobelny, Marian Adamski</i>	
Impact of Selected Java Idioms on Source Code Maintainability – Empirical Study	243
<i>Bogumiła Hnatkowska, Anna Jaszczak</i>	
Quantification of Temporal Fault Trees Based on Fuzzy Set Theory	255
<i>Sohag Kabir, Ernest Edifor, Martin Walker, Neil Gordon</i>	
Analysis of Physical Layer Model of WLAN 802.11g Data Transmission Protocol in Wireless Networks Used by Telematic Systems	265
<i>Zbigniew Kasprzyk, Mariusz Rychlicki</i>	
Web Systems Availability Assessment Considering Attacks on Service Configuration Vulnerabilities	275
<i>Vyacheslav Kharchenko, Alaa Mohammed Abdul-Hadi, Artem Boyarchuk, Yuriy Ponochovny</i>	
A Recommender System Based on Content Clustering Used to Propose Forum Articles	285
<i>Urszula Kuźelewska, Ewa Guziejko</i>	
Simple Measure of Network Reliability Using the Variance of the Degree Distribution	293
<i>Ho Tat Lam, Kwok Yip Szeto</i>	
CDM: A Prototype Implementation of the Data Mining JDM Standard	303
<i>Piotr Lasek</i>	
Confidential Transportation of Data on the Technical State of Facilities	313
<i>Dariusz Laskowski, Piotr Lubkowski</i>	
Test of the Multimedia Services Implementation in Information and Communication Networks	325
<i>Piotr Lubkowski, Dariusz Laskowski</i>	
Unified Approach to Network Systems Multicriterial Analysis ...	333
<i>Jacek Mazurkiewicz</i>	

A Comparison of Forecasting Methods for Ro-Ro Traffic: A Case Study in the Strait of Gibraltar	345
<i>José Antonio Moscoso López, J.J. Ruiz-Aguilar, I. Turias, M. Cerbán, M.J. Jiménez-Come</i>	
Partial Blur: Model, Detection, Deblurring	355
<i>Dmytro Peleshko, Mariya Rashkevych, Andriy Klywvak, Yuriy Ivanov</i>	
Software Support for Common Criteria Security Development Process on the Example of a Data Diode	363
<i>Dariusz Rogowski</i>	
Increasing Performance of SMS Based Information Systems	373
<i>Mariusz Rychlicki, Zbigniew Kasprzyk</i>	
Internet-Based Production Monitoring and Reporting	383
<i>Krzysztof Sacha, Wojciech Pikulski</i>	
Reliability Analysis of a Two-Stage Goel-Okumoto and Yamada S-shaped Model	393
<i>Ioannis G. Sideratos, Agapios N. Platis, Vasilis P. Koutras, Nicholas Ampazis</i>	
Reliability Assessment of Cooperation and Replacement of Surveillance Systems in Air Traffic	403
<i>Miroslaw Siegiejczyk, Karolina Krzykowska, Adam Rosiński</i>	
Swarm Intelligence Metaheuristics Application in the Diagnosis of Transformer Oil	413
<i>Anis Smara, M'hana Boukkit, Ahmed Boubakeur</i>	
Performance Aspect of SaaS Application Based on Tenant-Based Allocation Model in a Public Cloud	423
<i>Wojciech Stolarz, Marek Woda</i>	
Low Cost FPGA Devices in High Speed Implementations of Keccak-f Hash Algorithm	433
<i>Jaroslaw Sugier</i>	
Distributed Time Management in Wireless Sensor Networks	443
<i>Tomasz Surmacz, Bartosz Wojciechowski, Maciej Nikodem, Mariusz Stabicki</i>	
Heuristic Cycle-Based Scheduling with Backfilling for Large-Scale Distributed Environments	455
<i>Victor Toporkov, Anna Toporkova, Alexey Tselishchev, Dmitry Yemelyanov, Petr Potekhin</i>	

Behavior of Web Servers in Stress Tests	467
<i>Tomasz Walkowiak</i>	
The Impact of Reconfiguration Time on the Dependability of Complex Web Based Systems	477
<i>Tomasz Walkowiak, Dariusz Caban</i>	
Propagation Losses in Urban Areas	489
<i>Marian Wnuk, Leszek Nowosielski</i>	
Web Service for Data Extraction from Semi-structured Data Sources	499
<i>Marina V. Yashina, Ivan I. Nakonechnyy</i>	
Investigation of System Reliability Depending on Some System Components States	511
<i>Elena Zaitseva, Vitaly Levashenko, Miroslav Kvassay</i>	
Model Fusion for the Compatibility Verification of Software Components	521
<i>W.M. Zuberek</i>	
Erratum	
CDM: A Prototype Implementation of the Data Mining JDM Standard	E1
<i>Piotr Lasek</i>	
Author Index	531

Web Systems Availability Assessment Considering Attacks on Service Configuration Vulnerabilities

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Abstract. The paper examines the issues of web systems assessment availability. It is defined that unavailability of web services may be caused by internal and external factors in particular server side vulnerability attacks. Three Markov's models of web system availability are developed; these models consider influence of software defects and vulnerability attacks for DNS, DHCP and Route services. Elimination of configuration vulnerabilities during system operation is considered. Conclusions about the impact of the probability of detection and elimination of vulnerabilities and the recovery rate on the web systems availability function are proposed.

Keywords: web system availability, Markov's models, attacks on vulnerability services.

1 Introduction

The successful beginning and operation of web systems is only possible in case of payback on their functioning and positive profit earning. The break-even point is reached after the start of system exploitation, and it might not be achieved at all if risk assessment was wrong. This leads to the importance of modeling the functioning of web systems based on actual cyber security risks [1-3].

Nowadays, most web services experienced the attacks of various kinds. With regard to commercial Web services, they certainly are the most attractive target for attacks [1, 4]. In such circumstances, modeling of web attacks as events that lead to their inaccessibility is in high demand. However, today the majority of the models of attacks, threats and incidents have probabilistic nature of risk assessment. Only some sources refer to the possibility of web system modeling using semi-Markov processes and Petri nets [5].

The modern web system is a complex multileveled and distributed system. It can be presented by the charts with various hierarchy levels. This paper discusses the three-component reliability block diagram of the web system (RBD). It describes the interaction of basic services: IP-address assignment (DHCP), IP routing (Route) and support the direct and inverse transformation of text URLs to IP-addresses (DNS).

This decision is due to the fact that vulnerability subsets of mentioned services might be distinguished in line with CVE classifiers [6,7]. This allows getting estimates of the intensity of attacks and their criticality [8].

Unavailability of any of these services entails the refusal in customer service. On this basis, the RBD will include three consecutive elements, each of which corresponds the up-states of three services (fig.1).



Fig. 1. Reliability block diagram of web system

While assessing web systems availability the focus is given on Markov's models based on hardware and software failures (caused by physical and design faults correspondingly) and recoveries [9, 10]. Researches [11, 12] analyze the concept of an integrated approach of dependability as a property which combine in particular reliability, availability and information security. In [13] the possibility of the development of mathematical models that consider the unavailability of web systems in context security is proposed. Unavailability is caused by not only by software faults, but by attacks on their components as well.

The objective of this paper is to develop Markov models of web systems availability considering attacks, and to investigate the impact of input parameters of the model to the availability function. First of all, we research behavior of web systems in non-stationary modes taking into account various kinds of attacks and recovery procedures. The paper is structured as follows: the second section describes the simple Markov models of web-services without attacks (MA1) and with mechanism for restart after attack (MA2). The third section describes the MA3 model used for assessment of web-service availability considering consequent fixing of vulnerabilities after attacks. Verification results and case study of developed models are presented in the fourth and fifth sections. The last section includes the conclusions and directions of future work.

2 Availability Models of Web Systems without Attacks and with System Restart after Attack

2.1 Model MA1

We consider an ideal web system model without attacks as a basic model in which there are processes of software failures and recoveries of related network services (MA1). Resulting characteristics of such model often are used by hosting providers as the availability and uptime rate of hosting platforms.

Marked graph of states and transitions of such model is shown at the fig.2,a. It includes initial up-state S_0 and down-states S_1 , S_2 and S_3 . The transitions into down-states are marked with the corresponding failure rates (λ_{dns} , λ_{dhcp} and λ_{route}). System returns into up-state after service recovery with corresponding rates μ_{dns} , μ_{dhcp} and μ_{route} .

Author Index

- Abdul-Hadi, Alaa Mohammed 275
Aciu, Razvan-Mihai 1
Adamski, Marian 233
Adzhemov, Artem 13
Alanazi, Sultan 23
Albov, Nikolay 13
Alqahtani, Saeed M. 23
Ampazis, Nicholas 393
- Babczyński, Tomasz 37
Bereziński, Przemysław 47
Bessam, Ammar 59
Bialas, Andrzej 69, 81
Bluemke, Ilona 93
Bogdan, Lucyna 103
Boubakeur, Ahmed 413
Bouktit, M'hana 413
Boyarchuk, Artem 275
Brzozowska, Agata 115
Buslaev, Alexander 123
- Caban, Dariusz 477
Cerbán, M. 345
Chudzikiewicz, Jan 133
Ciocarlie, Horia 1
Ciskowski, Piotr 145
Czubak, Adam 211
- Derezińska, Anna 155
Drabowski, Mieczysław 165
- Edifor, Ernest 177, 255
- Fominykh, Nataliia 223
Frolov, Alexander 189
- Gawkowski, Piotr 199
Gola, Mariusz 211
Gordieiev, Oleksandr 223
Gordon, Neil 177, 255
Greblicki, Jerzy 115
Grobelna, Iwona 233
Grobelny, Michał 233
Guziejko, Ewa 285
- Hałas, Konrad 155
Hnatkowska, Bogumiła 243
- Ivanov, Yuriy 355
- Jaszczak, Anna 243
Jiménez-Come, M.J. 345
- Kabir, Sohag 255
Kasprzyk, Zbigniew 265, 373
Kharchenko, Vyacheslav 223, 275
Klyuvak, Andriy 355
Koutras, Vasilis P. 393
Krzykowska, Karolina 403
Kulesza, Karol 93
Kuźelewska, Urszula 285
Kvassay, Miroslav 511
- Lam, Ho Tat 293
Lasek, Piotr 303
Laskowski, Dariusz 313, 325
Levashenko, Vitaly 511
López, José Antonio Moscoto 345
Lubkowski, Piotr 313, 325

- Magott, Jan 37
 Małowidzki, Marek 47
 Mazurkiewicz, Jacek 333
 McAuley, Derek 23

 Nakonechnyy, Ivan I. 499
 Nikodem, Maciej 443
 Nowosielski, Leszek 489

 Papadopoulos, Yiannis 177
 Pawelec, Józef 47
 Peleshko, Dmytro 355
 Petriczek, Grażyna 103
 Pikulski, Wojciech 383
 Piotrowski, Rafał 47
 Platis, Agapios N. 393
 Ponochovny, Yuriy 275
 Potekhin, Petr 455

 Rashkevych, Mariya 355
 Rogowski, Dariusz 363
 Rosiński, Adam 403
 Ruiz-Aguilar, J.J. 345
 Rychlicki, Mariusz 265, 373

 Sacha, Krzysztof 383
 Sideratos, Ioannis G. 393
 Siergiejczyk, Mirosław 403
 Sineva, Irina 13
 Sklyar, Vladimir 223

 Ślabicki, Mariusz 443
 Smara, Anis 413
 Stolarz, Wojciech 423
 Studziński, Jan 103
 Sugier, Jarosław 433
 Sułek, Maciej 199
 Surmacz, Tomasz 443
 Szeto, Kwok Yip 293

 Toporkov, Victor 455
 Toporkova, Anna 455
 Tselishchev, Alexey 455
 Turias, I. 345

 Vinnikov, Alexander 189
 Volkov, Mikhail 123

 Walker, Martin 177, 255
 Walkowiak, Tomasz 467, 477
 Wantuch, Edward 165
 Wnuk, Marian 489
 Woda, Marek 423
 Wojciechowski, Bartosz 443

 Yashina, Marina V. 499
 Yemelyanov, Dmitry 455

 Zaitseva, Elena 511
 Zieliński, Zbigniew 133
 Zuberek, W.M. 521