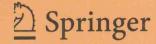
Vladimir Gorodetsky Igor Kotenko Victor A. Skormin (Eds.)

Communications in Computer and Information Science

1

# Computer Network Security

Fourth International Conference on Mathematical Methods, Models, and Architectures for Computer Network Security, MMM-ACNS 2007 St. Petersburg, Russia, September 2007, Proceedings

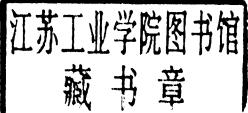


Vladimir Gorodetsky Igor Kotenko Victor A. Skormin (Eds.)

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Fourth International Conference on Mathematical Methods, Models, and Architectures for Computer Network Security, MMM-ACNS 2007 St. Petersburg, Russia. September 13-15, 2007

Proceedings





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## Communications in Computer and Information Science

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## **Preface**

This volume contains papers presented at the Fourth International Workshop on Mathematical Methods, Models and Architectures for Computer Network Security (MMM-ACNS 2007) held in St. Petersburg, Russia, during September 13–15, 2007. The workshop was organized by the St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS) in cooperation with Binghamton University (SUNY, USA).

The organizers are proud that the MMM-ACNS workshops hosted by the St. Petersburg Institute for Informatics and Automation in 2001, 2003 and 2005 evolved into a bi-annual series recognized in the professional community. These events not only demonstrated the keen interest of the participating researchers in the subject matter and the opportunity to present and disseminate individual achievements, but also promoted the spirit of cooperation, camaraderie, free exchange of ideas, and intellectually stimulating interaction between colleagues.

Again, MMM-ACNS 2007 provided an international forum for sharing original research results among specialists in fundamental and applied problems of computer network security. An important distinction of the conference was its focus on mathematical aspects of information and computer network security addressing the ever-increasing demands for secure computing and highly dependable computer networks.

A total of 56 papers from 18 countries related to significant aspects of both theory and applications of computer network and information security were submitted to MMM-ACNS 2007. In total, 18 papers were selected for regular presentations and 12 for short presentations (32 % of acceptance for full papers and 53 % for all papers).

The MMM-ACNS 2007 program was enriched by invited papers presented by six distinguished invited speakers: Christian Collberg (University of Arizona, USA), Angelos D. Keromytis (Columbia University, USA), Paulo Verissimo (University of Lisbon, Portugal), Jean-Daniel Aussel (Gemalto, France), Mauricio Sanchez (ProCurve Networking, HP, USA) and Victor Serdiouk (DialogueScience, Inc., Russia) addressing important theoretical aspects and advanced applications.

The success of the workshop was assured by the team efforts of sponsors, organizers, reviewers and participants. We would like to acknowledge the contributions of the individual Program Committee members and thank the paper reviewers.

Our sincere gratitude goes to the participants of the workshop and all authors of the submitted papers. We are grateful to our sponsors: European Office of Aerospace Research and Development (EOARD) of the U.S. Air Force and the U.S. Office of Naval Research Global (ONRGlobal) for their generous support.

#### VI Preface

We also wish to express our gratitude to the Springer LNCS team managed by Alfred Hofmann for their help and cooperation.

September 2007

Vladimir Gorodetsky Igor Kotenko Victor Skormin

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## **Author Index**

Altaibek, A. 320	Korzhik, Valery 115
Aussel, Jean-Daniel 42	Kotenko, Igor 197, 248
Hassel, wear Damer 12	Kreinovich, Vladik 346
Balcerek, Bartlomiej 334	Krishnamurthy, Arunn 396
Basile, Cataldo 242	Krishnan, Ram 153
Bogdanov, Vitaly 197	Kwiat, Kevin 396
Boudol, Gérard 85	Kwiat, Kevin 550
Burdescu, Dumitru Dan 402	Leversage, David John 213
Byres, Eric James 213	and the same of th
Byres, Elic James 215	Lioy, Antonio 242
Cappadonia, Alberto 242	Longpré, Luc 141, 346
Cassez, Franck 159	VII
Chesnokov, Roman 115	Mihaescu, Cristian Marian 402
Chin, Shiu-Kai 99	Moldovyan, A.A. 147
The state of the s	Moldovyan, N.A. 147
6,	Molisz, Wojciech 362
Crampton, Jason 127	Morales-Luna, Guillermo 115
D Ch 171	Moronski, J. 286
Dong, Changyu 171	Mullins, John 159
Dragan, Piotr 334	
Dulay, Naranker 171	Nagra, Jasvir 1
Eberhardt, Gergely 408	Nagy, Zoltán 408
Eberhardt, Gergely 408	Narayanan, Krishnan 396
Freudenthal, Eric 141, 346	Nowicka, Elżbieta 272
Freudenthai, Effc 141, 540	
Gorodetsky, Vladimir 260	Ochsenschläger, Peter 228
Grebnev, Nick 187	Older, Susan 99
Gritzalis, Stefanos 390	
Grusho, Alexander 187	Rak, Jacek 362
Gutstein, S. 141	Rieke, Roland 228
Gutstein, 5. 141	Roux, Olivier H. 159
Herrera, D. 141	Rowe, Harry 127
Hornák, Zoltán 408	Russello, Giovanni 171
Hornak, Zoltan 408	, , , , , , , , , , , , , , , , , , , ,
Ion, Anca 402	Samoylov, Vladimir 260
1011, 111104 402	Sanchez, Mauricio 57
Jeges, Ernö 408	Sandhu, Ravi 153
veges, Erno	Sastry, Manoj 153
Kalinin, Maxim O. 254	Serdiouk, Victor 75
Kambourakis, Georgios 390	Serebryakov, Sergey 260
Karopoulos, Giorgos 390	Shiryayeva, O. 286
Karsaev, Oleg 260	Sidelnikova, Ekaterina 248
Keromytis, Angelos D. 22	Skormin, V. 286, 320
Kolundžija, Marija 85	Spring, R. 141
Kort, Semyon 340	Stanescu, Liana 402
Nort, Semyon 540	Statiescu, Liana 402

## **Table of Contents**

## **Invited Papers**

Academia Track	
Surreptitious Software: Models from Biology and History	1
Characterizing Software Self-healing Systems	22
Assumptions: The Trojan Horses of Secure Protocols	34
Industry Track	
Smart Cards and Digital Security	42
Virus Throttle as Basis for ProActive Defense	57
Technologies for Protection Against Insider Attacks on Computer Systems	75
Authentication, Authorization and Access Control	
Full Papers	
Access Control and Declassification	85
Reasoning About Delegation and Account Access in Retail Payment Systems	99
Performance Evaluation of Keyless Authentication Based on Noisy Channel	115
Avoiding Key Redistribution in Key Assignment Schemes	127

## Short Papers

Fern: An Updatable Authenticated Dictionary Suitable for Distributed Caching	141
Class of Provably Secure Information Authentication Systems  N.A. Moldovyan and A.A. Moldovyan	147
A New Modeling Paradigm for Dynamic Authorization in Multi-domain Systems	153
Language-Based Security, Trust Management and Covert Channels	
Full Papers	
Synthesis of Non-interferent Distributed Systems	159
Privacy-Preserving Credential Verification for Non-monotonic Trust Management Systems	171
Covert Channel Invisibility Theorem	187
Security Verification and Evaluation	
Full Papers	
Policy-Based Proactive Monitoring of Security Policy Performance Vitaly Bogdanov and Igor Kotenko	197
Comparing Electronic Battlefields: Using Mean Time-To-Compromise as a Comparative Security Metric	213
Abstraction Based Verification of a Parameterised Policy Controlled System	228
Short Papers	
Algebraic Models to Detect and Solve Policy Conflicts	242

Table of Contents	XIII
Event Calculus Based Checking of Filtering Policies	248
A New Approach to Security Evaluation of Operating Systems  Peter D. Zegzhda, Dmitry P. Zegzhda, and Maxim O. Kalinin	254
Intrusion Detection and Prevention	
Full Papers	
Multi-agent Peer-to-Peer Intrusion Detection	260
An Interval Temporal Logic-Based Matching Framework for Finding Occurrences of Multi-event Attack Signatures	272
Towards Fully Automatic Defense Mechanism for a Computer Network Emulating Active Immune Response	286
Mathematical Models of Intrusion Detection by an Intelligent Immunochip	308
A Novel Intrusion Detection System for a Local Computer Network $\dots$ . A. Tokhtabayev, A. Altaibek, V. Skormin, and U. Tukeyev	320
Short Papers	
Investigation of the Effectiveness of Alert Correlation Methods in a Policy-Based Security Framework	334
Host-Based Intrusion Detection System: Model and Design Features $Pyotr\ Zegzhda\ and\ Semyon\ Kort$	340
Network Survivability and Privacy	
Full Papers	
Interval Approach to Preserving Privacy in Statistical Databases: Related Challenges and Algorithms of Computational Statistics Luc Longpré, Gang Xiang, Vladik Kreinovich, and Eric Freudenthal	346

### XIV Table of Contents

Fast Service Restoration Under Shared Protection at Lightpath Level in Survivable WDM Mesh Grooming Networks	362
Anycast Communication – A New Approach to Survivability of Connection-Oriented Networks	378
Short Papers	
Privacy Preserving Context Transfer in All-IP Networks	390
Environment-Aware Trusted Data Delivery in Multipath Wireless	
Protocols	396
Watermarking	
Short Papers	
A Spatial Watermarking Algorithm for Video Images	402
Watermarking Software to Signal Copy Protection	408
Author Index	415

## Surreptitious Software: Models from Biology and History

Christian Collberg<sup>1,\*</sup>, Jasvir Nagra<sup>2,\*\*</sup>, and Fei-Yue Wang<sup>3</sup>

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**Abstract.** Over the last decade a bewildering array of techniques have been proposed to protect software from piracy, malicious reverse engineering, and tampering. While we can broadly classify these techniques as obfuscation, watermarking/fingerprinting, birthmarking, and tamperproofing there is a need for a more constructive taxonomy. In this paper we present a model of Surreptitious Software techniques inspired by defense mechanisms found in other areas: we will look at the way humans have historically protected themselves from each other and from the elements, how plants and animals have evolved to protect themselves from predators, and how secure software systems have been architected to protect against malicious attacks. In this model we identify a set of primitives which underlie many protection schemes. We propose that these primitives can be used to characterize existing techniques and can be combined to construct novel schemes which address a specific set of protective requirements.

**Keywords:** Software protection, defense mechanisms, taxonomy.

#### Introduction 1

Your computer program can contain many different kinds of secrets that you may feel need to be protected. For example, you may want to prevent a competitor from learning about a particularly elegant algorithm. You therefore obfuscate our program, i.e. make it so convoluted and complex that reverse engineering it becomes a daunting task. Or, you may want to bind the copy sold to each person who buys it to prevent them from illegally reselling it. You therefore fingerprint the program, i.e. embed a unique identifier into each copy you sell.

<sup>\*</sup> Supported in part by the Institute of Automation, Chinese Academy of Sciences.

<sup>\*\*</sup> Supported by the European Commission, contract N° 021186-2, RE-TRUST project.

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allowing you to trace a pirated copy back to the original purchaser. Or, you may want to prevent a user from running a program after he has manipulated it, for example by removing a license check. You therefore *tamperproof* the program, i.e. make it unexecutable/self-destructing/self-repairing if it detects that its code has changed. Or, you may want to detect if part of your program has been incorporated into your competitor's program. You therefore check for *birthmarks*, unique characteristics of your code, within your competitor's code.

These techniques have collectively been referred to as *intellectual property* protection of software, or software protection, or whitebox cryptography. However, we will henceforth refer to the area as Surreptitious Software.

Over the last decade many algorithms have been proposed to protect secrets in programs. Seeing as the area has been (and is still) in a great deal of flux, a core set of ideas and techniques on which these algorithms are built has yet to be identified. It is the purpose of this paper to serve as a starting point for constructing such a classification scheme. Our goal is to identify a set of primitives which can be used to build algorithms protecting secrets in programs, and to use these primitives to model and classify software protection schemes that have been proposed in the literature. It is our hope that this model will provide a uniform language for researchers and practitioners, making it easier to discuss existing protection schemes and to invent new ones.

In software engineering, researchers have developed the concept of "design patterns" [1] to capture the rules-of-thumb that regularly occur during the development of large pieces of software. Garfinkel [2] also describes user-interface design patterns for security applications. The models of attacks and defenses we will describe in this paper are similar. Our motivation for identifying and classifying software protection schemes is to eliminate the need to develop new schemes from first principles. Instead we seek to model attacks and defenses that occur repeatedly so experiences and solutions can be reused. We hope that as a result, the insights gained from defending against any one instance of an attack can be generalized to the entire class of defenses.

We will seek inspiration for this model from defense mechanisms found in nature, from the way humans have protected themselves from each other and from the elements, and from protection schemes found in software systems. We will see how, since the dawn of time, plants, animals, and human societies have used surreptition to protect themselves against attackers, and then see how (or if) these ideas can be applied to the intellectual property protection of software.

The model we present here is still in its infancy. In particular, to complement our model of the techniques used by the *defender* we're still working to model the techniques used by the *adversary*. Our ultimate goal is a model which will allow us to classify a proposed new software protection scheme as

- 1. a simple variant of another, previously published scheme, or,
- 2. a novel combination of two known schemes, which we can predict will have certain properties, or
- a novel scheme not fitting the model, forcing us to reconsider the model itself.