

## Contact Information

**Simon S. Woo**

**Computer Science Department**

**University of Southern California, Los Angeles, CA**

**Affiliated with Information Sciences Institute (ISI), Marina del Rey, CA**

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## Education

**Ph.D. Candidate, Computer Science**

**University of Southern California (USC), Los Angeles, CA**

**Information Sciences Institute (ISI), Marina del Rey, CA**

Concentrations: Computer Networking, Usable Security, and Computer Network Security

Adviser: Professor Jelena Mirkovic (ISI/CS)

Committee members: Dr. Elsi Kaiser (Linguistics), Dr. Ron Artstein (ICT/CS), Dr. Kevin Knight (ISI/CS), and Dr. Aleksandra Korolova (CS)

**Master of Science, Computer Science, 2012**

**University of Southern California (USC), Los Angeles, CA**

**Master of Science, Electrical and Computer Engineering, 2005**

**University of California, San Diego (UCSD), CA**

Concentration: Communication Theory and Systems

Master Project: Joint power control and scheduling algorithm for wireless Ad hoc network

Master Project Advisers: Professor Laurence B. Milstein and Rene L. Cruz

**Bachelor of Science, Electrical Engineering, minor in Mathematics, 2003**

**University of Washington (UW), Seattle, WA**

## Research Interests

**Usable Security, Network Security, and Privacy in Social Media using Machine Learning (ML) and Natural Language Processing (NLP), Cybersecurity Curriculum Development**

- Usable Security, Privacy, and Network Security with applications of Natural Language Processing, Machine Learning, Information Analysis, and Computer Graphics techniques
- Secure Network Architecture Design, Cross Domain Solution, PKI, DNS Protection
- Cybersecurity Research and Education using Testbed

**Mission Critical Networking and Space/Satellite Communications**

- Satellite Communications, Deep Space Communications, Space Networks
- Time Synchronization

- Simulation, Modeling, and Performance Analysis of Networking and Communication Protocols

### **Cloud Computing**

- Advanced Research and Development of Cloud Computing
- Hybrid/Multiple/Private/Public Cloud Computing System Design

### **Industrial and System Engineering, and Entrepreneurship**

- Systems Engineering and Project Management
- Technology Commercialization and Entrepreneurship

## **Academic Experience**

- Graduate Research Assistant at USC/ISI 2012-Current
- Teaching Assistant at USC for CSCI 353 Introduction to Internetworking (Prof. Alefiya Hussain) (Overall Course Evaluation **3.38/5.0**) Jan-May 2016
- Teaching Assistant at USC for CSCI 530 Security Systems (Prof. Cliff Neuman) (Overall Course Evaluation **4.38/5.0**) Aug-Dec 2014
- Teaching Assistant at USC for CSCI 430 Intro to Computer & Network Security (Prof. Jelena Mirkovic) (Overall Course Evaluation **4.5/5.0**) Jan-May 2014
- Lab Assistant at USC for CSCI 530 Security Systems (Prof. David Morgan/Prof. Mirkovic/Prof. Neuman) Jan-Dec 2011
- Teaching Assistant at UCSD for ECE 158A-B Data Networks (Prof. Rene. L. Cruz) Sept 2004-March 2005
- Teaching Assistant at UCSD for Math Calculus and Vector Calculus Sept-Dec 2003

## **Publications**

### **Journals**

[J1] **Simon S. Woo** and Jelena Mirkovic, “Optimal Application Allocation on Multiple Public Clouds”, *Elsevier Computer Networks Journal Special Issue on Cloud Computing*, Volume 68, 5 August 2014, Pages 138-148, (**Acceptance rate: 21%**)

### **Peer-Reviewed Conference, Symposium, and Workshop Papers**

#### **Computer Security**

[C17] Ameya Hanamsagar, **Simon S. Woo**, Jelena Mirkovic, and Chris Kanich, “Understanding Password Habits and Their Causes: Study in a College Student Population” Oakland S&P 2017 (in submission)

[C16] **Simon S. Woo** and Jelena Mirkovic. “Improving Recall and Security of Passphrases Through Use

of Mnemonics”, Proceedings of the 10th International Conference on Passwords (Passwords), Bochum, Germany, 2016.

[C15] **Simon S. Woo**, Jelena Mirkovic, Elsi Kaiser, and Ron Artstein, “Life Experience Passwords (LEPs)”, Annual Computer Security Applications Conference (ACSAC), Los Angeles, 2016 (**Acceptance Rate: 22.8%**)

[C14] **Simon S. Woo**, Jingul Kim, Duoduo Yu, and Beomjun Kim, “Exploration of 3D Texture and Projection for New CAPTCHA Design,” The 17th World Conference on Information Security Applications (WISA), Jeju, 2016 (**Best Paper**)

[C13] **Simon S. Woo**, Zuyao Li, and Jelena Mirkovic, “Good Automatic Authentication Question Generation”, International Natural Language Generation Conference (INLG), Edinburgh, 2016

[P8] **Simon S. Woo**, and Jelena Mirkovic, “Exploration of Memorable and Secure Mnemonic Passphrase Generation”. Information Sciences Institute Graduate Student Symposium (ISI-GSS), March, 2016 (**Best Student Paper**)

[C12] **Simon S. Woo** and Harsha Manjunatha, “Empirical Data Analysis on User Privacy and Sentiment in Personal Blogs”, Proceeding of the 2nd ACM SIGIR-International Workshop on Privacy-Preserving IR: When Information Retrieval Meets Privacy and Security (PIR 2015). 2015.

[C11] Jelena Mikovic, Aimee Tabor, **Simon S. Woo**, and Portia Pusey, “Engaging Novices in Cybersecurity Competitions A Vision and Lessons Learned at ACM Tapia 2015,” In Proceedings of the USENIX Security-Summit on Gaming, Games and Gamification in Security Education (3GSE), 2015.

[C10] **Simon S. Woo**, Jelena Mikovic, Ron Artstein, and Elsi Kaiser, “Life-Experice Passwords”, Who are you?! Adventures in Authentication: ACM SOUP-WAY Workshop, 2014, Menlo Park, CA

[P7] **Simon S. Woo**, and B. Kim, “3D Object CAPTCHA”, Information Sciences Institute Graduate Student Symposium (ISI-GSS), Nov, 2014 (**Best Student Paper**)

[P6] **Simon S. Woo**, B. Kim, W. Jun, and J. Kim, “3DOC: 3D Object CAPTCHA”, 23<sup>rd</sup> International World Wide Web (WWW) Conference, 2014

[P5] **Simon S. Woo**, Jelena Mirkovic, and Elsi Kaiser, “Life Experience-Passwords”, Network and Distributed System Security (NDSS) Symposium, Feb, 2014

[P4] **Simon S. Woo**, Jelena Mirkovic, Elsi Kaiser and Pat Dyroff, “Life Experience-Passwords”, Information Sciences Institute Graduate Student Symposium (ISI-GSS), Nov, 2013 (**Best Student Poster**)

## **Communications and Networking**

[C9] **Simon S. Woo**, “*Analysis of Proximity-1 Space Link Interleaved Time Synchronization Protocol*,” IEEE *Globecom* 2011, Houston, TX (**Acceptance rate: 36%**)

[C8] E. Jennings, J. Segui, and **Simon S. Woo**, “MACHETE: A Protocol Evaluation Tool for Space-Based Networking Architecture and Simulation,” AIAA *SpaceOps* 2010, Huntsville, AL

[C7] **Simon S. Woo**, David Mills, and J. Gao, “Space Time Distribution and Synchronization Protocol Development for Mars Proximity Link”, AIAA *SpaceOps* 2010

[C6] E. Jennings, R. Borgen, C. Chevalier, E. Wesley, Sam Nguyen, John Segui, Tudor Stoenescu, Shin-Ywan Wang, and **Simon S. Woo**, “Space Communications and Navigation (SCaN) Network Simulation Tool Development and Its Use Cases”, AIAA, *Modeling and Simulation Technologies* (AIAA-MST) Conference, 2009

[C5] **Simon S. Woo** and Tudor Stoenescu, "Efficient File Sharing by multicast - P2P protocol using network coding and rank based peer selection", IEEE 69th Vehicular Technology Conference (IEEE-VTC) 2009-Spring, Barcelona, Spain, April, 2009

[C4] Esther H. Jennings, Sam P. Nguyen, Shin-Ywan Wang, and **Simon S. Woo**, “Interfacing Space Communications and Navigation Network Simulation with Distributed System Integration Laboratories (DSIL)”, *AIAA SpaceOps 2008*

[C3] **Simon S. Woo** and Mike Cheng, “Prioritized LT codes,” *Annual Conference on Information Sciences and Systems (CISS)*, Princeton, NJ, March 2008.

[P2] **Simon S. Woo** - 332 Mike Cheng - 332; Kar-Ming Cheung- 332; Chris Chang, Matt Klimesh, Sam Dolinar – 332, “Improved In Situ Communications Using Network Coding”, Research and Technology Development (R&TD) Poster session, Pasadena, Nov, 2008

[P1] Mike Cheng, **Simon S. Woo**, Kar-Ming Cheung, Sam Dolinar, and Jon Hamkins, “Improved In Situ Communications Using Network Coding”, *Research and Technology Development Poster session*, (R&TD), Pasadena, Nov, 2007

[C2] **Simon S. Woo**, Esther Jennings, and Loren Clare, “A Simulation Tool for ASCTA Microsensor Network Architecture,” *IEEE Aerospace Conference, Big Sky*, MT, March, 2008

[C1] **Sung U** and Jay Gao, “CFDP Performance Over Weather- Dependent Ka-Band Channel,” *AIAA SpaceOps 2006*, Rome, Italy

### **Book Chapters**

[B2] **Simon S. Woo**, David Mills, and Jay Gao , Chapter 29 of Progress in Astronautics and Aeronautics, “Space Operations: Exploration, Scientific Utilization & Technology Development,”, *AIAA*, **2011**

[B1] **Simon S. Woo** and Jay Gao, Chapter 8 of “Space Operations: Mission Management, Technologies, and Current Applications–CFDP Performance Over Weather- Dependent Ka-Band Channel,” *Progress in Astronautics and Aeronautics Series*, 220 Published by AIAA, © 2007

### **Book Review**

[BR1] Mills, D.L. *Computer Network Time Synchronization: the Network Time Protocol on Earth and in Space, Second Edition*. CRC Press, March 2011, 466 pp, ISBN 978-1-4398-1463-5, (<http://www.eecis.udel.edu/~mills/book.html>)

### **Inventions/Awarded New NASA Technology Report (NTR)**

[N10] Autonomous Information Unit (AIU) (NTR #49106) for Distributed Access Control, Awarded on April 2013

[N9] Enhanced Precision Time Protocol (PTP) (NTR # 49000), Awarded on Feb, 2013

[N8] JPL Policy Based Network Management (PBM) Cybersecurity Testbed Design (NTR # 48963), Awarded on Dec, 2012

[N7] Autonomous Byte Stream Randomizer (NTR#48495), Awarded on Nov, 2011

[N6] Autonomous Information Unit (AIU) for the Policy-Based Adaptive Network (NTR#48224), Awarded on Sept, 2011

[N5] Software Modules for Proximity-1 Space Link Interleaved Time Synchronization (PITS), (NTR # 47404), Awarded on Sept, 2010

[N4] Time Synchronization and Distribution Mechanisms for Space Networks (NTR # 47403), Awarded on Nov, 2009

[N3] Space Communications and Navigation (ScaN) Network Simulation Tool (NTR#46896): the contributor for DSIL scenario, ScaN PHY model, and Link budget library interface development, Awarded on Feb, 2009

[N2] Prioritized LT Codes (NTR#46653) the primary contributor for developing Prioritized LT codes, Awarded on March, 2009

[N1] Simulation Tool for ASCTA Microsensor Network Architecture (STAMiNA) (NTR#45213): Key contributor for STAMiNA development, Awarded on June, 2007

### Awarded Software Copyrights/Licenses

[S-L6] Autonomous Information Unit (AIU) for Distributed Access Control, Feb, 2014

[S-L5] Enhanced Precision Time Protocol (PTP), Feb, 2014

[S-L4] JPL Policy Based Network Management (PBM) Cybersecurity Testbed Design, Feb, 2014

[S-L3] Autonomous Byte Stream Randomizer, Jan, 2012

[S-L2] Space Communications and Navigation (SCaN) Network Simulation Tool, April, 2009

[S-L1] Simulation Tool for ASCTA Microsensor Network Architecture (STAMiNA), August, 2007

### NASA Tech Brief Awards

[TB6] Autonomous Byte Stream Randomizer, Awarded on July 2013

[TB5] Software Modules for Proximity-1 Space Link Interleaved Time Synchronization (PITS), Awarded on July, 2012

[TB4] Autonomous Information Unit (AIU) for Fine-Grain Data Access Control and Mission Data Protection in Net-Centric System Testing Environment, 2011

[TB3] Time Synchronization and Distribution Mechanisms for Space Networks (Space NTP), Dec 2011, <http://www.techbriefs.com/ntb1211>

[TB2] Prioritized Luby Transform (LT) Codes, 2011, <http://www.techbriefs.com/component/content/article/9894>

[TB1] Simulating Operation of a Complex Sensor Network, 2008, <http://www.techbriefs.com/component/content/article/2703>

### Skills

- **High Level Program:** C, C++, C#, Bash Scripting, Perl, Matlab, Java, Hadoop, Configuration Management, Python
- **Security Software:** Wireshark, Snort, John Doe Ripper, Hashcat, openSSL, openSC, openLDAP, PKI
- **Natural Language Processing/ML:** NLTK, Stanford Core NLP, Alchemi API, Scikit-Learn
- **Web Programming:** Javascript, XML, CSS, Document Object Model (DOM), Apache, Tomcat, JSON, AJAX
- **Network Simulation & Emulation:** Network Simulator 2 (*ns-2*), Oment+ network simulator, QualNet, OPNET, DETER, Emulab, Shunra Traffic Emulator
- **Assembly Programming:** MIPS, Intel Xscale/WMMX, MIPS R2000, TI TMS320C6X DSK assembly
- **Project Management:** Task/Project/Schedule Management and System Architecting from concept to development

### Work Experience

Verisign Research Lab/CTO Ph.D. Intern, 2016

Mentor: Dr. Eric Osterweil, Tomofumi Okubo, and Dr. Andrew West

**Networking and Security Technologist/Member of Technical Staff, 2012-2014**

Reasoning, Modeling, and Simulation Group, Flight Software and Data Systems Section at **NASA Jet Propulsion Lab (JPL)**

**Engineering Applications Software Engineer/Member of Technical Staff, 2010-2012**

Network & Security Research and System Architecting for various DoD Projects

Reasoning, Modeling, and Simulation Group, Flight Software and Data Systems Section at **NASA's Jet Propulsion Lab (JPL)**

**Telecommunications Systems Engineer/Member of Technical Staff, 2005-2010**

Communications and Networking Research and System Engineering

Computer Networks Group, Communication Architecture and Research Section at **NASA's Jet Propulsion Lab (JPL)**

**Linux Security Consultant, 2012-2013**

Volunteer as a Linux Security Subject Matter Expert and Coach for CyberPatriot Program

**Beyond the Bell program at Los Angeles Unified School District (LAUSD)**

**JPL Summer Student/Faculty Mentor, 2012-2013**

**MAC Layer Protocol Design Intern, 2004**

Entropic Communications, San Diego, CA

**Application Engineering CO-OP, 2002**

Wireless Computing and Communication Group at **Intel Corp**, Austin, TX

**Validation Engineering CO-OP, 2001**

Pre-Silicon System Level Simulation Group at **Intel Corp**, DuPont, WA

## **Awards and Honors**

- **Best Paper Award**, World Conference on Information Security Applications (WISA), 2016
- **Best Student Paper Award** at the ISI Graduate Research Symposium, sponsored by USC/ISI and Google, March. 2016
- **Best Student Paper Award** at the ISI Graduate Research Symposium, sponsored by USC/ISI and Google, Nov. 2014
- **Best Student Poster Award** at the ISI Graduate Research Symposium, sponsored by USC/ISI and Google, Nov. 2013
- **JPL Individual Spot Award** for "For contributions leading to successful hiring and mentoring of five summer interns," 2012
- **JPL Team Bonus Award**, "The JPL Policy-Based Network Management (PBNM) Team performed Superbly and successfully created a fundamentally novel and first-of-its-kind advanced Policy Management Technology," 2011

- **JPL Individual Spot Award** for "Performance above and beyond the call of duty in preparation of the PBM Proposal," 2011
- **NASA Honor Award - Group Achievement Award** for the SCIP System Engineering and Integration, "For outstanding contribution to the definition of NASA's Space Communication and Navigation Infrastructure required to support Constellation's Vision," 2010
- **NASA Tech Brief Awards**, 2008, 2010, 2011, 2012
- **NASA Software Award** 2008
- **Mary Gates Scholar**, University of Washington for undergraduate research, Seattle 2002

### Awarded Research/Travel Grants

- [R4] NDSS Student travel grant (\$665), 2016
- [R3] Symposium On Usable Privacy and Security (SOUP)/WAY Workshop travel grant (\$600), 2014
- [R2] JPL R&TD, Improved In Situ Communications Using Network Coding (CO-I) (\$170K for 2 years), 2006-2008
- [R1] 2002, Mary Gates Undergraduate Research Training Grant (\$3K for 2 quarters), 2002

### Major Project Involvement at NASA-JPL (2005-2013)

#### U.S. DoD Funded Projects:

Various R&D projects funded by U.S. Navy, and Army Research Lab

#### NASA Funded Projects:

- End-to-End Network Modeling and Simulation Study (NASA Constellation Program)
- DSN New Network Service Development (NASA IND DSN Space Networking Technology Program)
- Distributed System Integration Laboratories (DSIL) (NASA Constellation Program)
- DSN Space Network Time Protocol Development (NASA IND DSN Space Networking Technology Program)
- Integrated Mission Simulation (NASA Constellation Program)
- Improved In Situ Communications Using Network Coding (JPL Research and Development Technology)
- Hybrid simulation network environment development using QualNet (JPL Interplanetary Network Directorate Program)
- Characterizing latency performance of CCSDS File Delivery Protocol (CFDP) under weather-dependent correlated channel (JPL Interplanetary Network Directorate Program)

### Ph.D. Research Project Descriptions

#### [Proj1] Life-Experience Passwords (LEPs)

*User-supplied* textual passwords are extensively used today for user authentication. However, these passwords have serious deficiencies in a way they interact with human natural ability to form memories. Strong passwords that are hard to crack are also hard for humans to remember, while memorable passwords are easily brute-forced or guessed. Recently, a number of alternatives to textual passwords have been proposed, such as drawing a password, selecting images from a list, learning a tune, etc. All these approaches have a common deficiency that they ask users to form new memories, which leads

either to easily remembered, easily-guessed or secure but easily-forgotten passwords. We propose novel *life-experience passwords* (LEPs). Unlike existing approaches, our passwords are built from a user's episodic memory about defining life events, and should be both more memorable and harder to guess than traditional passwords.

**Publications: C10, C13, C15, P4, P5**

### **[Proj2] Education and Cybersecurity Curriculum Development**

The goals of this project are to develop (1) curriculum modules and practical exercises to demonstrate key concepts in OS, networking and security tailored to cybersecurity issues; (2) capture-the-flag (CTF) exercises to be performed in security classes among student teams. In the current landscape of cybersecurity education, it is critical to develop practical projects and homeworks that allow students to experience, design, and implement cyber defense mechanisms and further enhance student hands-on computer networking and security skills. The developed materials will be publicly released through the [Deterlab testbed education site](#) in order to benefit educators and institutions throughout the world and to enhance the cybersecurity awareness.

**Publications: C11**

### **[Proj3] 3DOC: 3D Object CAPTCHA**

Current 2D CAPTCHA mechanisms can be easily defeated by character recognition and segmentation attacks by automated machines. Recently, 3D CAPTCHA schemes have been proposed to overcome the weaknesses of 2D CAPTCHA for a few websites. However, recent researcher demonstrates the offline pre-processing techniques to break 3D CAPTCHA as well. In this work, we propose a novel 3D object based CAPTCHA scheme that projects the CAPTCHA image over a 3D object. We develop the prototype and present the proof-of-concept of 3D object based CAPTCHA scheme to protect websites against automated attacks.

**Publications: P7, C14**

### **[Proj4] Optimal Application Allocation on Multiple Public Clouds**

Cloud computing customers currently host all of their application components at a single cloud provider. Single-provider hosting eases maintenance tasks, but reduces resilience to failures. Recent research also shows that providers' offers differ greatly in performance and price, and no single provider is the best in all service categories. In this paper we investigate the benefits of allocating components of a distributed application on multiple public clouds (multi-cloud). We propose a resource allocation algorithm that minimizes the overall cloud operation cost, while satisfying required service-level agreements (SLAs). In spite of the additional delays for inter-cloud communication and the additional costs for inter-cloud data transfer, our simulation study, using real cloud performance and cost data, demonstrates that multi-cloud allocation outperforms single-cloud allocations in a variety of realistic scenarios.

**Publications: J1, P3**

### **[Proj5] Memorable and Secure Mnemonic Passphrase Generation (MNPass)**

Strong passwords or passphrases tend to be long and complex for humans to remember. In this work, we explore an approach to generate memorable and secure passphrases using mnemonics. A mnemonic is a sequence of alphabet characters presented to users when creating a passphrase. Users need to

generate a sequence of words that correspond to each mnemonic character. We propose MNPass, which is a passphrase comprised of the words chosen by users containing each mnemonic character. This mnemonic sequence enforces a user to produce an uncommon word sequence to improve security. Also, we allow users to choose their own word corresponding to each mnemonic, which can improve memorability. When a user authenticates, we present the same mnemonics as a hint to remember the specific word sequence. We conducted a small-scale user study with Amazon Mturk and evaluated the memorability, security, and diversity of MNPass with system generated passphrases as well as user-chosen passphrases. The initial result has shown that MNPass can be used for improving user memorability, compared to the system-generated passphrases and enhance security, compared to the user chosen passphrases.

**Publications: P8, C16**

### **[Proj6] Understanding Password Habits and Their Causes**

Weak or reused passwords are guilty for many contemporary security breaches. It is critical to study both how users choose and reuse passwords, and the causes that lead users to adopt unsafe practices. Existing literature on these topics is limited as it either studies patterns but not the causes (using leaked or contributed datasets), or it studies artificial patterns and causes that may not align with the real ones (lab interviews and/or fictional servers). Our research complements the existing works by studying the semantic structure, strength and reuse of real passwords, as well as conscious and unconscious causes of unsafe practices, in a population of 50 participants. The participants took part in a carefully designed, ethical and IRB-approved lab study, where we harvested their existing online credentials, and interviewed them about their password strategies and their risk perceptions. We found that: (1) an average password is weak and used at more than four sites, (2) important-site passwords are only 1-2 characters longer and 10 times stronger than those for non-important sites, (3) main causes of weak passwords are security fatigue and short password length, (4) 98% of users reuse their passwords with no changes and the rest make slight changes, which can be easily brute-forced, (5) 84% of users reuse passwords between important and non-important sites, and (6) main causes for password reuse are misconceptions about risk, and preference for memorability over security.

**Publications: In Submissions**

### **Services/Volunteer Activities**

- Led TRUST Security Code-a-thon, ACM Richard Tapia conference of Diversity in Computing, Feb. 2015  
<http://tapiaconference.org/schedule/saturday-february-15-2015/800am-500pm/codeathon/>
- Student Volunteer, PAM, Marina Del Rey, 2014
- Volunteered to teach Linux Security to L.A. Unified School District (LAUSD) high school students to compete regional and national CyberPatriot ([www.uscyberpatriot.org](http://www.uscyberpatriot.org)) competition, 2013
- Invited Reviewer for IEEE Aerospace Conference, 2006-2012
- Invited Reviewer for IEEE Communications letters, 2012
- Session Chair for JPL Summer Student Presentation, 2012
- USC Ph.D. Student Admission Committee Member, 2013
- Caltech SURF Program Reviewer

## Mentoring Students/Hosting External Researchers and Collaborators

- Prof. Pei Wang, Temple University, JPL Summer 2013
- Ben Yuan, Caltech, Caltech SURF on AIU and security software, JPL Summer, 2012
- Eddie Huang, Caltech, JPLSIP on Time Synchronization and network performance, Summer, 2012
- Arleena Faith, Santa Monica College, CIPAIR on National Cyber Range Program, JPL Summer, 2012
- Prof. David Morgan, Santa Monica College, CIPAIR on Emulab Testbed Design and National Cyber Range Program, JPL Summer, 2012

**Status** U.S. Citizen

## References

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