

## Christopher A. Wood

### Permanent Address

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### RESEARCH INTERESTS

Computer and network security and privacy, cryptographic algorithms and engineering, network architectures and protocols, and software engineering.

### EDUCATION

*Doctor of Philosophy*, Computer Science  
University of California Irvine, Irvine, CA  
Advisor: Dr. Gene Tsudik

2013 - 2017 (expected)

*Master of Science*, Computer Science  
Rochester Institute of Technology, Rochester, NY  
Thesis: Large Substitution Boxes with Efficient Combinational Implementations  
Advisor: Dr. Stanisław Radziszowski

2012 - 2013

*Bachelor of Science*, Computer Science and Software Engineering  
Rochester Institute of Technology, Rochester, NY  
Concentrations: Computational Mathematics and Computer Engineering  
Minor: Mathematics

2008 - 2012

### PUBLICATIONS

#### Conference Proceedings

- C-1. C. Ghali, G. Tsudik, E. Uzun, and C. A. Wood, "Closing the Floodgate with Stateless Content-Centric Networking," to appear in the *26th International Conference on Computer Communication and Networks (ICCCN 2017)*, July 31 - August 3, 2017, Vancouver, Canada.
- C-2. C. A. Wood, "Protecting the Long Tail: Transparent Packet Security in Content-Centric Networks," to appear in the *IFIP Networking 2017*, June 12-16, 2017, Stockholm, Sweden.
- C-3. M. Mosko, E. Uzun, and C. A. Wood, "Mobile Sessions in Content-Centric Networks," to appear in the *IFIP Networking 2017*, June 12-16, 2017, Stockholm, Sweden.
- C-4. M. Mosko, C. A. Wood, "Secure Off-Path Replication in Content-Centric Networks," to appear in the *IEEE ICC 2017 Next Generation Networking and Internet Symposium (NGNI 2017)*, May 21-25, 2017, Paris, France.
- C-5. C. Ghali, G. Tsudik, C. A. Wood, "(The Futility of) Data Privacy in Content-Centric Networking," in the *2016 Workshop on Privacy in the Electronic Society (WPES 2016)*, October 24, 2016, Vienna, Austria.
- C-6. C. Ghali, G. Tsudik, C. A. Wood, "Network Names in Content-Centric Networking," to appear in the *3rd ACM Conference on Information-Centric Networking (ICN 2016)*, Sept. 26 - 28, 2016, Kyoto, Japan.
- C-7. C. Tschudin, E. Uzun, C. A. Wood, "Trust in Information-Centric Networking: From Theory to Practice," in *Proceedings of the 25th International Conference on Computer Communication and Networks (ICCCN 2016)*, August 1 - 4, 2016, Waikoloa, Hawaii, USA.

- C-8. C. Ghali, G. Tsudik, C. A. Wood, "BEAD: Best Effort Autonomous Deletion in Content-Centric Networking," *FIP Networking 2016*, May 17 - 19, 2016, Vienna, Austria.
- C-9. C. Ghali, G. Tsudik, C. A. Wood, E. Yeh, "Practical Accounting in Content-Centric Networking," *NOMS 2016, IEEE/IFIP Network Operations and Management Symposium*, April 25 - 29, 2016, Istanbul, Turkey.
- C-10. G. Tsudik, E. Uzun, and C. A. Wood, "AC3N: An API and Service for Anonymous Communication in Content-Centric Networking," in *Proceedings of CCNC 2016*, Las Vegas, NV, USA. January 2016.
- C-11. C. A. Wood, S. P. Radziszowski, and M. Lukowiak, "Constructing Large S-boxes with Area Minimized Implementations," in *Proceedings of MILCOM'2015*, Tampa, FL, USA. October 2015.
- C-12. M. Mosko and C. A. Wood, "Secure Fragmentation for Content-Centric Networking," *IEEE MASS 2015 Workshop on Content-Centric Networking (CCN 2015)*, Dallas, TX, USA. October 2015.
- C-13. C. Ghali, M. A. Schlosberg, G. Tsudik, and C. A. Wood, "Interest-Based Access Control for Information Centric Networks," in *Proceedings of ICN 2015, the 2nd ACM Conference on Information Centric Networking*, San Francisco, CA, USA. September 2015.
- C-14. C. Ghali, A. Narayanan, D. Oran, G. Tsudik, and C. A. Wood, "Secure Fragmentation for Content-Centric Networks," *NCA 2015, the 14th IEEE International Symposium on Network Computing and Applications*, Cambridge, MA, USA. September 2015. (Best paper award winner)
- C-15. J. Kurihara, C. A. Wood, and E. Uzun, "An Encryption-Based Access Control Framework for Content-Centric Networking," *IFIP Networking 2015*, Toulouse, France. May 2015.
- C-16. S. Skalicky, S. Lopez, M. Lukowiak, and C. A. Wood, "Mission Control: A Performance Metric and Analysis of Control Logic for Pipelined Architectures on FPGAs," to appear in *Proceedings of the 2014 International Conference on Reconfigurable Computing and FPGAs - ReConFig 2014*, Cancun, Mexico. December 2014.
- C-17. C. A. Wood and E. Uzun, "Flexible End-to-End Content Security in CCN," *IEEE Consumer Communications and Networking Conference (CCNC 2014) Special Session: Information Centric Networking*, Las Vegas, Nevada. January 2014.
- C-18. S. Skalicky, C. A. Wood, M. Lukowiak, and M. Ryan, "High Level Synthesis: Where Are We? A Case Study on Matrix Multiplication," in *Proceedings of the 2013 International Conference on Reconfigurable Computing and FPGAs - ReConFig 2013*, Cancun, Mexico. December 2013.
- C-19. M. Lukowiak, A. Meneely, S. Radziszowski, J. Vallino, and C. Wood, "Developing an Applied, Security-Oriented Computing Curriculum," in *Proceedings of the ASEE 2012*, San Antonio, Texas. June 2012.
- C-20. C. A. Wood, "Chaos-Based Symmetric Key Cryptosystems," in *Proceedings of the 2011 International Conference on Security & Management*, Las Vegas, Nevada. July 2011.
- C-21. C. A. Wood and R. K. Raj, "Keyloggers in Cybersecurity Education," in *Proceedings of the 2010 International Conference on Security & Management*, Las Vegas, Nevada. July 2010.

## Journal Articles

- J-1. G. Acs, M. Conti, P. Gasti, C. Ghali, G. Tsudik, and C. A. Wood, "Privacy-Aware Caching in Information-Centric Networking," to appear in the *IEEE Transactions on Dependable and Secure Computing*.
- J-2. E. Ngai, B. Ohlman, G. Tsudik, E. Uzun, M. Wahlisch, C. A. Wood, "Can We Make a Cake and Eat It Too? A Discussion of ICN Security and Privacy," *ACM SIGCOMM Computer Communication Review*, Volume 47 Issue 1, January 2017, Pages 49-54.
- J-3. P. Bajorski, A. Kaminsky, M. Kurdziel, M. Lukowiak, S. Radziszowski, and C. Wood, "Stochastic Analysis and Modeling of a Tree-Based Group Key Distribution Method in Tactical Wireless Networks," in *Journal of Telecommunications System & Management, Engineering Journals, OMICS Publishing Group*.

- J-4. C. A. Wood and J. Jacob, "Characterization of Small Trees Based on their  $L(2,1)$ -Span," *AKCE International Journal of Graphs and Combinatorics*, Volume 12, Issue 1, July 2015, Pages 2631.
- J-5. M. Lukowiak, S. Radziszowski, J. Vallino, C. Wood, "Cybersecurity Education: Bridging the Gap between Hardware and Software Domains," *ACM Transactions on Computing Education*, 14(1) (2014).

## Posters

- P-1. C. A. Wood and G. Scott, "A Network-Agnostic Data Framework and API for CCN," ICN 2015, the 2nd ACM Conference on Information Centric Networking, September 30 - October 2, 2015, San Francisco, CA, USA.
- P-2. M. Mosko, G. Scott, I. Solis, and C. A. Wood, "Secure Prefix Registration in CCN," ICN 2015, the 2nd ACM Conference on Information Centric Networking, September 30 - October 2, 2015, San Francisco, CA, USA.

## Theses

- D-1. C. A. Wood, "Large Substitution Boxes with Efficient Combinational Implementations," M.S. Thesis, Computer Science, Rochester Institute of Technology, Rochester, NY. August 2013.

## Technical Reports

- TR-1. E. Ngai, B. Ohlman, G. Tsudik, E. Uzun, and C. A. Wood, "Information-centric Networking and Security (Dagstuhl Seminar 16251)," Dagstuhl Reports. Vol. 6. No. 6. Schloss Dagstuhl-Leibniz-Zentrum fuer Informatik (2016). Available online at [http://drops.dagstuhl.de/opus/volltexte/2016/6727/pdf/dagrep\\_v006\\_i006\\_p049\\_s16251.pdf](http://drops.dagstuhl.de/opus/volltexte/2016/6727/pdf/dagrep_v006_i006_p049_s16251.pdf).
- TR-2. C. Ghali, G. Tsudik, E. Uzun, C. A. Wood, "Living in a PIT-less World: A Case Against Stateful Forwarding in Content-Centric Networking," December 24, 2015. Available online at <https://arxiv.org/abs/1512.07755>.
- TR-3. C. Ghali, G. Tsudik, C. A. Wood, E. Yeh, "Practical Accounting in Content-Centric Networking (extended version)," October 7, 2015. Available online at <https://arxiv.org/abs/1510.01852>.
- TR-4. M. Mosko, I. Solis, E. Uzun, and C. A. Wood, "CCNx 1.0 Protocol Architecture," Technical report, August, 2015. Available online at <http://www.ccnx.org/pubs/CCNxProtocolArchitecture.pdf>.
- TR-5. C. Ghali, M. A. Schlosberg, G. Tsudik, C. A. Wood, "Interest-Based Access Control for Content Centric Networks (extended version)," May 23, 2015. Available online at <https://arxiv.org/abs/1505.06258>.
- TR-6. C. Ghali, A. Narayanan, D. Oran, G. Tsudik, C. A. Wood, "Secure Fragmentation for Content-Centric Networks (extended version)," May 12, 2014. Available online at <https://arxiv.org/abs/1405.2861>.

## TALKS AND PRESENTATIONS

- T-1. "Content-Centric Networking: Overview, Open Problems, Closed Future?," presentation, Gene Tsudik's Network and Distributed Systems Security course, UCI, February 21, 2017.
- T-2. "A Study of Privacy and Anonymity in the DNS," presentation, DNS OARC 25, Dallas, TX, USA, October 15, 2016.
- T-3. "Access Control in Information-Centric Networks," presentation, Invited Talk at SRI, Menlo Park, CA, USA, August 17, 2016.
- T-4. "File-Like ICN Collection (FLIC)," presentation, ICNRG Meeting, Berlin, Germany, July 21, 2016.
- T-5. "CCNx Testrig," presentation, ICNRG Interim Meeting, Berlin, Germany, July 17, 2016.
- T-6. "Secure Transport Offload with Encrypted PEPs," presentation, ICNRG Interim Meeting, Berlin, Germany, July 17, 2016.

- T-7. “Group Key Encryption,” presentation, ICNIRG Interim Meeting, Berlin, Germany, July 17, 2016.
- T-8. “CDN Architecture Pain Points and ICN Cures?,” presentation, ICNIRG Interim Meeting, Berlin, Germany, July 17, 2016.
- T-9. “Let’s Check Let’s Encrypt: A Tool for Code-Driven Threat Modeling,” presentation, BSidesROC, Rochester, NY, USA. April 23, 2016.
- T-10. “Session-Based Content Distribution with CCNx-KE,” presentation, ICNIRG Interim Meeting, Buenos Aires, Argentina. April 3, 2016.
- T-11. “CCNx-KE vs (D)TLS,” presentation, ICNIRG Interim Meeting, Buenos Aires, Argentina. April 3, 2016.
- T-12. “Private Communication in ICN,” presentation, ICNIRG Interim Meeting, Buenos Aires, Argentina. April 3, 2016.
- T-13. “TLV Encryption and Packet Encapsulation,” presentation, ICNIRG Interim Meeting, Paris, France. January 15, 2016.
- T-14. “CCNx Key Exchange - Updates,” presentation, ICNIRG Interim Meeting, Paris, France. January 15, 2016.
- T-15. “FLIC Manifests,” presentation, ICNIRG Interim Meeting, Paris, France. January 14, 2016.
- T-16. “CCNx Key Exchange,” presentation, IETF 94 ICNIRG Meeting, Yokohama, Japan. November 4, 2015.
- T-17. “Static Manifest Requirements,” presentation, IETF 94 ICNIRG Meeting, Yokohama, Japan. November 4, 2015.
- T-18. “CCNx over UDP,” presentation, IETF ICNIRG Interim Meeting, San Francisco, CA. October 3, 2015.
- T-19. “Manifests,” presentation, IETF ICNIRG Interim Meeting, San Francisco, CA. October 3, 2015.
- T-20. “Efficient Security Bindings for Information Centric Networks,” *CCNxCon 2015, Palo Alto Research Center, Palo Alto, CA*. May 20, 2015.
- T-21. “Handling Trust Enforcement,” presentation, *CCNxCon 2015, Palo Alto Research Center, Palo Alto, CA*. May 20, 2015.
- T-22. “Digital Signatures and Implicit Certificates,” guest lecture for Dr. Stanislaw Radziszowski’s (CS@RIT), Crypto II course, May 5, 2015.
- T-23. “On the  $L(2,1)$  Labeling of Trees,” with Jobby Jacob (presenter), *Joint Mathematics Meetings*, Baltimore, MD. January 15-18, 2014.
- T-24. “Secure Content Dissemination in Content Centric Networking,” *CCNxCon 2013, Palo Alto Research Center, Palo Alto, CA*. September 5, 2013.
- T-25. “Cryptographic S-boxes,” guest lecture for Dr. Stanislaw Radziszowski’s (CS@RIT) Crypto II course, April 8, 2013.
- T-26. “Characterization Results for the  $L(2,1)$ -Labeling Problem on Trees,” *AMS Sectional Meeting, RIT, Rochester, NY*. September 22, 2012.
- T-27. “Chaos-Based Symmetric Key Cryptosystems,” *RIT Graduate Research Symposium, RIT, Rochester, NY*. July 22, 2011.
- T-28. “Layered Driver Rootkit Detection on Microsoft Windows PCs,” *RIT Undergraduate Research Symposium, RIT, Rochester, NY*. August 24, 2009.

## PROFESSIONAL EXPERIENCE

- Apple, Inc.* October 2016 - present  
Cupertino, CA Secure Transports Engineer
- Work on securing data in transit.
- Palo Alto Research Center* September 2014 - October 2016  
Computer Science Laboratory, Palo Alto, CA Software Engineer and Researcher
- Developed the CCNx 1.0 network stack, security libraries, APIs, and applications.
  - Lead CCNx technical meetings and drove IRTF RFC drafts for the ICNRG.
  - Contributed to the PARC CCN patent portfolio.
  - Implemented internal code measurement tools for quantifiable software quality improvements.
- Palo Alto Research Center* June 2014 - September 2014  
Computer Science Laboratory, Palo Alto, CA Security and Privacy Research Intern
- Designed manifests and a manifest-based access control framework for CCNx.
  - Implemented encryption-based access control modules based on Broadcast Encryption and Proxy Re-Encryption for CCNx.
  - Designed and implemented trust enforcement mechanics in the transport stack for CCNx.
- Cigital, Inc.* March 2014 - July 2014  
Dulles, MD Security Consultant Contractor
- Contributed to security-oriented C/C++ source code review and architectural analyses.
- Palo Alto Research Center* July 2013 - September 2013  
Computer Science Laboratory, Palo Alto, CA Security and Privacy Research Intern
- Researched security and privacy aspects related to content-centric network (CCN).
  - Implemented the Green-Ateniese (pairing-based) and Chow-Weng-Yang-Deng (Schnorr- and ElGamal-based) Proxy Re-Encryption schemes in Java for use in a CCNx application.
  - Studied and tested various techniques for securing content.
  - Experimented with techniques for improving name privacy in CCN.
- Intel Corporation* June 2012 - August 2012  
Virtual & Parallel Computing Group, Folsom, CA Graphics Software Engineer Intern
- Developed production features for tool that processes hardware specifications to generate web content and source code for VHDL and C/C++ testbeds.
  - Interacted with internal customers within the VPG to utilize debug tools and environments for architecture specification and post-silicon testing.
- L-3 Communications* March 2011 - August 2011  
Victor, NY Software Engineer Intern
- Designed and implemented a library and supporting drivers for the  $\mu$ -blox NEO5/6 GPS receiver driven by an Analog Devices Blackfin processor.
  - Extended an existing FAT file system driver to add support for SD devices.
  - Improved functionality of a CPLD controller for an embedded power supply.
- Rochester Software Associates* November 2010 - March 2011  
Rochester, NY Software Engineer Intern
- Led the design, development, and documentation efforts for a new printer job management application that would service any number of jobs from clients across the network.
  - Tested and debugged an existing .NET implementation of an LPD client.
- C Speed, LLC* May 2010 - August 2010  
Liverpool, NY Software Engineer Intern

- Designed and implemented an internal manufacturing part supply management system.
- Implemented embedded firmware features and test routines in C, C++, and assembly for Coldfire V2 processors.

## ACADEMIC EXPERIENCE

*Advanced Cryptography* May 5, 2015  
 Guest Lecturer for Dr. Stanisław Radziszowski (CS) (RIT)  
 - Lectured about digital signature algorithms, ElGamal and ECDSA batch verification techniques, standard public key infrastructures, and the OMC and ECQV implicit certificate schemes.

*Cryptography II* April 8, 2013  
 Guest Lecturer for Dr. Stanisław Radziszowski (CS) (RIT)  
 - Lectured about recent research on the security and (hardware) implementation efficiency of cryptographic S-boxes.

*Hardware and Software Design with Cryptographic Applications* February 2011 - May 2013  
 Teaching Assistant and Lecturer for Dr. Marcin Lukowiak (CE) (RIT)  
 - Developed and delivered lecture material on cryptography, embedded software optimization techniques, the Impulse C high-level synthesis tool, and AES cache timing attacks.  
 - Assisted students with weekly assignments and graded lab and project deliverables.

*Computer Science I, II, and IV* January 2009 - May 2013  
 Student Lab Assistant and Grader (RIT)  
 - Proctored problem solving sessions and ran lab meetings with lectures of weekly material.  
 - Graded weekly lab assignments and midterm examinations.

*Personal Software Engineering* December 2011 - March 2012  
 Teaching Assistant for Professor Tom Reichlmayr (SE) (RIT)  
 - Assisted students with in-class programming assignments and course projects.  
 - Graded projects written in C/C++ and Ruby (with Ruby on Rails).

*Engineering of Software Subsystems* September 2011 - December 2011  
 Teaching Assistant for Dr. James Vallino (SE) (RIT)  
 - Assisted students with in-class exercises and unit questions based on a subset of the design patterns taught during the course.  
 - Spent time with each student team to discuss course projects, including design decisions, application of design patterns, and alternatives considered.

## MEMBERSHIPS

IEEE, Student Member  
 ACM, Student Member  
 SIAM, Student Member  
 IACR, Student Member  
 Internet Society, Member  
 Tau Beta Pi, Member

## HONORS AND ACTIVITIES

- NSF GRFP fellowship recipient, 2014
- RIT Honors Program, 2009 - 2013
- RIT Tau Beta Pi Engineering Honors Society, 2011 - 2013

- RIT Outstanding Undergraduate Student award, selected, Winter 2012
- RIT Computer Science MS Student Delegate, selected, Winter 2012
- Recipient of Golisano College Honors research assistantship stipend, Winter 2009/2010
- Recipient of Golisano College Honors research assistantship stipend, Spring 2011
- Recipient of RIT undergraduate research award stipend, Summer 2009
- RIT Golisano College Dean's List, 2008 – 2013
- Student mentor for the FIRST LEGO League team hosted by RIT, Fall 2009 – Winter 2010
- Rochester Foodlink volunteer, Winter 2012/2013 – March 2013
- Society of Software Engineers, member, Fall 2008 – Winter 2009/2010
- RIT Electronic Gaming Society, member, Fall 2008 – Spring 2010
- RIT Intramural Flag Football Team, member, Fall 2010

### **INTERESTS**

Guitar, running, cycling, swimming, languages, and the natural sciences.