

T. Charles Clancy, Ph.D.
Curriculum Vitæ

General Information

Laboratory for Telecommunications Sciences
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Research Interests

My primary research interests are wireless networks and communication security, particularly relating to cognitive radio and next-generation wireless networks. I also have a general interest in information theory, coding theory, queuing theory, cryptographic protocol security, and stochastic network analysis.

My current work focuses on cognitive radio, delay-tolerant wireless networks, and WLAN/WMAN technologies. I manage a variety of in-house R&D projects and several academic partnerships in these fields. Additionally, I'm involved in the standardization of back-end authentication and security in wireless networks within the Internet Engineering Task Force.

Education

Ph.D. Computer Science

University of Maryland, College Park
Advisor: William A. Arbaugh

M.S. Electrical Engineering

University of Illinois, Urbana-Champaign
Advisor: Richard E. Blahut

B.S. Computer Engineering, *magna cum laude*

Rose-Hulman Institute of Technology, Terre Haute, Indiana

Employment

2000–present US Department of Defense
2006–present, *Senior Researcher*, Laboratory for Telecommunications Sciences
2004–2006, *Researcher*, Laboratory for Telecommunications Sciences
2000–2004, *Summer Intern*, Various Offices

2003–present University of Maryland, College Park
2007–present, *Adjunct Assistant Professor*, Electrical and Computer Engineering
2005–present, *Affiliate Researcher*, Institute for Advanced Computer Studies
2003–2005, *Graduate Research Assistant*, Computer Science

2001–2003 *Graduate Research Assistant*, University of Illinois, Urbana-Champaign
1997–2003 *Adjunct Lecturer & Software Engineer*, Indiana University, Indianapolis
1998–2001 *Systems Administrator*, Rose-Hulman Institute of Technology

Publications

Journals and Periodicals:

- J1. B. Wang, Z. Ji, M. Abdulrehem, R. Liu, T. Clancy. "Primary-Prioritized Markov Approach for Dynamic Spectrum Allocation," *IEEE Transactions on Wireless Communications*, to appear.
- J2. Y. Wu, B. Wang, R. Liu, T. Clancy. "Repeated Open Spectrum Sharing Game with Cheat-Proof Strategies," *IEEE Transactions on Wireless Communications*, to appear.
- J3. T. Clancy. "Secure Handover in Enterprise WLANs: CAPWAP, HOKEY, and 802.11r," *IEEE Wireless Communications*, to appear.
- J4. B. Wang, Y. Wu, Z. Ji, R. Liu, T. Clancy. "Game Theoretical Mechanism Design for Cognitive Radio Networks with Selfish Users," *IEEE Signal Processing Magazine*, to appear.
- J5. T. Clancy. "Formalizing the Interference Temperature Model," *Wiley Journal on Wireless Communications and Mobile Computing*, vol. 7, (9), pp. 1077-1086, November 2007.
- J6. T. Clancy, J. Hecker, T. O'Shea, E. Stuntebeck. "Applications of Machine Learning to Cognitive Radio Networks," *IEEE Wireless Communications*, vol. 14, (4), pp. 47-52, August 2007.
- J7. A. Mishra, M. Shin, N. Petroni, T. Clancy, W. Arbaugh. "Proactive Key Distribution using Neighbor Graphs," *IEEE Wireless Communications*, vol. 11, (1), pp. 26-36, February 2004.

Conferences and Workshops:

- C1. B. Wang, R. Liu, T. Clancy. "Evolutionary Game Framework for Behavior Dynamics in Cognitive Radio Networks," IEEE Global Communications Conference (GLOBECOM), December 2008.
- C2. Y. Wu, B. Wang, R. Liu, T. Clancy. "Collusion-Resistant Multi-Winner Spectrum Auction for Cognitive Radio Networks," IEEE Global Communications Conference (GLOBECOM), December 2008.
- C3. W. Lin, R. Liu, T. Clancy. "Modulation Forensics for Space Time Coding in Wireless Communications," SDR Forum Technical Conference (SDR), October 2008.
- C4. Y. Wu, B. Wang, R. Liu, T. Clancy. "A Multi-Winner Cognitive Spectrum Auction Framework with Collusion-Resistant Mechanisms," IEEE Dynamic Spectrum Access Networks Conference (DySPAN), October 2008.
- C5. M. Seligman, B. Walker, T. Clancy. "Delay-Tolerant Network Experiments of the MeshTest Wireless Testbed," ACM MobiCOM Challenged Networks (CHANTS) Workshop, September 2008.
- C6. A. Mills, B. Smith, T. Clancy, E. Soljanin, S. Vishwanath. "On Secure Communication over Wireless Erasure Networks," IEEE International Symposium on Information Theory (ISIT), July 2008.
- C7. N. McCarthy, E. Blossom, N. Goergen, T. O'Shea, T. Clancy. "High-Performance SDR: GNU Radio and the IBM Cell Broadband Engine," Virginia Tech Wireless Personal Communications Symposium, June 2008.
- C8. T. Clancy, N. Goergen. "Security in Cognitive Radio Networks: Threats and Mitigation," Third International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CrownCom), May 2008.
- C9. A. Soysal, S. Ulukus, T. Clancy. "Channel Estimation and Adaptive M-QAM in Cognitive Radio Links," IEEE International Conference on Communications (ICC), May 2008.

- C10. B. Walker, T. Clancy. "A Quantitative Evaluation of the MeshTest Testbed," IEEE Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCom), March 2008.
- C11. T. Clancy. "Adaptation Overhead in Time-Varying Cognitive Radio Channels," IEEE CCNC Workshop on Cognitive Radio Networks (CRN), January 2008.
- C12. T. O'Shea, T. Clancy, H. Ebeid. "Practical Signal Detection and Classification in GNUradio," SDR Forum Technical Conference (SDR), November 2007.
- C13. T. Clancy, Z. Ji, B. Wang, R. Liu. "Planning Approach to Dynamic Spectrum Access in Cognitive Radio Networks," IEEE Global Communications Conference (GLOBECOM), November 2007.
- C14. B. Walker, J. Glenn, T. Clancy. "Analysis of Simple Counting Protocols for Delay-Tolerant Networks," ACM MobiCOM Challenged Networks Workshop (CHANTS), September 2007.
- C15. T. Clancy. "Dynamic Spectrum Access: The Capacity versus Complexity Tradeoff," Virginia Tech Symposium on Wireless Personal Communications, June 2007.
- C16. T. Clancy, B. Walker. "MeshTest: Laboratory Testbed for Large Wireless Topologies," IEEE Conference on Testbeds and Research Infrastructure (TridentCom), May 2007.
- C17. T. Clancy. "Achievable Capacity under the Interference Temperature Model," IEEE Conference on Computer Communications (INFOCOM), May 2007.
- C18. E. Stuntebeck, T. O'Shea, J. Hecker, T. Clancy. "Architecture for an Open-Source Cognitive Radio," SDR Forum Technical Conference (SDR), November 2006.
- C19. T. Clancy, B. Walker. "Spectrum Shaping for Interference Management in Cognitive Radio Networks," SDR Forum Technical Conference (SDR), November 2006.
- C20. T. Clancy, B. Walker. "Predictive Dynamic Spectrum Access," SDR Forum Technical Conference (SDR), November 2006.
- C21. T. Clancy, W. Arbaugh. "Measuring Interference Temperature," Virginia Tech Symposium on Wireless Personal Communications, June 2006.
- C22. T. Clancy, N. Kiyavash, D. Lin. "Secure Smartcard-Based Fingerprint Authentication," ACM SIGMM Workshop on Biometrics Methods and Applications (WBMA), November 2003.
- C23. N. Boston, T. Clancy, Y. Liow, J. Webster. "Genus Two Hyperelliptic Curve Coprocessor," Workshop on Cryptographic Hardware and Embedded Systems (CHES), LNCS vol. 2523, pp 400–414, August 2002.
- C24. J. Predina, et al. "Use of Apodization to Improve the Quality of Radiometric Measurements from Interferometric Sounders," Twelfth International TOVS Study Conference, March 2002.

Theses, Tech Reports, Invited Papers:

- T1. T. Clancy. "Dynamic Spectrum Access in Cognitive Radio Networks," Ph.D. Dissertation, University of Maryland, April 2006.
- T2. R. Blahut, T. Clancy, et al.. "Secure Middleware for Infrastructure Systems," Technical Report, Coordinated Science Laboratory, University of Illinois, January 2004.
- T3. T. Clancy. "FPGA-based Hyperelliptic Curve Cryptosystems," AMS Central Section Meeting, Special Session on Cryptography and Computational Number Theory, *invited paper*, April 2003.
- T4. T. Clancy. "Analysis of FPGA-based Hyperelliptic Curve Cryptosystems," Master's Thesis, University of Illinois, December 2002.

Standards Work:

- S1. T. Clancy, W. Arbaugh. "EAP Password Authenticated Exchange," RFC 4746, Informational, November 2006.

- S2. T. Clancy, M. Nakhjiri, V. Narayanan, L. Dondeti. “Handover Key Management and Re-Authentication Problem Statement,” RFC 5169, Informational, March 2008.
- S3. T. Clancy, H. Tschofenig. “EAP Generalized PSK (GPSK),” draft-ietf-emu-eap-gpsk, Internet Draft, Active, Standards Track.
- S4. P. Calhoun, M. Montemurro, D. Stanley (Eds.). “CAPWAP Protocol Specification,” draft-ietf-capwap-protocol-specification, Active, Standards Track.
- S5. P. Calhoun, M. Montemurro, D. Stanley (Eds.). “CAPWAP Protocol Binding for IEEE 802.11,” draft-ietf-capwap-protocol-binding-ieee80211, Active, Standards Track.
- S6. S. Kelly, T. Clancy. “CAPWAP Threat Analysis for 802.11 Deployments,” draft-ietf-capwap-threat-analysis, Internet Draft, Active, Informational Track.
- S7. V. Narayanan, L. Dondeti, C. Vogt, T. Clancy. “Security Requirements for IP MObility Protocols,” draft-vidya-ip-mobility-sec-reqs, Internet Draft, Active, Best Current Practices Track.
- S8. V. Narayanan, L. Dondeti, C. Vogt, T. Clancy. “IP Mobility Protocols – Threat Analysis,” draft-vidya-ip-mobility-threats, Internet Draft, Active, Best Current Practices Track.
- S9. T. Clancy. “EAP Method Support for Transporting AAA Payloads,” draft-clancy-emu-aaapay, Active, Standards Track.
- S10. T. Clancy, K. Hoepfer. “Channel Binding Support for EAP Methods,” draft-clancy-emu-chbind, Active, Standards Track.
- S11. T. Clancy. “HOKEY Re-authentication Protocol Plan,” draft-clancy-hokey-plan, Internet Draft, Expired, Informational Track.
- S12. T. Clancy, N. Petroni, W. Arbaugh. “Technique for Method-Specific Fast EAP Rekeying,” draft-clancy-eap-rekeying, Internet Draft, Expired, Experimental Track.

Invited Lectures, Talks, and Panels

- P1. “New protocol standards for wireless mobility: CAPWAP and HOKEY”, Security for Seamless Mobility Forum, IEEE Globecom 2008, New Orleans, December 2008.
- P2. “Game Theory and Dynamic Spectrum Access”, Panelist, DSO Emerging Spectrum Technology Workshop, March 2008.
- P3. “Security Threats to Intelligent Wireless Networks”, Security and Privacy for 4G Workshop, IEEE Globecom 2007, Washington, DC, November 2007.
- P4. “Securing Next-Generation Mobile Networks: How Far Are We?”, Panelist, Security and Privacy for 4G Workshop, IEEE Globecom 2007, Washington, DC, November 2007.
- P5. “Challenges in Signal Detection and Identification”, SASDCRT Symposium, Naval Postgraduate School, Monterey, CA, September 2007.
- P6. “WiMAX Security”, Briefing for Ron Jost, Deputy Assistant Secretary of Defense & DoD CTO for Wireless Technologies, July 2007.
- P7. “Software-Defined and Cognitive Radio”, University of Maryland Telecommunications Seminar, College Park, MD, February 2007.
- P8. “Whither WiMAX?”, Red Blue (ReBl) Symposium, Johns Hopkins APL, Laurel, MD, October 2006.
- P9. “Open-Source Cognitive Radio”, SASDCRT Symposium, Naval Postgraduate School, Monterey, CA, September 2006.
- P10. “Unlicensed Devices in Licensed Bands”, University of Illinois Communications Seminar, Urbana, IL, May 2006.

- P11. “CAPWAP System Security”, IETF CAPWAP Working Group, Vancouver, BC, November 2005.
- P12. “Interference Temperature Multiple Access”, Virginia Tech Wireless Seminar, Blacksburg, VA, November 2005.
- P13. “EAP Password Authenticated Exchange”, IETF EAP Working Group, San Diego, CA, August 2004.
- P14. “Password Authentication in the Wireless World”, Rose-Hulman Institute of Technology, Terre Haute, IN, March 2004.
- P15. “Provably Secure Middleware for Distributed Application Development”, Boeing Phantomworks, Seattle, WA, November 2003.
- P16. “FPGA-Based Hyperelliptic Curve Cryptosystems”, AMS Central Section Meeting, Indiana University, Bloomington, April 2003.
- P17. “On the Feasibility and Security of Biometric Cryptosystems”, Rose-Hulman Institute of Technology, Terre Haute, IN, March 2003.

Teaching

- Lecturer, Communications Networks (3cr), UMD/ECE (2008, 2009)
- Lecturer, Computer and Network Security (3cr), UMD/ENTS (2008)
- Lecturer, Introduction to Wireless LAN Security (8hr), DoD (2005, 2007, 2008)
- Lecturer, Wireless Networks (24hrs), DoD (2007)
- Supervisor, Independent Study, Topics in Software-Defined Radio (3cr), UMD/ECE (2007)
- Lecturer, Software-Defined and Cognitive Radio (4hr), IEEE MILCOM (2007)
- Assistant, Cryptology (3cr), UMD/CS (2003)
- Lecturer, UNIX Systems Administration using Solaris (16hr), IU/CS (2001, 2002, 2003)
- Assistant, Communication Networks for Computers (3cr), UIUC/ECE (2001)
- Lecturer, Computer and Network Security (16hr), IU/CS (2001)

Research Supervised

- Todd Finkler, Ph.D. Student, ECE, University of Maryland (co-advisor)
- Nate Goergen, Ph.D. Student, ECE, University of Maryland (advisor)
- Ahmed Ibrahim, Ph.D. Student, ECE, University of Maryland (committee member)
- Scott Kim, Ph.D. Student, ECE, University of Maryland (co-advisor)
- Eric Like, Ph.D. Student, EE, Air Force Institute of Technology (committee member)
- Tejas Patel, M.S. Student, ENTS, University of Maryland (advisor)
- Alkan Soysal, Ph.D. ECE (2008), University of Maryland (committee member)

Professional Activities

- Internet Engineering Task Force (IETF)
 - **Chair**, Handover Keying (HOKEY) Working Group, *2006–present*

- **Security Advisor**, Extensible Authentication Protocol (EAP) Working Group, *2005–present*
- **Security Advisor**, Control and Provisioning of Wireless Access Points (CAPWAP) Working Group, *2006–present*
- **Member**, Security Directorate (SEC DIR), *2006–present*
- **IEEE**: Expert reviewer for various WLAN security protocol standards (802.11r, 802.11s)
- Conference Service:
 - **Program Chair**: DoD WMAN Symposium (2006, 2008)
 - **Session Chair**: SDR Forum (2008)
- **Professional Societies**: IEEE Member, ACM Member
- Amateur Radio, KB9ZNF, Technician Class

Honors and Awards

- Outstanding Paper Award, “Architecture for an Open-Source Cognitive Radio,” Software Defined Radio Forum Technical Conference (2006)
- Outstanding Paper Award, “Spectrum Shaping for Interference Management in Cognitive Radio Networks,” Software Defined Radio Forum Technical Conference (2006)
- DoD Deckert-Foster Engineering Award, WLAN Team (2006)
- Best Paper Award, “Measuring Interference Temperature,” Virginia Tech Symposium on Wireless Personal Communications (2006)
- Graduate Fellowship, University of Maryland, Department of Computer Science (2003-2004)