

# Walter O. Krawec

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*(Updated August 2024)*

## Education:

### **Ph.D. Computer Science**

Stevens Institute of Technology, Hoboken NJ

Dissertation: *Semi-Quantum Key Distribution: Protocols, Security Analysis, and New Models*

Graduated May 2015

### **MA Mathematics**

University at Albany (SUNY), Albany NY

Graduated May 2010

### **BA Mathematics**

Mount Saint Mary College, Newburgh NY

Graduated May 2008

## Professional Experience:

Associate Professor of Computer Science & Engineering  
**University of Connecticut**, Storrs CT 2023-Present

Assistant Professor of Computer Science & Engineering  
**University of Connecticut**, Storrs CT 2017-2023

Assistant Professor of Computer Science  
**Iona College**, New Rochelle NY 2015-2017

Research Assistant  
**Stevens Institute of Technology**, Hoboken NJ 2011-2015

Instructor  
**University at Albany (SUNY)**, Albany NY 2010-2011

## Funding:

### External:

- **NIUVT:** Underwater Quantum Key Distribution  
Principle Investigator, \$132,500 (1/1/24 to 12/31/25)
- **NSF:** CAREER: Hybrid Approaches to Quantum Cryptography: New Methods and Protocols  
Principle Investigator, \$497,433 (3/15/22 to 2/28/27)
- **Comcast:** Advanced Modular Quantum Key Distribution Software Stack  
Principle Investigator, \$15,000 (5/23/2021 to 5/22/2022)
- **NSF:** FET: Small: Theoretical Foundations and Applications of High Dimensional Quantum Communication  
Principle Investigator, \$317,846 (9/30/20 to 9/29/23)
- **NSF:** CIF: Small: Secure Quantum Communication with Limited Resources  
Principle Investigator, \$309,582 (10/1/18 to 9/30/22)
- **Comcast:** Development of Experimental Test-Bed for Multi-User Quantum Communication Protocols  
Principle Investigator, \$225,125 (4/1/2019 to 2/29/2020)
- **Comcast:** Survey of Practical Quantum Key Distribution Systems  
Principle Investigator, \$27,129 (8/1/18 to 12/31/20)

### Internal:

- **University of Connecticut (REP):** Analyzing the Security of Quantum Cryptographic Protocols through Classical-Quantum Sampling  
Principle Investigator, \$18,069 (9/1/2019 to 6/1/2020)
- **University of Connecticut:** UConn Scholarship Facilitation Fund (SFF)  
Principle Investigator, \$1120.12 (08/18 to 09/18)

## Teaching Experience:

### University of Connecticut, Storrs CT

2017-Present

- Introduction to Computing for Engineers
  - Redesigned course in a “flipped” format
- Introduction to Computer and Network Security
- Cryptography
- Introduction to Quantum Computing
- Quantum Computing, Cryptography, and Networking

**Iona College**, New Rochelle NY 2015-2017

- Cryptography (Spring 2016, Spring 2017)
- Computer Networking and Network Programming (Spring 2016, Spring 2017)
- Introduction to Robotics (Fall 2017)
- Network Security (Fall 2016)
- Automata and Formal Languages (Fall 2016)
- Computer Science II (Spring 2016, Fall 2016)
- Data Structures and Algorithm Analysis (Fall 2015)
- Programming Languages (Fall 2015)

**University at Albany (SUNY)**, Albany NY 2010-2011

- Algebra and Calculus I (Fall 2010)
- Calculus I (Spring 2011)

**Awards:**

Robert Crooks Stanley Graduate Fellowship 2014-2015  
**Stevens Institute of Technology**

**Invited Talks:**

Quantum Cryptography over Noisy Networks and Devices May. 21, 2024  
*2024 Future of Semiconductor Workshop: Quantum Computing and Systems*

A Modular QKD Software Stack Sep. 22, 2021  
*ATIS: Quantum-Safe Communication and Information Initiative (QSII)*

Quantum Sampling and QKD Security Analysis May 27, 2021  
*Quantum Reading Group, University of Massachusetts, Amherst*

Quantum Key Distribution with Limited Resources. Nov. 15, 2019  
*CICS Seminar. University of Massachusetts, Amherst*

Quantum Computing – The Final Frontier? Aug. 5, 2019  
*CableLabs Summer Conference*

Quantum Key Distribution. June 8, 2018  
*Comcast Quantum Computing Working Group*

Quantum Computing. Feb. 16, 2018  
*University of Connecticut EE-CS Graduate Seminar*

Semi-Quantum Key Distribution. Oct. 24, 2017  
*University of Connecticut ECE/CSE Security Seminar*

**Publications:**

(\* Represents a student coauthor.)

***Peer-Reviewed Journal and Conference Papers:***

1. R. Maule, N.K. Panigrahy, N.L. Anipeddi, P. Dhara, D. Kilbane, Md.Z. Hossain, W.O. Krawec, D. Towsley, and B. Wang. Fair and Efficient Scheduling Strategies for Satellite Assisted Quantum Key Distribution Systems. To appear: Proc IEEE QCE 2024.
2. W.O. Krawec, B. Wang, and R. Brown. Finite Key Security of Simplified Trusted Node Networks. To appear: Proc IEEE QCE 2024. pre-print available online: arXiv:2404.17420
3. H. Iqbal and W.O. Krawec. New Security Proof of a Restricted High-Dimensional QKD Protocol. To appear: Proc. IEEE ISIT 2024. pre-print available online: arXiv:2307.09560
4. O. Amer, W.O. Krawec, V.U. Manfredi, and B. Wang. Dynamic Routing and Post-processing Strategies for Hybrid Quantum Key Distribution Networks. To appear: Proc. ICDCS 2024. pre-print available online: arXiv:2212.03144
5. M. Gado, M. Ismail, and W.O Krawec. Upgrading the Cyber Layer of Power Systems to Support Semi-Quantum Key Distribution. 2024 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT).
6. W.O Krawec. A New Security Proof for Twin Field QKD. MDPI Applied Sciences, Invited Paper for Special Edition on Recent Development and Application of Quantum Communication and Security Protocols, Volume II.
7. W.O Krawec. Entropic Uncertainty for Biased Measurements. Proc. IEEE QCE 2023. Pages 1220-1230. pre-print available online: arXiv:2305.09753
8. J. Guskind\* and W.O Krawec. Semi-Quantum Random Number Generation. Proc. IEEE QCE 2023. Pages 1211-1219 pre-print available online: arXiv:2210.16427
9. W.O Krawec, R. Liss, T. Mor. Security Proof Against Collective Attacks for an Experimentally Feasible Semi-Quantum Key Distribution Protocol. IEEE Transactions on Quantum Engineering, 2023. pre-print available online: arXiv:2012.02127
10. W. O. Krawec. Improving Bit Generation Rates for Quantum Random Number Generators. Proc. SPIE Quantum Information Science, Sensing, and Computation XV. Vol. 12517, pages 68-77, 2023.
11. W. O. Krawec (2022). Security of a high dimensional two-way quantum key distribution protocol. To appear: *Advanced Quantum Technologies*. Pre-print available online: arXiv:2203.02989
12. S. Mutreja & W. O. Krawec (2022). Improved Semi-Quantum Key Distribution with Two Almost-Classical Users. To appear: *Quantum Information Processing*. Pre-print available online: arXiv:2203.10567
13. O. Amer, W. O. Krawec, and V. Garg. A Standardized Design for Sifting in Quantum Key Distribution Software. Proc. IEEE Globecom Workshop on 6G-Quantum Communication

Networks, 2022. Pages 808-813.

14. K. Yao\*, W. O. Krawec, & J. Zhu (2022). Quantum sampling for finite key rates in high dimensional quantum cryptography. *IEEE Transactions on Information Theory*, 68 (5), pp. 3144-3163. Pre-print available online: arXiv:2012.04151
15. O. Amer\* & W. O. Krawec (2022) High-Dimensional Quantum Conference Key Agreement. To appear: *Proc. IEEE International Symposium on Information Theory (ISIT)*. Pre-print available online: arXiv:2202.00140
16. W. O. Krawec (2022). Quantum random number generation with practical device imperfections. *Proc. Quantum Information Science, Sensing, and Computation XIV* vol. 12093 pp. 44-52.
17. J. Guskind\* & W. O. Krawec (2022). Mediated semi-quantum key distribution with improved efficiency. *Quantum Science and Technology*, 7(3) 035019. Pre-print available online: arXiv:2111.01627
18. Z. Tang, P. Zhang, W. O. Krawec, & L. Wang (2022). Quantum Networks for Resilient Power Grids: Theory and Simulated Evaluation. To appear: *IEEE Transactions on Power Systems*.
19. Bae, M.\*, & Krawec, W. O. (2021). Semi-source independent quantum walk random number generation. *Proc: IEEE Information Theory Workshop (ITW)* pp. 1-6. arXiv preprint arXiv:2102.02252.
20. H. Iqbal\* & W. O. Krawec (2021). Analysis of a High-Dimensional Extended B92 Protocol. *Quantum Information Processing* vol. 20 (10) pp 1-22. Pre-print available online: arXiv:2106.11460
21. Amer, O.\*, Garg, V., and Krawec, W.O. (2021). An Introduction to Practical Quantum Key Distribution. *IEEE Aerospace and Electronic Systems Magazine*, 36(3), pp. 30-55
22. Tang, Z., Zhang, P., & Krawec, W. O. (2021). A Quantum Leap in Microgrids Security: The Prospects of Quantum-Secure Microgrids. *IEEE Electrification Magazine*, 9(1), 66-73.
23. S. Han, W.O. Krawec, and F. Miao. (2020) A Game Theoretic Security Framework for Quantum Cryptography: Performance Analysis and Application. *Quantum Information Processing*, vol. 19 (10), pages 1-24.
24. O. Amer\*, W.O. Krawec., and B. Wang. (2020) Efficient Routing for Quantum Key Distribution Networks. *Proc. IEEE Quantum Computing and Engineering (QCE) 2020*, pp. 137-147. pre-print available online: arXiv:2005.12404
25. H. Iqbal\* and W.O. Krawec. (2020) High-Dimensional Semi-Quantum Cryptography. *IEEE Transactions on Quantum Engineering* vol. 1, pages 1-17. pre-print available online: arXiv:1907.11340
26. Tang, Z., Zhang, P., Krawec, W.O., and Jiang, Z. (2020). Programmable Quantum Networked Microgrids. *IEEE Transactions on Quantum Engineering* vol. 1 pp 1-13
27. O. Amer\* and W.O. Krawec. Finite Key Analysis of the Extended B92 Protocol. *Proc. IEEE International Symposium on Information Theory (ISIT) 2020*, pp. 1944-1948. pre-print available online: arXiv:2001.05940

28. Tang, Z., Qin, Y., Jiang, Z., Krawec, W. O., & Zhang, P. (2020). Quantum-Secure Microgrid. *IEEE Transactions on Power Systems* vol. 36 (2), pp. 1250-1263. arXiv preprint arXiv:2001.02301.
29. Tang, Z., Qin, Y., Jiang, Z., Krawec, W. O., & Zhang, P. (2020). Quantum-secure networked microgrids. In 2020 IEEE Power & Energy Society General Meeting (PESGM) pp. 1-5.
30. W.O. Krawec. A New High-Dimensional Quantum Entropic Uncertainty Relation with Applications. *Proc. IEEE International Symposium on Information Theory (ISIT) 2020*, pp. 1978-1983. pre-print available online: arXiv:2005.04773
31. W.O. Krawec and S.A. Markelon\*. A Semi-Quantum Extended B92 Protocol and its Analysis. *Proc. SPIE 11391, Quantum Information Science, Sensing, and Computation XII, 113910G (24 April 2020)*
32. H. Iqbal\* and W.O. Krawec. Semi-Quantum Cryptography. *Quantum Information Processing* (2020) 19 (3), 97. pre-print available online: arXiv:1910.05368
33. W.O. Krawec. Quantum Sampling and Entropic Uncertainty. *Quantum Information Processing* (2019) 18 (12), 368. pre-print available online: arXiv:1804.08788
34. W.O. Krawec. Multi-mediated semi-quantum key distribution. In 2019 *IEEE Globecom Workshops (GC Wkshps)* (pp. 1-6). IEEE.
35. O. Amer\* and W.O. Krawec. Semi-Quantum Key Distribution with High Quantum Noise Tolerance. *Physical Review A* 100 (2) 022319. pre-print available online: arXiv:1812.04144 (2019)
36. A. Gagliano\*, W.O. Krawec, and H. Iqbal\*. From Classical to Semi-Quantum Secure Communication. To appear: *Proc. IEEE International Symposium on Information Theory (ISIT) 2019*. pre-print available online: arXiv:1901.01611
37. W.O. Krawec, S. Picek, and D. Jakobovic. Evolutionary Algorithms for the Design of Quantum Protocols. In *Applications of Evolutionary Computation (EvoApplications) 2019*. Lecture Notes in Computer Science, vol. 11454, Springer.
38. W.O. Krawec and E. Geiss\*. Semi-Quantum Key Distribution with Limited Measurement Capabilities. *Proc. International Symposium on Information Theory and Its Applications (ISITA)*, Singapore, 2018, pp. 462-466
39. C. Vlachou, W.O. Krawec, P. Mateus, N. Paunkovic, and A. Souto. Quantum Key Distribution with Quantum Walks. *Quantum Information Processing* (2018) 17:288.
40. W.O. Krawec and F. Miao. Game Theoretic Security Framework for Quantum Key Distribution. *International Conference on Decision and Game Theory for Security*. Springer, pp. 38-58. (2018)
41. W.O. Krawec. Key-Rate Bound of a Semi-Quantum Protocol Using an Entropic Uncertainty Relation. To appear: *IEEE International Symposium on Information Theory (ISIT) 2018*.
42. W. O. Krawec and S. A. Markelon\*. Genetic Algorithm to Study Practical Quantum Adversaries. *Proc. ACM GECCO 2018*. pp. 1270-1277. (2018)
43. W. O. Krawec. Practical Security of Semi-Quantum Key Distribution. *Proc. SPIE Quantum Information Science, Sensing, and Computation X. Vol. 10660 (2018)*.

44. W.O. Krawec, M.G. Nelson\*, E.P. Geiss\*. Automatic Generation of Optimal Quantum Key Distribution Protocols. *Proc. ACM GECCO 2017, Berlin (2017)*. pp. 1153-1160.
45. W.O. Krawec. Quantum Key Distribution with Mismatched Measurements over Arbitrary Channels. *Quantum Information & Computation*. Vol 17, No. 3 and 4, pages 209-241. (2017) Available online: arXiv:1608.07728
46. W.O. Krawec. An Improved Asymptotic Key Rate Bound for a Mediated Semi-Quantum Key Distribution Protocol. *Quantum Information & Computation*. Vol. 16, No. 9 and 10, pages 813-834 (2016). Available online: arXiv:1509.04797
47. W.O. Krawec. An Asymptotic Analysis of a Three State Quantum Cryptographic Protocol. *Proc. IEEE International Symposium on Information Theory (ISIT), Barcelona 2016*. Pages 2489 – 2493 (2016). Available online: arXiv:1601.00185
48. W.O. Krawec. Security of a Semi-Quantum Protocol where Reflections Contribute to the Secret Key. *Quantum Information Processing*, 15 (5), 2067-2090 (2016). Available online: arXiv:1510.07181
49. W.O. Krawec. A Genetic Algorithm to Analyze the Security of Quantum Cryptographic Protocols. *Proc. IEEE CEC 2016 (Vancouver Canada)*. Pages 2098-2105. (2016)
50. W.O. Krawec. Security Proof of a Semi-Quantum Key Distribution Protocol. *Proc. IEEE International Symposium on Information Theory (ISIT), Hong Kong 2015*. Pages 686-690 (2015). Available online: arXiv:1412.0282
51. W.O. Krawec. Mediated Semi-Quantum Key Distribution. *Physical Review A*, 91 032323 (2015). Available online: arXiv:1411.6024
52. W.O. Krawec. History Dependent Quantum Walk on the Cycle with an Unbalanced Coin. *Physica A: Statistical Mechanics and its Applications*, 428, pages 319-331 (2015). Available online: arXiv:1411.6298
53. W.O. Krawec. n-Player Impartial Combinatorial Games with Random Players. *Theoretical Computer Science*, 569, pages 1-12 (2015).
54. W.O. Krawec. Restricted Attacks on Semi-Quantum Key Distribution Protocols. *Quantum Information Processing*, 13 (11), pages 2417-2436 (2014)
55. W.O. Krawec. On the Application of Quantum Decision Theory to Artificial Life. *Proc. IEEE CEC*, pages 3323-3330, Cancun Mexico (2013)
56. W.O. Krawec. Regarding Modular Multiplicative Graphs. *Graph Theory Notes of NY LXIV*, pages 45-48. (2013)
57. W.O. Krawec. On the Emergent Behaviors of a Robot Controlled by a Real-Time Evolving Neural Network. *Proc. Of the 13th International Conference on the Simulation and Synthesis of Living Systems (ALife 13)*, pages 364-371, East Lansing MI. (2012)
58. W.O. Krawec. Modular Multiplicative Graphs. *Ars Combinatoria*. Vol. 124, pages 33-40
59. W.O. Krawec. Analyzing n-Player Impartial Games. *International Journal of Game Theory*, 41 (2) pages 345-367 (2012)

***Posters and Poster Papers (Peer-Reviewed):***

60. W.O. Krawec. Applications of Sampling-Based Entropic Uncertainty Relations. *International Conference on Quantum Communication, Measurement and Computing (QCMC) 2022.*
61. O. Amer\*, K. Freyberg\*, V. Garg, & W. O. Krawec (2021). A Modular Quantum Key Distribution Software Stack for Rapid Experimental Prototyping. *Proc. IEEE International Conference on Quantum Computing and Engineering (QCE)* pp 467-468.
62. O. Amer\*, W. O. Krawec, and B. Wang. (August 2021) Efficient Routing in Quantum Key Distribution Networks with Trusted Nodes and Repeaters. *International Conference on Quantum Cryptography (QCrypt) 2021.*
63. F. Massa, P. Yadav, A. Moqanaki, W. O. Krawec, P. Mateus, N. Paunkovic, A. Souto, P. Walther. Experimental semi-quantum key distribution with classical users. *International Conference on Quantum Cryptography (QCrypt) 2020.*
64. W.O. Krawec. Quantum Sampling and Entropic Uncertainty, with Applications. *9<sup>th</sup> International Conference on Quantum Cryptography (Qcrypt) 2019, Montreal Canada.*
65. C. Vlachou, W.O. Krawec, P. Mateus, N. Paunkovic and A. Souto Quantum Walks and Quantum Key Distribution. *9<sup>th</sup> International Conference on Quantum Cryptography (Qcrypt) 2019, Montreal Canada.*
66. W.O. Krawec. Mismatched Measurements and Quantum Key Distribution. *6<sup>th</sup> International Conference on Quantum Cryptography (QCrypt) 2016, Washington D.C.*
67. W.O. Krawec. An Algorithm for Evolving Multiple Quantum Operators for Arbitrary Quantum Computational Problems. *Proc. ACM GECCO (Companion) 2014, Vancouver Canada, pages 59-60*
68. W.O. Krawec. Minimal Variable Quantum Decision Makers for Robotic Control. *Proc. ACM GECCO (Companion) 2014, Vancouver Canada, pages 33-34*
69. W.O. Krawec. Using Evolutionary Techniques to Analyze the Security of Quantum Key Distribution Protocols. *Proc. ACM GECCO (Companion) 2014, Vancouver Canada, pages 171-172*

***Theses:***

70. W.O. Krawec. Semi-Quantum Key Distribution: Protocols, Security Analysis, and New Models. Ph.D. Thesis, Stevens Institute of Technology, Hoboken NJ, May 2015
71. W.O. Krawec. Analyzing n-Player Impartial Games. MA Thesis, University at Albany (SUNY), Albany NY, May 2010

***Abstracts:***

72. W.O. Krawec. Security in the Semi-Quantum Setting. Presented at the AMS/MAA Joint Math Meetings, San Antonio TX, January 2015



***Manuscripts:***

73. W.O. Krawec. Simulating Quantum Algorithms with Q-Prog.

74. M. Daven and W.O. Krawec. Three-legged Spiders with Even Edge Count are Harmonious

***Other (Not Peer-Reviewed) Articles:***

75. W.O. Krawec. Evolutionary Robotics (Parts I and II). *Circuit Cellar Ink*. November-December 2015.

76. W.O. Krawec. Experiments in Developmental Robotics (Parts I and II). *Circuit Cellar Ink*. September-October 2013

77. W.O. Krawec. Creating an HC11 OS. *Dr. Dobbs Journal*. December 2008

78. W.O. Krawec. Programming the Pocket PC. *Nuts & Volts Magazine*. June 2006

79. W.O. Krawec. Palm Programming: An Introduction. *Nuts & Volts Magazine*. October 2004

80. W.O. Krawec. An HC11 File Manager. *Circuit Cellar Online*. April-May 2001

**Professional Service:**

I have served as reviewer for the following journals and conferences:

- *Nature Quantum Information*
- *New Journal of Physics*
- *IEEE Transactions on Information Theory*
- *IEEE Quantum Computing and Engineering Conference*
- *IEEE Information Theory Workshop*
- *Nature Physics*
- *Quantum Information & Computation*
- *SIAM Reviews (SIREV)*
- *IEEE International Symposium on Information Theory (ISIT)*
- *Quantum Information Processing*
- *Theoretical Computer Science*
- *Discrete Mathematics*
- *Discrete Applied Mathematics*
- *Scientific Reports*

I am also a reviewer for the *AMS Mathematical Reviews* and serve on NSF panels.

I am a regularly PC member of the *Attacks and Solutions in Hardware Security (ASHES)* workshop at ACM CCS.

I am an Associate Editor for the journal *Quantum Information Processing*.

## **Students:**

### **PhD:**

1. Omar Amer: Fall 2018 – 2022. Now at JP Morgan Chase Bank.
2. Hasan Iqbal: Fall 2018 – 2024. Now at University of Wyoming.
3. Trevor Thomas: Fall 2023 - Present

### **Undergraduate:**

1. Adrian Harkness (2022)
2. Saachi Mutreja (2021)
3. Kevin Freyberg (2020-present)
4. Julia Guskind (2019-present)
5. Keegan Yao (2019-2021)
6. Calvin Roth (2019)
7. Allison Gagliano (2018)
8. Alex Masi (2018)
9. Omar Amer (Honor's Student, Spring 2018)
10. Sam Markelon (2017-2020)
11. Michael Nelson (2017)
12. Eric Geiss (2016-2017)