

# Dijiang Huang

(Chief Scientist)

Beijing Academy of Blockchain and  
Edge Computing  
Beijing, China

(Updated as January 2024)

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## RESEARCH AND ACHIEVEMENTS HIGHLIGHTS

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### Research and education areas:

Computer/mobile/edge/cloud/network security; attribute-based encryption & access control; AI/ML enabled security; blockchain and distributed system security.

### Research publications and grants

- Google scholar citations: 8910, h-index: 49 (data: Jan 15, 2024)
- Published 2 professional books and 1 textbook, 10 US patents, over 200 peer-reviewed publications.
- Total basic/applied research awards: total ~\$25M, personal share ~\$11M.

### Awards and recognitions

- IEEE ComSoc Distinguished Lecturer
- ONR Young Investigator
- JSPS (Japan Society for the Promotion of Science) Research Fellow
- HP Innovation and Research Program (IRP) award.
- Member of National Academy of Inventors (NAI)
- Senior members of IEEE and ACM.

### Mentoring and teaching

- Advised and graduated 17 PhDs (5 assistant professors) and 26 MS students.
- Taught CS undergraduate courses and graduate courses in Computer Networks, Computer Network Security, Cloud Computing, and online courses.

### Entrepreneur

- Cofounder of two startup companies: *Athena Network Solutions LLC* and *CyNET LLC*.
- Fulton Entrepreneurial Professor

### Professional Services

- Over 10-year services in IEEE Internet Technical Committee (ITC) and finished the Chair term of the ITC.
- Served 4 journal editorial boards, and 3 IEEE technical working group, and over 40 IEEE and ACM conference and workshop chairs & technical committees.

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## EDUCATION

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(In reverse chronological order)

2004	Ph.D.	Computer & Telecommunication Networking	University of Missouri–Kansas City, USA
2001	M.S.	Computer & Telecommunication Networking	University of Missouri–Kansas City, USA
1995	B.S.	Telecommunications	Beijing University of Posts and Telecommunications, P.R. China

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## POSITION ASSIGNMENTS

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(In reverse chronological order)

1. Dean, Donghai Marine Digital Science Research Institute, 8/2023-present
2. Chief Research Scientist, Beijing Academy of Blockchain and Edge Computing, 2/2022-present
3. Associate Professor: Arizona State University, 8/2011-12/2021
4. Assistant Professor: Arizona State University, 4/2005 – 8/2011
5. Visiting Scientist, International Guest Academic Talents (IGAT)/111 Program, Beijing University of Posts and Telecommunications (BUPT), 2017-2021
6. Co-Founder of CyNET LLC, June 2017 – 2021
7. Co-Founder of Athena Network Solutions LLC, June 2014 – 2021
8. Fulton Entrepreneurial Professor, 2015 - 2018
9. ASU Leadership Academy (TeamLA) 2016-2017
10. Visiting Erskine Fellow, University of Canterbury, New Zealand, July-August 2013
11. JSPS (Japan Society for the Promotion of Science) Research Fellow, Osaka City University, Japan, April-June 2013
12. Visiting Professor: Conservatoire National des Arts et Métiers (CNAM), France, 6/2012-7/2012
13. Visiting Professor: Conservatoire National des Arts et Métiers (CNAM), France, 5/2011-6/2011
14. Post-Doctoral Scholar: University of Missouri–Kansas City, 1/2005 – 4/2005
15. Research Assistant: University of Missouri-Kansas City, 8/1999-12/2004
16. Research Intern: Sprint - Network Design Group, 6/2002 - 8/2002
17. Research Intern: Sprint - Consumer Technology Lab (CTL), 6/2001 - 8/2001

18. Research Intern: Sprint - Broadband Wireless Group (BWG), 5/2000 - 5/2001
19. Network Engineer: Computer Center of Civil Aviation Administration of China (CAAC), 7/1995 - 4/1999

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## AWARDS

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(In reverse chronological order)

### Personal Awards and Recognitions

1. Visiting Scientist, International Guest Academic Talents (IGAT)/111 Program, Beijing University of Posts and Telecommunications (BUPT), 2017-2021
2. IEEE ComSoc Distinguished Lecturer 2019-2020
3. ACM Senior Member, September 2019
4. Member of the National Academy of Inventors, 2019
5. Fulton Engineering KEEN Professorship 2017 – 2018
6. Fulton Entrepreneurial Professor, June 2015 – 2017
7. Fulton Schools of Engineering Best Teacher Award (Top 5%), 2016
8. AzTE Inventor Recognition, 2014 – 2019
9. Visiting Erskine Fellowship, University of Canterbury, New Zealand, July-August 2013
10. JSPS (Japan Society for the Promotion of Science) Fellowship, April-June 2013
11. Conservatoire National des Arts et Métiers (CNAM) visiting scholar fellowship, June 2011, June-July 2012
12. HP Innovation Research Program (IRP) Award, 2011 – 2012
13. IEEE Senior Member, January 2011
14. Office of Naval Research (ONR) Young Investigator Program (YIP) Award, 2010
15. ONR Summer Faculty Fellowship, 2010
16. U.S Air Force Research Lab Summer Visiting Faculty Scholar Program, 2008
17. Nominated by UMKC for the ACM doctoral dissertation award, 2005
18. Distinguish PhD Dissertation Award, Computer Science and Electrical Engineering Department, University of Missouri-Kansas City, 2004.
19. Graduate Studies Distinguished Dissertation Fellowships, University of Missouri-Kansas City, 2002 – 2003.
20. Chancellor's Interdisciplinary PhD merit award, University of Missouri-Kansas City, 2001 – 2002.
21. Student Travel Award, ICNP 2003.
22. Student Travel Award, ICDCS 2003.

23. Travel Grant Award, CRA Academic Careers Workshop, Computing Research Association, 2003.
24. Student Travel Award, ACM SIGCOMM, Pittsburgh, PA August 19-23, 2002.

Project/Publication/Team Awards and Recognitions:

1. West Regional Collegiate Cyber Defense Competition (WCCDC) Finalist, #1 in Injection, and #8 in overall ranking, March 2018. Role: Coach.
2. West Regional Collegiate Cyber Defense Competition (WCCDC) Finalist, #1 in Injection, and #8 in overall ranking, February 2017. Role: Coach.
3. The research article "iDoctor: Personalized and Professionalized Medical Recommendations Based on Hybrid Matrix Factorization" published by Elsevier Future Generation Computer Systems in January 2017 was selected by Elsevier Article Selection Celebrating Computer Science Research in China (<https://www.elsevier.com/physical-sciences/computer-science/article-selection-celebrating-computer-science-research-in-china>), 2017. Role: Contributing Author.
4. TechConnect Defense Innovation Award (CyNET LLC: Moving Target Defense based Security for Cloud Network project), 2017. Role: Cofounder.
5. Reimagine Education Bronze Award in Engineering/IT Discipline (Athena Network Solutions LLC: ThoTh Lab Project), 2016. Role: Cofounder. ([http://content.qs.com/re2016/REIMAGINE\\_EDUCATION\\_AWARDS\\_BOOKLET.pdf](http://content.qs.com/re2016/REIMAGINE_EDUCATION_AWARDS_BOOKLET.pdf))
6. International Conference on Mobile Computing and Ubiquitous Networking (ICMU), Best paper award, 2008. Role: First Author.

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## PRINCIPAL AREAS OF TEACHING AND RESEARCH

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### Teaching

- Computer Networks
- Computer Network Security
- Virtualization and Cloud Computing
- IoT Security

### Research

- Computer Network Security
- Applied Cryptography
- IoT Security
- AI/ML enabled security
- Behavioral Biometrics
- Secure Network Architecture Design

- Mobile Cloud Computing
- Mobile Ad Hoc Network

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## SCIENTIFIC AND PROFESSIONAL SOCIETIES

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- Senior Member, Institute of Electronics and Electric Engineering (IEEE)
- Senior Member, Association for Computing Machinery (ACM)
- Member, National Academy of Inventors (NAI)

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## PUBLICATIONS

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*Note: Authors who were mentored ASU students at the time of publication are marked in Underlines. Authorship order is based on the level of contribution save for the last author position which is typically the faculty that organized and lead the project.*

*Google Scholar page: [https://scholar.google.com/citations?user=Y\\_Bm7IwAAAAJ&hl=en](https://scholar.google.com/citations?user=Y_Bm7IwAAAAJ&hl=en)*

The publications in below are arranged in chronological order.

### U.S. Patents:

1. Dijiang Huang, Jim Luo, Myong Hoon Kang, Qiuxiang Dong, Method and apparatus for achieving fine-grained access control with discretionary user revocation over cloud data, U.S. Patent # U.S 11,310,041, Issued on April 19, 2022
2. Lu, Duo, and Dijiang Huang. "Systems and methods for a multifactor user identification and authentication framework for in-air-handwriting with hand geometry and deep hashing." U.S. Patent 11,120,255, issued September 14, 2021.
3. Dijiang Huang, Duo Lu, "Three-Dimensional In-the-air Motion Based User Login Framework", U.S. Patent # U.S 10,877,568, Issued on December 29, 2020
4. Dijiang Huang, Ankur Chowdhary, and Sandeep Pishoardy, "Security policy analysis framework for distributed software defined networking (SDN) based cloud environments", U.S. Patent # U.S 10,868,737, Issued on December 15, 2020
5. Dijiang Huang, "Systems and Apparatuses for a Secure Mobile Cloud Framework for Mobile Computing and Communication", U.S. Patent # U.S 10,425,411, Issued on September 24, 2019
6. Dijiang Huang and Zhijie Wang, "Enabling Comparable Data Access Control for Lightweight Mobile Devices in Clouds", U.S. Patent # 10,419,404, Issued on September 17, 2019.
7. Dijiang Huang and Zhijie Wang, "Enabling Comparable Data Access Control for Lightweight Mobile Devices in Clouds", U.S. Patent # 9,705,850, Issued on July 11, 2017.
8. Dijiang Huang, "Systems and Apparatuses for a Secure Mobile Cloud Framework for Mobile Computing and Communication", U.S. Patent # 9,357,331, Issued on May 31, 2016.

9. Chun-Jen Chung, Pankaj Khatkar, Tianyi Xing, Jeongkeun Lee, and Dijiang Huang, "Selection of a countermeasure" (Based on our original work "Network Intrusion Detection and Countermeasure Selection in Virtual Network Systems"), U.S. Patent # 9,160,761, Issue date: October 13, 2015.
10. Dijiang Huang and Zhibin Zhou, "Methods, Systems, and Apparatuses for Optimal Group Key Management for Secure Multicast Communication", U.S. Patent # 8,837,738, Issue date: September 16, 2014.

### Tutorials

1. "Moving Target Defense (MTD): A Software Defined Networking (SDN) Approach", *IEEE International Conference on Communications (ICC)*, Kansas City, 2018
2. "Enhancing Cloud Security Through Software Defined Networking Approaches", *IEEE International Conference on Cloud Networking (CloudNet)*, Paris, Nov 2012
3. "Enhancing Cloud Security Through Software Defined Networking Approaches", *International Conference on Network and Service Management (CNSM)*, Las Vegas, Oct 2012
4. "Mobile Cloud Computing", *IEEE International Conference on Consumer Electronics (ICCE)*, January 13, 2012, Las Vegas, USA
5. "Elliptic & Curve Cryptography and Their Applications," *The Fourth IASTED International Conference on Communication, Network, and Information Security (CNIS) 2007*, September 24-26, 2007, UC Berkeley, Berkeley, California, USA

### Published Books

1. Dijiang Huang, Qiuxiang Dong, and Yan Zhu, "Attribute-Based Encryption and Access Control", CRC Press, Publishing Date: February 25, 2020.
2. Dijiang Huang, Ankur Chowdhary, and Sandeep Pishoardy, "Software-Defined Networking And Security: From Theory to Practice", CRC Press, Dec 2018.
3. Dijiang Huang and Huijun Wu, "Mobile Cloud Computing: Foundations and Service Models", *Morgan Kaufmann Publishers (An imprint of Elsevier Science)*, Publishing date: September 22, 2017.
4. Dijiang Huang and SNAC Research Group, "ThoTh Lab: Computer Network Security Lab Manuel", online, 2020.

### Book Chapters (in reverse chronological order)

(Book chapters #1, #2, and #3 are selected through open call for book chapter and book chapter #4 is invited.)

1. Tianyi Xing, Zhenyang Xiong, Dijiang Huang, Deep Medhi, "Cloud Computing Security", *Cloud Services, Networking and Management*, (Eds) N. Fonseca and R. Boutaba, IEEE and Wiley, page 269-294, 2014.
2. Nirav Shah and Dijiang Huang, "DRP: Data Regulation Protocol for Source-End Mitigation of Distributed Denial of Service," *Network Security, Administration and Management: Advancing Technologies and Practices*, D. C. Kar and M. R. Syed (Eds), IGI Global, 2010

3. Dijiang Huang and Zhibin Zhou, "A Secure RFID Access Control Mechanism," *Security in RFID and Sensor Networks*, Y. Zhang, P. Kitsos (Eds), Auerbach Publications, CRC Press, Taylor and Francis Group, 2008
4. Dijiang Huang, "Secure Multi-Path Data Delivery in Wireless Sensor Networks," *Wireless and Sensor Networks Security*, Z. Jiang, Y. Pan (Eds), Nova Science Publishers, Inc. 2008.
5. Deep Medhi and Dijiang Huang, "Secure and Resilient Routing: A Framework for Resilient Network Architectures," *Information Assurance: Dependability and Security in Networked Systems*, Y. Qian, D. Tipper, P. Krishnamurthy, and J. Joshi, (Eds.), Morgan Kaufmann Publishers (an imprint of Elsevier), 2007.

#### Ph.D Dissertation

- PhD Dissertation, "Many-to-Many Secure Group Communication and Its Applications,"  
 Department: Computer Science and Electrical Engineering  
 Institution: University of Missouri-Kansas City  
 Award date: December 17 2004  
 Dissertation Advisor: Deep Medhi  
 Committee Members: Cory Beard, Lein Harn, Appie Van de Liefvoort, Xiaojun Shen, Khosrow Sohraby

#### Refereed Journals and Magazines

1. Zeng, Zhen, Dijiang Huang, Guoliang Xue, Yuli Deng, Neha Vadnere, and Liguang Xie. "ILLATION: Improving Vulnerability Risk Prioritization By Learning From Network." *IEEE Transactions on Dependable and Secure Computing* (2023).
2. Myneni, Sowmya, Kritshekhar Jha, Abdulkhikim Sabur, Garima Agrawal, Yuli Deng, Ankur Chowdhary, and Dijiang Huang. "Unraveled—A semi-synthetic dataset for Advanced Persistent Threats." *Computer Networks* 227 (2023): 109688.
3. Myneni, Sowmya, Garima Agrawal, Yuli Deng, Ankur Chowdhary, Neha Vadnere, and Dijiang Huang. "SCVS: On AI and Edge Clouds Enabled Privacy-preserved Smart-city Video Surveillance Services." *ACM Transactions on Internet of Things* 3, no. 4 (2022): 1-26.
4. Ankur Chowdhary, Abdulkhikim Sabur, Neha Vadnere, and Dijiang Huang. "Intent-Driven Security Policy Management for Software-Defined Systems." *IEEE Transactions on Network and Service Management*, June 16, 2022.
5. Sowmya Myneni, Ankur Chowdhary, Dijiang Huang, and Adel Alshamrani, "SmartDefense: A distributed deep defense against DDoS attacks with edge computing", *Computer Networks*, 2022
6. Sabur, Abdulkhikim, Ankur Chowdhary, Dijiang Huang, and Adel Alshamrani. "Toward scalable graph-based security analysis for cloud networks." *Computer Networks* 206 (2022): 108795.
7. Zhen Zeng, Zhun Yang, Dijiang Huang, and Chun-Jen Chung "LICALITY – Likelihood vs Criticality: Assessing Vulnerabilities Through Logical Reasoning and Machine Learning Approaches", *IEEE Transactions on Network and System Management*, 2022

8. Sowmya Myneni, Garima Agrawal, Yuli Deng, Ankur Chowdhary, Neha Vadnere, and Dijiang Huang, "SCVS: On AI and Edge Clouds Enabled Privacy-Preserved Smart-City Video Surveillance Services", *in press ACM Transactions on Internet of Things*, 2022.
9. Ankur Chowdhary, Abdulhakim Sabur, Dijiang Huang, James Kirby, and Myong Kang, "Object Oriented Policy Conflict Checking Framework in Cloud Networks (OOPC)", *IEEE Transactions on Dependable and Secure Computing*, April 28, 2021.
10. Deng, Yuli, Zhen Zeng, Kritshekhar Jha, and Dijiang Huang. "Problem-Based Cybersecurity Lab with Knowledge Graph as Guidance." *Journal of Artificial Intelligence and Technology*, 2021.
11. Zhu, Yan, Ruyun Yu, E. Chen, and Dijiang Huang. "An Efficient Broadcast Encryption Supporting Designation and Revocation Mechanisms." *Chinese Journal of Electronics* 28, no. 3, pages 445-456, 2019
12. Adel Alshamran, Sowmya Myneni, Ankur Chowdhary, and Dijiang Huang, "A Survey of Advanced Persistent Threats: Techniques, Solutions, Challenges, and Research Opportunities", *IEEE Survey and Tutorials*, 2019
13. Yan Zhu, Ruyun Yu, E. Chen, and Dijiang Huang, "Dual-mode broadcast encryption", *Science China Information Sciences*, 2018.
14. Yan Zhu, Guohua Gan, Ruiqi Guo, and Dijiang Huang, "PHE: An Efficient Tracing and Revoking for Traitors in Cloud File Syncing-and-Sharing", *IEEE Transactions on Cloud Computing*, Volume 6, Issue 4, Pages 1110-1124, Oct-Dec, 2018.
15. Safaa Mahrach, Iman EL MIR, Abdelkrim HAQIQ, Dijiang Huang, "SDN-based SYN Flooding Defense in Cloud", *Journal of Information Assurance & Security*, Vol. 13, Issue 1, pages 30-39, 2018.
16. Oussama Mjihil, Hamid Taramit, Abdelkrim Haqiq, and Dijiang Huang, "Beyond Dynamic Programming: Performance Evaluation and Enhancement of Multi-tenant Cloud Infrastructures." *Journal of Information Assurance & Security*, Vol. 13, Issue 1, pages 21-29, 2018.
17. Zhijie Wang and Dijiang Huang, "Privacy-Preserving Mobile Crowd Sensing in Ad Hoc Networks", *Elsevier Ad Hoc Networks*, Pages 14-26, Volume 73, NO. 1, May 2018.
18. Bo Li, Yijian Pei, Hao Wu, Dijiang Huang, "MADM-based smart parking guidance algorithm", *PLOS one*, Issue 12, NO. 12, 2017.
19. Jin B. Hong, Dong Seong Kim, Chun-Jen Chung, and Dijiang Huang, "A Survey on the Usability and Practical Applications of Graphical Security Models", *Computer Science Review*, Elsevier, Jun 2017
20. Sandeep Pisharody, Janakarajan Natarajan, Ankur Chowdhary, Abdullah Alshalan, and Dijiang Huang, "Brew: A Security Policy Analysis Framework for Distributed SDN-Based Cloud Environments", *IEEE Transactions on Dependable and Secure Computing*, July, 2017.
21. Yin Zhang, Min Chen, Dijiang Huang, Di Wu, Yong Li, "iDoctor: Personalized and Professionalized Medical Recommendations Based on Hybrid Matrix Factorization", *Elsevier Future Generation Computer Systems*, Pages 30-35, Volume 66 Issue C, January 2017. *This paper was selected by Elsevier Article Selection Celebrating Computer Science Research in China* (<https://www.elsevier.com/physical-sciences/computer-science/article-selection-celebrating-computer-science-research-in-china>)



22. Bing Li, Dijiang Huang, Zhijie Wang, and Yan Zhu, "Attribute-based Access Control for ICN Naming Scheme", *IEEE Transactions on Dependable and Secure Computing*, April 2016
23. Abdullah Alshalan, Sandeep Pisharody, and Dijiang Huang, "A Survey of Mobile VPN Technologies", *IEEE Communications Surveys and Tutorials*, Vol PP, Issue 99, November 2015
24. Huijun Wu, Dijiang Huang, and Yan Zhu, "Establishing a personal on-demand execution environment for mobile cloud applications," *Springer Journal on Mobile Networks and Applications (MONET)*, Volume 20, Number 3, pp. 297–307, June, 2015.
25. Zhijie Wang, Dijiang Huang, Yan Zhu, Bing Li, and Chun-Jen Chung, "Efficient Attribute-Based Comparable Data Access Control", *IEEE Transactions on Computers*, Vol 64, Issue 12, Pages 3430-3443, February 2015.
26. Yan Zhu, Dijiang Huang, Xin Wang, and Changjun Hu, "From RBAC to ABAC: Constructing Flexible Data Access Control for Cloud Storage Services", *IEEE Transactions on Service Computing*, Vol 8, Issue 4, pages 601-616, August 2015
27. Zhibin Zhou, Dijiang Huang, and Zhijie Wang, "Efficient Privacy-Preserving Ciphertext-Policy Attribute Based Encryption and Broadcast Encryption", *IEEE Transactions on Computers*, Vol 64, Issue 1, pages 126-138, January, 2015.
28. Shingo Ata, Dijiang Huang, Xuan Liu, Akira Wada, Tianyi Xing, Parikshit Juluri, Chun-Jen Chung, Yasuhiro Sato, Deep Medhi, "SeRViTR: A Framework, Implementation, and a Testbed for a Trustworthy Future Internet", *Computer Networks*, Vol 63, No. 22, April 2014.
29. Yang Qin, Dijiang Huang, and Bing Li, "STARS: A Statistical Traffic Pattern Discovery System for MANETs", *IEEE Transactions on Dependable and Secure Computing (TDSC)*, Vol 11, Issue 2, pages 181-192, March-April, 2014.
30. Le Xu, Dijiang Huang, and Wei-Tek Tsai, "Cloud-Based Virtual Laboratory for Network Security Education", *IEEE Transactions on Education*, Vol 57, Issue 3, Pages 145-150, October 17, 2014.
31. Dijiang Huang, Tianyi Xing, and Huijun Wu, "Mobile Cloud Computing Service Models: A User-Centric Approach", *IEEE networks*, Vol 27, Issue 5, Pages 6-11, Sep-Oct, 2013.
32. Hongbin Liang, Tianyi Xing, Lin X. Cai, Dijiang Huang, Daiyuan Peng and Yan Liu, "Adaptive Computing Resource Allocation for Mobile Cloud Computing", *International Journal of Distributed Sensor Networks*, Vol 2013, 2013.
33. Chun-Jen Chung, Pankaj Khatkar, Tianyi Xing, Jeongkeun Lee, and Dijiang Huang, "NICE: Network Intrusion Detection and Countermeasure Selection in Virtual Network Systems", *IEEE Transactions on Dependable and Secure Computing (TDSC)*, Special Issue on Cloud Computing Assessment, Vol. 10 NO. 4, pages 198-211, July-Aug 2013.
34. Le Xu, Dijiang Huang, Wei-Tek Tsai, and Robert K. Atkinson, "V-Lab: A Mobile, Cloud-Based Virtual Laboratory Platform for Hands-On Networking Courses", *International Journal of Cyber Behavior, Psychology and Learning (IJCBPL)*, Vol 2, Issue 3, pages 73-85, 2012.
35. Hongbin Liang, Lin X. Cai, Dijiang Huang, Xuemin (Sherman) Shen, and Daiyuan Peng, "An SMDP-based Service Model for Inter-domain Resource Allocation in Mobile Cloud Networks", *IEEE Transactions on Vehicular Technology*, vol. 61, no. 5, pages 2222-2232, June 2012.

36. Zhibin Zhou and Dijiang Huang, "Gradual Identity Exposure Using Attribute-Based Encryption", *International Journal of Information Privacy, Security and Integrity (IJIPSI)*, Vol. 1, No. 2/3, 2012.
37. Dijiang Huang, Satyajayant Misra, Guoliang Xue, and Mayank Verma, "PACP: An Efficient Pseudonymous Authentication Based Conditional Privacy Protocol for VANETs", *IEEE Transactions on Intelligent Transportations*, Vol 12, Issue 3, pages 736-746, Sep., 2011
38. Dijiang Huang, "Mobile Cloud Computing", E-Letter of Multimedia Communications Technical Committee (MMTC), IEEE Communications Society, 2011. (invited paper)
39. Dijiang Huang, Wei-Tek Tsai, Yi-hsin Tseng, "Policy Management for Secure Data Access Control in Vehicular Networks," *Springer Journal of Network and Systems Management (JNSM)*, Vol. 19, No. 4, pages 448-471, 2011
40. Dijiang Huang, Xiaoyan Hong, and Mario Gerla, "Situation-Aware Trust Architecture for Vehicular Networks", *IEEE Communications Magazine*, Volume 48, No. 11, Pages 128-135, 2010
41. Dijiang Huang and Vinayak Kandiah, "Low-latency Mix using Split and Merge Operations," *The third special issue on Security and Management, Springer Journal of Network and Systems Management (JNSM)*, Volume 18, Number 3, Pages 244-264, September, 2010.
42. Sean A. Williams and Dijiang Huang, "Group force mobility model and its obstacle avoidance capability", *Journal of the International Academy of Astronautics, Acta Astronautica*, Volume 65, Issues 7-8, Pages 949-957, October-November 2009.
43. Dijiang Huang and Mayank Verma, "ASPE: Attribute Based Secure Policy Enforcement for Data Access Control in Vehicular Ad Hoc Networks", *Ad Hoc Networks Journal (Special Issue of Privacy & Security in WSNs)*, Vol 7, Issue 8, pages 1526-1535, 2009.
44. Hao Li, Jian Huang, Philip Sweany, and Dijiang Huang, "FPGA Implementations of Elliptic Curve Cryptography and Tate Pairing over a Binary Field", *Journal of Systems Architecture* (an Elsevier journal), Vol 54, Issue 12, Pages 1077-1088, Dec 2008.
45. Dijiang Huang, "Unlinkability Measure for IEEE 802.11 based MANETs", *IEEE Transactions on Wireless Communications*, Vol. 7, NO. 2, Pages 1025-1034, Feb 2008.
46. Dijiang Huang, Deep Medhi, "A Secure Group Key Management Scheme for Hierarchical Mobile Ad-hoc Networks," *Ad Hoc Networks Journal*, Vol. 6 NO. 4, Pages 560-577, Feb, 2008.
47. Zhibin Zhou and Dijiang Huang, "Computing Cryptographic Pairing in Sensors" *ACM SIGBED Review, Special Issue on the RTSS Forum on Deeply Embedded Real-Time Computing*, Vol. 5, NO. 1, Jan, 2008.
48. Dijiang Huang, Manish Mehta, Appie van de Liefvoort, and Deep Medhi, "Modeling Pairwise Key Establishment for Random Key Predistribution in Large-scale Sensor Networks," *IEEE/ACM Transactions on Networking*, Vol 15, Issue 5, Pages 1204-1215, Oct. 2007.

49. Dijiang Huang and Deep Medhi, "Secure Pairwise Key Establishment in Large-scale Sensor Networks: an Area Partitioning and Multi-group Key Predistribution Approach," *ACM Transactions on Sensor Networks*, Vol 3, Issue 3, No. 16, Aug. 2007.
50. Dijiang Huang, "Pseudonym-Based Cryptography for Anonymous Communications in Mobile Ad-hoc Networks," *Special Issue on Cryptography in Networks, int. J. Security and Networks*, Vol. 2, NOs. 3/4, pages 272-283, 2007.
51. Dijiang Huang, Qing Cao, Amit Sinha, Marc Schniederjans, Cory Beard, Lein Harn, and Deep Medhi, "New architecture for Intra-domain network security issues," *Communications of the ACM*, Vol 49, Issue 11, Pages: 64 - 72, Nov. 2006.
52. Dijiang Huang and Deep Medhi, "A Key-chain Based Keying Scheme for Many-to-Many Secure Group Communication," *ACM Transactions on information and System Security (TISSEC)*, Vol 7, NO. 4, Pages 523-552, Nov. 2004.

#### Refereed Conferences and Workshops

1. Alexander Y.C. Huang, Yitao Chen, Dijiang Huang, Ming Zhao, "Semantic Privacy-Preserving for Video Surveillance Services on the Edge" in *Proceedings of Trustworthy Edge Computing Workshop, in conjunction with ACM/IEEE Symposium on Edge Computing (SEC)*, December 2023.
2. Duo Lu, Yuli Deng, and Dijiang Huang, "Global Feature Analysis and Comparative Evaluation of Freestyle In-Air-Handwriting Passcode for User Authentication", in *Proceedings of Annual Computer Security Applications Conference (ACSAC)*, December 2021.
3. Yuli Deng, Zhen Zeng, and Dijiang Huang "NeoCyberKG: Using an ML-enabled Knowledge Graph for Cybersecurity Education via Hands-on Labs", in *proceedings of the 26th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE)*, Germany 2021
4. Ankur Chowdhary, Dijiang Huang, Abdulkhaleq Sabur, Neha Vadnere, Myong Kang and Bruce Montrose, "SDN-based Moving Target Defense using Multi-agent Reinforcement Learning", in *proceedings of the first International Conference on Autonomous Intelligent Cyber-defence Agents (AICA)*, France, March 2021
5. Sowmya Myneni, Ankur Chowdhary, Abdulkhaleq Sabur, Sailik Sengupta, Garima Agrawal, Dijiang Huang, and Myong Kang, "DAPT 2020 - Constructing a Benchmark Dataset for Advanced Persistent Threats", in *proceedings of the First International Workshop on Deployable Machine Learning for Security Defense (MLHat)*, in conjunction with *ACM KDD*, 2020.
6. Duo Lu, Linzhen Luo, Dijiang Huang, and Yezhou Yang, "FMKit - An In-Air-Handwriting Analysis Library and Data Repository", in *proceedings of the Fourth Workshop on Computer Vision for AR/VR, in conjunction with CVPR 2020*.
7. Adrienne J. Raglin, Dijiang Huang, Huan Liu, and James McCabe, "Smart CCR IoT: Internet of Things Testbed", in *Proceedings of the 5<sup>th</sup> IEEE International Conference on Collaboration and Internet Computing (CIC)*, Dec 12-14, Los Angeles, 2019.
8. Sailik Sengupta, Ankur Chowdhary, Dijiang Huang, and Subbarao Kambhampati, "General Sum Markov Games for Strategic Detection of Advanced Persistent Threats

- using Moving Target Defense in Cloud Networks”, in *Proceedings of the Conference on Decision and Game Theory for Security (GameSec)*, 2019
9. Abdulkhaleq Sabur, Ankur Chowdhary, Dijiang Huang, Myong Kang, Anya Kim, and Alexander Velazquez, “S3: A DFW-based Scalable Security State Analysis Framework for Large-Scale Data Center Networks”, in *Proceedings of the 22nd International Symposium on Research in Attacks, Intrusions and Defenses (RAID)*, 2019.
  10. Ankur Chowdhary, Dijiang Huang, Gail-Joon Ahn, Myong Kang, Anya Kim, and Alexander Velazquez, “SDNSOC: Object Oriented SDN Framework”, In *proceedings of the ACM International Workshop on Security in Software Defined Networks & Network Function Virtualization (SDN-NFVSec '19)*, 2019. (Invited Paper).
  11. Jiayue Li, Tracy Cheng, Xiaohua Jia, and Dijiang Huang, “Partially Overlapped Channel Detection in Heterogeneous Cognitive Networks”, IEEE WCNC 2019.
  12. Ankur Chowdhary, Adel Alshamrani, Dijiang Huang, Myong Kang, Anya Kim, and Alexander Velazquez, “TRUFL: Distributed Trust Management framework in SDN”, IEEE ICC 2019.
  13. Duo Lu and Dijiang Huang, “FMHash: Deep Hashing of In-Air-Handwriting for User Identification”, IEEE ICC 2019.
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141. Dijiang Huang, Deep Medhi, Cory Beard, and Lein Harn "Trust Analysis of Link State Network Routing", in *Proceedings of the 2nd International Workshop on Trusted internet (TIW)*, Hyderabad, India, December 17, 2003.
142. Dijiang Huang, Amit Sinha, and Deep Medhi, "A Double Authentication Scheme to Detect Impersonation Attack in Link State Routing Protocols," in *Proceedings of the IEEE International Conference on Communications (ICC)*, pages 1723 - 1727, Vol. 3, May. 2003.
143. Dijiang Huang, "Secure Link State Routing Protocol: A Framework," In the *Doctoral Symposium, International Conference on Distributed Computing System (ICDCS)*, Providence, RI, May 19-22, 2003.

#### Other Publications:

1. Massimiliano Albanese and Dijiang Huang, "MTD 2018: 5<sup>th</sup> ACM Workshop on Moving Target Defense (MTD)", *TPC co-chairs' message. Toronto, Canada, 2018*.
2. Alexey Vinel, Xiaomin Ma, and Dijiang Huang, "Reliable and Secure VANETs [Guest Editorial]", *IEEE Transactions on Dependable and Secure Computing, Vol. 13, NO. 1, 2015*.
3. Xiaoming Fu, Stefano Secci, Dijiang Huang, and Rittwik Jana, "Mobile Cloud Computing [Guest Editorial]", *IEEE Communications Magazine, Volume 53, Number 3, Pages 61-62, 2015*.

#### ePrint Publications:

1. Duo Lu and Dijiang Huang, "FMCode: A 3D In-the-Air Finger Motion Based User Login Framework for Gesture Interface", arXiv.org eprint <https://arxiv.org/abs/1808.00130>, August 1, 2018.
2. Duo Lu and Dijiang Huang, "FMHash: Deep Hashing of In-Air-Handwriting for User Identification", arXiv.org eprint <https://arxiv.org/abs/1806.03574>, June 10, 2018
3. Jay Aikat, Ilya Baldin, Mark Berman, Joe Breen, Richard Brooks, Prasad Calyam, Jeff Chase, Wallace Chase, Russ Clark, Chip Elliott, Jim Griffioen, Dijiang Huang, Julio

- Ibarra, Tom Lehman, Inder Monga, Abraham Matta, Christos Papadopoulos, Mike Reiter, Dipankar Raychaudhuri, Glenn Ricart, Robert Ricci, Paul Ruth, Ivan Seskar, Jerry Sobieski, and Kobus Van der Merwe, “The Future of CISE Distributed Research Infrastructure”, arXiv.org eprint <https://arxiv.org/abs/1803.09886>, March 27, 2018
4. Weijia Wang, Zhijie Wang, Bing Li, Qiuxiang Dong, Dijiang Huang, “IR-CP-ABE: Identity Revocable Ciphertext-Policy Attribute-Based Encryption for Flexible Secure Group-Based Communication”, <https://eprint.iacr.org/2017/1100>, 2017
  5. Qiuxiang Dong, Dijiang Huang, Jim Luo, Myong Kang, “HIR-CP-ABE: Hierarchical Identity Revocable Ciphertext-Policy Attribute-Based Encryption for Secure and Flexible Data Sharing”, <https://eprint.iacr.org/2017/1101>, 2017
  6. Q Dong, D Huang, J Luo, M Kang, “ID-HABE: Incorporating ID-based Revocation, Delegation, and Authority Hierarchy into Attribute-Based Encryption”, <https://eprint.iacr.org/2017/1102>, 2017
  7. Zhibin Zhou and Dijiang Huang, “Efficient and Secure Data Storage Operations for Mobile Cloud Computing”, <https://eprint.iacr.org/2011/185>, 2011
  8. Zhibin Zhou and Dijiang Huang, “On Efficient Ciphertext-Policy Attribute Based Encryption and Broadcast Encryption”, <https://eprint.iacr.org/2010/395>, 2010
  9. Zhibin Zhou and Dijiang Huang, “Optimal Multicast Group Communication”, <https://eprint.iacr.org/2009/010>, 2009

Invited and Contributed Research Presentations and Panels (in reverse chronological order)

1. “Distributed Access Control and Privacy Protection in Blockchain”, IEEE Distinguished Lecture Talk, Washington DC chapter, 9/21,2020
2. “Intelligent Software Defined Networking and Security”, International Telecommunication Day, Invited speaker, IEEE ComSoc Peru Chapter, May 14, 2020
3. “Building Private Blockchains over Public Blockchains (PoP)”, ASU IUCRC CES center, Industry Advisory Board (IAB) Mid-term Update Meeting, Jan 28, 2020
4. “Smart CCR IoT: Internet of Things Testbed”, Panel of the MERIF Workshop on Future Midscale Experimental Research Infrastructures, Miami, January 7, 2020.
5. “Smart CCR IoT: Internet of Things Testbed”, Vision Panel of the 5th IEEE International Conference on Collaboration and Internet Computing (CIC), Dec 12-14, Los Angeles, 2019.
6. Software Defined Network Security and Attribute-Based Access Control, Naval Research Lab, September 17, 2019.
7. “Software-Defined Networking and Security”, IEEE Distinguished Lecture Talk, Montevideo, Peru chapter, May 5, 2019
8. “Software-Defined Networking and Security”, IEEE Distinguished Lecture Talk, Montevideo, Peru chapter, May 4, 2019
9. “Distributed Access Control and Privacy Protection in Blockchain”, IEEE Distinguished Lecture Talk, Santiago, Peru chapter, May 4, 2019
10. “Software-Defined Networking and Security”, IEEE Distinguished Lecture Talk, Montevideo, Uruguay chapter, May 2, 2019

11. “Software-Defined Networking and Security”, IEEE Distinguished Lecture Talk, Santiago, Chile chapter, April 30, 2019
12. “Distributed Access Control and Privacy Protection in Blockchain”, IEEE Distinguished Lecture Talk, Santiago, Chile chapter, April 29, 2019
13. Multi-Agent-Based Threat Detection and Intelligent Cyber Defense, Army Netcom, January 16, 2019.
14. Intelligent Network Security and Attribute-Based Cryptography, Naval Research Laboratory, August 16, 2018.
15. Attribute-based cryptography and Blockchain Data Privacy Protection, China Union Bank, June 17, 2018
16. Panel on Next Generation IOT Security, 2018 Cybersecurity Summit, May 3, 2018
17. Policy-based access control and cloud security, China Academy of China Medical Sciences, December 19, 2017.
18. Attribute-Based Access Control and SDN-Based Moving Target Defense, Naval Research Laboratory, October 3, 2017.
19. Moving Target Defense: A Software Defined Networking Approach, University of Electronic Science and Technology (UEST) of China, July 3, 2017.
20. Moving Target Defense: A Software Defined Networking Approach, Beijing University of Posts and Telecommunications, June 27, 2017.
21. Moving Target Defense: A Software Defined Networking Approach, Nantong University, JiangSu Province, China, June 24, 2017.
22. Cybersecurity: New Advances in Moving Target Defense and Attribute-Based Access Control, invited talk, Beijing University of Posts and Telecommunications, Dec 26, 2016.
23. Security for Science DMZ, Panel at 2016 NSF Campus Cyberinfrastructure Program PI Workshop, Oct 19, 2016.
24. Securing Software Defined Networks: From Theory to Practice, Panel at IEEE Conference on Communications and Network Security (CNS), Oct 17, 2016.
25. Mobile SDN – Challenges and Directions, invited talk at GENI Engineering Conference 24 (GEC-24), March 8-9, 2016. Web link at <http://groups.geni.net/geni/wiki/GEC24Agenda/MobileSDN4GLTE>
26. Cybersecurity Education Through a Social and Personalized Approach, Sonoran Desert Security User Group (SDSUG) Quarterly Meeting, Nov 4 2015.
27. Moving Target Security: Establishing SDN-based Secure Data Center Networking Environments, invited talk, Spanish National Cybersecurity Institute (incibe\_), July 7, 2015.
28. Moving Target Security: Establishing SDN-Based Secure Data Center Networking Environments, invited talk, Chinese Academy of Sciences Institutes, Beijing, China, July 11, 2014.



29. MobiCloud – Where Cloud Meets Mobile – A User-centric Approach, invited talk, Beijing University of Posts and Telecommunications, Beijing, China, July 10, 2014.
30. MobiCloud – Where Cloud Meets Mobile – A User-centric Approach, invited talk, University of Science Technology-Beijing, Beijing, China, July 5, 2014.
31. Mobile Cloud Computing, keynotes talk, The Fifth International Conference on Next Generation Networks and Services (NGNS), Casablanca, Morocco, May 28, 2014.
32. SDN-based Security Models and Risk Modeling Techniques, invited talk, Hassan 1st University, Settat, Morocco, May 23, 2014.
33. Moving Target Security: Establishing SDN-based Secure Data Center Networking Environments, invited talk, Rabat International University, Rabat, Morocco, May 20, 2014.
34. Federated Security Platforms: Are we there yet? Collaboratecom Panel, October 21, 2013
35. SDN-based Network Intrusion Detection/Prevention for Cloud Virtual Networking System, The Hong Kong Polytechnic University, August 13, 2013
36. SDN-based Network Intrusion Detection/Prevention for Cloud Virtual Networking System, University of Canterbury, July 24, 2013
37. SDN-based Network Intrusion Detection/Prevention for Cloud Virtual Networking System, NEC Research Lab, June 10, 2013
38. SDN-based Network Intrusion Detection/Prevention for Cloud Virtual Networking System, NICT (National Institute of Information and Communications Technology), June 5, 2013
39. SDN-based Network Intrusion Detection/Prevention for Cloud Virtual Networking System, Osaka City University, June 4, 2013
40. Research and Challenges in Mobile Cloud Computing, Orange Lab, Paris, France, July 12, 2012.
41. Secure Mobile Cloud Computing - A software defined networking approach, University of Paris VI (LIP6), Paris, France, June 20, 2012.
42. Building the Cloud – Security and Privacy Technology Issues Present in a Personal Mobile Cloud, invited by Conference of Mobile Personal Clouds with Silver Linings, Columbia Institute for Tele-Information Columbia Business School, June 8th, 2012.
43. Establish Secure Framework for Mobile Cloud Computing, Chinese Academy of Sciences, State key Laboratory of information Security (SKLOIS), 2/10/2012.
44. Mobile Cloud Computing, Tutorial, at the IEEE International Conference on Consumer Electronics (ICCE), January 13, 2012, Las Vegas, USA
45. Cloud-Based Security Measurement (CBSM), Duke University, July 24, 2011.
46. Mobile Cloud Computing, Conservatoire National des Arts et Métiers (CNAM), France, June 7, 2011.
47. Establish Secure Framework for Mobile Cloud Computing, Chinese Academy of Sciences, State key Laboratory of information Security (SKLOIS), 2/10/2012.

48. Cloud-Based Security Measurement (CBSM), Duke University, July 24, 2011.
49. Secure Network Virtualization to Support Enterprise Collaborations, Orange Lab, Paris, France, June 20, 2011.
50. Secure Mobile Cloud Framework for Mobile Computing and Communication, Conservatoire National des Arts et Métiers (CNAM), France, June 16, 2011.
51. Mobile Cloud Computing – Security Challenges and Solutions, University of Electronic Science and Technology of China, April 11, 2011
52. “Security Challenges In Cloud Computing”, the “Challenges in SaaS” Panel, 5th IEEE International Symposium on Service-Oriented System Engineering (SOSE), Nanjing, June 4, 2010
53. “Secure Mobile Cloud Computing”, Peking University, June 8, 2010
54. “Anonymous Communications for Mobile Wireless Ad Hoc Networks”, Tsinghua University, June 2009.
55. “Anonymous Communications for Mobile Wireless Ad Hoc Networks”, Airforce Research Lab, Rome, June 2008.
56. “Anonymous Communications for Mobile Wireless Ad Hoc Networks”, Syracuse University, June 2008.
57. “An Integrated Real-time Wireless Monitoring and Video Capturing Surveillance System,” NSF IUCRC Planning Meeting, ASU, June 10, 2007.
58. “An Integrated Real-time Wireless Monitoring and Video Capturing Surveillance System,” Semi Annual Connection-one Meeting, San Diego, CA, May 23-24, 2007.
59. “Anonymous Communications: An Identity-Based Solution,” Information Assurance Seminar, Computer Science and Engineering Department, Arizona State University, March 3, 2006.
60. “Secure Group Communication and Its Applications,” Computer Science Department, University Tennessee at Chattanooga, October 2004.
61. “Secure Group Communication and Its Applications,” Computer Science and Engineering Department, Arizona State University, September 2004.
62. “Secure Link State Routing Protocol: A Framework,”  
In the *Doctoral Symposium, International Conference on Distributed Computing System (ICDCS)*, Providence, RI, May 19-22, 2003.
63. “On A Framework for Secure Network Routing Protocol,”  
School of Interdisciplinary Computing and Engineering, University of Missouri – Kansas City, March 28, 2003

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## RESEARCH GRANTS

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**Award Total:** \$24,738,298

**Personal Share:** \$1,093,5130

Past Research Grants:

1. Sponsor: Ministry of Science and Technology of China  
Project title: Blockchain edge computing hardware technology  
Role: PI  
Personal Share 43%  
Year: 2023-2026  
Amount: \$ 11,487,964
2. Sponsor: Beijing Science and Technology Commission  
Project title: Research on lattice cryptography algorithm for quantum property encryption for data privacy protection  
Role: PI  
Personal Share 100%  
Year: 2022-2023  
Amount: \$410,000
3. Project title: CC\* Integration-Large: (BLUE) Software-Defined CyberInfrastructure to enable data-driven smart campus applications  
Sponsor: NSF OAC – 2126291  
Role: PI  
Personal Share 40%  
Year: 2021-2023  
Amount: \$500,000
4. Project title: SaTC-EDU: AISeckG: AI for Cybersecurity Education via an ML-enabled Security Knowledge Graph  
Sponsor: NSF SaTC – 2114789  
Role: PI  
Personal Share 50%  
Year: 2021-2023  
Amount: \$300,000
5. Project Title: ISDNS: On Intelligent Software Defined Networking Security  
Sponsor: Naval Research Lab (NRL) N0017319-1-G002  
Role: PI  
Personal Share 100%  
Year 2018-2022  
Amount: \$800,000
6. Project Title: EDU: Learning Moving Target Defense Concepts: Teaching and Training Curricula Development Based on Software Defined Networking and Network Function Virtualization  
Sponsor: NSF DGE-1723440  
Role: PI  
Personal Share 100%

- Year 2017-2022  
Amount: \$299,756
7. Project Title: NSF-SFS: Arizona Cyber Defense Scholarship  
Sponsor: NSF DGE-1663651  
Role: coPI  
Personal Share: 25%  
Years: 2017-2022  
Amount: \$4,998,009
  8. Project Title: CICI: Secure and Resilient Architecture: SciGuard: Building a Security Architecture for Science DMZ based on SDN and NFV Technologies  
Sponsor: NSF OAC-1642031  
Role: coPI  
Personal Share 33%  
Year 2017-2021  
Amount: \$499,484
  9. Project title: CRII: Planning: Establishing a Hand-Gesture Research Platform for Behavior Biometrics and Cognitive Robotics (HGRP)  
Sponsor: NSF CNS - 1925709  
Role: PI  
Personal Share 60%  
Year 2019-2021  
Amount: \$100,000
  10. Project Title: Private Data Retrieval over Public Blockchains  
Sponsor: CES  
Role: PI  
Personal Share 100%  
Year 2019-2020  
Amount: \$50,000
  11. Project Title: SRN: On Establishing Secure and Resilient Networking Services  
Sponsor: NSF SaTC CNS 1528099  
Role: PI  
Personal Share 100%  
Year 2015-2019  
Amount: \$667,000 (\$230,000 ASU portion)
  12. Project Title: Enabling Personalized Learning for Hands-on Lab Based Cybersecurity Education  
Sponsor: Athena Network Solutions LLC (through NSF SBIR Phase I, #1622192)  
Role: Senior Personnel  
Personal Share 14.5%  
Year 2016-2017  
Amount: \$225,000
  13. Project Title: SFS: An Information and Systems Assurance Scholarship Program  
Sponsor: NSF DUE-1129561  
Role: coPI

Personal Share: 25%

Years: 2012-2017

Amount: \$1,527,871

14. Project Title: Attribute-Based Cryptography for Attribute-Based Access Control  
Sponsor: Naval Research Lab (NRL) N00173-15-G017  
Role: PI  
Personal Share 100%  
Year 2015-2018  
Amount: \$158,048
15. Project Title: Building Entrepreneurial Mindset in Cybersecurity Courses  
Sponsor: Kern Family Foundation  
Role: PI  
Personal Share: 100%  
Years: 2018  
Amount: \$10,000
16. Project Title: Security Research for Mobile Cloud Computing  
Sponsor: National Science Foundation China (University of Science Technology Beijing), 61628201  
Role: PI  
Personal Share 100%  
Year 2017-2018  
Amount: 180,000RMB (\$27,000)
17. Project Title: Incorporating Entrepreneurial Mindset into Computer Network Security Courses  
Sponsor: Kern Family Foundation  
Role: PI  
Personal Share: 100%  
Years: 2017  
Amount: \$10,000
18. Project Title: OHReST: Open Human-Robotic Mobile Networking and Security Testbed  
Sponsor: Army Research Office (Proposal NO. 65156-CS-RIP)  
Personal Share: 100%  
Years: 7/18/2014-7/17/2016  
Amount: \$97,879
19. Project Title: Cyber Security Analysis and Assurance using Cloud-Based Security Measurement System  
Sponsor: NATO Science For Peace (SFP), subcontract from Duke University  
Personal Share: 100%  
Years: 6/1/2012-9/30/2016  
Amount: \$31,204
20. Project Title: Collaborative Research: A Cyber Physical System for Proactive Traffic Management to Enhance Mobility and Sustainability  
Sponsor: NSF (ASU: 1239396 UF: 239364)

D. Huang

Role: Co-PI

Personal Share: 35%

Years: 2012-2016

Amount: \$836,000 (ASU)/\$164,000 (UF)

Collaborators: (ASU PI) Pitu Mirchandani (PI), Dijiang Huang, Baoxin Li; (UFL) PI: Yafeng Yin

21. Project Title: NSF: I-Corps: VLab: Enhancing Cyber Security Education Through A Hands-on Virtual Laboratory Approach  
Sponsor: NSF IIP-1539684  
Role: PI  
Personal Share: 100%  
Years: 2015  
Amount: \$50,000
22. Project Title: HSAP URAP Research: Traffic Analysis Models for Wireless Mobile Ad Hoc Networks  
Sponsor: ARO  
Role: PI  
Personal Share: 100%  
Years: 2014-2015  
Amount: \$6,618
23. Project Title: Traffic Analysis Models for Wireless Mobile Ad Hoc Networks  
Sponsor: Army Research Office (W911NF-11-1-0191)  
Role: PI  
Personal Share: 100%  
Years: 7/1/2011-6/30/2014  
Amount: \$150,000
24. Project Title: MobiCloud: A Secure Mobile Cloud Framework for Pervasive Mobile Computing And Communication  
Sponsor: Office of Naval Research (ONR) Young Investigator Program (YIP) Award, N00014-10-1-0714  
Role: PI  
Personal Share: 100%  
Years: 6/15/2010-6/14/2014  
Amount: \$504,225
25. Project Title: Datacenter Traffic Engineering and Security  
Sponsor: China Mobile US Research Center  
Personal Share: 100%  
Years: 12/15/2013-4/31/2014  
Amount: \$35,000
26. Project Title: Establishing Research and Education Capacity for Mobile Cloud Computing  
Sponsor: ONR DURIP (N000141310709)  
Personal Share: 100%  
Years: 6/15/2013-6/14/2014  
Amount: \$322,682

27. Project Title: Involving High School Students in the Research of Traffic Analysis Models for Wireless Mobile Ad Hoc Networks  
Sponsor: ARO  
Role: PI  
Personal Share: 100%  
Years: 2012-2013  
Amount: \$9,342
28. Project Title: Collaborative Research: A Secure and Resilient Virtual Trust Routing Framework for Future Internet  
Sponsor: NSF, CNS-1029546  
Role: PI  
Personal Share: 100%  
Years: 5/1/2010-4/30/2013  
Amount: \$133,000 (ASU portion)  
Collaborators: Deep Medhi (University of Missouri-Kansas City), Shingo Ata (Osaka City University, Japan)  
Total Amount: \$250,000
29. Project Title: Collaborative Research: A Secure and Resilient Virtual Trust Routing Framework for Future Internet  
Sponsor: NSF, CNS-1243636 (supplemental grant to CNS-1029546)  
Role: PI  
Personal Share: 100%  
Years: 7/30/2012-4/30/2013  
Total Amount: \$26,600
30. Project Title: A Cloud-based Resource and Service Sharing Platform for Computer and Network Security Education  
Sponsor: NSF, DUE-0942453  
Personal Share: Dijiang Huang (PI 60%), Wei-Tek Tsai (Co-PI 40%)  
Years: 7/15/2010-6/30/2013  
Amount: \$200,000
31. Project Title: Fortifying Data-at-Rest Encryption with a Credential/Functional-Based Encryption Layer  
Sponsor: DoD Navy STTR (N00014-12-M-0368), subcontract from ATC  
Role: PI  
Personal Share: 100%  
Years: 2012-2013  
Amount: \$24,000
32. Project Title: Secure Mobile Cloud Networking Infrastructure To Support Enterprise Mobile Applications (Phase II)  
Sponsor: Hewlett-Packard Innovation Research Program (IRP) Award  
Role: PI  
Personal Share: 100%  
Years: 8/1/2012-7/31/2013  
Amount: \$67,647

D. Huang

33. Project Title: Secure Mobile Cloud Networking Infrastructure To Support Enterprise Mobile Applications (Phase I)  
 Sponsor: Hewlett-Packard Innovation Research Program (IRP) Award  
 Role: PI  
 Personal Share: 100%  
 Years: 7/15/2011-7/14/2012  
 Amount: \$50,000
34. Project Title: DoD Information Assurance Scholarship Program (IASP) Program: Building Information Assurance Forces at Arizona State University  
 Sponsor: DoD  
 Personal Share: Stephen Yau (PI, 50%), Dijiang Huang (Co-PI 20%), K. Selcuk Candan (Co-PI 10%), Partha Dasupta (Co-PI 10%), Guoliang Xue (Co-PI 10%)  
 Years: 9/11/08-9/10/09  
 Amount: \$52,766
35. Project Title: Efficient Pairing Algorithms and Implementations for Intel Sensors  
 Sponsor: Consortium of Embedded System (CES)/Intel  
 Role: PI  
 Personal Share: 100%  
 Years: 9/13/2007-9/12/2008  
 Amount: \$50,000

Other research and education awards/gifts

1. Visiting Erskine Fellowship, University of Canterbury, New Zealand, 7/1/2013-8/25/2013  
 Amount: 4,900NZD
2. JSPS (Japan Society for the Promotion of Science) Fellowship, 4/12/2013-6/11/2013  
 Amount: 1,080,000JPY
3. Conservatoire National des Arts et Métiers (CNAM) visiting scholar fellowship  
 6/1/2012-7/31/2012  
 Amount: \$9,280
4. Fulton Schools of Engineering Infrastructure Competition Award  
 Year: 2012  
 PI/CoPIs: Dijiang Huang (PI), Yann-Hang Lee (Co-PI), Lincoln Slade (Co-PI)  
 Amount: \$50,000
5. Conservatoire National des Arts et Métiers (CNAM) visiting scholar fellowship  
 Year 2011  
 Amount: \$4,640
6. Windows Education Gift (2 Windows 7 Phone)  
 Year 2011  
 Amount (estimate): \$200
7. Google Education Gift (2 Google TVs)  
 Year: 2011  
 Amount (estimate): \$400



8. Office of Naval Research (ONR) Summer Faculty Fellowship  
Year: 2010  
Amount: \$14,000
9. Google Education Gift  
Year: 2010  
Amount (estimate): 20 Droid phones (\$8,500)
10. Airforce Research Lab Summer Faculty Visiting Scholarship  
Year: 2008  
Amount: \$12,500
11. Fulton Schools of Engineering Infrastructure Competition Award  
Year: 2006  
PI/CoPIs: Dijiang Huang (PI), Stephen Yau (Co-PI)  
Amount: \$24,400

## TEACHING

### **Developed New Courses**

(in reverse chronological order)

1. CSE546 Cloud Computing (former CSE591 Virtualization and Cloud Computing)  
Fall semester 2015, Arizona State University  
Course level: Graduate
2. Virtualization and Cloud Computing – CSE591  
Spring semester 2011, Arizona State University  
Course level: Graduate
3. Advanced Network Security – CSE548 (former CSE591 Advanced Network Security)  
Fall semester 2005, Arizona State University  
Course level: Graduate
4. Computer Network Security – CSE468/598 (former CSE494/598 Computer Network Security, this course is a combined session with undergraduate and graduate students)  
Spring semester 2007, Arizona State University  
Course level: Undergraduate/Graduate

### **Taught Courses**

(in reverse chronological order)

1. Computer Networks – CSE434  
Arizona State University  
Course level: Undergraduate  
Number of students: 110  
Term: Spring 2015
2. Virtualization and Cloud Computing – CSE591/CSE546  
Arizona State University  
Course level: Graduate

Year	S'11	F'11	F'13	F'14	F'16
# of students	13	28	66	119	99

## 3. Advanced Network Security – CSE548

Arizona State University

Course level: Graduate

Year	F'05	F'07	F'08	S'10	S'11	S'12	S'14	S'16	S'17	S'18
# of students	33	30	24	43	13	20	51	41	9	35

Year	S'19	S'21
# of students	28	18

## 4. Network Security –CSE468/598

Arizona State University

Course level: Undergraduate/Graduate

Year	S'07	S'08	S'09	F'09	F'10	F'11	F'12	F'13	F'14
# of students (468)	9	24	37	28	31	27	52	40	54
# of students (598)	20	18	4	15	12	15	14	14	24
Year	F'15	F'17	F'18	F'19					
# of students (468)	62	105	80	79					
# of students (598)	36								

## 5. Introduction to Computer Science and Engineering – CSE101

Arizona State University

Course level: Undergraduate

Number of students: 37

## 6. The ASU Experience –ASU101

Arizona State University

Course level: Undergraduate

Number of students: 10

## 7. Concept of Computer Science and Data Structure –CSE205

Arizona State University

Course level: Undergraduate

Year	F'06	F'07	F'08
# of students	15	59	80

8. Algorithms and Data Structure –CSE310  
Arizona State University  
Course level: Undergraduate  
Number of students: 18
9. Discrete Structures I (internet Class) –CS191  
University of Missouri–Kansas City  
Course level: freshman.  
Number of Students: 10
10. Network Security –CS490NS  
University of Missouri–Kansas City  
Course level: Undergraduate, senior.  
Number of students: 13
11. Introductory Network Models and Interconnections  
University of Missouri—Kansas City  
Course level: Undergraduate, senior.  
Number of students: 24

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## STUDENT THESES AND DISSERTATIONS SUPERVISED

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### Postdocs

1. Jiayue Li, PhD. Hong Kong University of Science and Technology, October 2017 to Oct 2019.
2. Chun-Jen Chung, PhD. Arizona State University, July 2015 to July 2016, and December 2017-March 2019.

### Doctoral Dissertations

1. Dr. Abdulhakim Sabur  
Dissertation Title: “Towards Scalable Security State Management in the Cloud”  
Dissertation defense data: August 16, 2022  
Affiliation (after graduation): Assistant Professor at King Saud University, Saudi Arabia
2. Dr. Zhen Zeng  
Dissertation Title: “Risk-based Network Vulnerability Prioritization”  
Dissertation defense data: May 16, 2022  
Affiliation (after graduation): Assistant Professor (tenure-track) at University of Wisconsin-Milwaukee
3. Dr. Sowmya Myneni  
Dissertation Title: “Defeating Attackers by Bridging the Gaps Between Security and Intelligence”  
Dissertation defense data: January 31, 2022  
Affiliation (after graduation): Lexis Nexis Risk Solutions
4. Dr. Yuli Deng  
Dissertation Title: “Personalized Learning in a Virtual Hands-on Lab Platform for Computer Science Education”

- Dissertation defense data: November 1, 2021  
Affiliation (after graduation): Lecturer at Arizona State University University
5. Dr. Duo Lu  
Dissertation Title: “3D In-Air-Handwriting based User Login and Identity Input Method”  
Dissertation defense data: July 2, 2021  
Affiliation (after graduation): Assistant Professor (tenure-track) at Rider University
  6. Dr. Ankur Chowdhary  
Dissertation Title: “Software-Defined Situation-aware Cloud Security”  
Dissertation defense data: November 4, 2020  
Affiliation (after graduation): Lincoln Heritage Life Insurance Company
  7. Dr. Oussama Mjihil (Fulbright scholar visiting student), Prof Abdelkrim Haqiq from Hassan 1st University, Morocco, is the chair, and I serve as the co-chair for his PhD study  
Dissertation Title: “Security Assessment and Countermeasure Selection for Scalable Cloud Computing Environments”.  
Dissertation defense data: June 8, 2019  
Affiliation (after graduation): CEO and the founder of ENADEV
  8. Dr. Adel Alshamrani  
Dissertation Title: “Cyber Attacks Detection and Mitigation in SDN Environments”  
Dissertation defense date: November 5, 2018  
Affiliation (after graduation): Assistant Professor at University of Jeddah, Saudi Arabia
  9. Dr. Abdullah Alshalan  
Dissertation Title: “MobiVPN: Towards a Reliable and Efficient Mobile VPN”  
Dissertation defense date: August 30, 2017  
Affiliation (after graduation): Assistant Professor at King Saud University, Saudi Arabia
  10. Dr. Sandeep Pisharody  
Dissertation Title: Policy Conflict Management in Distributed SDN Environments  
Dissertation defense date: May 16, 2017  
Affiliation (after graduation): MIT Lincoln Lab
  11. Dr. Huijun Wu  
Dissertation Title: “Mobile Cloud Application Framework and Offloading Strategies”  
Dissertation defense date: July 22, 2016  
Affiliation (after graduation): Twitter
  12. Dr. Bing Li  
Dissertation Title: “Anonymity and Access Control in Mobile Network Environment”  
Dissertation defense date: June 1, 2016  
Affiliation (after graduation): Google
  13. Dr. Zhijie Wang  
Dissertation Title: “Effective and Privacy-Preserving Mobile Crowd Sensing”  
Dissertation defense date: February 9, 2016  
Affiliation (after graduation): GE Lab
  14. Dr. Chun-Jen Chung  
Dissertation Title: “SDN-based Proactive Defense Mechanism in a Cloud System”

Dissertation defense date: July 20, 2015

Affiliation (after graduation): CTO, Athena Network Solutions LLC

15. Dr. Tianyi Xing

Dissertation Title: “Establishing the Collaborative Software Defend Networking Based Intrusion Prevention System in MobiCloud Environment”.

Dissertation defense date: October 2, 2014

Affiliation (after graduation): Wal-Mart Research Lab

16. Dr. Zhibin Zhou

Dissertation Title: “Attribute-based Cryptography and its Applications”.

Dissertation defense date: April 27, 2011

Affiliation (after graduation): Amazon

17. Dr. Yang Qin

Dissertation Title: “Anonymous MANET Communications: Attacks and Countermeasures”.

Dissertation defense date: September 17, 2010

Affiliation (after graduation): Microsoft

Master Theses Supervised

1. Qiuxiang Dong

Thesis Title: “Attribute-Based Encryption for Fine-Grained Access Control over Sensitive Data”, November 25, 2019

Affiliation: Facebook

2. Abdulhakim Sabur

Thesis Title: “Analysis and Management of Security State for Large-Scale Data Center Networks”, November 5, 2018

Affiliation: Joined ASU PhD Program

3. Fanjie Lin (MS student, female)

Thesis Title: “Constructing Knowledge Graph for Cybersecurity Education”, November 5, 2018

Affiliation: Siemens

4. Shilpa Nagendra (MS student, female)

Thesis Title: “Evaluation of Storage Systems for Big Data Analytics”, October 31, 2017

Affiliation: Commvault Systems

5. Bhakti Bohara (MS student, female)

Thesis Title: “Moving Target Defense Using Live Migration of Docker Containers”, June 9, 2017

Affiliation: Akamai Technologies

6. Janakarajan Natarajan

Thesis Title: “Analysis and Visualization of OpenFlow Rule Conflicts”, April 13, 2016

Affiliation: Startup

7. Ankur Chowdhary

“Secure Mobile SDN”, June 24, 2015.

Affiliation: Joined ASU PhD Program

8. Qinyun Li

“Constructing an Interactive Multimedia Enabled Virtual Lab Learning Environment on

- Vlab Platform”, November 10, 2014.  
Affiliation: Startup
9. Pankaj Kumar Khatkar  
“Firewall Rule Set Analysis and Visualization”, October 7, 2014.  
Affiliation: CAaNES (Computational Analysis and Network Enterprise Solutions)
  10. Zhengyang Xiong, “An SDN-Based IPS Development Framework in Cloud Networking Environment”, July 18, 2014.  
Affiliation: Omedix
  11. Ashwin Narayan Prabhu Verleker  
“An Ontology Based Approach to Attribute Management in ABAC”, April 17, 2014.  
Affiliation: Juniper
  12. Yuli Deng  
“A Cloud Based Continuous Delivery Software Developing System on Vlab Platform”, November 20, 2013.  
Affiliation: Joined ASU PhD Program
  13. Dong, Xinyi (MS student, female)  
“Service Oriented Architecture for Mobile Cloud Computing”, May 16, 2012  
Affiliation: Amazon
  14. Archana Ramchandran (MS student, female)  
“Efficient Algorithms and Implementation of Tate Pairing for Wireless Sensors,” June 14, 2007.  
Affiliation: Qualcomm.
  15. Vinayak Kandiah  
“Constructing Efficient Anonymous Communication Schemes: Solutions Based on Splitting, Merging and Polynomial Interpolation,” October 16, 2007.  
Affiliation: CERNER Corporation.
  16. Mayank Verma  
“A New Trust Framework for Using Pseudonyms and Attribute-based Cryptography for Vehicular Ad Hoc Networks”, August 20, 2008.  
Affiliation: Brocade.
  17. Harsh Kapoor  
“Using Polynomial Interpolation based Secret Sharing Scheme for Secure Communications”, November 12, 2008.  
Current Affiliation: Startup
  18. Utkarsh Agarwal  
“Watermark Based Attack on the Second-Generation Onion Router”, April 24, 2009.  
Affiliation: Garmin
  19. Mukesh Jagasia  
“Distributed Protocols to Solve Non-Linear Optimization Problem for Node Localization and Malicious Node Detection in Wireless Sensor Networks”, April 28, 2008.  
Affiliation: Intel
  20. Vijayakrishnan Nagarajan  
“Using Secure Search Engine to Counter Web-Based Man-in-the-Middle and Phishing Attacks”, August 28, 2009.  
Affiliation: Juniper

21. Swaroop Shere  
“Using Shock Waves to Detect and predict Highway Congestion”, September 1, 2009.  
Affiliation: ForceSale
22. Vetri Arasan  
“Establishing Email Based Social Network Trust”, February 19, 2010.  
Affiliation: Garmin
23. Nirav Shah  
“A-Weor: Communication Privacy Protection for Wireless Mesh Networks Using Encoded Opportunistic Routing”, April 23, 2010  
Affiliation: Intel
24. Sushma Myneni (MS student, female)  
“Secure and Efficient Authentication Scheme for EPC Generation 2 Passive RFID Tags”, April 23, 2010  
Affiliation: Microchip
25. Aniruddha Kadne  
“vLab: A Cloud Based Resource and Service Sharing Platform for Computer and Network Security Experiments”, November 17, 2010  
Affiliation: F5
26. Yunji Zhong  
“Establishing Distributed Social Network Trust Model in MobiCloud”, November 16, 2012.  
Affiliation: Microsoft

#### Supervised Undergraduate/Graduate Scholar and Honor Students

1. Daniel Romo (NSF SFS scholar MS student), Project: “AI-enabled Pentest”, 2020/2021 summer Intern
2. Shanna Peterson (NSF SFS scholar MS student), Project: “AI-enabled Pentest”, 2020 summer Intern
3. Christopher Laine, (Undergraduate Barrett honor thesis student), Topic “ML-based knowledge graph for cybersecurity education”, 2020-2021
4. Eric Dejarnett (Undergraduate Barrett honor thesis student), Thesis Title: “AI-Based Autonomous Security Assessment Tool”, defense date: 4/2/2020
5. Connor Belanger (Undergraduate Barrett honor thesis student), Thesis Title: “Automated Vulnerability/Adversary Testing Using AI/ML Algorithms”, defense date: 4/2/2020
6. Collin Christensen (Undergraduate Barrett honor thesis student), 2017-2018  
Thesis Title: ThoTh Lab Development
7. Bridge, Lucas (Undergraduate thesis student, NSF SFS scholarship student)
8. Esquivel, Nicole (Female, Undergraduate, ASU grand challenging student)
9. Rebecca Napper (Female, Undergraduate, NSF SFS scholarship student)

#### Visiting Scholars and students

1. Dr. Bin Zhang, Guilin University of Electronic Technology, China, (7/2018-7/2019)
2. Dr. Wen Liu, Communication University of China, (2/2018-2/2019)
3. Dr. Chunming Wu, Southwest University, Chongqing China (12/2016-12/2017)

4. Oussama Mjihil, Visiting student, Hassan 1<sup>st</sup> University, Morocco (4/2016-6/2016, 8/2016-8/2017 Fulbright scholar student)
5. Elmir Iman, Visiting student, Hassan 1<sup>st</sup> University, Morocco (2/2016-4/2016)
6. Dr. Weijia Wang, Beijing Jiaotong University, China (9/2015-8/2016)
7. Dr. Xiang Gu, Nantong University, Zhejiang Province, China (2/2015-2/2016)
8. Dr. Bo Li, Yunnan University, Yunnan Province, China (2/2015-2/2016)
9. Dr. Weiping Peng, Henan Polytechnic University, Henan Province, China (12/2014-12/2015)
10. Dr. Haihua Zhao, Ba Yin Vocational and Technical College, Kuerle, Xinjiang, China (10/2014-10/2015)
11. Ziyuan Ma, Visiting student, UESTC, China (9/2014-9/2015)
12. Dr. Jin Wang, Nantong University, China (12/2013-12/2014)
13. Dr. Aiguo Chen, University of Electronic Science and Technology, China (1/2013-12/2013)
14. Dr. Jingsong Cui, Wuhan University, China (8/2012-8/2013)
15. Dr. Weijia Wang, Beijing Jiaotong University, China (3/2011-9/2011)

#### Mentored Capstone Projects

1. Project: Wireless Location Tracking,  
Students (6): Andrew Coleson, Brian Folts, Kevin Janaes, Shanshan Liang, Matthew Martindale, Ivan Zhou  
Semesters: Fall 2007, Spring 2008
2. Project: Using Palm Handheld to Control Robot Movement  
Students (5): Ansari, Mohammed, Hedrick, Micah, Branson, Walter, Macheia David, Vincent Nicholas  
Semesters: Spring 2008
3. Project: SMART: Sensor-based Mobile Ad Hoc Network Testbed  
Students (5): Jason Duo Li, Mike Sedillo, Michael Brown, Kanami Saiki, Hamzeh Obeid  
Semesters: Fall 2009, Spring 2010
4. Project: EMT: Email Trust  
Students (4): Andrew Davison, Daniel Peterson, Jeremy Ralston, Mohal Shukla  
Semesters: Fall 2009, Spring 2010
5. Project: SSE: Secure Search Engine  
Students (5): Amir Abdollahi, Corey Casado, Joe Campbell, Jordon Wesolowski, Michael Bartholomew  
Semesters: Fall 2009, Spring 2010
6. Project: Secure Data Sharing in Mobile Cloud Computing  
Students (7): Colin Taylor, Elissa Thomas, Mahmoud Saada, Qingyun Li, Yu Liu, Yu Zhang(Nancy), Lin Yang  
Semesters: Fall 2011, Spring 2012



7. Project: Cloud Sensing: A Cloud-based Sensing Platform for Internet of Things  
Students (4): Nick DePalma; Brandon Czaplicki; Malcolm Dalton; Greg Humphrey  
Semesters: Fall 2013, Spring 2014
8. Project: Cloud Sensing: A Cloud-based Sensing Platform for Internet of Things  
Students (4): Nick DePalma; Brandon Czaplicki; Malcolm Dalton; Greg Humphrey  
Semesters: Fall 2013, Spring 2014
9. Project: Semi-Autonomous Driving Robot  
Students (7): Edward Schweitzer, Justin Arispe, Nikita Bhambhani, Autumn Conner, Abdullah Al Dhabaib, Jimi Aguirre, Jackson Curless  
Semesters: Spring 2016, Fall 2016
10. Project: Cybersecurity Defense Competition  
Students(7): Chase Lybbert, Jose Frausto, Jeffrey Moore, Michael O'Loughlin, Andrew Stanton, Jacqueline Fazekas, Jacob Loden  
Semesters: Spring 2017, Fall 2017
11. Project: Sensor-App Development  
Students(3): Bader Alkhaldi, Vanshay Khurana, and Connor Phillips  
Semesters: Fall 2017, Spring 2018
12. Project: CCDC training team  
Students(7): Joseph Aorahim, Daniel Romo, Alexander Cure, Christian Lopez, Michael Brand Martinez, Karisa Kauspedas, and Shanna Peterson  
Semesters: Fall 2019, Spring 2020

#### Other Mentoring Activities

1. Following undergraduate and high school students through the ARO HSAP/URAP grant during the summer of 2012:
  - a. URAP: ASU Undergraduate student: George Chen,
  - b. HSRP: High school student (McClintock High School, grade 11): Thomas F. Liu
  - c. Volunteer: High school student (female): Natalie Mionis
2. Following undergraduate and high school students through the ARO HSAP/URAP grant during the summer of 2014:
  - a. URAP: ASU Undergraduate student: Perry Waxman,
  - b. HSRP: High school student (Hamilton High School, grade 12): Samuel Wang
  - c. Volunteer: High school student (female): Drew Carrillo
3. Supervised Cybersecurity Competitions
  - a. 2016 CCDC West Region Competition, February 2016  
Team members: Ankur Chowdhary (Graduate), Tejas Khairnar (Graduate), Jacques Ernotte (Undergraduate), David Hernandez (Undergraduate), and Fengwen Chen (Undergraduate)  
Rank: 9<sup>th</sup> place in west region of US
  - b. 2017 CCDC West Region Competition, February 2017  
Team members: Ankur Chowdhary (Graduate), Tejas Khairnar (Graduate), John Shaller (Undergraduate), William Gibbs (Undergraduate), Nicholas Ton

- (Undergraduate), Daniel Martin (Undergraduate), Emanuel Boderash (Undergraduate)  
 Rank: 8<sup>th</sup> place in west region of US (Injection #1)
- c. 2018 CCDC West Region Competition, March 2018  
 Team members: Ankur Chowdhary (Graduate), Vaibhav Dixit (Graduate), Jeffrey Moore (Undergraduate), Chase Lybbert (Undergraduate), Jacob Loden (Undergraduate), Michael O'Loughlin (Undergraduate), Jose Frausto (Undergraduate), Andrew Stanton (Undergraduate), Jacqueline Fazekas (Undergraduate)  
 Rank: 6<sup>th</sup> place in west region final, (Injection # 1)
- d. 2019 team members: Abdulhakim Sabur (Graduate), Ankur Chaowdhary (Graduate), Vu Coughlin (Graduate), Devyn Hedin (Undergraduate), Joseph Aorahim (Undergraduate), Javier Benavides (Undergraduate), Chenguang Li (Undergraduate), Meet Pathak (Undergraduate), Nate Cortes (Undergraduate), Allen Foust (Undergraduate).  
 Rank: 16<sup>th</sup> place in qualify (Injection # 1)
- e. 2020 team members: Matthew Keeley (Undergraduate), Allen Foust (Undergraduate), Abdulhakim Habur, Austin Ballard (Undergraduate), Nathan Smith (Undergraduate), Sarah Ferenczi (Undergraduate), Gabe Do (Undergraduate), Karisa Kauspedas (Undergraduate), Joseph Aorahim (Undergraduate), Christian Lopez (Undergraduate), Ryan Jones (Undergraduate), Alexander Cure (Undergraduate)
- f. AVENET TechGames April 2, 2016  
 Team members: Ankur Chowdhary (PhD), David Hernandez (Undergraduate)  
 Rank: 2<sup>nd</sup> place

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## PROFESSIONAL AND SCIENTIFIC SERVICES

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### University Services

(in reverse chronological order)

1. Personnel Committee, 2018-2019, 2021-2022
2. Distributed Computing Faculty Search Committee, 2018-2019
3. Cybersecurity Faculty Search Committee, 2015-2018
4. Research Computing Governance Board, 2017- 2019
5. Entrepreneurial Professor Selection Committee, 2017-2018
6. ASU Leadership Academy (TeamLA) 2016-2017
7. Graduate Program Committee, 2016-2017
8. Academic Program Review Committee, 2015-2016
9. Graduate Program Committee, 2015-2016 (Chair)
10. Graduate Admission Committee, 2013-2014

11. Cyber Security Faculty Search Committee, 2012, 2013, 2015-16, 2016-2017, 2017-2018
12. Graduate Admission Committee, 2011-2012
13. Undergraduate Program Committee, 2011-2012
14. Undergraduate Program Committee (Chair), 2009-2010
15. Undergraduate Program Committee, 2008-2009
16. Serve for ASU Senate, Aug-Dec 2007.
17. Computing Resource Committee (CRC), 2006—2007.
18. Computing Resource Committee (CRC), 2005—2006.

### **Off-Campus Professional Services**

#### Serves in Editorial Boards

1. Associate Editor, IEEE Transactions on Network and System Management, 2019 - now
2. Associate Editor, Journal of Network & Systems Management (JNSM), 2010 - now
3. Editor, IEEE Communications Surveys & Tutorials, 2011- 2020
4. Lead guest editor, Journal of Network and Systems Management Special Issue on Intelligent and Trustworthy Internet Edge 2019-2020
5. Guest Editor, IEEE Communications Magazine Feature Topic on “Mobile Cloud Computing”, 2014
6. Guest Editor, IEEE Transactions on Dependable and Secure Computing (TDSC) Special Issue on “Reliable and secure VANETs”, 2015
7. Guest Editor of Special Issue on “Cloud Computing, Networking, and Services (CCNS) Management”, Journal of Network & Systems Management (JNSM), 2010

#### Professional and Technical Committees

1. IEEE Internet Technical Committee (ITC), Chair, 2018-2019
2. IEEE Internet Technical Committee (ITC), Vice Chair, 2016-2017
3. IEEE Internet Technical Committee (ITC), Secretary, 2013- 2015
4. IEEE Internet Technical Committee, Cloud Communications SIG, 2012- 2014
5. IEEE ComSoc Smart Grid Communications Committee (SGCC), 2010 - 2012
6. IEEE Cloud Communications & Networking Ad Hoc Committee, 2012 - 2013

#### Conference and Workshop Program Committee Member

##### 2021

- ACM CCS MTD workshop 2021

##### 2020

- ACM CCS MTD workshop 2020, The 6th International Conference on Mobile, Secure and Programmable Networking, 2020

##### 2019

- ACM CCS MTD workshop 2019, NMIC 2019

2018

- ACM CCS MTD workshop 2018

2017

- ACM CCS MTD workshop 2017

2016

- Infocom 2017, ACM CCS MTD workshop 2016, IEEE MobileCloud

2015

- Infocom 2016, ACM CCS MTD workshop 2015, IEEE MobileCloud, IAS

2014

- Infocom 2015, Globecom 2014, CNS 2014, ICC 2014, ACM CCS MTD workshop 2014

2013

- Infocom 2014, CloudNet13, Mobile Cloud14, Networking 2014, Globecom 2013, CNS 2013

2012

- Infocom 2013, CNSM 2012, PIMRC2012-NET, CloudNet12, NGNS'12, LATINCLOUD 2012

2011

- Infocom 2012, Globecom 2011 (AHSN, CIS), ICC 2012 (AHSN, WN), ICNC 2012 (MCVC)

2010

- Infocom 2011, Globecom 2010 (AHSN, CIS), ICC 2011 (AHSN, WN), Milcom 2010, CISSE 2010

2009

- Infocom 2010, Infocom student workshop 2010, Globecom 2009 (AHSN, NGNI), IEEE Intelligent Vehicular Communications System (ICVS) 2009, ICC AHSN 2009, International Conference on Multimedia and Expo (ICME) 2009, Workshop on Emerging Technology in Multimedia Communication and Networking 2009, Colloquium for information Systems Security Education (CISSE)

2008

- GlobeCom 2008, 12th Colloquium for information Systems Security Education (CISSE) International Conference on Advanced Computing and Communications (ADCOM), IEEE International Workshop on Security for Mobile Wireless Communications (SeMIC)

2007

- International Conference on Computer Communications and Networks (ICCCN), 15th International Conference on Advanced Computing & Communication (ADCOM), Workshop on information Assurance (WIA), ICC (WAS), Colloquium for information Systems Security Education (CISSE)

2006

- Colloquium for information Systems Security Education (CISSE), IEEE International Performance Computing and Communications Conference (IPCCC) ,Workshop on information Assurance (WIA)

2005

- International Conference on Computer Communications and Networks (ICCCN), ACM Workshop on Security of Ad Hoc and Sensor Networks (SASN)

Conference and Workshop Organization

- TPC co-Chair, NMIC 2019 (The First International Workshop on Network Meets Intelligent Computations), 2019
- TPC co-Chair, IEEE CloudNet 2018
- Publication co-chair, IEEE ICC, Kansas City, 2018
- TPC co-Chair, ACM Moving Target Defense (MTD) Workshop, 2015, 2018
- Steering Committee of ACM Moving Target Defense (MTD) Workshop, 2014 – Present
- General co-chair, IEEE MobileCloud, Oxford, April, 2016
- TPC co-chair, The 11th International Conference on Information Assurance and Security (IAS'2015), December 2015
- TPC co-chair, The 11th International Conference on Information Assurance and Security (IAS'2015), December 2015
- Conference General Chair, IEEE MobileCloud 2015, 2016
- Local Chair, IEEE IC2E 2015
- Workshop co-Chair, ACM CCS, Phoenix, November 2014
- TPC co-chair, IEEE MobileCloud 2014
- Publication chair, IEEE CloudNet 2013
- TPC co-chair, Sigcomm MCC: Mobile Cloud Computing workshop, Hong Kong, China, August 12, 2013
- TPC co-chair, Sigcomm MCC: Mobile Cloud Computing workshop, Helsinki, Finland, August 17, 2012
- Symposium Chair of Mobile Computing and Vehicle Communications, International Conference on Computing, Networking & Communications (ICNC), 2012
- TPC co-chair, IEEE Globecom Communication and Information System Security Symposium 2011
- TPC co-vice chair, IEEE Workshop on Networking Intelligent Vehicles and Infrastructures (IEEE NiVi09 in conjunction with IEEE Globecom 2009)
- International Conference on High Performance Switching and Routing (HPSR), 2008, publication chair
- The 8th International Symposium on Autonomous Decentralized Systems (ISADS), 2007, Finance Chair.
- The second International Workshop on Ad Hoc, Sensor and P2P Networks (AHSP) 2007, Finance Chair.

- The 11th International Workshop on Future Trends of Distributed Computing Systems (FTDCS), 2007/2008, Finance Chair.

Serve as a reviewer for the following journals

ACM Transactions on Sensor Networks  
 ACM/IEEE Transactions on Networking  
 Ad Hoc Networks Journal  
 Computer Networks  
 Elsevier International Journal of Computers and Electrical Engineering  
 EURASIP Journal of Wireless Communication Networks  
 IEEE Transactions on Dependable and Secure Computing  
 IEEE Transactions on Mobile Computing  
 IEEE Transactions on Wireless Communications  
 IEEE Communications  
 IEEE Communication Letters  
 IEEE Communications Surveys & Tutorials  
 IEEE Wireless Communications Magazine  
 IEEE JSAC Special Issue on Vehicle Networks  
 IET Information Security  
 International Journal of Security and Networks  
 Journal of Computer Security  
 Journal of High Speed Networks  
 Journal of Network and System Management  
 Journal of Systems and Software  
 Journal of Super Computing  
 Telecommunication Systems  
 Wireless Communications and Mobile Computing  
 Wiley Wireless Communication and Mobile Computing

Serve as a reviewer for the following conferences and workshops

- ACM Workshop on Security of Ad Hoc and Sensor networks (SASN), 2005
- International Conference on Advanced Computing & Communication (ADCOM), 2007, 2008
- Colloquium for Information Systems Security Education (CISSE) 2006,2007, 2008, 2009, 2010

- IEEE International Conference on Communications (ICC), 2003,2004,2007,2008,2009,2010
- IEEE International Workshop on Security for Mobile Wireless Communications (SeMIC), 2008
- IEEE GlobalCom, 2006,2008,2009,2010
- IEEE Infocom, 2009,2010
- IEEE/IFIP Network Operations & Management Symposium (NOMS), 2004,2006
- IEEE International Performance Computing and Communications Conference (IPCCC), 2005,2006
- IEEE Sarnoff Symposium, 2007
- IEEE Wireless Communications and Networking Conference (WCNC), 2005
- IEEE Workshop on IP Operations and Management (IPOM), 2003, 2004, 2005
- International Conference on Computer Communications and Networks (ICCCN), 2005,2007
- International Conference on Software, Telecommunications and Computer Networks (SoftCom) 2008
- International Conference on Embedded Software and System (ICCESS), 2007
- Workshop on information Assurance (WIA), 2006, 2007

#### Reviewed Grant Proposals

- NSF, NeTS 2008, SFS 2012, SFS 2014, CAREER 2014, SaTC 2016, AccelNet 2019, CCRI 2020, SaTC 2021, CC\* 2021
- Army Research Office (ARO) 2005, 2008, 2011, 2017
- Rutherford Discovery Fellowship 2013
- Swiss National Science Foundation 2012, 2013
- New Zealand Ministry of Business, Innovation, and Employment (MBIE) 2013
- Sam Houston State University 2008
- GENI 2008
- University of Missouri Research Board (UMRB), 2005, 2006

# Research Statement

Over the past 18 years, my career has been a diverse and transformative journey, encompassing roles as a researcher, educator, entrepreneur, and academic leader. My work has contributed mainly to mobile cloud computing, attribute-based cryptography, network security, and Moving-Target Defense (MTD). I have consistently focused on innovating to bolster security and privacy in mobile and networked systems.

## Early Research

In 2005, I joined ASU as a tenure-track assistant professor, and my research mainly focused on mobile network security and attribute-based cryptography. I developed a secure mobile cloud service model [1, 2], utilizing an avatar to manage resources for mobile users and envisioning each mobile device as a virtualized component in the cloud. This innovation, a precursor to today's secure cloud services for mobile phones, enhanced the sensing capabilities and elevated security services for mobile nodes.

This exploration into mobile cloud computing propelled me deeper into applied cryptography, focusing on Attribute-Based Encryption (ABE) to incorporate data access control into mobile data. I've been dedicated to exploring Attribute-Based Access Control (ABAC), a refined alternative to the traditional Role-Based Access Control (RBAC), and finding its significance, especially in dynamic and distributed environments like mobile applications.

To harmonize RBAC and ABAC, I initiated ABE-based policy management, formulating an attribute lattice approach in ABE to establish a seniority relation among all attribute values, facilitating efficient comparison operations between them [3].

To promote ABAC for more flexible mobile application scenarios, a pivotal dimension of my research has been the development of an ABAC-based trust framework to fortify data operations with multiple cooperative trusted authorities, effectively forming one or multiple private communication groups. My commitment to this research is steadfast, addressing the challenges in designing more flexible ABE access control features such as attributes revocation, comparable attributes, and their pragmatic applications to real-world scenarios.

In 2010, my mobile cloud and security research was honored with the prestigious Office of Naval Research Young Investigator Program (YIP) award. This accolade is given to a select few researchers nationwide, the only one in the information and communication system research field.

## Explore Intelligent Network Security Systems

Since 2011, my focus shifted to advancing software-defined security in cloud computing. I delved into leveraging the programmability of Software-Defined Networking (SDN) for



Moving-Target Defense (MTD), creating dynamic, unpredictable systems to counteract attackers strategically. This led to the development of a Network-Security-as-a-Service (NSaaS) model tailored to meet the specific security requirements of mobile and data center networks with precision, integrating security solutions seamlessly into these complex environments.

To handle the uncertainty due to MTD's dynamics, I developed an attack-graph-based analytical procedure to optimize MTD network reconfiguration strategies, modeling attackers' behaviors and integrating Bayesian reasoning methods to balance security performance and user intrusiveness [4]. This approach was pivotal in resolving security policy violation issues arising from MTD countermeasures or mitigation solutions, marking a significant stride in security policy enforcement and conflict resolution [5, 6, 7].

Research in MTD allows me to further focus on enhancing the adaptability and intelligence of network security systems by prioritizing identified vulnerabilities based on associated risk and severity measurements. To this end, my research is dedicated to crafting intelligent and adaptive security solutions for cloud networks. This involves the implementation of MTD strategies enhanced by game theory models. Central to this approach is using Stackelberg Games for intelligent placement and strategic switching of Intrusion Detection Systems (IDS), allowing for pinpointing crucial vulnerabilities [8]. Additionally, I employ general-sum Markov Games in conjunction with Stackelberg equilibrium to ensure optimal resource allocation in security measures [9]. This methodology considers the complexities of multi-stage attack models and integrates the Common Vulnerability Scoring System (CVSS) to evaluate utility values in diverse scenarios.

Furthermore, I developed a new neuro-symbolic model, combining neural network and probabilistic logic programming techniques, to discern threat attributes, assessing the risk of vulnerabilities from both the criticality and the likelihood of exploitation [10, 11]. This approach integrates AI techniques, such as neural networks and logical programming, to understand risk patterns from adversaries, vulnerability severity, and the network environment. It offers a comprehensive solution that not only learns and infers adversaries' motivations and abilities in a network but also understands the constraints governing interactions between vulnerabilities and network elements, paving the way for a more agile, adaptive, economic, and intelligent secure networking ecosystem.

My work in mobile network security, SDN security, and attribute-based access control has been pivotal in advancing security protocols and methodologies. My contribution to these areas led to the election as an IEEE Distinguished Lecturer<sup>1</sup> for 2018-2020.

## Technology Transfer

The research in mobile cloud and ABE to protect data transmission over public and unattended networking environments, sponsored by NRL, has yielded highly cited research works [12] and patents [13], focusing on developing ABE-based ABAC solutions for DoD applications [14] and contributing to my Navy and NSF SBIR/STTR projects. Moreover, I collaborated with Hewlett-Packard lab to develop an attack-graph-based analytical procedure for countermeasure selection, adopted by HP's security framework [15].

In 2014, I founded Athena Network Solutions LLC, which specializes in providing online

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<sup>1</sup><https://www.comsoc.org/dijiang-huang>

cybersecurity education. Our focus is on cloud-based hands-on network security courses project experimental environment named ThoTh Lab [16]. In 2017, I founded CYNET LLC, which aims to provide SDN-enabled intelligent network security services. From 2016 to 2018, I was honored with the title of Fulton Entrepreneurial Professor to recognize my dedication to converting cutting-edge research into practical and market-ready solutions. My technology transfer efforts also allowed me to be inducted into ASU's Nation Inventors chapter.

### **Recent Research and Leadership Roles**

In 2022, I stepped into a role that aligns closely with industry needs, taking up the position of Chief Scientist at the Beijing Academy of Blockchain and Edge Computing (BAEC). This role taps into my deep expertise in network security and applied cryptography, focusing on delivering practical, industry-relevant solutions in the burgeoning fields of blockchain and edge computing. This opportunity allows me to apply my academic knowledge and research skills to solve the industry's real-world challenges.

I aimed to develop a hardware-enabled blockchain platform to facilitate efficient, secure, and effective distributed ledger (DL) solutions. The research and development is rooted in a hardware-software co-designed trust execution environment to support fast and efficient blockchain transactions. My primary responsibilities include guiding BAEC's research trajectory, advising and guiding various research projects, constructing an open-source blockchain R&D and application ecosystem, and assembling collaborative teams to secure national-level grants for advancing DL technologies. Early in 2023, as the Principal Investigator, I led and collaborated with nine research institutions and industry partners, securing an 84M RMB (\$11.5M) award from the Chinese Ministry of Science and Technology. This award aims to develop a new hardware-based DL platform in edge networking environments.

I also serve as the research Dean of the Donghai (East Sea) Marine Digital Science Research Institute (DMDSRI), a dynamic spin-off of BAEC specializing in technology transfer, particularly in fostering the digital ocean economy. In this role, I had the opportunity to establish the research institute from the ground up, strategically leveraging resources from the local government of Zhejiang province of China and academic entities to create a robust and trustworthy digitizing environment to bolster the maritime economy. Under this initiative, DMDSRI houses over 50 dedicated researchers and developers, and engages in impactful technology transfer projects valued at 130M RMB (\$18M).

### **Journey Through Cybersecurity: Achievements and Aspirations**

Reflecting upon my nearly two decades of dedication to cybersecurity, it's evident that my journey has been deeply rooted in a passion for innovation, education, entrepreneurship, and leadership within academia. My endeavors have predominantly revolved around network security, data privacy protection, and secure access control, with a recent exploration into the promising fields of blockchain technology and AI-powered intelligent security research.

My passion for melding theoretical underpinnings with tangible applications in computer networks, cryptography, and data and system security has been recognized through over \$25M in research and educational grants from diverse federal entities and private sectors.

Of this, my direct contributions amount to over \$11M. I firmly believe that the triumphs of cybersecurity stem from its interdisciplinary nature, greatly amplified by expansive collaborations, enhancing both research and education. This belief has led me to spearhead over ten collaborative projects as the PI. The tangible results of these endeavors are showcased in my prolific output, which includes more than 200 peer-reviewed research articles and 10 ratified US patents. Additionally, I've authored three books, penned five book chapters, and delivered five tutorials, making significant inroads in areas like mobile cloud computing, intelligent network security, and attribute-based access control.

I've guided 17 Ph.D. dissertations and 26 MS thesis graduates, fostering the next generation of thinkers and innovators. Additionally, I've co-founded two start-up companies to bring our research results to the marketplace, emphasizing my commitment to practical, impactful solutions. Recognitions like the ONR Young Investigator award in 2010 and being named an IEEE ComSoc Distinguished Lecturer for 2018-2020 underscore the originality and impact of my work in areas such as data privacy and security, mobile computing, attribute-based data access control, and moving target defense. I am determined to continue expanding the frontiers in these domains, opening to broader collaborations, and striving to contribute to a digitally safer and more secure world.

## References

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# Teaching Statement

Dijiang Huang

My teaching philosophy centers on problem-based learning and a hands-on, "learn by doing" approach, which I believe is crucial for effective education. I am deeply committed to teaching, finding it both rewarding and fulfilling. My effectiveness as an educator has been recognized through positive feedback and accolades, including the ASU Fulton Schools of Engineering Best Teacher Award. Teaching energizes me, particularly as I witness the growth and accomplishments of my students.

I've had the privilege of developing four new courses and leading three, focusing on the intricate and rewarding field of practical problem-solving in cybersecurity. My commitment to education has enabled me to secure several NSF-sponsored projects to enhance hands-on lab development and integrate AI into security education. I had PIed the following education projects:

- NSF DUE: A Cloud-based Resource and Service Sharing Platform for Computer and Network Security Education [1]
- NSF EAGER: AISeckG: AI for Cybersecurity Education via an ML-enabled Security Knowledge Graph [2]
- NSF SaTC-EDU: Learning Moving Target Defense Concepts: Teaching and Training Curricula Development Based on Software Defined Networking and Network Function Virtualization [3]

I remain actively engaged with students at both graduate and undergraduate levels, fostering interactions to understand their needs and provide support. I've voluntarily mentored undergraduate students' capstone teams yearly, guiding them to successful cybersecurity project realization. Additionally, I've supervised 17 Ph.D. and 26 MS graduates, many of whom have achieved prestigious academic positions and roles in renowned research institutions, with five becoming assistant professors.

My commitment to promoting diversity in education focuses on guiding underrepresented groups such as African American and female students. I am a staunch advocate for educational technology and have played a crucial role in securing NSF education grants to develop

new learning tools and materials to enhance problem-based learning. I have been a key contributor (coPIs) to NSF Cybercorps and DoD-sponsored scholarship programs, emphasizing the recruitment and guidance of American students in the field of cybersecurity.

In response to the dynamic nature of cybersecurity education, I have recognized and embraced the imperative of ongoing innovation and adaptation. I've had numerous opportunities to refine and update computer network security courses, ensuring the curriculum is both current and practical. I am the creator of the ThoTh Lab [4], a distinguished virtual laboratory utilizing cloud computing solutions, which has received recognition from cybersecurity educators and has overseen the completion of over 4,000 individual course projects since its inception in 2014. To develop a sustainable model for wider educational communities, ThoTh Lab was awarded an NSF SBIR Phase-I grant and was also honored with the Reimagine Education Award in the Engineering/IT Discipline in 2016.

During the unprecedented challenges of the pandemic, I assumed a crucial role in transitioning to online education. I led the security section of ASU's transfer security courses for the MCS program, and I formulated two comprehensive online courses in advanced network security and cloud computing, extending our reach to over 2,000 international students via ASU's online education platform.

Furthermore, I have crafted IoT security hands-on labs focusing on embedded system security and am vigorously pursuing grants to expand research and development in this area. I am also infusing an Entrepreneurial Mindset into my courses, prioritizing immersive, real-world projects—a commitment that earned me the ASU Fulton Engineering KEEN Professorship in 2017 and 2018 [5].”

Beyond formal teaching settings, I have led the ASU cybersecurity team, provided mentorship through intensive training sessions, and founded the “DevilSec” student club [6] to encourage interest in cybersecurity competitions. I served as the coach and led the ASU team to achieve first place in the West Regional Collegiate Cyber Defense Competition (WCCDC) Finalist, #1 in Injection, 2017 and 2018.

My teaching repertoire is diverse, ranging from foundational computer science/engineering courses to specialized security courses, and I am enthusiastic about developing new courses and exploring collaborative opportunities to refine our curricula and hands-on labs.

In conclusion, I am passionate about elevating cybersecurity education standards by delivering practical and transformative learning solutions. My extensive knowledge in Computer Science and IT Management empowers me to teach various courses, including but not limited to computer networks, cybersecurity, data structure and algorithm, digital forensics, database design and management, emerging technologies in AI and cybersecurity, network administration, etc. I am not only willing but eager to design and offer new courses as

required to meet the evolving needs of students. I am a staunch advocate for leveraging advanced educational technologies, such as personalized and problem-based learning, to navigate the unique and ever-present challenges in the continually evolving landscape of cybersecurity education. My foremost goal is to enhance student learning outcomes, and I remain steadfast in my commitment to innovate and inspire, contributing to advancing this dynamic field.

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