

2016 Annual Report

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December 31, 2016

In May 2016, the Isaac and Carol Auerbach Family Foundation awarded \$3 million to be paid over five years to Drexel's Cybersecurity Institute. In appreciation of the endowment, the Institute was renamed the Isaac L. Auerbach Cybersecurity Institute (ILACI). ILACI made great strides forward in 2016 on three fronts: research, teaching, and community engagement.

Research: Drexel cybersecurity research made great strides this year in several categories, including new federal grants, several research proposal submissions, articles published in top-tier conferences and journals, a successful defense of an a M.S. student, and continued steps toward technology commercialization.

Teaching: Drexel cybersecurity education also made great strides this year in several categories, including several new courses, our graduate class of students graduating with the MS in Cybersecurity degree and undergraduate class in Cyber Security Technology, fruitful engagement with Drexel University online, engagement with the College of Engineering Peace Engineering Program, funding from the NSA and the U.S. Army Reserve, and the creation of a new student group called the Drexel CyberDragons.

Community engagement: ILACI continued its commitment to meaningful engagement with the community by giving several invited talks, organizing or co-organizing a number of symposia, invited lectures, and events on campus, and attending national security community events. ILACI hosted the first ever BSides Philly in December 2016, and started hosting a monthly meeting of the cybersecurity community, the Philadelphia Security Shell. In addition, ILACI took the first steps in forming a new alliance among leadership in the military, government, industry, and academia cybersecurity sectors in the Philadelphia region.

This document summarizes Drexel University cybersecurity-related activities in 2016. Activities are broken down into the following categories:

- 1. Research activities
- 2. Business development activities
- 3. Educational activities
- 4. Community engagement
- 5. "In the news"

An appendix includes additional information:

1. Scrapbook

Steven P. Weber

Steven Weber Director, Drexel Isaac L. Auerbach Cybersecurity Institute

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1 Acknowledgment

The Isaac L. Auerbach Cybersecurity Institute gratefully acknowledges all of the assistance and guidance provided to us by the excellent administrators, faculty, staff, and students at Drexel University. We wish to give particular thanks to the following individuals, listed alphabetically:

Murugan Anandarajan	John Fry
M. Brian Blake	Joseph Hughes
Debbie Buchwald	Spiros Mancoridis
Kapil Dandekar	Aleister Saunders

We also gratefully acknowledge assistance from the following list of individuals, which is certainly not intended to be in any way exhaustive, also listed alphabetically:

Pramod Abichandani	Brian Keech
Susan Aldridge	Sherry Levin
Marcello Balduccini	Tharindu Mendis
LeeAnn Black	Denise McLeod
Kerry Boland	Greg Montanaro
Sean Clark	Gaurav Naik
Rob D'Ovidio	Chika Nwankpa
Britt Faulstick	Ioannis Savidis
Marie Fazio	Harish Sethu
Daniel Filler	Ali Shokoufandeh
Caitlin Gauthier	James Shackleford
Rachel Greenstadt	Brenda Sheridan
Greg Hislop	MaryAnn Skedzielewski
Tony Hu	Matthew Stamm
Nagarajan Kandasamy	Baris Taskin
Constantine Katsinis	Kairi Williams
Jennifer Katz	Christopher Yang
Colleen Kavanaugh	

2 Research activities

Cybersecurity research today is a far cry from its original focus on network protocols and cryptography. Today's cybersecurity challenges require an incredibly diverse collection of interdisciplinary approaches, including machine learning, big data, signal processing, algorithm design, computer hardware and software, biometrics, and many others. The scope of research topics pursued by Drexel's cybersecurity faculty illustrates this diversity. A brief list of topics includes:

- 1. Cyber crime and online identity theft (Anandarajan and D'Ovidio)
- 2. Adversarial stylometry (Greenstadt)
- 3. Sentiment analysis and security informatics (Yang)
- 4. Network and host anomaly detection (Sethu, Kandasamy, Mancoridis, Weber)
- 5. Biometric user authentication (Greenstadt and Weber)
- 6. Media forensics and anti-forensics (Stamm)
- 7. Wireless jamming and key generation (Dandekar)
- 8. Hardware security and trust (Savidis, Taskin, Stamm),
- 9. Malware detection, classification, and mitigation (Mancoridis and Balduccini)

Research activity in these and other areas is broken down into the following categories:

- 1. Research grants $(\S2.1)$
- 2. Research articles $(\S 2.2)$
- 3. Graduate student thesis proposals and defenses $(\S 2.3)$
- 4. Technology commercialization $(\S2.4)$

2.1 Research grants

The following is a list of **ongoing** cybersecurity research grants (initiated prior to 2016):

- Steven Weber (PI), Kapil R. Dandekar, Spiros Mancoridis, and Harish Sethu. TTP: Medium: Securing the Wireless Philadelphia Network. National Science Foundation Secure and Trustworthy Computing Program (NSF-SaTC), CNS-1228847, September, 2012 – August, 2018. \$1,080,800.
- [2] Rachel Greenstadt (PI). CAREER: Privacy analytics for end-users in a big data world. NSF Faculty Early Career Development Program (CAREER), CNS-1253418, February, 2013 – January, 2018. \$418,056.
- [3] Rachel Greenstadt (PI) and Andrea Forte. EAGER: Cybercrime science. National Science Foundation Division Of Computer and Network Systems (CNS), CNS-1347151, September, 2013 – August, 2016. \$188,676.
- [4] Hsinchun Chen (PI), Catherine Larson, Mark Patton, and Chris Yang. CIF21 DIBBs: DIBBs for intelligence and security informatics research community. *National Science Foundation (NSF) Division* Of Advanced Cyber Infrastructure (ACI), ACI-1443019, October, 2014 – September, 2017. \$1,499,531 total, \$150,000 to Drexel.

- [5] Spiros Mancoridis (PI), Harish Sethu, Naga Kandasamy, and Steven Weber. Machine learning and big data analytics. Comcast and University of Connecticut Center of Excellence for Security Innovation (CSI), January, 2015 – December, 2016. \$200,000.
- [6] Matthew C. Stamm (PI) and Nagarajan Kandasamy. High performance techniques to identify the source of digital images using multimedia forensics. *Defense Forensics and Biometrics Agency (DFBA)* and the Army Research Office (ARO), W911NF-15-2-0013, February, 2015 – July, 2016. \$374,971.
- [7] Kapil R. Dandekar (PI), Jaudelice C. de Oliveira, Karen Miu Miller, Chikaodinaka Nwankpa, and Steven Weber. Secure wireless control for future naval smart grids. Office of Naval Research (ONR), N000141612037, November, 2015 – December, 2018. \$749,831.
- [8] Baris Taskin (PI). Subtask 3.4.1 HPC prototype/component support. Subcontract to Pro2Serve, in response to Homeland Defense and Security Technical Area Tasks (HDTAT) Project HT-15-1158, for the National Security Agency (NSA) Laboratory for Physical Systems (LPS), November, 2015 –. (under contract negotiation).
- [9] Ali Shokoufandeh (PI), Gaurav Naik, and Steven Weber. Predicting QoE. Comcast/Xfinity R & D TechFund, November, 2015 – July, 2016. \$87,547.

The following is a list of **new** cybersecurity research grants (initiated or recommended for funding in 2016):

- Steven Weber (PI). Cyber risk management: Identification and quantification of unreported health care data breaches. *Casualty Actuarial Society (CAS) Cyber Risk Task Force*, January, 2016 – December, 2016. \$30,000.
- [2] Matthew C. Stamm (PI). CAREER: Scaling multimedia forensic algorithms for big data and adversarial environments. NSF Faculty Early Career Development Program (CAREER), March, 2016 – February, 2021 (estimated). \$587,000.
- [3] Ioannis Savidis (PI). Eager: Securing integrated circuits through realtime hardware trojan detection. NSF Computer and Network System (CNS), September, 2016 – August, 2018. \$288,650.

2.2 Research articles

The following is a list of cybersecurity research articles published in 2016, listed in reverse chronological order:

- Belhassen Bayar and Matthew Stamm. A deep learning approach to universal image manipulation detection using a new convolutional layer. ACM Workshop on Information Hiding and Multimedia Security (IH & MMSec), Vigo Galicia, Spain, 2016.
- [2] M. Ping, Bander Alsulami, and Spiros Mancoridis. On the effectiveness of application characteristics in the automatic classification of malware smartphones. *the IEEE International Conference on Malicious and Unwanted Software (MALWARE'16)*, Puerto Rico, October 2016.
- [3] Ahmad Darki, Alex Duff, Z. Qian, Gaurav Naik, Spiros Mancoridis, and M. Faloutsos. Don't trust your router:detecting compromised router. The IEEE proceedings of the 12th International Conference on Emerging Networking Experiments and Technologies CoNEXT'16 Student Workshop, Irvine, CA, 2016.

- [4] Kyle Juretus and Ioannis Savidis. Reducing logic encryption overhead through gate level key intertion. Proceedings of the IEEE International Symposium on Circuits and Systems (ISCAS), Montreal, Canada, May 2016.
- [5] Kyle Juretus and Ioannis Savidis. Reduced overhead gate level logic encryption. *IEEE/ACM Great Lake Symposium on VLSI (GLSVLSI)*, Boston, MA, May 2016.
- [6] Kyle Juretus and Ioannis Savidis. Low overhead gate level logic encryption. the Government Microcircuit Applications & Critical Technology Conference, Orlando, FL, March 2016.
- [7] Ni An and Steven Weber. On the performance overhead tradeoff of distributed principal component analysis via data partitioning. submitted for inclusion in the proceedings of the 50th Conference on Information Sciences and Systems (CISS), Princeton, NJ, March 2016.

2.3 Graduate student thesis proposals and defenses

The following is a list of cybersecurity-related M.S. student thesis defense, occurring in 2016:

[1] Brandon Katz. Enabling real-time wireless channel based encryption key generation (MS thesis defense). Advised by Kapil Dandekar, May 2016.

2.4 Technology commercialization

The following is a list of cybersecurity patents developed by the Drexel research community and marketed by the Drexel Office of Technology Commercialization in 2016:

- [1] Spiros Mancoridis, Raymond Canzanese, and Moshe Kam. Behavioral change-point malware detection system, 2016. Patent Pending.
- [2] Cem Sahin and Kapil Dandekar. Symmetric encryption key generation using wireless physical layer information without sharing any information paertinent to the key. Provisional Patent Application 62/261,761, 2016. Drexel University.
- [3] Kyle Juretus and Ioannis Savidis. Reduced overhead gate level logic encryption. Provisional US Patent Application Pending, 2016. DRX.P020.US.61.
- [4] Boris Shishkin, Kpil Dandekar, Danh Nguyen, Cem Sahin, Nagarajan Kandasamy, and David Dorsey. Real-time and protocol-aware reactive jamming in wireless networks. Granted Patent US 9531497 B2, 2016. Drexel University.

3 Business development

Drexel University had cybersecurity-oriented business development discussions and interactions with the following industry and government entities:

- 1. The Judge Group (July, 2015 present)
- 2. Foreign Policy Research Institute (FPRI) (January, 2016)
- 3. Alion Science and Technology (June, 2016 present)
- 4. Office of Government Relations (OGR) (January, 2016 present)
- 5. U.S Army Reserve (persistent relationship)
- 6. 4A Security and Compliance (August, 2016 present)
- 7. NetDiligence (June, 2016)
- 8. Susquehanna International Group (SIG) (January, 2016 present)
- 9. Innovative Defense Technologies (IDT) (August, 2015 present)
- 10. Kitware Inc. (December, 2015 present)
- 11. Federal Bureau of Investigation (FBI) (December, 2014 present)
- 12. Ben Franklin Technology Parteners of Southeastern PA (April, 2016)
- 13. Navigant (August, 2016)
- 14. Sabre Systems (March, 2016)
- 15. National Academies Government-University-Industry Research Roundtable (GUIRR) (March, 2016)
- 16. National Institute of Standards and Technology (NIST) (May, 2016)
- 17. Casualty Actuarial Society (March, 2015 present)
- 18. Vanguard (October, 2014 present)
- 19. Pro2Serve (September, 2015 present)
- 20. Federal Reserve Bank of Philadelphia (October, 2015 present)
- 21. FAA ASSURE Center of Excellence in Unmanned Aerial Systems Research (October, 2015 present)
- 22. NSA National Cryptologic School (NCS) (November 2016 present)
- 23. NSA Center of Academic Excellence (CAE) program (September 2016 present)

4 Educational activities

Drexel has established its presence in cybersecurity education through a suite of cybersecurity degrees and certificates. This section breaks down our cybersecurity educational activities into the following categories:

- 1. Courses, Degrees, Certificates (§4.1)
- 2. NSA/DHS CAE-CDE Recertification (§4.2)
- 3. U.S. Army Reserve Private Public Partnership (USAR-P3i) (§4.3)
- 4. Peace Engineering and Cybersecurity (§4.4)
- 5. CyberDragons $(\S4.5)$

4.1 Courses, Degrees, Certificates

Academic degree programs and certificates. Drexel cybersecurity-related academic degree programs and certificates include:

- 1. Masters of Science in Cybersecurity (CYBR)
- 2. Masters of Science in National Security Management (MSNSM)
- 3. Bachelor of Science in Computing and Security Technology (CST)
- 4. Bachelor of Science in Computer Science Computer Security Concentration.
- 5. Certificate in Computing and Security Technology
- 6. Professional Development Certificates in National Security Management, including:
 - (a) Cybersecurity, Law & Policy (online)
 - (b) Continuity Management (online)
 - (c) Homeland Security (online)
- 7. Undergraduate Minor in Computer Crime

Cybersecurity-related courses offered. Drexel offers a solid array of both undergraduate and graduate level cybersecurity courses. We briefly highlight two of these:

• Web Security I & II (H. Sethu). A list is topics covered in this two-quarter sequence provided.

A security-conscious intro. to web protocols	DNS Security Extensions (DNSSEC)
Symmetric and public key encryption	Security and AJAX
Digital certificates and authentication	Web privacy
A security-conscious intro. to HTML & CSS	Anonymous web browsing
A security-conscious intro. to JavaScript	Illegal hosting and anonymous publishing
Origin-based isolation of content	Internet censorship and surveillance
Encrypted web communications (HTTPS)	Elliptic curve cryptography (ECC)
Attacks on Domain Name System (DNS)	Web-based malware

• Media Forensics & Security (M. Stamm). Learning outcomes are on the left, and the list of topics are on the right:

Image representation, processing, storage.	Introduction to image processing
Information hiding in digital signals.	Coding & compression
Information for watermarking or authentica-	Information hiding & digital watermarking
tion.	Decision theory & machine learning
Forensic detection of image compression	Steganography & steganalysis
Forensic detection of contrast enhancement.	Multimedia for ensics - Manipulation detection
Reliable source determination of digital images.	Multimedia forensics - Device identification

The following is a select list of cybersecurity-related course offerings over the past three academic years:

Term	Course	Title	Instructor	#
Spr 2016	CS 475	Computer and Network Security	G. Naik	27
	CS 680	Special Topics: Topics in Crytography	O. Pandey	30
	CT 402	Network Security II	B. Green, C	20
	CT 420	Information Technology Security II	D. Comroe	21
	CT 222	Security and Information Warfare	W. Pehrsson	27
	INFO 333	Introduction to Information Security	C. Carroll	26
	INFO 375	Introduction to Information Systems Assurance	C. Mascaro	16
	INFO 517	Principles of Cybersecurity	S. White	24
	INFO 710	Information Forensics	C. McClain	12
	INFO 719	Introduction to National Security Enterprise	S. White	7
Win 2016	CS 303	Algorithmic Number Theory and Cryptopgraphy	J. Johnson	23
	CS 680	Special Topics: Program Verification	C. Gordor	28
	CST 614	Counterintelligence	S. White	10
	CT 382	Special Topics: Applied Cryptography	W. Pehrsson	10
	CT 395	Information Technology Security I	D. Comroe	24
	CT 325	Operating System Security Architecture I	A. Podhrodsky	15
	CT 402	Network Security II	C. Schaffer	10
	CT 422	Incident Response Best Practices	D. Whipple	10
	CT 472	Security Defense Countermeasures	R. Derangesco	14
	INFO 333	Introduction to Information Security	C. McClain	40
	INFO 712	Information Assurance	P. Grillo	28
Fall 2015	ECEC 457	Security in Computing	L. Trachtenberg	35
	INFO 375	Introduction to Information Systems Assurance	C. Mascaro	13
	INFO 517	Principles of Cybersecurity	S. White	23
	CST 609	National Security Intelligence	S. White	10
	$\operatorname{HSM}544$	Introduction to Homeland Security	S. White	13

Table 1: AY 2015-2016

Term	Course	Title	Instructor	#
Spr 2015	CS 303	Algorithmic Number Theory and Cryptography	B. Char	21
	CS 475	Computer and Network Security	R. Greenstadt	24
	$\operatorname{HSM}554$	Critical Infrastructure Protection	S. White	5
	INFO 333	Introduction to Information Security	C. Carroll	25
	INFO 375	Introduction to Information Systems Assurance	C. Mascaro	23
	INFO 517	Principles of Cybersecurity	S. White	16
	INFO 710	Information Forensics	S. Brown	11
	INFO 718	Cybersecurity, Law and Policy	J. Walters	9
Win 2015	ECEC 690	ST:Web Security II	H. Sethu	25
	ECES 690	ST: Forensic Signal Processing	M. Stamm	27
	CST 614	Counterintelligence	S. White	$\overline{7}$
	$\operatorname{HSM}549$	Terrorism and Homeland Security	S. White	12
	INFO 333	Introduction to Information Security	P. Grillo	25
	INFO 712	Information Assurance	P. Grillo	21
Fall 2014	ECEC 690	ST: Web Security I	H. Sethu	39
	CST 609	National Security Intelligence	S. White	4
	$\operatorname{HSM}544$	Introduction to Homeland Security	S. White	6
	INFO 333	Introduction to Information Security	C. Carroll	25
	INFO 375	Introduction to Information System Assurance	C. Mascaro	10
	INFO 517	Principles of Cybersecurity	S. White	25
	INFO 710	Information Forensics	S. Brown	19

Table 2: AY 2014-2015

Table 3: AY 2013-2014

Term	Course	Title	Instructor	#
Spr 2014	ECET 890	ST: SDR Security Laboratory	K. Dandekar	9
	CS 303	Algebraic Number Theory and Cryptography	B. Char	16
	CS 675	Reverse Software Engineering	G. Naik	20
	INFO 333	Introduction to Information Security	C. Carroll	24
	INFO 336	Distributed Systems Security	C. Geib	12
	INFO 517	Principles of Cybersecurity	S. White	20
	INFO 710	Information Forensics	C. McClain	14
	INFO 718	Cybersecurity Policy	H. Rishikof	$\overline{7}$
Win 2014	ECEC 690	ST: Web Security II	H. Sethu	19
	CS 475	Computer and Network Security	R. Greenstadt	20
	INFO 712	Information Assurance	P. Grillo	26
	INFO 717	Cyber Crime Law	H. Rishikof	11
Fall 2013	ECEC 690	ST: Web Security I	H. Sethu	36
	CS 680	ST: Privacy in Electronic Society	R. Greenstadt	17
	INFO 333	Introduction to Information Security	C. Carroll	49
	CJ 276	Introduction to Computer Crime	I Schlanger	23

4.2 NSA/DHS CAE-CDE recertification

- Drexel University has held the designation as a National Security Agency (NSA) / Department of Homeland Security (DHS) Center of Academic Excellence (CAE) in Information Assurance Education for over ten years.
- Throughout 2016, the Institute worked on the application to be recertified as a NSA-CAE Cyber Defense Education (CDE). The application will be submitted in January 2017.

• Recertification required establishing coverage of each of twenty-two (22) knowledge units (KUs):

Basic data analysis	Networking concepts
Basic scripting	Operating systems concepts
Cyber defense	Policy, legal, ethics, compliance
Cyber threats	Probability and statistics
Databases	Programming
Fundamental security design principles	Systems administration
IA Fundamentals	Advanced network technology and protocols
Intro to cryptography	Database management systems
IT system components	Low level programming
Network defense	Operating systems theory
Network technology and protocols	Security risk analysis
and demonstration of:	
Program outreach and collaboration	CD multidisciplinary efforts
Center for CD education	Practice of CD at the institution level
A robust and active CD academic program	Student and faculty CD efforts

4.3 U.S. Army Reserve Private Public Partnership (USAR-P3i)

ILACI was notified on August 30th 2016 that the Drexel Cybersecurity for Soldiers Program (DCSP), a proposal written by Drexel, was recommended for funding by the NSA and U.S. Army Reserve.

- Use. The funds will be used to develope new cybersecurity courses and laboratories in CCI and in CoE over the next twelve months.
- Seminar series. Besides the courses, the DCSP Seminar Series, consisting of six cybersecurity seminars, will also be developed. Several talks were given in 2016, see (§5.2).
- Thanks to all the people at Drexel who helped with the process, including:

Ellen Bass	Greg Hislop
Colleen Cannon	Naga Kandasamy
Chris Carroll	Kimberly Logan
Sean Clark	ChiKa Nwankpa
Kapil Dandekar	Aleister Saunders
Marie Fazio	Ioannis Savidis
Wayne Hill	Matthew Stamm

[1] Steven Weber (PI). The Drexel Cybersecurity for Soldiers Program (DCSP). National Security Agency (NSA), August 30. \$206,165.

4.4 Peace engineering and cybersecurity

College of Engineering Dean Joe Hughes has initiated partnerships with Bernard Amadei (founder of Engineers without Borders) and the PeaceTechLab (a non-profit organization spun out of the U.S. Institute for Peace in Washington, D.C.), with the goal of establishing Drexel as an academic leader in the field

of peace engineering. The Drexel Cybersecurity Institute has been involved in these discussions, and will continue to play an active role moving foward.

4.5 CyberDragons

In August 2016, the Drexel CyberDragons, a student group was officially formed. The club focuses on general education in cybersecurity and the training for the Collegiate Cyber Defense Competition (CCDC). The logo and pictures for the club can be found at §A Scrapbook.

- Initial Officers. Colbert Zhu (President), Jennifer Bondarchuk (Vice President), Maksim Bazhydlouski (Treasurer), and Chuck Clift (System Administrator).
- Mentorship. Mr. Chuck Ludwig, head of security at Susquehanna International Group (SIG).
- Outreach. Colbert made presentations at both CCI and ECE new student orientations.
- Structure. Any student with an interest in cybersecurity can join the CyberDragons and participate in the trainnings.
- Equipment. SIG has donated equipment for use by the Drexel CyberDragons; the equipment is housed in the ECE Department.
- [1] Steven Weber and Debbie Buchwald (coordinator). Drexel Cybersecurity Institute and Susquehanna International Group (SIG). *CCDC introductory meeting*, Mitchell auditorium Drexel University Edmund D. Bossone Research Enterprise Center Philadelphia PA, April 4 2016.
- [2] Debbie Buchwald Chris Carroll Chuck Cliff and Steven Weber. Visited Susquehanna International Group (SIG). Discussion on SIG's mentorship and coaching of the CCDC team., Susquehanna International Group Bala Cynwyd PA, June 10 2016.

5 Community engagement

Invited talks given in 2016 by Drexel faculty are listed in §5.1. Events, symposia, invited speakers, and panels organized or co-organized by the Drexel and the Isaac L. Auerbach Cybersecurity Institute are listed in §5.2. Security Community events attended by the ILACI are listed in §5.3. Drexel ILACI has been hosting meetups for the cybersecurity communities like §5.4 BSides Philly and §5.5 Philly Security Shell.

5.1 Invited talks by Drexel faculty

Drexel faculty from the ILACI have given the following invited presentations:

- [1] Rachel Greenstadt. Stylometry of Source Code and Binaries. *KU Leuven Privacy Seminar*, Leuven, Belgium, February 2016.
- [2] Matthew Stamm. High performance techniques to identify the source of digital images using multimedia forensics. *Defense Forensics and Biometrics Agency (DFBA)*, March 2016.
- [3] Rachel Greenstadt. Enhanced attribution teaming brief. Defense Advanced Research Projects Agency (DARPA), Arlington, VA, April 2016.
- [4] Kapil Dandekar. Does the future of wireless network security lie at the physical layer? Center of Academic Excellence in Information Education Tech Talk, April 2016.
- [5] Rachel Greenstadt. Attrobuting Identities Online with Stylometry. Security in Times of Surveillance, TU Eindhoven, Netherlands, May 2016.
- [6] Rachel Greenstadt. Deanonymizing programmers. Crypto Working Group, Utrecht, Netherlands, May 2016.
- [7] Kyle Juretus. Hardware Security for the Internet of Things. *IEEE Council on Electronic Design* Automation (CEDA), May 9 2016.
- [8] Rachel Greenstadt. Deanonymizing programmers. Crypto Summer School, Croatia, June 2016.
- [9] Rachel Greenstadt. Attributing Identities Online with Stylometry. *TU Delft Seminar*, Delft Netherlands, June 2016.
- [10] Rachel Greenstadt. PoPETs Townhall Meeting Panel. Privacy Enhancing Technologies Symposium, Darmdtadt, Germany, July 2016.
- [11] Rachel Greenstadt. Erosion of Privacy: Hacking and Privacy Enhancing Technologies. Pennsylvania Conference of State Trial Judges, July 28 2016.
- [12] Matthew Stamm. High Performance Techniques to Identify the Source of Digital Images Using Multimedia Forensics. Defense Forensics and Biometrics Agency (DFBA), August 2016.
- [13] Rachel Greenstadt. Implications of Adversarial Learning for Security and Privacy. 2016 USENIX Summit on Hot Topics in Security (HotSEC), Austin, TX, August 9 2016.
- [14] Steven Weber. Cyber Insurance Modeling: Recent Advances and Challenges. 4A Security Healthcare Data Privacy Symposium, Drexel Gerri C. LeBow Building, October 4 2016.

[15] Matthew Stamm. Multimedia Forensics: Using Mathematics and Machine Learning to Determine an Image's Source and Authenticity. NSA Center of Academic Exellence Tech Talk, October 2016.

5.2 Events organized by the Drexel Isaac L. Auerbach Cybersecurity Institute

The Drexel Isaac L. Auerbach Cybersecurity Institute has organized or co-organized the following events in 2016:

- Drexel University. Delaware Valley Chapter of the Information Systems Security Association (ISSA). *The quarterly meeting of the Delaware Valley Chapter of the ISSA*, Behrakis Grand Hall of the Creese Student Center, December 16 2016.
- [2] Drexel University. Steven Weber and Ed Croot. Cybersecurity military/industry/academia thought leadership meeting, Auerbach and Berger Cybersecurity Lab in 3401 Market St, December 9 2016.
- [3] BSides. Brad Bowers. *Philly BSides Conference*, Behrakis Grand Hall in the Creese Student Center, December 2 3 2016.
- [4] Seminar by Dr. Avinash Srinivasan. Avinash Srinivasan. Research and Education in Cybersecurity and Forensics: Quo Vadis?", November 30 2016.
- [5] Drexel Cybersecurity Fall Symposium. Drexel University. Recognition and celebration of the endowment of the Institute from the Isaac and Carol Auerbach Family Foundation, Paul Peck Alumni Center, November 14 2016.
- [6] When Power Meets Multimedia. IEEE Signal Processing Society Distinguished Lecturer Program Drexel ECE Seminar Series and Institute's Drexel Cybersecurity for Soldiers Program (DCSP) Seminar Series. Seminar by Professor Min Wu (U. Maryland), October 18 2016.
- [7] 4A Security Healthcare Data Privacy Symposium. Drexel University. Drexel hosted the second annual 4A Security Healthcare Data Privacy Symposium, Gerri C. LeBow Building, October 4 - 5 2016.
- [8] Philadelphia Security Shell. Drexel Cybersecurity Institute. DCI hosted the Philadelphia Security Shell month meeting first time (continued), Auerbach and Berger Cybersecurity Lab Philadelphia PA, June 16 2016.
- [9] Drexel University. Drexel University College of Computing and Informatics and Graduate Student Association and Drexel NMIA. *Drexel Cybersecurity Conference*, 3rd floor Atrium, Edmund D. Bossone Research Center, Drexel University, Philadelphia PA, 19104, April 2 2016.
- [10] Department of Electrical and Computer Engineering (coordinator). Steven Weber. *The Department of Electrical and Computer and Computer Engineering held the first "ECE Day"*, Drexel University Edmund D. Bossone Research Enterprise Center Philadelphia PA, February 23 2016.
- [11] Drexel University. Philly Code Fest. Philly CodeFest was held at Drexel University, Drexel University, February 20 - 21 2016.
- [12] Marty Schratz (Judge Group). Judge Group seminar on job search skills for ECE graduate students, Drexel University Edmund D. Bossone Research Enterprise Center Philadelphia PA, January 28 2016.

5.3 Security Community Events attended by the institute

The Drexel Isaac L. Auerbach Cybersecurity Institute has attended the following events in 2016:

- Steven Weber. Attended the fourth annual "day with the U.S. Army Reserve." Discussion about developments in the USAR-P3i-Cyber program, U.S. Chamber of Commerce in Washington D.C., May 5 2016.
- [2] National Security Agency. Steven Weber. First NSA Signal Information Directorate Senior Executive Academic Liaison (SID SEAL) Day, Ft. Meade, June 1 2016.
- [3] NetDiligence. Steven Weber and Mark Greisiger. *NetDiligence annual Conference*, Hyatt Bellevue hotel downtown, June 7 8 2016.
- [4] CISSE/ISEW. Steven Weber. 2016 Colloquium for Information Systems Security Education (CISSE) And International Security Education Workshop (ISEW), Sheraton Society Hill Hotel Philadelphia PA, June 13 -15 2016.
- [5] NIST National Initiative on Cybersecurity Education (NICE) Annual Conference. NIST. Kansas City MO, November 1 -2 2016.
- [6] Steven Weber. NSA Center of Academic Excellence Program Community Annual Meeting, Kansas City MO, November 3 2016.

5.4 Bsides Philly

The first annual BSides Philadelphia Security Conference was held on December 2-3, 2016 on the Drexel campus. The BSides conferences are held in major cities across the nation, and are designed to provide an opportunity for the security community in the city to meet and exchange knowledge. BSides Philadelphia was organized by Mr. Brad Bowers. The figure 5 from §A is the logo for the event. More information about Philly BSides Conference can be found here:https://www.bsidesphilly.org/.

5.5 Philadelphia Security Shell

Philly Security Shell is intended to be a meetup focused on hands-on learning and networking for those interested in information security. The community meets monthly on the third Thursday of the month. Other than their regular meetups, they organize or announce events related to cybersecurity in the Philadelphia area. Since June 2016, the Institute has hosted the monthly meetup at the Auerbach and Berger Cybersecurity Lab. The main organizers for this community are Leonardo Serrano and Chris Rossi. The meetings are open to everyone with an interest in cybersecurity. More information about this community can be found on their website here:https://www.meetup.com/Philly-Shell-info-sec-meetup/.

6 Drexel cybersecurity in the news

Drexel cybersecurity-related activities mentioned in the news in 2016 include:

- [1] Britt Faulstick. Were You Part of a Cyberattack? *Drexel News Blog*, October 27, 2016. Quotes Gaurav Naik.
- [2] Steven Weber and David Whipple. "6 tips for cleaning up your cyber hygiene". Drexel University Online (DUO) blog post The Digital Dragon, October 18, 2016.

Snapshots of some of these articles are shown on the following pages.

https://newsblog.drexel.edu/2016/10/25/qa-were-you-part-of-a-cyberattack/

Q+A: Were You Part of a Cyberattack? - Drexel News Blog

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EXPERTS, SCIENCE & TECHNOLOGY By BRITT FAULSTICK / OCTOBER 25, 2016 @ 3:07 PM

Q+A: WERE YOU PART OF A CYBERATTACK?

You might have been an unwitting participant in the **cyberattack that took down Twitter**, **Netflix**, *The New York Times'* website and many others last week. According to cybersecurity analysts, the widespread and highly coordinated cyberattack, designed to disrupt access to several popular websites by overwhelming them with an onslaught of bogus requests, was orchestrated using tens of thousands of poorly secured internetaccessible devices, such as home monitoring systems, digital video recorders and routers



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The assault targeted Dyn, Inc., a company that provides the domain network system (DNS) services that allow users to connect to these websites. By disrupting Dyn's ability to provide this infrastructure many of these high-traffic sites could not be reached starting in the early hours of Friday morning on the East Coast.

Gaurav Naik, an expert from Drexel's Isaac L. Auerbach Cybersecurity Institute and an assistant research professor who studies computer network security in the College of Computing & Informatics, suggests that most of the people whose devices were hacked and used in the attack would not have been aware of it.

Naik recently took some time to explain the nature of this type of attack – called distributed denial-of-service – why so many people were affected by this particular one, and why we should anticipate more like it in the future.

Page 1 of 11

Figure 1: Drexel News Blog - October 27, 2016



Figure 2: Drexel University Online (DUO) blog post "The Digital Dragon" – October 18, 2016

A Scrapbook of events and meetings

The following pages hold pictures, announcements, and agendas for important events.



Figure 3: December 9, 2016 – Cybersecurity Military/Industry/Academia thought leadership meeting



Figure 4: December 2 - 3, 2016 – Drexel University held BSides Philadelphia

Research and Education in Cybersecurity and Forensics

Quo Vadis?

Speaker: Avinash Srinivasan, Ph.D., CEH

Abstract: Cybersecurity, and more recently cyberforensics, have been a national security priority for the U.S. and many other nations. Repeated cyber attacks, including the most recent IoT fueled Internet DoS affecting users reaching an array of sites, including Twitter, Amazon, Tumblr, Reddit, Spotify and Netflix., have become harsh realities in today's world. With such expansive and complex attacks, it remains glaringly obvious that we are acutely under-prepared in countering sophisticated cyber criminals.

Investing in research and education, both very tightly coupled and perhaps the two sides of the same coin, are critical to dealing with current cyber-threats. The US government has specially created strong and wellbalanced program standards for enabling academic institutions to incorporate cybersecurity and forensics topics into their academic curriculum. The primary objective of these program standards is to produce well-trained cyber workforce with the necessary technical skills, awareness, and security consciousness to design and build a secure cyberspace for the future.

In my talk, I will discuss my current research in cybersecurity and forensics, primarily focusing on current funded topics and future research plans. I will also talk about the STEM education needs and current opportunities for MOUs and exclusive funding vehicles supporting educational initiatives in cybersecurity and forensics.

Speaker Bio: Dr. Avinash Srinivasan has held numerous academic positions since 2008. Currently, he is an Associate Professor in the CIS department at Temple University (TU), Visiting Researcher at Center for Secure Information Systems (GMU), and a Fellow of the National Cybersecurity Institute at Washington D.C. Prior to joining TU in Summer 2014, he was an Assistant Professor in the CS department at George Mason University (GMU) from Spring 2012-Spring 2014, and an Assistant Professor of Computer Forensics at Bloomsburg University from Fall 2008 to Fall 2011. He is also a *Certified Ethical Hacker* since January 2015.

Dr. Srinivasan's research interests broadly span the areas of Cybersecurity and Digital Forensics with primary focus in – networks, cloud computing, memory, and mobile and embedded devices; malware analysis and intrusion detection; conditional anonymity and privacy, and vehicular networks. He has published 42 refereed papers in scholarly conferences and journals, including IEEE INFOCOM, ACM SAC, IEEE ICC, IEEE ICDCS, and IEEE MALWARE, and recipient of the **Best Paper Award** at ICITST 2012. Since 2008, Dr. Srinivasan has been involved as PI/Co-PI on federally funded research exceeding \$1.2Mil, and his current research is funded by NSF and DoD/NAVY.

Dr. Srinivasan has over 450 hours of formal training in *Cybersecurity and Digital Forensics*. He has close working relationships with both industry and law enforcement (LE) agencies including FBI Regional Computer Forensics Lab, FBI Cybersquad, and DC3. Since 2008, he has trained LE officers and civilians in various cybersecurity and digital forensics topics including – *Network Forensics, Macintosh Forensics*, and *Ethical Hacking & Pen Testing*.

Dr. Srinivasan earned his B.E. (Industrial Production, 1999) from University of Mysore (India) with Honors and M.S. (Computer Science, 2003) from Pace University (NY, USA), with *Distinguished Achievement Award* for Academic Excellence. He received Ph.D. in Computer Science from Florida Atlantic University (FL, USA) in August 2008 and Prof. Jie Wu (IEEE Fellow) was his advisor.

Figure 5: November 30, 2016 – Abstract & Bio of Dr. Avinash Srinivasan

University Isaac L. Auerbach Cybersecurity Institute

You are cordially invited to attend

The Fall Symposium of the Isaac L. Auerbach Cybersecurity Institute

Monday, November 14, 2016 2:30 to 5 p.m. Symposium Reception to follow

The Paul Peck Alumni Center 3142 Market Street, Philadelphia

RSVP by November 10 to Kaylyn Edelman kedelman@drexel.edu or 215.895.0982

The Symposium celebrates the recent endowment of the Drexel Isaac L. Auerbach Cybersecurity Institute through the generous donation of Carol Auerbach.

> Remarks and Introductions: M. Brian Blake, PhD Executive Vice President and Provost Drexel University

Dr. Steven Weber Professor, Drexel College of Engineering Director, Isaac L. Auerbach Cybersecurity Institute

Three prominent Drexel cybersecurity faculty researchers and a distinguished Drexel alumnus will speak on topics of interest to everyone in the age of cybersecurity.

Speakers: Dr. Kapil Dandekar Professor and Associate Dean of Research and Graduate Studies Drexel University College of Engineering

Dr. Spiros Mancoridis Distinguished Professor, Drexel College of Computing and Informatics Technical Fellow, The Isaac L. Auerbach Cybersecurity Institute

> Dr. Matthew Stamm Assistant Professor Drexel University College of Engineering

> > Mark Greisiger President NetDiligence



Figure 6: November 14, 2016 – Drexel Cybersecurity Conference Invitation

November 3, 2016 Kansas City, MO		WIFI Network(Guestrooms): WESTIN-GUEST Network (Meeting space): WESTIN-MEETING Passcode: NICE2016
	Agenda	
Starts at 7:30am	Check-In	
8:00am-8:25am	Welcome, Logistics, and Roadmap Flag Ceremony Tony Coulson (CSUSB), Lynne Clark (NSA), Rodney Peterson (NIST), Dan Stein (DHS)	Century A Ballroom
8:25am-8:40am	CAE Community- Evolution and Mission Tony Coulson (CAE Community Lead)	Century A Ballroom
8:40am-10:00am	NSA/DHS: State of CAEs Lynne Clark (NSA), Dan Stein (DHS) CAE Program Team, Corby Hovis (NSF)	Century A Ballroom
10:35am-10:50am	Morning Break (Sponsored by CyberWatch West)	
10:50am-11:55am	CAE Fast Pitch Sessions (8 Minutes Each) (See page 2 for descriptions.)	Century A Ballroom
12:00pm-1:00pm	Working Lunch - CAE Website and Signups Anastacia Webster	Century A Ballroom
1:00pm-1:30pm	KU Refinement Art Conklin	Century A Ballroom
1:30pm-2:30pm	Dismiss to Special Interest Group Sessions (4) (See page 2-4 for room locations and descriptions.)	Century A Ballroom
2:30pm-2:45pm	Afternoon Break (Sponsored by CyberWatch West)	Century A Ballroom
2:45pm-4:15pm	Presentations (See page 3-4 for room locations and descriptions.)	Century A Ballroom
2:45pm-4:15pm	Government Representative Appointments DHS – Dan Stein (High School, Internships, Infrastructure) NSA – Lynne Clark (NSA CAE CD Program Office) NSA – Heather Elkenberry (Cyber Ops) NSF – Corby Hovis (Grants) NIST – Rodney Peterson/ Bill Newhouse (NICE)	Century A Ballroom
4:15pm-5:00pm	Interactive Plenary & SIG's Work/Open Mic/ Farewell	Century A Ballroom

Figure 7: November 3, 2016 – NSA-CAE-PI Meeting Agenda



		Mobile Health	Big Health Data	Cyber Security	Privacy & Compliance	Governance & Risk Management	Legal & Regulatory
Start	End	Day 1 - Tuesday, October 4th					
11:30	1:00 PM	Registration					
1:00 PM	1:30 PM	The Industry's #1 Threat - Part 1					
1:40 PM	2:50 PM	Day 1 - Breakout Sessions 1					
		Tech, Security & Privacy		Govern Man	ance & Risk agement	Legal & Regulatory	
		CISO, CPO, & Big Da	Mobile Health ata - Part 1	Cyber Risk of Direc	and the Board tors - Part 1	Data Sharing Agre	ements
2:50 PM	3:00 PM	Break					
3:00 PM	4:30 PM	Day 1 - Breakout Sessions 2					
		CISO, CPO, & Big Da	Mobile Health ata - Part 2	Cyber Risk of Direc	and the Board tors - Part 2	HHS OCR, FDA & FTC Regulatory Com	Healthcare pliance
4:30 PM	5:00 PM	The Industry's #1 Threat - Part 2					

Figure 8: October 4 - 5, 2016 – 4A Security Healthcare Data Privacy Symposium Agenda



Figure 9: August 16, 2016 – Philly Security Shell regular meeting is held at Drexel University



Figure 10: August, 2016 – Drexel CyberDragons was officially formed (logo)

International Security Education Workshop

Agenda

June 13-15, 2016 – Sheraton Philadelphia Society Hill Hotel

MONDAY, JUNE 13, 2016

8:00 AM - 1:15 PM	Follow CISSE Agenda				
	Note: ACM JTF Introduction to CISSE (10:45-11:30AM)				
1:30 PM = 4:20 PM	ISEW Opening Session				
1.50 PM - 4.20 PM	istwopening session				
1:30 - 1:35 PM	Workshop Opening				
	Diana Burley, George Washington University				
	Scott Buck, Intel				
1:35 - 2:15 PM	Keynote: "Cybersecurity Across the Professions – Who Should Know What"				
	Dr. Herb Lin				
	Senior Research Scholar, Center for International Security and Cooperation				
	Research Fellow, Hoover Institution				
	Stanford University				
2:20 - 2:30 PM	Workshop Introduction – Purpose/Goals				
	Matt Bishop, University of California, Davis				
	Scott Buck, Intel				
2:30 - 3:20 PM	Panel: Academia/Industry Collaboration in Cybersecurity Programs				
	Moderator:				
	Herb Mattord, Kennessaw State University				
	Panelists:				
	Ron Dodge, Palo Alto Networks				
	Lisa Depew, Chief of Staff, Intel Security CTO				
	Drew Morin, T-Mobile				
	Barbara Endicott-Popovsky, University of Wasnington				
3:25 - 3:55 PM	Community Engagement - Contextualizing the Curriculum Development Process				
	Allen Parrish, US Naval Academy				
4:00 - 4:30 PM	Introduction to ACM Joint Task Force (JTF) on Cybersecurity Education and				
	Preparation for Working Sessions				
	David "Hoot" Gibson, USAir Force Academy				
	Beth Hawthorne, Union County College				
	Costa Michailidis, Knowinnovation				
4:30 PM – 6 PM	Follow CISSE Agenda				
6 PM	ACM JTF Working Dinner [By Invitation Only]				



Figure 11: June 13 - 15, 2016 – Snapshot of CISSE/ISEW Conference Agenda

HB Litigation Conferences presents the

NetDiligence® Cyber Risk & Privacy Liability Forum

June 7-8, 2016 | Philadelphia | Welcome reception June 6, 2016

Program Chairs

David Navetta Norton Rose Fulbright Bo Holland AllClear ID John Merchant Validus Rebecca Swanson Markel Jill Salmon Berkshire Hathaway Specialty Insurance



7:00 a.m. | Registration & Breakfast

Figure 12: June 6-7, 2016 – Snapshot of NetDiligence Conference information

SID SEAL Academic Day at NSA Wednesday, 01 June 2016

Thank you for participating in the Academic Day at NSA. Please read this information thoroughly to ensure a smooth arrival to our campus.

Please park in the lot adjacent to National Vigilance Park, located at 8223 Colony Seven Rd, Annapolis Junction, MD 20701. The visitors' center (VCC 1) is across the street from this parking lot and about a five minute walk. In case the aforementioned lot is full by the time you arrive, you may park at the National Cryptologic Museum located at 8290 Colony Seven Rd, Annapolis Junction, MD 20701. There is a shuttle labeled N11 that will bring you to the VCC or you may walk to the VCC 1. There is a sidewalk that will lead you to the VCC and it is approximately a 10-15 minute walk.

Please see attached maps for further detail.

Important: Before you leave your parked car, please remember to leave your cell phone and any other electronic devices in your vehicle. This includes laptops, iPads, wearable fitness devices, etc. These items are not allowed in our facilities and security will ask you return it to your vehicle once you arrive.

It is recommended that you arrive to VCC 1 at 0800 on Wednesday, 01 June 2016, as it will take a few minutes to clear security and acquire your visitor badge. Please ensure that you have a valid, government-issued, picture ID.

You will be met at the Visitors' Center (VCC 1) at 0830 by LTJG Jason Lawless, and escorted into the building. Briefings and discussions will begin at 0900.

Topics that will be covered during Academic Day include:

- REDHAWK: Framework supporting Software Defined Radios,
- Greybox: the unclassified mock-up and associated APIs of NSA architecture, and
- Code Breaker Challenge: unclassified reverse software engineering challenge.

In addition, multiple senior Technical Directors from various mission elements will present briefings and host discussions regarding current areas of interest at NSA.

Figure 13: June 1, 2016 – Snapshot of SID SEAL Day invitation

Drexel Collegiate Cyber Defense Team Information meeting: Monday April 4 5pm Bossone 302

	Drexel is starting a NEW Collegiate Cyber Defense Team to train for and participate in the National Collegiate Cyber Defense Competitions (CCDC).						
what:	Security experts from Susquehanna International Group (SIG) will mentor and coach the team. SIG representatives will be at this meeting to answer questions. This is the information meeting for YOU to learn about the team.						
	Knowledge - You will learn valuable cybersecurity skills from working experts that dramatically increase your value on the job market.						
Why:	Fun - CCDC competitions are incredibly FUN events.						
	School pride - Drexel has not participated in CCDC in the past, and we need to show the world we have what it takes to win.						
	CCDC teams develop a DIVERSE collection of cybersecurity / computing / IT / networking / programming skills.						
Who:	If you have SOME of these skills and want to learn MORE, then come to the meeting.						
	We are looking for ALL RANKS of students: undergraduate and graduate students.						
Contac	Steven Weber - Director Drexel Cybersecurity Institute sweber@coe.drexel.edu						
	Cybersecurity SIG						
	nstitute SUSQUEHANNA						

Figure 14: April 4, 2016 – CCDC Introductory meeting



Figure 15: April 4, 2016 – CCDC Introductory meeting

AIM

The aim of this conference is to cater to both beginners and professionals alike, to educate the general public on basic security measures and introduce the concept of security and to connect with security professionals in the greater Philadelphia area.



Drexel University Philadelphia, PA 19104

WHEN

Saturday, April 2nd 2016 at 9:00 AM – 5:30 PM

WHERE

3rd Floor Atrium, Edmund D. Bossone Research Center, Drexel University Philadelphia PA 19104

Graduate Student Lounge, Main Building,

Drexel CSX 2016 ||csxdrexel@gmail.com

Figure 16: April 2, 2016 - Snapshot of Drexel Cybersecurity Conference flier

CODE. COMPETE. INNOVATE.

Philly {CODEFEST}

FEBRUARY 20-21, 2016

DREXEL UNIVERSITY

REGISTRATION NOW OPEN

Open to students and professionals of all skill levels and backgrounds!

phillycodefest.com

Figure 17: February 20 -21, 2016 – Philly CodeFest at Drexel University



Figure 18: January 28, 2016 – Judge Group Presentation on job search skills for ECE Graduate students

