Educational Programs

- Minor Degree
- Masters Degree
- 4+1 Program
- Masters Degree
- Certificate Program
- 2+2 Program

Reflections on Technology Research and Transfer in Cybersecurity

NSF Cybersecurity TTP Workshop

Chase Cotton
Electrical & Computer Engineering
University of Delaware

Research

cloud application performance analytics / networking / ad-hoc networks / malware characterization & detection / machine learning / software analysis & validation / IOC collection & analysis / virtualization & orchestration / malware detection / high-availability / exfiltration / cryptography / trust / counter-measures / deterrence / compliance / insider threats / vehicle systems / hardware trust / high speed digital systems / post-quantum cryptography (lattice, polynomial factoring) / web applications security / secure software / high-performance computing & big data / security/resilience/protection / multi-level cyber simulations / networking / cloud/network security / online fraud defense & system security / secure query processing / wireless security & privacy / mobile crowdsourcing & systems for the disabled / social networks …

Department Snapshot

People

- ✓ Faculty: 25
  - ➢ 1 NEA, 14 Fellows, 5 Named Profs., 2 PECASE, 17 CAREER
- ✓ Grad. students: 261
  - ➢ 105 PhDs, 156 MS
- ✓ Undergrad. students: 391

Degrees

- ✓ Bachelors Degrees:
  - ➢ Electrical Eng.; Computer Eng.
- ✓ Minors:
  - ➢ Electrical & Computer Eng.; Bioelectrical Eng.; Cybersecurity
- ✓ Graduate Degrees:
  - ➢ MS Electrical & Computer Eng.; MS Cybersecurity; PhD Electrical & Computer Eng.
- ✓ Integrated BE/MS (4+1) Degrees

Facilities & Resources

University of Delaware — Electrical & Computer Engineering

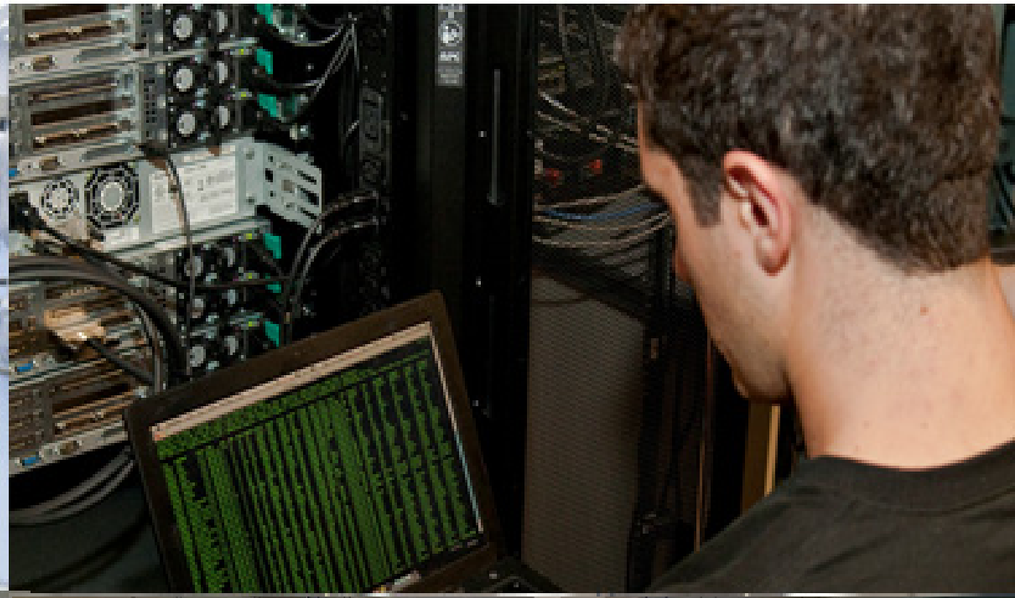
$10 million in annual research expenditures

40,000 ft.^{2} of laboratory & support facilities

State-of-the-art nanofabrication laboratories

Cloud computing and cyber infrastructure facilities

Modern teaching laboratories & IEEE student commons



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NSF SFS Capacity Building Grant and Other Programs

XChange Viewer

The National Security Agency (NSA) and Department of Homeland Security (DHS) have designated The University of Delaware a National Center of Academic Excellence in Cyber Defense Education.

DTCC 2+2
- Information Security
- Associate Degree

HCC 2+2
- Information Systems Security
- Associate Degree

UD

ECE
- Computer, Electrical Engineering (BS)

CIS
- Computer and Information Science (BS)

MIS
- Management Information Systems (BS)

Other
- Criminal Justice, Math (BS), other engr, etc.

Fall 2014 70+ students

Cybersecurity Minor
- +18 Hours
- ~12 Hours (for ECE & CIS)

Fall 2015 / Online Spring 2016

MS, 4+1 Cybersecurity Masters
- Follows established 4+1 programs

Spring 2016

Certificate Programs
- U. S. Army / CERDEC and APG

Other Programs (Future)
- Executive Programs
- Workshops, Contract Education

2 to 4 (2+2) Year Program Articulation Agreements

Joint Summer Programs (K12 + College + Graduate Student + Industry)

Follow-on Programs (Future)

Our view on Cybersecurity Education

What is Cybersecurity?

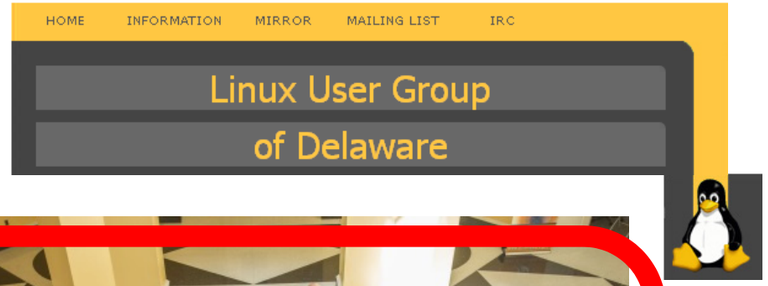
Cybersecurity is just a new word for Computer and Network Security

Why study Cybersecurity?

As an engineer, scientist, or even in business almost everything you are likely to work on in your future career will need to incorporate security considerations – whether a computer system, a network, or an information system, or some other product or service.

As such, we think an understanding of security should be a component of a technology education going forward.

Stresses Hands-On



LUG (Linux User Group of Delaware) student meetings
campus meetings often discuss security topics

Since 2010 Delaware holds one of the few Cybersecurity Boot Camps in the US for college and high school students
see http://uscc.cyberquests.org/

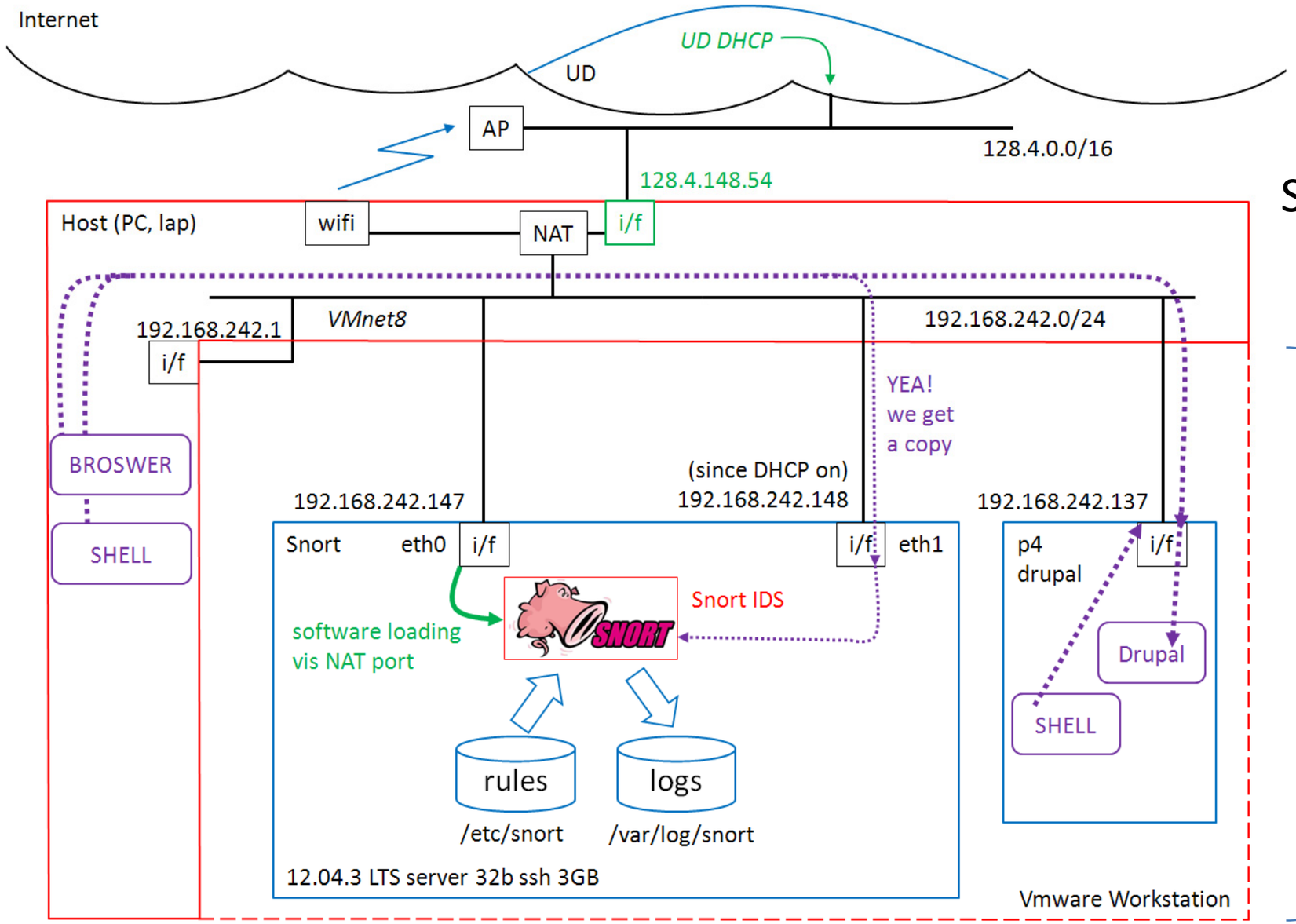
Cyber Aces - excellent security ba
networks, system admin) see https

UD students participate in Intern
Flag's (CTF) 3-4 times a year. Tea

We think of our program as
Third Generation Cybersecurity Education

Influenced by the intense hands-on nature of Commercial Computer and Network Security Training (e.g. SANS)

Need a room full of computers?



Nah!

System Hardening and Protection
Lab on IDS and Logging
CPEG494/694 **DEFENSE**

many (5+)
virtual computers
inside a
“hypervisor”
running on a
students laptop

MINOR IN CYBERSECURITY

The minor in Cybersecurity requires the successful completion of 18 credits with a minimum grade of C in each course.

Required Foundation Courses

12 credits (four courses)

- CPEG465 Introduction to Cybersecurity [since Spring ’13]
- CPEG494 System Hardening and Protection [since Fall ’13]
- CISC361 Operating Systems [Required for majors Computer Engr and CIS]
- CPEG 419/CISC450 Computer Networks [Required for majors Computer Engr and CIS]

Technical Elective Courses

6 credits (two courses)

- CPEG497 Advanced Cybersecurity [since Fall ‘14]
- CPEG495 Digital Forensics [since Spring ’15]
- MATH549 Coding Theory and Cryptography [Department of Mathematical Sciences]
- CRJU457 Criminal Evidence [Department of Sociology and Criminal Justice]
- CISC367 Simulation-based Cybersecurity [since Fall ‘14]

Courses being added as part of Cybersecurity Masters

- CPEG470 Web Applications Security [since Spring ‘16]
- CPEG471 Pen Test & Reverse Engineering [since Fall ‘15]
- CPEG472 Applied Cryptography [since Spring ‘15]
- CPEG473 Cloud Computing and Security [since Fall ‘15]
- CPEG474 SCADA Systems and Security [FUTURE]
- CPEG475 Embedded Computer Systems [FUTURE]
- CPEG476 Secure Program Design [since Fall ‘16]

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MASTERS IN CYBERSECURITY

Fundamentals of Cybersecurity – Computer & Network Security	15 credits (five courses)
CPEG 665 Introduction to Cybersecurity (CYBER I) **CPEG 697 Advanced Cybersecurity (CYBER II)** **CPEG 694 System Hardening & Protection (DEFENSE)** **CPEG 695 Digital Forensics**	**CPEG 676 Secure Software Design** **CPEG 671 Pen Test and Reverse Engineering** **CPEG 672 Applied Cryptography**

Concentration Areas	15 credits (five courses, at least three in chosen concentration area)
Secure Software **CPEG 670 Web Applications Security** CISC 621 Algorithm Design and Analysis CISC 663 Operating Systems CISC 672 Compiler Construction or CPEG 621 Compiler Design CISC 675 Software Engineering Principles and Practices	CISC 611/CPEG 611 Software Process Management CISC 612/CPEG 612 Software Design CISC 613/CPEG 613 Software Requirements Engineering CISC 614/CPEG 614 Formal Methods in Software Engineering CISC 615/CPEG 615 Software Testing and Maintenance **CPEG 676 Secure Software Design**
Secure Systems ELEG 635 Digital Communication ELEG 658 Advanced Mobile Services ELEG 617 The Smart Grid **CISC 6xx / CPEG 696 Topics in Cybersecurity (Simulation-based Cybersecurity)** ELEG 812 Wireless Digital Communication	**CPEG 675 Embedded Computer Systems (FUTURE)** CISC 650 / ELEG 651 Computer Networks CISC 853 Network Management **CPEG 673 Cloud Computing and Security** CISC 886 Multi-Agent Systems **CPEG 674 SCADA Systems and Security (FUTURE)** CPEG 853 Computer Systems Reliability
Security Analytics ELEG 815 Analytics I - Statistical Learning ELEG 817 / FSAN 817 Large Scale Machine Learning CISC 683 Introduction to Data Mining CISC 637 Database Systems	CPEG 657 Search and Data Mining CISC 681 Artificial Intelligence CISC 689 TPCS: Artificial Intelligence: Machine Learning ELEG 630 Information Theory CISC 684 Introduction to Machine Learning
Security Management MISY 850 Security and Control FINC 855 Financial Institutions & Markets BUAD 840 Ethical Issues in Domestic and Global Business Environments	MISY 840 Project Management and Costing ACCT 806 Systems Analysis and Design BUAD 870 Leadership and Organizational Behavior BUAD 877 Skills for Change Agents MISY 810 Telecommunications and Networking

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Cyber Focused Research

Stephan Bohacek

ECE/CIS — Cloudamize

cloud application performance analytics, networking, ad-hoc networks

John Cavazos

CIS/ECE, JP Morgan Chase Faculty Fellow — Cyber 20/20

malware characterization and detection, machine learning, software analysis and validation

Chase Cotton

ECE

IOC collection & analysis, virtualization & orchestration, malware detection, high-availability, exfiltration

Robert Coulter

Math

cryptography, trust

John D'Arcy

Business

counter-measures, deterrence, compliance, insider threats

Fouad Kiamilev

ECE — Chip Design Systems LLC

vehicle systems, hardware trust, high speed digital systems

Andy Novocin

ECE — Golden Egg Labs

post-quantum cryptography (lattice, polynomial factoring), web applications security, secure software

Guang Gao

ECE — ET International Inc. (ETI)

high-performance computing & big data systems, security/resilience/protection

Chien-Chung Shen

CIS

multi-level cyber simulations, networking

Haining Wang

ECE

cloud/network security, online fraud defense & system security

Chengmo Yang

ECE

secure query processing, wireless security & privacy, mobile crowdsourcing & systems for the disabled, social networks

Rui Zhang

CIS

secure query processing, wireless security & privacy, mobile crowdsourcing & systems for the disabled, social networks