A Model for Establishing a Cybersecurity Center of Excellence

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Abstract

In order to effectively ensure our continued technical advantage and future cybersecurity, we need a technologically skilled and cyber savvy workforce and an effective pipeline of future employees. Our Government has identified Cybersecurity as one of the most serious economic and national security challenges we face as a nation and has ear-marked cybersecurity education as a major part of its Comprehensive National Cybersecurity Initiative. By establishing a Cybersecurity Center of Excellence as part of our Computer Science - Cybersecurity curriculum, Saint Peter's University will be well positioned to train and educate students on this very important National initiative. In addition, we will be providing our students with the skill-sets necessary to become a member of the cybersecurity workforce that is expected to increase from global revenues of $95 billion in 2014 to $155 billion in 2019.

Keywords: Cybersecurity, Center of Excellence, Security, Information Technology

1. INTRODUCTION

The need for information security has been increasing in all industry sectors, including energy, healthcare, financial services, manufacturing, transportation, and homeland security. Associated with this need for information security, is the demand for professionals with knowledge in the areas of computer security and information risk and assurance.

In February 2012, the Commerce Department's National Institute of Standards and Technology (NIST) established a National Cybersecurity Center of Excellence. According to NIST, the Center is to operate as a public - private collaboration for accelerating the widespread adoption of integrated cybersecurity tools and technologies (National Institute of Standards and Technology, 2014). The National Cybersecurity Center of Excellence (NCCoE), located in Rockville, Maryland, provides businesses with real-world cybersecurity solutions, based on commercially available technologies. The center brings together experts from industry, government and academia to demonstrate integrated cybersecurity that is cost-effective, repeatable and scalable (National Cybersecurity Center of Excellence, 2014).

During the design of our Cybersecurity Center of Excellence Model, the NCCoE has been our advisor and has provided us with cybersecurity educational information. They have also introduced us to cybersecurity technology vendors and business partners. This advisor capacity role has played an important part in the design of our Cybersecurity Center of Excellence.

2. WHAT IS CYBERSECURITY?

Cybersecurity refers generally to the ability to control access to networked systems and the information they contain. Where cyber security controls are effective, cyberspace is considered a reliable, resilient, and trustworthy digital infrastructure. Where cyber security controls are

absent, incomplete, or poorly designed, cyberspace is considered the wild west of the digital age
(Bayuk, Healey, Rohmeyer, Sachs, Marcus, Schmidt, Weiss, 2013). Given the rapid global diffusion of Internet and social networking technologies, the degree to which societies around the world are increasingly linked is on the rise. With each new participant in the information age added to the network, the possibilities for threats and opportunities increase exponentially. Today, due to the Internet and the access it provides to file servers containing databases throughout the world, information has become available at virtually no cost to anyone who has a computer and Internet connectivity (Johnson, 2014).

3. CYBERCRIME COSTS & STATISTICS

According to an industry study by McAfee, cybercrimes cost the global economy up to US$500 billion annually. The study also found that cybercrimes can potentially result in the loss of 500,000 jobs in the United States (McAfee, 2013). Ponemon Institute's 2013 Cost of Cyber Crime study finds the average company in the U.S. experiences more than 100 successful cyber-attacks each year at a cost of $11.6M. That's an increase of 26% from 2012. The study also shows that companies who implement enabling security technologies reduced losses by nearly $4M, and those employing good security governance practices reduced costs by an average of $1.5M (Ponemon Institute, 2013). A study by Norton found that about 556 million adults are victims of cybercrime each year, which equates to 1.5 million victims per day and 18 victims per second (Norton, 2012). A good website that collects information on global cybersecurity attacks and reports statistics on the attacks is Hackmageddon.com. To illustrate, Figure 1 shows attacks based on country distribution, Figure 2 shows motivations behind attacks, and Figure 3 shows distribution of attack techniques. All illustrations are from the Hackmageddon.com (2013), web site and are for a snapshot in time, the month of August 2013. As illustrated in Figures 1-3, cyber-attacks are global. They are classified into 4 main areas of motivation: cybercrime, hacktivism, cyber warfare, and cyber espionage. Leading in the type of attack techniques that are known are DDoS with 17.8% and account hijacking with 16.8%. Out of all attack techniques, 24.3% are categorized an Unknown. Despite the estimated loss of money and information and known threats from adversaries, the precise impact of cybercrime is unknown because it is not always detected and reported.

Figure 1

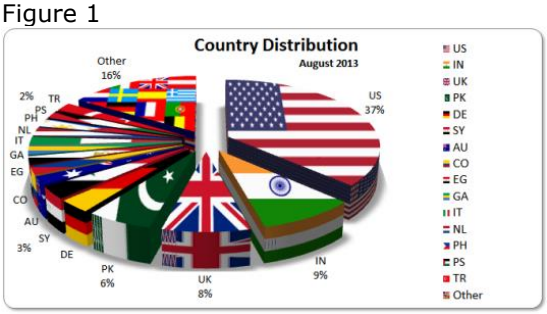


Figure 2

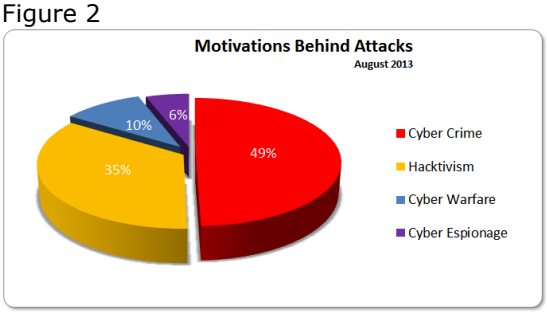
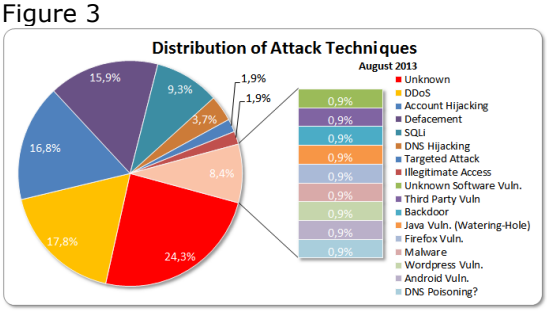


Figure 3



As a result of sophisticated technology and computers linked to information systems and databases, which are networked via lightning fast telecommunications links, we are in an era where the information revolution has changed the way organizations conduct business. Cyber-attacks continue to proliferate as vulnerabilities in computer systems and threats from hackers have increased every year. Malicious software threats, attacks, and botnets make front page news displaying the infamous success of hackers stealing data, crippling companies, and spying on corporations and governments.

Appropriate cybersecurity controls and tools need to be in place with a cybersecurity-savvy workforce that can combat the many risks and vulnerabilities faced in today's global society.

Our Government has identified Cybersecurity as one of the most serious economic and national security challenges we face as a nation. As a result, a Government project has been initiated to review the federal efforts to defend the United States information and communications infrastructure and the development of a comprehensive approach to secure America's digital infrastructure. One of the tenants of the comprehensive approach is to encourage institutions/organizations to provide education programs and training in Cybersecurity (The White House, 2014).

4. RESEARCH METHODOLOGY

During the 2013/2014 Academic Year, the Computer Science Department received approval to implement a new undergraduate concentration in Cybersecurity. Appendix A identifies the Cybersecurity curriculum concentration. We wanted to implement a Cybersecurity Center of Excellence as part of the curriculum to provide a value-added computing and learning environment for our students. Therefore, we conducted a study to determine what other United States colleges and universities were doing with Cybersecurity Labs in connection with their undergraduate and graduate Cybersecurity curriculums. The study would help us in designing the Model of our Cybersecurity COE. A total of 100 colleges and universities were studied. The schools that were part of the study were identified from literature searches on the Internet and from selecting schools around the country that have computer science degree offerings.

Table 1: Geographic Breakdown of Cybersecurity Degrees

North East	**17**
Mid Atlantic	**8**
South East	**1**
Mid West	**5**
South	**2**
South West	**0**
North West	**0**
West	**2**
Online	**3**
Total	**38**

Appendix B identifies schools studied that offer Cybersecurity undergraduate and graduate degrees including schools that have Cybersecurity Labs. From the 100 colleges and universities studied, thirty-eight schools offer Cybersecurity degrees and seventeen of those schools have Cybersecurity Labs.

Appendix C identifies schools studied that do not offer Cybersecurity degrees. There are sixty-two schools that do not offer Cybersecurity degrees. Twenty-four of the schools have Cybersecurity Labs.

Table 1 shows the geographic breakdown of schools offering Cybersecurity degrees.Of the 38 schools that offer Cybersecurity degrees:

- 27 have undergraduate programs
- 20 have graduate programs
- 9 have both undergraduate and graduate programs
- 3 are Online
- 17 have a Cybersecurity Lab

Adding the schools that have a Cybersecurity Lab from Appendix B and C, we come up with 41 schools that have a Cybersecurity Lab.

5. CYBERSECURITY CENTER OF EXCELLENCE MODEL

A detailed review of the 41 colleges and university Cybersecurity Labs led to the model that we developed for the Saint Peter's University Cybersecurity Center of Excellence. Implementation is planned for the start of the fall 2015 Term. Appendix D is an illustration of the Cybersecurity Center of Excellence (COE) Model. The Cybersecurity COE will consist of (1) a physical 24/7 state-of-the art computer network facility consisting of hardware platforms and operating systems, network, and security software/tools and (2) a 24/7 virtual web portal that consists of Cybersecurity documents, products, tools, and an eLearning repository that can be accessed anywhere around the world.

In reviewing the 41 colleges and universities that have Cybersecurity Labs, while they had good hardware and software infrastructures and ongoing research projects, none of them included other academic departments as part of their Cybersecurity Lab. To help differentiate the Saint Peter's University Cybersecurity COE from other colleges and universities Cybersecurity Labs, we are including in our Cybersecurity COE, two academic departments: (1) Criminal Justice, and (2) Business Administration. We are also including our Guarini Institute for Government and Leadership. The two departments and the Guarini Institute will be participants and have a role in the COE. They will include their students

in educational related activities/events and also emphasize cybersecurity technical, legal, and ethical issues during course lectures, assignments, and seminars.

Technology and equipment for the COE will be made possible from vendor donations, grants, and University funding. It will include large computer screens that provide real-time information on Cyber-attack timelines, world-wide geographic locations, cyber threats and vulnerabilities, metrics, and computer dashboards from SANS (SysAdmin, Audit, Network and Security, 2014), the CERTStation (CERTStation, 2014), and the Arbor Networks Attacks Source Map (Arbor Networks, 2014).

6. CYBERSECURITY COE CONTENTS

The Cybersecurity COE will consist of a network of Windows and Linux computers. The network is currently in the design stage and will include:

- Software:
  - Microsoft SQL Server R2
  - Microsoft .NET Framework 4.0
  - IBM Security AppScan: Security Vulnerability Program
  - HP WebInspect: Security Vulnerability Program
  - LogRhythm: Log Event and Management Analysis
  - CISCO Network Simulator
  - Department of Homeland Security Cyber Security Evaluation Tool
  - Network Sniffers and Intrusion Detection Software

- Virtual Machines:
  - NETinVM: VMWare Virtual Machine Image that contains a series of User-Mode Linux Virtual Machines
  - CISCO Virtual Lab

- Vendor Testing Sites:
  - IBM Altoromutual
  - HP Freebank
  - CrackMeBank

As illustrated in Appendix D, The Cybersecurity COE, consists of four domains:
Education, Leadership, Communication, and Innovation. The domains constitute the major tenants on which we designed our Cybersecurity COE. Following is what each domain will consist of/provide for:

Education:
- Programs
- Internships
- Workshops
- Tools
- Test Beds
- Physical Labs
- Virtual Labs
- Cyber Club
- Ethical Hacking Contest

Leadership:
- Subject Matter Experts
- Coordination of Resources
- Vendor Relations
- Business Relations
- Government Relations
- Liaison with other Universities

Communications:
- Increase University Awareness
- Increase Public Awareness
- Newsletters
- Multi-Media
- Threat/Vulnerability Dashboards

Innovation:
- Research
- Collaborations
- Case Studies
- Publications

In the Appendix D illustration at the top of the domains is also labeled: the National Cybersecurity Center of Excellence. We will continue to work with the NCCoE to get new ideas and incorporate state-of-the-art technology and software tools into our Cybersecurity COE. They are the overarching umbrella of our Cybersecurity COE that will help guide our future direction.

7. CYBERSECURITY COE OPERATIONS

The Cybersecurity COE, will operate in the Computer & Information Sciences Department of the University. It will be managed by a Director. The Director will be responsible for the day-to-day activities and growth of the COE. Student interns will provide technical support, work on projects, and conduct research in collaboration with University professors. We will create a Cybersecurity COE Board which will consist of Subject Matter Experts, by industry, from local businesses that will report to the Cybersecurity COE Director. This Board will meet to discuss the direction and technology/software to be deployed in the Cybersecurity COE and work to help promote the COE to the community and public. Our Cybersecurity COE will go live at the start of the fall 2015 Term.

8. RESEARCH AND WORKSHOP OPPORTUNITIES

Research will be conducted at the Cybersecurity COE that has a complex cybersecurity challenge that requires an integrated solution that has benefits for one or more industry sectors. Some examples of research could be in the area of cloud computing, mobile and wireless computing, and military information protection. The research conducted will lead to journal publications and conference presentations and papers. Workshops and seminars will be conducted by Computer Science Department subject matter experts. These workshops and seminars will be open to students, faculty and the public to educate the community, promote the Center and showcase the research activities that we are engaged in.

9. SUMMARY

Establishing a Cybersecurity COE at a college/university will provide an environment where students can learn, collaborate, conduct research, and have hands-on training to the latest technology providing a rich and dynamic learning experience. Students could participate in internships in the Cybersecurity field to allow them to further excel intellectually. By establishing a Cybersecurity COE, colleges/universities will be well positioned to train/educate their students on the very important National Cybersecurity initiative ear-marked by our Government on cyber-security education. In addition, students can be provided with the skill-sets necessary to become a member of the cybersecurity workforce that is estimated to grow from $95.60 billion in 2014 to $155.74 billion by 2019, at a Compound Annual Growth Rate of 10.3% from 2014 to 2019 (MarketsandMarkets, 2014).

During Academic Year 2014/2015, our University we will be putting in place the Cybersecurity COE. More details on our Cybersecurity Model including implementation progress and our collaboration efforts with the NCCoE will be discussed at the 2014 ISECON Conference.

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Editor's Note:

This paper was selected for inclusion in the journal as an ISECON 2014 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2014.

APPENDIX A

Requirements for Computer Science Major - Cybersecurity Concentration.

This option is designed for those who want to learn the technology that is necessary to secure and defend information systems and networks. Students will be able to:

- Protect an organization's vital information and assets
- Implement cybersecurity best practices and risk management
- Understand how to use software to minimize vulnerabilities
- Implement network monitoring and real-time security solutions
- Analyze persistent threats and implement counter measures
- Conduct risk assessments on information systems and networks
- Examine cybercrimes and support recovery of operations
- Create and communicate cybersecurity strategies
- Manage cybersecurity projects

COURSE	CREDITS
Elementary Calculus I	3
Elementary Calculus II	3
Fund Comp Prog: Html, JavaScript, C++	3
Introduction to C++	3
Advanced Programing Techniques Using C++	3
Information Technology Ethics	3
Data Structures	3
Computer Mathematics	3
Quantitative Methods for Business	3
Database Concepts	3
Information Technology Audit	3
Disaster Recovery	3
Cybersecurity and Risk Management	3
Telecommunications Networks	3
Cryptography	3
Cybersecurity Lab	3
Computer Science Major Capstone Course	3
	Total Credits 51

APPENDIX B

Colleges and Universities Offering Cybersecurity Degrees with associated Labs.

College/University	Undergrad	Graduate	Cyber Security Lab
Air Force Academy	**Y**		**Y**
Champlain University	**Y**		
Columbia		**Y**	**Y**
DePaul University	**Y**		
FDU	**Y**		
George Mason University	**Y**	**Y**	**Y**
George Washington University		**Y**	
Georgia Tech		**Y**	**Y**
Mercy College	**Y**	**Y**	
New England Institute of Technology	**Y**		
NJIT		**Y**	**Y**
NYU-Poly		**Y**	**Y**
Penn State (ONLINE)	**Y**		**Y**
Purdue	**Y**	**Y**	**Y**
Rasmussen College	**Y**		
RIT	**Y**	**Y**	**Y**
Robert Morris University	**Y**		
Sacred Heart University		**Y**	
Saint Peter's University	**Y**		
South East Missouri State University	**Y**		
Southern Methodist University	**Y**		**Y**
St. Johns University	**Y**	**Y**	
Stevens Institute of Technology	**Y**	**Y**	**Y**
Temple		**Y**	
University of Massachusetts Amherst	**Y**		**Y**
University of Dallas		**Y**	
University of Maryland	**Y**	**Y**	**Y**
University of Maryland Baltimore County		**Y**	**Y**
University of Maryland University College (ONLINE)	**Y**	**Y**	
University of Phoenix (ONLINE)	**Y**		
University of Notre Dame	**Y**		
University of Pittsburgh	**Y**		

US Military Academy	**Y**		**Y**
US Naval Academy	**Y**		**Y**
USC	**Y**	**Y**	**Y**
Villanova		**Y**	
Virginia College		**Y**	
West Chester University	**Y**		
TOTALS	**27**	**20**	**17**

APPENDIX C

College/University No Cybersecurity Degree – Has Cybersecurity Lab	College/University No Cybersecurity Degree – No Cybersecurity Lab
Boston University	Alabama
Carnegie Mellon	Auburn
Clemson	Boston College
Duke	Brigham Young
Indiana University	Brown University
Iowa State University	Case Western Reserve
James Madison University	Fairfield
Kansas State	Florida International
LSU	Georgetown
Mississippi State	Gonzaga University
MIT	Harvard
North Carolina State	Manhattan College
Oklahoma State	Memphis University
Oregon	Michigan
Pace University	Michigan State
Penn State	Northwestern University
Santa Clara University	Ohio State
Stanford	Princeton
Stony Brook	Rutgers
UCLA	Saint Louis University
University of California - Berkley	Seton Hall
University of Texas	Syracuse
University of Washington	University of Chicago
Virginia Tech	University of Cincinnati
	University of Florida
	University of Georgia
	University of Illinois
	University of Miami
	University of North Carolina
	University of Pennsylvania
	University of San Diego
	University of South Florida
	University of Wisconsin
	Virginia

	Wake Forest William & Mary Xavier Yale

APPENDIX D

Cybersecurity Center of Excellence – Model