BUILDING A CYBERSECURITY PIPELINE THROUGH EXPERIENTIAL VIRTUAL LABS AND WORKFORCE ALLIANCES

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Agenda

- Introduction
- Project overview
- Virtual laboratories
- Internships
- Capstone projects
- Workshops
- Conclusion and Future work
Introduction

• The primary institution of this project is the University of South Carolina (USC)
• Other institutions are Northern New Mexico College (NNMC) and University of South Florida (USF)
• The project is motivated by the need of cybersecurity professionals
Project Overview

• The project goals are:
  ➢ Strengthen the cybersecurity curriculum in three degree programs (USC, NNMC, USF) using virtual laboratories (vLabs)
  ➢ Establish cybersecurity-related internships and capstone projects in conjunction with national laboratories and industry
  ➢ Increase the capacity for education of cybersecurity professionals in SC, NM, and FL

• Key partners include agencies, private businesses, and national laboratories
Virtual Laboratories

• Hands-on experiences are essential in IT
• Physical labs are not scalable, they require maintenance
• Time consuming to setup the experimental environment
• Costly in labor (technician), equipment, and space

How to include authentic practice, professional tools and platforms, access to computing technology in the work environment in a scalable way?
Virtual Laboratories

- Virtual platform based on virtual machines (VMs)
- Pods launched on demand on an server hosted in IIT
- Access to the virtual platform via web interface
- Development of custom pods
- Pod elements (computer, firewall, router, equipment) are VMs rather than physical devices

Partnership w/ NDG

1The Network Development Group (NDG), www.netdevgroup.com
Pod Examples – Introduction to Cryptography

- Symmetric-key encryption
- Generation of public keys
- Public-key encryption
- Certificate authorities
- Digital signatures
- Digital envelopes
- Web of trusts
- Encryption protocols
Pod Examples – Next-generation Firewalls

- Firewalls
- Malware analysis
- Application identification
- User identification
- URL filtering
- Virtual Private Networks
- Monitoring and reporting
- Modern techniques for malware identification
- Palo Alto Firewalls provided VMs at no cost

Course: ITEC 493 (Security)
Pod Examples – Bro Intrusion Detection

- High-performance tools
- Big data transfers
- Access-control lists
- Traffic routing for high speeds
- Intrusion detection systems
- Passive network monitoring

Course: ITEC 493 (Security)
Virtual Laboratories - Impact

- Virtual labs currently used in two courses at USC and NNMC, and one course at USF
- Spring 2019: ~50 students
- Hours attended: 1,399.25
- Hours per user: 27.9
- Hours per user / week: 2.5
Internships

• Students are required 400 hours of internship for graduation
• Prior to the internship, students take a 3-credit seminar
• The seminar matches students’ interest and skills with business needs
• Internships permit students to develop real-world cyber-skills, and ease their transition from academia to the workplace
• Students gain employability and soft skills
Internships

- Recruitment of companies
- Internship seminars
- Workshops on how to apply to internships: twice per year
Internships - Impact

- Companies recruited during the first year of the project

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th># positions</th>
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<tbody>
<tr>
<td>Los Alamos National Laboratory</td>
<td>Los Alamos, NM</td>
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<td>Capgemini</td>
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<td>IT Services USC</td>
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<td>USC</td>
<td>Columbia, SC</td>
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<tr>
<td>Global Pundits</td>
<td>Lexington, SC</td>
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<tr>
<td>Savannah River National Lab</td>
<td>Savannah River Site, SC</td>
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<td>SC Government</td>
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<td>IBM</td>
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<td>Blue Cross Blue Shield</td>
<td>Columbia, SC</td>
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<td>SC Election Commission</td>
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<td>Sealed Air</td>
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<td>Spirit Communications</td>
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<td>Charles Schwab</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>29</strong></td>
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</tbody>
</table>

SRNL Interns Meet and Greet

Internships Presentation Day
Capstone Projects

- A pilot component of this project is the integrative capstone
- Students work in teams to complete an industry-sponsored capstone project
- ~10 cybersecurity capstone projects per year
Dissemination – Workshops

• Activities rely on a good cybersecurity preparation
• Virtual Labs are fundamental (hands-on skills)
• The project team organizes workshops on “Developing Virtual Labs”
Dissemination – Workshops

- During the first year of the project, two two-day workshops were organized:
  - 1\textsuperscript{st} workshop: 30 instructors
  - 2\textsuperscript{nd} workshop: 61 instructors / 25 states

![Bar chart showing satisfaction scores for Workshop 1 and Workshop 2]

<table>
<thead>
<tr>
<th>Question</th>
<th>Workshop 1</th>
<th>Workshop 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 Overall rate</td>
<td>4.5</td>
<td>4.3</td>
</tr>
<tr>
<td>Q2 Instructor rate</td>
<td>4.6</td>
<td>4.7</td>
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<tr>
<td>Q3 Presentation material</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Q4 Would you attend another workshop?</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Q5 Would you attend another online workshop?</td>
<td>-</td>
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</tbody>
</table>

- 5: Extremely satisfied
- 4: Very satisfied
- 3: Moderately satisfied
- 2: Slightly satisfied
- 1: Poor / not at all satisfied
Conclusion and Future Work

- This project enhances the cybersecurity education in multiple institutions in SC, NM, and FL

- Components
  - **vLabs**: permit students to learn core cybersecurity concepts combined with authentic practice and use of professional tools
  - **Internships and capstones**: permit students develop real-world cyber-skills; gain employability and soft skills; and transition from academia to the workplace
  - **Dissemination**: strong interest in the adoption of vLabs is reflected on the attendance to the workshops (100 instructors, from more than 70 institutions in 25 states)

- Future work includes
  - Quantify the impact of the different activities
  - Expand capacity for vLabs and internships
  - Continue to recruit companies for internships and capstone projects