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Cybersecurity research and education: Helping meet the high demand for cybersecurity experts

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Why Cybersecurity?

- Computers, smart phones, smart TVs and other devices are all connected to Internet, and are part of our everyday lives
  - Banking, shopping, communication, social media
- Critical infrastructure depend on online systems
  - Power grid, Water, Sewage treatment, Dams
  - Hospitals
  - National defense and Law enforcement
- All must be protected from cyber attacks carried on by criminals, terrorists, or national states

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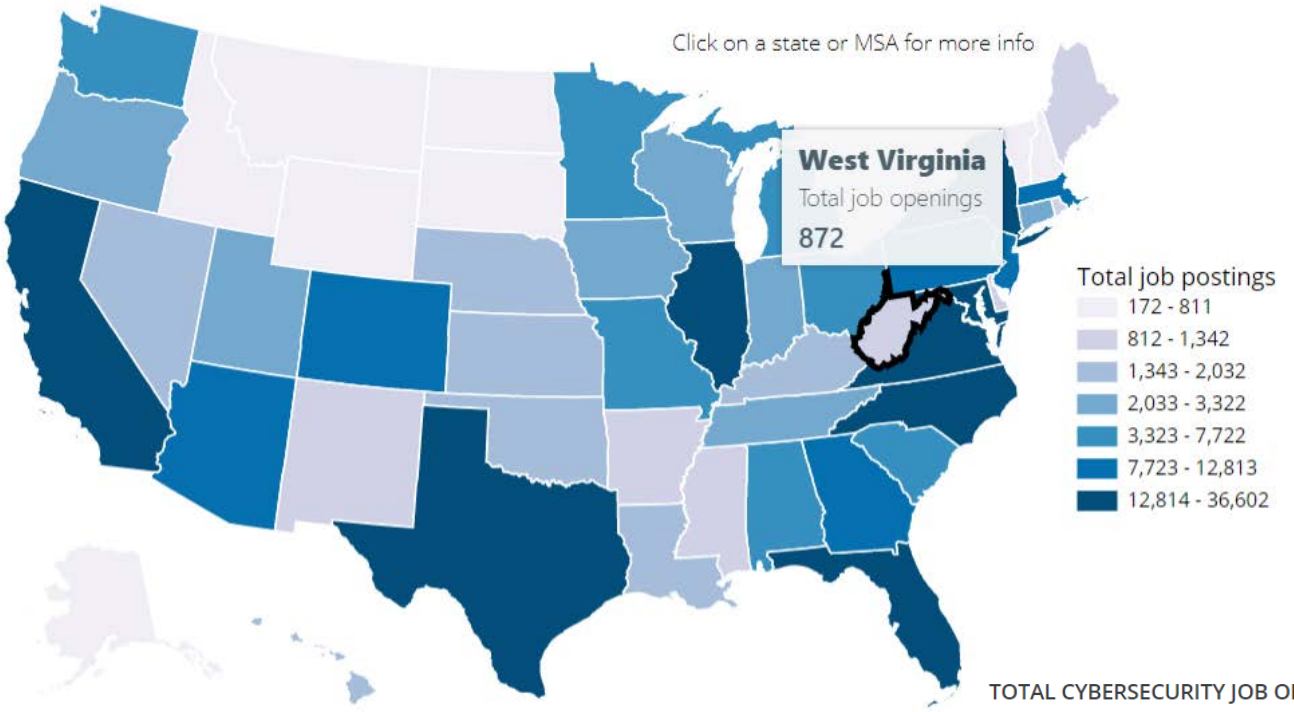
Huge demand for cybersecurity professionals

Cybersecurity Supply/Demand Heat Map



National level

TOTAL CYBERSECURITY JOB OPENINGS
313,735

TOTAL EMPLOYED CYBERSECURITY WORKFORCE
715,715

SUPPLY OF CYBERSECURITY WORKERS

CYBERSECURITY WORKFORCE SUPPLY/DEMAND RATIO

National average
2.3

Academic Media Day

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Growth of the demand

- The number of positions rose 70% in five years from 2010-2015
- The Bureau of Labor Statistic has projected that the employment of information security analysts will grow 28% from 2016 to 2026 (average growth for all occupations is 7%)
- WV Forward specifically targets cybersecurity as a growth area for the State and points out the need cybersecurity workforce to be educated in WV

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LCSEE expertise in Cybersecurity

- Offering undergraduate & graduate courses in Cybersecurity, Computer and Network Forensics since 2003
- Since 2006 designated by the National Security Agency and Department of Homeland Security as a National Center of Academic Excellence in both Cyber Defense Education and Cyber Defense Research
  - Current designation through 2021
    https://www.iad.gov/NIETP/reports/cae_designated_institutions.cfm

- Active research in Secure Software, Information Assurance, Digital Forensics, and Intelligent Malware Detection, funded by the NSF, NASA, and Dept. of Justice, WV State Police

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Cybersecurity research

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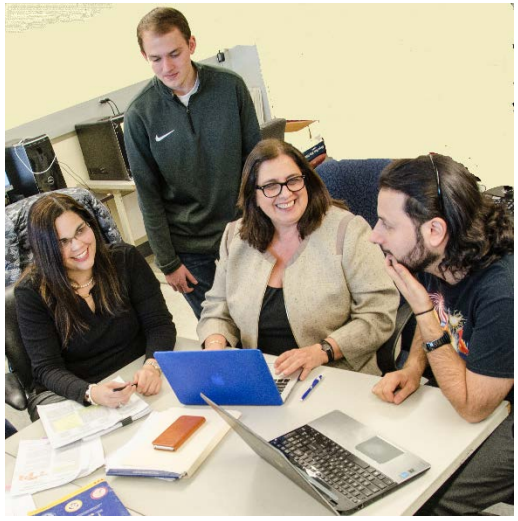
Reliable and Secure Cyberspace Research Lab



Continuous monitoring by honeypots & predicting malicious behaviors

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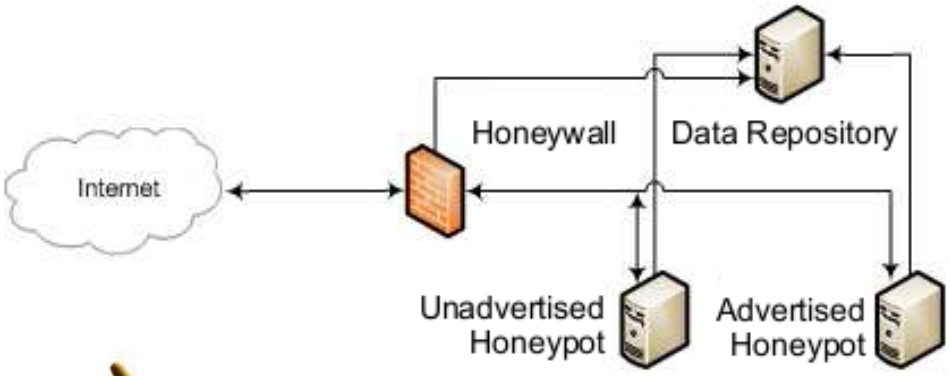
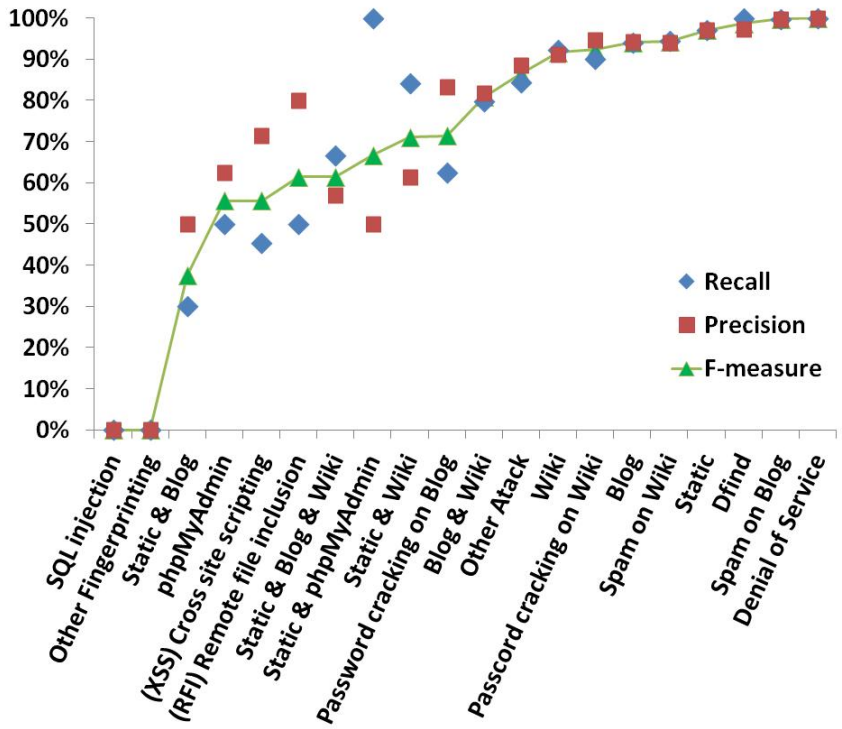
Funded by: NASA & NSF





- Generate behavioral malware signatures & dynamic firewall rules
- Assist intrusion detection & risk mitigation, improve resilience

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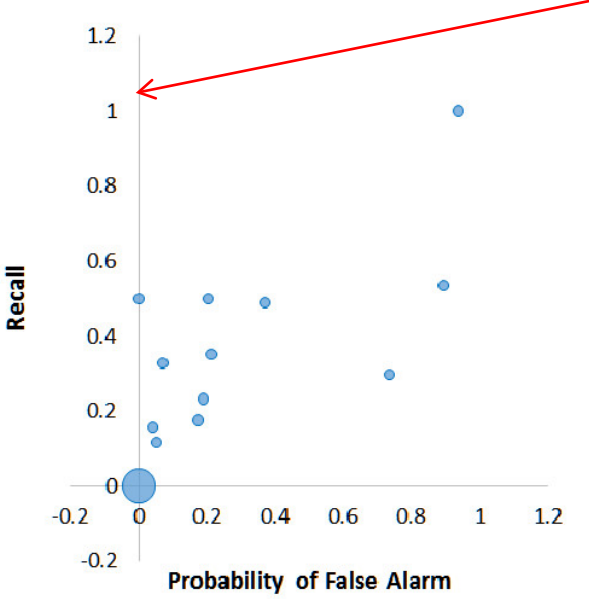
Information assurance

Funded by: NASA

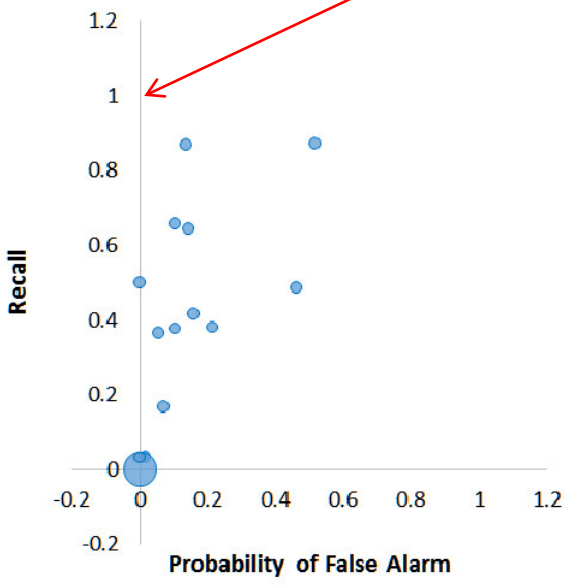
Evaluation of static code analysis for Information Assurance

Performance for the C/C++ Common Weakness Enumerations (CWEs)

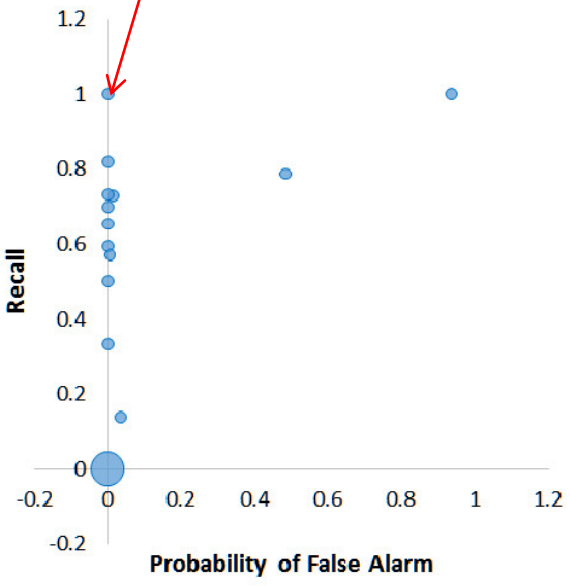
Ideal result
(pf, pd) = (0, 1)



Tool A



Tool B



Tool C

All tools had median and mean recall (per CWE and overall, across all CWEs) close to or below 50%

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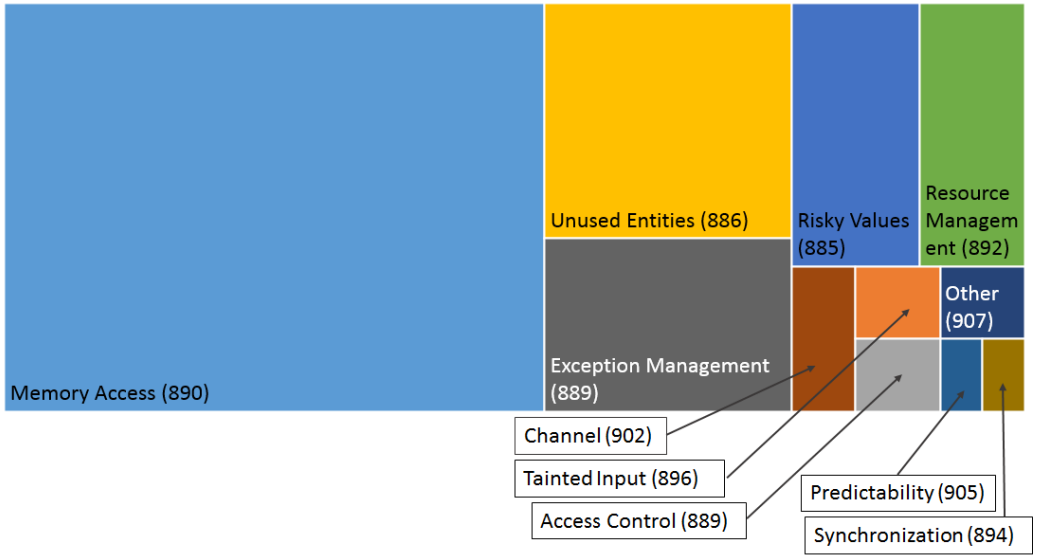
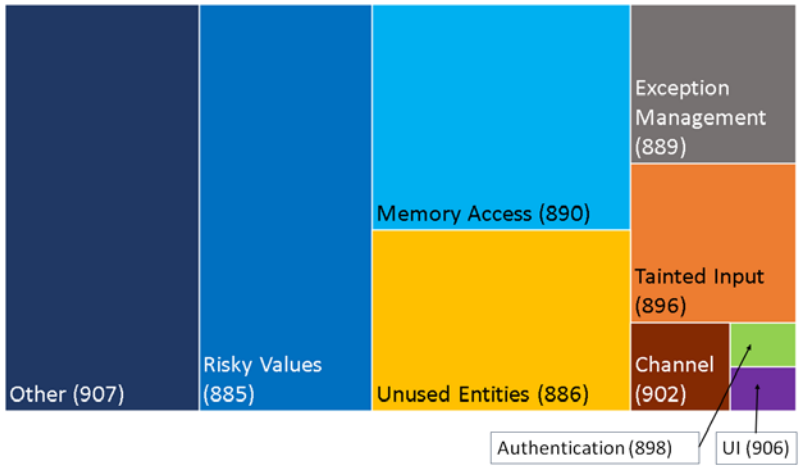
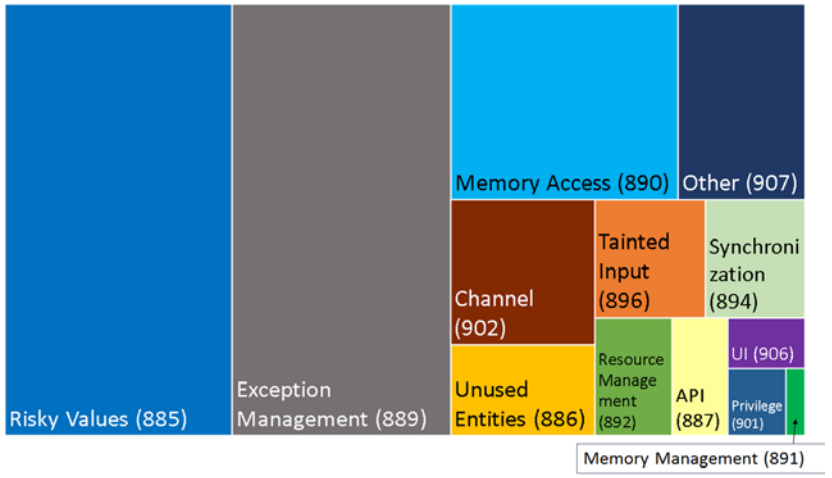
Secure software

Funded by: NASA

Security vulnerability profiles of mission critical software







Five (out of 21) CWE classes had from 80% - 90% of all security related issues

Results were incorporated into the NASA's Secure Coding Portal

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Secure software

Funded by: NASA

Automatic identification of security related bug reports

- Approaches based on text mining
- Proposed both unsupervised and supervised approaches

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Social engineering attacks & Cybersecurity of social media networks

Funded in part by: Leidos

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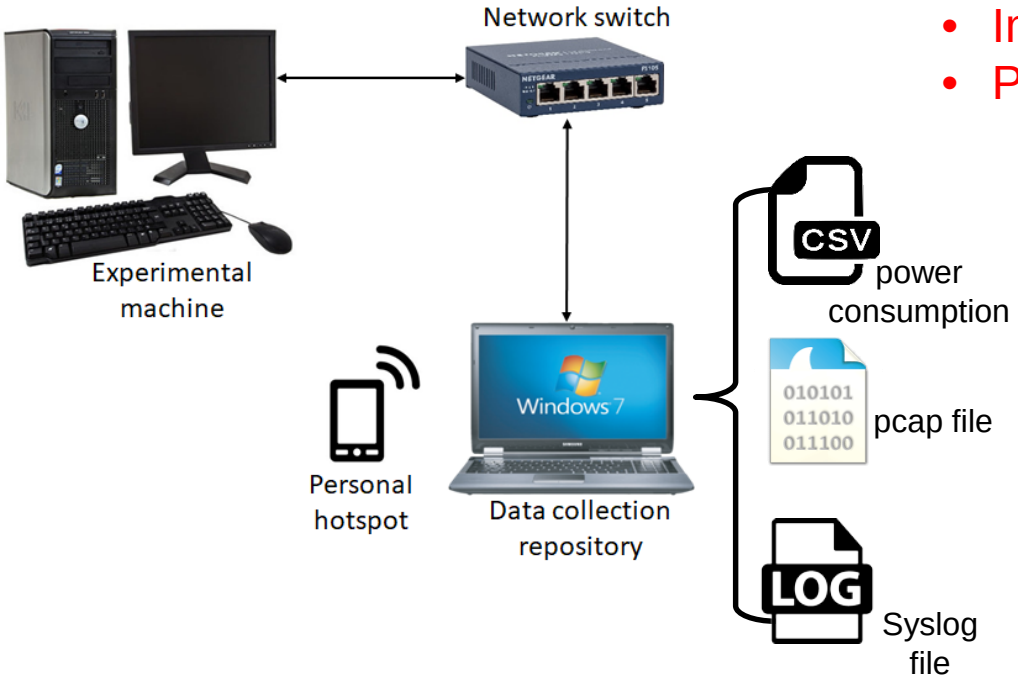
Multimodal malware detection

Funded by: NSF



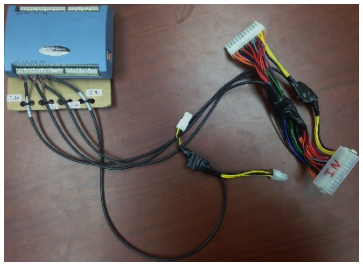
Motivation

- Improve classification performance
- Prevent malware to evade detection

Static code-based features

Dynamic behavior features

- power consumption
- network traffic data
- system logs



Instrumentation for collecting power consumption was developed in collaboration with the Oak Ridge National Lab

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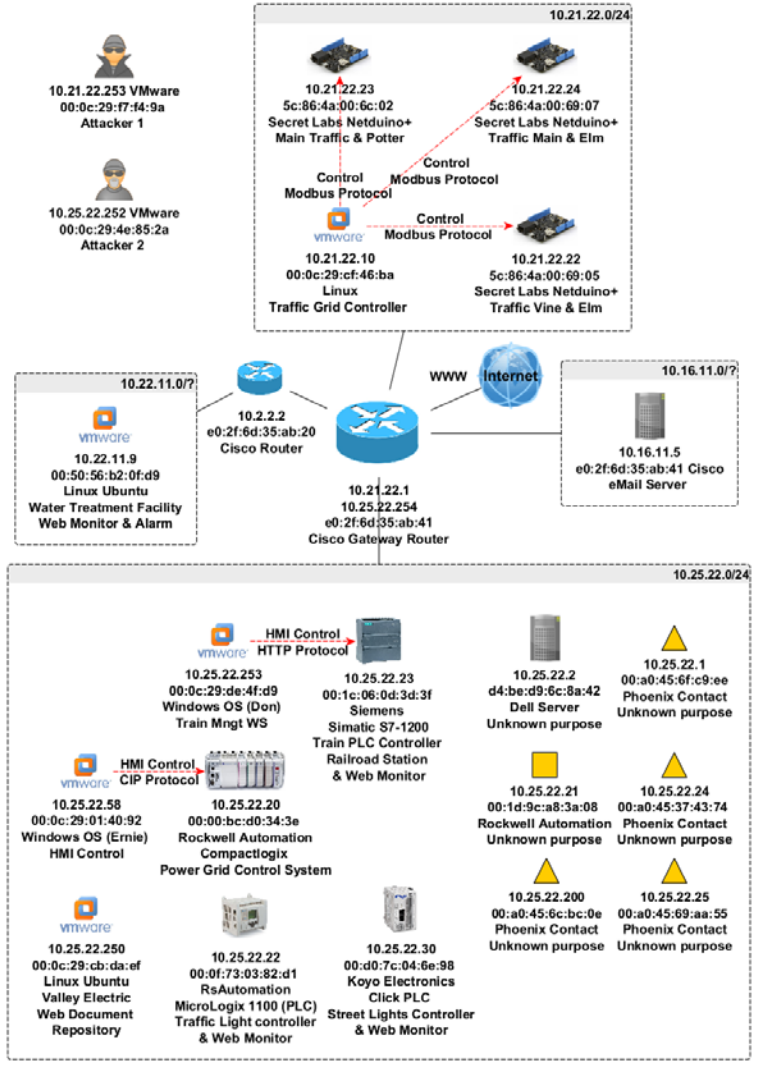
Cybersecurity of Industrial Control Systems (ICS)

- Cybersecurity of ICS
  - Initial work based on the dataset produced by the SANS Institute
  - Current work in collaboration with the Oak Ridge National Lab

Probes	Frequency		Attacks	Frequency	
Scan	3	7.5%	ARP Poisoning	7	17.5%
Port Scan	3	7.5%	Code Injection	5	12.5%
Vulnerability Scan	1	2.5%	Information Disclosure	5	12.5%
Modbus Scan	1	2.5%	Password Guessing	3	7.5%
			SQL injection	2	5.0%
			Reverse Connection	2	5.0%
			Phishing	2	5.0%
			XSS	1	2.5%
			Malware Trojan	1	2.5%
			Malware Shell	1	2.5%
			Malware Backdoor	1	2.5%
			HMI Control	1	2.5%
			Command Injection	1	2.5%



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Graduate students employment

- MIT Lincoln Lab
- Army Research Lab
- Oak Ridge National Lab
- NASA Katherine Johnson Independent Verification and Validation Facility
- Science Applications International Corporation (SAIC)
- Department of Defense
- Microsoft

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Cybersecurity education

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Cybersecurity education @ LCSEE

- B.S. in Cybersecurity (started Fall 2018)
  - Solid foundation in programming and computer science
  - Courses that address the technical aspects of cybersecurity
  - Interdisciplinary courses on cryptography, sociology, cybercrime, and information ethics
- Undergraduate Area of Emphasis (AoE) in Cybersecurity for other LCSEE majors
- Undergraduate minor in Cybersecurity for other non-LCSEE majors (e.g., MIS)
- Graduate AoE in Cybersecurity

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Scholarships for Cybersecurity students

- NSF funded S-STEM ACCESS scholarships for undergraduate students with financial need
  - 120 annual scholarships to around 40 unique students over five years
  - $5,000 /year, for up to four years
- DoD Cyber Scholarship Program (CySP)
  - Undergraduate students: full tuition + $25,000 /year
  - Graduate students: full tuition + $30,000 /year

CYBERSECURITY SCHOLARSHIPS

APPLY FOR SCHOLARSHIPS

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Other opportunities for Cybersecurity students

- Faculty mentored research on Cybersecurity topics
- CyberWVU student group meets regularly and competes in the Collegiate Cyber Defense Competition, HacerCon, etc.

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Opportunities for Cybersecurity graduates

- Job positions with government and different industry sectors such as defense, space, finance, healthcare, transportation, and manufacturing
  - Secure software development
  - Application security engineer
  - Systems and network administrator
  - Cybersecurity analysts
  - National cyber defense

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Opportunities for Cybersecurity graduates

- WVU works closely with industry to place students in internships and permanent positions
  - Spring and Fall Career fairs with ~140 companies recruiting
  - Companies that hire LCSEE graduates for cybersecurity positions include: FBI, Department of Defense, NASA Katherine Johnson Independent Verification and Validation Facility, Leidos, KeyLogic, Northrup-Grumman, SAIC