Overview
Department of Integrated Information Technology
University of South Carolina

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Virtual Meeting – College of Engineering and Computing
November 12, 2020

IIT Program

- B. S. Integrated Information Technology
- 120 credit hours, 400-hour internship
- Curriculum includes
  - Cybersecurity
  - IT Business Operations
  - Databases
  - Networking
  - Project Management
  - Web Development
- The department is developing a fully online BSc
- ABET accredited (“quality assurance”)

IIT Program

- Programs are more practical than theoretical
- Courses reinforce the theoretical knowledge with hands-on activities
- What do graduates do?
- They build, maintain, operate, and repair hardware and software associated with computer systems
  - Network engineer
  - Cybersecurity analyst
  - Web design and services
  - User experience / human-computer interaction professional
  - Cloud system specialist
  - Security Operation Center (SOC) analyst
  - Data analytics professional

IIT Program

- Minor in Integrated Information Technology
- 18 credit hours
- Several concentrations
  - **Cybersecurity Operations**
  - IT Business Operations
  - Databases
  - Networking
  - Project Management
  - Web Development

Minor Requirements

Course	Title	Credits
Cybersecurity Operations		18
ITEC 101	Thriving in the Tech Age	
ITEC 233	Introduction to Computer Hardware and Software	
ITEC 245	Introduction to Networking	
ITEC 293	Cybersecurity Operations	
ITEC 445	Advanced Networking	
ITEC 493	Information Technology Security for Managers	

Courses map learning objectives to the U.S. NICE framework (ITEC 293, ITEC 445, ITEC 493)

The National Initiative for Cybersecurity Education (NICE) Framework is a national-focused resource that categorizes and describes cybersecurity work

Additional Credentials

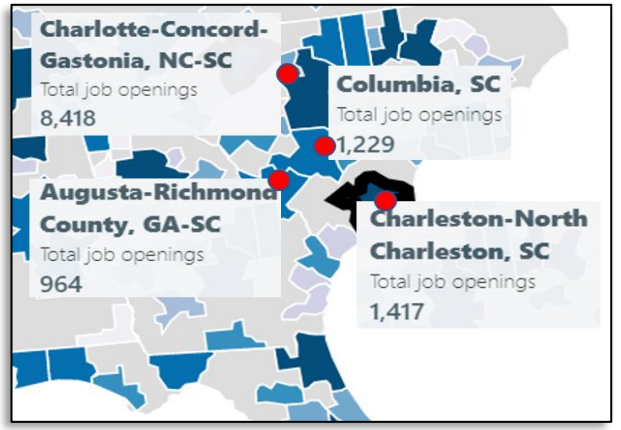
- DoD's Information Assurance (IA) workforce is classified in IA technical (IAT):
  - Level 1 (IAT 1): Computing environment information assurance
  - Level 2 (IAT 2): Network environment information assurance
  - Level 3 (IAT 3): Enclave, advanced network & computer information assurance
- It requires partnership
  - Cisco Systems, Palo Alto Networks, VMware, Juniper, Intel

Certificate	Material Covered in	IAT 1	IAT 2	NICE framework	Networks cert.
A+	ITEC 233	✓		✓	
Cyberoperations	ITEC 293	✓		✓	
Security+	ITEC 293	✓	✓	✓	
CCNA Security	ITEC 493	✓	✓	✓	
CCNA Routing/Switching	ITEC 245, ITEC 445				✓
ACE	ITEC 493			✓	
PCNSE	ITEC 493			✓	

NICE: National Initiative for Cybersecurity Education

Office of Naval Research (ONR) Project

- "Enhancing the Preparation of Next-generation Cyber Professionals"
- South Carolina cybersecurity needs
  - NIWC Atlantic, SRNL, Fort Jackson, Shaw Air Force Base, private industry
- Recruiting the American military's cyber force is more difficult than ever
  - DoD has been struggling to hire more than 8,000 cyber positions (2018)[1]
  - Shortage of cybersecurity professionals
- The College of Engineering and Computing is addressing the workforce needs:
  - Encourage students to acquire "cyber" knowledge
  - Undergraduate applied research
  - Private cloud
  - Collaboration among industry, government, education institutions



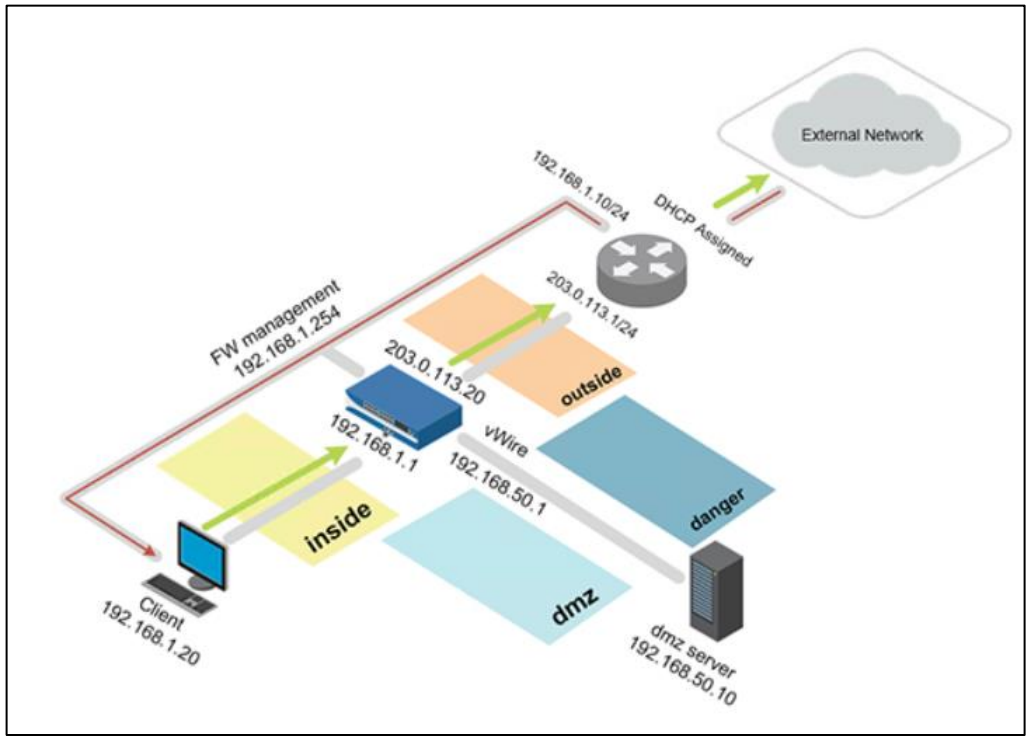
Cybersecurity job openings in four metro areas near Columbia, Feb. 2020

1. J. Lynch, "Inside the Pentagon's Struggle to Build a Cyber Force," Fifth Domain publication, October 29, 2018. Online: https://tinyurl.com/yyelqomp

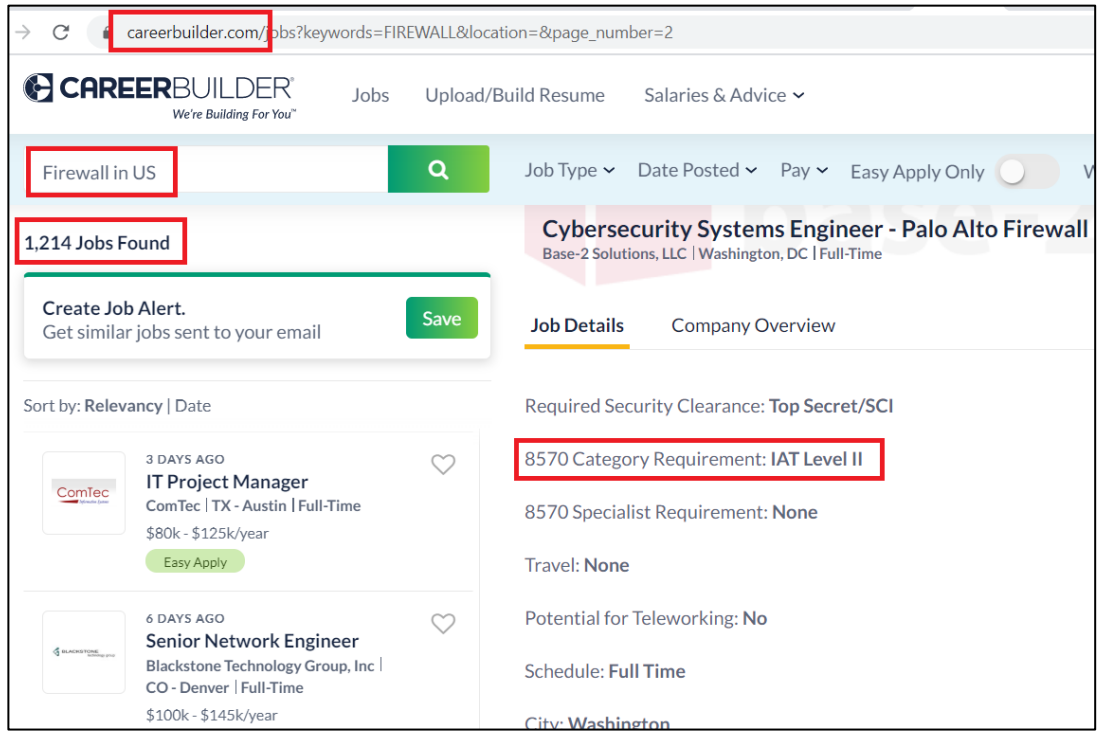
ONR's Cyber Project

- Collaboration
  - Applied teaching and research -> professional tools, platforms, market validation
  - Cisco Systems, Palo Alto Networks, VMware, Juniper, Intel

- ✓ Bachelor's degree
- ✓ IAT credential
- ✓ Theory
- ✓ Hands-on expertise



Pod deployed in private cloud



Job search

ONR's Cyber Project

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  - Applied teaching and research -> professional tools, platforms, market validation
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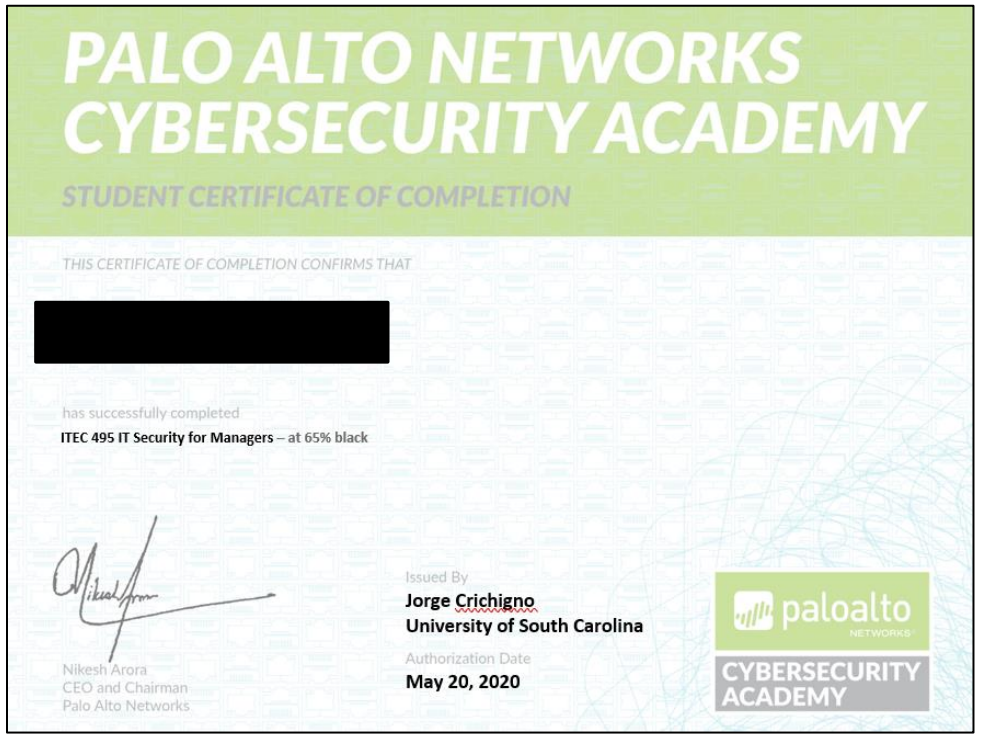
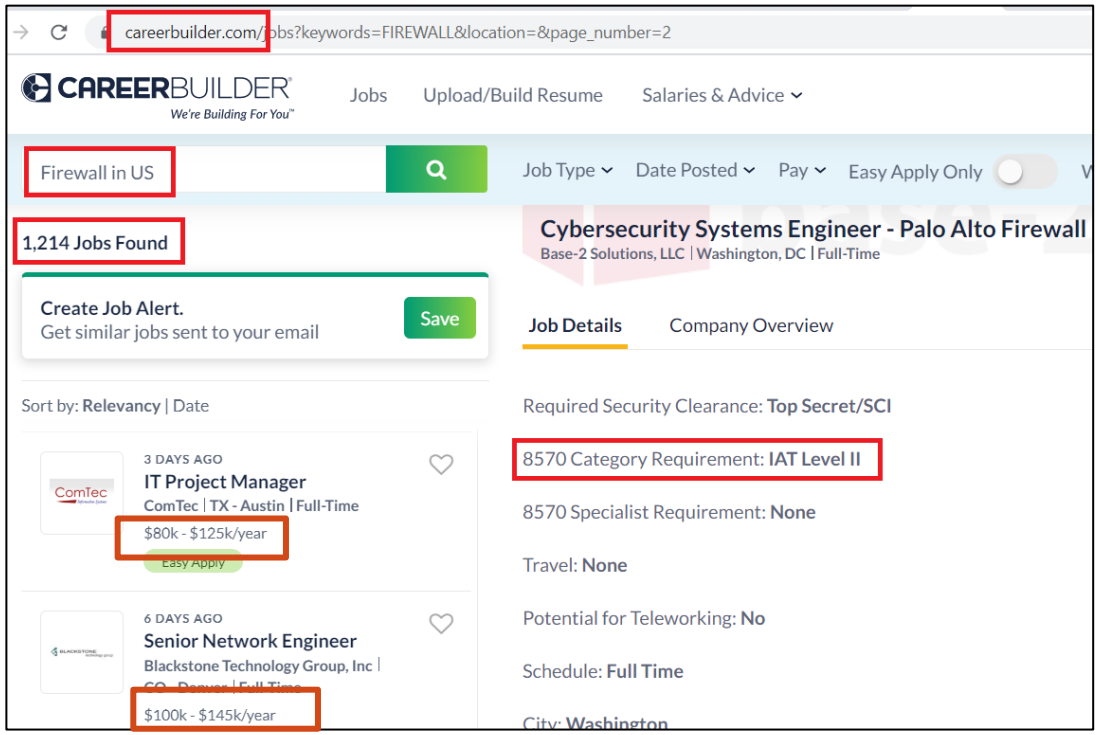


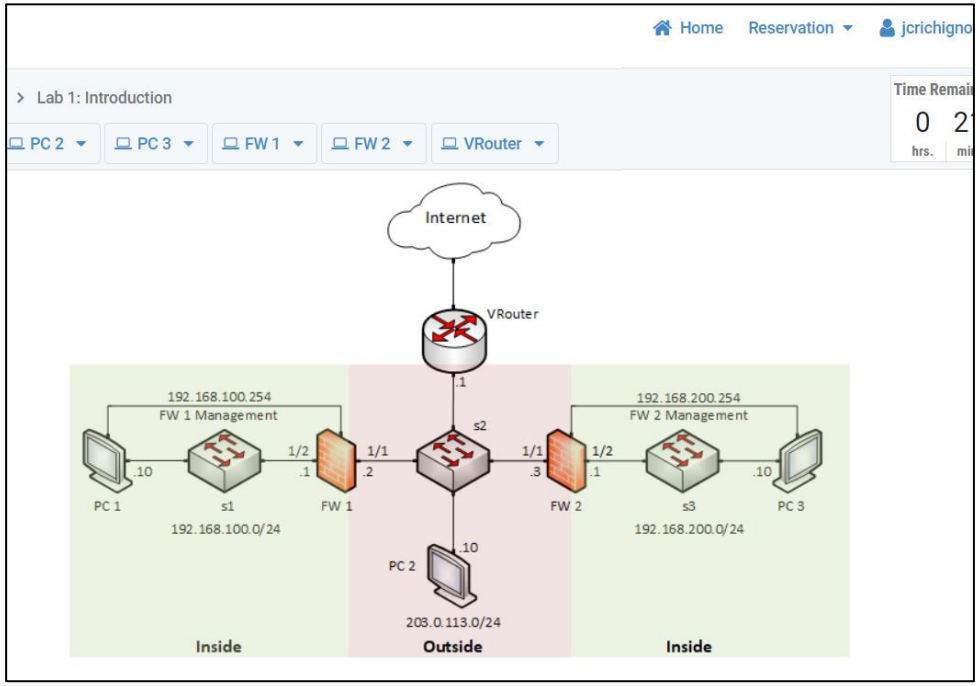
Additional credentials



Job search

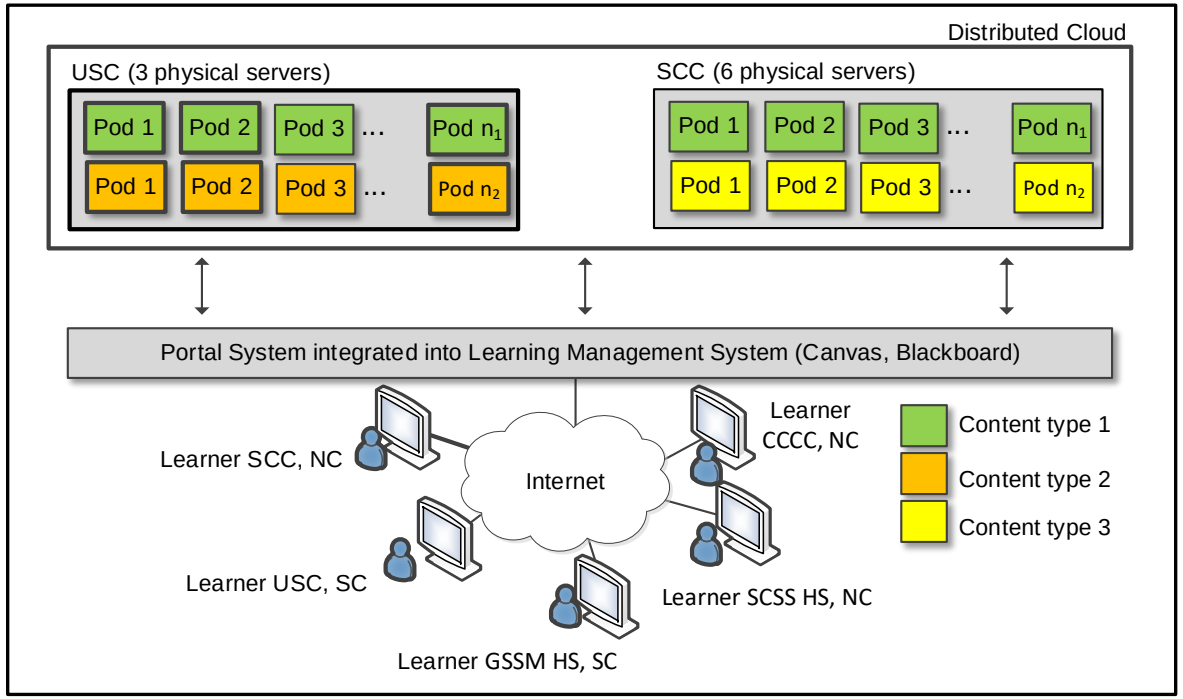
ONR's Cyber Project

- Undergraduate students work 18 hours per week, 15 weeks, $18 per hour ($4,050)
  - Applied research
  - Professional tools, platforms, market validation
  - Cisco Systems, Palo Alto Networks, VMware, Juniper, Intel
  - Focus on relevant technology, customized scenarios; e.g., IPsec-based VPNs with NGFWs



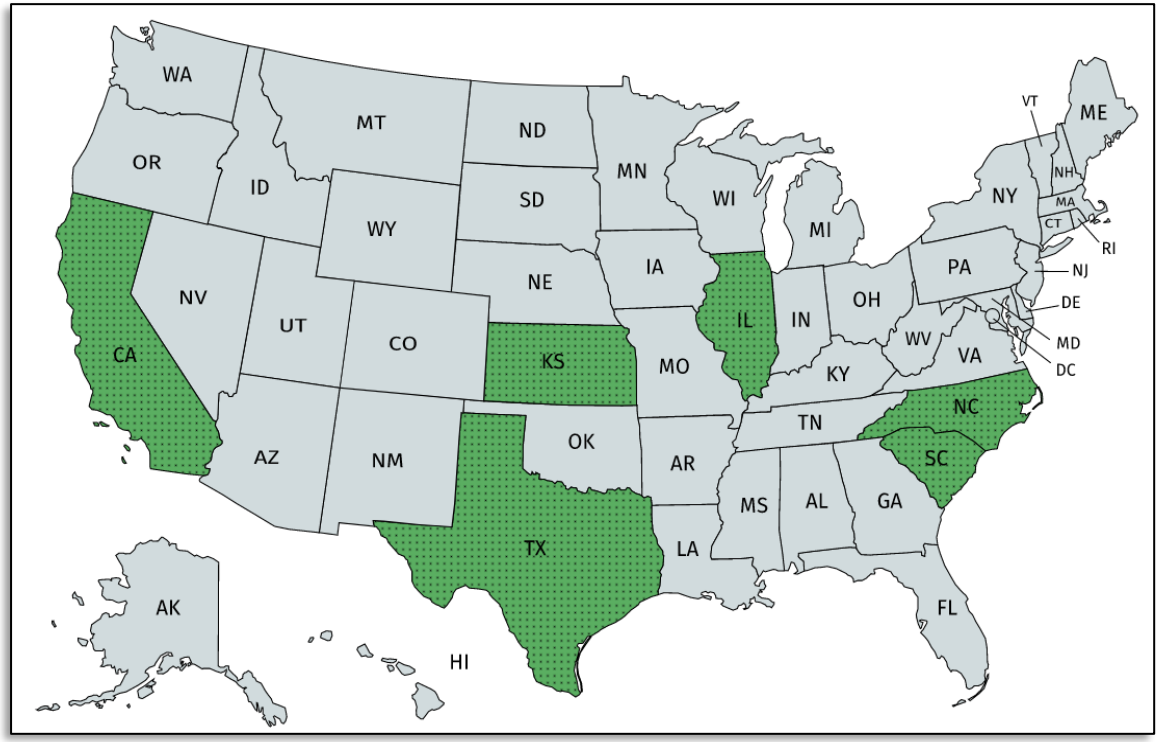
NSF ATE and CC

- NSF Advanced Technical Education (ATE) and NSF Campus Cyberinfrastructure (CC) (2019)
- Development of a multi-state distributed cloud to support teaching, research
- 2+2+2 program (HS + College + University)
- Distributed cloud pools resources from SC and NC, serves institutions seamlessly
- Requests to use the platform
  - Berkeley National Lab
  - SANS institute (“girlsgocyber”)
  - Multiple higher-ed institutions
  - International Networks at Indiana
  - Fort Gordon (PAN’s NGFW, VMware Clouds)
  - Texas’ Lonestart Education and Research



NSF ATE 2021- …

- National Online Platform
- Consortium of Colleges and Universities
- Industry
  - Palo Alto Networks Cybersecurity Academy
  - Cisco Network Academy
  - VMware IT Academy
  - …



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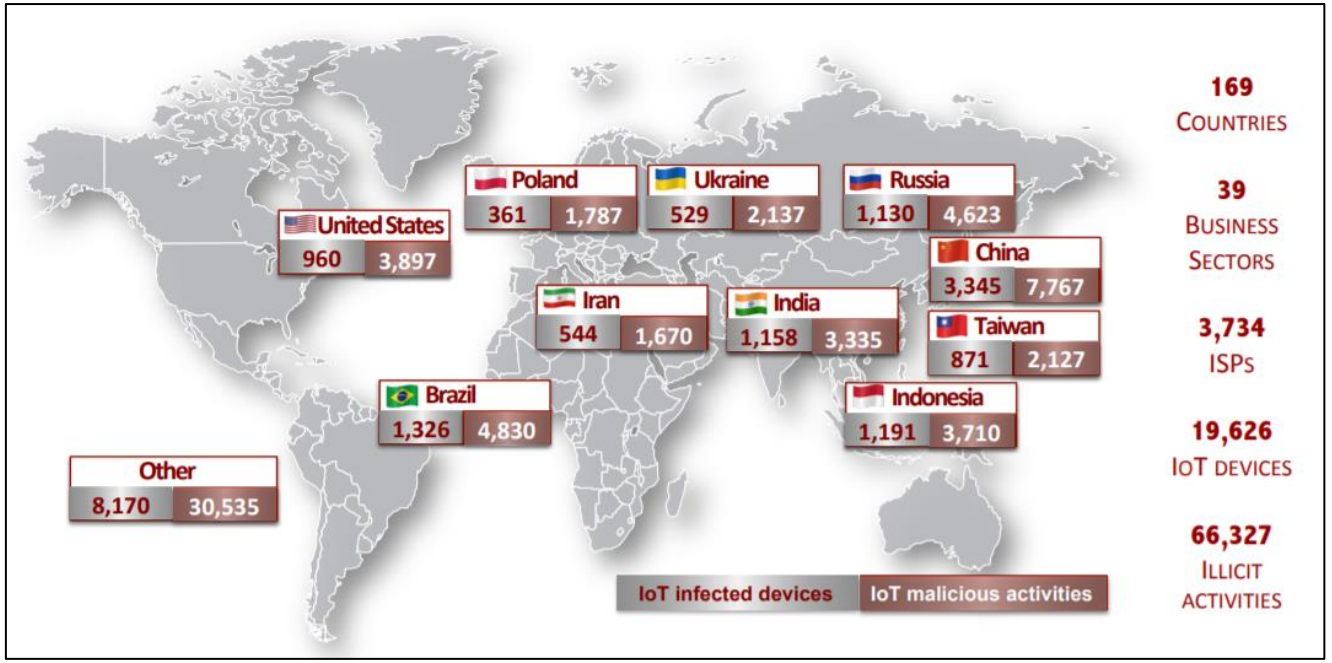
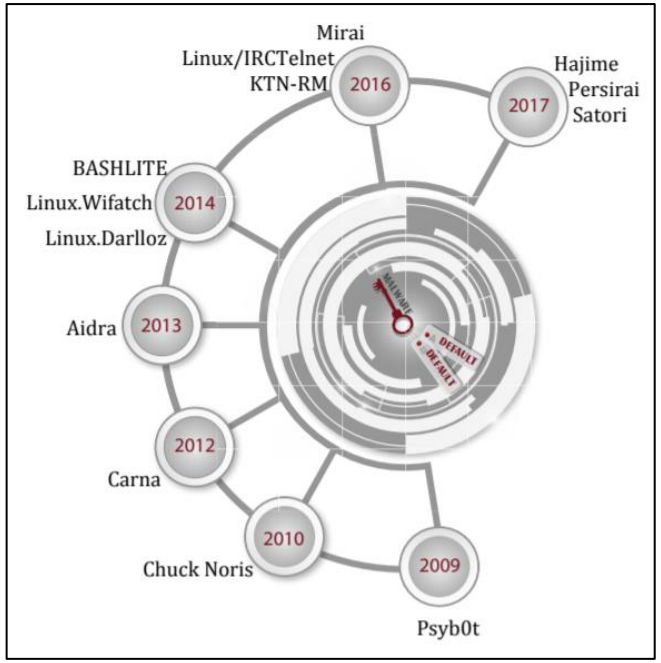
Additional Slides

Graduate Projects

- Development of new techniques against attacks targeting “Internet-of-Things” devices
- Agreement with the Center for Applied Internet Data Analysis (CAIDA) (San Diego)



Global distribution of exploited IoT devices; results from this research project



Malware exploiting default credentials

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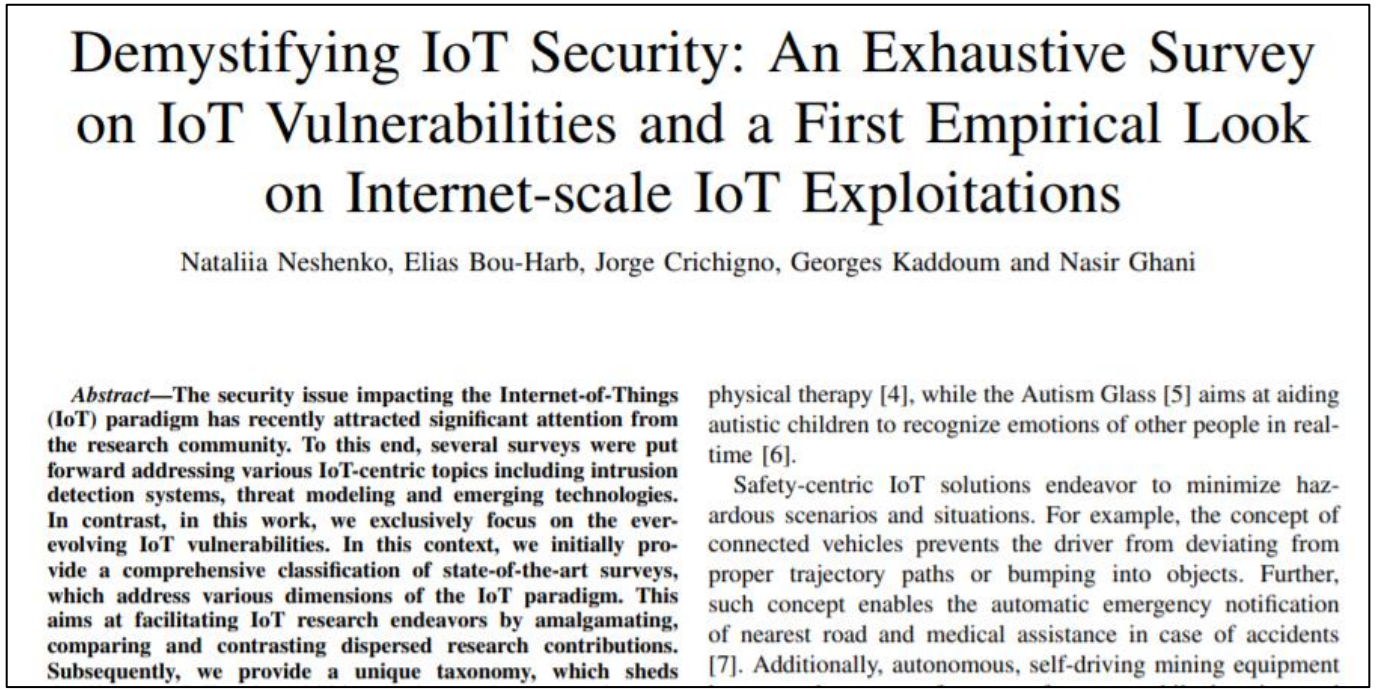


Demystifying IoT Security: An Exhaustive Survey on IoT Vulnerabilities and a First Empirical Look on Internet-scale IoT Exploitations

Nataliia Neshenko, Elias Bou-Harb, Jorge Crichigno, Georges Kaddoum and Nasir Ghani

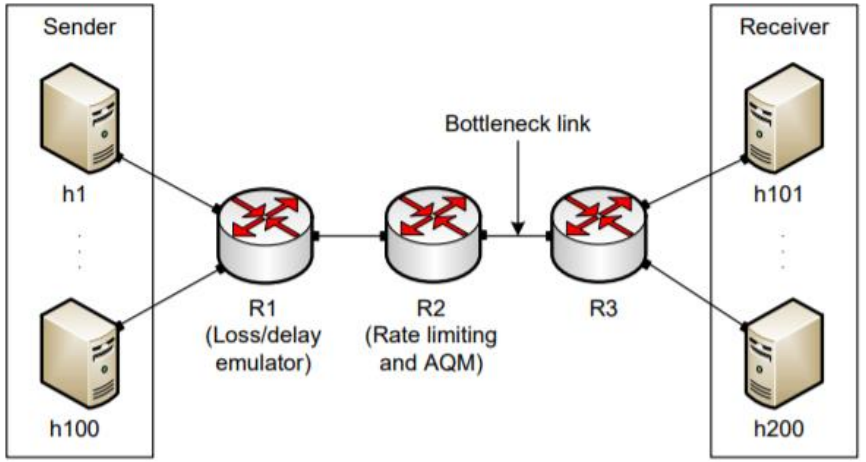
***Abstract*—The security issue impacting the Internet-of-Things (IoT) paradigm has recently attracted significant attention from the research community. To this end, several surveys were put forward addressing various IoT-centric topics including intrusion detection systems, threat modeling and emerging technologies. In contrast, in this work, we exclusively focus on the ever-evolving IoT vulnerabilities. In this context, we initially provide a comprehensive classification of state-of-the-art surveys, which address various dimensions of the IoT paradigm. This aims at facilitating IoT research endeavors by amalgamating, comparing and contrasting dispersed research contributions. Subsequently, we provide a unique taxonomy, which sheds**

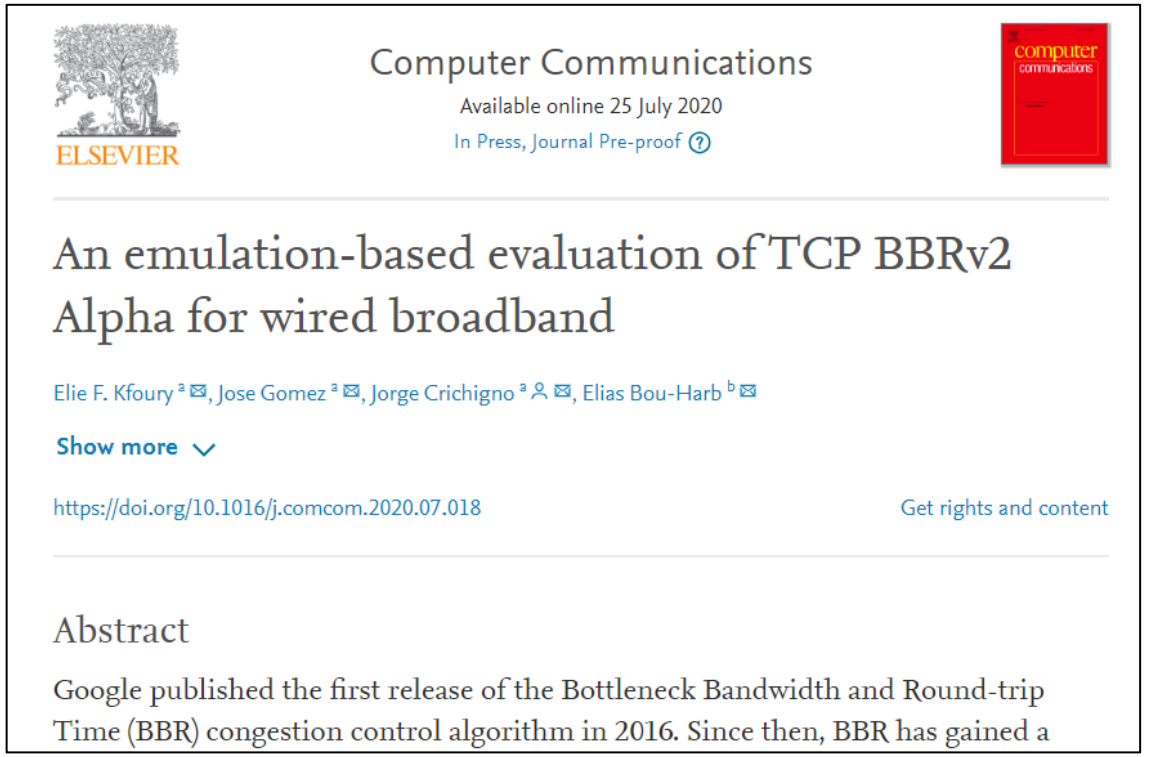
physical therapy [4], while the Autism Glass [5] aims at aiding autistic children to recognize emotions of other people in real-time [6].

Safety-centric IoT solutions endeavor to minimize hazardous scenarios and situations. For example, the concept of connected vehicles prevents the driver from deviating from proper trajectory paths or bumping into objects. Further, such concept enables the automatic emergency notification of nearest road and medical assistance in case of accidents [7]. Additionally, autonomous, self-driving mining equipment

Graduate Projects

- Performance testing Google's new communication protocol
- Feedback to Google (used in Youtube, Chrome, and other apps)
- Emulating behavior in private cloud before Google's protocol public release





ELSEVIER

Computer Communications

Available online 25 July 2020

In Press, Journal Pre-proof

An emulation-based evaluation of TCP BBRv2 Alpha for wired broadband

Elie F. Kfoury [a], Jose Gomez [a], Jorge Crichigno [a], Elias Bou-Harb [b]

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https://doi.org/10.1016/j.comcom.2020.07.018

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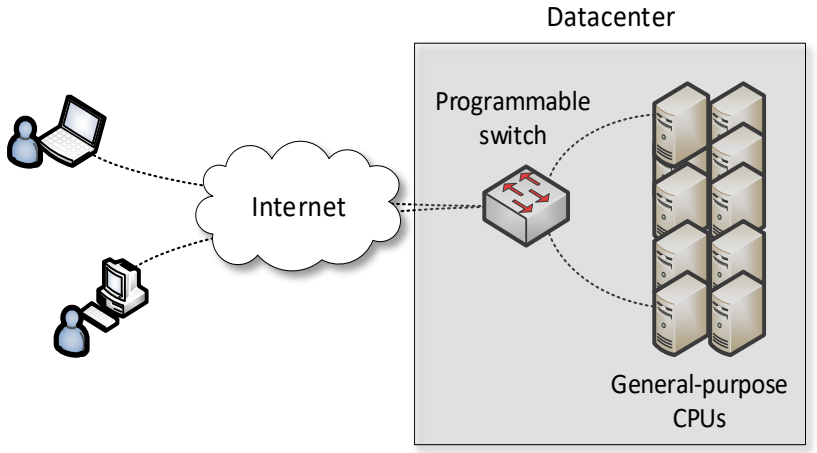
Abstract

Google published the first release of the Bottleneck Bandwidth and Round-trip Time (BBR) congestion control algorithm in 2016. Since then, BBR has gained a

Graduate Projects

- Improving system's performance using next-generation switches
- Offloading computational tasks to network switches
  - Orders of magnitude faster than general-purpose CPU
  - Very limited instructions set (e.g., no multiplication, no division, simple operations)
- Agreement with Intel (chips, software development environment)



Application example: media (voice) relay server

	Programmable Switch	General-purpose CPU
Cost	$6,000	$ 10,000 - 25,000
Capacity	~35,000,000 connections per switch	~500 connections per core
Latency	400 nanoseconds	Tens to hundreds of milliseconds

Graduate Projects

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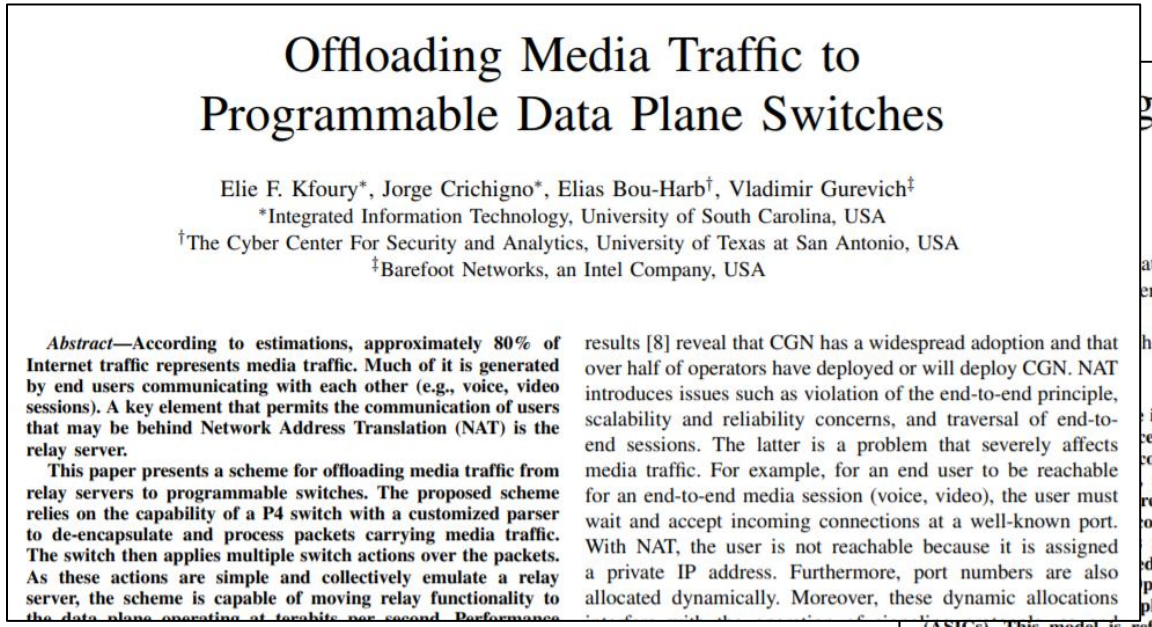


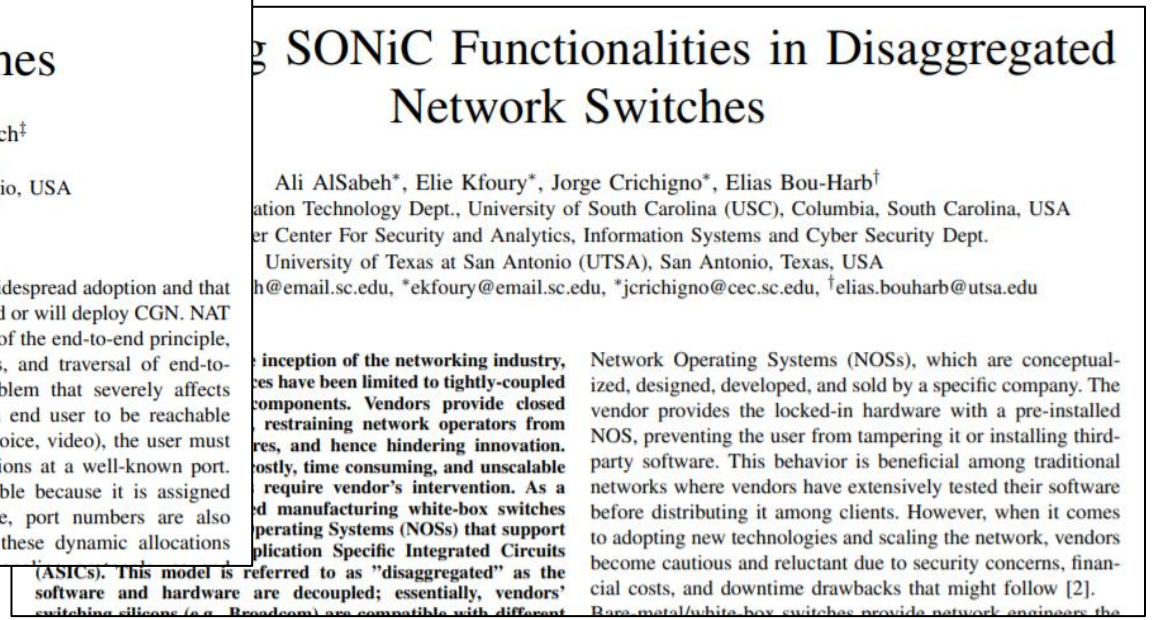
Offloading Media Traffic to Programmable Data Plane Switches

Elie F. Kfoury*, Jorge Crichigno*, Elias Bou-Harb†, Vladimir Gurevich‡
*Integrated Information Technology, University of South Carolina, USA
†The Cyber Center For Security and Analytics, University of Texas at San Antonio, USA
‡Barefoot Networks, an Intel Company, USA

***Abstract*—According to estimations, approximately 80% of Internet traffic represents media traffic. Much of it is generated by end users communicating with each other (e.g., voice, video sessions). A key element that permits the communication of users that may be behind Network Address Translation (NAT) is the relay server.**

This paper presents a scheme for offloading media traffic from relay servers to programmable switches. The proposed scheme relies on the capability of a P4 switch with a customized parser to de-encapsulate and process packets carrying media traffic. The switch then applies multiple switch actions over the packets. As these actions are simple and collectively emulate a relay server, the scheme is capable of moving relay functionality to

results [8] reveal that CGN has a widespread adoption and that over half of operators have deployed or will deploy CGN. NAT introduces issues such as violation of the end-to-end principle, scalability and reliability concerns, and traversal of end-to-end sessions. The latter is a problem that severely affects media traffic. For example, for an end user to be reachable for an end-to-end media session (voice, video), the user must wait and accept incoming connections at a well-known port. With NAT, the user is not reachable because it is assigned a private IP address. Furthermore, port numbers are also allocated dynamically. Moreover, these dynamic allocations



g SONiC Functionalities in Disaggregated Network Switches

Ali AlSabeh*, Elie Kfoury*, Jorge Crichigno*, Elias Bou-Harb†
ation Technology Dept., University of South Carolina (USC), Columbia, South Carolina, USA
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inception of the networking industry, ces have been limited to tightly-coupled components. Vendors provide closed restraining network operators from res, and hence hindering innovation. costly, time consuming, and unscalable require vendor's intervention. As a ed manufacturing white-box switches perating Systems (NOSs) that support plication Specific Integrated Circuits (ASICs). This model is referred to as "disaggregated" as the software and hardware are decoupled; essentially, vendors'

Network Operating Systems (NOSs), which are conceptualized, designed, developed, and sold by a specific company. The vendor provides the locked-in hardware with a pre-installed NOS, preventing the user from tampering it or installing third-party software. This behavior is beneficial among traditional networks where vendors have extensively tested their software before distributing it among clients. However, when it comes to adopting new technologies and scaling the network, vendors become cautious and reluctant due to security concerns, financial costs, and downtime drawbacks that might follow [2].