

# VIRTUAL LEARNING ENVIRONMENT

NATIONAL CENTER OF ACADEMIC EXCELLENCE - CYBER OPERATIONS

UNIVERSITY OF ARIZONA  
JASON DENNO  
2018





*- Purpose built Cyber Virtual Learning Environment specifically designed to support an NSA CAE-CO degree program -*

# 2016

Created in 2016 to support the  
Bachelor of Applied Science degree in  
Cyber Operations



Web-based access with multi-factor  
authentication and encrypted  
communications to ensure security,  
accounting, and auditability.

# 850<sup>+</sup>

Over 850 students enrolled covering  
20 different locations including US,  
South/Central America, Europe,  
Africa, Asia, and Afghanistan.



## **Why we built and use our VLE**

- Consistently deliver all 26 courses across the Cyber Operations program
- Focus all course time on achieving the learning objectives – not fighting their systems
- Avoid distributing USB drives or requiring students to download and install 100s of security tools and files
- Simplify and minimize student environment maintenance & support requirements
- Create an environment to deliver Offensive Cyber Operations (OCO) education – Not on the open Internet!
- No weaponization of students

## **How we achieve this**

- Provide a hybrid cloud-based solution that includes student desktops
- Baseline all students and prevent installation, versioning, and configuration management issues
- Preconfigure and test all desktops, tools, data, and networking
- Centrally manage all updates, data distribution, software versioning and patching, etc.



# CYBERAPOLIS



CENTER OF ACADEMIC EXCELLENCE

Cyber Operations

## 15,000 Detailed Virtual Residents

- 100+ Highly Detail Virtual Persona
- Underground Hacker Community
- Organized Crime Element
- Entity & Data Relational Linkages
- Patterns of Life
- Web Browsing, Emailing, Social Media Posts

## Web and Network Infrastructure

- City Infrastructure with IRC Servers
- Water Company
- Power Company
- 2 Online News Agencies
- Bank
- Hospital
- Shipping Company
- Large Retailer
- 20 Small Retailers/Service Providers

## Social Media Sites

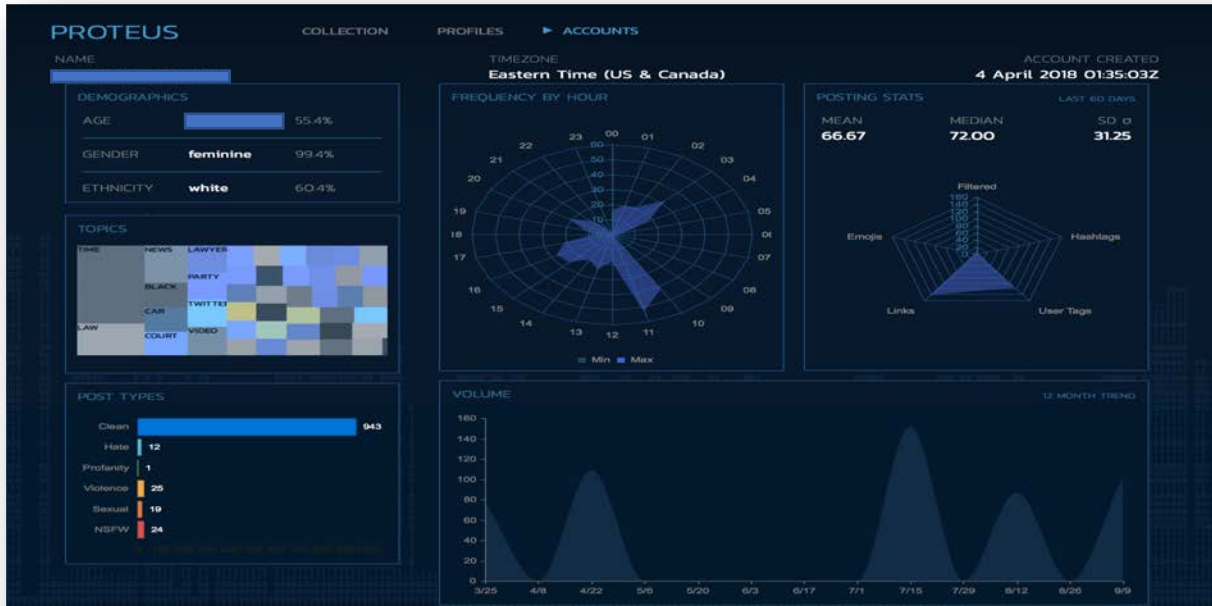
- Social Park
- ChirpyHub





# VIRTUAL PERSONAS

- Reverse Engineered to Support Learning Objectives
- Relationships & Patterns of Life
  - Web Surfing, Email, Social Media, Purchasing, Shipping, Work & School
- Functional CyberApolis Accounts
  - Bank, Credit Cards, Customer Accounts, Digital Health Records
- Metadata Embedded in Documents & Pictures
- Proteus AI Driven and/or Manually Crafted Activities



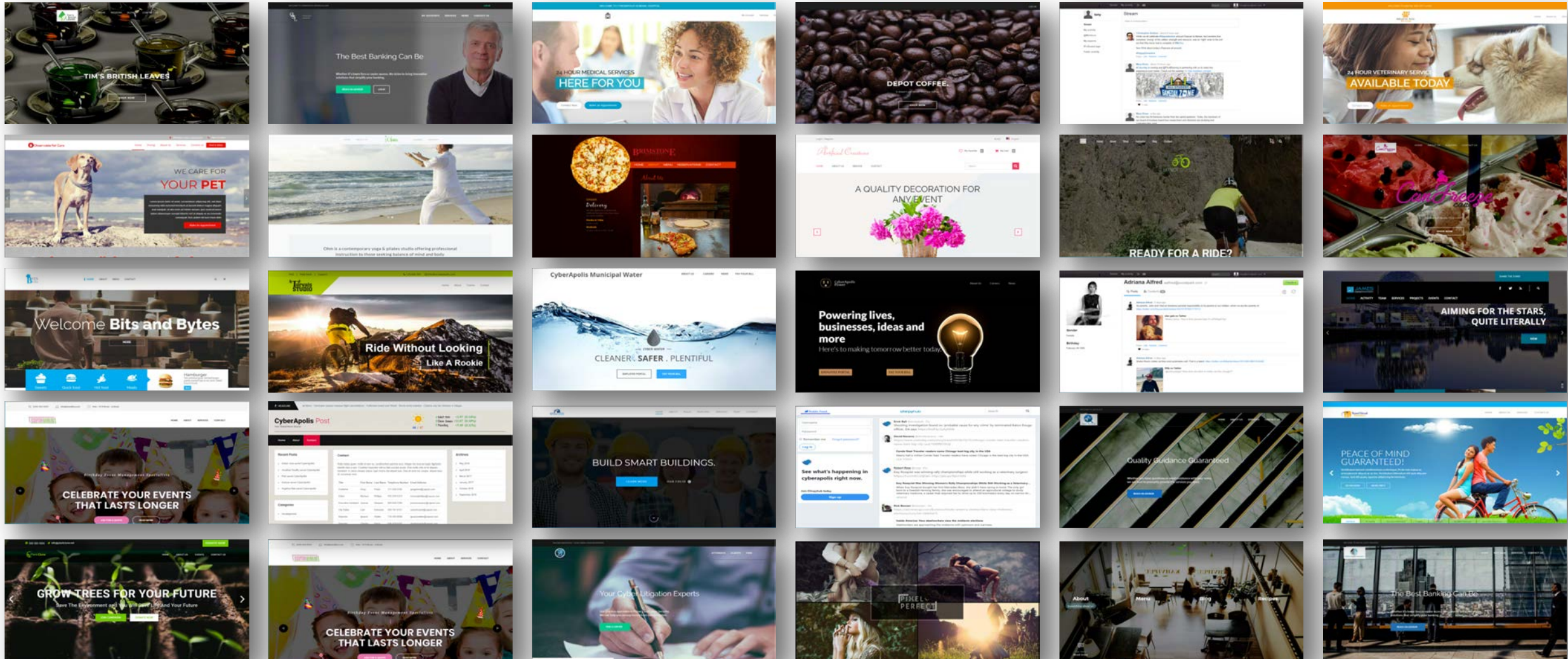
The CYBER OPERATIONS / PEOPLE PORTAL interface displays a user profile for 'ADRIANA ALFRED'. The interface includes the following sections:

- Header:** CYBER OPERATIONS / PEOPLE PORTAL, JASONDENNO@EMAIL.ARIZONA.EDU, LOG OFF.
- Navigation:** Personas, Profiles, Gallery.
- System Status:** System may be offline 9-10am AZ (UTC-7) M-F for updates.
- Profile:**
  - Profile:** Teen profile 1, Sex female, Age 24 years old.
  - POSTS:** ChirpyHub, Social Park. Last Post: As parents, John and I feel an immense parental responsibility to be parents to our children, whom we are the parents of https://twitter.com/theyearofelan/status/1051157076871770112.
- INFORMATION:**
  - Phone: 781-602-8811, Location: Barbados.
  - Birthdate: 9 February 1994, Primary Email: AdrianaSAlfred@teleworm.u.
  - Company: Shoe Kicks.
- ACCOUNTS:**

System	Username	Password
ChirpyHub	aalfred	[icon]
Cyber Bank	aalfred	[icon]
Cyber Depot	aalfred	[icon]
Cyber Hospital	aalfred	[icon]
SocialPark	aalfred	[icon]
- LOCATION:** Barbados ( ) is an island country in the Lesser Antilles, in the Caribbean region of North America. It is 34 kilometres (21 miles) in length and up to 23 km (14 mi) in width, covering an area of 432 km2 (167 sq mi). It is situated in the western area of the North Atlantic and 100 km (62 mi) east of the Windward Islands and the Caribbean Sea; therein, it is about 168 km (104 mi) east of the islands of Saint Vincent and the Grenadines and 400 km (250 mi) north-east of Trinidad and Tobago. Barbados is outside the principal Atlantic hurricane belt. Its capital and largest city is Bridgetown.
- Current time in Barbados:** 18:24 Sat, 20 Oct 2018. Barbados Dark Sky.
- 78° and falling** Light Rain and Breezy Wind: 20 mph (NW).
- TOPICS & RESPONSE INFO:** Beauty & Fitness, Shopping, Cosmetic Procedures.
- STATS:** ChirpyHub Social Park. Likes, Posts, Shares.
- Images:** Silver Sands > South: Blue Ocean Cottage ... Hermitage > East: Atlantic Ocean.



# CYBERAPOLIS ORGANIZATIONS





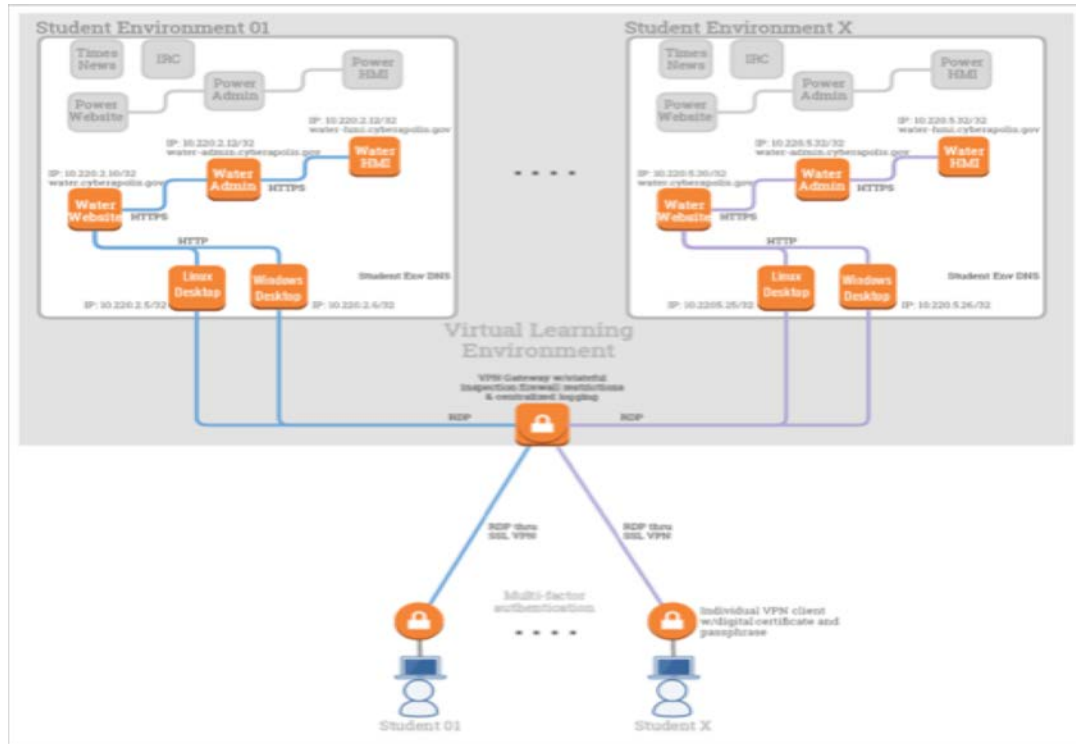
# CYBERAPOLIS WATER COMPANY



CENTER OF ACADEMIC EXCELLENCE

Cyber Operations

- Organizational Structured Tied to Website & Network
- 136 Detailed Employees (Future Scenario Growth)
- Corporate Data & Metadata to Support Scenarios
- Security Vulnerabilities Built Into Website & Networks
- Full Network Architecture Implemented in the Cloud
- Students Segmented in Separate Security Groups



**CyberApolis Municipal Water**

ABOUT US CAREERS NEWS

CYBER WATER

CLEANER . SAFER . PLENTIFUL

EMPLOYEE PORTAL PAY YOUR BILL

**CyberApolis Water Company**

Board of Directors (10)

Management (10)

Accounting & Finance (10)

Human Resources (10)

Customer Service (10)

Legal (10)

Water Treatment (10)

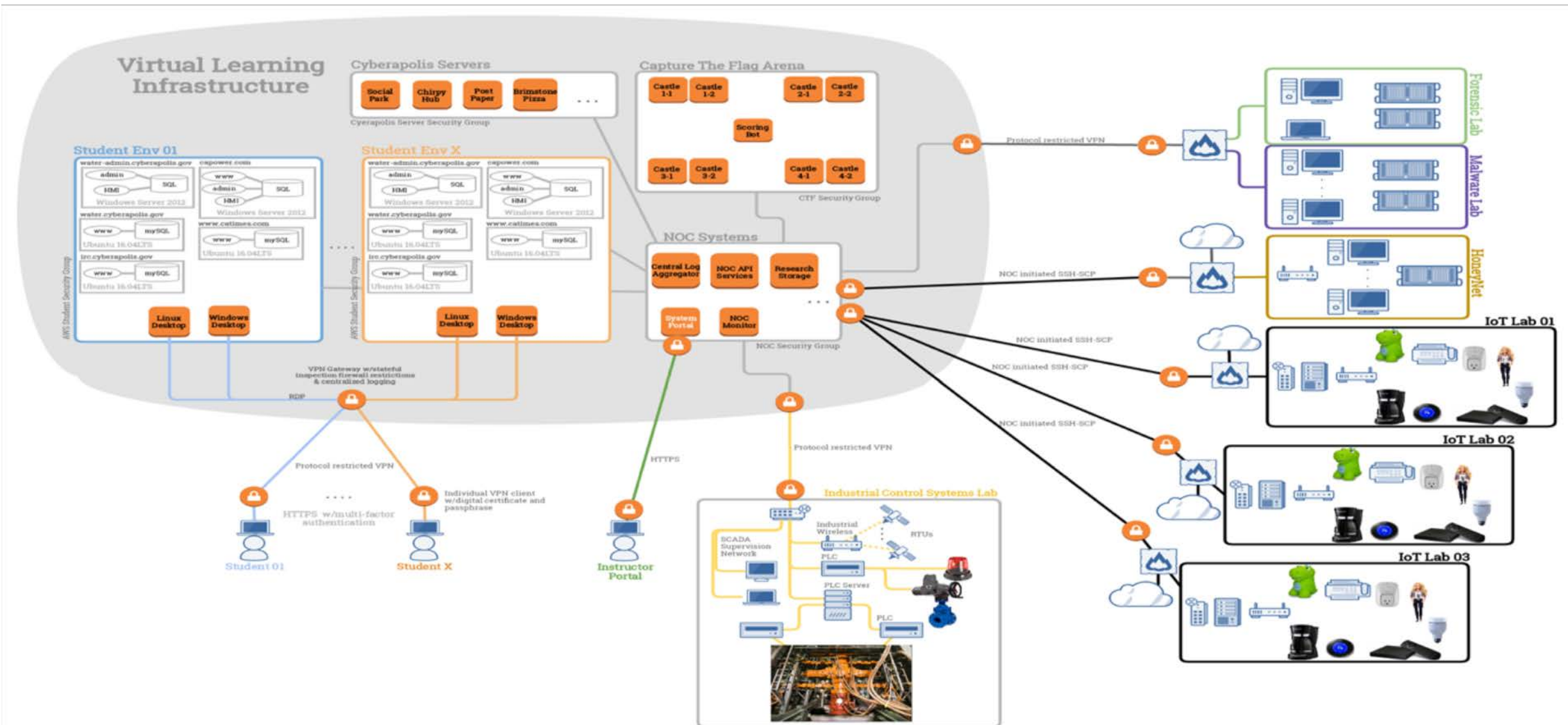


# VLE ARCHITECTURE



CENTER OF ACADEMIC EXCELLENCE

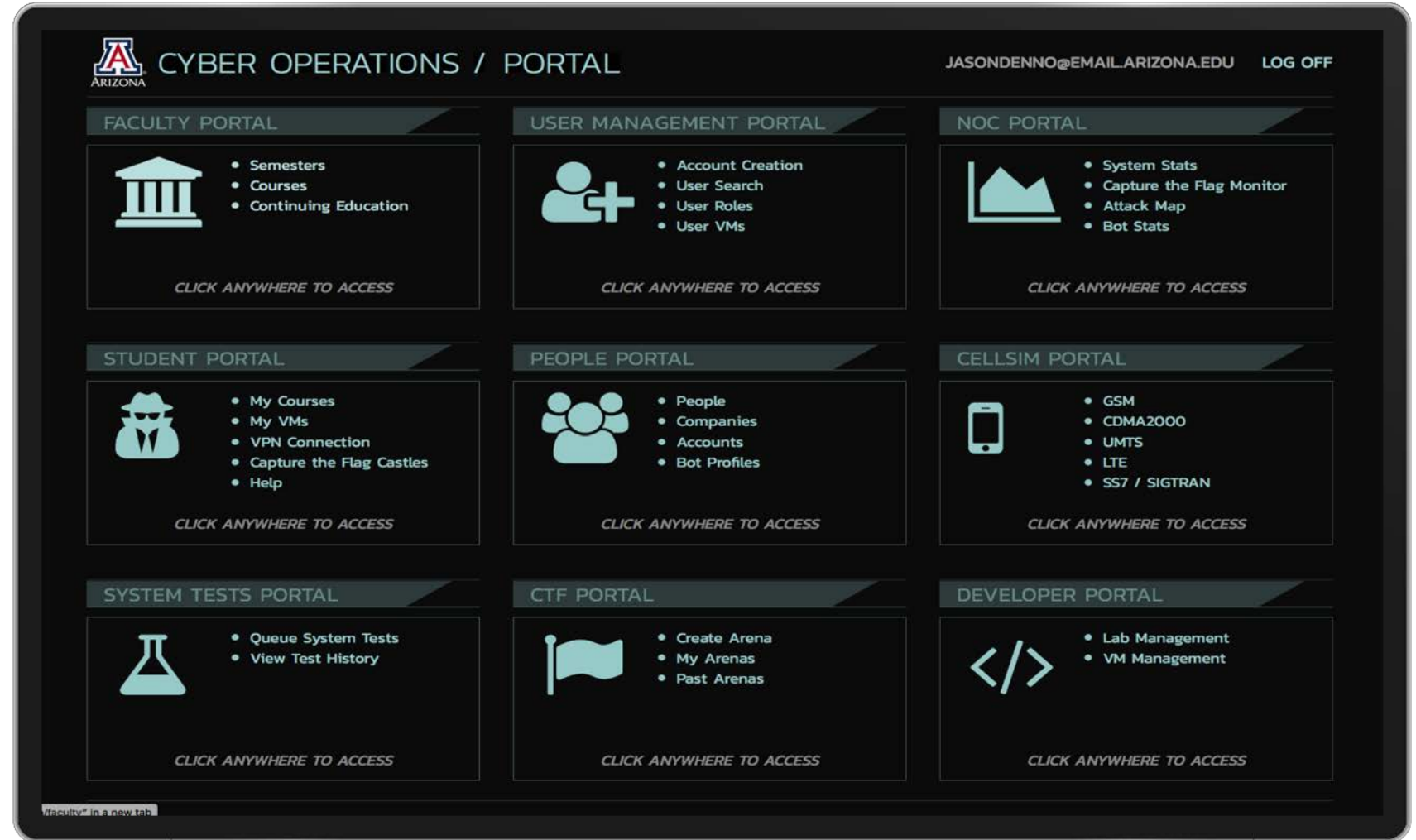
Cyber Operations





# VLE MAIN PORTAL

- Main Entry Point to VLE
  - Access All Areas of VLE
  - NOC Portal
  - Faculty Portal
  - Student Portal
  - User Management Portal
  - People Portal
  - CTF Portal
  - Development Portal
  - System Test Portal
  - CellSim Portal
- Rules-Based Access Control





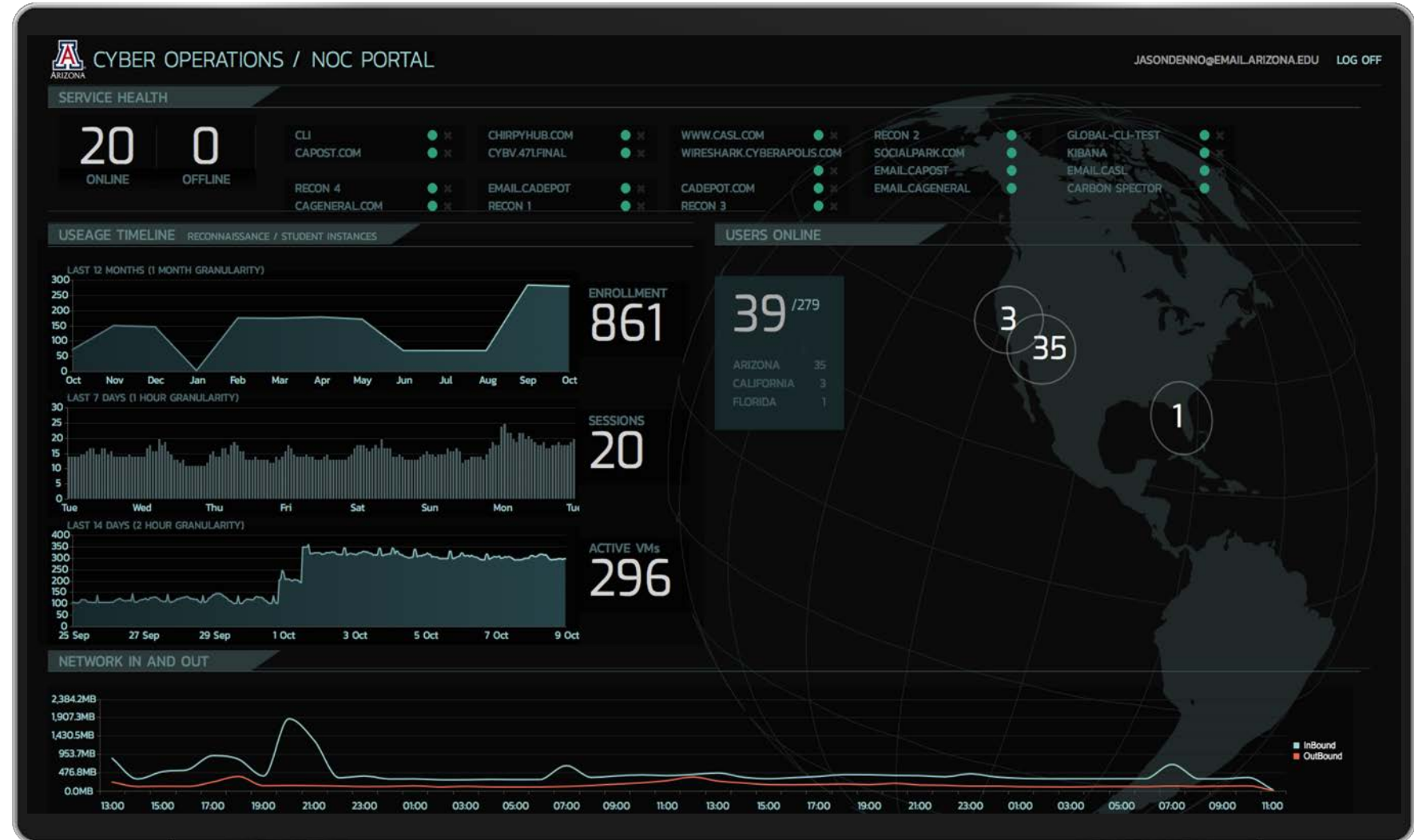
# NOC PORTAL



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Cyber Operations

- Status of VLE Servers
- Online Users & Locations
- Total Enrollment
- Active Sessions
- Active VMs
- Bandwidth Usage





# FACULTY PORTAL

- Central Faculty Dashboard
- Search, Schedule and Launch Existing Courses
- Dynamically Create New Cyber Courses & Training
- Enroll & Monitor Students
- Record Learning Sessions
- Add, Delete, & Update Course Content
- Reset Student & Environment Resources
- Monitor Course Interactions & Record Statistics



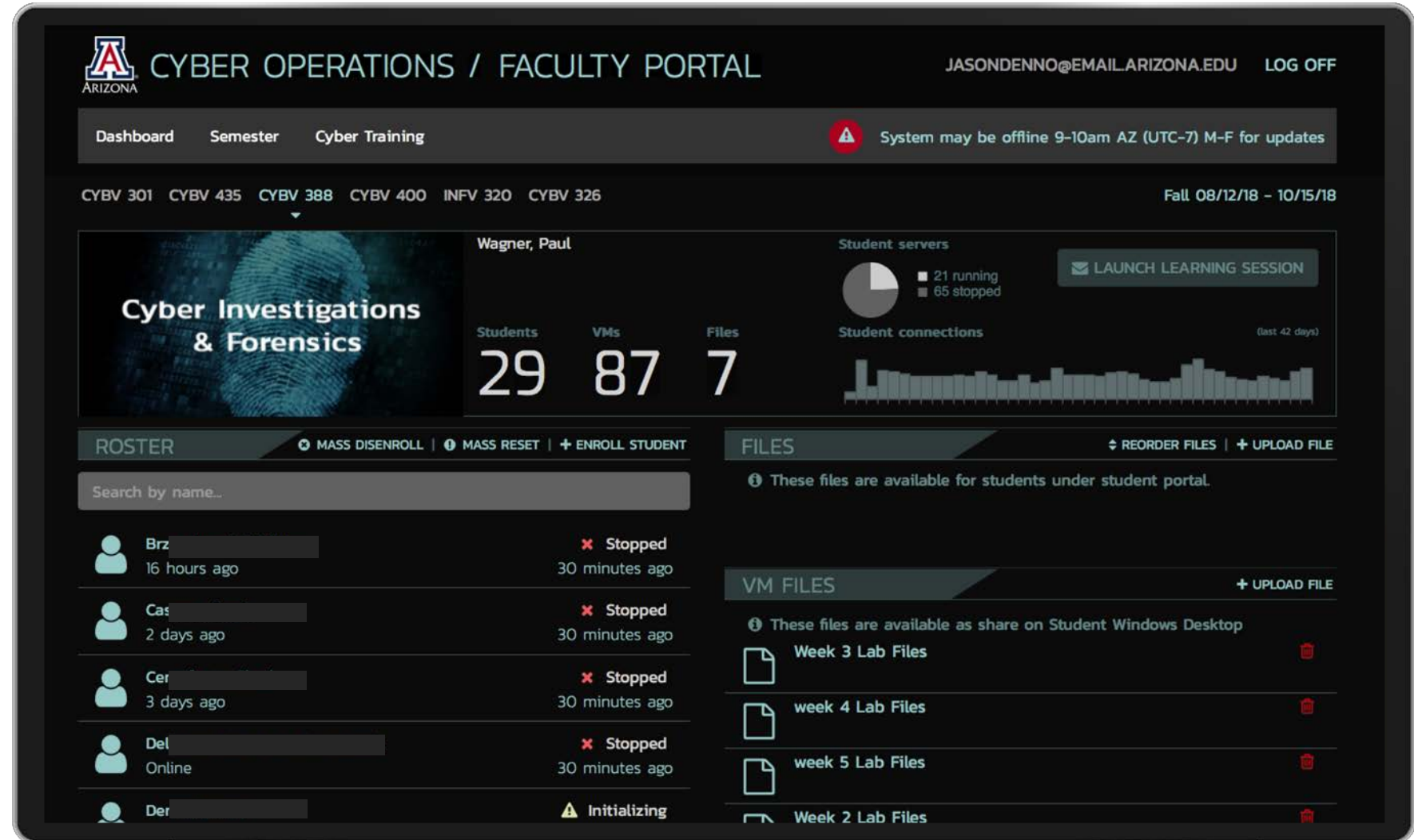
The screenshot displays the 'CYBER OPERATIONS / FACULTY PORTAL' interface. At the top, there is a navigation bar with tabs for 'Dashboard', 'Semester', and 'Cyber Training'. The user is logged in as 'JASONDENNO@EMAIL.ARIZONA.EDU' and can click 'LOG OFF'. A system status message indicates: 'System may be offline 9-10am AZ (UTC-7) M-F for updates'. Below the navigation bar is the 'SEMESTER MANAGEMENT' section, which includes tabs for 'SPRING 2018 15W', 'FALL 2018 7W1', 'FALL 2018 15W', 'FALL 2018 7W2', and a '+ ADD SEMESTER' button. The main content area lists five courses, each with a thumbnail, title, instructor, schedule, and time. Each course entry also features a 'student connections' bar chart, a 'student servers' pie chart, and 'EDIT' and 'DELETE' buttons.

Course ID	Course Title	Instructor	Schedule	Time	Student Connections	Student Servers	Actions
CYBV 301	Fundamentals of Cybersecurity	Jewkes, Tom	Wed	1700 - 2200	[Bar Chart]	[Pie Chart]	[EDIT] [DELETE]
CYBV 435	Intro to Cyber Intelligence	Drennan, David			[Bar Chart]	17 running, 33 stopped	[EDIT] [DELETE]
CYBV 388	Cyber Investigations & Forensics	Wagner, Paul			[Bar Chart]	16 running, 71 stopped	[EDIT] [DELETE]
CYBV 400	Active Cyber Defense	Jewkes, Tom			[Bar Chart]	18 running, 42 stopped	[EDIT] [DELETE]
INEV 320	Computational Thinking & Doing	Wolf, Odile			[Bar Chart]		[EDIT]



# FACULTY PORTAL – COURSE MANAGEMENT

- Central Course Dashboard
- Enroll/Drop Students
- Launch Learning Sessions
- Visualize Course Resources
- Visualize Student Interactions & Resource Status
- Centrally Manage Student & VM Files
- Reset Student Resources





# STUDENT PORTAL



CENTER OF ACADEMIC EXCELLENCE

Cyber Operations

- Central Student Dashboard
- View Course Details
- Access Enrolled Courses
- ~320kbs Bandwidth <200ms
- Access Virtual Desktops
- View VLE Alerts & Messages

The screenshot shows the 'CYBER OPERATIONS / STUDENT PORTAL' interface. At the top, there's a navigation bar with 'My Courses', 'Virtual Desktops', and 'Help'. A user is logged in as 'JASON DENNO' with a 'LOG OFF' option. A system message indicates the portal may be offline from 9-10am AZ (UTC-7) M-F for updates. The main section is titled 'MY COURSES' and lists three courses for 'SPRING 2018':

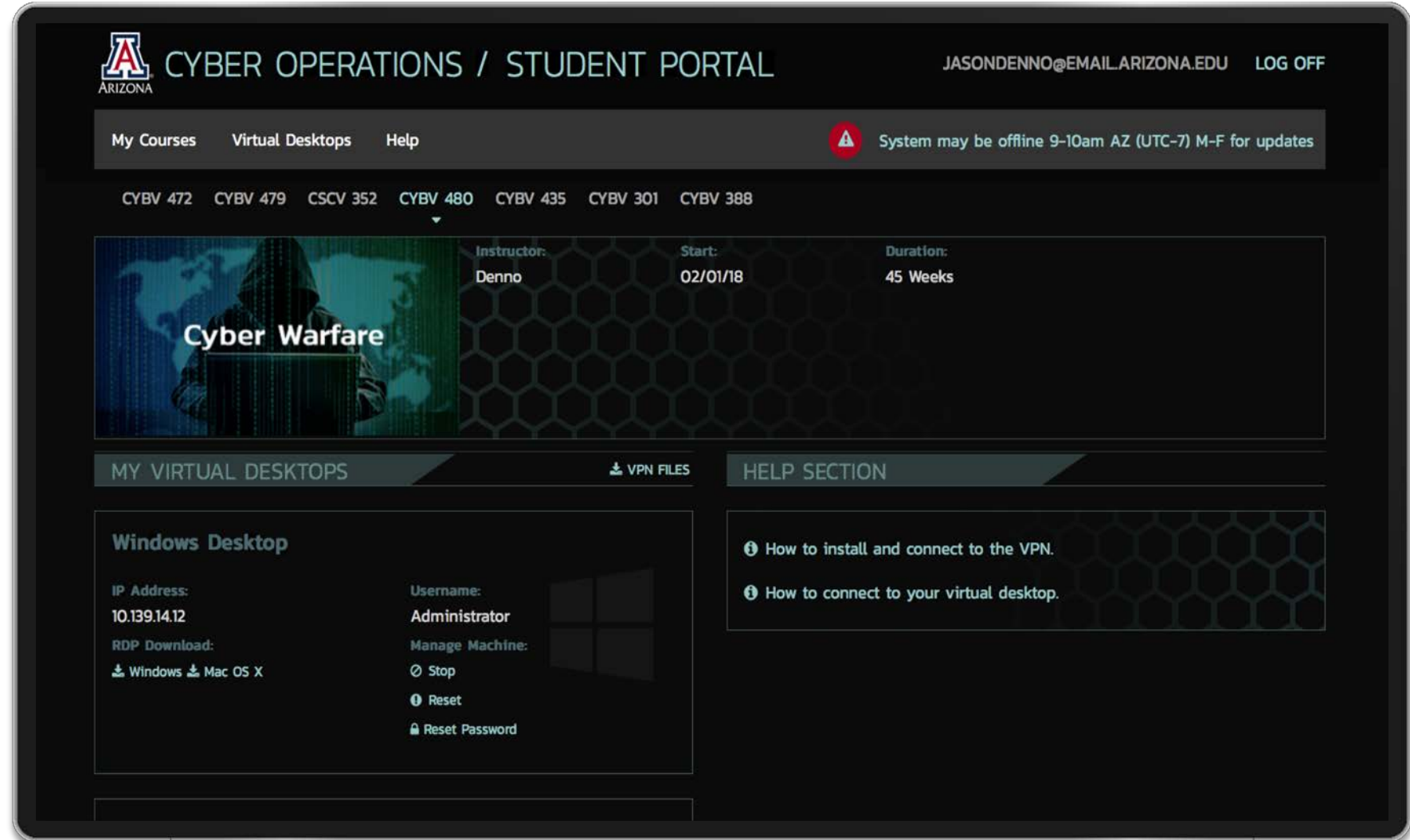
Course ID	Course Title	Instructor	Start	Duration	Action
CYBV 472	Secure Software Development & Assessment	Denno	02/01/18	45 Weeks	<a href="#">Access Course</a>
CYBV 479	Wireless Networking & Security	Denno	02/01/18	45 Weeks	<a href="#">Access Course</a>
CSCV 352	System Programming and Unix	Denno	02/01/18	45 Weeks	<a href="#">Access Course</a>

On the right side, a welcome message states: 'Welcome to Cyber Operations Student Portal. This portal allows you to access course materials, install a vpn client, and connect to virtual desktops or sites to complete course assignments. If you have any questions or issues, view the Help page.'



# STUDENT PORTAL – COURSE ACCESS

- Start, Stop, Reset, and Fix Assigned Compute Resources
- View Assigned Account Details
  - IP Address
  - User Name
  - Reset Password
- View and Access Assigned Courses Material and VM Files

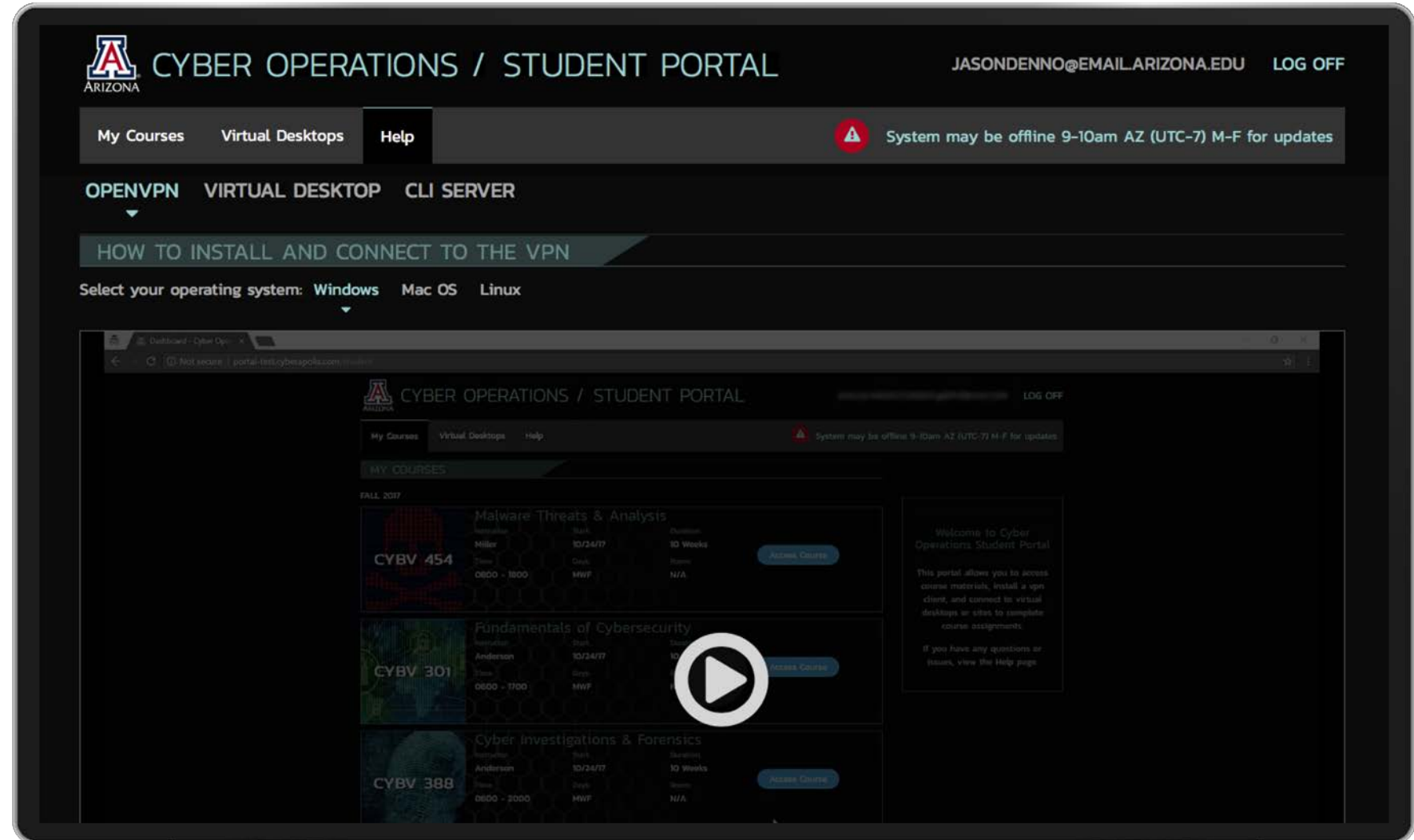


The screenshot displays the 'CYBER OPERATIONS / STUDENT PORTAL' interface. At the top, the University of Arizona logo is on the left, and the user 'JASONDENNO@EMAIL.ARIZONA.EDU' is logged in with a 'LOG OFF' option. A navigation bar includes 'My Courses', 'Virtual Desktops', and 'Help'. A system message states: 'System may be offline 9-10am AZ (UTC-7) M-F for updates'. Below this, a list of courses is shown: 'CYBV 472', 'CYBV 479', 'CSCV 352', 'CYBV 480' (selected), 'CYBV 435', 'CYBV 301', and 'CYBV 388'. The main content area for 'Cyber Warfare' shows 'Instructor: Denno', 'Start: 02/01/18', and 'Duration: 45 Weeks'. A 'MY VIRTUAL DESKTOPS' section features a 'Windows Desktop' card with the IP address '10.139.14.12', an 'RDP Download' link for Windows and Mac OS X, and management options: 'Stop', 'Reset', and 'Reset Password'. A 'VPN FILES' link is also present. A 'HELP SECTION' on the right provides instructions on installing and connecting to the VPN, and connecting to the virtual desktop.



# STUDENT PORTAL – HELP PAGES

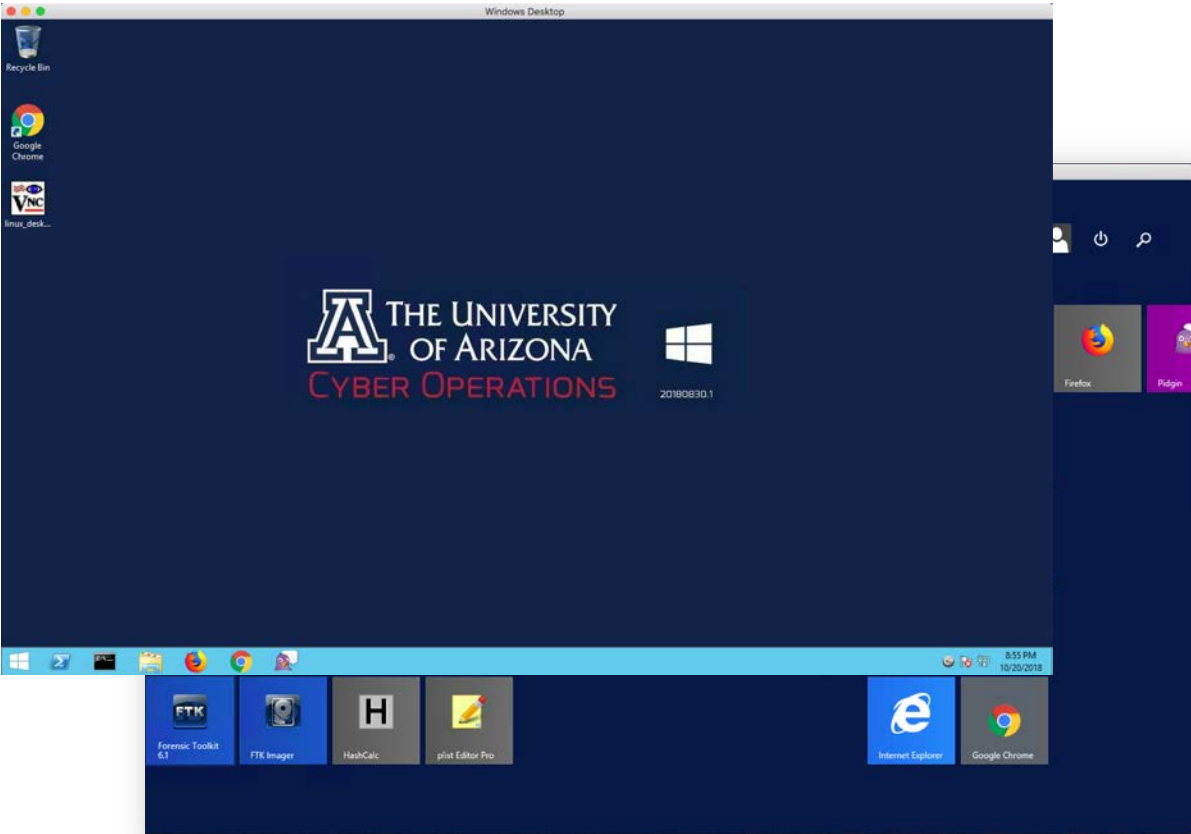
- Central Help Dashboard
- Access Download Links
- Video Demonstrations with Voice & Closed Caption Narration
- Step by Step Instructions
  - VPN Install & Launch
  - Virtual Desktops
  - CLI Servers
- All Platforms
  - Windows
  - Mac OS
  - Linux



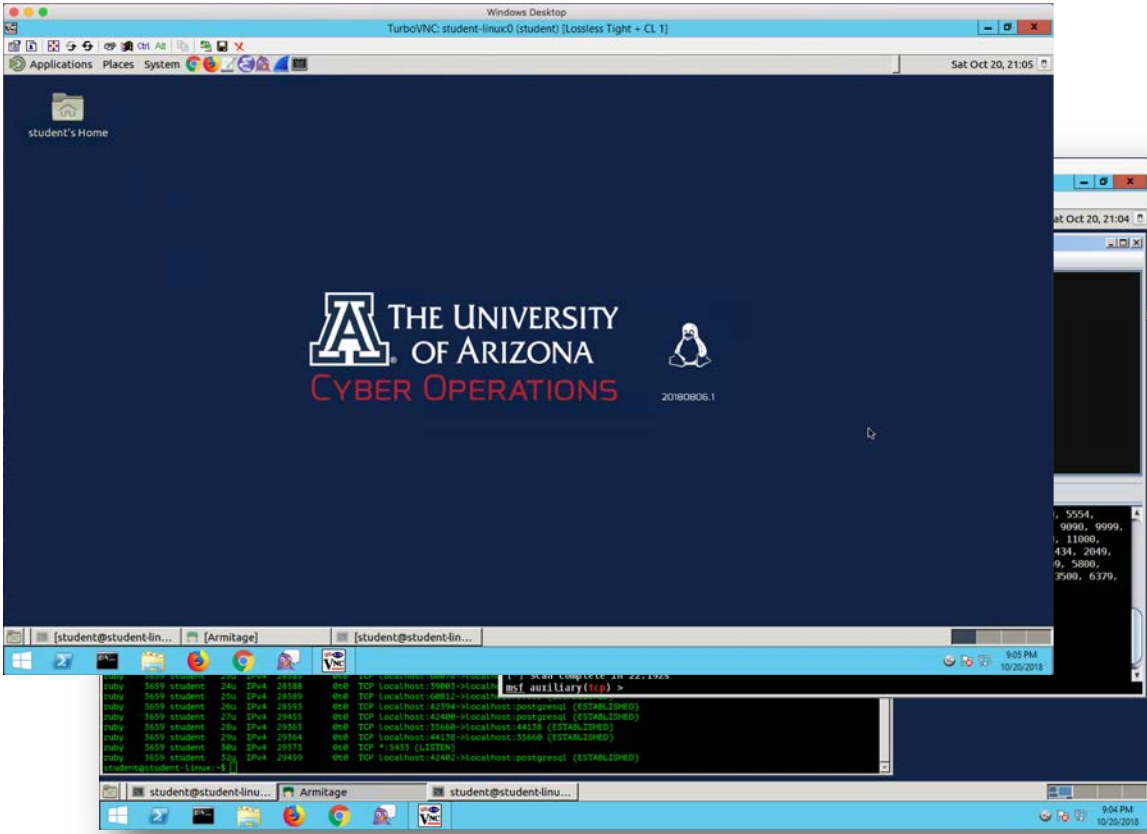


# STUDENT DESKTOPS

## WINDOWS



## LINUX





# TRAINING & STAFFING REQUIREMENTS

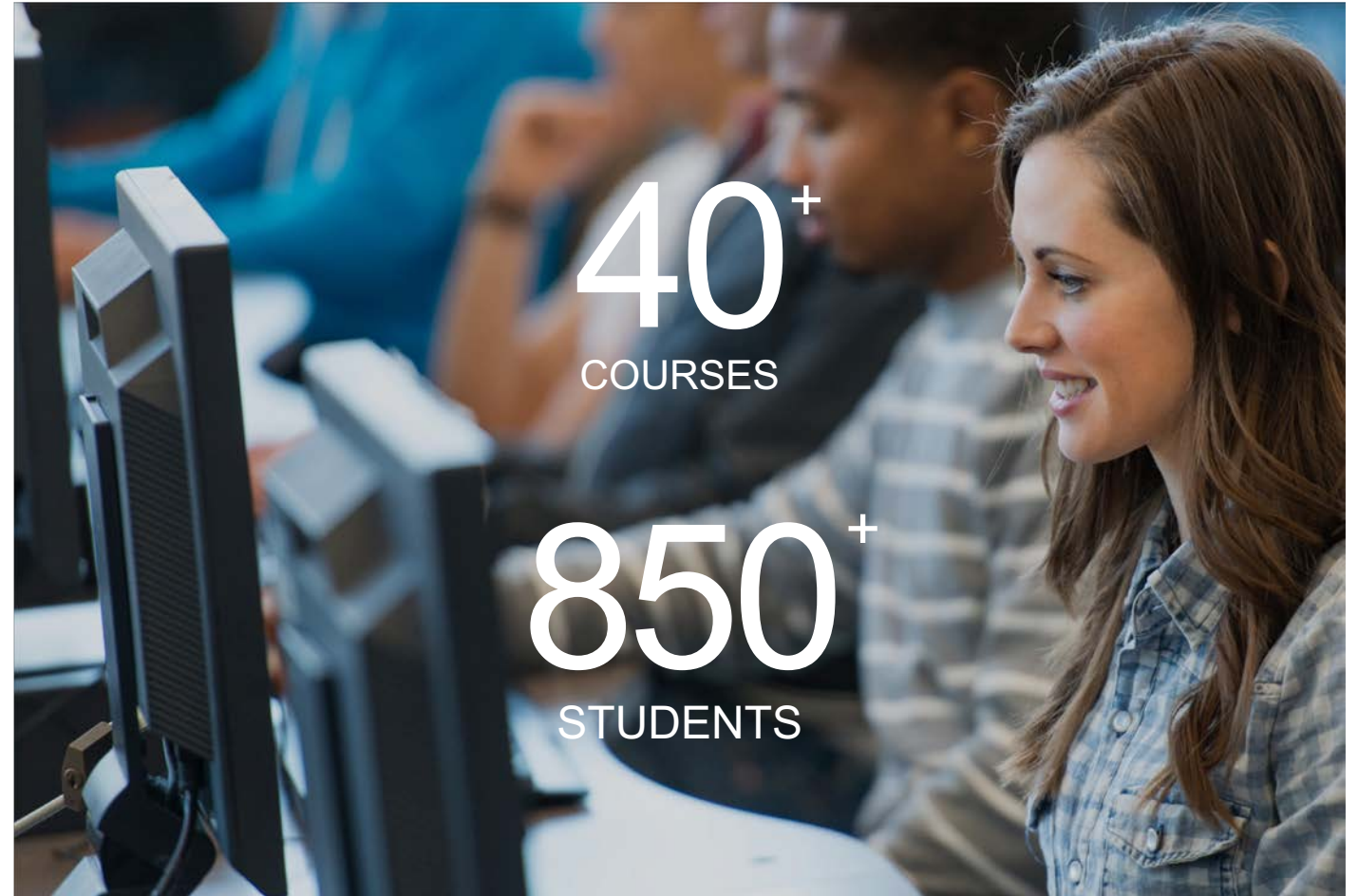
	New Student	New Faculty
Time	< 1 Hour	< 2 Hours
Skill	Use a Web browser	Use a Web browser

## OUR SYSTEM IS MAINTAINED BY

1 Developer

1 Cloud Engineer

1 Product Manager







## **Fix Button**

Course administrators are presented with a Fix button when one of their students' VMs fails a status check. e.g. If the VM's file system is corrupted or there are hardware issues on the physical host.



## **Self Healing**

This is a job that runs nightly to ensure that each student's environment is in a good state. It automatically fixes impaired VMs, reassigns missing VMs, and sends a summary of any fixes performed to the development team.



## **Jason Denno**

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VIRTUAL LEARNING ENVIRONMENT

THANK YOU

