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# *Network2U*: Cloud Business Templates

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*Abstract*—**Businesses are transitioning towards using cloud services for many of their networking and system needs. However, designing and implementing these cloud services can be costly for business owners. In this paper, we propose *Network2U*, a business cloud network infrastructure service built upon *Google Cloud*. *Network2U* can be fit into several types of business by extending two sample templates. Current templates include a school system where hundreds of students will connect to a network, with strict security requirements regarding student data. The other template is a hybrid workforce finance company, where its users will connect to the network from different locations, and customer data security is key. These templates provide the different business types with all the systems, networking and security services needed to run their business. *Network2U* is for small or medium business owners who cannot invest in the large cost of getting a business cloud network infrastructure implemented.**

***Keywords—Network and System Design, Cloud Services, Business Templates***

## I. Introduction

The modern world has forced most businesses to access the Internet and implement new computing systems and solutions into their business model. By this point, many businesses require complicated networks, computing systems, and cybersecurity services to conduct business effectively in the current technology-oriented society. With this ever-growing need to meet the current technological standards to conduct business successfully, businesses are struggling to meet these needs. Cloud services are a popular method for providing this needed infrastructure for a business, as the business owner can be free from hardware operations and maintenance cost. This is appealing to business owners as they can pay for the exact resources and services they need, and it is easily scalable to the growth or downsizing of a business. The downside to this is that setting up this cloud infrastructure requires specialized skills and can be very expensive, which makes many businesses hesitant about updating their infrastructure to the cloud. This leads to either the company being forced to pay for expensive cloud infrastructure setup services, or risk losing market share to competitors who can conduct business more effectively due to their ability to streamline business operations with updated technology. The *Phoenix Business Journal* reported that businesses who do not update their technology to meet current standards will lose money, as it was found that US businesses that are using obsolete technology lose up to 1.8 billion dollars each year [1]. Even worse, if the businesses' cybersecurity practices are not up to date, cyber attackers can conduct attacks on the business, which can lose them money in lost time, ransom, or expensive fines. The *Washington Post* has stated that in 2020, global losses from cyberattacks reached over $1 trillion dollars globally [2].

In this paper, we propose *Network2U*, a cloud business template solution which provides many business types with most of the networking, systems, and cybersecurity services needed to run their business. Templates can be made based on many different types of businesses. In order to accommodate all needs for each business type in our templates, our *Network2U* is designed to be easily modified to meet the needs of any business. *Network2U* uses *Google Cloud* [3] as our cloud service platform because it is one of the most popular cloud services and offers rich functionality and easy-to-use environment to meet each business' specific requirements. By having an affordable cloud solution, small and medium businesses can implement the backbone of their networks, systems, and cybersecurity services at a low cost, which can be very helpful for businesses who have been struggling with getting their systems up-to-date due to lack of funding.

The rest of this paper is organized as follows. Section II provides insight into what services most modern businesses need in their computer networks to effectively run their business. Section III provides details of how *Network2U*'s business templates are designed, and how our project provides these important services to its customers. Section IV outlines ideas to improve upon existing templates.

## II. Busineess Infrastructure Needs

While each business category and each specific business have their own dedicated infrastructure needs, many of these needs overlap for most businesses. Each business needs at least three pieces of a network to be successful. First, is the network itself, as the different computing devices in business need to communicate with each other and access resources on the network and on the Internet. Second, is a system to manage the computing devices and resources on the network. Lastly, cybersecurity is a must, as it is very important to keep malicious attackers out of the network. This is important as business resources need to be protected so the company does not lose money due to an attacker mismanaging these resources in some way.

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### *A. Networking services*

Every business that wants to have updated Information Technology (IT) services needs to have a network that can support it. Without a functioning network, the devices throughout the network will not be able to communicate with each other or with other devices or services on the Internet. It is important that the network is built to support the amount of data and users of each business. If it is not built large enough to support a larger business, issues such as network congestion or lack of internet protocol (IP) addresses may occur.

### *B. Systems Needs*

All businesses that want to have a computer network implemented need to have adequate system implementations to manage the computing devices and services that are required to effectively run the network. These systems are needed to provide necessary network services such as domain name system (DNS), dynamic host configuration protocol (DHCP), and more. Systems are required to manage network resources and allow for devices on the network to access these resources as needed. Without an effective system implementation, the advantages a computer network brings to a business cease to exist.

### *C. Cybersecurity Infrastructure and Requirements*

All businesses that use computers and IT technology to improve workflow are at risk of a cybersecurity attack. This has been seen with the rise in the number of cyberattacks in recent years, which can range from a ransomware attack on a school, to a distributed denial-of-service (DDOS) attack on a stock trading application. A cyberattack could leave a business inoperable for weeks at a time, causing lost revenue, or fines that can be imposed for not adequately protecting customer data. This risk of cyberattack at any point for any business reinforces the need for every business to have strong cybersecurity practices and updated cybersecurity countermeasures.

## III. NETWORK2U

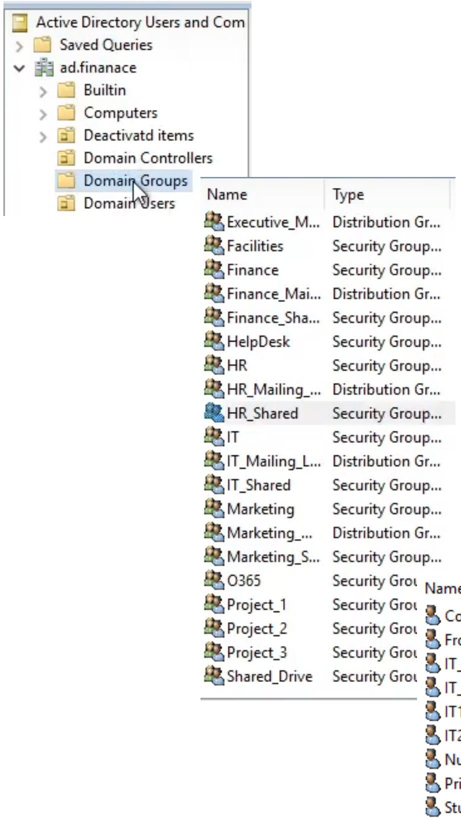
*Google Cloud* (GC) is a platform with over 150 embedded products that allow projects to be made for all sorts of applications and services. For *Network2U* we primarily used *Google Compute Engine* (GCE) for hosting the virtual machines (VM) and *Virtual Private Cloud* (VPC) Network for configuring the networks and security features. Within GC, all templates are running at minimum, two virtualized servers. An *OpenVPN* access server VM for host connectivity to the cloud local area network (LAN), and a Windows Server 2016 VM to provide the domain, DNS, and fileserver services for the network. Everything else was done with GC services and products. Utilizing the services of GC to their fullest potential allows organizations to meet their networking and security needs at a very low cost. Organizations need modern solutions to their networking and security infrastructure. *Network2U* strives to provide a low-cost, easy to maintain environment that organizations can copy and use as they see fit. While working on and testing *Network2U* we appreciated how scalable GCE and by extension VPC were. Out of the options for cloud hosting out there – like *Microsoft Azure* and *Amazon Web Service*, GC is the competitive option. However, we had two technical limitations that impacted the project; the lack of support for Windows hosts on GC (so we had to use our own VMs to simulate the hosts) and having to use one of the default network configurations for both projects. Neither of those limitations severely impacted on the functionality of the project but they were obstacles we needed to overcome to make sure our templates functioned correctly. Despite the setbacks while starting this project, the services and application we ended up using worked wonders.

*Network2U* provides two business templates – the school and the financial business, and can be divided into four parts for both templates: The Domain, the Network, Security, and the Wireless Simulation.

### *A. The Domain*

Both templates utilize Windows Server 2016 for their domain. Each domain has fully configured simulated users and groups for the sake of access control. The groups were designed with the needs of the organization in mind, and both domains have a mix of security and distribution groups that cater to the business. These users and groups can be easily modified to meet the needs of each customer.

In Fig. 1 the general makeup of the active directory setup for both templates are shown; the organizational unit (OU) setup for the finance domain (left most), the group setup for the finance company (middle), and the user setup for the school (right most). Each user on the domain was assigned to an OU and to the groups they needed for their specific job position to complete

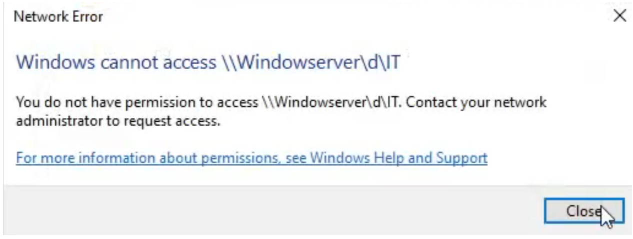


Active Directory Users and Com
Saved Queries
ad.finanace
Builtin
Computers
Deactivatd items
Domain Controllers
Domain Groups
Domain Users

| Name | Type |
|---|---|
| Executive_M... | Distribution Gr... |
| Facilities | Security Group... |
| Finance | Security Group... |
| Finance_Mai... | Distribution Gr... |
| Finance_Sha... | Security Group... |
| HelpDesk | Security Group... |
| HR | Security Group... |
| HR_Mailing_... | Distribution Gr... |
| HR_Shared | Security Group... |
| IT | Security Group... |
| IT_Mailing_L... | Distribution Gr... |
| IT_Shared | Security Group... |
| Marketing | Security Group... |
| Marketing_... | Distribution Gr... |
| Marketing_S... | Security Group... |
| O365 | Security Grou |
| Project_1 | Security Grou |
| Project_2 | Security Grou |
| Project_3 | Security Grou |
| Shared_Drive | Security Grou |

| Name | Type |
|---|---|
| Counselor1 | User |
| Front_Office | User |
| IT_Admin1 | User |
| IT_Admin2 | User |
| IT1 | User |
| IT2 | User |
| Nurse1 | User |
| Principal | User |
| Student1 | User |

Fig.1. Example Active Directory Setups

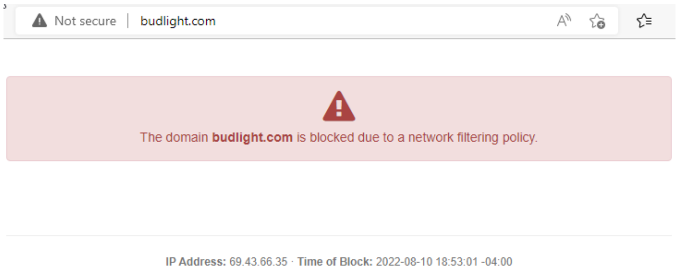


Network Error

Windows cannot access \\Windowserver\d\IT

You do not have permission to access \\Windowserver\d\IT. Contact your network administrator to request access.

For more information about permissions, see Windows Help and Support



Not secure | budlight.com

The domain **budlight.com** is blocked due to a network filtering policy.

**IP Address:** 69.43.66.35 · **Time of Block:** 2022-08-10 18:53:01 -04:00

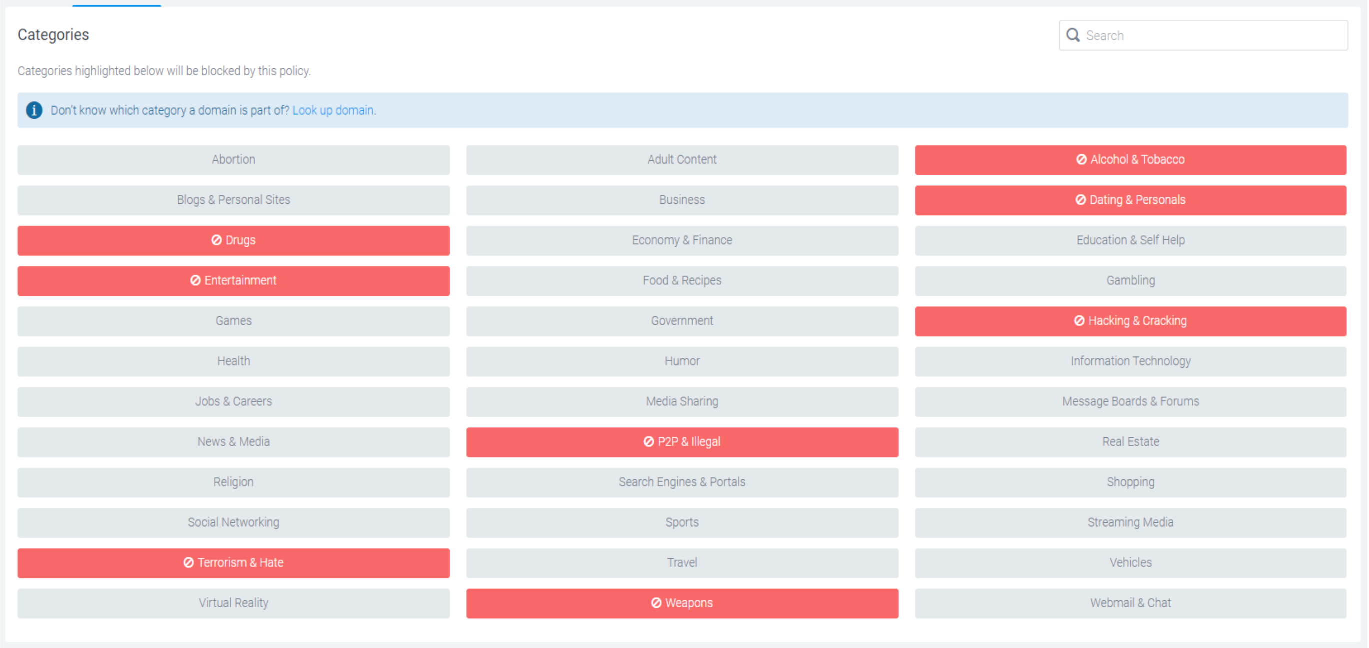
their day-to-day work. Everyone by default was assigned access to their necessary share drive and email group. These groups then linked with the file servers themselves. An example of this would be that the HR1 user in the finance template would be added to the HR and HR_Shared groups. These groups will allow that user to access resources on the domain that the HR groups are allowed, such as access to the HR folder on the fileserver. As shown in Fig. 2, if a member of the HR Groups in the financial company tried to access non-approved resources, such as the IT folder on the share drive, they would not be able too.

A feature specific for the school's template is that there are two servers instead of one. On the school template there is a separate server for storing the health records of students. Thus, the important information related to students can be separated from the original server and only accessible by those who have the authority. Finally, for DNS we used a combination of the Windows Server and *DNSFilter* [4]. The Windows DNS redirects to the *DNSFilter* servers when doing DNS requests. *DNSFilter* is a service that provides DNS server capabilities and DNS based content filtering. As shown in Fig. 3, the content filtering is applied based on DNS filter categories specified by an administrator. These categories have a list of website DNS addresses that are considered related to that category. If a DNS request comes in from a host that is classified as a specific category is considered inappropriate for the business, *DNSFilter* will not reply with the standard DNS reply for the website. *DNSFilter* will just show a message in browser saying that the domain has been blocked by DNSFilter as shown in Fig 4.

When deciding what content to filter we wanted to remove things that normally would not be considered appropriate for each business type. The difference between the two content filters was also impacted by the type of organizations we were working with. The school has a stricter policy than the finance company because laws about the protection of children online are much stricter.

### *B. The Nertwork*

Table 1 and 2 shows the network makeup for both templates. Template 1 is designed to support total 1024 students and 256 faculty/staff members in a school. Template 2 supports 5 different departments including IT, HR, marketing, finance, and reserved for future.



Categories

Categories highlighted below will be blocked by this policy.

Don't know which category a domain is part of? Look up domain.

| | | |
|---|---|---|
| Abortion | Adult Content | ⊘ Alcohol & Tobacco |
| Blogs & Personal Sites | Business | ⊘ Dating & Personals |
| ⊘ Drugs | Economy & Finance | Education & Self Help |
| ⊘ Entertainment | Food & Recipes | Gambling |
| Games | Government | ⊘ Hacking & Cracking |
| Health | Humor | Information Technology |
| Jobs & Careers | Media Sharing | Message Boards & Forums |
| News & Media | ⊘ P2P & Illegal | Real Estate |
| Religion | Search Engines & Portals | Shopping |
| Social Networking | Sports | Streaming Media |
| ⊘ Terrorism & Hate | Travel | Vehicles |
| Virtual Reality | ⊘ Weapons | Webmail & Chat |

TABLE I. TEMPLATE 1 ADRESSING SCHEME

| Address Range | # of Hosts | Subnet Name |
|---|---|---|
| 10.182.0.0 - 10.182.0.255 /24 | 256 | IT |
| 10.182.1.0 - 10.182.1.255 /24 | 256 | Faculty/Staff |
| 10.182.2.0 – 10.182.2.255 /24 | 256 | Reserved |
| 10.182.3.0 – 10.182.3.127 /25 | 128 | Health |
| 10.182.3.128 – 10.182.3.255 /25 | 128 | Admin |
| 10.182.4.0 – 10.182.7.255 | 1024 | Students |

TABLE II. TEMPLATE 2 ADRESSING SCHEME

| Address Range | # of Hosts | Subnet Name |
|---|---|---|
| 10.138.0.0 - 10.138.0.127 /25 | 128 | IT |
| 10.138.0.128 - 10.138.0.254 /25 | 128 | Reserved |
| 10.138.1.0 - 10.138.1.127 /25 | 128 | HR |
| 10.138.1.128 - 10.138.1.254 /25 | 128 | Marketing |
| 10.138.1.128 - 10.138.1.254 /25 | 512 | Finance |

Fig. 5 shows how the network functions. To connect to the respective networks a user first connects to the virtual private network (VPN). After connecting to the VPN, the *OpenVPN* access server redirects the connection into the organizations network and assigns the user an IP address based on what subnet their login is a member of. For example, a student in the school would be assigned an IP address from 10.182.4.0 to 10.182.7.255. Once assigned an IP address, the host should be able to access the domain. Once the user connected to the domain, they are subject to all the organizations policies and has access to the file server.

## C. Security

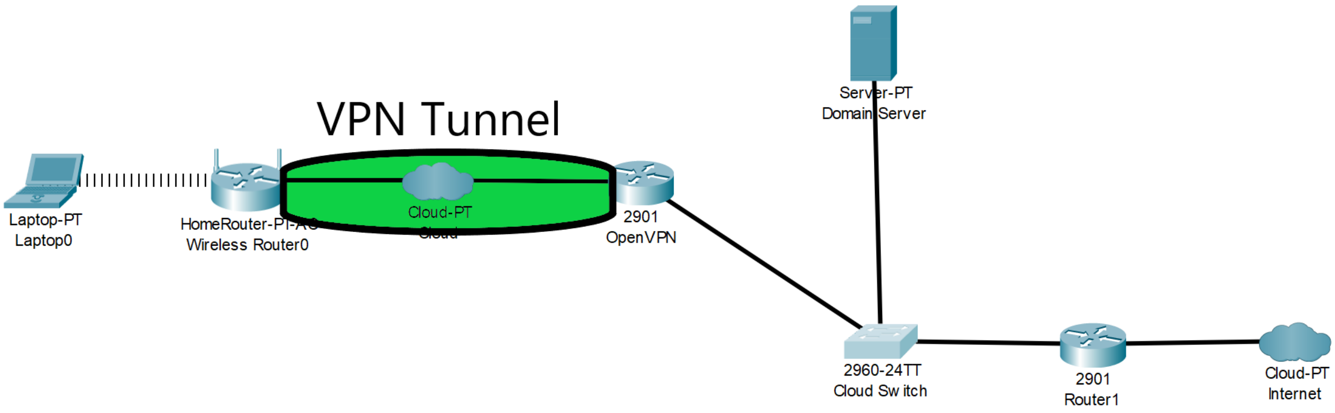
Security was one of our main concerns when designing each template. Each business type has different security standards they need to follow. For example, the school template needs to follow the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and the Family Educational Rights and Privacy Act (FERPA) standards for student data security. HIPPA states that only those authorized to access student health records should have access, and FERPA states that only those who are authorized to access student education records should have access. For the financial template, we had to follow the guidelines for the Gramm-Leach-Bliley Act, an act meant to keep company customer financial data secure. We aimed to meet these standards by creating rules on the domain's fileservers so only accounts with permission can access sensitive data.

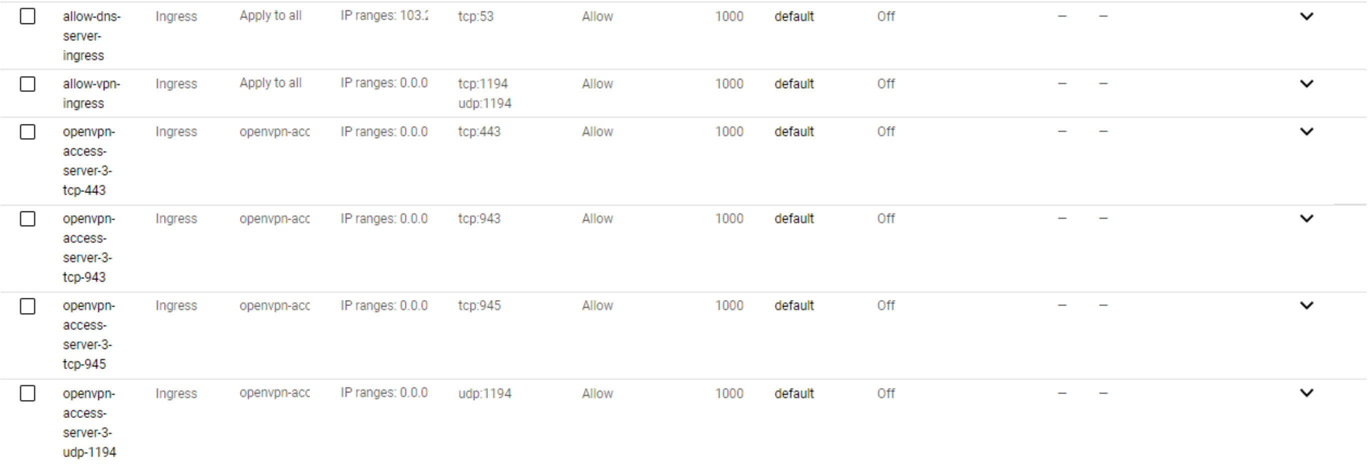
We also set up additional security features to ensure attackers cannot gain unauthorized access to the cloud network. To do this we utilized VPC security features to make our own firewall on the cloud with custom security rules based on port number. The firewall rules are set up to allow common services that will be used on the network, such as Hypertext Transfer Protocol (HTTP), Hypertext Transfer Protocol Secure (HTTPS), and DNS. Services such as telnet and Simple Network Management Protocol (SNMP) which are considered security risks are blocked. As shown in Fig. 6, these rules are applied at the entry point of the cloud network and are configured so they apply when traffic enters the network (Ingress) or when it leaves the network (Egress).

We also implemented a feature of *Google Cloud* called *Cloud IDS* that enables an intrusion detection system (IDS), which detects any malicious traffic on the network. *The Cloud IDS* feature is powered by the *Palo Alto Networks* IDS technology, in which they provide the data to determine what traffic on the network is considered malicious and categorizes that malicious traffic into separate threat levels.

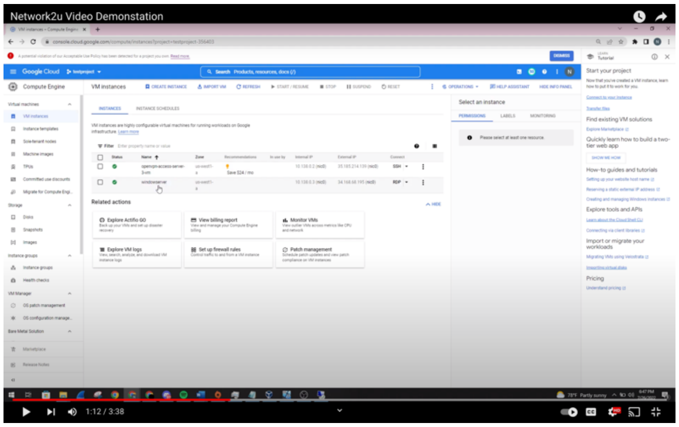
## D. Wireless Simulation

To simulate what a secure wireless network could look like for one of our businesses we used a *TP-Link Archer C50 AC1200 Wireless Dual Band* router and implemented best security practices lists in the Evaluation of Wireless Access Point Security and best practices for mitigation paper [5]. The goal was to setup a wireless network that was low cost, easy to maintain, and discourages attacks. We did this by changing the default credentials, using Wi-Fi Protected Access 2 (WPA2), and hiding the network so it could not be easily discovered by





| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| □ | allow-dns-server-ingress | Ingress | Apply to all | IP ranges: 103.: | tcp:53 | Allow | 1000 | default | Off | – | – | ⌄ |
| □ | allow-vpn-ingress | Ingress | Apply to all | IP ranges: 0.0.0 | tcp:1194<br>udp:1194 | Allow | 1000 | default | Off | – | – | ⌄ |
| □ | openvpn-access-server-3-tcp-443 | Ingress | openvpn-acc | IP ranges: 0.0.0 | tcp:443 | Allow | 1000 | default | Off | – | – | ⌄ |
| □ | openvpn-access-server-3-tcp-943 | Ingress | openvpn-acc | IP ranges: 0.0.0 | tcp:943 | Allow | 1000 | default | Off | – | – | ⌄ |
| □ | openvpn-access-server-3-tcp-945 | Ingress | openvpn-acc | IP ranges: 0.0.0 | tcp:945 | Allow | 1000 | default | Off | – | – | ⌄ |
| □ | openvpn-access-server-3-udp-1194 | Ingress | openvpn-acc | IP ranges: 0.0.0 | udp:1194 | Allow | 1000 | default | Off | – | – | ⌄ |



wireless scanning applications. We tested security by conducting a cracking attack using *aircrack-ng* and *Kali* Linux, which was successfully unsuccessful. When testing we discovered that the setup we used worked well and was a good simulation of what the average business's wireless network would look like in a real-world setting.

## IV. Conclusions

Our *Network2U* provides two business templates – school and finance company. We showed how *Network2U* templates met basic networking, system, and security requirements. Since we used GC, our templates can be implemented onto a production environment by just coping GC Project. The templates can be easily modified to meet the specific needs of each business. The network effectively allows for communication with devices in and outside of the network. The Windows server provides all necessary services for the users of the network to effectively do their work. The security on all aspects of the network is strong to prevent attackers from gaining access to the network and its resources. As shown in Fig. 7, *Network2U* provides a video demonstration via *YouTube* [6]. Since our templates provide the basics needed to run the network, the only expenses would be standard cloud computing costs, hiring someone to manage the network, and the initial low-cost purchase of the template. To expand on this product in the future, we would create more templates and flesh out the security features of the current ones.

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