Cyber

Security

***Networking Concepts and Cyber Security***

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# Introduction

Australian National University (ANU) is a national university locate in the capital of Australia. The first attack initiated in November 2018, leading to illegal access of the administrative system. Forensic evidence showed that high volumes of personal information were copied out of the systems. The estimated number of victims is over 200,000 people, including students and staff turned over during the past 19 years. In the following 8 domains, we will see what the role of each domain in cyber security is, and how each of them will benefit ANU, as well as the downsides when implemented.

**COMMUNICATION AND NETWORK SECURITY**

Securing your network is what network security is all about. In the case of ANU data breach, hackers monitored and captured the network traffic throughout the campaign, they got an overall view of how ANU’s computer network operated. Securing network components is critical to prevent this event.

Secure network components are the hardware and software elements of a network that protect the network from unauthorized access, malicious attacks, and data breaches. There are so many essential components like network firewall, it acts as a gatekeeper between enterprises’ private network and public network (*Dynamic Solutions Group, 2021*). An intrusion detection system (IDS) detecting potential threats in real-time network traffic monitoring (*Dynamic Solutions Group, 2021*). An intrusion protection system (IPS) is similar to IDS but can also take action to block malicious traffic. Moreover, a network access control (NAC) prevents unauthorized users and devices from gaining access to corporate networks (1). Finally, security information and event management (SIEM), its role is to collect, aggregate and store log data from those sensors stated above (*Dynamic Solutions Group, 2021*). Network security follows a principle of the CIA, and aims to preserve confidentiality, integrity and availability (*Palo Alto Networks*). Confidentiality - reject unauthorized entities that want to get into assets. Integrity - make sure that data is correct and modified in an unauthorized way, and Availability - ensure that authorized users always have access to data if they need (*Palo Alto Networks*).

As previously stated, network security prevents illegal access, meaning it can keep sensitive information safe. In fact, ANU’s scheduled firewall interrupted the attackers once, even though they found a foothold in a legacy computer right after that (*Stephanie, 2019*). A secure network also has accessibility levels, the authentication will determine which level in software the user is authorized to access. The first campaign was initiated in November 2018, and they only spotted the intrusion in April 2019. By strengthening the network security compensating safeguards for legacy servers by intrusion detection or prevention security appliances, ANU could have spotted the suspicious action earlier.

Anything has downsides, installing network security solutions undoubtedly costs more. However, security is important so it must not be overlooked by any chance. Highly trained experts are also necessary to deal with any security problems in a huge network. A network administrator is needed for a network to run well, and to meet the criterion, he must be properly trained.

In conclusion, securing a network is a critical task, it involves many components undertaking different tasks. Implementing and improving network security may have prevented data leaks at the ANU.

**IDENTITY & ACCESS MANAGEMENT**

Identity and management access (IAM) helps manage and secure access to organizations’ resources *(Microsoft).* This domain aims to give the right range of access to the right people so wrong people, like hackers, are not allowed to enter. Each subdomain inside this domain is in charge of a securing task, for example, conducting access restriction measures. However, this report will only focus on Managing identification and authentication of people, devices, and servicessub-domain.

Digital identity is the primary key to gaining access to any resources as it contains users’ information. Managing identification focuses on the processes and mechanisms involved in verifying the identity of individuals, devices, and services within an organization. On the other hand, authentication management includes the management of user accounts, authentication methods, and access control policies.

In ANU data breach, attackers had access to the university’s infrastructure through credentials, gained from spear-phishing emails, of people with high levels of access. Thus, the university can prevent this by increasing the level of identity and device authentication with access control services. This service includes identification, authentication, authorization, and accountability. Identification is the first step of the access control process, which asserts the identity of users based on its guideline *(Witcher, 2023)*. The following step is to verify identity, three factors of single-factor authentication are based on: knowledge (password), ownership (OTP), characteristics (fingerprint). Some multifactor authentication (MFA) solutions organizations can consider are implementing protocols, like Kerberos or SESAME, and using CAPTCHA. However, some hackers might be able to get over the authentication mentioned above, so additional session management is suggested *(Witcher, 2023)*. This helps manage users’ action and detect illegitimate users, and a method to terminate the session is using frequent re-authentication.

Implementing those security measures benefits organizations in many ways. First, the MFA enhances protection for the university in general and for each student, faculty as well *(Winbuzzer.com, 2021)*. It also includes a warning system to alert possible breaches so a defensive solution can be made on time. Secondly, re-authentication makes sure that the user remains the same person after a period of time so hackers can’t access the resource even if the user forgets to logout. Moreover, it includes stronger authentication policies and helps eliminate the threat of on-premises security.

To conclude, ANU's data breach, identity and management access framework, will play an important role in strengthening the security of the university’s resources. Although measures in managing identification and authentication have both pros and cons, considering the results after using this method, its advantages outweigh its drawbacks.

**SOFTWARE DEVELOPMENT SECURITY**

When developing any system, developers must go through a process of planning, creating, testing, and deploying that system, it is called Software Development Life Cycle (SDLC). It is essential to apply security in SDLC, which focuses on the protection of programs against attacks that exploit vulnerabilities in them (*Assal and Chiasson, 2018*). Security in developing and maintaining software is not a reason that caused the data breach, but still essential in any enterprise.

To be truly secure and being the most effective, security must be planned and initiated in every stage of SDLC. That being said, Secure Software Development Life Cycle is the most important topic when it comes to security of software.

On one hand, eliminating vulnerabilities in a program improves safety, minimizes risks and prevents further issues. Enhance efficiency and speed of development and operations release cycles.

On the other hand, securing the SDLC obviously increases the time and cost of the project. SDLC also needs technical expertise in security, coding, and testing (*Intellect Soft, 2019*). However, both downsides are too little compared to how important the security of the program brings.

In conclusion, security in software development did not directly affect the ANU data breach but is still important to the university to strengthen security and prevent further data breaches.

**ASSET SECURITY**

Asset security includes the concepts, structures, and standards of securing and protecting valuable assets from unauthorized access. It involves instituting security measures and controls to protect assets and guarantee their availability, integrity, and confidentiality. In this domain we are going to look through asset classification. (*Infosec Resources*)

Assets classification is based on sensitivity, criticality, and the degree of protection required to ensure their security. According to Queensland law, every university must adhere to the Information Privacy Principles. There are various classifications depending on the organization, but we should focus on Information assets. Every part of institutional information must be categorized into one of three sensitivity levels: public, internal and restricted. Basically, public information like accessible websites or promotional materials is permitted and does not contain sensitive or proprietary information. Next is internal, assets for internal use within the organization may contain sensitive or proprietary information. Access to these assets is limited, examples include internal documents, non-public financial information. Last is restricted information, which is extremely sensitive or secret. Unlike the 2 previous classifications, access to these assets is tightly controlled, and they require stringent security measures. (*Infosec Resources*)

Pros of asset classification is enhanced security. Asset classification helps improve security and protection by separating into different types of information (public, internal and restricted).

On the other hand, it also has drawbacks, which are insider threats. Authorized users with access to classified assets may nevertheless inadvertently or willfully abuse their credentials.

For the ANU attack, basically after reaching the university’s system, they went into each classification, everything has been cracked. Data encryption should be added to enhance security and mitigate risks. It means adding another layer of protection, even if attackers gain access to the data, they won't be able to read or utilize it without the decryption key.

**SECURITY ASSESSMENT AND TRAINING**

Security assessment and training are essential cybersecurity procedures that assist businesses in identifying vulnerabilities, evaluating risks, and enhancing their overall security posture.*(Smith, n.d.)*

There are two sub-domains that we need to focus on are vulnerability assessment and penetration testing. Conduct regular vulnerability assessments to identify weaknesses in systems such as vulnerabilities or misconfigurations (*Umrao et al., 2012*). Organizations may proactively detect and remedy security flaws before attackers take advantage of them by regularly conducting vulnerability assessments. This enhances overall security posture, lowers the possibility of security events, and safeguards sensitive data and priceless assets. Penetration testing, also known as ethical hacking, uses the same tool as vulnerability assessments but adds attack techniques where an assessor tries to penetrate the system by utilizing weaknesses. A few strategies that may be employed in this are war dialing, sniffing (monitor the network), eavesdropping (listening), dumpster diving, social engineering (human manipulation). The difference between these two methods is that vulnerability assessment is a high-level, automated evaluation that identifies and reports possible weaknesses whereas  penetration test is a comprehensive, hands-on examination conducted by an actual individual to identify and exploit system vulnerabilities. (*Glover, n.d*.)

Pros of vulnerability assessment and penetration are identifying almost all known vulnerabilities and demonstrating at what depth vulnerabilities can be exploited. With this, organizations can define attack range, reduce or eliminate the vulnerabilities and weaknesses of resources are now potential targets for hackers. Weakness of these methods can have a high false positive rate and be easily detected by the Intrusion Detection System firewall (*Umrao et al., 2012*).

We all know that the security systems of ANU are extremely strong, but no one had expected that a single preview of an email could cause a cyber-attack. We all understand that clicking a link can lead to cyber-attack, but no one could aware that only viewing it can also be bad. Based on my analysis, ANU did not have enough vulnerability assessment  and penetration testing for cases like this. It was just a small space that the hacker could totally access to ANU systems for half a year. To enhance this, ANU and other companies or organizations should improve their cybersecurity audit model (CSAM) and improve interpretability for vulnerability assessment and emulate more real-world attack scenarios. Or in my perspective one more way is to collapse with an external red team or ethical hackers to have their view of hacking.

**Security Architecture and Engineering**

Security Architecture and Engineering focuses on the design, implementation, and management of security systems and infrastructure. It covers topics such as security models, architectural frameworks, and secure system design principles. This domain aims to ensure that security is built into every aspect of ANU’s systems and infrastructure, from design to implementation and ongoing management.

During the process of building an environment, in this case Enterprise Systems Domain (ESD), organizations often need to purchase products from vendors. It is crucial that these products are well-designed and meet the required functionality. Consumers should consider various evaluation criteria, including certification and accreditation. Common Criteria (ISO 15408) is a widely used evaluation standard that enhances trust between customers and vendors in the field *(Intertek)*.

As systems become increasingly sophisticated, vulnerabilities are inevitable. One such vulnerability is single-point-failure, where the failure of a single component can result in system-wide failure or compromise its security *(Kirvan, 2021)*. This risk can be mitigated by implementing redundancy, where backup components or systems are in place to ensure continuous operation in case of failure.

Another vulnerability arises when large amounts of data are placed in one location, leading to the risk of unauthorized inference. To address this, the concept of polyinstantiation can be employed. Polyinstantiation allows different versions of the same information to exist at different classification levels *(Taylor, 2020)*. This means that even if attackers gain access to the database, the information they see might not reveal the complete data, reducing the risk of data loss.

SQL injection is one of the common risks of web servers. In a web application, SQL commands are sent to a backend database to verify user identity and retrieve or store data. Attackers exploit SQL injection by passing malicious SQL commands through input fields *(Witcher, 2023)*, potentially gaining unauthorized access to the database. Input validation is the solution to this problem. The server should validate and sanitize user input by removing special characters or spaces, and never allow direct execution of SQL code.

Redundancy strengthens security by allocating systems across different locations, making it challenging for attackers to find vulnerabilities since each one is different *(Zalox, 2022)*. Polyinstantiation is a suitable strategy for limiting unauthorized access therefore enhancing data security and preventing data loss *(Taylor, 2020)*.

Although these are all security measures, there are a few problems when it comes to putting these methods into use. Additional costs might be added not only for the duplicate products used for redundancy but also for maintenance. Furthermore, the implementation process is also more challenging due to its complexity.

Considering certification, and accreditation, addressing single-point failure through redundancy, implementing polyinstantiation for data protection, and employing input validation for mitigating SQL injection, even if they are high in cost, are essential in establishing a secure environment and protecting against potential threats.

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