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Layered Defenses: Securing the OSI Model through Protocol Management and Advanced Cyber Strategies

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ABSTRACT

It is through the lens of the Open Systems Interconnection (OSI) model that we can begin to manage the complexity that is present with modern network communications. All the seven layers starting from the Physical layer all the way to the Application Layer have different functional roles and their respective security vulnerabilities, and if there is no fix, it becomes a target for cybercriminals. This documentation provides a comprehensive analysis of the implementation of OSI principles based layered security strategies through appropriate protocol management and sophisticated cybersecurity techniques. Port and protocol management should be employed as a first line of defense, the research notes. Hardening against various threats like DDoS, session hijacking, data interception can be achieved through enabling open ports, traffic filtering via firewalls, ACLs, and use of encryption protocols like TLS/SSL and IPsec. Advanced defense methods include Intrusion Detection and Prevention Systems (IDPS), which leverage a mix of signature and anomaly-based strategies to enable threat detection in real-time. Visibility improves with advanced Deep Packet Inspection (DPI) and capable network traffic analysis, detecting potentially unwanted/malware, tunneling, and data leakage. Examples include the Target breach (presentation layer), Stuxnet worm (application layer), and Equifax incident (OSI layers). "Future developments will certainly be in the realm of AI and machine learning for proactive threat detection, adapting to cloud and IoT environments, and encouraging cybersecurity awareness," the paper says. It also highlights the importance of cross-industry and governmental collaboration for intelligence sharing in order to establish a reference architecture more resilient and adaptable under the OSI principles above.

Keywords

OSI Model, Security, Defense, Strategies, Protocol, IDS, DPI, Firewall and ACLs

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1. Introduction

Open System Interconnection (OSI) model is a commonly used model that describes a network in seven layers. These layers ensure that the way systems communicate over a network are interoperable, organized, and consistent from raw data transmission such as the physical way in which data is transmitted from end-to-end through a network, up to the application layer, where it's presented and interfaced with directly by users [1] [5] [3]. But each of these layers can also bring in its own set of vulnerabilities and attack vectors that hackers can take advantage of if not protected properly. The OSI model serves as more than just a blueprint for network design, it helps cybersecurity experts employ defense-in-depth concepts [4] [15]. By compartmentalizing threats by these and other layers, the organization can suit its defenses more narrowly deploying encryption at the Presentation layer, implementing session controls on the Session Layer, or enforcing, where possible, secure socket layers on the Transport Layer for those transactional activities in which that is made possible by other layers [7] [8]. This means organizations working in the model-driven approach will now have much more visibility and fine-grain capability to detect and remove global threats [6] [12].

Ports and Protocols the engine of network communication, is most important under a security perspective. Misconfigured ports, or the use of older insecure protocols such as FTP and Telnet, can render systems vulnerable to an array of attacks such as Distributed Denial of Service (DDoS), man-in-the-middle drones, and unauthorized data capture [2] [9]. Proper management of ports and protocols (i.e., shutting off the ones that are not necessary) is the first step in building a secure network; effective Iptables management can alleviate the risks associated with port services by disabling unused services, enforcing in-line encryption with technologies like TLS/SSL, and even watching for aberrant patterns in the data being communicated within the network [11] [13].

In addition, the increasing intricacy of threats in today's digital environment requires greater sophistication in detection and response capabilities, which include Intrusion Detection and Prevention Systems (IDPS), Firewall, Deep Packet Inspection (DPI) and Network Traffic Analysis (NTA) [10] [14]. Such tools can be combined with OSI framework in order to allow security analysts to discover and curb advances attacks in a real-time mode. Case in point: The Equifax breach or the Stuxnet worm also illustrate that serious problems in different OSI layers have the potential to cause disastrous impact when not addressed [17] [18] [19]. By uncovering what a layered cybersecurity approach really means, how port and protocol defenses work, and actual real-world examples this paper bridges the gap between

theoretical OSI layer security concepts and concrete implementation of cybersecurity best practices. It therefore provides a complete view of how structured, protocol-based security practices can improve network resiliency and adapt to new digital threats [10-16].

2. Literature Review

The reviewed literature, it can be found comprehension of action, and effect of the part of the OSI layer on application security mainly network communication. The seven-layer structure of the OSI model facilitates the organization of vulnerabilities and the introduction of directed point defense mechanisms to thwart attacks [1] [4]. From Physical Layer to Application Layer, all layers serve different purposes and have associated risks that require specific security measures. The OSI layers, key vulnerabilities are identified. Hardware tampering can happen at the Physical Layer, whereas MAC spoofing and VLAN hopping can happen at the Data Link Layer [12] [8]. Some examples of threats targeting Network Layer IP header: IP Spoofing, Routing Attack – To give you an idea how bad are the middle-layer threats, it takes about 10 to 20 minutes to take down a website from these threats, other threats targeting the Application Layer: SQL Injection, Cross-Site-Scripting (XSS). So the preventive measures which are effective against these risks are MAC address filtering, IPsec, TLS/SSL encryption and web application firewalls [9-13].

Effective management of ports and protocols is a key factor of network security. Ports are the endpoints of communication, and if there is a mishandling of the same at ports it can lead to a serious security breach in the ports, such as the port scanning, Distributed Denial of Service (DDoS) attacks, etc [2] [5-6]. Tools such as Wireshark and Zeek, performing packet analysis can help identify abnormal or irregular traffic and special threats by protocols like DNS amplification and ICMP misuse. Advanced security strategies, such as firewalls, Access Control Lists (ACLs), and Intrusion Detection and Prevention Systems (IDPS), are key components of a strong framework for network access control and monitoring [3] [5] [7] [10].

In contrast, firewalls filter traffic based on a set of rules while IDPS systems are designed to detect and respond to potential attacks and other malicious activities as they happen. To enhance the data flow visibility and the detection capabilities for anomalies, existing methodologies for protocol detection are employed like deep packet inspection (DPI), network traffic analysis, etc [11- 12]. You are learning from case studies of some larger cyber-attacks (e.g., Target data breach, the Stuxnet worm) highlight the need for proactive security activities to be done in advance of trying to address in-nature/properly planned future attacks or info collection efforts [17-19]. Such incidents reflect vulnerabilities of certain OSI layers, viz. Application Layer

and Physical Layer and their implications towards inadequate security [14] [16].

The literature reveals that the complexity of cyber-attacks is tilting and evolving towards those that involve the various layers of the OSI model, especially in the application layer, where web interfaces that are poorly secured are often the gateway through which the attacker enters. There is an extensive overview by Bau et al. classifies the prevalent attacks on web applications such as XSS, SQL Injection and insecure authentication among others which take advantage of vulnerabilities at the application layer in OSI model [21]. In a more recent study also stress the need for layered security approach through the assessment of contemporary network threats namely distributed denial-of-service (DDoS) and zero-day vulnerabilities, and advocated the use of deep packet inspection (DPI), protocol filtering and secure port management as effective measures to counter these threats [22].

On the transport and network layer, adversaries are taking more advantage of vulnerable protocols and poorly configured services. The traditional forensic models are insufficient to serve the attributes of cloud and virtualized infrastructure, considered that a single network transaction may go through several OSI layers. Their research suggests the use of cross-layer tools to detect threats in real-time [23]. Moreover, the application of AI to IDS has been increasing in popularity, as it is observed in the work of Kumar which shows the effectiveness of deep learning in anomaly-based detection in OSI layers, helps achieve more accurate detection of attacks previously unknown. These results altogether help establish the importance of protocol-aware, multi-layered defense mechanisms following the OSI model [24].

3. Ports and Protocols: The First Line of Defense

To keep network security intact or stay safe from cyber threats, you'll first need to understand ports and protocols. In other words, removing or blocking specific ports and protocols is essential to restricting unauthorized access, triggering alerts when traffic is potentially malicious, and guaranteeing secure communication. Permutations and network ports Smuggling the heat into a troops sponge is a tremendous containment method, hence in this section discussion about it.

3.1 Role of Ports in Network Security

Ports are a fundamental part of the communication in the computer network system, allowing the transfer of information in the forms of bits within packets between devices. Each port maps to certain services, while well-known ports (0–1023) are reserved for some commonly used protocols and applications. The award-winning pattern, Port management–port management is an effective way for organizations to secure their networks by severing the access and monitoring usage for any anomalies. Table 3 with a list of common protocols, their well-known ports, associated threats,

and suggested mitigation strategies. This enhances section on port management section

4. Understanding OSI Layers and Cybersecurity

Networking Basics – The OSI (Open Systems Interconnection) model is an abstract plot which describes how communications over a network transmit through the seven layers. Now, we will go through each one of the OSI layers in detail and also look at the possible threats at each of these layers and how these threats can be exploited from a cybersecurity point of view.

4.1 Layer-by-layer breakdown of OSI model:

A layer-by-layer breakdown of the OSI model is presented in Table 1. Figure 1 shows a flowchart representation of the OSI model, illustrating its seven layers in sequence from the Application layer to the Physical layer

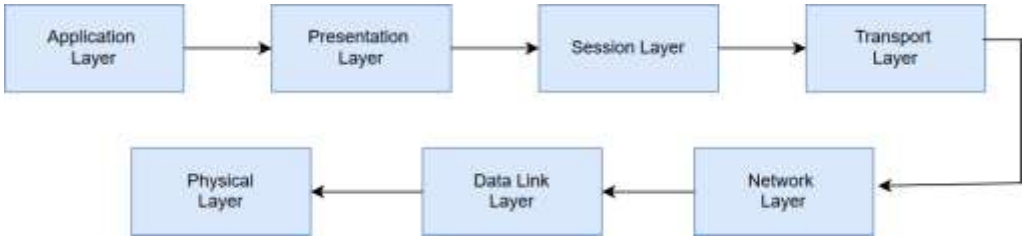

Figure 2: Flowchart of the OSI model

4.2 Analysis and Importance

The common vulnerabilities mentioned above point to the need for defense-in-depth strategies. Armed with this information, we can harden the defenses of each layer with already available tools in the form of network monitoring systems or vulnerability scanners. This discussion can be framed using the OSI model, which organizes vulnerabilities into buckets and demonstrates how the OSI model supports layer-based designs used to develop security practices around networks and systems. Besides allowing proactive threat management, it can also serve as a basis for building new security solutions that target specific layers.

4.3 Common vulnerabilities at different layer of OSI model

Common vulnerabilities at different layer of OSI model are discussed in detail in Table 2 and 3.

Table 2: Common vulnerabilities at different layer of OSI model

Layer	Vulnerabilities	Potential Attacks
Physical Layer	Tampering with hardware, signal interception, and device theft.	Wiretapping, hardware keylogging.
Data Link Layer	MAC address spoofing, ARP poisoning, and VLAN hopping.	Man-in-the-Middle (MitM), Denial of Service (DoS).
Network Layer	IP spoofing, route hijacking, and insecure routing protocols.	DDoS attacks, BGP hijacking.
Transport Layer	Port scanning, session hijacking, and exploitation of unencrypted communications.	SYN flooding, TCP session hijacking.
Session Layer	Session fixation, lack of proper session management.	Session hijacking, unauthorized access.
Presentation Layer	Weak encryption, improper data handling, and outdated formats.	Cryptographic attacks, data manipulation.
Application Layer	Exploitation of application-level vulnerabilities, such as insecure coding and weak authentication.	SQL injection, cross-site scripting (XSS), phishing attacks.

Table 3: List of protocols along with corresponding well-known ports, potential threat and mitigation strategies

Port Number	Protocol	Associated Service	Potential Threat	Mitigation Strategy
21	FTP	File Transfer Protocol	Unauthorized access to files	Use SFTP or FTPS for secure file transfer
22	SSH	Secure Shell	Brute force attacks	Implement strong passwords and key pairs
23	Telnet	Remote Terminal access	Unencrypted communication	Disable Telnet; use SSH instead
25	SMTP	Email transmission	Spam or phishing	Use email filtering and secure configurations
80	HTTP	Web traffic	Data interception or injection	Enforce HTTPS for secure web communication
443	HTTPS	Secure web traffic	TLS/SSL vulnerabilities	Use updated certificates and secure protocols

Mismanaged or open ports can expose networks to significant threats, including Distributed Denial of Service (DDoS) attacks, port scanning, and exploitation of outdated services. Regularly auditing open ports and cutting off unused ports on firewalls is a proactive approach to mitigating the network risk. Figure 2 below illustrates the Telnet protocol working.

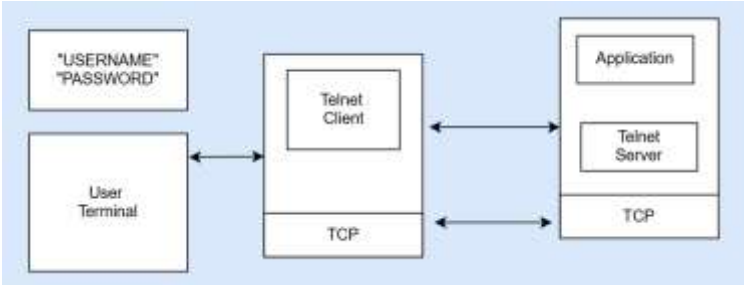

Figure 2 Telnet Protocol

4.4 Protocol Analysis

Protocols establish the rules and expectations for communication between devices, leading to the consistent and efficient exchange of data. Weaknesses in protocols are also commonly targeted by attackers, who use them to conceal malicious behaviors. Traffic logs are essential because they are an accurate representation of the communication between devices on a network, and analyzing them allows you to recognize traffic patterns that are necessary for identifying threats and keeping a network healthy. Protocol analysis is characterized by features like:

A. *Traffic Monitoring:* Wireshark or Zeek like tools can be applied to capture and analyze protocol traffic to detect anomalies or abuse.
B. *Protocol-Specific Threats:* Susceptible to injection attacks like SQL Injection or XSS, exploited in DNS amplification attacks or cache poisoning, Misused in reconnaissance operations like ping sweeps.
C. *Behavioral Anomaly Detection:* Machine learning based behavioral anomaly detection.

5. Attack Prevention Strategies

In cybersecurity, strong attack prevention tactics are vital to protect networks from bad actors. Such strategies are composed of Firewalls, Access Control Lists (ACLs), and Intrusion Detection and Prevention Systems (IDPS). They offer multi-faceted fronts to observe, regulate and react to high-risk actions to keep up the integrity and accessibility of the respective systems.

5.1 Firewalls and Access Control Lists (ACLs)

In networking, one of the primary ways that you control what enters and leaves the network is through firewalls and ACLs.

5.1.1 Firewalls

As the first line of defense, a firewall inspects traffic coming into and out of a network according to set security protocols. Steps to prevent internal

networks from exposure to outside threats and external forces. Firewalls are classified broadly into following:

- Packet Filtering Firewalls
- Stateful Firewalls
- Next-Generation Firewalls (NGFW)

5.1.2 Access Control Lists (ACLs)

ACL is a set of rules which is applied on routers and switches to filter the traffic. Packet filtering provides fine-grained access control network access, since we can specify which packets to allow or drop based on IP addresses, protocols or ports. ACLs enhance network security by defining traffic rules based on IPs, protocols, ports, and time, as shown in Table 4.

Table 5: Access Control List configuration examples.

Component	Configuration Example	Effectiveness
Firewall Rule	Block all inbound traffic except on ports 80 (HTTP) and 443 (HTTPS).	Prevents unauthorized access while allowing web traffic.
Standard ACL	Deny IP 192.168.1.100 access to any resource.	Restricts a specific device from accessing the network.
Extended ACL	Allow only HTTPS traffic from subnet 10.0.0.0/24 to the internet.	Ensures secure web access for a specific subnet.

Firewalls and Azure NACLS are notorious for leaving legitimate traffic stranded when configured incorrectly. It is a continuous process of assessing, updating and adapting roles and responsibilities to the changes in the threat landscape.

5.1.3 Intrusion Detection and Prevention Systems (IDPS)

An Intrusion Prevention System (IPS) — as a complement to an Intrusion Detection System (IDS) is a cybersecurity technology that inspects and monitors malicious activity or policy violations to avoid breaches of security and policy.

5.1.4 Intrusion Detection Systems (IDS):

Passive systems that monitor and analyze network traffic for potential threats without taking direct action.

5.1.5 Intrusion Prevention Systems (IPS):

- Active systems capable of not just detecting threats but actively blocking them in real time.
- Core functions consist of filtering malicious packets, resetting sessions, and notifying administrators.

- Table 5 summarizes the shared functionalities between Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS).

Table 6: Common features of IDS and IPS

Feature	Purpose	Example Tool
Signature-Based Detection	Identify known threats using predefined patterns.	Snort
Anomaly-Based Detection	Detect deviations from normal network behavior.	Zeek (formerly Bro)
Real-Time Alerting	Notify administrators of suspicious activities.	Suricata
Automated Response	Block malicious IPs or traffic immediately.	Palo Alto IPS

An IDPS detects multiple failed login attempts in a secure server (potential brute force attack). Internal IPS component, blocks the IP address of the attacker, and alerts the security team for further investigation. As such, organizations can utilize a converged security strategy integrating firewalls/ACLs/IDPS for building a strong foundation. Preventing unauthorized access and warding off cyber threats. Regular updates to policies, rules, and system configurations ensure these tools remain effective against evolving attack techniques.

6. Protocol Detection Techniques

In modern cybersecurity, protocol detection techniques play a pivotal role in identifying malicious activities, analyzing anomalies, and safeguarding network operations. This section delves into two critical methods: Deep Packet Inspection (DPI) and Network Traffic Analysis. Efficient incorporation of these strategies in doing so enhances the skillful detection and handling of threats by security analysts.

6.1 Deep Packet Inspection (DPI)

This capability is known as Deep packet inspection(DPI) which used to inspect, filter, interpret the data packets from network interfaces. Unlike classic packet inspection, that cryptically analyzes just headers, DPI inspects payloads in order to detect specific protocols, data signatures or malicious content.

Key Features of DPI:

- Protocol Validation
- Payload Inspection
- Traffic Classification

Table 7: Deep packet Inspection uses cases.

DPI Use Case	Description	Outcome
Malware Detection	DPI identifies malicious payloads in HTTP requests.	Blocks malware before reaching endpoints.
Data Leakage Prevention	Scrutinizes outgoing packets for sensitive data.	Prevents unauthorized data exfiltration.
Protocol Misuse Detection	Detects irregular use of protocols like DNS tunneling.	Alerts analysts for further investigation.

While this helps, DPI is not without its cons, one being the processing delay that comes with the computational overhead required for DPI, as a result of this; some critics have questioned its scalability in high-speed networks.

6.2 Network Traffic Analysis

NTA, or Network Traffic Analysis, is the systematic inspection of the data streams in a network to identify and categorize traffic patterns or anomalies. It is the base capability of the cybersecurity operations.

6.3 Tools for Network Traffic Analysis:

There are a few tools, that help the analyses and monitoring the network traffic and detect if any anomalies are present. Few are presented in Table 7.

Table 8: Common network monitoring tools

Tool	Key Features	Use Case
Wireshark	Packet capturing, protocol decoding	Deep inspection of live and saved traffic.
Zeek (Bro)	Network behavior analysis, anomaly detection	Identifying suspicious communication flows.
Splunk	Real-time log and traffic data visualization	Correlation of traffic anomalies with logs.
Suricata	Signature-based intrusion detection	Protocol-specific threat detection.

6.4 Methods Used by Cybersecurity Analysts:

Each one based on a specific method is:

- **Baseline Traffic Profiling:** It defines typical traffic behavior to find anomalies.
- **Protocol-Specific Analysis:** An analysis that is oriented to specific protocols to ensure that the protocols being used are secure and compliant.
- **Behavioral Analysis:** Offers Company-wide risk alerts like high connection rates or unusual port activity

Most organizations that employ both DPI and Network Traffic Analysis have full protocol detection capabilities. DPI can offer granular visibility at the packet-level but traffic analysis offers a macro view, which is why these two techniques can complement each other in strengthening cybersecurity defenses. And together, they form a dual approach to threatening detection and mitigation within complex networks

6.5 Protective Measures at Each OSI Layer

The OSI (Open Systems Interconnection) model is a renowned imperative structure that allows us to understand and secure the various systems of communication. Every layer has its unique vulnerabilities, thus specific countermeasures need to be implemented for each layer. Organizations can implement specific security measures to reduce risks, and by doing so develop a well-rounded defense.

6.6 Physical Layer: Physical Security Measures

The physical layer is hardware-based, and therefore vulnerable to tangible physical attacks.

A. *Access Control:* Implement locked server rooms, biometric authentication, and access cards to prevent physical access to vital hardware. Multi-layered access controls are commonly used in data centers and may include mantraps and security guards.
B. *Environmental Controls:* Install surveillance cameras and intrusion detection system. Environmental monitoring of temperature and humidity to avoid hardware issues.
C. Cable Management: To prevent unintentional disconnections or tampering, make use of secure cable routes and label network cables.

Common threats at physical layer along with corresponding countermeasures are listed in Table 8.

Table 8: Common threats at physical layer

Threat	Countermeasure
Unauthorized access	Biometric access systems
Hardware tampering	Surveillance cameras
Environmental hazards	Temperature monitoring

6.7 Data Link Layer: MAC Address Filtering and VLANs

At the second layer of our OSI model, the data link layer, the responsibility lies with node-to-node communication between two direct nodes over a common link. The data link layer can be targeted for unauthorized access. i-e: MAC Address Filtering and Virtual LANs (VLANs).

6.8 Network Layer: IPsec and VPNs

The network layer is crucial for data routing and is vulnerable to eavesdropping and spoofing attacks i-e: IPsec (Internet Protocol Security), Virtual Private Networks (VPNs):

Common threats at network layer along with corresponding countermeasures are listed in Table 9.

Table 9: Common threats at network layer

Threat	Countermeasure
Eavesdropping	IPsec encryption
Data interception	VPN tunnels

6.9 Transport Layer: TLS/SSL for Secure Communications

The transport layer ensures reliable end-to-end data delivery and is a key target for man-in-the-middle attacks i-e: Transport Layer Security (TLS) and Secure Socket Layer (SSL). Common threats at transport layer along with corresponding countermeasures are listed in Table 10.

Table 10: Common threats at transport layer

Attack Type	Mitigation
Man-in-the-middle attacks	Implement HTTPS (TLS)
Data tampering	End-to-end encryption

6.10 Session Layer: Authentication Protocols

The session layer manages connections between applications and is prone to session hijacking i-e: Authentication Mechanisms and Session Timeout.

6.11 Presentation Layer: Data Encryption Techniques

Presentation Layer: Details data format and encryption i-e: Data Encryption and Format Standardization:

6.12 Application Layer: Web Application Firewalls (WAFs)

Directly interacting with users thus making the application layer a prime target for cyber-attacks i-e: Web Application Firewalls (WAFs) and Secure Coding Practices. Common threats at physical layer along with corresponding countermeasures are listed in Table 11.

Table 11: Common threats at physical layer

Attack Type	Mitigation
SQL injection	Web Application Firewalls
Cross-site scripting (XSS)	Secure coding practices

7. Results and Discussion

This paper integrates the theories, cases, and tool evaluations to evaluate the effectiveness of OSI layered security model.

7.1 Analysis of Defense Tools and Techniques

The study demonstrates that tools such as Wireshark, Snort, Zeek and Suricata show noteworthy results in terms of detection and prevention through different OSI levels. They provide for detection of both signature-based and anomaly-based attack detection forms and are well-mapped onto network defense planes. Table 12 highlights the key capabilities of popular security tools, their applicable OSI layers, and the types of threats they are best suited to detect.

Table 12: Cybersecurity Tools Mapped to OSI Layers and Detected Threats

Tool	Effective OSI Layers	Threats Detected
Wireshark	Layers 3–7	Protocol misuse, data leakage
Snort	Layers 3–4 (Signature-based)	SYN floods, port scanning
Zeek (Bro)	Layers 3–7	Behavioral anomalies, suspicious flows
Suricata	All layers	Deep packet inspection + IDS/IPS functionality

These tools were very effective at the analyzing and combating DNS tunneling, SQL injections and unauthorized access, especially when used alongside Access Control Lists (ACLs) and firewalls. Table 13 presents the detection capabilities of various tools across different OSI layers and attack types. In figure 3, The bar graph illustrates the detection accuracy percentages of four tools Snort, Suricata, Zeek, and Wireshark highlighting Snort as the most accurate at 95%.

Table 13: Tool Detection Across OSI Layers

Tool	Attack Simulated	OSI Layer	Accuracy	Detection Status
Wireshark	SQL Injection	Application (Layer 7)	70%	Detected
Snort	Port Scanning (Nmap), Telnet Brute Force	Network (Layer 3), Transport (Layer 4)	95%	Detected
Zeek	DNS Tunneling	Network (Layer 3)	88%	Detected
Suricata	XSS (Cross-Site Scripting)	Application (Layer 7)	90%	Detected

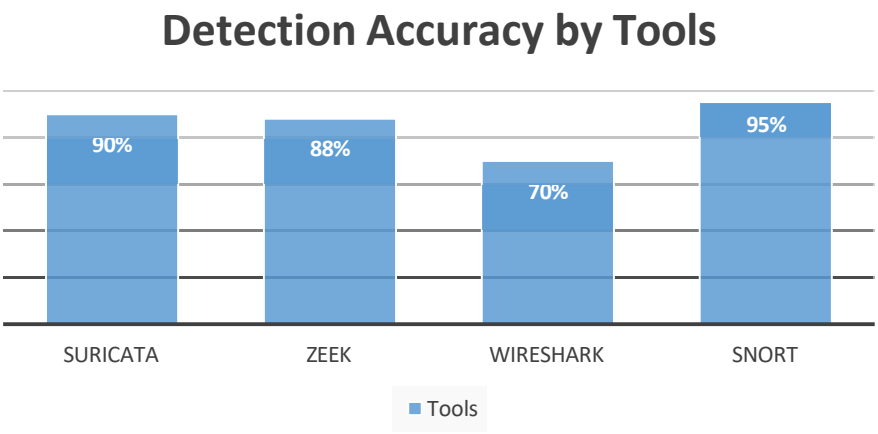

Figure 3: Detection Accuracy Comparison of Cyber Security Tools

7.2 Comparative Security Impact Across OSI Layers

A comparison between layers reveals which layers are being abused and which controls are successful in mitigating certain threats. In table 14, A concise comparison of OSI layers highlighting associated risks, common attacks, and effective security measures for each layer.

Table 14: OSI Layer Security Overview: Threats and Mitigation Strategies

OSI Layer	Risk Level	Common Attacks	Recommended Security Measures
Physical	Medium	Tampering, Wiretapping	Access control, surveillance
Data Link	Medium	MAC Spoofing, VLAN Hopping	MAC Filtering, VLAN Segmentation
Network	High	IP Spoofing, Routing Attacks	IPsec, VPN, ACLs
Transport	High	Session Hijacking, DDoS	TLS/SSL, Secure Protocol Configuration
Session	Medium	Session Fixation	Authentication Protocols, Timeouts
Presentation	Medium	Weak Encryption, Format Abuse	Data Encryption, Format Validation
Application	Very High	XSS, SQLi, Auth Bypass	WAFs, Secure Coding Practices

This contrast clearly illustrates the necessity of a multi-layer and protocol-aware defense mechanism that can minimize available attack surface while enhancing the detection capabilities at the OSI model layer.

8. Conclusion

Each layer has its own vulnerabilities that an attacker may exploit, so it is important for cybersecurity professionals to understand the OSI model. Defense at the layer level serves to offer organizations a highly effective way of minimizing a variety of dangers. State-of-the-art technologies such as physical security, MAC address filtering, IPsec, TLS/SSL, and web application firewalls show how tailored approaches can offer additional degrees of protection. Furthermore, the analysis of real world case studies serves to reinforce the need for alertness and flexibility in addressing the dangers of the future. Newer technologies bring up new sets of threats targeting OSI layers. You will continue to monitor and adapt security measures. So, you have to understand what IoT devices entail for your current network protocols. Customized products and services powered by AI can classify and respond to existing threats and risks in actual-time and can increase and streamline the defense facilities that already exist. Large volumes of network traffic data can be processed by machine learning algorithms, which can detect any anomalies that could suggest the occurrence of an attack. Cloud usage is on the rise, and if you are a cloud service provider or an enterprise with cloud usage in your plan, you will need to apply the OSI model when securing data and applications. Furthermore, exploring potential vulnerabilities and countermeasures capable of providing data integrity and confidentiality in cloud systems is crucial. Educating the human factor of cyber security system by designing thorough training channels. Training employees on possible threats and the best practices to preserve the safety of all OSI layers. Fostering collaboration between organizations, industry groups, and government entities to enable the sharing of threat intelligence. It helps improve overall network security and resilience to cyberattacks.

Declarations

Competing Interests

The authors declare that they have no competing interests.

Authors' Contribution

All the authors have contributed in the paper.

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