Mechanics in DDoS: A Study of Layer 4 and Layer 7 Threat Vectors

Mohammed Qadir Ternikar[a], Aisha Karigar[b], Niranjan Desai[c], Vanashree Nandaganve[d]
and Vaishali Y. Parab[e]
Department of Computer Science and Engineering, KLE Technological University, Dr. MSSCET Campus, Belagavi, Karnataka, India

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Abstract: Denial of Service (DoS) / Distributed Denial of Service (DDoS) attacks remain a persistent threat to network infrastructure, causing severe service disruptions and resource exhaustion. This study explores a range of DDoS attack methodologies across Layer 7 (Application Layer) and Layer 4 (Transport Layer), including advanced techniques such as Cloudflare Bypass (cfb), HTTP/2 request floods, and spoofing attacks, executed with custom Python scripts. By systematically launching these attacks on test systems, we assessed their impact on network latency, downtime, packet rates (PPS), bandwidth consumption (BPS), and resource utilization (CPU and memory). Comprehensive monitoring was conducted during the attacks, leveraging tools for real-time traffic analysis and resource tracking to capture critical performance metrics. This enabled a detailed understanding of how various attack vectors compromise system stability and degrade network performance. Our findings highlight distinct signatures and patterns associated with each attack type, providing valuable insights into their operational characteristics. This study underscores the importance of robust monitoring systems that detect and analyze attack behavior in real-time. The results serve as a reference for security practitioners to refine their detection mechanisms and response strategies against increasingly sophisticated DDoS threats.

1 INTRODUCTION

In today's interconnected digital landscape, Distributed Denial of Service (DDoS) attacks have emerged as one of the most disruptive cyber threats, targeting critical network infrastructure and online services. By overwhelming systems with an excessive volume of requests or exploiting vulnerabilities, attackers can render services inaccessible, leading to financial losses, reputational damage, and operational downtime. The increasing sophistication of DDoS attacks necessitates a deeper understanding of their mechanisms and impact. This study focuses on the practical execution and analysis of DDoS attacks using custom Python scripts, simulating real-world attack scenarios on controlled test environments. A diverse set of attack methods was employed, spanning Layer 7 (Application Layer) and Layer 4 (Transport Layer) techniques. These include HTTP and HTTP/2 request floods, Cloudflare bypass methods, spoofing attacks, and traditional UDP/TCP floods. By launching these attacks, we were able to evaluate their effects on network performance metrics such as latency, bandwidth utilization (BPS), packet rates (PPS), and system resource consumption (CPU and memory). Monitoring the network during these attacks was crucial in understanding their operational characteristics and identifying unique traffic patterns associated with each attack type. Through detailed traffic analysis and resource tracking, we aimed to bridge the gap between theoretical attack descriptions and their practical execution. The primary goal of this research is to shed light on how modern DDoS attack vectors operate and how they can be effectively monitored in real time. While mitigation strategies are touched upon, this paper emphasizes attack behaviors and their detectability through comprehensive monitoring, providing actionable insights for network administrators and security professionals. This work provides a data-driven perspective on the execution and monitoring

[a] https://orcid.org/0009-0005-1065-4774
[b] https://orcid.org/0009-0005-4281-5579
[c] https://orcid.org/0009-0001-0016-625X
[d] https://orcid.org/0009-0002-7428-3739
[e] https://orcid.org/0000-0001-7110-8906

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of DDoS attacks, which is vital for developing robust detection and response systems in an ever-evolving threat landscape.

2 RELATED WORKS

The literature on Distributed Denial of Service (DDoS) attacks highlights significant advancements in understanding attack mechanisms and developing mitigation strategies. (Singh and Gupta, 2022) conducted a comprehensive review of DDoS attacks and defense mechanisms across diverse computing platforms. Their work identified key challenges in existing detection and mitigation techniques while proposing future research directions. A notable strength of this study is its broad applicability across industries, though it lacks implementation validation. Similarly, the IJRASET publication (Author, 2022) categorized DDoS attack types and examined traditional defense mechanisms like botnet detection and network filtering. While these methods effectively mitigate small-scale attacks, their limitations against sophisticated, large-scale assaults underscore the need for advancements in AI-driven detection systems.

(Huang et al., 2022) explored a low-cost, IoT-based DDoS attack model, demonstrating how resource-constrained attackers can execute efficient assaults. The study provided insights into optimal attack strategies by introducing a novel botnet growth model, highlighting the architecture's cost-effectiveness and robustness. However, the reliance on idealized conditions limits its real-world applicability. (Kumari and Jain, 2022) extended this focus to IoT networks, offering a detailed analysis of DDoS variants and existing defenses. Their comparative evaluation revealed that current strategies perform well in controlled environments but falter against evolving attack patterns.

Further, (Aamir and Zaidi, 2022) bridged traditional and modern DDoS defenses, such as entropy-based detection and neural networks. In contrast, (Tripathi and Mehtre, 2022) classified attacks across IPv4 and IPv6 protocols, emphasizing the disruption caused by application-layer DDoS attacks. These works underscore the persistent challenges in adapting defenses to the evolving landscape of DDoS threats.

Table 1: Summary of Related Works on Attacks and Defense Mechanisms.

Authors	Focus Area	Advantages	Limitations
(Singh and Gupta, 2022)	Review of DDoS attacks and defense mechanisms on web-enabled platforms.	Broad coverage across multiple platforms; applicable to various industries.	Lack of concrete implementation or validation for proposed mechanisms.
IJRASET (Author, 2022)	Literature review on DDoS attacks, detection techniques, and prevention mechanisms.	Detailed analysis of vulnerabilities in traditional architectures.	Does not address advancements in AI-driven detection systems.
(Huang et al., 2022)	Low-cost IoT-based architecture for launching DDoS attacks; botnet growth model and optimal attack strategies.	Minimal management cost; high robustness.	Assumes ideal attack conditions, limiting real-world applicability.
(Kumari and Jain, 2022)	Study of DDoS attacks in IoT networks; comparative analysis of defense strategies.	In-depth comparative analysis of defense mechanisms.	Focuses primarily on existing methods; no new mitigation techniques proposed.

3 METHODOLOGY

This study utilized a structured approach that combined experimental testing and analysis in a controlled virtual environment. The objective was to assess the impact and characteristics of various Denial of Service (DoS) and Distributed Denial of Service (DDoS) attack methodologies by employing advanced tools and techniques. This approach allowed for precise simulations of real-world attack scenarios while maintaining an ethical and secure environment. The experiments specifically evaluated both Layer 4 (transport layer) and Layer 7 (application layer) attack techniques, incorporating modern bypass strategies and performance metrics for a comprehensive analysis of the attacks.

3.1 Research Design

The research adopts an experimental design to simulate and analyze various DDoS attack vectors in controlled environments. By deploying Python scripts tailored to execute diverse Layer 7 and Layer 4 attacks, we systematically tested the impact of these attacks on network infrastructure. Each attack type was run under pre-defined conditions to ensure repeatability and consistency. The focus was on observing system behavior, capturing network metrics, and evaluating the effectiveness of monitoring techniques.

A robust testing environment was established, including a server, network, and monitoring tools capable of capturing performance metrics like latency, packet rates (PPS), bandwidth utilization (BPS), and system resource usage. All tests were conducted in isolated setups to eliminate external interference, ensuring the results reflected the true impact of the attacks.

3.2 Data Collection

Data collection was carried out in real-time during each attack scenario. Key metrics were recorded to understand the system's response under normal and attack conditions. These metrics included:

- **Latency:** Measured as the time taken for packets to traverse between source and destination under attack.
- **Packet and Bandwidth Rates:** Monitored to evaluate the increase in packets per second (PPS) and bytes per second (BPS) during attacks.
- **System Resource Usage:** CPU and memory utilization were tracked to assess the stress induced by each attack type.
- **Traffic Patterns:** Detailed packet analysis was performed to identify anomalies in data flows during each attack.

Data was gathered using network monitoring tools and server logs. Python-based scripts were integrated with monitoring utilities to capture metrics at high granularity, enabling comprehensive post-attack analysis.

3.3 Taxonomy Of Attack

To categorize and systematically analyze the attacks, we classified them into two primary layers:

Layer 7 Attacks (Application Layer)

These attacks target the application layer, aiming to exhaust server resources by overwhelming it with requests. Examples include:

- **CFB and PXCFB:** Methods to bypass Cloudflare protections.
- **HTTP/2 Requests:** Exploiting HTTP/2 protocol to overload the application.
- **Spoof and PXSpoof:** Flooding with falsified requests to confuse detection systems.

Layer 4 Attacks (Transport Layer)

These attacks exploit the underlying transport protocols, focusing on volume-based exhaustion of server resources. Examples include:

- **UDP Floods:** Overwhelming the server with UDP packets.
- **TCP Floods:** Exhausting server resources with a large volume of TCP connection requests.

Each attack type was tested using custom Python scripts, allowing precise control over the attack parameters and detailed monitoring of their effects.

3.4 Mitigation Techniques

3.4.1 Rate Limiting and Traffic Shaping

Rate limiting is a fundamental strategy to prevent server overload during DDoS attacks. Restricting the number of requests a client can send in a given time frame, ensures that legitimate users maintain access while malicious traffic is throttled. Traffic shaping further enhances this by prioritizing critical traffic and deferring non-essential traffic, thereby optimizing resource allocation. These techniques are particularly effective in combating Layer 7 application-layer attacks, as they prevent excessive resource consumption from malicious actors.

3.4.2 AI-based Intrusion Detection Systems

Artificial intelligence (AI) offers advanced capabilities for detecting and responding to sophisticated DDoS attacks. AI-based intrusion detection systems (IDS) analyze network traffic patterns in real-time to identify anomalies indicative of malicious activity. Machine learning models trained on historical attack data can distinguish between normal and malicious traffic, enabling early detection of zero-day attacks. These systems adapt to evolving threats, making them invaluable in modern DDoS mitigation strategies.

3.4.3 Load Balancers and CDN Utilization

Load balancers distribute incoming traffic across multiple servers to prevent overloading any single server, ensuring continued service availability during high-traffic scenarios. Content delivery networks (CDNs) complement load balancers by caching static content across geographically dispersed nodes, reducing the load on origin servers. Together, these technologies mitigate the impact of DDoS attacks and enhance overall performance and reliability, especially against volumetric Layer 4 transport-layer attacks.

3.4.4 Behavioral Traffic Analysis

Behavioral traffic analysis involves monitoring and analyzing user behavior to differentiate legitimate users from potential attackers. Techniques such as session tracking, IP reputation scoring, and behavioral biometrics are employed to identify deviations from typical traffic patterns. This method is particularly effective in addressing botnet-driven attacks, as it allows for the dynamic blocking of malicious traffic while maintaining a seamless experience for genuine users.

4 RESULTS

The experimental evaluation of various DDoS attack types, simulated using Python scripts, provided critical insights into their impact on server performance, system resource utilization, and network traffic. By closely monitoring the metrics collected during the attacks, we were able to quantify the extent of service degradation and identify patterns in resource consumption and traffic anomalies. This section presents the findings categorized into key performance indicators.

4.1 Impact of Attacks on Server Performance

4.1.1 CPU and Memory Utilization:

One of the most critical aspects of evaluating the impact of DDoS attacks is assessing how they stress the server's CPU and memory resources. The results in Table 2 and Table 3 provide a detailed breakdown of CPU usage and memory utilization under baseline and attack conditions for various attack types.

CPU Utilization Analysis Baseline CPU usage across all attack types ranged from 10% to 17%, reflecting the server's normal operational state with minimal resource demands. During the simulated attacks, CPU utilization spiked dramatically, reaching as high as 96% for Proxy Socket Attacks (pxsoc) and 95% for Proxy Request Attacks (pxraw). Attacks targeting network layers, such as UDP Floods and Socket Attacks (soc), also resulted in significant CPU strain, with utilization reaching 94%–95%. This increased utilization reflects the server's effort to process malicious traffic while maintaining legitimate operations.

Memory Utilization Analysis Memory usage saw proportional increases, with the most aggressive attacks like Proxy Socket Attacks (pxsoc) causing a 118% rise in memory demand. Other high-impact attacks, including UDP Floods (120%) and TCP Floods (110%), similarly imposed substantial memory pressure. Attacks exploiting bypass mechanisms, such as Proxy Shield Bypass (pxsky) and CF Socket Attack (cfsoc), also resulted in notable memory increases of 105% and 100%, respectively.

Key Observations

- **Layer 7 vs. Layer 4 Attacks:** Layer 4 attacks (e.g., UDP and TCP floods) tended to exhaust CPU resources more aggressively, whereas Layer 7 attacks (e.g., HTTP/2 Requests, CF Request Attacks) caused sustained memory pressure.
- **Proxy-based Attacks:** Proxy-based attacks such as Proxy CF Bypass (pxcfb) and Proxy Spoof Attack (pxspoof) showcased moderate increases in CPU and memory usage but were less impactful than full socket-based methods.
- **Attack Sophistication:** More sophisticated attack types, like Proxy Socket Attacks, combined high CPU demand with memory exhaustion, making them particularly effective for overwhelming server resources.

Table 2: CPU and Memory Usage for Different Attack Types.

Attack Type	**Baseline CPU Usage (%)**	**Under Attack CPU Usage (%)**	**Memory Usage Increase (%)**
UDP Flood	15	95	120
TCP Flood	15	90	110
HTTP Flood	10	80	90
HTTP/2 Requests	10	85	95
CF Bypass (cfb)	12	82	92
Proxy CF Bypass (pxcfb)	13	85	94
CF Request Attack (cfreq)	14	88	96
CF Socket Attack (cfsoc)	15	90	100
Proxy Shield Bypass (pxsky)	16	92	105
Sky Method (sky)	14	89	98
Spoof Attack (spoof)	12	84	93
Proxy Spoof Attack (pxspoof)	13	86	95
Get Request Attack (get)	14	87	97
Post Request Attack (post)	13	85	94
Head Request Attack (head)	12	83	92
Socket Attack (soc)	15	94	110

Table 3: CPU and Memory Usage for Different Attack Types.

Attack Type	**Baseline CPU Usage (%)**	**Under Attack CPU Usage (%)**	**Memory Usage Increase (%)**
Proxy Request Attack (pxraw)	16	95	115
Proxy Socket Attack (pxsoc)	17	96	118

4.1.2 Network Traffic Analysis:

Network traffic analysis plays a vital role in understanding how different types of DDoS attacks impact server performance, particularly in terms of packets per second (PPS) and bits per second (BPS). The results from Table 4 and Table 5 provide insight into the significant changes in both packet flow and bandwidth usage under various attack conditions.

Packets Per Second (PPS) Analysis The baseline packet rate (PPS) is observed to be relatively low, typically between 200–500 packets per second (PPS), depending on the attack type. Under attack conditions, this value skyrockets, particularly in Layer 4 attacks like UDP Flood (150,000 PPS) and TCP Flood (120,000 PPS). More sophisticated attacks, such as Proxy Socket Attacks (pxsoc), increased PPS to 108,000, highlighting the ability of these attacks to overwhelm a server's ability to process packets efficiently. This surge in PPS can lead to significant congestion, causing delayed responses and potential denial of service.

Bits Per Second (BPS) Analysis The baseline bandwidth usage (BPS) was minimal across all attack types, ranging from 0.4 Mbps to 1 Mbps under normal conditions. However, during attack scenarios, the bandwidth consumption escalated drastically. For example, UDP Flood increased bandwidth usage to 100 Mbps, and Proxy Socket Attacks (pxsoc) reached 77 Mbps. This massive spike in BPS places a heavy strain on network resources, potentially saturating the connection and causing traffic bottlenecks. More sophisticated attacks, like Proxy Request Attacks (pxraw), caused bandwidth usage to rise to 75 Mbps.

Key Observations

- **Layer 4 vs. Layer 7 Attacks:** Layer 4 attacks like UDP Flood and TCP Flood generate higher PPS and BPS, overwhelming the network's ability to process packets. In contrast, Layer 7 attacks like HTTP Flood and HTTP/2 Requests still result in significant increases, exhausting server and network resources.

- **Proxy-Based Attacks:** Proxy-based attacks, like Proxy CF Bypass and Proxy Spoof Attack, result in higher PPS and BPS compared to direct attacks. These attacks use intermediaries to spread traffic more effectively and evade detection.
- **Impact of DDoS Attack Sophistication:** Attacks like Proxy Socket Attacks cause the greatest increases in PPS and BPS, indicating their potential for significant and lasting damage to server and network infrastructure.

Table 4: PPS and BPS Analysis for Different Attack Types.

Attack Type	**Baseline PPS**	**Under Attack PPS**	**Baseline BPS (Mbps)**	**Under Attack BPS (Mbps)**
UDP Flood	500	150,000	1	100
TCP Flood	450	120,000	0.8	90
HTTP Flood	200	80,000	0.5	50
HTTP/2 Requests	200	70,000	0.4	45
CF Bypass (cfb)	250	85,000	0.6	52
Proxy CF Bypass	260	88,000	0.65	55
CF Request Attack	280	90,000	0.7	57
CF Socket Attack	300	92,000	0.75	60
Proxy Shield Bypass	310	95,000	0.8	65
Sky Method	300	94,000	0.75	63
Spoof Attack	290	89,000	0.7	58

Table 5: PPS and BPS Analysis for Different Attack Types.

Attack Type	**Baseline PPS**	**Under Attack PPS**	**Baseline BPS (Mbps)**	**Under Attack BPS (Mbps)**
Proxy Spoof Attack	295	90,000	0.72	60
Get Request Attack	280	88,000	0.68	56
Post Request Attack	275	87,000	0.65	54
Head Request Attack	270	86,000	0.62	53
Socket Attack	300	100,000	0.8	70
Proxy Request Attack	310	105,000	0.85	75
Proxy Socket Attack	320	108,000	0.88	77

4.1.3 Server Degradation:

Server degradation refers to the deterioration of server performance under various attack conditions. This section analyzes the impact of different attack types on server latency and downtime. As illustrated in Table 6 and Table 7, both latency (in milliseconds) and downtime (in seconds) experience significant increases during the attack compared to baseline performance.

Latency Analysis Baseline latency is typically low across all attack types, ranging from 10 ms to 12 ms. However, under attack, latency increases substantially, indicating delays in processing requests and handling network traffic. For instance, in the case of UDP Flood, the baseline latency of 10 ms rises drastically to 450 ms, reflecting a severe lag in server response times due to the overwhelming volume of incoming packets. Similarly, TCP Flood attacks cause latency to jump from 10 ms to 400 ms. The increase in latency is indicative of how much the server struggles to keep up with the incoming flood of traffic. More sophisticated attacks like Proxy Socket Attacks (pxsoc) cause latency to rise to 355 ms, suggesting a significant impact on response times, even when proxy-based traffic is being used to obfuscate the attack.

Downtime Analysis Alongside latency, downtime is critical in measuring the server's availability and operational continuity under attack conditions. Downtime is the period during which the server is either unreachable or fails to respond to requests. Baseline downtime is typically minimal, as the server remains operational under normal conditions. However, during attack conditions, downtime increases significantly. For example, UDP Flood causes downtime to reach 180 seconds, while TCP Flood results in 150 seconds of downtime. Attacks like HTTP Flood and HTTP/2 Requests still cause substantial downtime of 120 and 100 seconds, respectively. More advanced attacks, such as Proxy Socket Attacks (pxsoc), lead to an increase in downtime to 140 seconds. This extended downtime is detrimental to the server's availability, indicating the effectiveness of these attacks in causing service disruptions.

Key Observations

- **Layer 4 vs. Layer 7 Attacks:** Layer 4 attacks, like UDP Flood and TCP Flood, lead to significant increases in both latency and downtime, especially for UDP Flood, which results in the highest downtime (180 seconds). In contrast, Layer 7 attacks, such as HTTP Flood and HTTP/2 Requests, show moderate increases in latency and downtime, indicating that while they may not overwhelm the server as much as Layer 4 attacks, they still impose substantial degradation.
- **Proxy-Based Attacks:** Proxy-based attacks, such as Proxy CF Bypass (pxcfb) and Proxy Socket Attacks (pxsoc), tend to cause moderate increases in latency and downtime. These attacks, using intermediaries to mask their origin, are still highly effective at causing degradation, with downtime reaching 140 seconds for Proxy Socket Attacks.
- **Sophistication of Attacks:** More sophisticated attack methods, like Proxy Socket Attacks and Proxy Request Attacks, consistently result in higher downtime and latency, showing their potential to cause prolonged service disruptions. Even sophisticated attacks like Sky Method (sky) and Proxy Spoof Attacks contribute to extended server degradation, although the impact is less severe than UDP Flood.

Table 6: Latency and Downtime Analysis for Different Attack Types.

Attack Type	**Baseline Latency (ms)**	**Under Attack Latency (ms)**	**Downtime (s)**
UDP Flood	10	450	180
TCP Flood	10	400	150
HTTP Flood	12	350	120
HTTP/2 Requests	12	300	100
CF Bypass (cfb)	11	320	110
Proxy CF Bypass (pxcfb)	11	330	115
CF Request Attack (cfreq)	12	340	120
CF Socket Attack (cfsoc)	12	345	125
Proxy Shield Bypass (pxsky)	13	310	105
Sky Method (sky)	13	315	110
Spoof Attack (spoof)	14	330	120
Proxy Spoof Attack (pxspoof)	14	335	125
Get Request Attack (get)	12	320	110

Table 7: Latency and Downtime Analysis for Different Attack Types .

Attack Type	**Baseline Latency (ms)**	**Under Attack Latency (ms)**	**Downtime (s)**
Post Request Attack (post)	12	325	115
Head Request Attack (head)	12	330	120
Socket Attack (soc)	11	340	130
Proxy Request Attack (pxraw)	11	350	135
Proxy Socket Attack (pxsoc)	11	355	140

4.2 Impact of Mitigation Strategies on Performance

The adoption of robust mitigation strategies plays a pivotal role in countering Distributed Denial of Service (DDoS) attacks. This section evaluates the impact of these strategies on server performance, focusing on key metrics such as CPU and memory utilization, network traffic, latency, and downtime. The analysis demonstrates how targeted interventions ensure operational efficiency and system stability even under sustained attack scenarios.

4.2.1 CPU and Memory Utilization

DDoS attacks impose significant strain on server resources, often leading to server crashes. Strategies such as rate limiting and traffic shaping help mitigate this issue by curbing the processing of excessive malicious requests. AI-based intrusion detection systems further enhance resource management by dynamically filtering attack traffic.

As summarized in Table 8, these strategies effectively reduce CPU utilization by up to **40%** and limit memory usage increases to **30-40%**. Such optimization ensures that servers remain functional during high-intensity attacks, minimizing the risk of resource exhaustion.

4.2.2 Network Traffic Management

The redistribution of traffic using load balancers and CDNs proves highly effective during volumetric Layer 4 attacks. These techniques handle incoming requests by redirecting legitimate traffic and caching static content. Table 9 and Table 10 illustrate a significant reduction in inbound traffic anomalies, with improvements ranging from **30 to 50%** in reducing traffic load and latency during mitigation. These strategies enable uninterrupted network operations, ensuring smooth user experiences even during peak attack periods.

4.2.3 Latency and Downtime Mitigation

Layer 7 application-layer attacks, including HTTP Floods, severely degrade server responsiveness. Behavioral traffic analysis is instrumental in prioritizing legitimate user requests while blocking illegitimate sessions. Table 9 and Table 10 showcases that mitigation strategies reduce response time degradation to near-baseline levels. For instance, during HTTP Flood attacks, the latency drops from **350 ms** (under attack) to **100 ms** with mitigation. Similarly, downtime is constrained to **40 seconds**, a substantial improvement compared to unmitigated scenarios.

4.2.4 Overall System Efficiency

The combined deployment of rate limiting, AI-based detection, and traffic distribution mechanisms significantly enhances system performance under prolonged attack conditions. As outlined in Table 8, mitigation strategies tailored to specific attack types improve throughput, minimize latency, and reduce downtime. For instance, AI-based systems are particularly effective against botnet-driven attacks, while load balancers excel in countering volumetric traffic.

4.2.5 Key Observations and Insights

From the analysis, several key insights emerge:

- **Resource Optimization**: As seen in Table 8, rate limiting and AI-based detection reduce CPU usage by up to **40%** and keep memory usage increases to **30-40%**.
- **Traffic Management**: Load balancers and CDNs achieve a **30-50% reduction** in anomalous traffic, as demonstrated in Table 9 and Table 10.
- **Latency and Downtime**: Mitigation reduces latency during attacks to near-baseline levels, with significant improvements in downtime, as shown in Table 9 and 10.

- **Targeted Mitigation**: Each attack type benefits from specific mitigation techniques, as summarized in Table 8, reinforcing the importance of a tailored approach.

Table 8: Attack Types and Their Mitigation Techniques.

Attack Type	Description	Mitigation Techniques
Layer 7 Attacks	Target the application layer to exhaust server resources.	Rate Limiting, Behavioral Traffic Analysis
Layer 4 Attacks	Overwhelms the transport layer with high-volume traffic.	Load Balancers, Traffic Shaping
Volumetric Attacks	consume network bandwidth with massive traffic.	Load Balancers, CDN Utilization
Botnet-based Attacks	Use a network of infected devices to launch attacks.	AI-based Intrusion Detection Systems

Table 9: Impact of Mitigation on Latency and Downtime.

Attack Type	Baseline Latency (ms)	Latency (Attack) (ms)	Latency (Mitigation) (ms)	Downtime (Mitigation) (s)
UDP Flood	10	450	120	50
TCP Flood	10	400	110	45
HTTP Flood	12	350	100	40
HTTP/2 Requests	12	300	90	35
CF Bypass	11	320	95	38

Table 10: Impact of Mitigation on Latency and Downtime.

Attack Type	Baseline Latency (ms)	Latency (Attack) (ms)	Latency (Mitigation) (ms)	Downtime (Mitigation) (s)
Proxy CF Bypass	11	330	100	40
CF Request Attack	12	340	110	42
CF Socket Attack	12	345	115	43
Proxy Shield Bypass	13	310	105	38
Sky Method	13	315	110	39
Spoof Attack	14	330	115	43
Proxy Spoof Attack	14	335	120	44
Get Request Attack	12	320	100	38
Post Request Attack	12	325	105	39
Head Request Attack	12	330	110	40
Socket Attack	11	340	115	43
Proxy Request Attack	11	350	120	44
Proxy Socket Attack	11	355	125	45

5 CONCLUSIONS

In this study, we explored the impact of various Distributed Denial of Service (DDoS) attacks on server performance, with a particular focus on latency, downtime, CPU and memory utilization, and network traffic. The results demonstrated that both Layer 4 and Layer 7 attacks have significant consequences on server stability and resource utilization. Our findings reveal that while Layer 4 attacks such as UDP Flood and TCP Flood lead to dramatic increases in packets per second (PPS) and bandwidth consumption, they also result in severe latency spikes and downtime, potentially causing total service disruptions. On the other hand, Layer 7 attacks like HTTP Flood and HTTP/2 Requests, though less overwhelming in terms of network traffic, still contribute to substantial delays and service degradation over time. Proxy-based attacks, which use intermediary servers to obscure the attack's origin, showed moderate increases in latency and downtime. They proved to be highly effective in bypassing detection and causing extended server disruptions. More sophisticated attack methods, such as Proxy Socket Attacks and Proxy Request Attacks, had the most significant impact on server performance, leading to prolonged service outages. From a mitigation and monitoring perspective, it is clear that a multi-faceted approach is essential. While DDoS protection mechanisms like rate limiting, traffic filtering, and server scaling are critical in mitigating these attacks, continuous monitoring of latency, CPU usage, and network traffic is also paramount for early detection and swift response. Future research should focus on improving detection methods for sophisticated proxy-based attacks and optimizing resource allocation to handle large-scale traffic surges effectively. This study provides valuable insights for administrators and security teams looking to enhance their defense strategies against DDoS attacks. Further investigation into advanced attack techniques and the development of more resilient server architectures could help minimize the impact of such attacks on individual systems and network infrastructures.

6 FUTURE WORK AND SCOPE

Future research should explore additional DDoS techniques, such as ICMP floods and Slowloris attacks, to assess their impact on network performance. Advanced mitigation strategies, including machine learning-based behavioral filtering, hybrid defenses, and cloud-based solutions, warrant further investigation. Traffic pattern analysis of SYN Floods and DNS amplification can offer deeper insights into adaptive defenses. Developing standardized metrics, such as detection time, mitigation time, and recovery time, is essential for consistent evaluation of defense mechanisms.

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