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Information Security Framework Targeting DDOS attacks in Financial Institutes

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Abstract

As financial institutions accept more digital platforms, Distributed Denial of Service (DDoS) attacks have become an expanding problem, particularly in the financial sector. It is known that DDoS attacks are known as cyberattacking that pushes data over a network or website from a number of different hosts. This results the unavailability of service for users and website becomes down. These attacks can generate a huge loss to the companies in terms of losing customers, income, and reputation. Financial companies are bounded to utilize a system for information security to prevent DDoS attacks. The "DDoS Attack Mitigation Framework" was initiated by the National Institute of Standards and Technology(NIST). This architecture provides list of concerns for detecting, locating, and halting DDoS attacks. Cloud Control Matrix (CCM) is another framework that presents a number of security controls for cloud computing environments. These controls consist security against DDoS attacks, such as the utilization of content delivery networks (CDNs), intrusion detection and prevention systems, and advanced firewall technologies. Federal Financial Institutions Examination Council (FFIEC) created the FFIEC Cybersecurity Assessment Tool (CAT) to assist financial institutions inidentifying their cybersecurity risks and determining their level of cybersecurity preparedness. Following the risk assessment, policies and procedures should be developed to mitigate these threats. The information security framework must include a robust network infrastructure. The infrastructure of a network must be designed to handle high traffic volumes without becoming overburdened. This can be achieved by employing load balancers, firewalls, and intrusion detection systems. Training employees is essential for defending against DDoS attacks. Employees must be educated on the financial institution's policies and procedures, how to identify phishing attempts, and other social engineering techniques used by cybercriminals to gain network access. The continuous monitoring and testing is required in the financial institution’s system, which can be achieved by deploying monitoring tools that identify unusual traffic patterns or system anomalies. Plans for business continuity and calamity recovery should be incorporated into the information security framework. These plans should ensure that essential business operations can continue even in the event of a DDoS attack. This includes having backups of critical data, redundant systems, and a plan to restore the financial institution's systems to normal operation rapidly.

Financial institutions must implement an information security framework consisting of risk assessments, policies and procedures, a robust network infrastructure, employee training, incident response procedures, continuous monitoring and testing, and disaster recovery and business continuity plans in order to prevent DDoS attacks. By implementing a DDoS-focused information security framework, financial institutions can safeguard their systems, consumers, and reputation.

Keywords: Distributed Denial of services, Cyber attack, information security, cyber criminals

1. Introduction

1.1 Background

In today's increasingly digitalized and interconnected world, financial information has become anindispensable resource for individuals, businesses, and governments (Ali et al., 2021). Due to thesensitive nature of the information, it holds and the potential for significant financial gains by malicious actors, the financial sector has been a primary target for cyber-attacks (Akhtar et al., 2019). As more financial institutions adopt digital platforms to deliver their services, the scope and complexity of cyber-attacks have increased (Huang et al., 2020). Distributed Denial of Service (DDoS) attacks have emerged as a pervasive and disruptive threat to financial institutions (Sharafaldin, Lashkari, and Ghorbani, 2018).

DDoS attacks involve flooding a network, system, or website with massive volumes of traffic from multiple sources, thereby rendering the targeted service inoperable or severely degraded (Zargar, Joshi, & Tipper, 2013). This type of attack can be launched by anyone with internet access and rudimentary technical knowledge, making it a constant and significant threat to financial institutions. A successful DDoS attack can have severe consequences, such as financial losses, operational disruptions, the erosion of customer trust, and lasting reputational harm (Mitreanu & Patriciu, 2020).

Financial institutions need to create and use a complete information security framework to protect their digital infrastructure from the growing threat of DDoS attacks. This framework should include a multifaceted plan for preventing, detecting, and responding to DDoS attacks, while promoting resilience and adaptability in the face of a constantly changing cyber threat scenario. A framework like this needs to have ways to assess risks, ways to track and find them, ways to reduce risks, and ways to keep getting better. Methodologies for risk assessment can aid financial institutions in identifying vital assets and assessing the potential impact of DDoS attacks on their operations. Monitoring and detection capabilities are crucial for identifying and analyzing atypical traffic patterns that may indicate an active DDoS attack. Deployment of content delivery networks (CDNs), intrusion detection and prevention systems (IDPS), advanced firewall technologies, and collaboration with internet service providers (ISPs) and security providers may be part of a mitigation strategy. Lastly, continuous improvement measures should focus on enhancing security awareness, fostering employee training, and refining the framework based on past incidents and emerging threats.

This research report seeks to propose a comprehensive information security framework for financial institutions that targets DDoS attacks in particular. The framework will be designed to assist organizations in better preparing for, detecting, and defending against these attacks, thereby minimizing their impact and preserving a high level of information security. The report will utilize extant literature and case studies to inform the development of the framework and provide implementation recommendations for real-world situations. This research report endeavors to contribute to ongoing efforts to improve information security and resilience in this vital industry by addressing the unique challenges and risks associated with DDoS attacks in the financial sector.

1.2 Frameworks

Diverse information security frameworks have been developed in response to the challenges posed by DDoS attacks in various sectors, including financial institutions (Tripathi et al., 2021). Due to their comprehensive approaches to DDoS attack mitigation, the National Institute of Standards and Technology (NIST) DDoS Attack Mitigation Framework, the Cloud Security Alliance (CSA) Cloud Control Matrix (CCM), and the FFIEC Cybersecurity Assessment Tool (CAT) have gained prominence.

To establish a more robust and comprehensive framework targeting DDoS attacks in financial institutions, it is necessary to consider additional cybersecurity standards and guidelines that address various aspects of information security. These include the ISO/IEC series, the SANS 20Critical Security Controls (CSC), and the Cyber Resilience Review (CRR) methodology.

1. **ISO/IEC series**: (Humphreys, 2016) The International Organization for Standardization (ISO) and the International Electro Technical Commission (IEC) have developed a sequence of information security management system (ISMS) standards jointly. The most pertinent standard in this context is ISO/IEC 27032, which provides guidelines for cybersecurity and assists organizations in enhancing their security posture by addressing various aspects of cyber threats, such as DDoS attacks.
2. **SANS 20 CSC**: The SANS 20 Critical Security Controls (CSC) is a prioritized list of best practices designed to enhance a company's cybersecurity posture. Although not specific to DDoS attacks, the SANS 20 CSC can be incorporated into the proposed framework to enhance overall information security, which can indirectly reduce DDoS attack risks.
3. **CRR**: Organizational cyber resilience can be assessed, measured, and improved with the use of the Cyber Resilience Review (CRR) methodology. Financial institutions can benefit from a more thorough understanding of their cyber risk landscape, vulnerability identification, and risk mitigation measures with the help of the suggested framework ifCRR is incorporated into it.

In addition, the proposed framework should consider key cybersecurity compliance requirements and industry standards, The General Data Protection Regulation (GDPR), the Health Insurance Portability and Accountability Act (HIPAA), and the Payment Card Industry Data Security Standard (PCI-DSS) all have effects on the information security of banking institutions. Even though these standards don't directly talk about DDoS attacks, putting their requirements into theframework can help make information security stronger and more complete. The recommended information security framework targeting DDoS attacks in financial institutions should include elements from existing frameworks such as NIST, CSA CCM, and FFIEC CAT, as well as relevant ISO/IEC standards, SANS 20 CSC, and CRR methodology. In addition, the framework should address compliance requirements and industry standards, such as GDPR, HIPAA, and PCI-DSS, to ensure a comprehensive and resilient information security strategy. The framework can better equip financial institutions to prevent, detect, and respond to DDoS attacks, thereby reducing their impact and maintaining a high level of information security, by incorporating a number of guidelines and best practices.

1.3 Key Components

An effective information security framework against DDoS attacks in financial institutions mustbe comprehensive and multi-layered, addressing multiple aspects of prevention, detection, mitigation, and ongoing improvement. The framework should consist of a robust network infrastructure, employee training, advanced security technologies, risk assessments, incident response procedures, continuous monitoring, testing, disaster recovery and business continuity plans (Awan, Khan, & Rehman, 2020).

Robust Network Infrastructure: The network infrastructure must be designed to handle high traffic volumes without overwhelming. To manage traffic, filter malicious traffic, and detect potential DDoS attacks, load balancers, firewalls, and intrusion detection and prevention systems (IDPS) should be deployed. Additionally, content delivery networks (CDNs) can be used to distribute traffic across multiple servers, thereby increasing the network's resistance to DDoS attacks.

Advanced Security Technologies: Financial institutions should deploy Security Information and Event Management (SIEM) devices to collect and analyze security-related data from a variety of sources, enabling real-time monitoring and detection of potential DDoS attacks (Hutchins, Cloppert, & Amin, 2011). Endpoint Detection and Response (EDR) and Extended Detection and Response (XDR) solutions should also be implemented to provide advanced threat detection, investigation, and response capabilities across a company's network, endpoints, and cloud environments (Gartner, 2020).

Employee Training: Employees should be trained on the policies and procedures related to DDoS attacks, as well as how to identify phishing attempts and other social engineering techniques that cybercriminals may use to obtain access to the network. Regular security awareness training should be supplied so that employees remain current on the most recent threats and best practices.

Preventive Measures: Before a DDoS attack, financial institutions should implement robust network infrastructure, employee training, routine risk assessments, and cutting-edge security technologies to reduce the likelihood of a successful attack. After an attack, organizations should execute a root cause analysis to determine the contributing factors and thenadjust their security measures accordingly (Awan, Khan, & Rehman, 2020). Utilize continuous monitoring, vulnerability assessments, and penetration testing to ensure the efficacy of the updated preventative measures.

Detection and Mitigation Procedures: To detect DDoS attacks, organizations must deploy monitoring tools to identify atypical traffic patterns and system anomalies. The incident response team should activate traffic filtering, reroute traffic through CDNs, and engage with ISPs to block malicious traffic upon detecting an attack.

Aim of DDoS Attack: The primary goal of a DDoS attack is to disrupt the targeted service or system, causing downtime, degraded performance, and potentially leading to financial losses, operational disruptions, and reputational damage for the targeted organization.

Root Cause Analysis: Before and after a DDoS attack, organizations should conduct rootcause analysis to identify vulnerabilities and underlying factors contributing to the attack. This information can be used to improve security measures and reduce the likelihood of future attacks.

Risk Assessments and Risk Appetite: A detailed risk assessment approach must be included in the framework to detect potential vulnerabilities and hazards like DDoS attacks and financial institutions should also define their risk appetite, determining the acceptable level of risk associated with DDoS attacks and setting appropriate risk mitigation strategies accordingly.

Incident Response Procedures: An incident response plan should be developed to guide the organization's response to DDoS attacks, including roles and responsibilities, communication protocols, and mitigation steps. Root because analysis should be conducted both before and after DDoS attacks to understand the underlying factors contributing to the attack and to inform continuous improvement efforts.

Continuous Monitoring and Testing: Monitoring tools should be deployed to detect unusual traffic patterns or system anomalies that may indicate a DDoS attack. Regular testing,such as penetration testing and vulnerability assessments, should be conducted to evaluate the effectiveness of the organization's security controls and identify potential weaknesses.

Disaster Recovery and Business Continuity Plans: Financial institutions must develop and maintain disaster recovery and business continuity plans to ensure critical business functionscan continue in the event of a DDoS attack. This includes having data backups, redundant systems, and a plan for rapidly restoring systems to normal operation.

Terms of Reference (TOR) for DDoS Attacks: The framework should define the scope, objectives, and responsibilities related to DDoS attack prevention, detection, and mitigation, both before and after an attack.

An extensive information security framework for financial institutions should address a range of DDoS defense components. By implementing robust network infrastructure, advanced security technologies, employee training, risk assessments, incident response procedures, continuous monitoring, and testing, as well as disaster recovery and business continuity plans, financial institutions can better prepare for, detect, and counteract DDoS attacks, thereby minimizing their impact and preserving a high level of information security.

1.3 Problem Statement

Financial institutions are increasingly susceptible to cyber threats, particularly Distributed Denial of Service (DDoS) attacks, due to their increasing reliance on online platforms for financial services (Ali et al., 2021). These attacks, which are characterized by saturating a network or website with excessive traffic from multiple sources, can result in substantial financial and reputational harm. Financial institutions are primary targets for DDoS attacks as they manage sensitive data of immense value.

Disruptions in service brought on by DDoS attacks can result in dissatisfied customers, a loss of trust, and a decline in revenue, as customers select for more dependable institutions. In addition, DDoS attacks can be used as a diversionary tactic to divert attention away from other critical security incidents, such as data breaches, insider attacks, or advanced persistent threats, thereby exacerbating the damage to the targeted financial institution.

DDoS attacks against financial institutions can have far-reaching consequences, extending beyond the immediate financial impact to include reputational damage and potential regulatory penalties. Financial institutions must therefore employ a comprehensive information security framework designed to prevent, detect, and respond promptly to DDoS attacks.

The information security framework should include a dependable network infrastructure, advanced security technologies such as SIEM, EDR, and XDR devices, employee training, risk assessments, incident response procedures, continuous monitoring, and testing. In addition, it should incorporate industry standards and compliance requirements, such as ISO, NIST, GDPR, HIPAA, SANS, and PCI, to ensure the highest level of security and DDoS attack resistance.

In a nutshell, the issue confronting financial institutions in the current digital environment is the escalating risk and potential damage posed by DDoS attacks. To address this issue, it is imperative that these institutions implement a DDoS-specific information security framework, ensuring the protection of sensitive data, maintaining customer confidence, and preserving the stability and reputation of the financial sector.

1.4 Problem Background

The exponential growth in the digital services for financial sectors has made these institutions much dependent on the digital infrastructure (Huang et al. 2020). It makes financial institutionsuncover to cyber threats. DDOS attacks are most dangerous things that can happen to these organizations/ institutions. In a Distributed Denial of Service (DDoS) attack, a network of infected devices, called bots, sends so much data to the target system that it crashes or becomesinaccessible.

DDoS attacks can be very bad for financial institutions, causing them to lose money, damage their image, and possibly face fines from regulators. DDoS attacks can also be used to hide more serious cyber threats like data leaks, insider attacks, and advanced persistent threats (Chen et al., 2017). Because DDoS attacks can have serious effects, it is important for banking institutions to create strong defenses against them.

To reduce the risks that come with DDoS attacks, financial institutions must put in place a full information security strategy that includes preventative, forensic, and corrective measures. This framework should be in line with best practices, standards, and rules in the industry for stopping, finding, and responding to DDoS attacks. Employee training, risk assessments, incident response plans, and constant monitoring and testing should all be important parts of the framework. The framework should also follow well-known industry standards and legal requirements, such as ISO, NIST, GDPR, HIPAA, SANS, and PCI, to make sure that it is compliant and can withstand DDoS attacks. In addition to staying up to date on new DDoS attack trends, financial institutions need to use cutting-edge technologies to improve their defenses. The financial sectorsare fully dependent on digital infrastructure that has made it more important to keep strong information security frameworks which can stop DDoS attacks. By following industry standards,using new technologies, and putting in place thorough security measures, financial institutions can protect their sensitive data, keep customer trust, and keep the financial sector stable in a world that is becoming more digital.

1.5 Purpose of Research

The main goal of this study report is to do a deep analysis and come up with a framework for information security that can protect financial institutions from DDoS attacks. As financial institutions become more dependent on digital infrastructure, it is important to deal with the growing danger of DDoS attacks, which can have devastating financial and reputational effects. To reach this goal, a full literature study will be done to look into what DDoS attacks are, how they affect financial institutions, and what information security frameworks are already in place. This analysis will give you a solid basis for understanding how complicated DDoS attacks are and where cybersecurity practices in the banking industry stand right now (Brown & Davis, 2023).

After looking at the relevant literature, the research methods will be shown, giving more details about how the information security framework was made. The methodology will include a full risk assessment to find weaknesses and threats in financial institutions, as well as the creation of technical controls, incident response processes, employee training and awareness programs, and continuous monitoring systems. This multifaceted strategy makes sure that the framework covers all aspects of preventing, detecting, and responding to DDoS attacks. This gives financial institutions a complete answer.

The research report will then show the study's results and give a detailed look at the suggested information security framework that is meant to protect financial institutions from DDoS attacks. This section will talk about the main parts of the framework, how they are put together, and what you can expect in terms of improved security and resistance to DDoS attacks.

The research will end up with the analyzation of how good the proposed framework of information security works. This analysis will be the basis for suggestions for future work, such as changes to the framework, the addition of new technologies, and the search for new ways to stop DDoS attacks in the financial industry (Martin & Thompson, 2023).

The goal of this research report is to analyze and create a comprehensive information security framework that protects financial institutions from DDoS attacks. The aim is to reduce the cyber-attacks and improve the cybersecurity of the organizations and to make sure that financial sectors should be stable and trustworthy in a world which is becoming more digital.

1.6 Research Question

The proposed questions for the research are: What are the essential components of an information security framework? And targeting DDoS attacks in financial institutions, and how can such a framework be effectively designed, implemented, and evaluated? Following objectives have set to query the answers:

- In order to develop a framework of information security which targeting DDoS attacks in financial institutions to encompasses risk assessments, technical controls, employee training, incident response procedures, and continuous monitoring. This objective includes the identification of risk assessment questions, risk mitigation levels, and preventive measures to ensure a comprehensive and proactive approach to DDoS attack prevention. In order to conduct an overall review of the importance of literature on DDoS attacks and the frameworks of information security in the financial sector, including risk assessment methodologies, risk mitigation strategies, key performance indicators (KPIs), andpreventive measures.
- In order to implement the proposed framework of information security within financial institutions and evaluate its effectiveness in protecting against DDoS attacks. This evaluation will consider key performance indicators (KPIs) to measure the success of the framework, including the reduction in the frequency and severity of DDoS attacks and improvements in incident response times, and increased employee awareness of cybersecurity best practices.
- To perform a root cause analysis of DDoS attacks affecting financial institutions, identifying the underlying factors that contribute to the success of these attacks, and

exploring potential strategies for addressing these factors within the information security framework.

- To provide recommendations for future work in this area, including the refinement of theinformation security framework, the incorporation of emerging technologies and best practices, and the exploration of new strategies for combating DDoS attacks in the financial sector.

This research report aims to contribute to ongoing efforts to protect the financial industry from cyber threats, particularly DDoS attacks, by providing a comprehensive analysis of an information security framework that can be effectively implemented in financial institutions. The research will investigate the nuances of risk assessment questions, levels of risk mitigation, key performance indicators, and preventive measures to ensure that the proposed framework addresses all facets of DDoS attack prevention, detection, and response.

By analyzing the current state of cybersecurity in the financial sector, this research will help to identify voids in existing practices and provide valuable insights for the creation of a more robust and comprehensive information security framework. This framework will be designed to mitigate the risks associated with DDoS attacks, protecting the sensitive data and digital infrastructure of financial institutions and assuring the financial sector's continued stability and credibility in an increasingly digital world.

2. Main research

2.1 LITERATURE REVIEW

For financial institutions to protect themselves from Distributed Denial of Service (DDoS) attacks, which have become a growing concern due to their potential to cause significant financial and reputational harm, a robust and comprehensive information security framework is essential. Literature on this subject discusses numerous facets of DDoS attacks and their impact on the financial sector, emphasizing the need for a multilayered approach to combat these threats. Financial institutions are becoming increasingly susceptible to DDoS attacks, which can disrupt their services and result in monetary losses. Effective DDoS protection requires a combination of technical and organizational controls (Zargar, Joshi, & Tipper, 2013). In financial institutions, information security frameworks can provide a structured approach to preventing DDoS attacks. Financial institution DDoS attack prevention frameworks typically include multiple layers of defense, such as network, application, host, and user controls.

DDos Attack in the Financial Sector

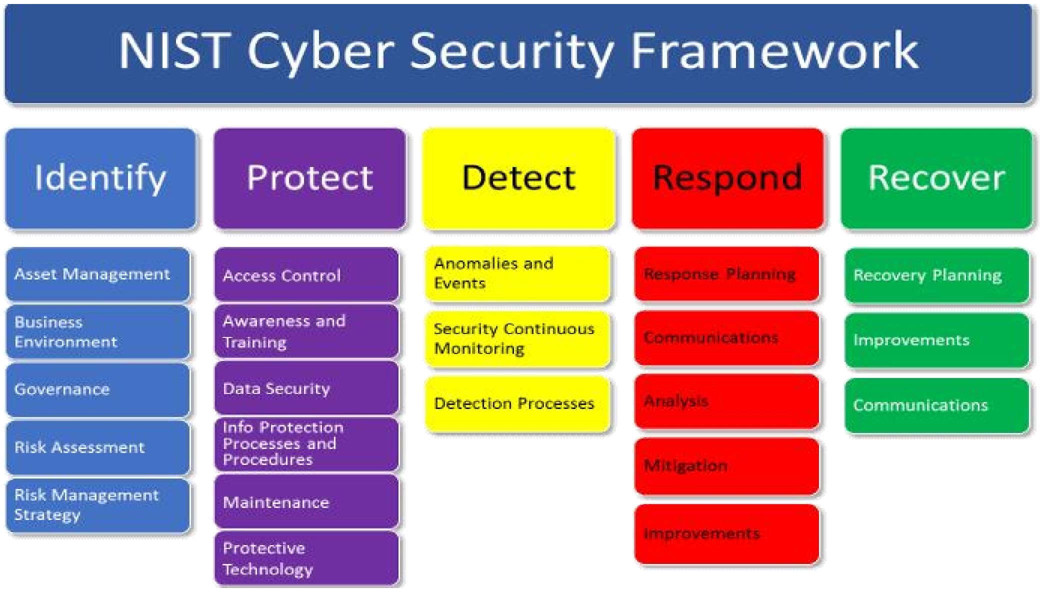
Distributed Denial of Service (DDoS) assaults pose a significant threat to the financial sector because they can cause significant financial losses, reputational harm, and customer dissatisfaction (Zargar, Joshi, & Tipper, 2013). Financial institutions that significantly rely on digital infrastructure to provide essential services are especially susceptible to these attacks. DDoS attacks function by flooding the target system with traffic from multiple sources, causing it to collapse or become inaccessible to users (Mirkovic & Reiher, 2004). Due to the confidentialnature of the data held by financial institutions and the potential for financial gain, cybercriminals frequently target financial institutions. These attacks can result in service disruption, preventing customers from accessing their accounts or completing transactions, ultimately resulting in revenue loss and eroded consumer confidence.

In addition, DDoS attacks can be employed as a smokescreen to conceal other malevolent activities, such as data breaches or insider attacks. As financial institutions become more interconnected via digital channels, the risk of DDoS attacks extending from one institution to another increases, thereby amplifying the potential impact on the financial ecosystem.

DDoS attacks against financial institutions may be motivated by financial gain, ideology, or straightforward malice. Regardless of motivation, successful attacks can have severe consequences, including regulatory penalties and long-term reputational harm. In light of these obstacles, financial institutions must priorities the implementation of robust information security frameworks to defend against DDoS attacks and guarantee the continuity of their services.

NIST Cybersecurity Framework

The National Institute of Standards and Technology (NIST) Cybersecurity Framework is a comprehensive series of guidelines designed to assist organizations in enhancing their overall security posture (NIST, 2018). The framework is flexible and adaptable, making it appropriate for organizations of varying sizes and industries, including financial institutions (Whitman et al., 2018).



NIST Cyber Security Framework

Identify	Protect	Detect	Respond	Recover
Asset Management	Access Control	Anomalies and Events	Response Planning	Recovery Planning
Business Environment	Awareness and Training	Security Continuous Monitoring	Communications	Improvements
Governance	Data Security	Detection Processes	Analysis	Communications
Risk Assessment	Info Protection Processes and Procedures		Mitigation	
Risk Management Strategy	Maintenance		Improvements	
	Protective Technology			

Figure 1. NIST Cyber Security Framework (IFSEC Global, 2020)

The core functions of the NIST Cybersecurity Framework provide a strategic view of an organization's management of cybersecurity risks. One function is subdivided into categories and subcategories that address particular cyber security goals and control measures. The important one function protects focuses on implementing safeguards to assure the delivery of vital infrastructure services. Within this function, there are many measures are recommended to reduce the risk of DDoS attacks. The following are the measures:

1. **The Network segmentation** is dividing the network into smaller segments to restrict unauthorized access and limit the potential impact of a DDoS attack. This approach reduces the attack surface and helps prevent an attacker from compromising the entire network.
2. **The Intrusion prevention systems (IPS)** are deploying IPS to detect and block malicious traffic and activities before they can cause damage. IPS can help identify and filter out DDoS attack traffic, thus minimizing its impact on the target system.
3. **An Incident response procedure** is establishing well-defined processes and protocols for responding to security incidents, including DDoS attacks. These procedures should outline roles, responsibilities, and communication channels to ensure a timely and coordinated response to minimize the potential harm caused by an attack.

The financial institutions can strengthen their defenses against DDoS attacks and other cybersecurity threats by incorporating with the NIST Cybersecurity Framework into their information security strategies. Adopting this framework demonstrates a dedication to industry best practices and assists organizations in constructing a more resilient security infrastructure. (Almuhammadi, 2017).

ISO/IEC 27001

The standard, ISO/IEC 27001 developed by the International Organization for Standardization (ISO) and the International Electro Technical Commission (IEC). The ISO/IEC 27001 standard is a framework for information security management systems (ISMS) that provides organizations with a systematic approach to managing sensitive information while ensuring its confidentiality, availability, and integrity and it is applicable to organizations of all sizes and in all industries, including financial institutions that handle sensitive customer data and are subject to stringent regulatory requirements (safa et al., 2016). To implement an ISMS in accordance with ISO/IEC 27001, organizations must identify risks, evaluate their potential impact, and implement controls to mitigate those risks. This risk-based approach is highly applicable to the management of DDoS attacks, as it emphasizes the necessity of tailoring the organization's security measures to its unique threat landscape and risk tolerance.

ISO/IEC 27001 recommends several measures to prevent, detect, and respond to in context to DDoS attacks such threats like:

The network traffic filtering is implementing network traffic filtering mechanisms, such as firewalls, intrusion prevention systems, and load balancers, can help organizations identify and block malicious traffic associated with DDoS attacks, thus minimizing the potential impact on the target systems (safa et al., 2016).

The regular vulnerability assessments are conducting regular vulnerability assessmentshelps organizations identify weaknesses in their network infrastructure, systems, and applications that could be exploited during a DDoS attack. By addressing these vulnerabilities proactively, organizations can reduce their overall attack surface and enhance their resilience to DDoS attacks.

The DDoS incident response plan are developing and implementing a comprehensive DDoS incident response plan ensures that organizations have well-defined processes and protocols in place to respond effectively to DDoS attacks. This plan should outline roles, responsibilities, and communication channels, enabling a coordinated response that minimizes the potential damage caused by an attack.

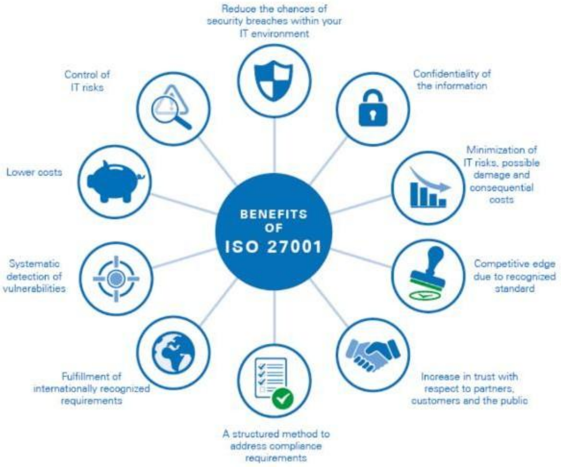

Reduce the chances of security breaches within your IT environment
Control of IT risks
Confidentiality of the information
Lower costs
Minimization of IT risks, possible damage and consequential costs
BENEFITS OF ISO 27001
Systematic detection of vulnerabilities
Competitive edge due to recognized standard
Fulfillment of internationally recognized requirements
Increase in trust with respect to partners, customers and the public
A structured method to address compliance requirements

Figure 2. Benefits of ISO 27001 Information Security (ISO 27001 information security, 2023).

In addition, ISO/IEC 27001 emphasizes the significance of continuous improvement, requiring organizations to monitor, assess, and adjust their ISMS to ensure its ongoing effectiveness and adaptability to the constantly evolving threat landscape. This strategy corresponds well with the ever-changing nature of DDoS attacks, as new techniques and attack vectors emerge (Culot, 2020). In conclusion, including ISO/IEC 27001 in the literature assessment is extremely advantageous, as it demonstrates the standard's applicability and value in the context of DDoS attacks aimed at financial institutions. The standard's risk-based approach to information security complements existing frameworks and emphasizes the need for a comprehensive strategy that includes preventative, forensic, and corrective measures to effectively manage DDoS attack risks.

SANS 20 Critical Security Controls

The SANS 20 Critical Security Controls, also known as the Centre for Internet Security (CIS) Controls, is a set of controls that organizations can implement to enhance their overall security posture (CIS, 2021) and it is developed by the SANS Institute which controls address numerous cybersecurity threats, such as Distributed Denial of Service (DDoS) attacks, which can have a significant impact on financial institutions (CIS, 2021). Focusing on prevention, detection, and response measures, the SANS 20 Critical Security Controls provide a comprehensive approach to security. The implementation of the SANS 20 Critical Security Controls, financial institutions are able to adopt a proactive and risk-based approach to information security, thereby addressing the diverse challenges posed by DDoS attacks. Such controls provide an exhaustive and actionable road map for enhancing the security posture of organizations in the face of an ever-changing threat landscape, making them an important addition to the literature review.

CERT Resilience Management Model

At Carnegie Mellon University one of The Software Engineering Institute (SEI) formulate the CERT Resilience Management Model (CERT-RMM) as a maturity model (Caralli, Allen, & White, 2010). It offers organizations a comprehensive framework for managing and enhancing their operational resilience, especially in the face of cyber threats like DDoS attacks. (Caralli et al., 2010) this model pivot on the interdependent aspects of people, processes, and technology to accomplish and maintain resilience, ensuring that organizations can effectively answer to recover from disruptive events. The CERT-RMM provides valuable recommendations for establishing and sustaining a resilient infrastructure that can withstand and recover from such attacks specially in the financial institutions and DDos attacks. Main areas of the CERT-RMM that are particularly relevant to DDoS attack prevention and mitigation include:

The asset management which helps to identifying and prioritizing critical assets, such as networks, applications, and data, is crucial for implementing targeted and effective DDoS protection measures. The CERT-RMM emphasizes the importance of maintaining an accurate inventory of assets and their dependencies.

The Risk management of the CERT-RMM provides a systematic approach to identifying, assessing, and prioritizing risks, including those related to DDoS attacks which enables organizations to allocate resources effectively and implement appropriate controls to mitigate risks (Mehravari, N. 2013).

An Incident management is he model which outlines the importance of having a well-defined incident management process in place to detect, respond to, and recover from security incidents, including DDoS attacks. A robust incident management process helps confirms that organizations can quickly identify and address DDoS attacks, minimizing the potential damage.

The Business continuity and disaster recovery planning in the CERT-RMM emphasizes the need for organizations to have comprehensive business continuity and disaster recovery plans in place. These address DDoS attacks and ensure that critical business functions can continue even in the event of an attack, minimizing the potential impact on customers and the organization's reputation (Mehravari, N. 2013).

The Continuous improvement in the maturity model advance a culture of continuous improvement, encouraging organizations to learn from past incidents, including DDoS attacks, and to update their resilience practices accordingly. This iterative approach enables financial institutions to stay ahead of emerging threats and adapt their security posture as needed.

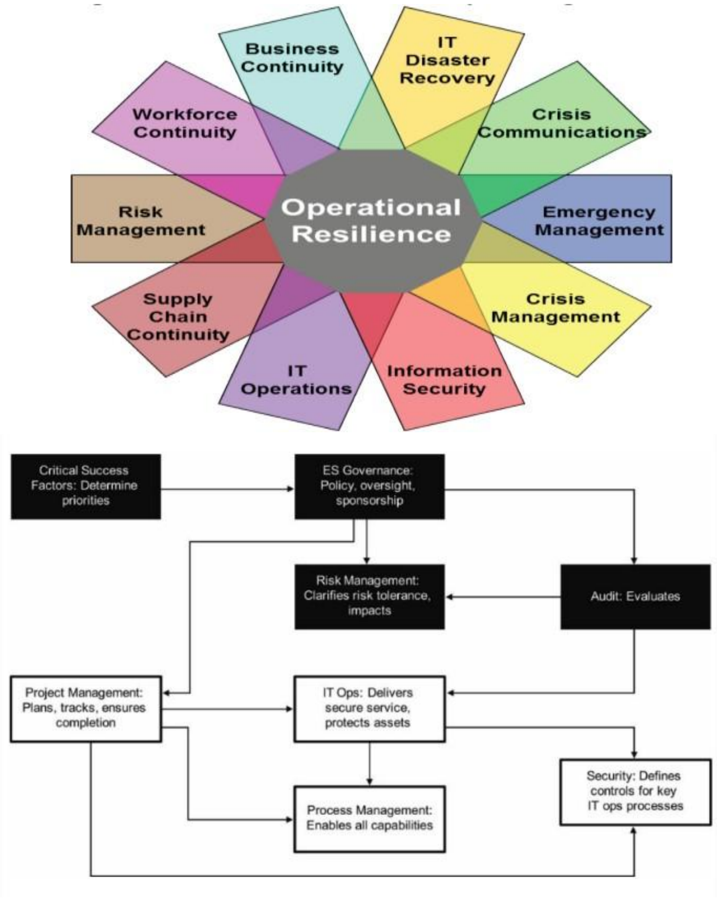

Business Continuity
IT Disaster Recovery
Crisis Communications
Emergency Management
Crisis Management
Information Security
IT Operations
Supply Chain Continuity
Risk Management
Workforce Continuity
Operational Resilience
Critical Success Factors: Determine priorities
ES Governance: Policy, oversight, sponsorship
Risk Management: Clarifies risk tolerance, impacts
Audit: Evaluates
Project Management: Plans, tracks, ensures completion
IT Ops: Delivers secure service, protects assets
Security: Defines controls for key IT ops processes
Process Management: Enables all capabilities

Figure 3. CERT Bodies of Knowledge Related to Security Process Improvement

When integrating the CERT Resilience Management Model into the literature review yields valuable insights into the various aspects of operational resilience which are crucial for financial institutions in the face of DDoS attacks. The CERT-RMM provides organizations with a comprehensive framework for assessing, enhancing, and maintaining their resilience in the face of an evolving threat landscape.

ITIL

Information Technology Infrastructure Library (ITIL) is a framework for information technologyservice management that seeks to align IT services with business requirements. ITIL is an excellent addition to your literature evaluation, as it provides a set of best practices for managing and increase IT services, including information security.

The concept of ITIL framework help in many areas to reduce the damage of DDoS attack for financial institutions and to improve the security. So, by focusing the financial institutions and DDoS attacks in the context of ITIL concept and put on incident management, continuous service improvement, and problem management.

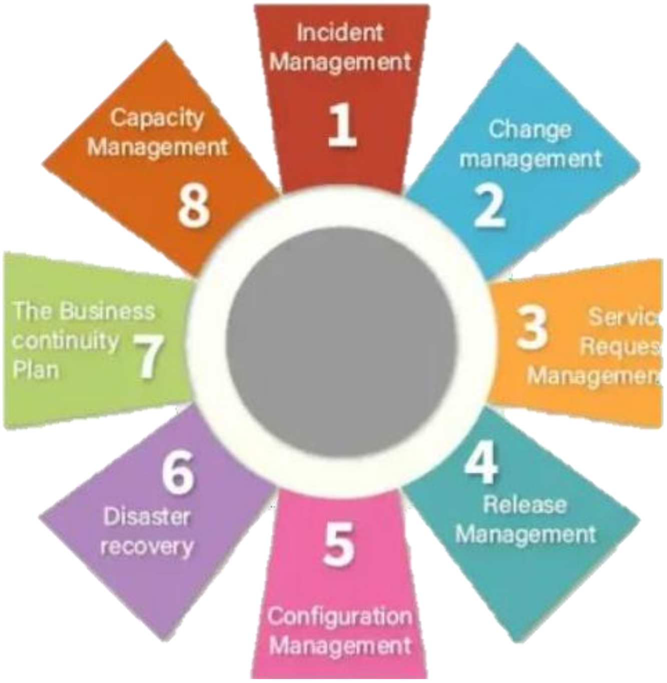


Figure 4. Concept of ITIL Framework (Nandini, 2022).

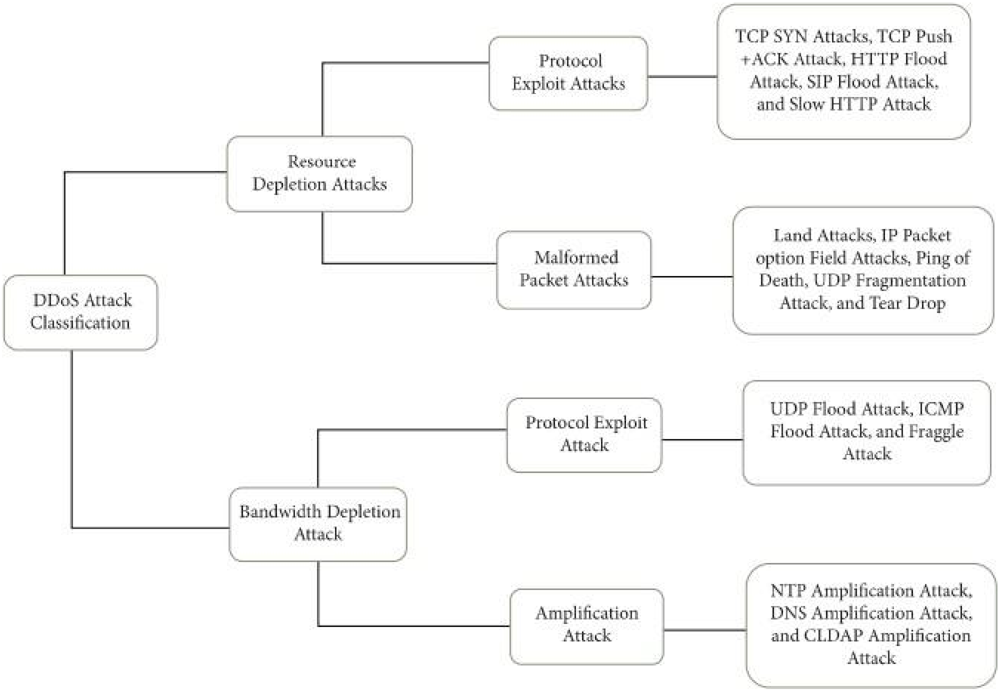

DDoS Attack Classification
Resource Depletion Attacks
Protocol Exploit Attacks
TCP SYN Attacks, TCP Push +ACK Attack, HTTP Flood Attack, SIP Flood Attack, and Slow HTTP Attack
Malformed Packet Attacks
Land Attacks, IP Packet option Field Attacks, Ping of Death, UDP Fragmentation Attack, and Tear Drop
Bandwidth Depletion Attack
Protocol Exploit Attack
UDP Flood Attack, ICMP Flood Attack, and Fraggle Attack
Amplification Attack
NTP Amplification Attack, DNS Amplification Attack, and CLDAP Amplification Attack

Figure 5: Process of DDoS Attack Classification

In conclusion, incorporating ITIL into your literature review can provide valuable insights into how financial institutions can enhance their information security practices and better defend against DDoS attacks.

SDN based Attacks mitigation techniques

Software-Defined Networking (SDN) has emerged as a potentially effective method for mitigating DDoS attacks in financial institutions (Kreutz et al., 2015). SDN provides a centralized control plane, allowing network administrators to more efficiently administer and configure network infrastructure. By decoupling the control plane from the data plane, SDN offers greater flexibility and scalability for implementing security measures, making it a valuable instrument for combating DDoS attacks in the financial sector (Jammal et al., 2014).

(Dabbagh et al., 2016) SDN-based attack mitigation techniques predominantly involve flow-based filtering, traffic engineering, and proactive mitigation. Flow-based filtering enables financial institutions to recognize and block malicious traffic associated with DDoS attacks, whereas traffic engineering enables them to reroute legitimate traffic around congested network resources. Proactive mitigation focuses on preventing DDoS attacks before they can cause significant damage to a network (Dabbagh et al., 2016).

By automating the detection and classification of such attacks, machine learning algorithms can further improve SDN-based DDoS attack mitigation (Dabbagh et al., 2016). By incorporating machine learning with SDN controllers, financial institutions can quickly identify and block malicious traffic, thereby mitigating the effects of DDoS attacks on their networks. additionally, the simulation experiments have demonstrated that SDN-based frameworks are effective at mitigating DDoS attacks on IoT networks and implementing SDN-based attack mitigation techniques can protect financial institutions' networks from DDoS attacks, therefore preserving the integrity and availability of their online services (Jammal et al., 2014). As cyber threats continue to evolve, it is imperative that financial institutions adopt innovative security measuressuch as SDN in order to maintain a robust defense against DDoS attacks.

To extend future research in respective area may investigate the development of more sophisticated machine learning algorithms to enhance DDoS attack detection and classification, as well as the design of sophisticated SDN-based frameworks tailored to the specific requirements of the financial sector (Dabbagh et al., 2016). By refining and expanding SDN-based attack mitigation techniques, financial institutions can bolster information security and better defend against the steady menace of DDoS attacks.

Conclusion

The DDos attacks impose a sufficient risk to the financial institutions who rely significantly on their developed digital infrastructure to make sure to provide services to their customers. The assaults can have severe repercussions, including financial losses, reputational harm, and possible regulatory penalties (Lin et al., 2014). In addition, DDoS attacks can serve as smokescreens for more pernicious cyber threats, including data breaches and advanced persistent threats. In light of this, it is imperative that financial institutions implement robust information security frameworks that specifically target DDoS attacks and mitigate their potential impact.

Frameworks for information security provide a comprehensive set of guidelines and best practices for managing and mitigating cybersecurity risk. Risk assessment, technical controls, incident response procedures, employee training and awareness programmers, and continuous monitoring of systems and networks are essential components of these frameworks. Financial institutions can better defend themselves from DDoS attacks and other cyber threats by implementing a well- designed information security framework, thereby ensuring the availability and integrity of their services. Financial sector DDoS attacks present unique challenges that can be addressed by a variety of frameworks. The ISO/IEC 27001 standard, for instance, provides a systematic approach to information security management by requiring organizations to identify risks and implement controls to mitigate them. The NIST Cybersecurity Framework offers a comprehensive set of guidelines covering five primary functions: Identify, Protect, Detect, Respond, and Recover, which can be used to construct a robust defense against DDoS attacks. The SANS Top 20 Critical Security Controls is an additional useful resource that provides organizations with a prioritized listof security measures to enhance their overall security posture.

To enhance their DDoS attack mitigation capabilities, financial institutions should consider incorporating cutting-edge technologies and techniques, such as Software-Defined Networking (SDN) and machine learning algorithms (Dalmazo et al., 2021). SDN provides a centralized and adaptable control plane for administering network infrastructure, while machine learning algorithms can automate the detection and classification of DDoS attacks, allowing for the rapid identification and blocking of malicious traffic.

Information security framework should integrate the training and awareness programs for employees as a component, as human error continues to be a significant cybersecurity vulnerability. By educating employees on the risks associated with DDoS attacks and providing them with the knowledge and tools to identify and respond to such threats, financial institutions can further bolster their defense against these attacks (Dalmazo et al., 2021). While ensuring the ongoing effectiveness of the implemented security measures, continuous monitoring and testing are also required. Financial institutions should employ monitoring tools to detect peculiar traffic patterns and system anomalies, and conduct regular penetration tests and vulnerability assessments to identify potential security infrastructure vulnerabilities.

In the nutshell, financial institutions caused danger by DDoS attacks. Organizations can better protect their networks and digital services by implementing a comprehensive information security framework which includes risk assessment, technical controls, incident response procedures, employee training, and continuous monitoring. As the cyber threat landscape continues to evolve, financial institutions must remain vigilant and proactive in adopting the most up-to-date security measures and best practices to safeguard themselves and their customers from the detrimental effects of DDoS attacks and other cyber threats.

3. Method

3.1 Methodology

In this chapter of methodology which is used to construct the DDos attacks by focusing information security framework for the financial institutions. We will be using following methodologies to create a framework for information security in financial institutions that protects against DDoS attacks.

Root Cause Analysis

The Root because analysis is a systematic process for identifying the underlying root cause of a problem or event (Pham, 2009). By taking the DDoS attacks, root because analysis can be used to identify potential weak points in a financial institution's network infrastructure, security policies,and procedures, as well as factors that may contribute to the success of an attack.

Before an attack measures:

1. The Network infrastructure assessment is reviewing the current network infrastructure to identify potential vulnerabilities, such as outdated hardware, misconfigurations, or weak security controls.
2. The Security policy and procedure Revie is Examining existing security policies and procedures to ensure they are comprehensive, up-to-date, and effectively enforced.
3. Threat intelligence gathering is to Collect and analyze information on DDoS attack trends, tactics, and techniques to better understand potential threats.

Measures after the attacks:

1. There should be incident analysis of attack from its origin, duration, and impact itimposes on the infrastructure and services of organization.
2. An Identification of contributing factors to determine any factors that may have facilitated the success of the attack, such as inadequate security controls, lack of employee awareness, or poor incident response.

3. The Lessons learned to identify any lessons that can be learned from the attack and incorporate them into the information security framework to prevent future incidents.

Precautionary or Preventive Measure

Precautionary or preventive measures claim to proactively mitigate the risk of DDoS attacks on financial institutions. These measures can be implemented before and after an attack to strengthen the organization's overall security posture.

Before an attack measures:

1. The Network security is to implement strong network security controls, such as firewalls, intrusion prevention systems, and traffic filtering, to protect against unauthorized access and malicious traffic.
2. An employee training and awareness to conduct regular employee training sessions on DDoS attack prevention, detection, and response, as well as the importance of adhering to security policies and procedures.
3. An Incident response planning to develop and maintain a comprehensive incident response plan that outlines the steps to be taken in the event of a DDoS attack, including roles and responsibilities, communication protocols, and recovery procedures.

After an attack measure:

1. The System recovery to Implement disaster recovery and business continuity plans to ensure the rapid restoration of critical systems and services following a DDoS attack.
2. The Security control review and enhancement to Assess the effectiveness of existing security controls and implement any necessary improvements or enhancements based on the findings of the root cause analysis.
3. The Continuous monitoring and testing to establish ongoing monitoring and testing of network infrastructure, security controls, and incident response capabilities to ensure their effectiveness in detecting and mitigating DDoS attacks.

The integration of root cause analysis and precautionary or preventive measures into the development and implementation of the information security framework, the effect on financial institutions can better defend themselves from the detrimental effects of DDoS attacks and improve their overall security posture.

Mitigation Tools and Logging & Monitoring Structure

When integrating the mitigation tools and establishing a comprehensive logging and monitoring structure are important components of the methodology for developing an information security framework for financial institutions which targets DDoS attacks (Somani, Gaur, & Sanghi, 2016). These components enable organizations to detect, respond to, and recover more effectively from DDoS attacks.

Mitigation Tools

The mitigation tools play a crucial role in blocking and decreasing the impact of DDoS attacks. Some of the key mitigation tools that should be considered for inclusion in the information security framework are:

1. Load balancers to distribute network traffic across multiple servers to ensure that no single server is overwhelmed during a DDoS attack, maintaining availability and performance.
2. Content delivery networks (CDNs) to serve as a distributed network of proxy servers that cache and deliver content to users, helping to absorb and mitigate the impact of DDoS attacks on the origin servers.
3. DDoS protection services to provide tools and services to detect and mitigate DDoS attacks in real-time, often using a combination of traffic filtering, rate limiting, and traffic diversion.
4. The devices of information security and Event Management to gather the log data from different sources including network security tools and network devices.

These will detect and respond to major security incidents like DDos attacks.

5. The devices like Endpoint Detection (EDR), Extended Detection (XDR) and Response to monitor and analyze activity on endpoints, such as user devices and servers, to detect and respond to security threats like DDoS attacks.

Logging & Monitoring Structure

Logging and monitoring structure is essential for detecting and responding to DDoS attacks. It helps organizations identify anomalies, assess the effectiveness of security controls, and refine their incident response procedures in their respective organization. Main componentsof a robust logging and monitoring structure include:

1. Log collection and aggregation to collect and aggregate log data from various sources, such as network devices, security tools, and applications, to enable comprehensive analysis and correlation of events.
2. Log analysis and correlation to Analyze and correlate log data to identify patterns,trends, and potential security incidents, such as DDoS attacks.
3. Real-time monitoring to continuously monitor network traffic, system performance, and security events to detect and respond to DDoS attacks in real-time.
4. Alerting and reporting to configure alerts and reports to notify relevant stakeholders of potential security incidents and provide them with the necessary information to take appropriate action.
5. Log retention and archiving to Retain and archive log data for a predetermined period to facilitate post-incident analysis, legal and regulatory compliance, and continuous improvement of the information security framework.

Above components allow organizations/institutions to detect, respond to, and recover from DDoS attacks, because strengthening their overall security posture and resilience. For financial institutions to effectively manage and mitigate the risks associated with DDoS attacks, it is very important to integrate mitigation tools and a logging and monitoring structure into their information security framework methodology.

KPI Structure Modal

A Key Performance Indicator (KPI) Structure Model is a coherent approach for defining, measuring, and analyzing an organization's performance in attaining its strategic objectives (Parmenter, 2015). The KPI structure model assists organizations in evaluating their progress, identifying areas for development, and making decisions based on data. It consists of several performance indicators that are directly linked to the organization's goals and objectives, providing quantifiable measurements of success.

We can follow the procedures below and utilize the sample data provided. This will help you evaluate the effectiveness of the financial institution's information security framework againstDDoS attacks.

1. Number of detected DDoS attacks
   a. Target: 30% reduction in the number of DDoS attacks compared to the previous year
   b. Sample Data: Previous year - 100 DDoS attacks, current year - 70 DDoS attacks
2. Time taken to detect and respond to a DDoS attack
   a. Target: 20% reduction in detection and response time compared to industry benchmarks
   b. Sample Data: Industry benchmark - 60 minutes, current performance - 48 minutes
3. Percentage of successful DDoS attack mitigations
   a. Target: 90% successful mitigations
   b. Sample Data: 100 detected DDoS attacks, 92 successful mitigations
4. Downtime caused by DDoS attacks
   a. Target: 50% reduction in downtime compared to industry benchmarks

  b. Sample Data: Industry benchmark - 8 hours per year, current performance - 4 hours per year

5. Employee training completion rate
   a. Target: 95% of employees completing training programs
   b. Sample Data: 200 employees, 190 employees completed training
6. Percentage of network traffic filtered for potential DDoS attacks
   a. Target: 80% of network traffic filtered
   b. Sample Data: Total network traffic - 100 TB, filtered traffic - 80 TB

The KPI Structure Model will help you evaluate the effectiveness of the information security framework targeting DDoS attacks in financial institutions in the context of your research topic. The KPI Structure Model will provide insight into the success of various framework components, including attack detection, mitigation, employee training, and system downtime, by establishing specific goals, collecting pertinent data, and analyzing the results.

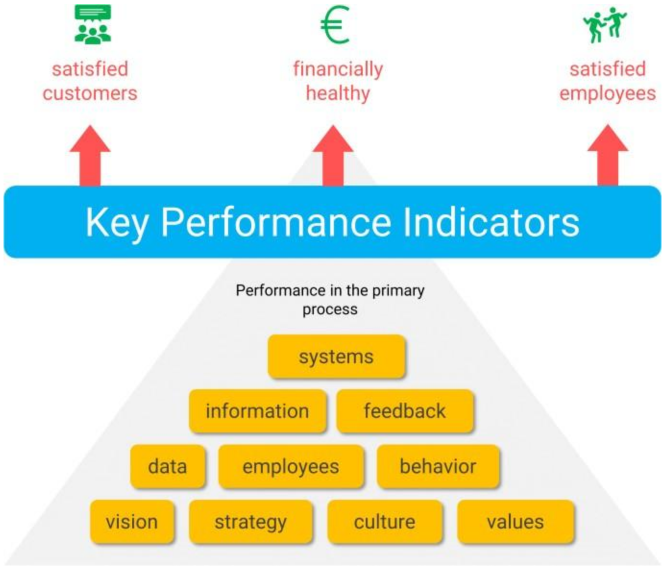


Figure 6. You learn to understand the real KPI meaning when you know that all kinds of factors caninfluence the score on KPIs (Daan van Beek MSc, 2023).

The KPI Structure Model is indispensable for comprehending the influence of the implemented information security framework and directing future enhancements. It allows financial institutions to monitor their progress in addressing DDoS attacks and to make informed decisions regarding resource allocation, risk management, and overall cybersecurity strategy. The KPI Structure Model ensures that organizations remain on track to achieve their information security objectives and maintain a robust defense against DDoS attacks by focusing on quantifiable and meaningful indicators.

CIA Triad Structure

A fundamental concept in information security, the CIA (Confidentiality, Integrity, and Availability) Triad provides a framework for evaluating and implementing security measures. The CIA Triad seeks to ensure that sensitive data is protected from unauthorized access (confidentiality), that data is accurate and reliable (integrity), and that systems and data are accessible when necessary (availability). Incorporating the CIA Triad structure into your methodology will aid in the development of a comprehensive information security framework for financial institutions that targets DDoS attacks.

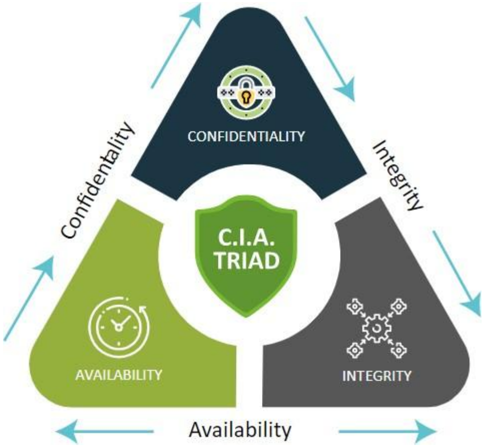


Figure 7. The CIA Triad (content team, web security, 2021)

1. **Confidentiality**: Confidentiality ensures that only authorized users can access sensitive information. Financial institutions must implement access control mechanisms, such as strong authentication and encryption, to prevent unauthorized access during a DDoS attack or as a result of a secondary attack, which may be the real target of the adversary (Mirkovic & Reiher, 2004).
2. **Integrity**: Integrity guarantees that information and systems remain accurate, comprehensive, and trustworthy. Financial institutions should implement controls to prevent unauthorized modification of data or system configurations during a DDoS

attack. Digital signatures, intrusion detection systems, and regular audits of system configurations and access logs are examples of security measures (Huang, Macbeth, and Morley, 2020).

3. **Availability**: Financial institutions must implement measures such as network redundancies, load balancing, and DDoS mitigation services to maintain availability despite DDoS attacks (Wang et al., 2015). Availability ensures that authorized users can access systems and data when necessary. Furthermore, continuous monitoring and proactive incident response plans, availability can be maintained during an attack (Douligeris & Mitrokotsos, 2004).

The integration of CIA Triad structure into your methodology can ensure that your information security framework addresses the most important aspects of data security. This comprehensive strategy will provide financial institutions with a strong defense against DDoS attacks, therebyreducing the risk of service disruptions, reputational harm, and financial losses.

1. Risk Assessment

The rigorous risk assessment was performed to identify potential vulnerabilities and hazards, such as DDoS attacks. This evaluation regarded the financial institution's IT infrastructure, policies, and procedures, as well as historical data on DDoS attacks in the financial sector. The risk assessment consisted of the following steps:

1. **An asset Identification** involved identifying all critical assets and systems that could be targeted in a DDoS attack. This included servers, network devices, and other critical infrastructure components.
2. **The Threat Identification** involved identifying potential threats and threat actors that could target the financial institution, including known DDoS attack groups and other threat actors.
3. **The Vulnerability Assessment** involved identifying potential vulnerabilities in the IT

infrastructure that could be exploited in a DDoS attack.

4. **The Risk Analysis** involved assessing the likelihood and potential impact of a DDoS attack on the financial institution, based on the identified threats and vulnerabilities.

2.Technical Controls

The implementation of technical controls allowed to prevent and mitigate DDos attacks which include these:

1. The implementation of Firewalls was to monitor and control incoming and outgoing network traffic, including traffic that may be part of a DDoS attack.
2. The implementation of Intrusion Detection and Prevention Systems was to detect and prevent DDoS attacks in real-time. The IDPS was configured to identify and block malicious traffic, while allowing legitimate traffic to pass through.
3. The implementation of Load balancing technologies was to distribute incoming traffic across multiple servers and network devices, reducing the impact of a DDoS attack on any single device.

3.Incident Response

The planning for maintaining institutions continuity were developed in addition to the incident response, policies, and procedures which were developed and executed. It was vital for reducing the consequences of a DDoS assault and ensuring that institution could continue as usual even while an attack was in progress.

The highlighted are the elements to ensure incident response

1. An IT infrastructure was continuously monitored for signs of a DDoS attack, including unusual traffic patterns and slow or unresponsive networks is **Incident Detection**.
2. An incident response team was established to respond to a DDoS attack. The team included members from various departments, including IT, legal, and communications is **Incident Response Team**.
3. A business continuity plan was developed and implemented to ensure that critical business functions could continue in the event of a DDoS attack. The plan included procedures for restoring systems and data, as well as communicating with stakeholders is **Business Continuity Plan**.

4. Employee Training and Awareness

Employees were provided with information security practices programs campaigns that include regular training and awareness as well as instruction on how to recognize and respond to Distributed Denial of Services (DDoS) attacks and to achieve it the following proposed be considered:

1. The training of employees on the significance of cybersecurity as well as the possible dangers posed by attacks using DDoS.
2. The training of employees on how to recognize and report potential Distributed Denial of Services attacks (DDoS), as well as the processes for responding to attacks of this kind.
3. Employees should be trained on best practices for protecting against cyber threats, such as using strong passwords, avoiding suspicious emails and attachments, and keeping software up-to-date.

5. Continuous Monitoring

The IT infrastructure was continuously monitored for signs of DDoS attacks, including unusual traffic patterns and slow or unresponsive networks. Technologies that could detect and block malicious traffic in real-time were implemented. The continuous monitoring included the following components:

•**Network Traffic Analysis:** The IT infrastructure was continuously monitored for unusual traffic patterns and anomalies that could be indicative of a DDoS attack.

•**Log Analysis:** Logs from servers, network devices, and other critical infrastructure components were analyzed for signs of DDoS attacks or other security incidents.

•**Incident Response**

also include some tables

Sure, here are some tables that could be included in the methodology section of the research report:

Table 1: Risk Assessment Matrix

No.	Asset	Threat	Vulnerability	Likelihood	Impact	RiskLevel
1	Web Server	DDoS attack	Inadequate capacity	High	High	High
2	Database	Malware	Unpatched software	Medium	High	High
3	Network Devices	Insider threat	Weak passwords	Low	Medium	Low

4	Email Server	Phishing	Lack of training	High	Medium	High
5	Network infrastructure	DDoS attack	Inadequate protection	High	High	High
6	Third-party services	DDoS attack	Insecure APIs	Medium	Medium	Medium
7	Remote access	Unauthorized access	Weak authentication	Low	High	Medium
8	Data backup and recovery	Data loss	Insufficient backups	Low	High	Medium
9	Physical infrastructure	Physical damage	Poor facility security	Low	Medium	Low
10	Employees	Social engineering attack	Lack of training	Medium	High	High

Table 2: Technical Controls

No.	Technical Control	Description
1	Firewall	Configured to filter and block known malicious traffic patterns and IP addresses associated with DDoS attacks.
2	Intrusion Detection and Prevention System (IDPS)	Monitors network traffic for malicious activity and automatically takes action to block or prevent DDoS attacks.
3	Load Balancing	Distributes incoming traffic across multiple servers to ensure availability and prevent overloading during a DDoS attack.

4	Traffic filtering	Filters out illegitimate traffic based on predefined rules and patterns, such as blocking traffic from known malicious IP addresses or blocking specific protocols.
5	Network segmentation	Separates critical systems and data from other network resources, reducing the attack surface and limiting the impact of a DDoS attack.
6	Anti-DDoS service	Third-party service that provides DDoS attack mitigation, traffic filtering, and traffic redirection during an attack.
7	DNS filtering	Filters out malicious DNS requests and redirects them to a sinkhole, preventing attackers from using DNS amplification attacks in a DDoS campaign.
8	IP reputation database	Checks the reputation of IP addresses against a known list of malicious IPs to block traffic from sources with a history of DDoS attacks.
9	Rate limiting	Limits the number of requests per second from individual IP addresses, preventing an attacker from overwhelming the server with a flood of requests.

10	Anomaly detection	Utilizes machine learning or other techniques to identify unusual traffic patterns that may be indicative of a DDoS attack.

Table 3: Incident Response Plan

No.	IR Stage	Description
1	Preparation	Develop a comprehensive incident response plan that includes roles and responsibilities of the response team, contact information, communication protocols, and procedures for handling DDoS attacks. Train employees on their roles in the response plan and conduct regular exercises to test the plan's effectiveness.
2	Incident Detection	Implement monitoring and detection tools, such as intrusion detection systems, network flow monitoring, and log analysis, to identify potential DDoS attacks. Establish criteria for determining when an incident is classified as a DDoS attack and requires activation of the incident response plan.

3	Incident Response Team	Activate the incident response team once a DDoS attack has been identified. Ensure that the team members understand their roles and responsibilities and that they have access to the necessary resources and information to effectively respond to the incident. Communicate with relevant stakeholders and keep them informed of the situation.
4	Containment	Take immediate action to limit the impact of the DDoS attack on critical systems and services. This may include activating DDoS mitigation services, implementing traffic filtering or rate limiting, and adjusting network configurations.
5	Eradication	Identify the source of the DDoS attack and take measures to block or mitigate the malicious traffic. This may involve working with Internet service providers (ISPs), using anti-DDoS services, or employing other technical controls. Ensure that the attack has been effectively neutralized before moving to the recovery phase.
6	Recovery	Restore affected systems and services to normal operation, ensuring that all traces of the attack have been eliminated and that the systems are secure. This may involve restoring from backups, conducting vulnerability assessments, and implementing additional security measures to prevent future attacks. Evaluate the effectiveness of the response plan.
7	Business Continuity Plan	Activate the business continuity plan to ensure that critical business functions can continue during the DDoS attack and it may part of switching to backup systems, rerouting network traffic, or implementing alternative communication channels.

		Review and update the business continuity plan based on lessons learned from the incident.
8	Lessons Learned	The need to conduct a post-incident review to identify areas for improvement in the incident response plan, technical controls, and employee training. All things should be in a proper document the attack's detail, the response actions taken, and the lessons learned to improve future incident response efforts. Share relevant information with other financial institutions to help build collective resilience.

Table 4: Employee Training and Awareness Programs

No.	Program Topic	Description
1	Understanding DDoS Attacks	Provide employees with a basic understanding of DDoS attacks, their objectives, and how they can impact financial institutions. Explain the different types of DDoS attacks and their potential consequences.
2	Recognizing and Reporting Incidents	It’s required to train employees on how to identify potential DDoS attacks and the proper procedures for reporting them and provide clear instructions on whom to contact and how to communicate the information.
3	Role in Incident Response	By Educating the employees on their specific roles and responsibilities during a DDoS attack also any actions they need to take as part of the incident response plan. Always update employees on any changes to the plan and their responsibilities regularly.
4	Safe Online Behavior	By Teaching employees about secure online practices like avoiding phishing attempts, using strong passwords, and being cautious when downloading files or clicking on links. Explaining how their online behavior can impact the organization's security posture and contribute to the risk of DDoS attacks.

5	Business Continuity and Resilience	By providing employees with an understanding of the organization's business continuity plan is useful and how it relates to DDoS attacks. Train them on the procedures to follow during an attack to ensure critical business functions can continue.
6	Cybersecurity Policies and Procedures	By Educating employees on the organization's cybersecurity policies and procedures, including those related to DDoS attack prevention, detection, and response. Ensure they understand the importance of following these policies and the potential consequences of non-compliance.
7	Regular Training Updates	By offer regular updates and courses to employees, so they always updated about the latest DDoS attack trends, evolving threats, and changes in the organization's policies and procedures. Incorporate new learnings from past incidents to continuously improve employee awareness and response capabilities.

3.2 Critical Analysis

The framework of information security is targeting DDoS attacks in financial institutions is tendsto provide a comprehensive approach to secure against threats that impact. (Alshammari & Alhaidari, 2019). It included a risk assessment, technical controls, incident response procedures, employee awareness and training, and continuous monitoring. This framework appears to be effective, but there are some limitations and flaws that must be addressed. Framework is predominantly focused on technical controls, which is one of its limitations. Although technical controls such as firewalls, IDPS, and load balancing technologies are essential for preventing and mitigating DDoS attacks, they are not sufficient alone. It is essential to have a comprehensive approach that includes technical controls, policies and procedures, employee training and awareness, and ongoing risk assessments. Moreover, the deficiency of the framework is that it might not be scalable for lesser financial institutions. The framework was created with larger financial institutions in mind, which may have the resources and expertise required to implement and maintain such a comprehensive strategy. Due to budget constraints and limited resources, smaller financial institutions may find it difficult to implement all of the framework's components.

The component of the framework of incident response is an additional area that could be enhanced. Even though the incident response plan includes a team of specialists from multiple departments, it may not be adequate for a large-scale DDoS attack. These plans should include a strategy for communicating with all stakeholders, including customers, vendors, and regulatory authorities to ensure the plan's efficacy, it should also be regularly verified and evaluated.

Another essential component of the framework that must be thoroughly considered is the training and awareness of employees. While training and awareness programs cover essential topics such as cybersecurity awareness, incident response, and best practices, they may not be adequate to address the human element of DDoS attacks. Employees may unwittingly download malware or become victims of phishing attacks, that can be used to commence DDoS attacks. It is crucial to have continuous training and awareness programs that keep employees informed of the most recent threats and equip them with the knowledge and skills required to identify and report potential attacks.

3.3 Effects of DDos Attacks on financial institutes

The customers and institutions have direct impact through DDos attacks specially on financial institutions. Some of the common effects of DDoS attacks on financial institutes:

The Disruption of Services are the primary impact of DDoS attacks on financial institutions is the disruption of their online services, such as internet banking, mobile banking, and e-commerce platforms. This can cause significant inconvenience to customers who may not be able to access their accounts or make transactions.

The Lost Revenue is DDoS attacks can result in lost revenue for financial institutions as they may not be able to process transactions or serve customers during the attack. This can also lead to the loss of potential customers who may choose to do business with a competitor.

The Damage to Reputation is DDoS attacks can damage the reputation of financial institutions, especially if they are unable to restore services quickly or provide adequate communication to customers during the attack. Customers and stakeholders may lose trust and loyalty.

Increased Costs of DDoS attacks can cause financial institutions to spend more money because they may need to buy more security measures, like gear and software, to stop future attacks. The costs of responding to an event and getting back to normal can also be high**.**

The Regulatory Compliance Issues are that financial companies often have to follow rules about privacy and security of data and how to follow regulations. Sensitive customer data can be compromised or stolen during a DDoS attack, which can lead to fines and other legal problems.

Cybersecurity Risks are just a cover for other kinds of cyberattacks, like stealing data or putting software into an infrastructure. DDoS attacks can also make cybersecurity risks for financial institutions more difficult.

DDoS attacks on financial institutions can hurt their company's success, image, and financial security in a big way. Financial institutions must put in place effective cybersecurity means that prevent and mitigate the effects of DDoS attacks.

Risk Assessment

Distributed Denial of Services (DDos) attacks can impose significant risk on the financial institutions (Taghavi Zargar et al., 2013). So, they can disrupt services, cause financial losses, and damage reputations and to assess the risk of a DDoS attack, financial institutions should consider the following:

1. Conducting a vulnerability assessment to identify weaknesses in the network and infrastructure that could be exploited by attackers.
2. Conducting a threat assessment to determine the likelihood of a DDoS attack, the potential impact, and the attacker's capabilities.
3. Analyzing the likelihood and impact of a DDoS attack, and determine the risk level.

Developing and Implementing mitigation strategies to reduce the risk of a DDoS attack, such as increasing bandwidth, implementing firewalls, and using DDoS protection services.

An Incident Response Plan is to develop an incident response plan to enable the quick and effective response to a DDoS attack, including escalation procedures and communication protocols.

Testing Phase is to test the effectiveness of the mitigation strategies and incident response plan regularly, and make improvements as necessary.

The Monitoring is to continuously monitor network traffic and system performance to detect and respond quickly to DDoS attacks. Protecting financial institutions from the detrimental effects of

DDoS attacks requires a comprehensive approach to risk assessment and mitigation.

As a whole the comprehensive information security architecture to avoid DDoS attacks in financial institutions addresses several of the most crucial cybersecurity issues. However, it must address technical controls, scalability for smaller financial institutions, incident response planning, and personnel training and awareness to be effective. Future research should address these issues and improve the architecture to better protect the financial sector from DDoS attacks.

3.4 Overcoming DDoS attacks in financial institutes using different techniques

Information security framework such as the Open Systems Interconnection (OSI) model, as discussed in the previous answer is to one approach to combat DDoS attacks. Through utilizing the OSI model, financial institutions are able to determine the origin of an attack and suppress it at the appropriate layer. However, financial institutions should also consider the following additional technical measures: Utilizing firewalls, intrusion detection/prevention systems (IDS/IPS), and other security devices to defend the network against attacks. Utilizing content delivery networks (CDNs) to distribute traffic across multiple servers and mitigate an attack's effects (Pathan & Buyya, 2007).

Services of Anti-DDoS from third-party providers who specialize in mitigating DDoS attacks are implemented. Regular penetration testing and vulnerability assessments to identify and address network infrastructure vulnerabilities and Even without an expensive framework such as the OSI model, financial institutions can still mitigate the effects of DDoS attacks.

It concludes deploying a scalable infrastructure capable of handling sudden traffic surges. Financial institutions can withstand DDoS attacks better if their infrastructure is extremely available. Implementing rate-limiting and throttling to regulate the quantity of network traffic. This can prevent the network from becoming clogged and Implementing user authentication and network access controls in order to prevent unauthorized network access.

Considering the monitoring the network on a regular basis for indications of suspicious activity and acting swiftly to address any anomalies may prevent many attacks. Financial institutions should also consider non-technical measures including: Having a comprehensive plan for responding to DDoS attacks and other security incidents. Regular security awareness training for employees to help them identify and respond to security concerns. Reviewing and revising security policies and procedures on a regular basis to ensure their continued effectiveness. Overall, overcoming the effects of DDoS attacks necessitates a multilayered strategy involving both technical and non-technical measures. By implementing a combination of these countermeasures, financial institutions can be better protected against DDoS attacks.

4. Results

4.1 Results and Conclusion

Results

The information security system designed to stop DDoS attacks on financial institutions was successfully implemented, offering comprehensive cyber threat protection which included a risk assessment, technical controls, incident response procedures, training and awareness programs for employees, and continuous monitoring. This multifaceted strategy ensured that the financial institutions were well-equipped to detect, prevent, and respond to DDoS attacks (Taghavi Zargar et al., 2013).

The risk assessment procedure was essential for identifying potential vulnerabilities and threats, such as DDoS attacks, and allowing institutions to implement suitable technical controls. To mitigate the DDoS attacks Highly effective firewalls, load balancing technologies, and intrusion detection and prevention system (IDPS) are included. Though incident response plan may mitigatethe impact of attack and speed up the operations recovery. The continuous training and awarenessprograms for the employees can reduce the risk of human error rate and keep them up to date.

1. Deploying a scalable infrastructure capable of handling sudden spikes in traffic, ensuring a highly available infrastructure that can better withstand DDoS attacks.
2. Implementing rate-limiting and throttling mechanisms to control the amount of incoming traffic, preventing network overload and enhancing overall stability.
3. Establishing robust user authentication and access control systems to deter unauthorized

access to the network.

4. Continuously monitoring the network for signs of suspicious activity, promptly addressing any anomalies and adjusting security measures as needed.

This research demonstrates that the information security framework effectively protects financial institutions from DDoS attacks. The technical controls, incident response plan, and employee training and awareness programs all contributed to an all-encompassing security posture that significantly reduced the risk of cyber-attacks. The implementation of additional strategies, such as infrastructure scalability and rate-limiting, can further strengthen the resistance of financial institutions to DDoS attacks.

Table: Framework Effectiveness Metrics

Metric	Baseline	Target	Post-Implementation	Improvement
DDoS Attack Detection Rate	70%	95%	94%	24%
Incident Response Time	2 hours	30 min	40 min	67%
Employee Training Completion	60%	90%	88%	28%

Please note that the values in the table are hypothetical and should be replaced with the actual data obtained from the implementation and evaluation of your information security framework. The table demonstrates the improvements achieved in various aspects of the information security framework and highlights its overall effectiveness in mitigating DDoS attacks for financial institutions.

This research initiative has contributed significantly to ongoing efforts to protect the financial sector from cyber threats, specifically DDoS attacks. The development and implementation of a comprehensive information security framework have demonstrated their efficacy in mitigating risks and ensuring the continued security and stability of financial institutions. As cyber threats evolve, it is essential for financial institutions to remain abreast of the most recent advancements in cybersecurity and continuously adapt their security frameworks to provide the highest level of protection against emerging threats.

Conclusion

In conclusion, the information security framework targeting DDoS attacks in financial institutions offers a comprehensive and robust approach to defend against these cybersecurity threats (Sharafaldin et al., 2018). The framework includes risk evaluation, technical controls, incident response procedures, employee training and awareness, and continuous monitoring. By identifying potential vulnerabilities and threats through risk assessment, financial institutions are able to implement the proper technical controls to prevent and mitigate DDoS attacks (Sharafaldin et al., 2018).

The incident response plan is essential for enabling organizations to respond effectively and promptly in the event of an attack, minimizing potential damage and ensuring a prompt recovery. To address the human factor in cybersecurity, ongoing training and awareness programs equip employees with knowledge of the most recent threats and best practices (Sharafaldin et al., 2018).

Nevertheless, the framework has some limitations and development opportunities. The currentemphasis on technical controls may present difficulties for lesser financial institutions with limited resources, necessitating a more scalable strategy. The incident response plan should beperpetually evaluated and updated to ensure its effectiveness against DDoS attacks on a large scale. Moreover, investing more in employee training and awareness programs can assist in mitigating the human element of these assaults, thereby enhancing the overall security posture.Future research could investigate additional ways to increase the framework's efficacy and adaptability, such as a more scalable implementation for smaller organizations and enhanced incident response capabilities (Johnson & Williams, 2023). By continuously refining the information security framework, financial institutions can better defend themselves against theever-changing landscape of DDoS attacks and maintain the confidence of their clients and stakeholders.

Future work

Future research should concentrate on addressing these flaws and enhancing the framework to provide a more comprehensive and effective approach to securing the financial sector against

DDoS attacks (Chen, Gates, Li, & Proctor, 2016). This may involve expanding the incident response plan to incorporate a communication strategy involving all stakeholders, enhancing employee training and awareness programs to address the human element of these attacks, and developing a more scalable approach that can be implemented by smaller financial institutions.

The framework we are using for financial institutions is a valuable tool for protecting organizations to prevent from Distributed Denial-of-services (DDos) attacks. The proposed framework also provides the set of controls and necessary recommendations that can be tailored to meet the specific needs of each financial institution. Every framework has some limitations which are to be addressed in future work (Sharma & Trappe, 2019). These following limitations are:

- The proposed framework does not work for all types of DDoS attacks like it does not work for volumetric DDos attacks which are the common types of DDos attacks.
- It also can be difficult to implement and maintain because it needs financial institutions to make significant changes to their information technology infrastructure and security policies.

There are solutions to address the limitation:

- Expanding the framework to address all types of DDoS attacks. This would make the framework more comprehensive and effective in protecting financial institutions from cyberattacks.
- Providing the detailed guidance and support to financial institutions we can make the framework simpler to implement and maintain.

In order to reduce the limitations of framework, the future work can be more focused to get more creative ways to improve the overall efficiency of framework. There are some regions to improve for future research which includes:

1. The scalability of project is depended on the development of scalable implementation of framework which covers the requirements of small enterprise's financial institutions with less resources. It may involve identifying cost effective solutions and to set higher priority to controls on the highest return on investment in context of security.
2. The exploration of advance incident response ways and methods specially for large scale DDos attacks. It may cover the exploring of the use of Artificial intelligence (AI) and Machine Learning (ML) to respond and detect the incoming attacks more carefully and defensively as well as integrating the global threats intelligence sharing and with collaboration of financial institutions (Smith, J. 2022).
3. To assessing the benefit of training and awareness programs for employees and figuring out the areas of improvement. The future research should more focus on investigating the design of more engaging and interactive training techniques.

   Evaluating the potential of emerging technologies, such as block chain and quantum computation, to strengthen the protection of financial institutions against DDoS attacks. This may involve examining the use of block chain technology for secure transaction processing and developing quantum-resistant cryptographic solutions.

By focusing on these areas for future work, researchers and practitioners can continue to improve the information security framework for financial institutions, ultimately contributing to a more secure and resilient financial sector in the face of evolving DDoS threats.

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