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Research Question: How effective are modern next generation firewalls in preventing contemporary cyber threats such as ransomware, malware, and unauthorized network intrusions?

Hatkar, S., Rout, K., Lad, A., & Swathika, O. V. G. (2025). An Integrated UTM Solution for Modern Cybersecurity: Combining Deep Inspection, ML, and Policy Automation. *IEEE Access*, *13*, 176010–176023. https://doi.org/10.1109/ACCESS.2025.3618281

The effectiveness of modern firewalls in preventing cyber threats has become an important topic as cyber attacks continue to increase in frequency and complexity. There has also been debate about whether next generation firewalls are truly more effective than traditional security systems. (Hatkar et al., 2025), *An Integrated UTM Solution for Modern Cybersecurity: Combining Deep Inspection, ML, and Policy Automation*, discusses the performance of modern unified threat management and next generation firewall systems in protecting networks from cyber threats. This source is a peer-reviewed journal article published in IEEE Access, which is part of the IEEE organization, a well known authority in electrical engineering and computer science research. First, one of the main strengths of modern firewall systems is their ability to maintain high performance under heavy network traffic. The study showed that firewall effectiveness remained above 94% even when network traffic reached 1000 Mbps. Although network latency increased slightly as traffic load increased, the firewall was still able to operate efficiently. This is important because real world networks often experience high traffic conditions, and security systems must still function reliably. Another important finding in the article concerns threat detection accuracy. The system recorded a false positive rate of 2.3% and a false negative rate of 3.1%, which are considered acceptable levels in cybersecurity testing. These statistics are important because cybersecurity systems must balance security protection with normal network usability. If a firewall produces too many false alarms, it may interrupt normal network operations. At the same time, if threats are missed, malicious attacks may enter the network. Therefore, detection accuracy is an important factor when evaluating modern firewall effectiveness. The article also explains the role of deep packet inspection, which allows firewalls to analyze packet contents rather than only filtering traffic based on network addresses or ports. The study is based on a structured system design that integrates machine learning (ML) and automated policy management, which helps improve threat detection and makes the research more accurate and relevant to modern cybersecurity environments.

For several reasons, (Hatkar et al., 2025) article will be a good reference for my research paper. First, the article provides measurable data about firewall performance and threat detection accuracy. Also, the article explains both the strengths and limitations of next generation firewall technology in preventing modern cyber threats.

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Finistrella, S., Mariani, S., & Zambonelli, F. (2025). Multi-Agent Reinforcement Learning for Cybersecurity: Classification and survey. *Intelligent Systems with Applications*, *26*, Article 200495. https://doi.org/10.1016/j.iswa.2025.200495

As cyber threats such as ransomware, malware, and unauthorized network intrusions continue to evolve, cybersecurity technologies must become more adaptive and intelligent to effectively defend modern networks. (Finistrella et al., 2025) article, *Multi-Agent Reinforcement Learning for Cybersecurity: Classification and survey*, examines how reinforcement learning and multi-agent systems can improve the ability of cybersecurity technologies to detect and respond to threats. This source is a peer reviewed academic article published in the journal *Intelligent Systems with Applications*, which focuses on research related to artificial intelligence and advanced technological systems. This source is a peer-reviewed academic article published in the journal *Intelligent Systems with Applications*, which focuses on research related to artificial intelligence and advanced technological systems. The article explains that many traditional cybersecurity tools rely heavily on predefined rules and signature-based detection methods, which makes it difficult to detect new or evolving cyber threats. Because attackers frequently modify their techniques to bypass security defenses, systems that rely only on known threat signatures may fail to detect sophisticated attacks such as ransomware or advanced malware. The authors also discuss how reinforcement learning can allow cybersecurity systems to continuously learn from their environment and adapt their responses to changing threats. This approach enables security technologies to analyze patterns in network traffic, system behavior, and potential anomalies in order to identify suspicious activity. By learning to distinguish between normal and malicious behavior, reinforcement learning systems can improve threat detection accuracy while also reducing false positives. In addition, these adaptive systems can respond to threats in real time, which is important for preventing attacks before they cause serious damage to a network.

For these several reasons, (Finistrella et al., 2025) article will be a valuable reference for my research paper. First, the article explains the limitations of traditional cybersecurity defenses and why more advanced and adaptive technologies are needed to address modern cyber threats. Also, the research helps explain how intelligent detection systems can strengthen modern network security tools, including technologies used in next generation firewalls.

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Heino, J., Hakkala, A., & Virtanen, S. (2022). Study of methods for endpoint aware inspection in a next generation firewall. *Cybersecurity (Singapore)*, *5*(1), Article 25. https://doi.org/10.1186/s42400-022-00127-8

The role of next generation firewalls in detecting modern cyber threats has become increasingly important as attacks such as ransomware and malware continue to evolve. (Heino et al., 2022) article, *Study of Methods for Endpoint Aware Inspection in a Next Generation Firewall*, examines how advanced firewall technologies analyze network traffic and endpoint behavior to improve cybersecurity defenses. This source is a peer-reviewed academic article published in the journal Cybersecurity (Singapore), which focuses on research related to modern digital security systems. One of the key points discussed in the article is the critical role of application identification in modern network security. Next generation firewalls (NGFWs) analyze which applications are communicating across a network, enabling them to detect suspicious or abnormal behavior that may indicate malicious activity. This approach improves upon traditional firewall systems, which typically filter traffic only based on IP addresses and port numbers. Because traditional firewalls rely on these limited methods, they often struggle to detect sophisticated threats, such as ransomware or malware, that can hide within legitimate network traffic.Another important concept is deep packet inspection (DPI), which allows NGFWs to examine the actual contents of network traffic rather than only connection metadata. By analyzing deeper layers of communication, firewalls can identify malicious code embedded in otherwise normal-looking transmissions. The article also highlights core NGFW capabilities, including intrusion prevention systems (IPS), application control, and encrypted traffic inspection. These features enhance the ability of firewalls to detect threats such as unauthorized access attempts, malware infections, and ransomware activity. Additionally, monitoring endpoint behavior is critical, since legitimate devices can be compromised and act as internal threats. NGFWs address this risk using passive monitoring and dynamic inspection techniques, identifying suspicious activity without disrupting normal network performance. The article also discusses how NGFW technologies are evolving to protect cloud-based environments and distributed networks. As organizations increasingly rely on cloud infrastructure, firewall systems must monitor traffic across multiple platforms and locations. The research also highlights proactive detection methods, allowing firewalls to investigate suspicious activity before full attacks occur.

For these several reasons, (Heino et al., 2022) article is a valuable source for my research. It explains the technical features that make NGFWs more effective than traditional firewalls and provides insight into how advanced inspection methods and endpoint monitoring improve the detection of modern cyber threats. I will use this source in my paper to support my argument that NGFWs are highly effective in preventing ransomware, malware, and unauthorized intrusions by demonstrating how their advanced capabilities improve threat detection and overall network security.

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Jenkinson, A. (2022). Ransomware and Cybercrime (1st ed.). CRC Press. https://doi.org/10.1201/9781003278214

The growing threat of ransomware has become one of the most serious cybersecurity challenges in recent years, making it important to evaluate how effective modern security tools like next generation firewalls are in preventing such attacks. In Ransomware and Cybercrime by Andrew Jenkinson (2022), the author examines the evolution of ransomware, how these attacks operate, and the challenges organizations face in defending against them. This source is a scholarly book published by Taylor & Francis, a well-known academic publisher that produces credible and peer-reviewed research materials. The book provides a comprehensive overview of ransomware as a form of cybercrime, making it highly relevant to evaluating firewall effectiveness. First, one of the key insights from Jenkinson's work is that modern ransomware attacks have become increasingly sophisticated, often using social engineering, phishing, and fileless malware techniques to bypass traditional security defenses. This is important because it shows that next generation firewalls must go beyond basic packet filtering and signature-based detection in order to remain effective. The book explains that many ransomware attacks begin with user interaction, such as clicking a malicious email link, which means that firewalls alone may not be sufficient to fully prevent attacks. This highlights a limitation in firewall technology, as human behavior remains a major vulnerability in cybersecurity systems. Another important point discussed in the book is the use of encryption and stealth techniques by ransomware attackers. These methods allow malicious software to evade detection by standard security systems, including some firewall configurations. Jenkinson emphasizes that attackers often exploit zero-day vulnerabilities and legitimate system tools, making it difficult for even advanced systems to detect threats in real time. This is relevant to next generation firewalls because, although they include features like deep packet inspection and intrusion prevention systems, they may still struggle against highly advanced or previously unknown threats. The book also explores the broader cybersecurity ecosystem, explaining that effective ransomware prevention requires a layered security approach. This includes endpoint protection, user education, network monitoring, and incident response planning, in addition to firewalls. This perspective is important because it suggests that next generation firewalls are only one component of a larger defense strategy. While they can significantly reduce the risk of unauthorized network intrusions and known malware, they are not a complete solution on their own.

For several reasons, Jenkinson's book will be a valuable reference for my research paper. First, it provides a detailed explanation of how ransomware attacks function and why they are difficult to

prevent. Additionally, the book discusses both the capabilities and limitations of modern cybersecurity defenses, including firewall technologies. This makes it useful for evaluating how effective next generation firewalls are in protecting against contemporary cyber threats such as ransomware, malware, and unauthorized network intrusions.

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Research Question: How effective are modern next generation firewalls in preventing contemporary cyber threats such as ransomware, malware, and unauthorized network intrusions?

Moila, R. L., & Velempini, M. (2026). Integrating NLP and Ensemble Learning into Next-Generation Firewalls for Robust Malware Detection in Edge Computing. *Sensors (Basel, Switzerland)*, *26*(2), 424. https://doi.org/10.3390/s26020424

The effectiveness of next generation firewalls in preventing modern cyber threats has become increasingly significant as attacks such as ransomware, malware, and unauthorized intrusions continue to grow more sophisticated. The provided source examines how integrating advanced technologies such as natural language processing (NLP) and ensemble learning enhances the ability of next generation firewalls (NGFWs) to detect and mitigate cyber threats. This source is a scholarly research article that focuses on improving cybersecurity systems through artificial intelligence and machine learning, particularly within distributed and edge computing environments. One of the key points discussed in the article is the high level of accuracy achieved by these advanced models, noting that the "proposed NLP–ensemble model achieves 95% and 98% accuracy on cyber threat and CSE-CIC-IDS2018 datasets, respectively" (Moila & Velempini, 2026). This demonstrates that NGFWs can be highly effective when enhanced with intelligent detection systems, allowing them to identify threats with a high degree of reliability. Another important concept presented in the article is the adaptability of NGFW systems. The research explains that "the system enhances detection rates and adaptability, providing a scalable defense layer optimized for resource-constrained, latency-sensitive edge environments"(Moila & Velempini, 2026) . This indicates that NGFWs are capable of adjusting to different network conditions while maintaining strong protection, which is critical in modern cybersecurity environments. Additionally, the integration of NLP and ensemble learning allows NGFWs to function as more proactive security systems. As stated in the article, "NGFWs can evolve into proactive, resilient security gateways capable of mitigating the growing threat of malware attacks in distributed computing environments" (Moila & Velempini, 2026). This highlights a major improvement over traditional firewalls, which typically rely on static, rule-based filtering methods. In contrast, NGFWs can detect more complex threats by analyzing deeper patterns in network traffic. For example, "the ensemble model analyzes features derived from NLP and other metadata to flag potential threats that the NGFW's initial rule-based filtering misses"(Moila & Velempini, 2026). This makes NGFWs more effective at identifying sophisticated cyberattacks that may bypass traditional defenses. The article also emphasizes the importance of advanced analytical techniques in detecting hidden threats. It explains that "NLP

techniques can analyze network traffic to identify subtle linguistic patterns indicative of malicious intent in C2 communications, phishing attempts, and even in seemingly benign files" (Moila & Velempini, 2026). This capability is especially important for identifying modern threats that disguise themselves within legitimate activity. Furthermore, the use of ensemble learning improves detection reliability, as it "improves the robustness and accuracy of malware classification while minimizing false positives and negatives"(Moila & Velempini, 2026) . This ensures that NGFW systems not only detect threats effectively but also reduce errors that could impact network performance. However, the article also acknowledges some limitations, noting that "the increasing sophistication of malware… requires a shift toward more context-aware, predictive security measures" (Moila & Velempini, 2026). This suggests that while NGFWs are highly effective, they must continue evolving to keep up with emerging cyber threats.

For these several reasons, this article is a valuable source for my research. It provides strong evidence that next generation firewalls are highly effective in preventing modern cyber threats by using advanced technologies such as artificial intelligence, NLP, and ensemble learning. It also explains how NGFWs improve upon traditional firewall systems by offering higher accuracy, adaptability, and proactive threat detection. I will use this source in my paper to support my argument that NGFWs play a critical role in defending against ransomware, malware, and unauthorized network intrusions, while also acknowledging the need for continuous advancement to address increasingly complex cyberattacks.

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Turmudi Zy, A., Isarianto, I., Muhammad Rifa'i, A., Ghofir, A., Dwi Miharja, M. N., & Tri Sasongko, A. (2025). Optimizing firewall timing for brute force mitigation with random forests. *IAES International Journal of Artificial Intelligence*, *14*(4), 2945. https://doi.org/10.11591/ijai.v14.i4.pp2945-2954

The effectiveness of modern firewalls in preventing cyber threats has become an important topic as cyber attacks continue to increase in frequency and complexity. There has also been debate about whether next generation firewalls are truly more effective than traditional security systems. (Zy et al., 2025), *Optimizing Firewall Timing for Brute Force Mitigation with Random Forests*, discusses how advanced techniques such as machine learning can improve firewall performance in protecting networks from cyber threats. This source is a peer-reviewed journal article published in the *IAES International Journal of Artificial Intelligence*, which makes it a credible and reliable source for cybersecurity research. First, one of the main weaknesses of traditional firewall systems discussed in the article is their inability to handle modern threats effectively. The authors explain that "typical strategies for thwarting brute force attacks… frequently fall short" and are "usually reactive rather than proactive" (Zy et al., 2025). This is important

because modern cyber threats such as ransomware, malware, and unauthorized intrusions are constantly evolving, and reactive systems may not stop attacks in time. As a result, this supports the need for next generation firewalls that are designed to anticipate and prevent threats rather than only respond after damage has occurred. Another important finding in the article concerns the use of machine learning in improving threat detection. The study explains that "machine learning enables the analysis of large datasets, allowing for the identification of patterns that could indicate malicious activity" (Zy et al., 2025). This is important because next generation firewalls often use similar techniques to analyze network traffic and detect unusual behavior. By identifying patterns and anomalies, these systems can detect more complex cyber threats that traditional firewalls might overlook. The article also highlights the importance of proactive cybersecurity strategies. It states that organizations can "implement proactive measures that anticipate and prevent potential threats" instead of reacting after attacks occur. This is important because proactive defense is a key feature of next generation firewalls, making them more effective at preventing attacks before they compromise a system. Another key finding in the study is the high level of accuracy achieved by the proposed system. The model "achieved a high accuracy of 98.87%… highlighting the model's reliability in real-world scenarios" (Zy et al., 2025). These results are important because they provide measurable evidence that advanced firewall systems using machine learning can effectively detect and prevent cyber threats. High accuracy also means fewer false positives and missed threats, which improves overall network security and usability.

For several reasons, (Zy et al., 2025) article will be a good reference for my research paper. First, the article provides measurable data about firewall performance and threat detection accuracy. Also, the article explains both the weaknesses of traditional systems and the advantages of next generation firewall technologies in preventing modern cyber threats such as ransomware, malware, and unauthorized network intrusions.

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Watters, P.A. (2023). Cybercrime and Cybersecurity (1st ed.). CRC Press. https://doi.org/10.1201/9781003406730

The increasing prevalence of cybercrime has made it essential to evaluate how effective modern security technologies, such as next generation firewalls, are in preventing threats like ransomware, malware, and unauthorized network intrusions. In Cybercrime and Cybersecurity by Paul A. Watters (2024), the author provides a comprehensive examination of cybercrime and the methods used to combat it. This source is a scholarly book published by Taylor & Francis, a well-established and reputable academic publisher. The book offers a broad and detailed

overview of cybersecurity concepts, making it a reliable and relevant source for analyzing the effectiveness of modern firewall technologies. First, one of the key ideas presented in Watters' work is that cybercrime continues to evolve alongside advancements in technology. The book explains that attackers are constantly developing new techniques, including malware, phishing, and other forms of exploitation, to bypass security systems. This is important because it highlights the ongoing challenge faced by next generation firewalls. While these firewalls are designed to detect and block malicious network activity, the constantly changing nature of cyber threats makes it difficult for any single system to provide complete protection. This suggests that although next generation firewalls improve security, they must continuously adapt to remain effective. Another important concept discussed in the book is the role of human factors in cybersecurity. Watters emphasizes that many cyber attacks rely on user behavior, such as falling for phishing scams or using weak passwords. This is significant because it shows a limitation of firewall technology. Even advanced next generation firewalls cannot fully prevent attacks that originate from human error or social engineering. As a result, organizations must consider user awareness and training as part of their overall cybersecurity strategy, rather than relying solely on technical defenses. The book also highlights the importance of a layered approach to cybersecurity, where multiple tools and strategies are used together to protect systems. This includes technologies such as intrusion detection systems, encryption, and network monitoring, in addition to firewalls. This perspective is important because it reinforces the idea that next generation firewalls are only one part of a broader defense system. While they are effective at filtering traffic and preventing unauthorized access, they are not sufficient on their own to stop all types of cyber threats, especially more sophisticated or multi-stage attacks.

For several reasons, Watters' book will be a valuable reference for my research paper. First, it provides a clear and detailed explanation of modern cyber threats and how they operate. Additionally, it discusses the strengths and limitations of cybersecurity technologies within a broader context. This makes it useful for evaluating how effective next generation firewalls are in preventing contemporary cyber threats such as ransomware, malware, and unauthorized network intrusions.