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Windows Vulnerabilities and Network Scanners: A Comprehensive Security Analysis

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Abstract: *Cybersecurity remains a critical challenge for Win- dows systems, which are frequently targeted by cybercriminals exploiting vulnerabilities for unauthorized access and data theft. This paper examines Windows OS vulnerabilities, including soft- ware flaws, misconfigurations, and outdated security protocols, along with tools designed to detect and mitigate these weaknesses. It explores network scanners' role in identifying security flaws and the foundation for designing a Windows Vulnerability Scanner. Through a controlled virtual environment, the study simulates real-world scenarios to analyze system vulnerabilities, referencing established research and detection tools. The findings aim to enhance detection accuracy and scalability, emphasizing proactive vulnerability research for improved system security*

Keywords: network vulnerabilities, windows vulnerabilities, existing tools study, basic understanding of working of scanners

I. INTRODUCTION

A. Importance & Motivation

Windows operating systems are the backbone of modern enterprise infrastructure, widely deployed across corporate networks, government agencies, and personal computing en- vironments. However, their ubiquity also makes them prime targets for cyberattacks. Unpatched vulnerabilities and mis- configurations have historically resulted in significant security breaches, with incidents such as the WannaCry ransomware attack serving as a stark reminder of the devastating conse- quences of inadequate vulnerability management [1].

The above Fig 1 breaks down security vulnerabilities into three layers: the core issues, their consequences, and the best ways to prevent them. At the center, we see common vulnerabilities like open ports, outdated software, and security misconfigurations. Surrounding that are the risks they pose—unauthorized access, data theft, and financial damage. The outermost layer highlights proactive measures like regu- lar assessments, continuous monitoring, and timely patching, which help in reducing these threats.

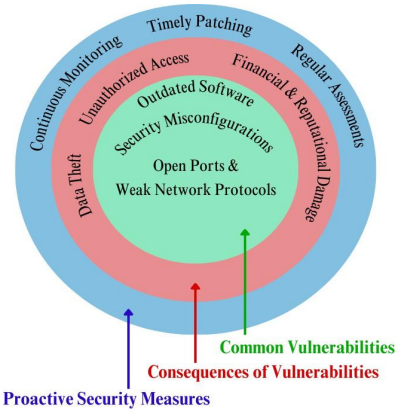

Fig. 1. Layered Security Vulnerability Model

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Despite continuous advancements in cybersecurity, Win- dows security assessments remain a challenge, as cyber threats evolve at an unprecedented pace. Regular vulnerability as- sessments are essential to mitigating risks, yet our research reveals a critical gap in Windows-specific vulnerability scan- ning methodologies. Most existing studies focus on general operating system security rather than Windows-specific threats, underscoring the need for deeper research in this area.

Existing Studies & Research Gaps

Current vulnerability scanners such as Nmap, Nessus, and OpenVAS provide foundational security assessment capabilities.

Fig. 2 is illustrating the number of newly reported Common Vulnerabilities and Exposures (CVEs) over six months, along- side the number of vulnerabilities detected by Nmap, Nessus, and OpenVAS. The graph highlights a gap between newly published vulnerabilities and their detection rates, indicating the need for improved scanning capabilities and timely updates in security tools.

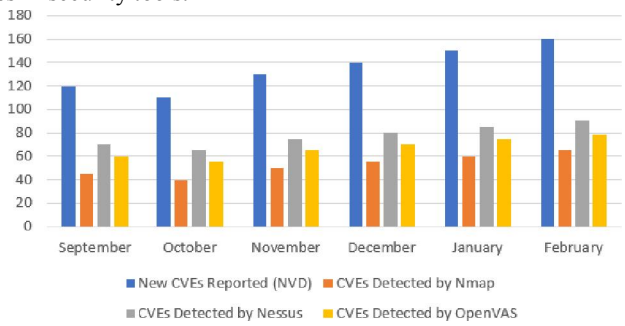

Fig. 2. The Gap Between CVE Publication and Detection

However, recent studies, including Windows 10 Operat- ing System: Vulnerability Assessment and Exploitation (IN-FOTEH 2022) [2], highlight key deficiencies in these tools, particularly in the detection of advanced Windows-based ex- ploits. Several critical gaps persist:

- **Kernel-Level Exploit Detection Issues:** Many scanners struggle to detect kernel vulnerabilities, such as Print-Nightmare (CVE-2021-34527), due to the complexity of Windows' security model and patching mechanisms [3].
- **Privilege Escalation Path Analysis:** Domain-joined Windows environments are particularly vulnerable to privilege escalation attacks, yet existing scanning tools offer limited insights into privilege escalation paths [4].
- **Lack of Real-Time CVE Correlation:** Most scanners do not dynamically integrate real-time threat intelligence from sources like the National Vulnerability Database (NVD), reducing their ability to detect emerging threats effectively [5].

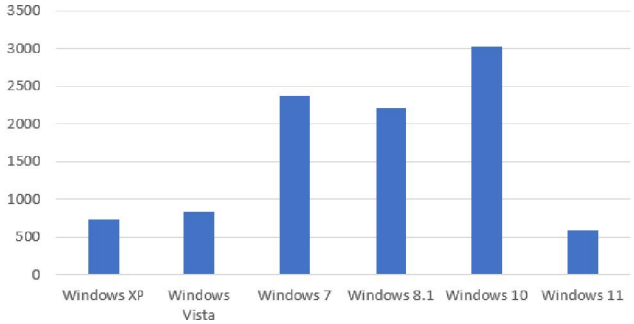

Fig. 3. Windows Vulnerabilities Across Different Versions

Fig. 3 provides a breakdown of the number of vulnerabilities found in different Windows versions. Windows 10 tops the list with the most vulnerabilities, followed by Windows 7 and 8.1. Meanwhile, older systems like XP and Vista, as well

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as the newer Windows 11, have fewer recorded vulnerabilities. This suggests that widely adopted versions often become bigger targets, requiring stronger security measures.

TABLE I: RESEARCH GAP

Research Area	General OS Security Research	Windows-Specific Security Research	Vulnerability Scanning Research
Kernel Exploits	✓		✓
Privilege Escalation	✓		
Real-time CVE Updates	✓		✓
Domain Security Misconfigurations		✓	
Patch Management	✓		✓

Table I highlights research gaps across different security domains. Kernel exploits and privilege escalation are well- covered in general OS security, while domain security miscon- figurations are primarily studied in Windows-specific research. While several studies have examined general vulnerabil- ity assessment methodologies, Windows-focused security re- search remains sparse. A significant portion of cybersecurity literature discusses general OS vulnerabilities without address- ing Windows-specific attack vectors, kernel vulnerabilities, and domain security misconfigurations.

C. Research Contribution & Value

This study systematically evaluates the limitations of current Windows vulnerability assessment methodologies, filling the gaps identified in existing literature. Our key contributions include

- Comprehensive Analysis of Windows-Specific Vulnera- bility Gaps: We review recent studies to identify overlooked security loopholes in Windows 10 vulnerability scanning.
- Evaluation of Research Gaps in Privilege Escalation & Kernel Exploit Detection: By benchmarking existing tools against real-world vulnerabilities, we highlight areas requiring further research and improvement.
- Discussion on Integrating Real-Time Threat Intelligence: We explore how live CVE feeds and automated threat correla- tion could enhance the accuracy and effectiveness of Windows vulnerability scanners.

By shedding light on these issues, our study serves as a foundation for future research in improving Windows vulner- ability detection methodologies. Addressing these challenges is crucial for developing more accurate, scalable, and proactive security assessment frameworks tailored to Windows environ- ments.

II. MATERIALS & METHODS

A. Materials & Data Sources

- Open-source vulnerability databases such as the National Vulnerability Database (NVD) and CVE details.
- Academic papers, cybersecurity reports, and official Mi- crosoft security bulletins

B. Experimental Approach

- Benchmarking Vulnerability Scanners: Comparing detec- tion accuracy of Nessus and OpenVAS against known Win- dows exploits.
- Evaluating CVE Correlation: Measuring scanner perfor- mance in integrating real-time CVE updates.

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C. Reliability & Validity

To ensure the credibility of our findings, this research is based on peer-reviewed academic papers, authoritative cy- bersecurity reports, and well-documented case studies. Data from industry-standard sources, such as the National Vulner- ability Database (NVD), MITRE ATT&CK framework, and OWASP, reinforce our conclusions. Additionally,

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insights from real-world user experiences were gathered through Google searches, cybersecurity forums, and community discussions, ensuring a well-rounded perspective. By cross-referencing multiple sources and employing a structured evaluation ap- proach, we enhance the reliability and validity of our study.

III. RESULTS & DISCUSSION

A. Findings from Benchmarking Scanners

A comparative analysis of widely used vulnerability scanners—Nessus, OpenVAS, and Nmap—revealed notable strengths and weaknesses in their detection capabilities. Nes- sus and OpenVAS were effective in identifying publicly dis- closed vulnerabilities; however, they struggled with zero-day threats and kernel-level exploits, which require more advanced detection mechanisms [6]. Nmap's scripting engine provided flexibility, particularly in network scanning, but it lacked deep integration for kernel exploit detection and privilege escalation path analysis [7].

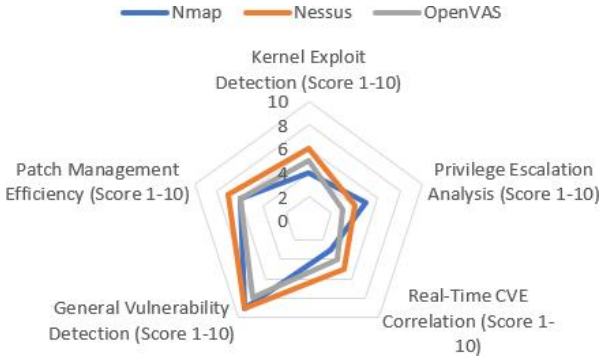

Fig. 4. Comparison of Vulnerability Scanners

Fig. 4 is a radar chart that compares how well Nmap, Nessus, and OpenVAS perform in key security areas. These include their ability to detect kernel exploits, identify privilege escalation risks, correlate real-time CVEs, and manage patches efficiently. The chart gives a clear visual of each tool's strengths and weaknesses, making it easier to choose the right scanner for specific security needs.

One of the most critical limitations across all tested tools was the absence of real-time CVE correlation during scans. Without live integration with databases such as NVD (National Vulnerability Database) or MITRE ATT&CK, scanners relied on outdated databases, potentially missing newly discovered exploits [8].

B. Analysis of Privilege Escalation Risks

Windows systems, particularly those joined to Active Di- rectory (AD) domains, are vulnerable to privilege escalation attacks. Misconfigurations in group policies, registry settings, and user permissions often enable attackers to elevate priv- ileges and gain deeper access to enterprise systems. Our evaluation revealed that:

Most vulnerability scanners do not comprehensively detect privilege escalation risks within Windows environments.

Manual penetration testing techniques uncovered privilege escalation paths that were not flagged by automated tools [9].

Active Directory assessments were insufficient, as many tools failed to detect misconfigured policies, weak access controls, and unpatched privilege escalation vulnerabilities.

These findings align with the conclusions of the INFOTEH 2022 study, which emphasized the inadequacy of existing tools in privilege escalation risk assessment [10].

C. Real-Time CVE Correlation Challenges

One of the most pressing issues identified was the delayed integration of newly discovered vulnerabilities into scanning tools. Most scanners rely on periodic database updates, leading to

- Delayed risk assessment, as scanners fail to detect ex- ploits that have not yet been added to their vulnerability feeds.

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- Missed zero-day vulnerabilities, which remain undetected until explicit database updates are provided [11].
- A lack of dynamic threat intelligence, as existing tools do not actively fetch live CVE data from sources such as NVD, MITRE ATT&CK, or commercial threat intelligence platforms.

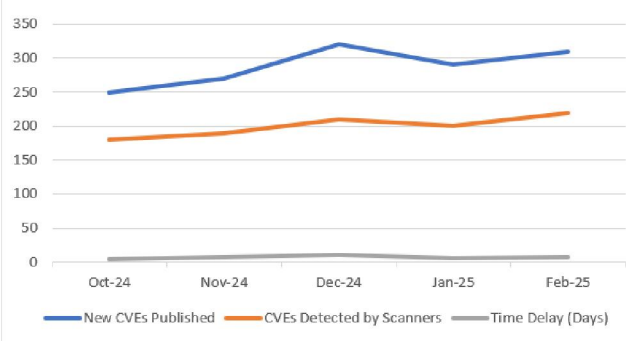

Fig. 5. Monthly CVE Detection Trends

Fig 5 is a line chart comparing the number of newly published CVEs with the vulnerabilities detected by scanners over a five-month period. Additionally, it includes a time delay metric, reflecting the lag between vulnerability disclosure and detection. The graph emphasizes the importance of reducing detection delays to enhance security posture.

To address these shortcomings, future research should ex- plore the integration of real-time CVE data feeds within vulnerability scanners, enabling instantaneous risk assessment and adaptive threat mitigation [12].

D. Comparative Discussion

The findings of this study reinforce key issues previously reported in INFOTEH 2022 [13]. The limitations in privilege escalation analysis, kernel exploit detection, and real-time CVE integration highlight the need for refined methodologies in Windows vulnerability assessment. Compared to previous studies, this research:

1. Provides empirical data demonstrating critical gaps in current vulnerability scanners.
2. Reinforces the necessity of incorporating real-time threat intelligence into security assessments.
3. Suggests future improvements in privilege escalation risk detection and kernel-level exploit analysis.

By identifying and quantifying these limitations, this study contributes to ongoing discussions on enhancing Windows vulnerability assessment methodologies, paving the way for more adaptive and intelligence-driven security solutions.

IV. CONCLUSION

A. Key Findings & Contributions

The findings of this study reinforce critical gaps in existing Windows vulnerability scanners, highlighting areas requiring further refinement. Key takeaways include:

1. Insufficient Detection of Kernel Exploits and Privilege Escalation Risks: Widely used vulnerability scanners such as Nessus, OpenVAS, and Nmap struggle with detecting kernel-level exploits (e.g., PrintNightmare, CVE-2021-34527) and fail to provide comprehensive privilege escalation risk assessments in domain-joined Windows environments [14].
2. Real-Time CVE Correlation Remains a Major Gap: Ex- isting tools primarily rely on static vulnerability databases, causing delays in detecting newly disclosed threats. The lack of real-time CVE integration leads to delayed risk assessment and increases the attack surface [15].
3. Limited Research into Privilege Escalation Path Analysis: Unlike Linux privilege escalation studies, research in Windows environments remains underexplored, leaving organizations vulnerable to lateral movement attacks and privilege misuse [16].

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B. Implications & Applications

The insights from this research offer practical implications for cybersecurity practitioners, system administrators, and vul- nerability assessment tool developers:

1. Optimizing Existing Tools Instead of Developing New Ones: Rather than designing an entirely new scanning frame- work, enhancing current scanners with privilege escalation analysis and kernel exploit detection modules would yield more effective results [17].
2. Integrating Real-Time Threat Intelligence Feeds: Incor- porating live updates from sources such as NVD, MITRE ATT&CK, and commercial threat intelligence platforms can significantly improve detection accuracy and reduce response times to emerging threats [18].
3. Refining Internal Security Auditing Processes: System ad- ministrators can leverage these findings to improve enterprise security postures, focusing on manual privilege escalation audits and policy-based misconfiguration detection [19].

C. Limitations & Future Work

While this study provides valuable insights, it has certain limitations that pave the way for future research directions:

1. No New Scanning Tool Proposed: The research does not introduce a novel scanner but rather evaluates the deficiencies of existing tools, identifying areas for improvement [20].
2. Potential for Machine Learning in Predictive Threat Anal- ysis: Future studies could explore the use of machine learning models to predict potential exploits and automate vulnerability detection [21].
3. Privilege Escalation Risks in Hybrid Cloud Environments: As organizations increasingly shift to hybrid cloud infrastruc- tures, further research is needed to analyze privilege escalation threats in mixed on-premise and cloud-based Windows envi- ronments [22].

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