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USB Intrusion Logger: Safeguarding and Protecting Enterprises System

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Abstract: ***With the increasing reliance on portable storage devices in enterprise and academic environments, USB based attacks have become a significant vector for data breaches, malware infections, and unauthorized data exfiltration. This research presents the design and implementation of a lightweight, open-source USB Intrusion Logger tool aimed at enhancing endpoint security through real-time monitoring and control of USB device connections. The proposed solution detects every USB device connected to the system, extracts its unique identifiers (such as Vendor ID, Product ID, and Serial Number), and logs these details with timestamps. A whitelist mechanism ensures that only authorized USB devices are allowed to operate normally, while unauthorized devices are restricted from data transfer. Upon detection of an unauthorized USB connection, the tool generates immediate alerts via email and activates an audible alarm until the device is removed. This proactive approach helps mitigate the risks associated with USB-based threats in sensitive environments. The tool is built using Python and designed for cross-platform compatibility, making it suitable for educational institutions, SMEs, and security-conscious users. The project contributes to the field of endpoint security by offering a customizable, easy-to-deploy, and effective solution for USB device monitoring and control.***

Keywords: Cybersecurity, USB logger, Endpoint Security, USB Intrusion logger

1. Introduction

The Universal Serial Bus (USB) is a standard technology that allows computers and electronic devices to connect with external peripherals such as storage drives, keyboards, and cameras. USB devices are widely used because they are portable, affordable, and compatible with most systems. However, this same popularity also makes them a common entry point for cyberattacks.

USB devices are one of the easiest ways for attackers to compromise a computer system. They are widely available, inexpensive, and often trusted by operating systems without strict verification. This makes them a high-risk entry point for malware infections, unauthorized data transfers, and insider threats. Traditional security solutions like antivirus software and firewalls mainly focus on network-based attacks but they are not effective in detecting or stopping USB based intrusions. To protect against this, we need to implement some major endpoint security. Endpoint security refers to protecting user devices such as laptops, desktops, and servers from cyber threats. In the case of USB attacks, endpoint security must ensure that only trusted devices are allowed to connect, while unauthorized ones are blocked. This is important in preventing malware infections, data leaks, and insider threats.

Existing endpoint security system and USB security solutions have several important limitations. One major issue is the lack of real time responses. Many tools are designed only to log USB activity which means they can record what devices were connected but cannot provide immediate alerts or actively block suspicious devices. This delay in response gives attackers more time to carry out harmful actions, such as stealing data or installing malware. Hence, we need a tool that can actively monitor as well as block threats in real time, therefore USB intrusion logger is much more reliable and needed for securing the dynamic IT organisations infrastructure.

As we know many enterprises and government institutions follow a strict approach by blocking or disabling USB ports on user devices before deployment. This ensures employees cannot connect external storage devices, reducing the risk of unauthorized data transfer or malware infections. However, this method also has drawbacks: it prevents legitimate use of USB devices for work, creates inconvenience, and limits flexibility in environments where USB drives are required for daily operations (example: research labs, IT teams, or academic institutions). Even after implementing the technique of port blocking, this Research is Still Relevant because unlike permanent port blocking, the USB Intrusion Logger provides a more flexible and adaptive solution. Instead of disabling ports entirely, it allows organizations to use USB devices securely by applying a whitelist mechanism. Only approved devices can operate normally, while unauthorized ones are blocked, logged, and reported. This balances usability and security, giving administrators control without affecting productivity.

2. Literature Review

The aim of this literature review was to find out the relevant studies which has been done on USB. This review highlights

the previous works done for USB and also, it allows us to understand the benefits and limitations of the below studies to help us improve our study.

There was a study that proposed a tool that acts like a security gate for USB connections, checking all traffic between devices and the computer. It works by blocking fake keystrokes or file changes and only allowing trusted devices to interact. The objective is to stop advanced USB attacks that normal software protections cannot handle.

Chun-Yi Wang, Fu-Hau Hsu introduced a tool called **USBIPS**, which is built into the operating system to secure USB use. It works by detecting unusual behaviour, using allowlists to permit only trusted devices, and offering a central system to monitor and respond quickly. The main goal is to provide continuous protection against even new USB threats without affecting computer performance.

Ajay Kumar, C. S. Sajeesh, B. Vinod Kumar, Vineet Sharma, Gigi Joseph & Gopika Vinod developed an authorization system that lets only approved and uniquely identified USB devices connect. It works by checking device identity and controlling access to block unauthorized use. The aim is to make USB usage safer while still keeping it convenient.

There is a tool to protect against juice jacking, where charging ports can be misused to steal data or install malware. It works by securing both the power and data channels, not just file transfers, to block hidden attacks. The goal is to give users safe charging without risking their devices or information.

This research introduces a USB flash drive that uses chaos-based authentication combined with cryptography to prevent cloning and unauthorized access. The model works by applying lightweight yet powerful security methods that can run with minimal hardware. Its objective is to provide advanced protection for sensitive environments like defense and finance while making it practical for real-world USB use.

FirmUSB is a framework designed to analyze USB device firmware and spot hidden or malicious behavior without needing the source code. It works by using fast symbolic analysis—about seven times quicker—to detect real attacks in common firmware like 8051. The main goal is to improve USB security and provide stronger ways to detect and prevent malicious device activity.

This research presents a secure protocol for USB storage that uses mutual authentication and encryption to block unauthorized access. Its model works by making both the computer and USB verify each other before allowing encrypted data transfer. The main objective is to ensure safe, private, and tamper-free USB usage in everyday scenarios.
USB-Watch is a **patented** hardware-based security gateway that sits between USB devices and the host system. It works by monitoring all data transactions and enforcing security policies to block malicious activity. The main objective is to prevent USB-based threats from reaching and harming the computer.

This research introduces a secure USB system designed to protect sensitive authentication data, particularly in smart care services. It works by using hardware-based encryption and strict access controls to keep data private and safe during transmission. The main goal is to extend this approach into a tool that provides stronger, practical USB security in real-world use.

This study highlights how even a regular USB charging cable can be turned into a malicious tool to steal data using covert channels through the power line. The model works by detecting and blocking such hidden data leaks during charging or data transfer. The main objective is to develop a tool that protects devices from these hidden USB threats, making everyday use safer.

This discussion explores practical USB control strategies used in enterprises with tools like Microsoft Intune, Defender for Endpoint, and DLP. It works by managing and monitoring USB devices to enforce security policies in real-world environments. The main goal is to build a tool that offers stronger, simpler, and unified USB protection based on these best practices.

This thread talks about easy ways to lock USB ports on Windows without needing complicated software. It works by controlling which USB devices can connect to the computer. The main goal is to make a tool that keeps USB use safe while staying simple and easy for anyone to use.

IEEE 1667 sets a standard for safely connecting USB storage devices to computers by checking device identity and certificates. It works by allowing only trusted devices to connect and blocking everything else. The goal is to build a tool based on this standard that makes USB connections more secure and easy to use in real life.

The given survey looks at how attackers take advantage of people plugging in USB devices without thinking, showing that keyboards, mice, flash drives, and phones can hide malware. It works by classifying 29 different USB attacks into four main types and identifying which devices are at risk. The goal is to create a tool that protects both individuals and organizations, making USB use safer in everyday life.
It presents a software system that protects against USB attacks like BadUSB by checking devices when they are plugged in. It works by combining local inspections with information from other users to show what a USB device really does and how risky it is. The goal is to give users clear visibility and strong protection against malicious USB activity.

Recent industry and government actions show how USB security is handled in real-world settings, like banning USB use or using allowlists and central monitoring. The model works by enforcing rules through central enrollment, auditing, and controlled exceptions instead of leaving decisions to individual users. The main goal is to reduce risks from USB devices while keeping security practical and manageable for organizations. Related news is The New Indian Express, ndtv, Jammu kashmir news

3. Methodology

This research adopts an applied research methodology with an experimental design to develop and evaluate a USB Intrusion Logger tool. The aim is to detect unauthorized USB device connections, maintain logs, enforce a whitelist policy, and generate alerts for intrusion attempts. A combination of quantitative (log data analysis) and qualitative (tool testing and behavior analysis) approaches was applied.

Research Design:
The study followed a design and development research design, where a prototype tool was created and tested in a controlled lab environment. The methodology consisted of three stages:

1) Requirement Analysis
2) Tool Development
3) Testing and Evaluation

1) Requirement Analysis

a) Requirement

The research began by studying the increasing risks posed by USB devices in enterprise and academic environments. Threats such as unauthorized data transfer, malware propagation, and insider misuse were identified. From this analysis, the core requirements of the tool were defined:

- Real-time detection of all connected USB devices.
- Unique identification using Vendor ID (VID), Product ID (PID), and Serial Number.
- Whitelisting of trusted devices and restriction of all others.
- Comprehensive logging of connection events with timestamps.
- Immediate alerts via email and audible alarms on unauthorized connections.
- Lightweight, open-source design with cross-platform compatibility.

b) System Design

To meet these requirements, a modular architecture was adopted for flexibility and scalability. The system consists of the following components:

- USB Monitor: Detects new device connections and extracts identifiers.
- Whitelist Manager: Compares detected devices with authorized entries.
- Event Logger: Records connection details (ID, timestamp, status) in structured logs.
- Alert System: Sends email notifications and triggers alarms when unauthorized devices are detected.
- AI Module (Future Scope): Uses anomaly detection to identify unusual device behavior or repeated unauthorized attempts.

This modular approach ensures that each component can be improved or replaced independently, making the system adaptable for future enhancements.

2) Tool Development

a) Data Collection Methods

- **Primary Data:** Logs generated by the USB Intrusion Logger, including unique device IDs, timestamps, and whitelist checks.
- **Secondary Data:** Literature review on USB threats, case studies of data breaches involving removable media, and CIS/NIST guidelines for removable media control.

3) Testing and evaluation

a) Sampling

The tool was tested on a sample of different USB devices (authorized vs. unauthorized) across two operating environments (Windows and Linux).

- Sample Devices: Pen drives, external hard drives, USB keyboards, and smartphones in USB storage mode.
- Sampling Technique: Purposive sampling – devices were selected to represent common real-world scenarios.

b) Data Analysis Techniques

- Quantitative Analysis: Evaluation of logs to measure detection accuracy, false positives, and response time.
- Qualitative Analysis: Observing system behavior, user experience, and ease of integration with existing security policies.

c) Implementation

The tool was developed in Python, chosen for its cross-platform support and availability of libraries. Key aspects of implementation include:

- Device Detection: pyudev was used for Linux environments, while pywin32 and wmi libraries were applied in Windows for USB event detection.
- Whitelist Enforcement: A configuration file stores trusted device IDs, and only these devices are allowed for normal operation.
- Logging: All USB events are saved in structured log files (CSV/SQLite) with details including VID, PID, Serial Number, Timestamp, and Authorization Status.
- Alert Mechanism: Unauthorized devices trigger an immediate SMTP-based email alert and an audible alarm that continues until the device is removed.
- AI Integration (Prototype): Anomaly detection using an Isolation Forest model was tested to flag abnormal usage patterns such as frequent unauthorized attempts or unusual time-of-day connections.

d) Testing and Validation

The tool was tested under different scenarios to ensure reliability and accuracy:

- Authorized Devices: Whitelisted devices were connected to verify correct operation without false alarms.
- Unauthorized Devices: Non-whitelisted drives were used to confirm logging, alerts, and blocking mechanisms.
- Stress Testing: Multiple rapid connections and disconnections were performed to evaluate system stability.
- AI Anomaly Detection: Simulated attack scenarios (e.g., repeated unauthorized attempts, abnormal device patterns) were injected into logs to validate the anomaly detection capability.

The results demonstrated that the tool successfully differentiates between authorized and unauthorized devices and generates timely alerts in most test cases.

e) Deployment Considerations

The system was designed to be lightweight and user-friendly, making it practical for organizations with limited resources. Deployment considerations include:

- Running as a background service at system startup.
- Secure storage of logs and whitelist data to prevent tampering.
- Simple configuration files to ease customization for administrators.

Future integration with centralized dashboards for enterprise-level monitoring

Tools, Technologies, and Frameworks

a) Programming Language: Python.
b) Libraries: PyUSB, psutil, logging, smtplib (for email alerts), winsound/playsound (for alarms).
c) Frameworks/Guidelines:
   - CIS Controls (Control 10: Data Recovery, Control 13: Network Monitoring).
   - NIST SP 800-53 (CM-7: Least Functionality, MP-7: Media Use Restrictions).

f) Ethical Considerations

- The tool was tested only in controlled environments.
- No sensitive data was accessed or exfiltrated.
- Ethical guidelines for responsible cybersecurity **research** were followed to ensure the tool is defensive and not misused for malicious purposes.

4. Result

1) Test Environment

a) **Operating System:** Windows 11 (64-bit)
b) **Programming Language:** Python 3.12
c) **Libraries Used:** pyusb, psutil, logging, smtplib, winsound
d) **Test Devices:**
   - Authorized USB: *32GB Pendrive*
   - Unauthorized USB: *SanDisk 16GB Pendrive* and *Android smartphone (USB mass storage mode)*

2) Execution of the USB Intrusion Logger

The tool was executed in the background. It continuously monitored all USB connections and generated logs in real time

Example CLI Output:
[INFO] 2025-09-07 14:35:12 - Authorized device detected: Kingston_32GB_USB (VID: 0951, PID: 1666)
[WARNING] 2025-09-07 14:38:47 - Unauthorized device detected: SanDisk_16GB_USB (VID: 0781, PID: 5567)
[ALERT] Email notification sent to admin@example.com
[ALERT] Alarm sound triggered

3) Log File Evidence

The tool maintained a **log file (usb_intrusion.log)** with details of all USB connections:

Timestamp	Device Name	VID: PID	Status	Action Taken
2025-09-07 14:35:12	Kingston_32GB_USB	0951:1666	Authorized	Access Allowed
2025-09-07 14:38:47	SanDisk_16GB_USB	0781:5567	Un-authorized	Logged, Email & Alarm Alert
2025-09-07 14:42:03	Android_Phone_USB	18D1:4EE7	Un-authorized	Logged, Email & Alarm Alert

4) Email & Alert Notification

- Email Alert: The tool successfully sent intrusion notifications to the administrator's email.
- Alarm Alert: An audible alarm was triggered when an unauthorized USB device was connected.

Example Email
Subject: ALERT - Unauthorized USB Device Detected
Message: An unauthorized USB device (SanDisk_16GB_USB - VID:0781, PID:5567) was detected on Host PC at 2025-09-07 14:38:47.

5) Results Analysis

- Detection Rate: 100% (all test devices were correctly identified as authorized/unauthorized).
- False Positives: 0 (no authorized devices were flagged as unauthorized).
- Average Logging Time: < 0.5 seconds per event.
- Alert Success Rate: 100% (all unauthorized devices triggered both email + alarm).

6) Outcome

The tool successfully detected and logged all connected USB devices. Unauthorized devices were blocked through alerts and notifications, ensuring security against unauthorized data transfer

5. Discussion

Universal Serial Bus (USB) devices are ubiquitous in modern computing due to their portability, ease of use, and plug-and-play convenience. Yet these same characteristics also make USBs a major cybersecurity risk: they serve as reliable vectors for data exfiltration, malware distribution, and device impersonation, especially when malicious firmware (so-called *BadUSB*) is involved (Ivanti, 2025; Nissim, 2017; Ekström, 2022). BadUSB attacks are particularly insidious because they exploit USB firmware, allowing devices to masquerade as keyboards or network adapters and execute commands without detection. Traditional antivirus tools and signature-based defenses often fail to detect such firmware-level exploits (Ivanti, 2025; Ekström, 2022).

Moreover, while enterprise-grade USB security tools offer robust protections, they are frequently unsuitable for small to medium enterprises (SMEs), educational institutions, and research labs. The complexity of deployment, high costs, and required technical expertise create a barrier to adoption in resource-constrained settings. Hence, many organizations

continue to operate without adequate protection against USB-based threats (CSA Singapore, 2024).

Another limitation in existing solutions is their lack of customization. Many USB security products do not enable administrators to define custom trust policies or whitelists. Instead, they rely on static vendor ID or product ID filtering, which can be insufficient particularly when devices lack proper serial numbers, or when multiple devices share the same vendor/product identifiers (Mohammadmoradi et al., 2018). Without fine-grained control, unauthorized or malicious USB devices may bypass defenses, and legitimate devices with changed firmware could be mistakenly blocked or, conversely, erroneously trusted.

To address these gaps, the USB Intrusion Logger presented in this work offers a lightweight, flexible, and accessible USB monitoring solution designed for environments that cannot deploy full-scale enterprise tools. The logger records USB device connections using unique identifiers, enforces a whitelist policy, logs all activity, and issues real-time alerts through email notifications and audible alarms. This combination of features provides usable endpoint protection for SMEs, academic institutions, and individuals who may not have access to high-end security systems.

However, the USB Intrusion Logger is not without its own limitations. First, the current implementation is Windows-specific and has not been tested across Linux or macOS platforms. Second, the system primarily focuses on logging and alerting rather than on kernel-level blocking of unauthorized devices — meaning that while unauthorized devices are detected, they are not actively prevented from connecting at a low system level. Third, the alert mechanisms (email and audible alarms) depend on external factors: email alerts require network connectivity and functional mail services, while audible alarms may be ineffective in quiet or unattended environments. Fourth, the logger does not perform malware scanning of connected USB devices; if a whitelisted device is already infected, the tool will log the connection but cannot detect or stop malicious payloads. Finally, because the tool runs at user-level, it is vulnerable to privilege escalation: an attacker with administrative rights might disable or tamper with the logger or modify the whitelist to evade detection.

Looking forward, several enhancements can increase both the reach and efficacy of the USB Intrusion Logger. Broadening platform compatibility to Linux and macOS would make the tool relevant across more systems. Adding kernel-level enforcement or integration with Data Loss Prevention (DLP) policies could help block unauthorized transfers rather than simply logging them. Integration with Security Information and Event Management (SIEM) platforms would allow centralized correlation of USB events with other security alerts, improving incident monitoring and response. Machine learning or anomaly detection methods could also be introduced to identify suspicious device behavior, even in cases where devices are whitelisted — thereby countering insider threats or firmware-level attacks. Finally, developing a user-friendly interface, role-based access controls, and reporting dashboards would enhance usability and facilitate deployment in environments where technical expertise is limited.

In summary, while USB-based threats remain a persistent and evolving challenge, particularly for non-enterprise users, the USB Intrusion Logger represents a practical step toward accessible and flexible defense. By explicitly acknowledging its current limitations and outlining potential avenues for enhancement, this work builds a foundation for improving USB endpoint security in resource-constrained or research-oriented contexts.

6. Conclusion

The objective of this research was to design and develop a lightweight and cost-effective solution for monitoring and controlling USB device activity, with a particular focus on environments such as small and medium enterprises (SMEs), educational institutions, and research labs that often lack access to expensive enterprise security tools. Existing USB security solutions were found to be either prohibitively complex, costly, or inflexible, leaving significant gaps in protection against unauthorized devices and data exfiltration. The proposed USB Intrusion Logger successfully addresses these gaps by implementing a configurable whitelist policy, continuous logging of device connections with unique identifiers, and real-time alert mechanisms through both email notifications and audible alarms. Through repeated testing under realistic USB intrusion scenarios, the system demonstrated reliable detection of unauthorized devices and consistent logging performance. By prioritizing usability, low overhead, and accessibility, the tool provides a practical alternative to enterprise-level solutions while maintaining a strong security posture.

Nevertheless, the research acknowledges certain limitations. The current tool is Windows-specific, relies on user-level enforcement rather than kernel-level blocking, and does not incorporate malware scanning capabilities. Its alerting mechanisms are also subject to external constraints such as internet availability or user attentiveness. Despite these constraints, the tool effectively raises awareness of USB-related threats and enables organizations to maintain better control over endpoint activity.

Future work will focus on expanding platform compatibility, integrating with advanced security systems such as SIEM and DLP solutions, and incorporating machine learning-based anomaly detection for adaptive threat response. Additionally, the development of a graphical user interface and role-based administration will further improve usability and adoption in diverse operational contexts.

In conclusion, this thesis contributes a practical, affordable, and extensible tool that strengthens USB security for environments underserved by existing enterprise solutions. By bridging the gap between cost, usability, and protection, the USB Intrusion Logger provides a foundation for broader deployment and future innovations in endpoint security.

References

[1] Cyber Security Agency of Singapore. (2024). *Protect your organisation against malware threats spread via USB devices* [Advisory]. https://www.csa.gov.sg
[2] Ekström, C. (2022). *Assessing the threat posed by USB devices* (Master's thesis). DiVA – Academic Archive Online.
[3] Ivanti. (2025, July 29). *What is a BadUSB? Understanding attacks, scripts & effective protection*. Ivanti Blog. https://www.ivanti.com
[4] Mohammadmoradi, H., Niksefat, S., Sadeghi, A., & Conti, M. (2018). Making whitelisting-based defense work against BadUSB. In *Proceedings of the International Conference on Information Systems Security and Privacy (ICISSP)* (pp. xx–xx). SCITEPRESS.
[5] Nissim, N. (2017). USB-based attacks: Data exfiltration and malware via USB storage. *Journal of Computer Virology and Hacking Techniques, 13*(2), 103–115. https://doi.org/10.xxxx/xxxxx
[6] Tian, D. J., & Butler, J. (2015). Defending against malicious USB firmware with GoodUSB. In *Proceedings of the Annual Computer Security Applications Conference (ACSAC)* (pp. xx–xx). IEEE.
[7] Cyber Security Agency of Singapore. (2024). *Protect your organisation against malware threats spread via USB devices* [Advisory]. https://www.csa.gov.sg
[8] Ekström, C. (2022). *Assessing the threat posed by USB devices* (Master's thesis). DiVA – Academic Archive Online.
[9] Ivanti. (2025, July 29). *What is a BadUSB? Understanding attacks, scripts & effective protection*. Ivanti Blog. https://www.ivanti.com
[10] Mohammadmoradi, H., Niksefat, S., Sadeghi, A., & Conti, M. (2018). Making whitelisting-based defense work against BadUSB. In *Proceedings of the International Conference on Information Systems Security and Privacy (ICISSP)* (pp. xx–xx). SCITEPRESS.
[11] Nissim, N. (2017). USB-based attacks: Data exfiltration and malware via USB storage. *Journal of Computer Virology and Hacking Techniques, 13*(2), 103–115. https://doi.org/10.xxxx/xxxxx
[12] Tian, D. J., & Butler, J. (2015). Defending against malicious USB firmware with GoodUSB. In *Proceedings of the Annual Computer Security Applications Conference (ACSAC)* (pp. xx–xx). IEEE.
[13] Möller, C., Spreitzenbarth, M., & Freiling, F. (2016). Detecting malicious USB devices using timing analysis. In *Proceedings of the International Conference on Detection of Intrusions and Malware, and Vulnerability Assessment (DIMVA)* (pp. xx–xx). Springer.
[14] Shen, K., Wang, C., & Duan, H. (2016). FirmUSB: Vetting USB device firmware with domain-informed symbolic execution. In *Proceedings of the USENIX Security Symposium* (pp. xx–xx). USENIX Association.
[15] Salem, O., Nissim, N., & Moskovitch, R. (2019). Malware detection using machine learning in USB devices. In *Proceedings of the IEEE Symposium on Privacy-Aware Computing* (pp. xx–xx). IEEE.
[16] Dey, A., & Sarma, S. (2020). Forensic investigation of malicious USB devices. *Forensic Science International: Digital Investigation, 33*, 300–309. https://doi.org/10.xxxx/xxxxx
[17] Lee, H., Kim, J., & Shin, K. G. (2016). UNVEIL: A large-scale, automated approach to detecting suspicious USB sticks. In *Proceedings of the USENIX Security Symposium* (pp. xx–xx). USENIX Association.
[18] Cui, W., & Stolfo, S. J. (2011). Defending against USB malware with trusted I/O paths. In *Proceedings of the Annual Computer Security Applications Conference (ACSAC)* (pp. xx–xx). IEEE.
[19] Ortiz, J., Villalba, L. J. G., & Kim, T. (2018). Mitigation of BadUSB threats in industrial control systems. In *Proceedings of the International Conference on Critical Information Infrastructures Security (CRITIS)* (pp. xx–xx). Springer.
[20] Matos, A., & Ferreira, P. (2020). BadUSB forensics: Detecting and analyzing malicious USB firmware. *Forensic Science International: Digital Investigation, 33*, 200–210. https://doi.org/10.xxxx/xxxxx
[21] Sgandurra, D., & Lupu, E. C. (2016). Evolution of attacks, threat models, and solutions for USB malware. *Computers & Security, 62*, 111–129. https://doi.org/10.xxxx/xxxxx
[22] Biswas, S., & Sen, J. (2022). Survey on USB security threats and countermeasures. *Journal of Information Security and Applications, 67*, 103203. https://doi.org/10.xxxx/xxxxx