MineSweeper: An In-depth Look into Drive-by Cryptocurrency Mining and Its Defense

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Outlines

- Introduction
- Motivation
- Background
- Threat Model
- Data Analysis
- Conclusion

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Intro

- Cryptocurrency

- A digital asset

- Work as a medium of exchange that uses strong cryptography to secure financial transactions, control the creation of additional units, and verify the transfer of assets

- Use blockchain method

- Example: Bitcoin

- Drive-by mining

- A web-based attack, in which an infected website secretly executes JavaScript code and/or a WebAssebly module in user's browser to mine cryptocurrencies without the consent of the user

- Also known as Cryptojacking

Intro

- Cryptocurrency Mining

- A process in which transactions for various forms of cryptocurrency are verified and added to the blockchain digital ledger

- Each time a cryptocurrency transaction is made, a cryptocurrency miner is responsible for ensuring the authenticity of information and updating the blockchain with the transaction

- The mining process need a lot of computational power

- The first cryptocurrency miner to crack the code is rewarded by being able to authorize the transaction

Cryptojacking Attack

- Using cryptomining service like Coinhive
- By compromising web servers
- Taking advantage of misconfiguration and installing JavaScript based miners
- Distributing miners through online advertisements
- Compromising third party libraries
- By using pop-under window
- By playing online video streaming

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Motivation

- Dedicated browser extensions and ad blockers use blacklists.
- Maintaining a complete blacklist is not scalable and prone to false negative.
- Easily defeated by URL randomization and domain general algorithms

- Some detection technique look for high CPU usage as an indicator of cryptocurrency mining.
- Causes both false positive and false negative as one program may take high CPU usage and on the other hand cryptocurrency miners have started to throttle their CPU usage to evade detection.

Proposed Method

- Focus on Wasm-based mining, the most efficient and widespread technique for drive-by mining attacks
- Identify the intrinsic characteristics of the mining itself: the hashing function.
- Two level approaces.

  - First, perform static analysis on the Wasm code and identify the hashing code based on cyptographic operations it performs.

  - Second, monitor CPU cache events at run time to identify cryptominers based on their memory access patterns.

Contributions

- Perform the first in-depth assessment of drive-by mining
- Discuss why current defense based on blacklisting and CPU usage are ineffective
- Propose a novel detection approach based on the identification of cryptographic functions through static analysis and monitoring of cache events during run time

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Existing Defenses against Drive-by Mining

- CoinBlockerList

  - Maintain a blacklist of mining pools and proxy servers that is manually collected from reports on security blogs and twitter

- Dr. Mine

  - Attempts to block drive-by mining by means of explicitly blacklisted URLs

Both approaches suffer from high false negative

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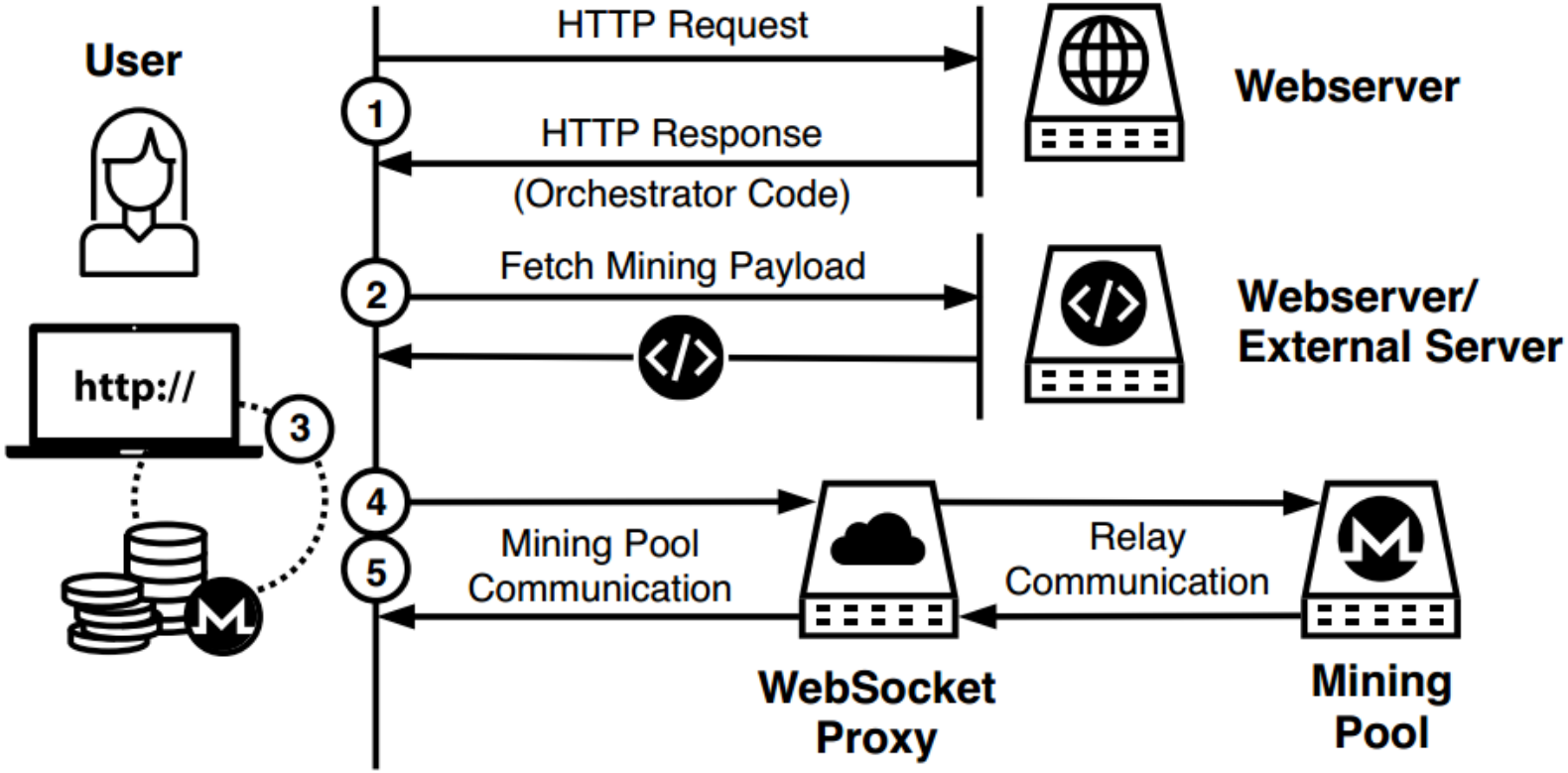
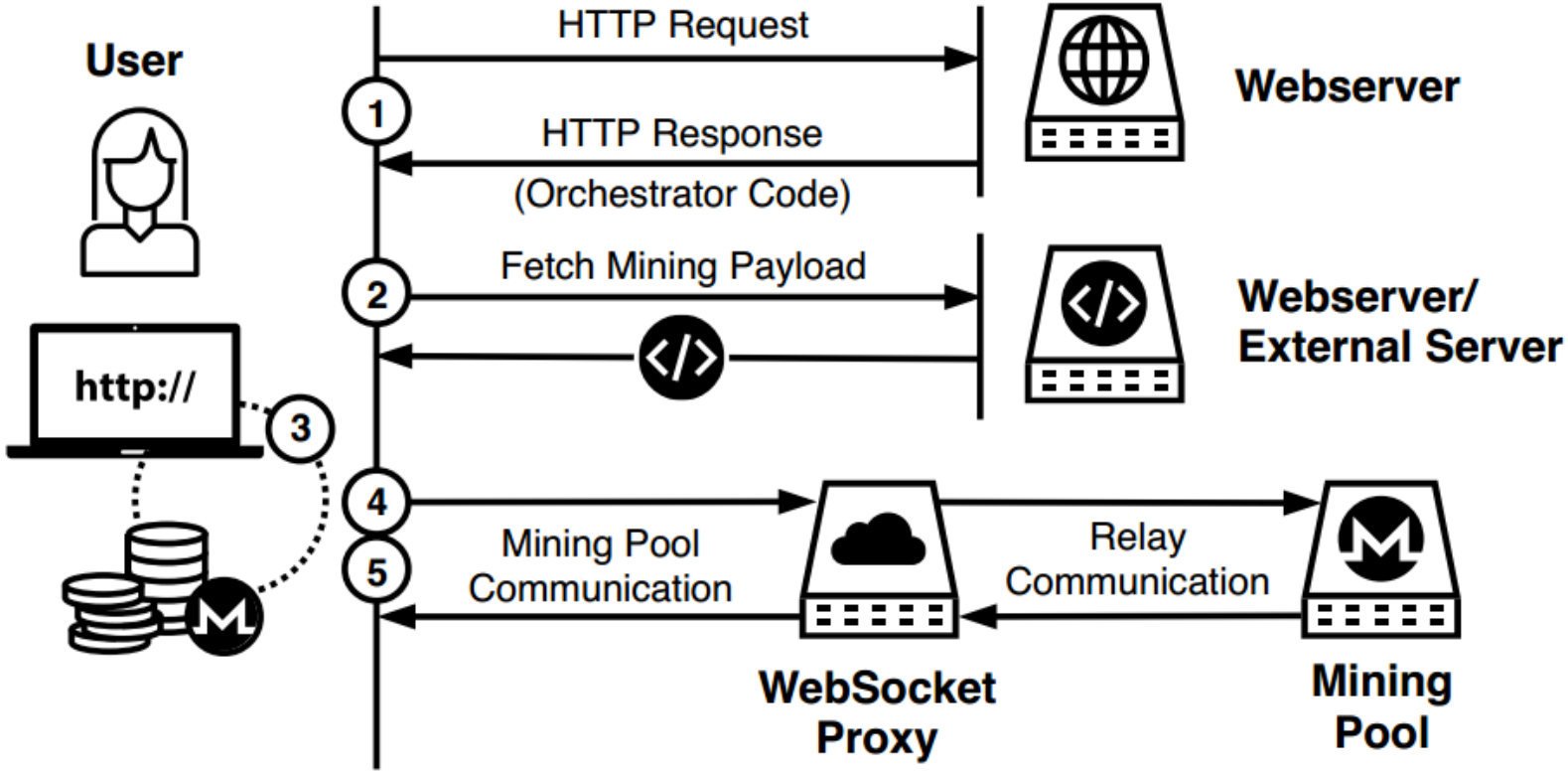
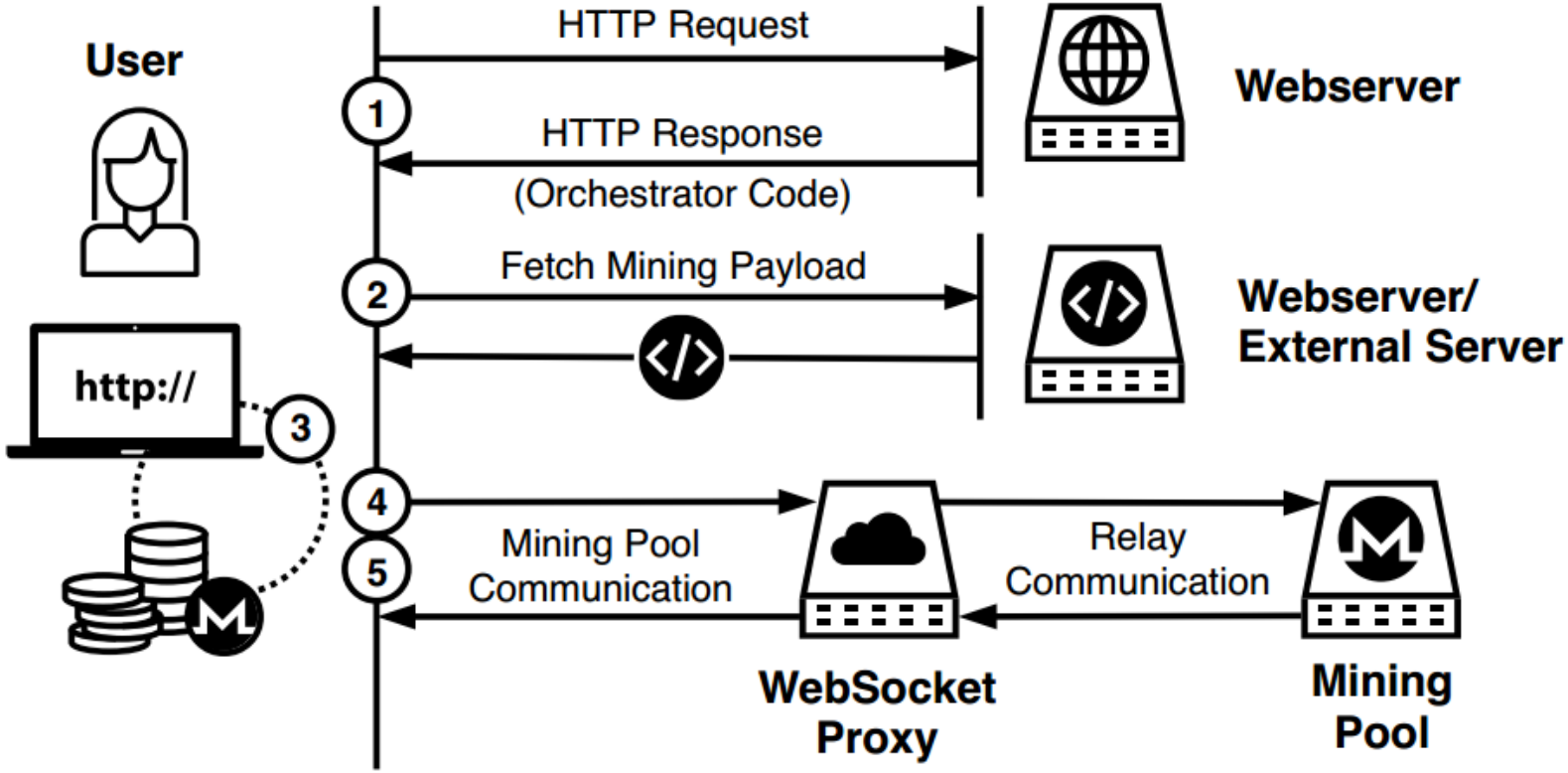
Threat Model

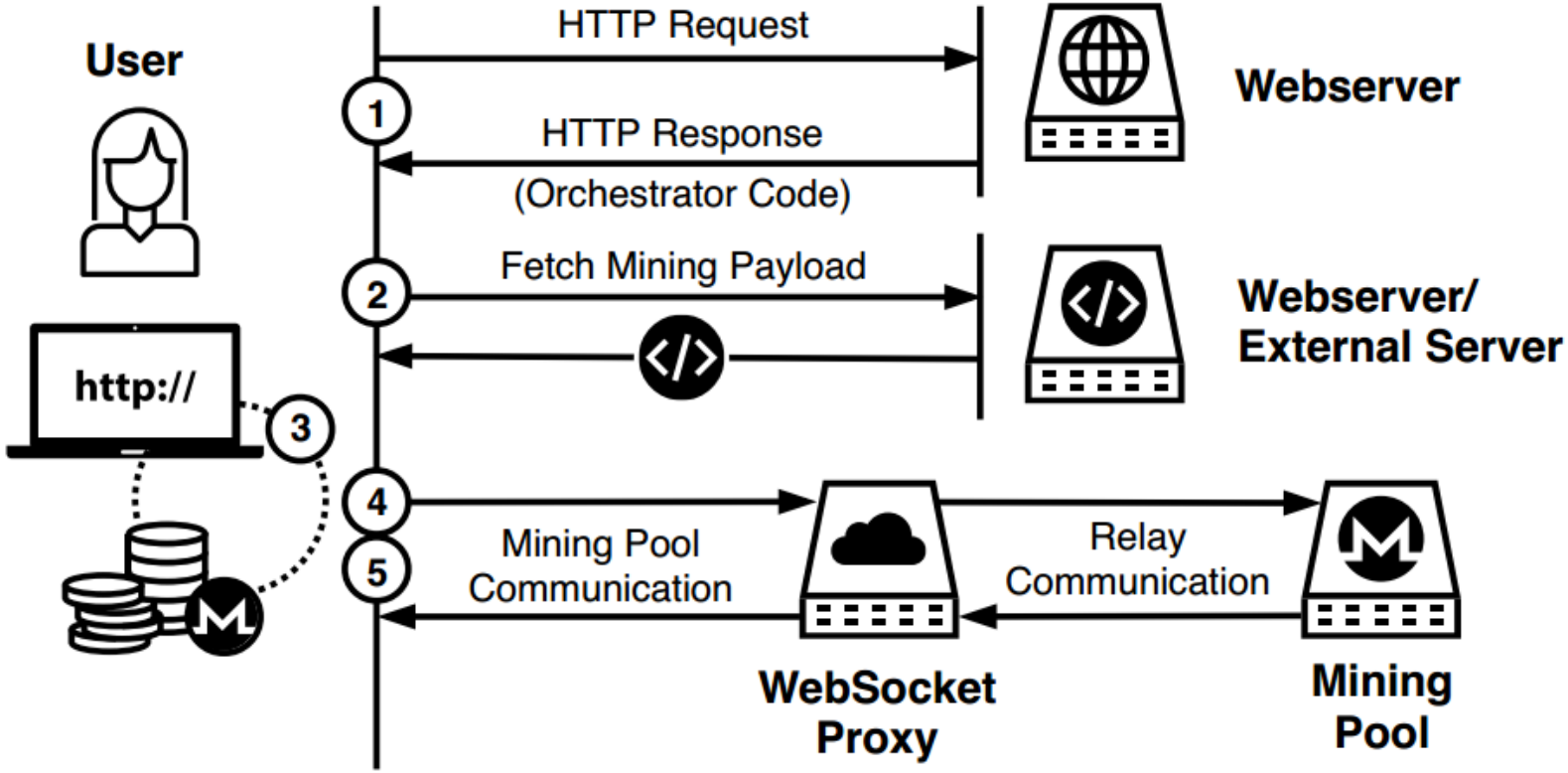




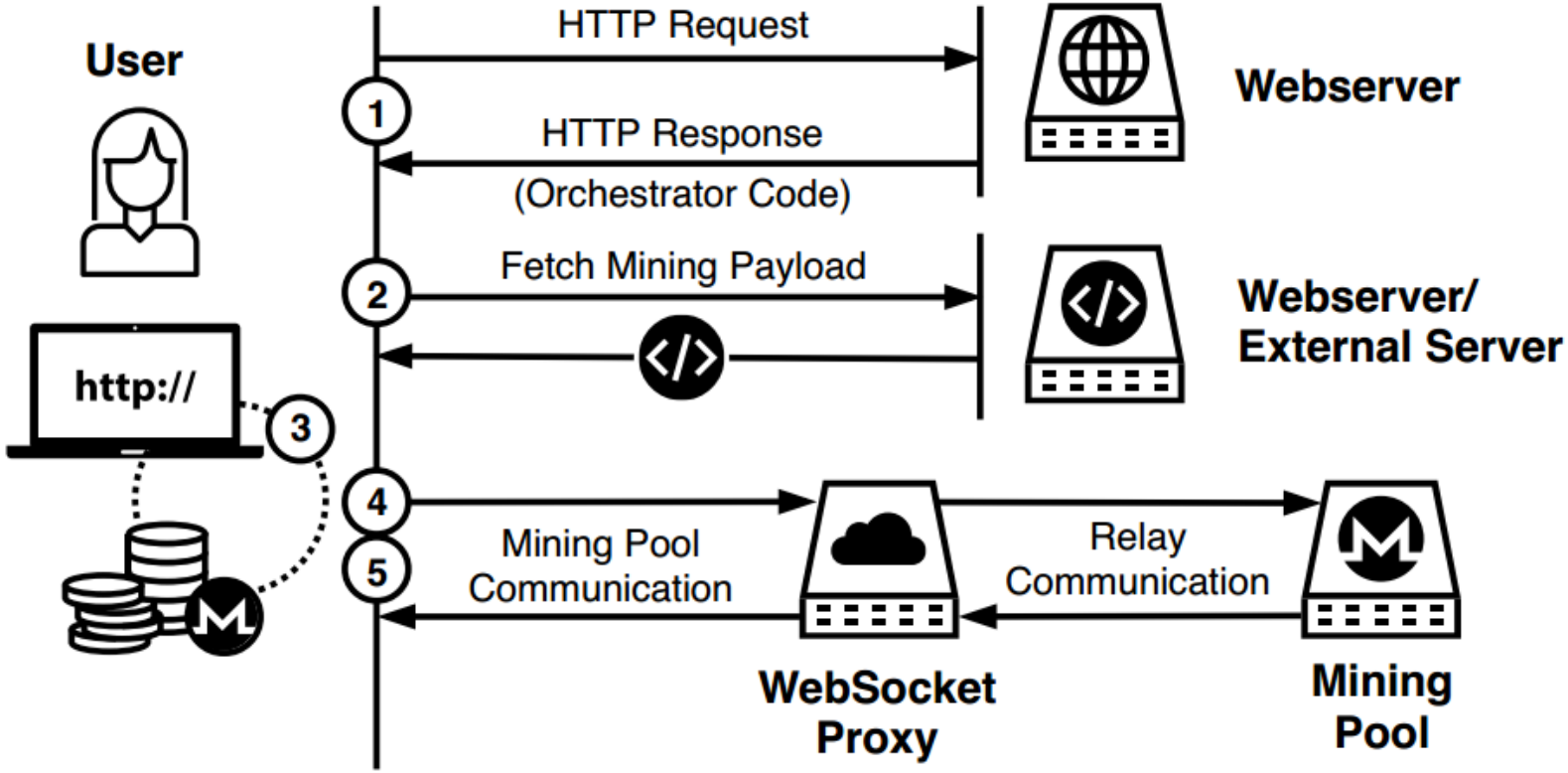
When a user visits a drive-by mining website, the website
(1) serves the orchestrator script, which checks the host environment to fnd out how many CPU cores are available



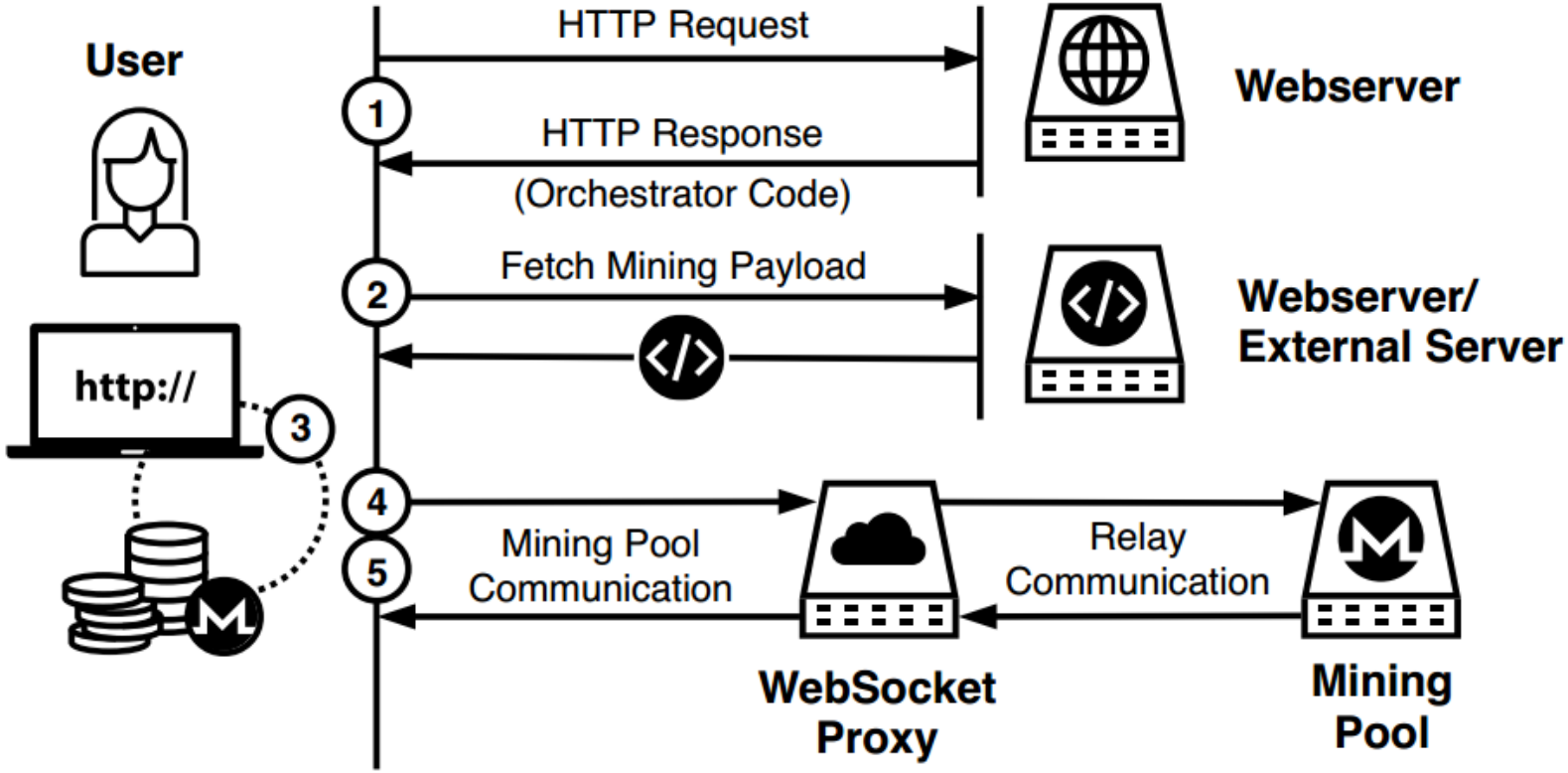
(2) downloads the highly-optimized cryptomining payload (as either Wasm or asm.js) from the website or an external server



(3) instantiates a number of web workers i.e., spawns separate threads, with the mining payload, depending on how many CPU cores are available



(4) sets up the connection with the mining pool server through a WebSocket proxy server



(5) fnally, fetches work from the mining pool and submits the hashes to the mining pool through the WebSocket proxy server

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Data Collection

- Build web crawler for visiting Alexa's top 1 million websites
- The crawler stays for four seconds on each visited page
- Collect data related to drive-by mining
- Identify Orchestrator and Mining Payload with the help of key word based search and Wasm module respectively

Data Analysis

Three different artifacts produced by the data collection system

1. Cryptomining Code
- Authors identified 13 well known cryptomining services using keywords listed below.
- 866 websites are using these 13 servides without obfuscating the orchestrator

Mining Service	Keywords
Coinhive	new CoinHive\.Anonymous | coinhive.com/lib/coinhive.min.js | authedmine.com/lib/
CryptoNoter	minercry.pt/processor.js | \.User\(addr
NFWebMiner	new NFMiner | nfwebminer.com/lib/
JSECoin	load.jsecoin.com/load
Webmine	webmine.cz/miner
CryptoLoot	CRLT\.anonymous | webmine.pro/lib/crlt.js
CoinImp	www.coinimp.com/scripts | new CoinImp.Anonymous | new Client.Anonymous | freecontent.stream | freecontent.data | freecontent.date
DeepMiner	new deepMiner.Anonymous | deepMiner.js
Monerise	apin.monerise.com | monerise_builder
Coinhave	minescripts\.info'
Cpufun	snipli.com/[A-Za-z]+\" data-id='
Minr	abc\.pema\.cl | metrika\.ron\.si | cdn\.rove\.cl | host\.dns\.ga | static\.hk\.rs | hallaert\.online | st\.kjli\.fi | minr\.pw | cnt\.statistic\.date | cdn\.static-cnt\.bid | ad\.g-content\.bid | cdn\.jquery-uim\.download'
Mineralt	ecart\.html\?bdata= | /amo\.js\"> | mepirtedic\.com'

Data Analysis

Three different artifacts produced by the data collection system

2. CPU Load as a Side Effect

- Not used to detect drive-by mining

Data Analysis

Three different artifacts produced by the data collection system

3. Mining Pool Communication

- Authors identified 1,008 websites that are communicating with mining pool servers using the Stratum protocol based on the keywords

Command	Keywords
Authentication	type:auth | command:connect | identifier:handshake | command:info
Authentication accepted	type:authed | command:work
Fetch job	identifier:job | type:job | command:work | command:get_job | command:set_job
Submit solved hash	type:submit | command:share
Solution accepted	command:accepted
Set CPU limits	command:set_cpu_load

Data Correlation

Using Cryptomining Code and Mining Pool Communication authors identify:

- There are 402 websites that don’t need user consent.

- Other 464 websites wait for user’s consent.

Results

Three evasion techniques have been identified:

- Code Obfuscation

- Obfuscated Stratum Communication

- Anti-debugging Tricks

Modus Operandi of Attack

Three ways

1. Miners inject through third-party services
2. Miners inject through advertisement networks
3. Miners inject by compromising vulnerable websites

Common Drive-by Mining Characteristics

Three characteristics:

1. All services use CryptoNight-based cryptomining implementations.

2. All identified websites use a highly-optimized Wasm implementation of the CryptoNight algorithm to execute the mining code.

3. All drive-by mining websites use WebSockets to communicate with the mining pool through a WebSocket proxy server

How MineSweeper Works?

Takes the URL of website as input

Detection Based on Primitive Identification

Generic Cryptographic Function Detection

Detection Based on CPU Cache Events

Deployment

MineSweeper Can be integrated into browswers easily.

- Will overcome the limitations of Blacklists based system.

Limitations

- It only spends 4 seconds on each webpage. Could miss websites that wait for more time.
- Not capable to capture the mining pool communication for websites that implement mining delays.

Thank You