CISPA
HELMHOLTZ CENTER FOR INFORMATION SECURITY

Welcome to Jurassic Park:

Studying the Security Risks of Deno

Abdullah AlHamdan, Cristian-Alexandru Staicu | NDSS'25 | Feb 2025

Deno

- An emerging JavaScript runtime with **a focus on security**
- Written in Rust, a **memory-safe language**
- The permission system aims to control the communication with the OS via runtime **permissions checks**
- Deno supports import code from arbitrary URL → **decentralized software supply chain** via `import(URL)`

Motivation … and Spoiler

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- Study the **security risks** of Deno

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- Evaluate how its **features** can influence **security**

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- Study the **security risks** of Deno
- Evaluate how its **features** can influence **security**

General Results

- **Smaller attack surface** compared to Node.js
- Still... there are **unmitigated** threats
- **New class of threats** to JavaScript/TypeScript applications

Studying Deno’s Security and Risks

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Security and Attack Surface

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Permission System

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Security and Attack Surface

Permission System

Software Supply Chain

Deno’s Security Model and Attack Surface

Did Rust and the security model solve everything?

Security Features in Deno

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Resistant to
memory-based attacks

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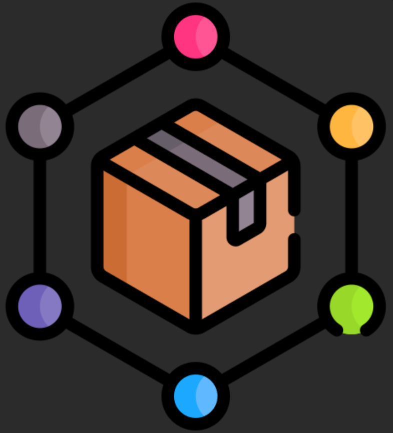

Distributed
supply chain

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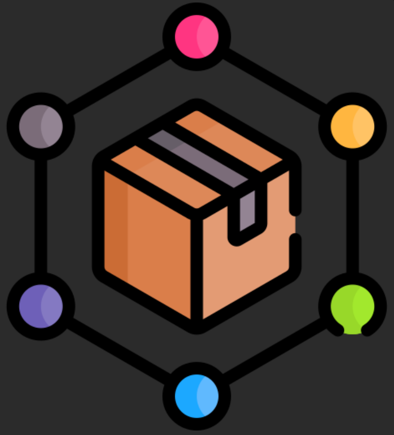

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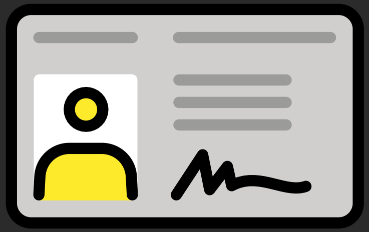

Third-party code
integrity checks

Security Features in Deno

Resistant to memory-based attacks

Distributed supply chain

Permissions to sensitive APIs calls

Third-party code integrity checks

Attack Surface Evaluation

- Deno has smaller attack surface in comparison to Node.js

Prototype Pollution

```
const user = {};
user.__proto__.isAdmin = true;
const newUser = {};
console.log(newUser.isAdmin);
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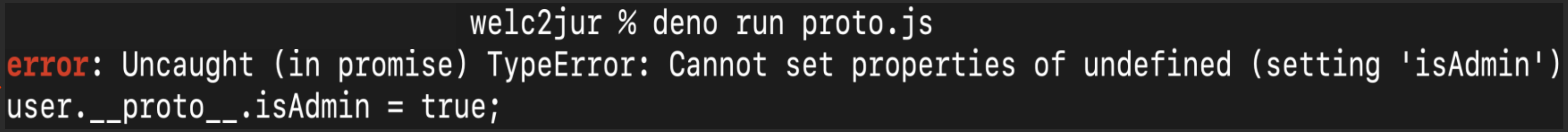

```
welc2jur % deno run proto.js
error: Uncaught (in promise) TypeError: Cannot set properties of undefined (setting 'isAdmin')
user.__proto__.isAdmin = true;
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Attack Surface Evaluation(cont.)

- Partially affected and not mitigated

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Attack Surface Evaluation

- When Deno security features affect the attack surface

Command Injection

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`const process = Deno.run({ cmd: ["cat", "/etc/passwd"],
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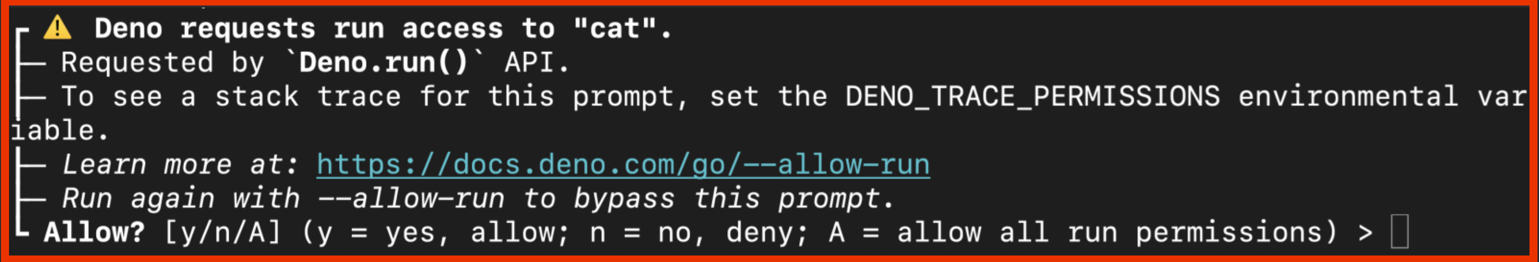

```
┌ ⚠️  Deno requests run access to "cat".
├ Requested by `Deno.run()` API.
├ To see a stack trace for this prompt, set the DENO_TRACE_PERMISSIONS environmental var
iable.
├ Learn more at: https://docs.deno.com/go/--allow-run
├ Run again with --allow-run to bypass this prompt.
└ Allow? [y/n/A] (y = yes, allow; n = no, deny; A = allow all run permissions) >
```

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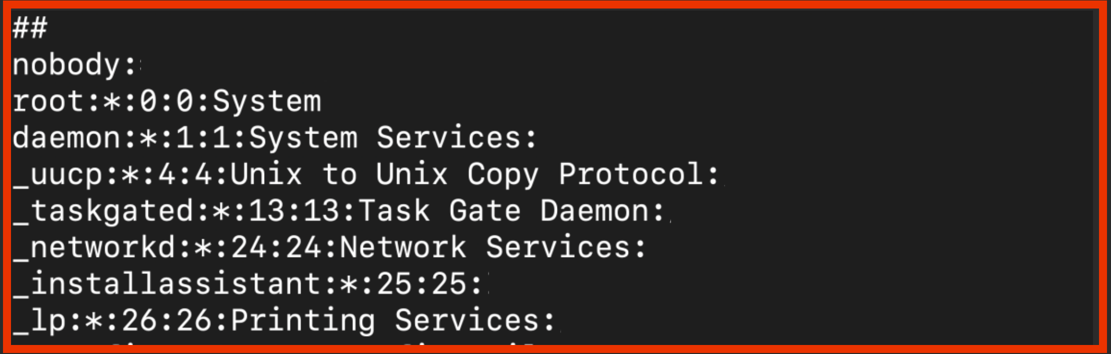

```
##
nobody:
root:*:0:0:System
daemon:*:1:1:System Services:
_uucp:*:4:4:Unix to Unix Copy Protocol:
_taskgated:*:13:13:Task Gate Daemon:
_networkd:*:24:24:Network Services:
_installassistant:*:25:25:
_lp:*:26:26:Printing Services:
```

Deno's Permission System

Is the permission system robust?

Deno Permission System

- Runtime permissions systems goals:
  - **Intercept calls** to all critical functionalities
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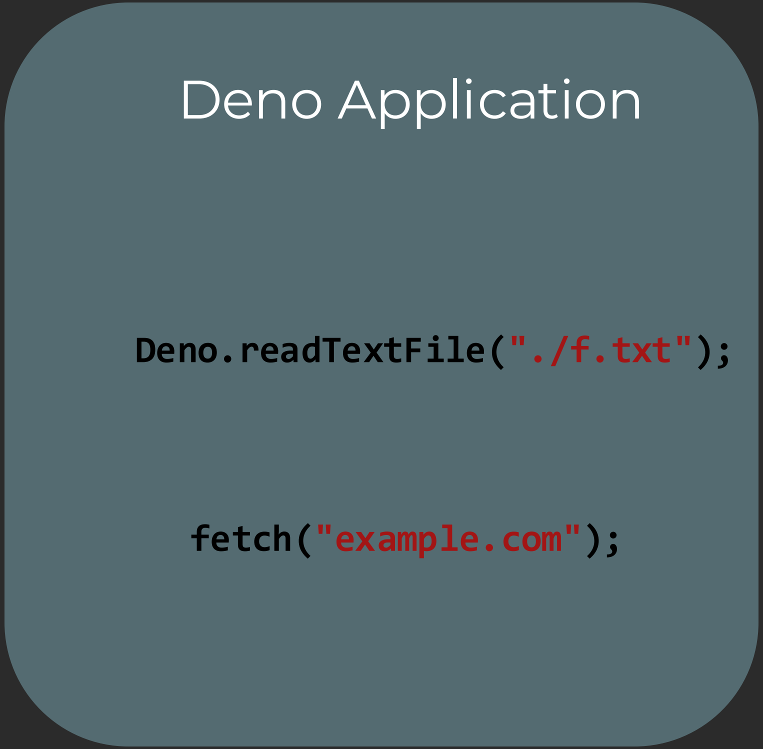

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Deno.readTextFile("./f.txt");

fetch("example.com");
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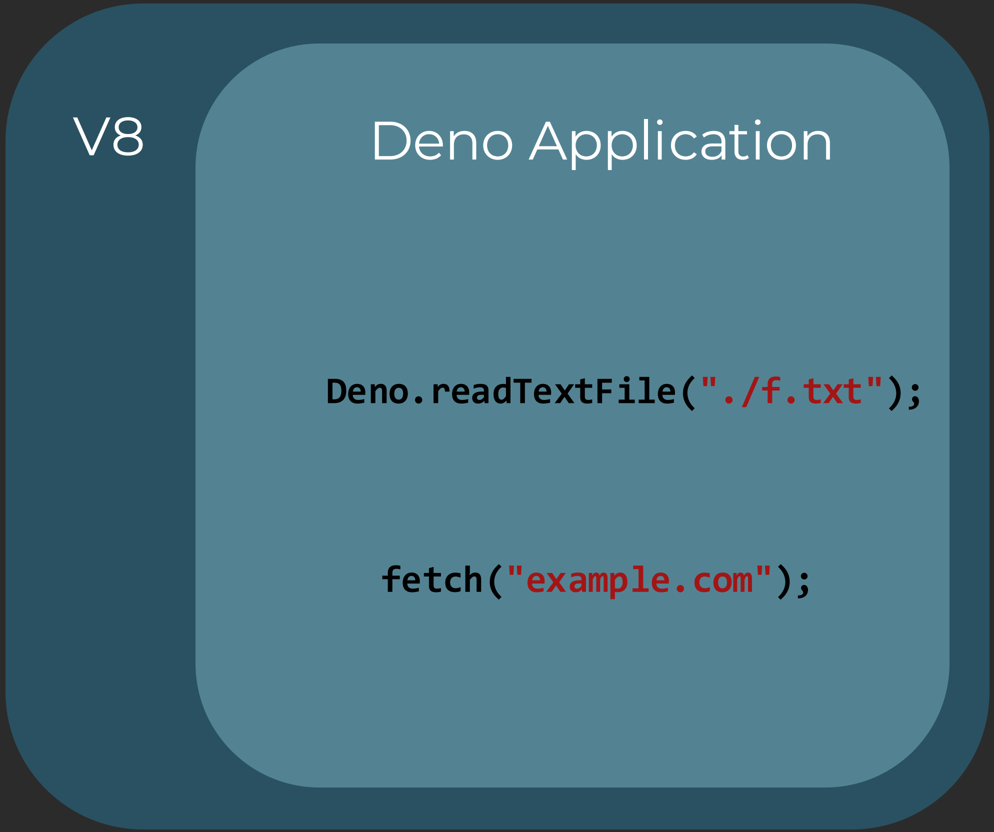

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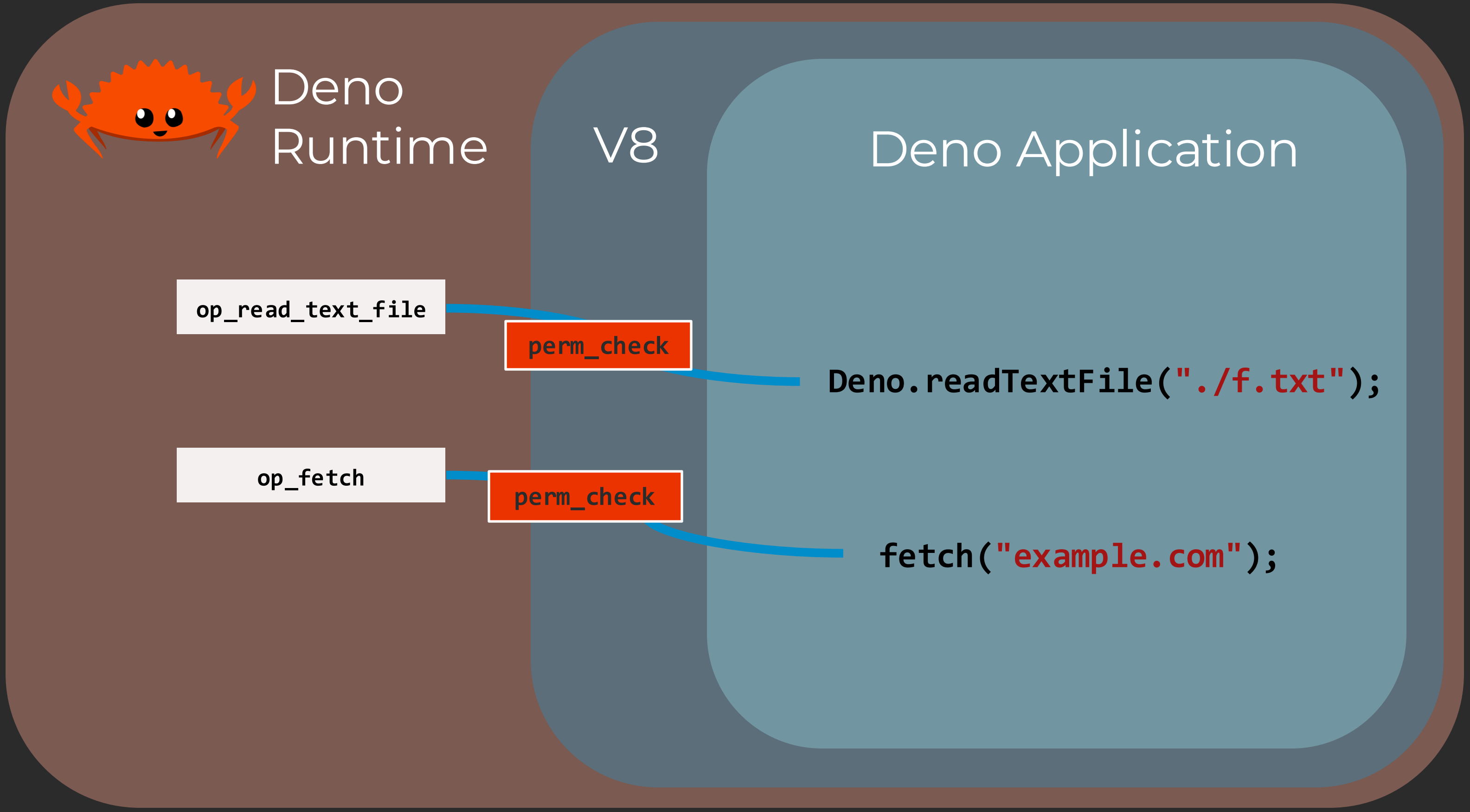

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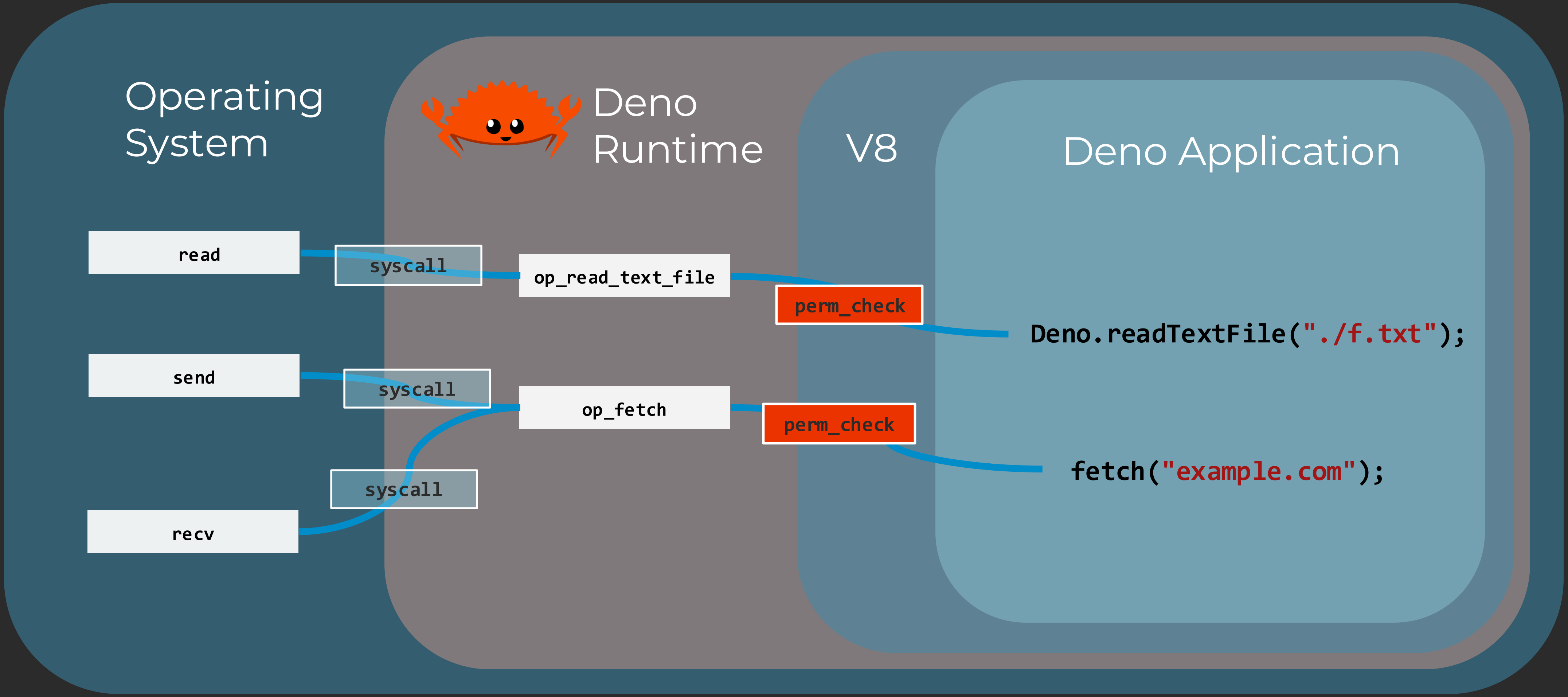

Escaping the Permission System

- Escaping the permission system by exploiting missing permission checks on static `import();`

ROUND 1

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await Deno.writeTextFile(_fname, pre + oldContent);
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Run command:

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deno run --allow-read --allow-write perm.js
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ROUND 2

Run command:

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ROUND 2

Run command:

Network permission is not given

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Run command:

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Data exfiltration via static import

CVE-2024-21486

ROUND 2

Deno’s Software Supply Chain

Hmm… is deno.land yet another npm?

Deno's Software Supply Chain

- Unlike Node.js, Deno allows **importing third-party packages from any available domain** via a valid URL
- deno.land supports package **version immutability**
- Allows **importing individual files** and their dependencies

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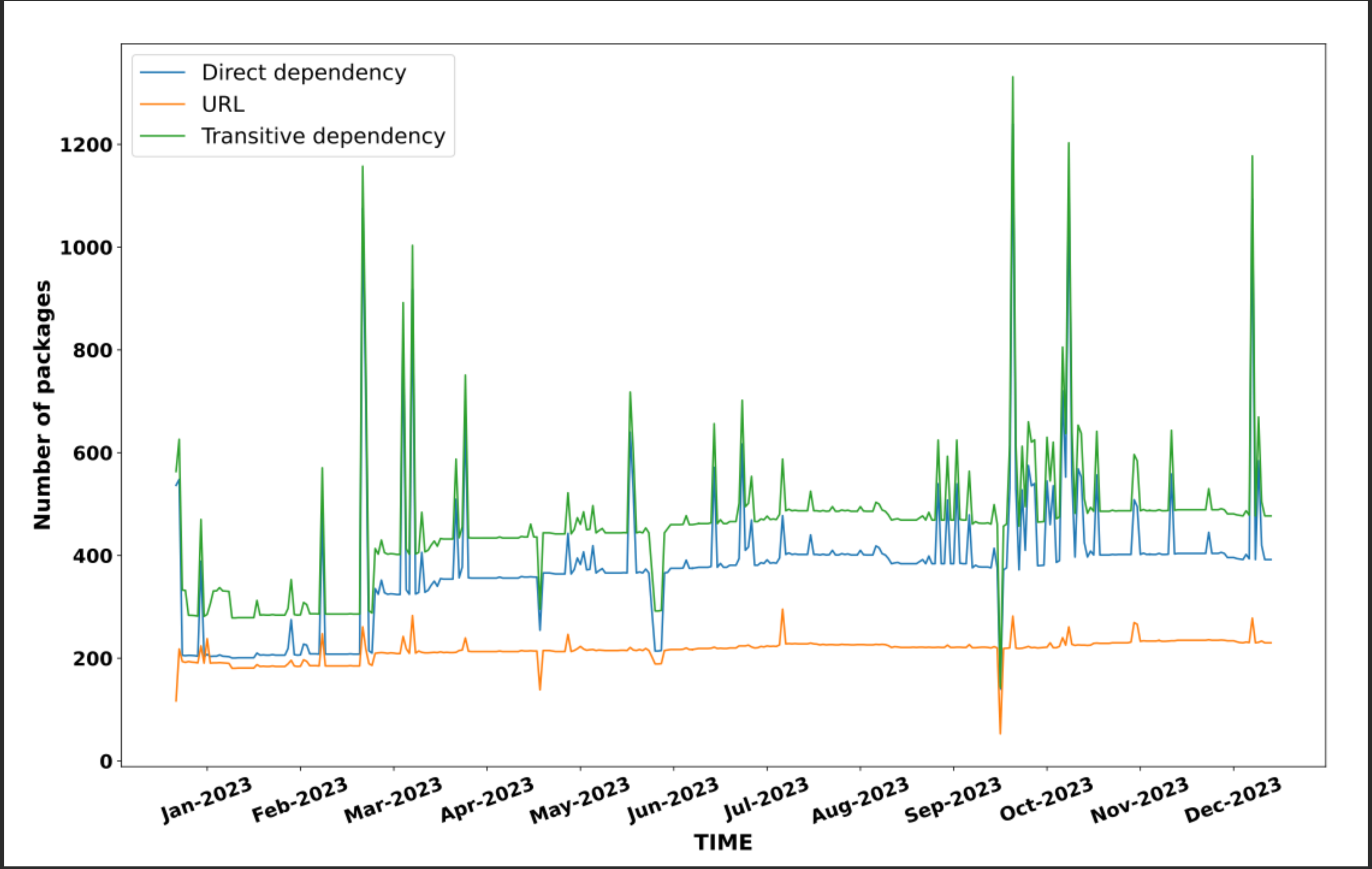
21 domains

Impact of Unavailable URLs on the Supply Chain

- Median of unavailable links = 220
- Breaking change caused by 21 permanently broken links to `deno std`



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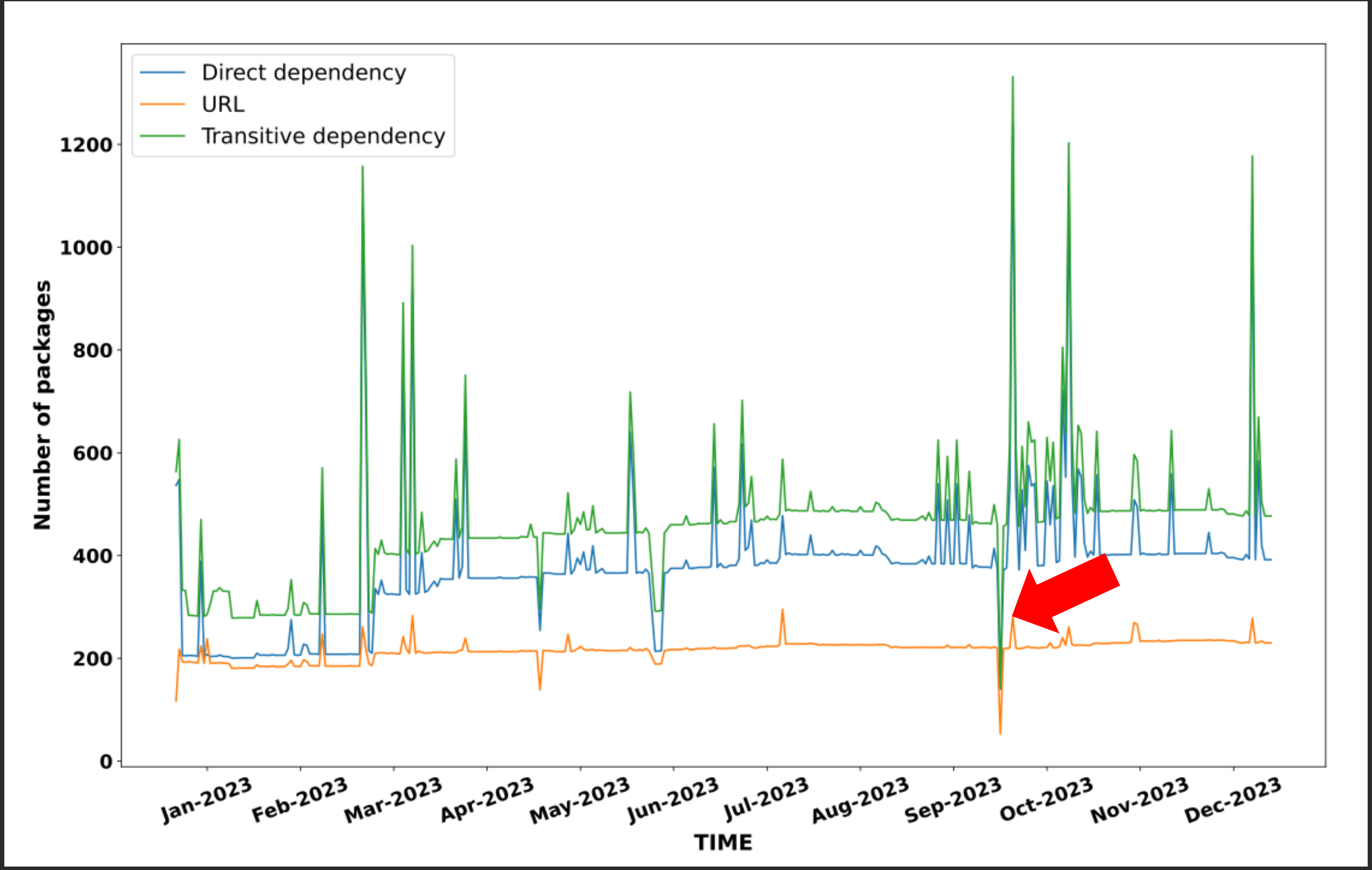
23/Sep/2023

- **283** unavailable URLs



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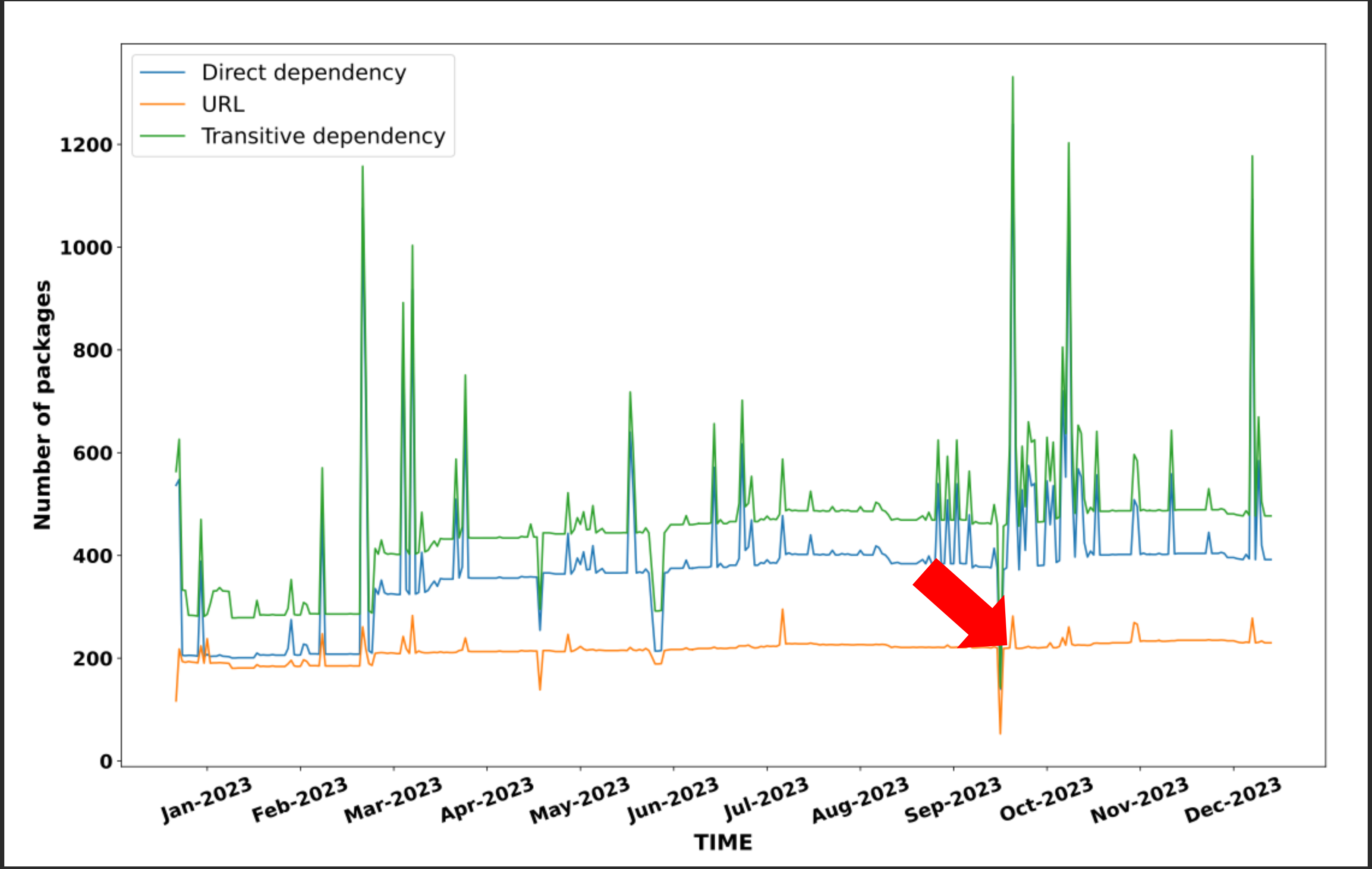
- **59.44%** of URLs available a day before



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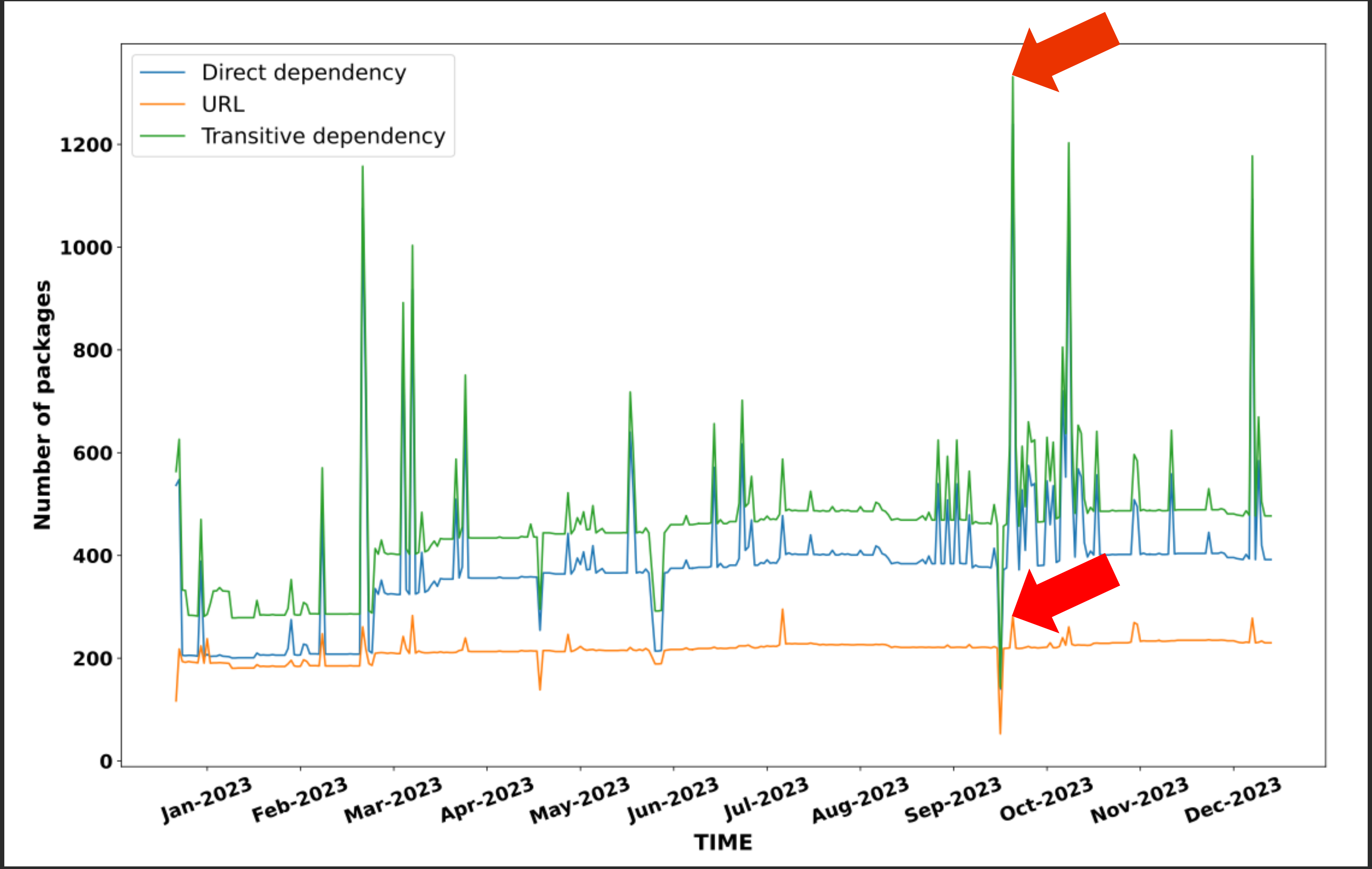
- **1332** affected transitive deps.



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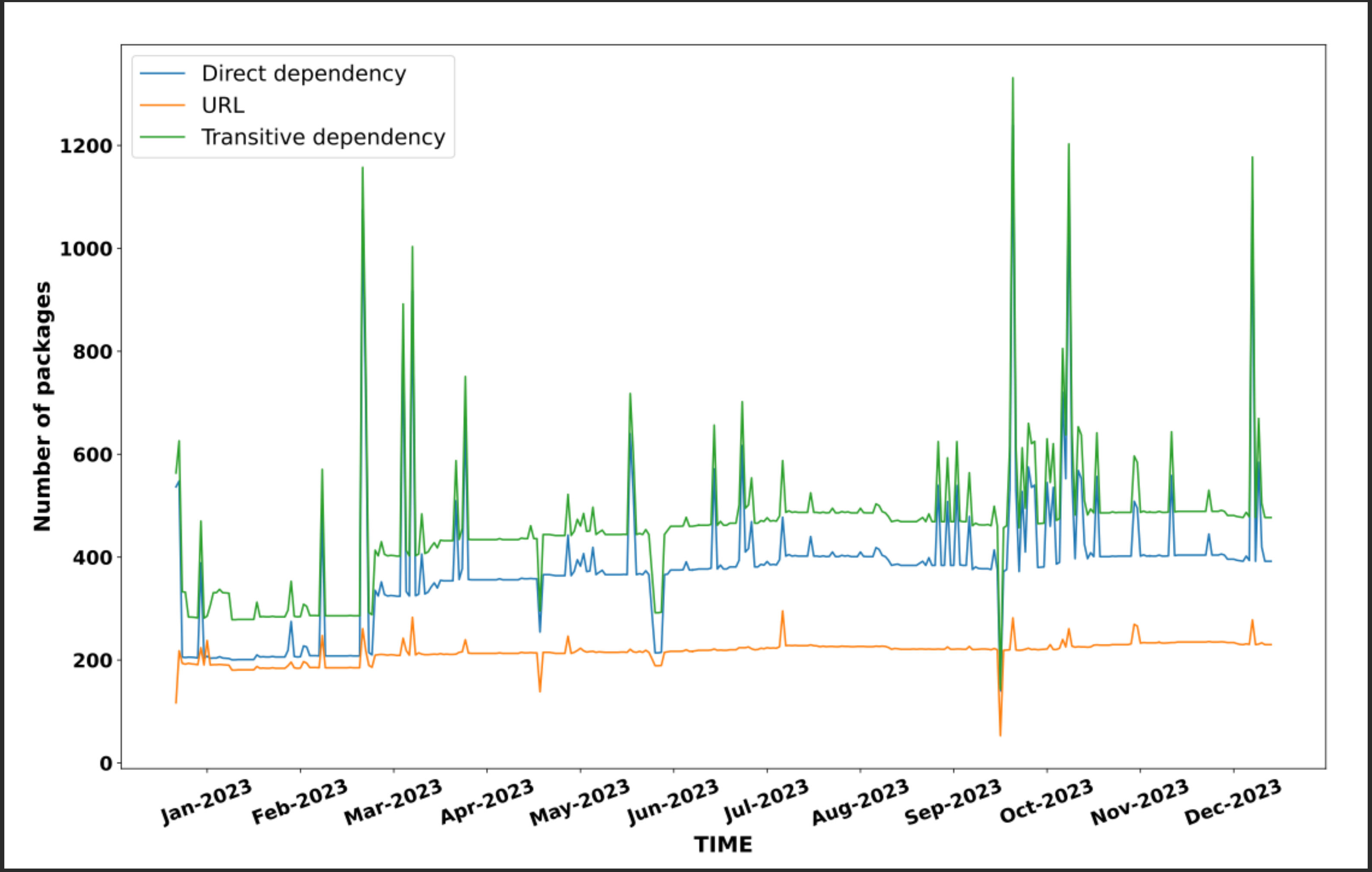

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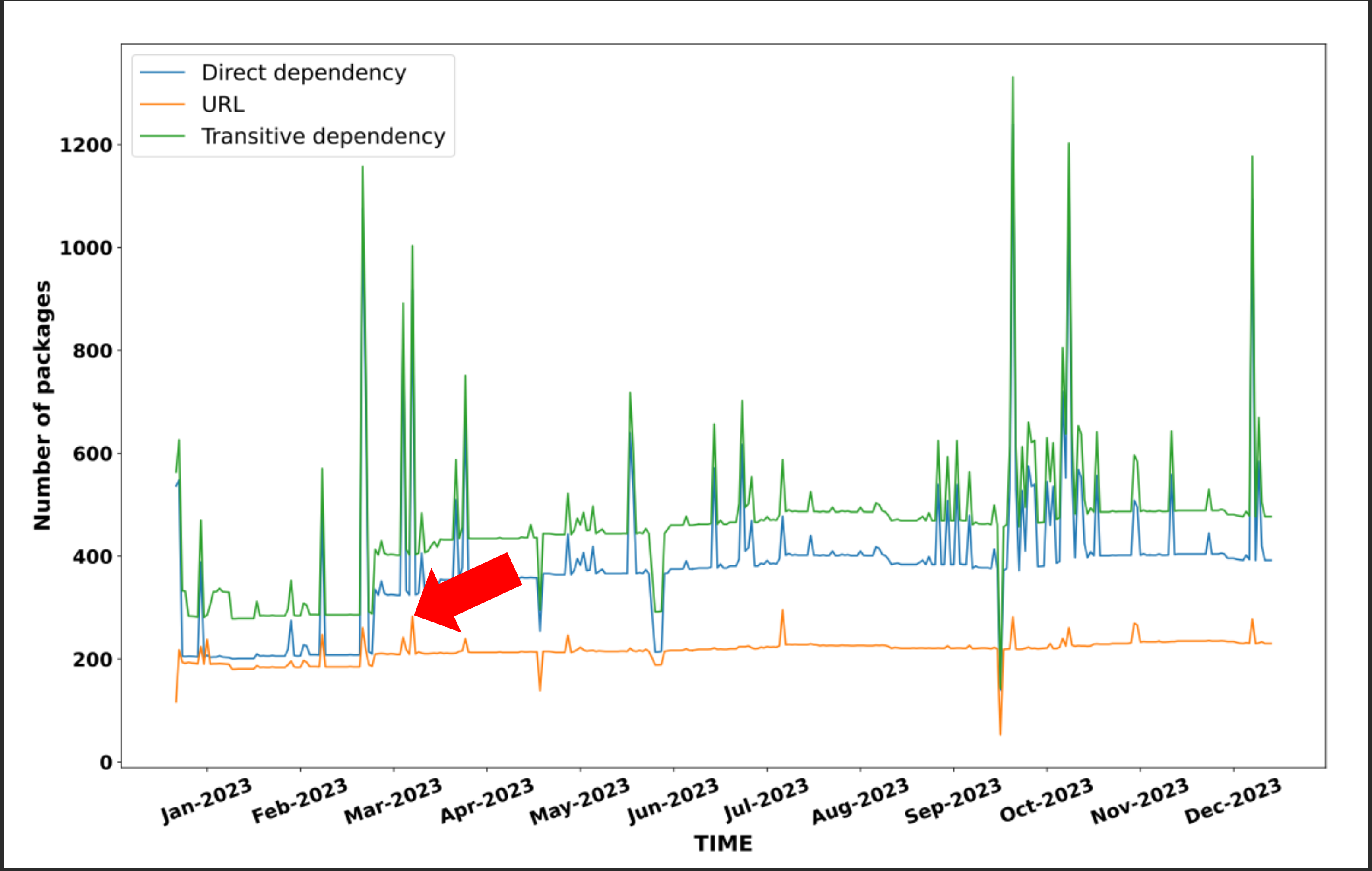
5/Mar/2023

- **276** unavailable URLs



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5/Mar/2023

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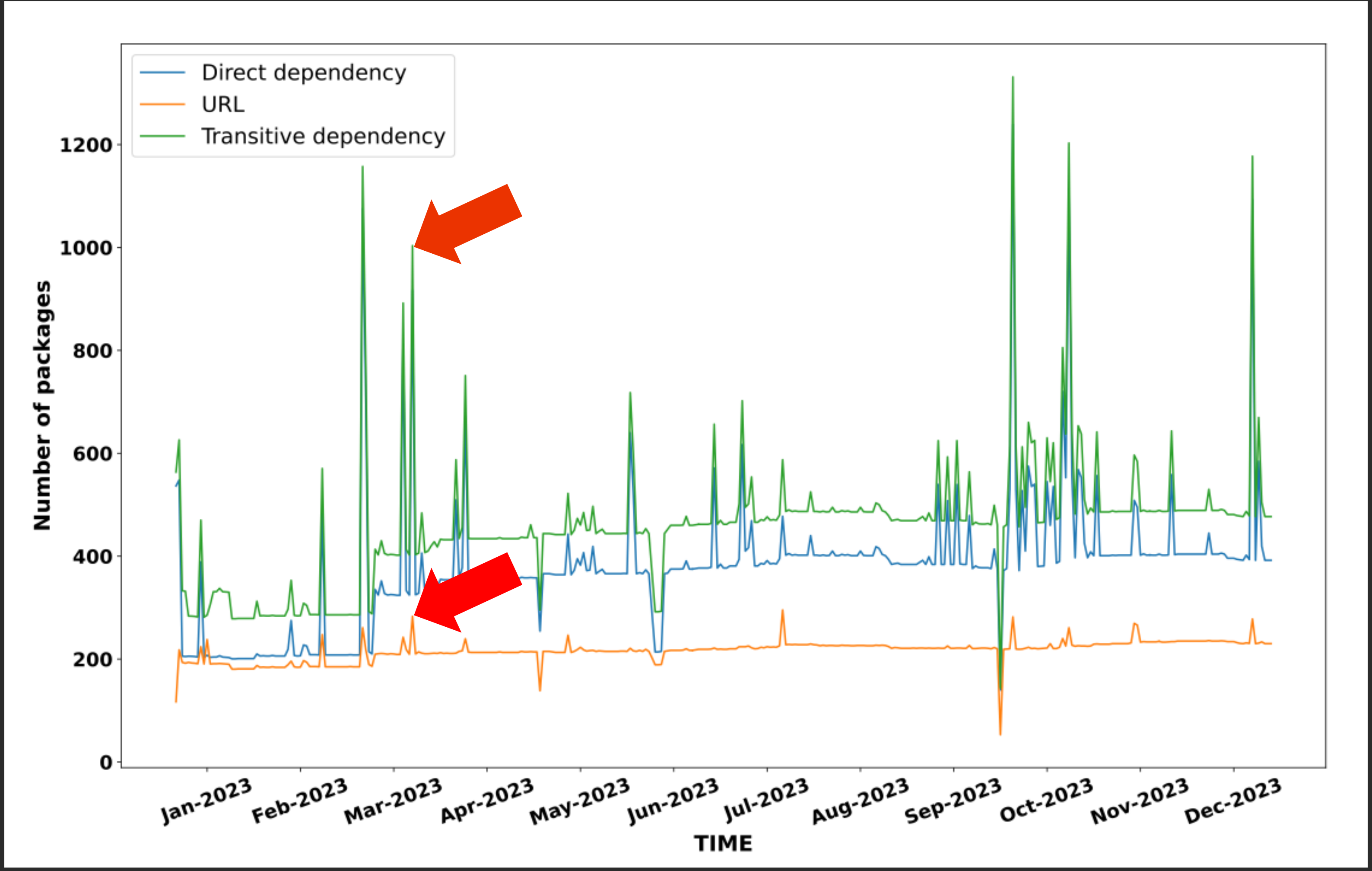

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5/Mar/2023

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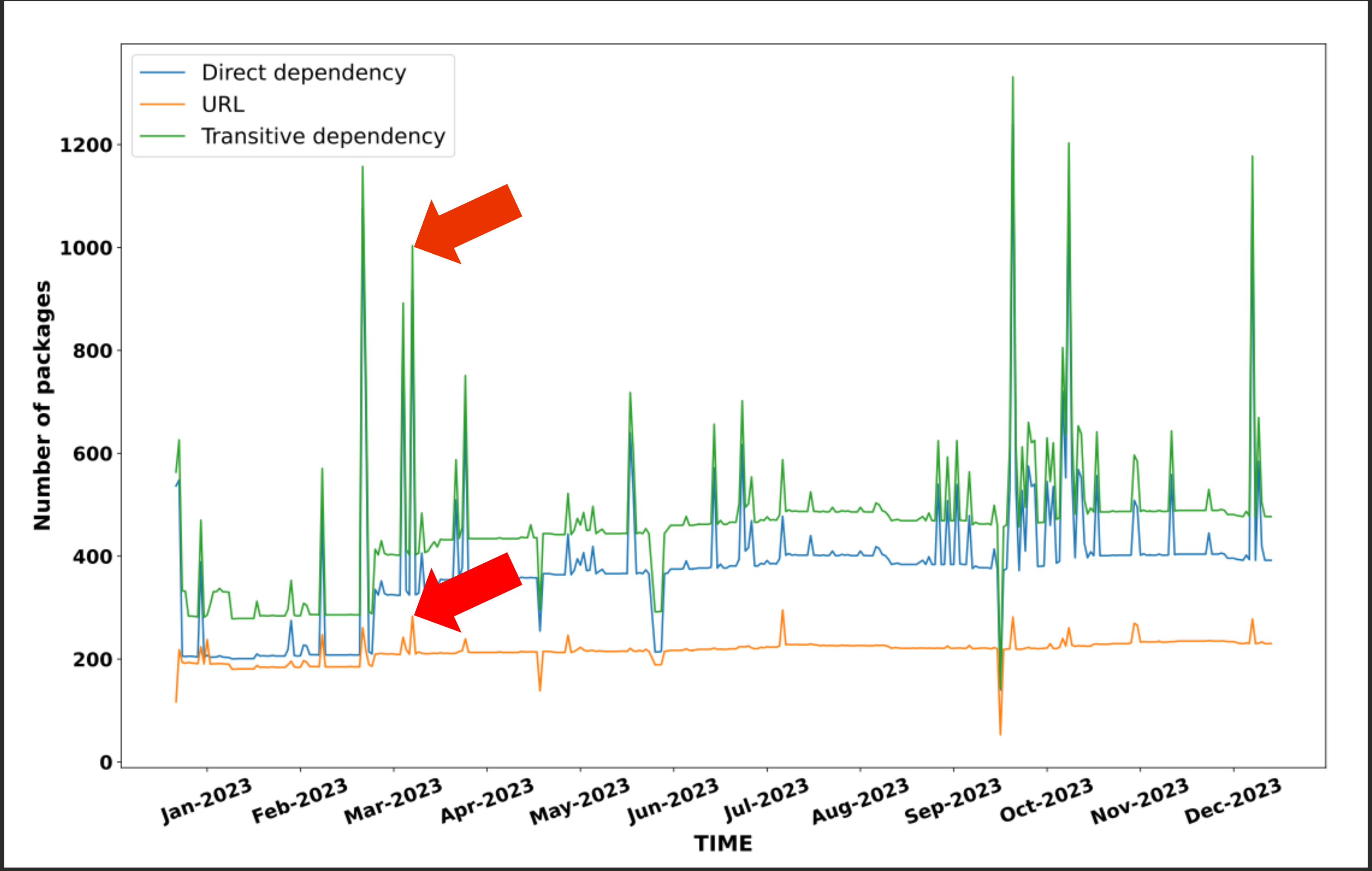
- **denopkg.com** was down



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5/Mar/2023

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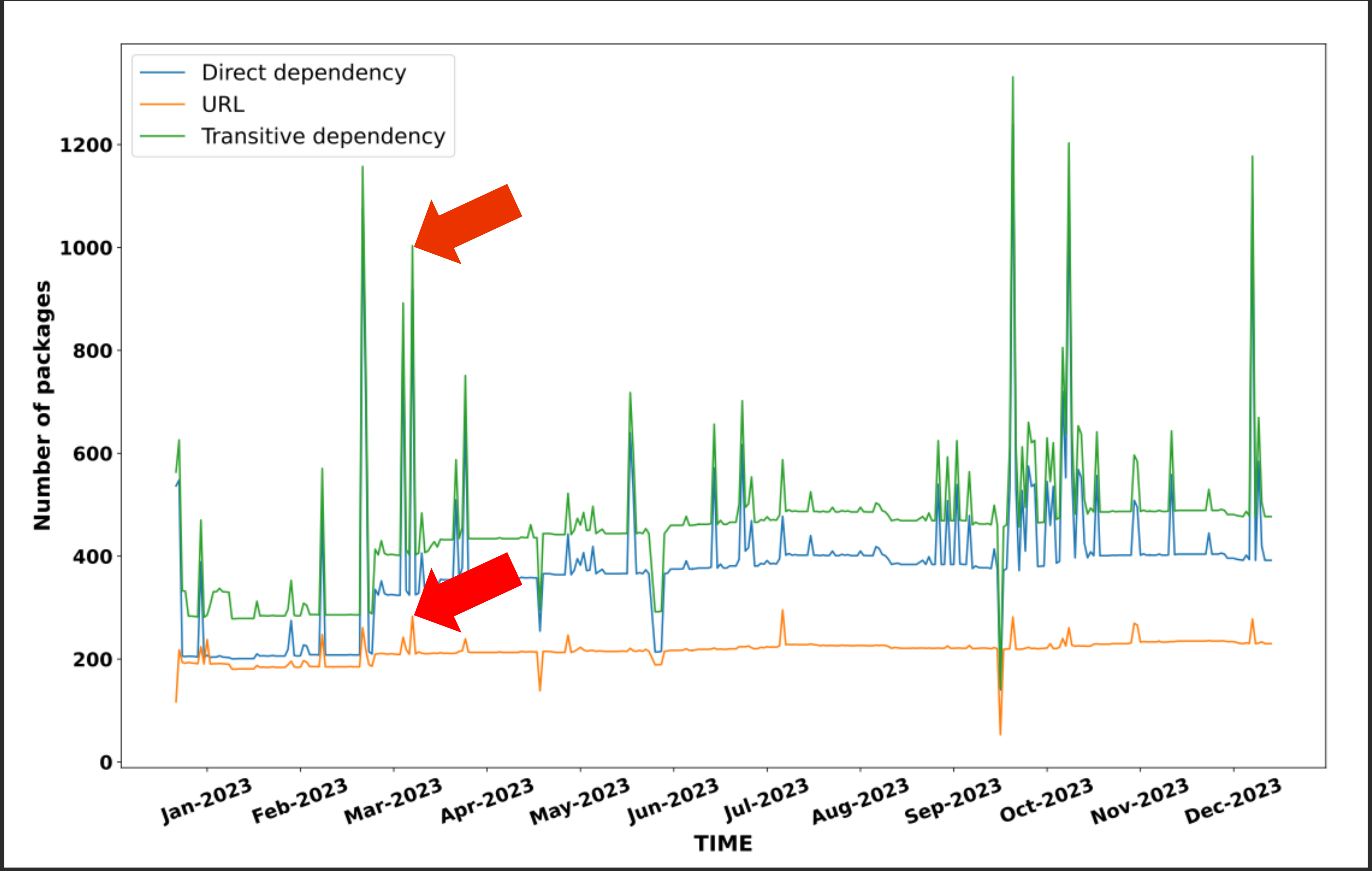
- **4 pkgs** from denopkg.com causes **10.8%** of total affected pakgs.



Takeaways

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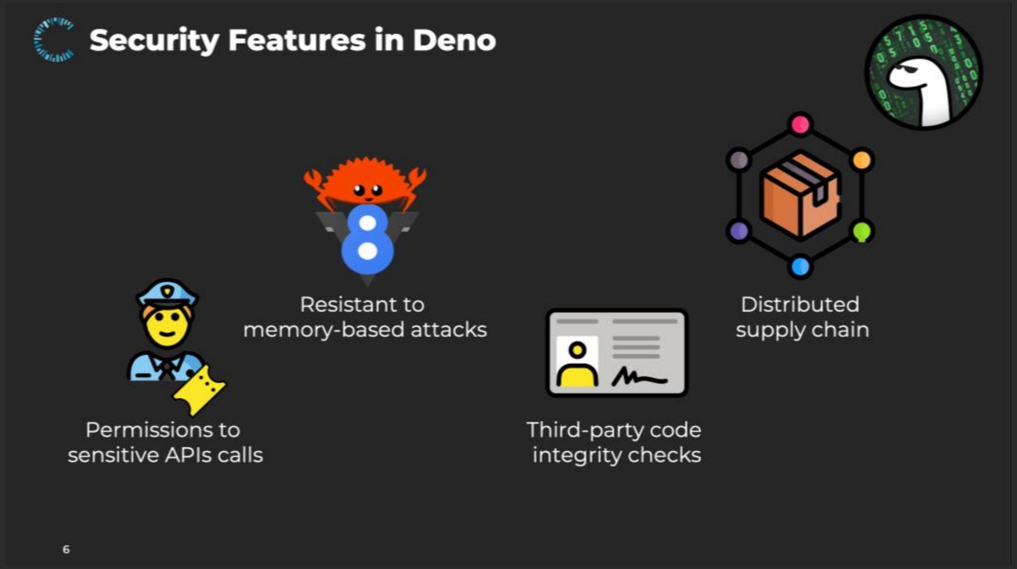

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Permissions to sensitive APIs calls

Third-party code integrity checks

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   With lots of new challenges.

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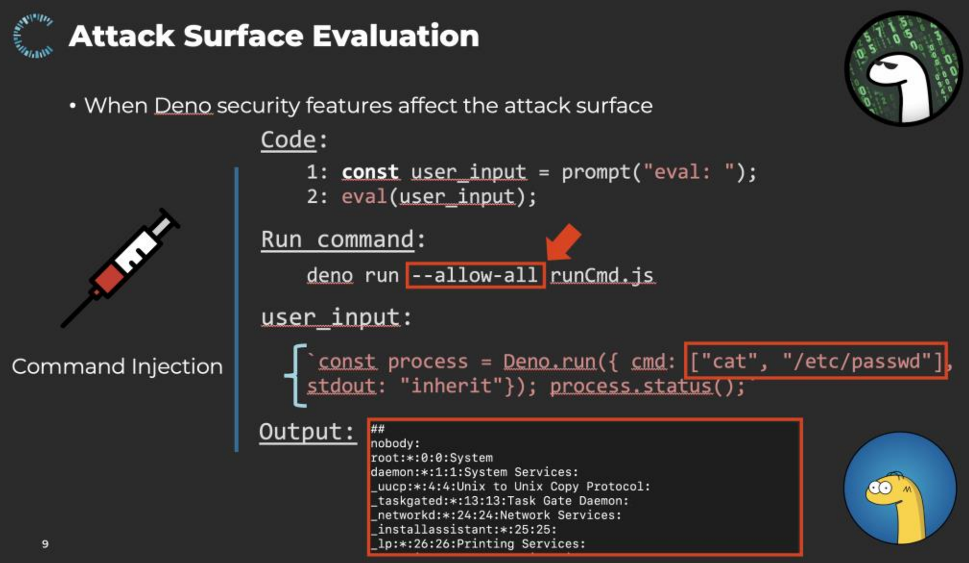

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- When Deno security features affect the attack surface

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2. **Deno has smaller attack surface**
   Many attacks are still not mitigated, or partially mitigated.

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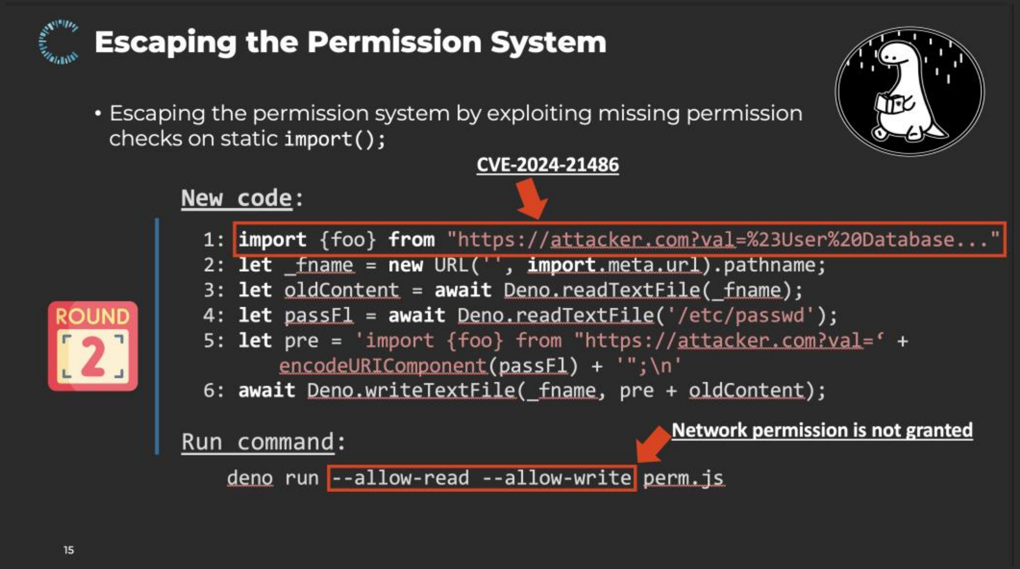

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Network permission is not granted

Run command:

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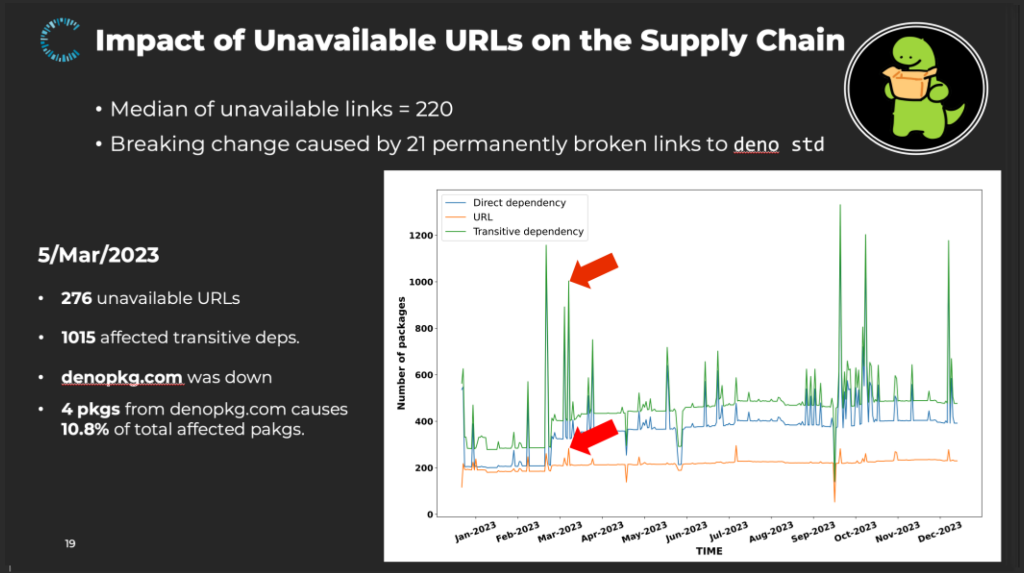
   With lots of new challenges.
2. **Deno has smaller attack surface**
   Many attacks are still not mitigated, or partially mitigated.
3. **Deno's permission system is able to minimise supply chain risks**
   It still has weaknesses within its permissions system.

Takeaways



Impact of Unavailable URLs on the Supply Chain

- Median of unavailable links = 220
- Breaking change caused by 21 permanently broken links to deno `std`

5/Mar/2023

- **276** unavailable URLs
- **1015** affected transitive deps.
- denopkg.com was down
- **4 pkgs** from denopkg.com causes **10.8%** of total affected pakgs.

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1. **Deno, an emerging JavaScript runtime with focus on security**
   With lots of new challenges.
2. **Deno has smaller attack surface**
   Many attacks are still not mitigated, or partially mitigated.
3. **Deno's permission system is able to minimise supply chain risks**
   It still has weaknesses within its permissions system.
4. **Implementing decentralised software supply chain for the server side is challenging**
   Domains need a uniform package distribution policy.

Graphics and icons are taken form:
https://deno.com/artwork,
https://openmoji.org

Attack Surface Evaluation

- Deno has smaller attack surface in compare to Node.js

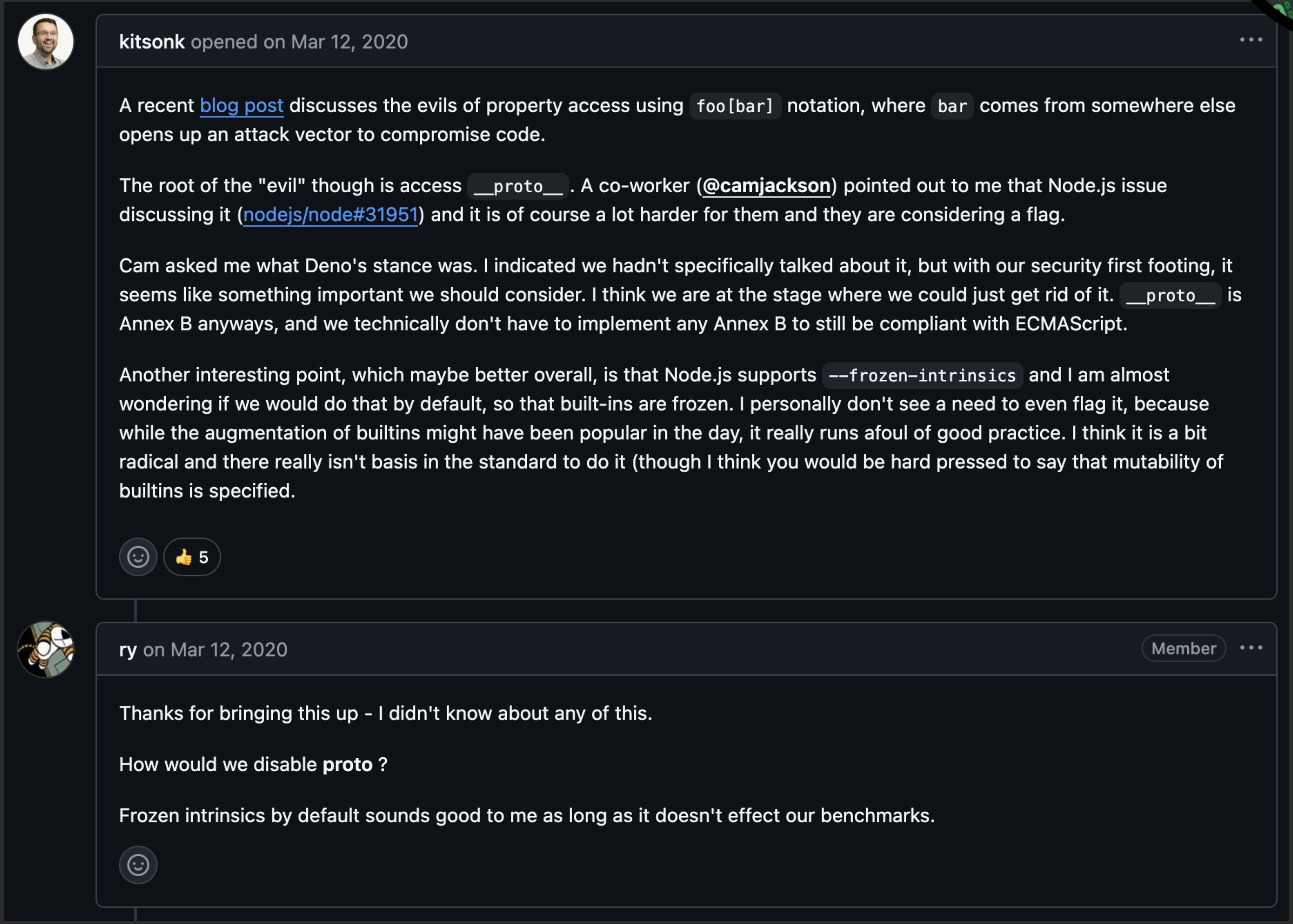
Prototype Pollution

```
const user = {};

user.__proto__.isAdmin = true;

const newUser = {};
console.log(newUser.isAdmin); // true
```

Node.js prototype pollution example

Attack Surface Evaluation

Prototype Pollution



kitsonk opened on Mar 12, 2020

A recent blog post discusses the evils of property access using `foo[bar]` notation, where `bar` comes from somewhere else opens up an attack vector to compromise code.

The root of the "evil" though is access `__proto__`. A co-worker (**@camjackson**) pointed out to me that Node.js issue discussing it (nodejs/node#31951) and it is of course a lot harder for them and they are considering a flag.

Cam asked me what Deno's stance was. I indicated we hadn't specifically talked about it, but with our security first footing, it seems like something important we should consider. I think we are at the stage where we could just get rid of it. `__proto__` is Annex B anyways, and we technically don't have to implement any Annex B to still be compliant with ECMAScript.

Another interesting point, which maybe better overall, is that Node.js supports `--frozen-intrinsics` and I am almost wondering if we would do that by default, so that built-ins are frozen. I personally don't see a need to even flag it, because while the augmentation of builtins might have been popular in the day, it really runs afoul of good practice. I think it is a bit radical and there really isn't basis in the standard to do it (though I think you would be hard pressed to say that mutability of builtins is specified.

👍 5

ry on Mar 12, 2020 Member

Thanks for bringing this up - I didn't know about any of this.

How would we disable **proto** ?

Frozen intrinsics by default sounds good to me as long as it doesn't effect our benchmarks.