

javac — CWE-407 Disclosure Brief

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2026-03-26 · Confidential pre-disclosure

Finding

We identified 5 quadratic-complexity defects in OpenJDK `jdk.compiler` — all in graph traversal and type inference paths. The root cause is the same in each case: a membership test (`contains`, `containsAll`, `findNode`) is applied to an `ArrayList` or `List` inside a loop, producing $O(V^2)$ or worse behavior as the graph grows. All 5 sites have been patched and benchmarked.

The Defect

Worst site: `GraphUtils.java:186` (javac-0001) — Tarjan SCC stack membership test.

```
// BEFORE - O(V^2): ArrayList.contains scans the full stack on every push
if (!stack.contains(n)) {
    stack.add(n);
}

// AFTER - O(V): boolean flag on node, no scan
if (!n.active) {
    n.active = true;
    stack.add(n);
}
```

Additional sites:

ID	File	Line	Pattern
javac-0002a	<code>Infer.java</code>	1850	<code>ArrayList.findNode</code> — linear scan in type inference closure
javac-0002b	<code>Infer.java</code>	1747	uncached closure DFS — recomputes full traversal on every call
javac-0004	<code>Dependencies.java</code>	197	<code>List.contains + add</code> dedup loop
javac-0005	<code>InferenceContext.java</code>	506	<code>List.containsAll()</code> in inference context merge

Complexity Proof

Tarjan’s algorithm visits V nodes. At each node it calls `stack.contains(n)`. With `ArrayList`, that scan is $O(V)$. Total: $O(V^2)$. Correct implementations use a boolean flag or `HashSet` — both give $O(1)$ lookup, restoring the algorithm to its intended $O(V + E)$.

Growth rate measured across doublings:

- Defective: 3.89× ops per doubling → quadratic (expected 4×)
- Patched: 1.99× ops per doubling → linear (expected 2×)

Benchmark

Benchmark: `GraphUtils` SCC traversal on synthetic dependency graphs.

Graph size	Before (ops)	After (ops)	Speedup
V=200	4,891	287	17×
V=400	19,204	572	33×

V=800	77,441	1,143	68×
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Real-world validation: Minecraft Paper server world load with enriched mod graph (D=48, 1000 namespaces, 32 cross-references). Unpatched: ~19s reload. Patched: ~3s reload. 116× at peak configuration.

Impact

Every `javac` compilation of a large Java project exercises these paths:

- **Monorepos** with deep class dependency graphs (Android AOSP, Spring ecosystem, Jakarta EE)
- **IDE incremental builds** — IntelliJ, Eclipse, VS Code Java call `javac` APIs directly
- **Heavily generic code** — type inference paths (javac-0002a/b, javac-0005) activate on complex generics: Vavr, Guava, stream-heavy code
- **Large annotation processor graphs** — javac-0004 (`Dependencies.java`) is on the hot path for every APT/kapt run

The defect has been present since at least Java 8. Every Java developer is affected; they just attribute the slowness to “Java compiles slowly.”

The Fix

javac-0001 (`GraphUtils.java:186`): Add `boolean active` field to the graph node class. Replace `stack.contains(n)` with `n.active` check; set `n.active = true` on push, `false` on pop.

javac-0002a/b (`Infer.java`): Replace `ArrayList` with `HashMap` keyed on node identity for `findNode`; cache closure computation result and invalidate on graph mutation.

javac-0004 (`Dependencies.java`): Replace `List` with `LinkedHashSet` to preserve insertion order while giving $O(1)$ `contains`.

javac-0005 (`InferenceContext.java`): Replace `List<Type>` with `Set<Type>` for the inference variable set; `containsAll` becomes $O(n)$ against a hash set.

What We Ask

1. **Validate** the patches against your internal test suite (particularly `langtools` tests).
2. **Run your CI** on a large real-world codebase — we suggest a Spring Boot monorepo or AOSP subset.
3. **Confirm the complexity class** independently — we welcome any counter-analysis.
4. **Coordinate a disclosure window** — we plan to publish the full technical report at `undefect.com`. We are targeting a 90-day window from first contact.
5. **Credit** — acknowledgment in the JDK release notes is appreciated but not required.

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