JSR 396: Java SE 21

Iris Clark

Specification Lead
iris.clark@oracle.com
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JSR 396: Java SE 21

Specification
- Latest: https://cr.openjdk.org/~iris/se/21/latestSpec (DRAFT 34)
- Public Review ends 21 Aug

Reference Implementation (RI) – JDK 21
- Latest: https://jdk.java.net/21 (build 34)
- Repository: https://github.com/openjdk/jdk21
- Rampdown Phase 2 (RDP2)
  - Feature set frozen
  - Development very strictly limited to selected bug fixes
- 12 Integrated SE JEPs; 129 approved SE CSRs
- General Availability (GA): 2023/09/19

Technology Compatibility Took Kit (TCK) – JCK 21
- Stabilization fork in Jul; Code freeze recently

Schedule

2022/12/07
Expert Group Formation

2023/07/18 – 2023/08/21
Public Review

2023/08/22 – 2023/08/28
Public Review –
Final Approval Ballot

2023/09
Final Release

SE JEPs in Java SE 21

Language

440	Record Patterns
441	Pattern Matching for `switch`
430	String Templates (Preview)
443	Unnamed Patterns & Variables (Preview)
445	Unnamed Classes & Instance `main` Methods (Preview)

Virtual Machine

451	Prepare to Disallow the Dynamic Loading of Agents

Libraries

431	Sequenced Collections
444	Virtual Threads
453	Structured Concurrency (Preview)
446	Scoped Values (Preview)
442	Foreign Function & Memory API (Third Preview)

Security

452	Key Encapsulation Mechanism API

An Aside: JEP 12: Preview Features

- Preview features are fully specified, fully implemented, but subject to change.
- Code using a preview feature may not necessarily compile or run in another release.
- Must be enabled at compile time and run time:

```
javac --release 21 --enable-preview Main.java

java --enable-preview Main
java --source 21 --enable-preview Main.java // source code launcher
jshell --enable-preview
```

- All preview features in the current release must take one of the following actions in the next feature release
  - Remove
  - Re-preview
  - Standardize

JEP 440: Record Patterns

Extend pattern matching to de-structure instances of Record classes.

```
static void printSum(Object obj) {
    if (obj instanceof Point(int x, int y)) {
        System.out.println(x+y);
    }
}
```

History

- First previewed in Java SE 19, re-previewed in Java SE 20

Why

- More sophisticated data queries
- Another step towards declarative, data-focused programming

JEP 441: Pattern Matching for `switch`

Enhance `switch` statements to support additional types and semantics.

```
static String formatterPatternSwitch(Object obj) {
    return switch (obj) {
        case Integer i -> String.format("int %d", i);
        case String s  -> String.format("String %s", s);
        default        -> obj.toString();
    };
}
```

History

- First previewed in Java SE 17, re-previewed in Java SE 18, 19, and 20

Why

- Express complex data-oriented queries concisely and safely

JEP 430: String Templates (Preview)

Introduce string composition that couples literal text with embedded expressions and template processors.

```
String name = "Duke";
String info = STR."My name is \{name}";
assert info.equals("My name is Duke");   // true
```

Why

- Commonly used feature used in other popular programming languages
- Existing string composition techniques (String concatenation with '`+`', `StringBuilder`, `Formatter.format()`) are verbose
- String composition that achieves the clarity of string interpolation without the inherent hazards (e.g. SQL injection attacks)

JEP 443: Unnamed Patterns & Variables (Preview)

Use the underscore character, '_', to identify unnecessary nested patterns and variables which must be declared but will not be used. Unnamed patterns may be used in record patterns.

```
// before nested pattern
if (r instanceof ColoredPoint(Point(int x, int y), Color c)) {
    ... x ...
}

// after, using unnamed pattern
if (r instanceof ColoredPoint(Point(int x, _), _)) { ... x ... }
```

Why

- Improve readability of record patterns by eliding unnecessary patterns
- Improve maintainability by eliminating useless declarations

JEP 445: Unnamed Classes & Instance `main` Methods (Preview)

Reduce syntactic complexity of simple programs for novice users.

```
void main() {
    System.out.println("Hello, World!");
}
```

Why

- Traditional “Hello, World” exposes too many concepts that may intimidate beginning programmers
- Reduce ceremony for simple programs such as scripts and command-line utilities

JEP 431: Sequenced Collections

Enhance the collections framework with new interfaces for sequenced collections which have a well-defined order.

	First element	Last element
`List`	`list.get(0)`	`list.get(list.size() - 1)`
`Deque`	`deque.getFirst()`	`deque.getLast()`
`SortedSet`	`sortedSet.first()`	`sortedSet.last()`
`LinkedHashSet`	`linkedHashSet.iterator.next()`	`// missing`
`SequencedCollection`	`c.getFirst()`	`c.getLast()`

Why

- Simplifies code that depends only on sequence rather than class-specific behaviour

JEP 444: Virtual Threads

Introduce lightweight threads that dramatically reduce the effort of writing, maintaining, and observing high throughput concurrent applications.

```
try (var executor = Executors.newVirtualThreadPerTaskExecutor()) {
    IntStream.range(0, 10_000).forEach(i -> {
        executor.submit(() -> {
            Thread.sleep(Duration.ofSeconds(1));
            return i;
        });
    });
}  // executor.close() is called implicitly, and waits
```

History

- First previewed in Java SE 19, re-previewed in Java SE 20

Why

- Concurrency limited by the number of platform threads, implemented as OS threads

JEP 453: Structured Concurrency (Preview)

Introduce APIs to structure a task as a family of concurrent subtasks, and to coordinate them as a unit.

```
Callable<String> task1 = ...
Callable<Integer> task2 = ...
try (var scope = new StructuredTaskScope<Object>()) {
    Subtask<String>  subtask1 = scope.fork(task1);
    Subtask<Integer> subtask2 = scope.fork(task2);
    scope.join();
    ... process results/exceptions ...
} // close
```

History

- First incubated in Java SE 19, re-incubated in Java SE 20

Why

- Provide structure for large numbers of virtual threads
- Streamline error handling, improving reliability and enhancing observability

JEP 446: Scoped Values (Preview)

Introduce scoped values, which enable safe and efficient sharing of immutable data within and across threads.

```
final static ScopedValue<...> NAME = ScopedValue.newInstance();

// In some method
ScopedValue.runWhere(NAME, “duke”, () -> { ... NAME.get() ... call methods ... });

// In a method called directly or indirectly from the lambda expression
... NAME.get() ...
```

History

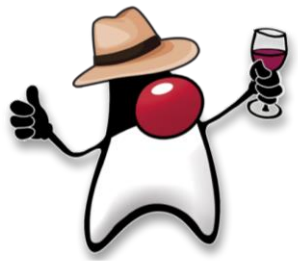
- Incubated in Java SE 20

Why

- Alternative to thread-local variables and method arguments for sharing data across components

JEP 442: Foreign Function & Memory API (Third Preview)

Project Panama



The API enables Java programs to call native libraries and process native data without the brittleness and danger of JNI.

```
Linker linker = Linker.nativeLinker();
SymbolLookup stdlib = linker.defaultLookup();
MethodHandle strlen = linker.downcallHandle(
    stdlib.find("strlen").orElseThrow(),
    FunctionDescriptor.of(ValueLayout.JAVA_LONG, ValueLayout.ADDRESS) );
try (Arena arena = Arena.ofConfined()) {
    MemorySegment cString = arena.allocateUtf8String("Hello");
    long len = (long)strlen.invokeExact(cString); } // 5
```

History

- Incubated in Java SE 17 and 18. First previewed in Java SE 19, re-previewed in Java SE 20

Why

- Provide a safer alternative to JNI

JEP 451: Prepare to Disallow the Dynamic Loading of Agents

Introduces a warning when dynamic loading of agents is attempted

```
WARNING: A {Java,JVM TI} agent has been loaded dynamically (file:/u/duke/agent.jar)
WARNING: If a serviceability tool is in use, please run with -XX:+EnableDynamicAgentLoading to hide this warning
WARNING: If a serviceability tool is not in use, please run with -Djdk.instrument.traceUsage for more information
WARNING: Dynamic loading of agents will be disallowed by default in a future release
```

Command-line option `-XX:+EnableDynamicAgentLoading` will suppress this warning in Java SE 21 and will be required to enable dynamic agent loading in a future release.

History

- Originally proposed in 2017 circa Java SE 9 but deferred

Why

- Integrity by default

JEP 452: Key Encapsulation Mechanism API

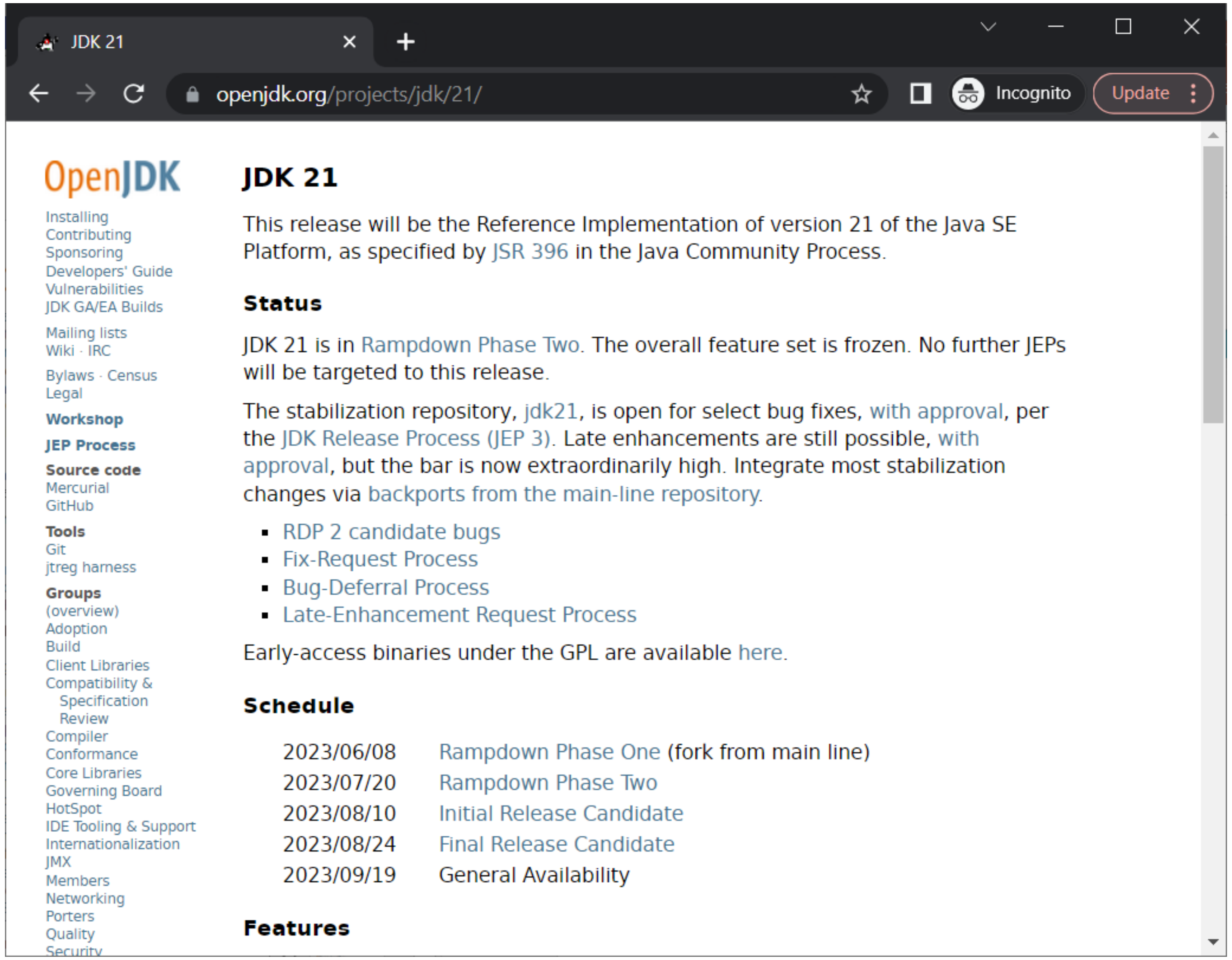
Define APIs for key encapsulation mechanisms (KEMs) which use encryption to secure symmetric keys using public key cryptography.

- Example KEM algorithms include:
  - RSA-KEM
  - Elliptic Curve Integrated Encryption Scheme (ECIES)
  - Future NIST Post-quantum cryptography standard

Why

- Support current and future industry standards
- Defend against quantum attacks

openjdk.org/projects/jdk/21



JDK 21

This release will be the Reference Implementation of version 21 of the Java SE Platform, as specified by JSR 396 in the Java Community Process.

Status

JDK 21 is in Rampdown Phase Two. The overall feature set is frozen. No further JEPs will be targeted to this release.

The stabilization repository, jdk21, is open for select bug fixes, with approval, per the JDK Release Process (JEP 3). Late enhancements are still possible, with approval, but the bar is now extraordinarily high. Integrate most stabilization changes via backports from the main-line repository.

- RDP 2 candidate bugs
- Fix-Request Process
- Bug-Deferral Process
- Late-Enhancement Request Process

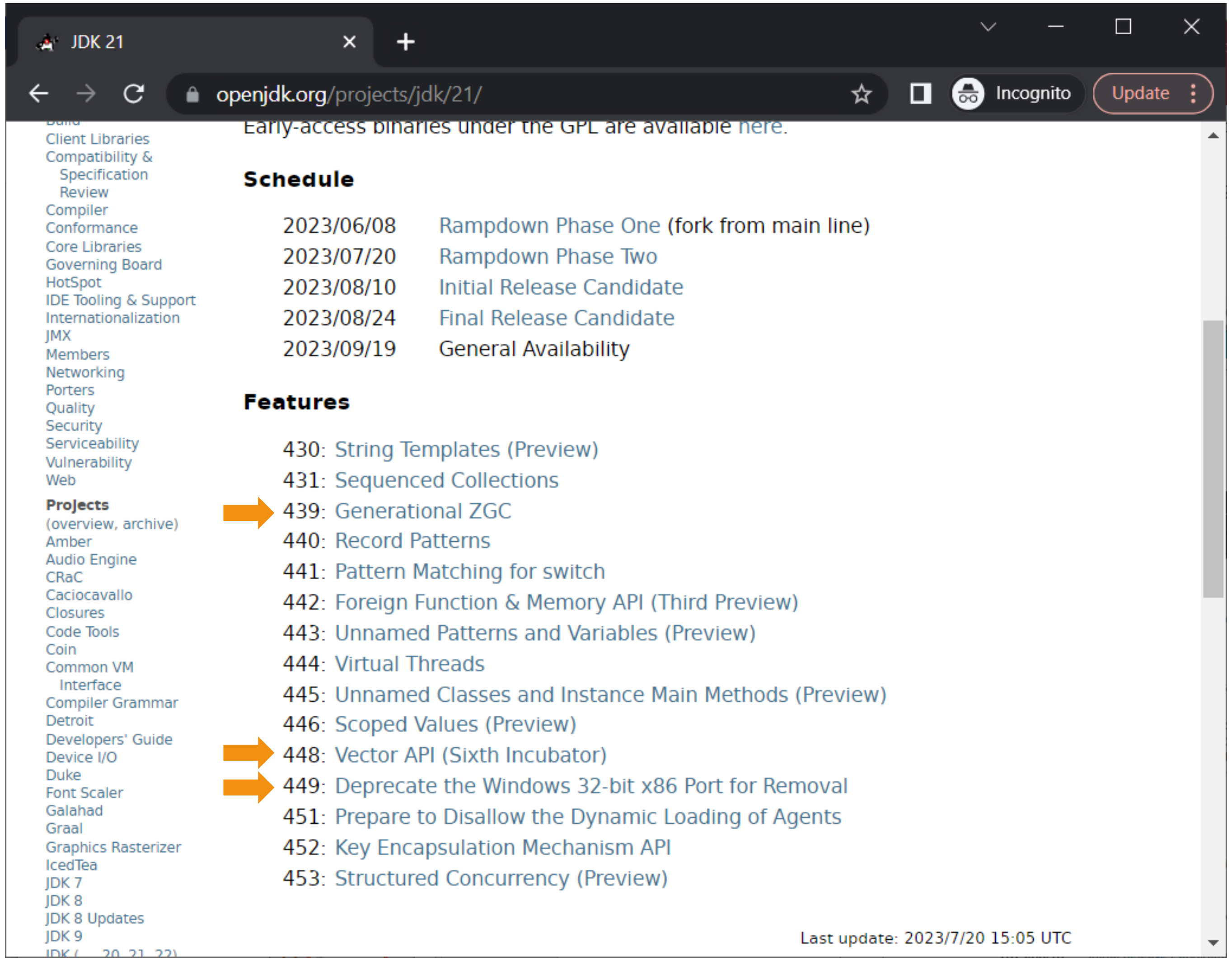
Early-access binaries under the GPL are available here.

Schedule

2023/06/08	Rampdown Phase One (fork from main line)
2023/07/20	Rampdown Phase Two
2023/08/10	Initial Release Candidate
2023/08/24	Final Release Candidate
2023/09/19	General Availability

Features

Other JEPs



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Client Libraries
Compatibility & Specification Review
Compiler
Conformance
Core Libraries
Governing Board
HotSpot
IDE Tooling & Support
Internationalization
JMX
Members
Networking
Porters
Quality
Security
Serviceability
Vulnerability
Web

Projects
(overview, archive)
Amber
Audio Engine
CRaC
Caciocavallo
Closures
Code Tools
Coin
Common VM Interface
Compiler Grammar
Detroit
Developers' Guide
Device I/O
Duke
Font Scaler
Galahad
Graal
Graphics Rasterizer
IcedTea
JDK 7
JDK 8
JDK 8 Updates
JDK 9

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Features

430: String Templates (Preview)
431: Sequenced Collections
439: Generational ZGC
440: Record Patterns
441: Pattern Matching for switch
442: Foreign Function & Memory API (Third Preview)
443: Unnamed Patterns and Variables (Preview)
444: Virtual Threads
445: Unnamed Classes and Instance Main Methods (Preview)
446: Scoped Values (Preview)
448: Vector API (Sixth Incubator)
449: Deprecate the Windows 32-bit x86 Port for Removal
451: Prepare to Disallow the Dynamic Loading of Agents
452: Key Encapsulation Mechanism API
453: Structured Concurrency (Preview)

Last update: 2023/7/20 15:05 UTC

Other notable changes in Java SE 21

129 Compatibility & Specification Review (CSR) Requests
https://bugs.openjdk.org/issues/?filter=43361

1 JSR Maintenance Release
269: Pluggable Annotations
    Processing API [MR15]

3 Removed APIs

```
java.lang.Compiler (9)
java.lang.ThreadGroup
  .allowThreadSuspension(boolean) (14)
javax.management.remote.rmi
  .RMIIOPServerImpl (9)
```

2 Terminally Deprecated APIs Added

```
javax.management.remote.JMXConnector
  .getMBeanServerConnection()
javax.swing.plaf.synth.SynthLookAndFeel
  .load()
```

Resources

- https://openjdk.org/projects/jdk/21/spec/
    - https://jcp.org/en/jsr/detail?id=396
    - JEPs: https://bugs.openjdk.org/secure/Dashboard.jspa?selectPageId=21418
    - CSRs: https://bugs.openjdk.org/secure/Dashboard.jspa?selectPageId=21419
    - https://mail.openjdk.org/mailman/listinfo/java-se-spec-experts
    - https://jdk.java.net/21/
- https://openjdk.org/projects/jdk/22/spec/
- https://mail.openjdk.org
- https://github.com/openjdk