

Debugger Support

Enumerating Threads

Virtual threads are just objects in the heap, there may be millions of them. There is no API support in the debugger API for enumerating all virtual threads.

JDI [VirtualThreads.allThreads\(\)](#) (and JDWP [VirtualMachine/AllThreads](#)) enumerates all active platform threads, virtual threads are not enumerated.

For thread dumps and troubleshooting purposes the debugger can invoke the [com.sun.management.Threads](#) API in the target VM to enumerate threads. This can be used as stop-gap solution until there is better support in the debugging in the APIs for finding virtual threads.

Thread groups

Virtual threads are not active members of a thread group.

JDI [ThreadGroupReference::threads](#) (and JDWP [ThreadGroupReference/Children](#)) enumerate all active platform threads in a group, virtual threads are not enumerated.

ThreadStart/ThreadEnd events

JDI [ThreadStartEvent/ThreadDeathEvents](#) are sent for all threads when enabled. This may impact performance if there are a huge number of virtual threads.

JDWP [EventRequest/Set](#) defines a new *PlatformThreadsOnly* filter that can be used when requesting `THREAD_START` and `THREAD_END` events. This allows these events to be filtered for virtual threads so they are not sent to the front-end/debugger.

JDI [ThreadStartRequest/ThreadDeathRequest](#) define a new method to control whether thread start/end events are sent for all threads or only platform threads.

IsVirtual

JDI [ThreadReference](#) defines [isVirtual\(\)](#) to test if a thread is a virtual thread.

JDWP [ThreadReference/IsVirtual](#) is the equivalent.

Testing if target VM supports virtual threads

The following is temporary, to allow debuggers to distinguish JDK 17 EA builds from Loom EA builds.

JDI [VirtualMachine](#) defines [supportVirtualThreads\(\)](#) to test if the target VM supports virtual threads.

The `supportsVirtualThread` boolean in the reply to the JDWP [CapabilitiesNew](#) command is the equivalent.

Not Supported

The following are not currently supported for virtual threads:

- JDI [ThreadReference.stop](#)
- JDI [ThreadReference.popFrame](#)
- JDI [ThreadReference.forceEarlyReturn](#)
- JDI [StackFrame.setValue](#)

JDWP agent options

As a temporary solution to allow existing debuggers work with virtual threads, the JDWP agent will track virtual threads so they can be enumerated for debuggers that want to enumerate all virtual threads. The options that control this behavior are:

Option Name and Value	Description	Default
<code>enumeratevthreads=y n</code>	thread lists include virtual threads	n
<code>notifyvthreads=y n</code>	send <code>THREAD_START/END</code> events for all virtual threads	y

- `enumeratevthreads` control whether or not virtual threads are included in the list of threads returned by JDWP [VirtualThread.GetAllThreads](#) and [ThreadGroupReference.Children](#) commands. This flag can be turned on for compatibility purposes. This flag will eventually go away and the debug agent will operate as if it was set to 'n'.
- `notifyvthreads` controls whether or not `THREAD_START` and `THREAD_END` events are sent for virtual threads. The default is to send them. The purpose is to allow debugger writers to use `notifyvthreads=n` to see how the debugger works without getting these events. This is meant as a

short term convenience flag rather than having to set the *PlatformThreadsOnly* filter as described above. Once support for *notifyvthreads=n* is gone, if debuggers don't want *THREAD_START* and *THREAD_END* events for virtual threads, they will need to set the *PlatformThreadsOnly* filter. When using the *PlatformThreadsOnly* filter, the debugger can learn about virtual threads when events are delivered for them, such as a *BreakpointEvent*. Since no *THREAD_END* event will be sent for the virtual thread, the debugger will then need to figure out how to "forget" about the virtual threads it is tracking when they have terminated. This could possibly be done with a *ThreadDeathRequest* that filters on the virtual thread. This would need to be done for each virtual thread being tracked by the debugger. Please note that *notifyvthreads=y* will not override any *PlatformThreadsOnly* filter that is in place.

Issues with too many virtual threads hitting breakpoints

Each running virtual thread is mounted on a carrier thread. There are a limited number of carrier threads (usually defaulting to the number of available cores). When a virtual thread hits a debugger breakpoint, it pins its carrier thread, preventing any other virtual thread from running on it. If you have an application with a large number of virtual threads, and you setup a breakpoint that many virtual threads will hit, you can wind up in a situation where every carrier thread is running a virtual thread that is at a breakpoint. No virtual threads will make progress when this happens. Those that are mounted are all at breakpoints, and those that unmounted have no carrier thread to run on. If you resume one of the virtual threads, when it yields it will allow unmounted virtual thread to run, which likely itself will then hit this same breakpoint, leaving back to having all virtual threads being stuck.

If you single step in one of these virtual threads that are at a breakpoint, single stepping will work until you step over a call that can lead to the virtual thread yielding. At this point the virtual thread is unmounted and a new one can run on the carrier thread (once again, likely quickly hitting the same breakpoint). It will appear that the single step has failed to ever complete. In reality it is waiting for the yielding virtual thread to be remounted and start running again. This can't happen until a carrier thread is freed up. Thus you'll find that you need to start resuming various virtual threads that are at breakpoints until eventually one of them yields AND its carrier thread is used to mount and run the single stepping virtual thread. There's no telling how many virtual threads at breakpoints you will need to resume before this happens.

It is possible to avoid getting into this situation. The first thing to do is to setup the breakpoint so that it suspends all threads rather than just the event thread. This way you'll never have more than one virtual thread hitting the breakpoint at the same time. If you do this, you also need to make sure to setup the debugger's single stepping "thread resumption policy" to resume all threads, rather than just the single stepping thread. If you take these two steps, breakpoints and single stepping should work much better when dealing with a large number of virtual threads that can hit the same breakpoint.

Links

[Project Loom Early Access builds](#)

[Java Debug Interface \(JDI\)](#)

[JDWP protocol details](#)

[JVM Tool Interface](#)

[Java Native Interface](#)

[Slides from March 24, 2021 meeting with IntelliJ and Eclipse maintainers](#)

[Sample application \(uses Helidon MP configured to run each service in its own virtual thread\)](#)

[Eclipse Bug 527000 tracks adding support for virtual threads](#)