Project Loom

October 18, 2018
Agenda

• Introductions
• Current status
• Areas of exploration
• Areas to collaborate
Current status
Current status

- Early exploration/prototype in loom/loom repository
  - `cont` branch
  - `fibers` branch
- Nothing on tail-calls for now
Continuations prototype

• Continuation API
  • run (to start or continue), yield, test if done, …
  • Nested continuations

• Current implementation/approach
  • Freezing and thawing of stacks
  • Lazy copy
  • Rationale for current approach
  • Performance
Fibers prototype

• Minimal API
  • create, schedule, await termination, …

• LockSupport can park/unpark fibers

• Socket and pipe APIs park fibers rather than block threads in syscalls

• Attempting to park fiber with native frame or synchronized method/block on stack will park carrier thread
I/O APIs

- Mostly focused on network APIs so far
  - java.nio.channels API
  - java.net.Socket
  - Blocking operations park fiber when socket not ready for I/O
  - May advance some refactoring in jdk/jdk to make this easier
- Prototyped console and a few other APIs
- File I/O ignored for now (as file I/O is mostly buffered I/O)
Current limitations

• Can’t yield with native frames on continuation stack

• Can’t yield while holding a monitor

• For fibers, parking may pin the carrier thread

• `monitorenter/Object.wait` parks carrier thread until unlocked/notified
Ports, testing, ...

- macOS and Linux x64 only for now
  - Trying to keep product and fastdebug builds stable
  - Ignoring Windows, AArch64, SPARC at this time

- Testing
  - Basic tests for continuations and fibers
  - Some microbenchmarks
Work in progress

- Performance
- JVM TI support - first step towards debugger support
- Eliminating native frame from Method.invoke and AccessController.doPrivileged
- Exploration …
Areas of exploration
Can Fibers run existing code?

• Big question: Will fibers be able to run *all existing code*?

• Do we completely re-imagine threads?

• We expect to wrestle with this topic for a long time

• Current prototype can run a lot of existing code by emulating `currentThread` and `Thread API`
Re-imagine threads

• Project Loom provides big opportunity to re-examine threads

• What is wrong with java.lang.Thread
  • ThreadGroup
  • Context ClassLoader
  • Inheritance: InheritedThreadLocal, TCCL, ACC
  • Deprecated for 20+ years: suspend/resume/stop
  • java.lang.Thread has 22 fields in JDK 11, at least 11 are not interesting to fibers

• and thread pools …
  • ThreadLocals do not work well with thread pools
  • Thread interruption does not work well with thread pools
Strand as superclass for Thread and Fiber

- java.util.concurrent and I/O area have many places that need the current strand
  - Waiter queues
  - Checking and re-asserting interrupt status
  - ...
- Needs further analysis
Locals

• Assuming `-Djdk.emulateCurrentThread=false`

• No fiber locals in API at this time

• No equivalent of TCCL or other locals

• Exploring usages of ThreadLocal

  • Many cases are candidates for *frame locals* (dynamic bind, special variables, …)

  • Some cases use thread locals as approximation to *processor local*
• Planning to prototype frame locals
  • Lisp has special variables, Clojure has dynamic binding
  • Semantics, API, to be explored

• Also thinking about processor locals
  • Locals keyed on cpu id rather than currentThread
  • Would be nice to drop threadLocalRandomXXX and other fields from Thread
Debugging and serviceability

- Exploring debugging support
  - Basic support in JVM TI to track fiber scheduling, mount and unmount
  - Debugger agent support will take time
- No investigation yet on JMX/java.lang.management and other tool APIs
Structured Concurrency

• Background reading and motivations:

  • Nathaniel J Smith blogs:
    • Notes on structured concurrency, or: Go statement considered harmful
    • Timeouts and cancellation for humans

  • Martin Sustrik blogs:
    • Getting rid of state machines (II)
    • Structured Concurrency in High-Level Languages
Structured Concurrency

- Many interesting concepts
  - *block* doesn’t exit until all fibers created in the block have terminated
  - level-triggered and cooperative cancellation
  - composable timeouts and deadlines
  - cancel scopes
- May create a branch in loom repo for prototyping
- Not sure if concepts are mature enough for Java SE
Channels

• Existing APIs

  • SynchronousQueue = non-buffered channel. Designed for high contention rather than fibers

  • ArrayBlockingQueue = buffered channel

• Need to decide if we want to introduce new IPC mechanism for fibers.

  • What is the scope?

  • Select-like features?

  • Specialized for primitive elements?
Future work

- Cloning
- Serialization
- Forced preemption
- Tail calls
Potential areas to collaborate or widen involvement

- Adapt existing code to use Fibers API and provide feedback
- Feedback/input on structured concurrency concepts
- Full-time involvement?
  - Monitors
  - JFR
  - Performance
- More tests would be useful. Benchmarks would be useful at a later time.
- Channels
- Interest in pushing out porting to other architectures until project is further along
Future meeting?
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