JSR 236: Concurrency Utilities for Java EE
Anthony Lai
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Agenda

• Introduction
• Overview
• Technical Details
Introduction

Brief History

• BEA-IBM CommonJ API for Java EE
• 2003 - JSR 236-237 provides context aware Thread Pools and Timers to Java EE applications
• 2006 – Extending existing Java SE concurrency foundations, replacing CommonJ
• 2008 - Combined into JSR 236. JSR 237 withdrawn.
• April 2012 - Restarted under JCP 2.8
• Nov 2012 – EDR under JCP 2.9
• Jan 2013 – Public Review started
## Introduction

### Expert Group

<table>
<thead>
<tr>
<th>Corporate Members</th>
<th>Individual Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM</td>
<td>Adam Bien</td>
</tr>
<tr>
<td>Oracle</td>
<td>Cyril Bouteille</td>
</tr>
<tr>
<td>RedHat</td>
<td>Andrew Evers</td>
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<td></td>
<td>Doug Lea</td>
</tr>
</tbody>
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Introduction
JSR Transparency

- Mailing lists:
  - users@concurrency-ee-spec.java.net
  - jsr236-experts@concurrency-ee-spec.java.net
  - Both lists are archived and are publicly readable
  - Users list available to public to subscribe. Includes all discussions in experts list

- Issue Tracker:
  - http://java.net/jira/browse/CONCURRENCE_EE_SPEC
  - Everyone can track existing issues and file new issues
Introduction
JSR Transparency

• Spec work
  • Open source project
  • concurrency-ee-spec java.net
  • Latest browseable javadoc
  • Updated spec document drafts

• Reference Implementation
  • Open source project
  • cu-javaee java.net project is used for reference implementation work
Introduction

Schedule

• Align with Java EE 7 schedule
  • Early Draft: Nov 15 – Dec 15, 2012
  • Public Review: Jan 3 – Feb 4, 2013
  • Proposed Final Draft: Mar 2013
  • Final Release: Apr 2013
Overview
Limitation of concurrency in Java EE

- Java SE threads and timers are not well integrated with Java EE containers
  - Threads not controlled by Java EE containers
  - Thread context like class loader, security, naming are not propagated
  - Lack of manageability and transaction isolation semantics
- Asynchronous support is available in Java EE, such as in servlet and EJB, but
  - Advanced features can be provided by java.util.concurrent APIs such as invokeAll, invokeAny, or custom thread pool with managed threads provided by Java EE product provider
  - Needs mechanism to provide managed threads for async servlets
Overview
Concurrency uses in Java EE

• Decouple user execution from slow moving background processing
• Improvements in processor architecture promote parallelism
• One big task into smaller concurrent tasks
• Asynchronous notification use case
• Timer use cases like periodic cleanup, cache maintenance
Overview
Special Java EE requirements

• Managed threads
  • Coordination between application server lifecycle and asynchronous task lifecycle
    • Server shutdown
    • Application deployment/undeployment
    • Administration and monitoring

• Intelligent workload classification and routing
  • Batch vs interactive
  • Local vs distributed

• Application Integrity
  • Different context for different applications
  • Applications to coexist
Overview

Goals

• Provide consistent programming model
• Leverage existing technology to provide migration from Java SE
• Allow adding concurrency to existing applications
• Provide simple API for simple use cases
• Provide flexible API for advanced use cases
Overview
Extending Java SE

• Extend existing Java SE concurrency utilities by providing managed versions:
  • ManagedThreadFactory
  • ManagedExecutorService
  • ManagedScheduledExecutorService

• Add Java EE extensions
  • ContextService
  • ManagedTaskListener
  • Trigger
  • ManagedTask
Overview
Extending Java SE

• Provide manageability using JMX Mbeans
  • ManagedThread
  • ManagedThreadFactory
  • ManagedExecutorService
  • Mbeans support are optional
Overview
Java EE Architecture Diagram with Concurrency
ManagedThreadFactory
Overview

• Standard interface and method for creating threads
  • Thread newThread(Runnable r)
• Centrally defined on an application server
• Java EE product providers provide the thread
• Referenced by applications through JNDI lookup or @Resource annotation
• Default pre-configured ManagedThreadFactory
• Extension of Java SE ThreadFactory
  • Adds container context and manageability
  • UserTransaction support (does not enlist in parent component's transaction)
ManagedThreadFactory
Usage Scenarios

• Long Running Tasks
  • Work Consumers/Producers
  • Batch jobs
  • Embedded servers

• Custom Thread Pools
  • Use Java SE thread pools
  • Any service that can use ThreadFactory
ManagedThreadFactory
Code Sample - Daemon

// Within your servlet or EJB method...
// Lookup the ManagedThreadFactory
InitialContext ctx = new InitialContext();
ManagedThreadFactory tf = (ManagedThreadFactory)
    ctx.lookup("java:comp/env/concurrent/myTF");

// Create and start the thread.
Thread daemonThread = tf.newThread(myDaemonRunnable);
daemonThread.start();

// The runnable behaves as if it were running in the
// servlet or EJB container.
// The thread's lifecycle is tied to the application
// and is interrupted when application stops.
ManagedThreadFactory
Code Sample – Custom Thread Pool

// Within your servlet or EJB method...
// Lookup the ManagedThreadFactory
@Resource
ManagedThreadFactory tf;

void businessMethod() {
// Use a custom Java SE ThreadPoolExecutor
CustomThreadPoolExecutor pool =
new CustomThreadPoolExecutor(coreSize, maxSize, tf);

// When the executor allocates a new thread, the
// thread will use the current container context.
ManagedThreadFactory
Thread Management with JMX

- Monitor when threads are allocated using the ManagedThreadFactory MBean
- Monitor thread activity and health
  - What task is running on the thread?
  - How long has the task been running?
  - Correlate to the Java SE thread name and id
- Cancel a thread (cooperative)
  - Hung threshold notifications help identify problems
  - Proper interruption detection is essential in the task implementation.
ManagedThreadFactory
Task Identity

• Runnable and Callable that are run on a managed thread may optionally implement the ManagedTask interface.
• Allows runtime introspection of thread's current state.
• Exposed on the ManagedThread MBean
• Short name available as an attribute
• Locale-specific description available as an attribute for the current locale or an operation for alternative locales.
ManagedThreadFactory
Code Sample – Supplying identity to task

class MyConsumerTask implements Runnable, ManagedTask {
    private Map<String, String> props;
    public void run() {
        // Update the identity name periodically
        props.put(IDENTITY_NAME, "MonitorApp:MyConsumerTask:Phase1");
        ...
        props.put(IDENTITY_NAME, "MonitorApp:MyConsumerTask:Phase2");
    }

    public Map<String, String> getExecutionProperties() {
        // Called by ManagedThread.taskIdentityName
        return props;
    }
    public String getIdentityDescription(Locale l) {
        // Called by ManagedThread.taskIdentityDescription
        // Get description from NLS bundle
    }
}
ManagedExecutorService
Overview

• Typical way of running tasks asynchronously from a Java EE container method
• Centrally defined on an application server
• Java EE product providers provide the implementation
• Referenced by applications through JNDI lookup or @Resource annotation
• Default pre-configured ManagedExecutorService
• Typically used for centralized thread pooling
• Implementations may offer extended capabilities
ManagedExecutorService
Overview continued

- Extension of Java SE ExecutorService
  - No extension APIs. Same execute, submit, invokeAll, invokeAny APIs as in Java SE parent classes
  - Adds container context, manageability, task lifecycle tracking and application component lifecycle constraints
  - UserTransaction support (does not enlist in parent component transaction)
  - Distributed (remote) capability - optional
ManagedExecutorService
Overview continued

- Server-managed
  - Multiple applications share a single executor
  - Application developer defines the requirements of the executor: What container contexts to propagate (e.g. namespace)
  - Lifecycle managed by server. Lifecycle APIs such as shutdown not allowed
- Deployer configures the appropriate executor and maps the resource environment reference to the executor
ManagedExecutorService
Management

• Hung tasks can be monitored and cancelled using JMX.
  • Threads are created from a ManagedThreadFactory
  • Each thread therefore is associated with a ManagedThread MBean
  • Tasks can provide identifying info
• Task lifecycle can be monitored using ManagedTaskListeners
  • Monitoring extensions (logging)
  • Work-flow control and management
ManagedExecutorService
ManageTaskListener

• Listeners are Java objects that are registered with the task when submitted to the executor.

• The listener method can be configured to run in the same container context as the task.
  • taskSubmitted – The task was submitted to the executor
  • taskAborted – The task was unable to start or was cancelled.
  • taskStarting – The task is about to start
  • taskDone – The task has completed (successfully, exception, cancelled, aborted, or rejected)
ManagedExecutorService
Code Sample – Registering ManagedTaskListener

// Runnable implements ManagedTask
Public class TaskWithListener implements Runnable, ManagedTask {
    ...
    public ManagedTaskListener getManagedTaskListener {
        return aManagedTaskListener;
    }
}
// Or use ManagedExecutors utility method to associate
// a ManagedTaskListener to a task
Runnable aTask;
ManagedTaskListener myTaskListener;
Runnable taskWithListener =
    ManagedExecutors.managedTask(aTask, myTaskListener);
// submit taskWithListener to a ManagedExecutorService
ManagedExecutorService
ManageTaskListener - Lifecycle
ManagedExecutorService
Code Sample – Typical Parallelism

// Within your [async] servlet or [async] EJB method
@Resource(name="concurrent/myExecutor")
ManagedExecutorService mes;
void businessMethod() {
    Callable<Integer> c = new Callable<>() {
        Integer call() {
            // Interact with a database... Return answer.
            // The namespace is available here!
        }
    }
    // Submit the task and do something else. The task
    // will run asynchronously on another thread.
    Future result = mes.submit(c);
    ...
    // Get the result when ready...
    int theValue = result.get();
    ...
}
ManagedExecutorService Distributable

- Same rules as a ManagedExecutorService
- Allows distributing the task to a peer on another server instance (JVM).
  - Task must implement serializable
- Optional feature – Java EE Providers do not have to supply a distributable ManagedExecutorService.
- Two distributable types are available:
  - With and without affinity
- Tasks could provide distributable hint to Java EE product providers through executionProperties in ManagedTask.
ManagedScheduledExecutorService Overview

• Typical way of running periodic tasks asynchronously from a Java EE container method
• Typically used for transient timers
• Inherits semantics of ManagedExecutorService:
  • Centrally defined on an application server
  • Java EE product providers provide the implementation
  • Referenced by applications through JNDI lookup or @Resource annotation
  • Default pre-configured ManagedScheduledExecutorService
  • Implementations may offer extended capabilities
ManagedScheduledExecutorService
Overview continued

• Extension of ScheduledExecutorService
  • Adds container context, manageability, task lifecycle tracking and application component lifecycle constraints
  • UserTransaction support (does not enlist in parent component transaction)
  • Trigger mechanism

• Server-managed
  • Multiple applications share a single executor
  • Application developer defines the requirements of the executor: What container contexts to propagate (e.g. namespace)
  • Lifecycle managed by server. Lifecycle APIs such as shutdown not allowed
ManagedScheduledExecutorService
Usage Scenarios

- Periodic cache invalidations
- Request timeouts
- Polling
- Custom Scheduler
  - Would need implementation extension to support persistence.
  - Use Triggers for custom calendaring:
    - N-time fixed-rate with time-sensitive skip.
    - Run time based on previous task calculation result.
    - Condition-based trigger
    - Centralized business calendar
ManagedScheduledExecutorService API

- execute, submit, invokeAny, invokeAll, schedule, scheduleAtFixedRate, scheduleWithFixedDelay from Java SE parent classes
- Extension APIs for custom trigger schedule support
  - `ScheduledFuture<??> schedule(Runnable command, Trigger trigger)`
  - `<V> ScheduledFuture<V> schedule(Callable<V> callable, Trigger trigger)`
interface Trigger {

    // Return true if you want to skip the
    // currently-scheduled execution.
    boolean skipRun(LastExecution lastExecutionInfo, Date scheduledRunTime);

    // Retrieves the time in which to run the task
    // next. Invoked during submit time and after
    // each task has completed.
    Date getNextRunTime(LastExecution lastExecutionInfo, Date taskScheduledTime);
}

ManagedScheduledExecutorService
Trigger
ContextService
Overview

• Mechanism for applications to capture container context and run within that context later, even on another server or after server restart
  • Security, naming, classloader
  • Additional types of context could be supported by Java EE product providers
  • ManagedExecutorService likely to use this service internally to propagate container context.

• Centrally defined on an application server

• Referenced by applications through JNDI lookup or @Resource annotation

• Default pre-configured ContextService
ContextService
Overview continued

• Java EE product providers provide the implementation
  • Implementations may offer extended capabilities
• Current thread context is captured and stored within a context proxy for your object
• Customizable through executionProperties
  • Can enable transaction pass-through
• Used in advanced scenarios
• Use with non-ManagedThreadFactory-created threads (threads created with new Thread())
ContextService
Use Cases

• Workflow
  • Store and propagate user identity

• Java SE or third-party thread reuse
  • Allows thread to behave as-if it were on a container thread.
ContextService
API

• For creating new contextual object proxy for the input object instance
  • Object createContextualProxy(Object instance, Class<?>... Interfaces)
  • Object createContextualProxy(Object instance, Map<String,String> executionProperties, Class<?>... Interfaces)
  • <T> T createContextualProxy(T instance, Class<T> intf)
  • <T> T createContextualProxy(T instance, Map<String,String> executionProperties, Class<T> intf)

• For returning the execution properties on the given contextual object proxy instance
  • Map<String,String> getExecutionProperties(Object contextualProxy)
ContextService
Code Example – Creating Contextual Object Proxy

// Within your servlet or EJB method...
@Resource
ContextService ctxSvc;
void businessMethod() {
    Runnable runnableTask = new Runnable() {
        void run() {
            // Interact with a database... use component's
            // security
        }
    }
    // Wrap with the current context
    Runnable runnableTaskWithCtx = (Runnable) ctxSvc.createContextualProxy (runnableTask, Runnable.class)
    // Store the runnable with context somewhere and
    // run later..
    store.putIt(runnableTaskWithCtx);
ContextService
Code Example – Using Contextual Object Proxy

// Retreive the Runnable with Context
Runnable runnableTaskWithContext = store.getIt();

// Runnable will run on this thread, but with the
// context of the servlet/EJB that created it.
runnableTaskWithContext.run();

// If the Runnable implemented Serializable and it
// was serialized/deserialized... the context would
// still come with it.
Resources

- JSR 236 page

- java.net project for spec work
  - http://concurrency-ee-spec.java.net

- JSR 236 javadoc
  - http://concurrency-ee-spec.java.net/javadoc/

- java.net project for RI work
  - http://java.net/projects/cu-javaee