JSR 236: Concurrency Utilities for Java EE

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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 JSR 237 withdrawn.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

Corporate Members
IBM
Oracle
RedHat

Individual Members
Adam Bien
Cyril Bouteille
Andrew Evers
Doug Lea

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/CONCURRENCY_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

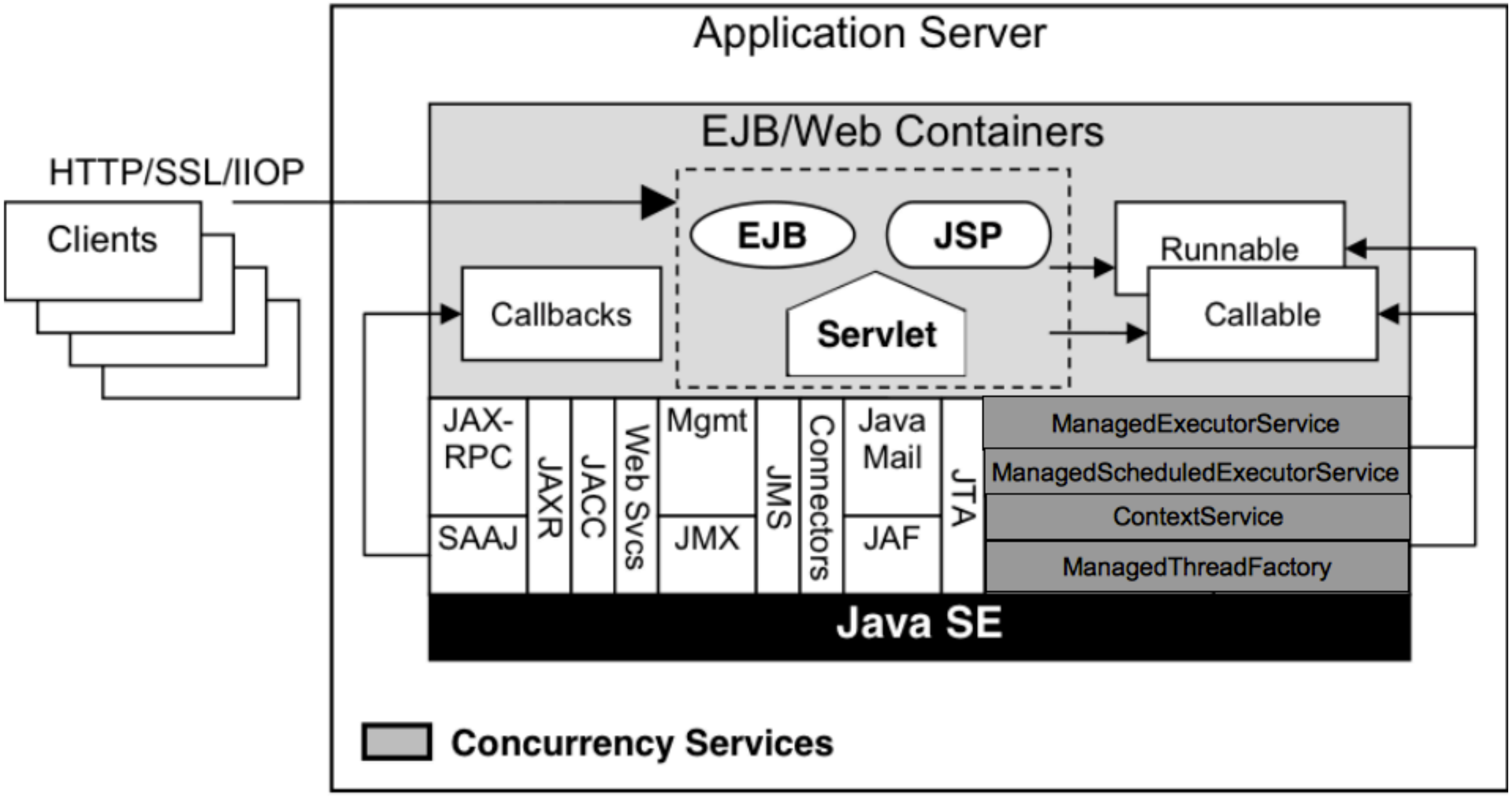
Overview

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(IDENITY_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)

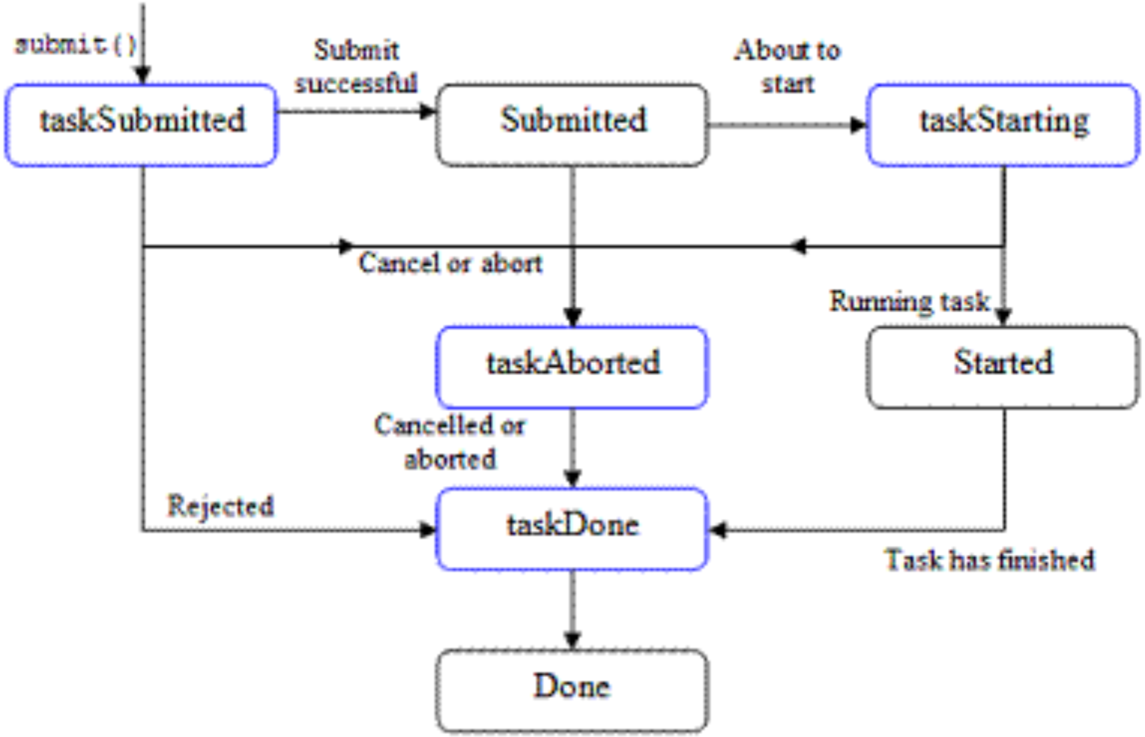
ManagedExecutorService

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 myTaskListner;
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)`

ManagedScheduledExecutorService

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);
}
```

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
  - http://jcp.org/en/jsr/detail?id=236
- 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