Java StampedLock: Example Application

Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

Institute for Software
Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA
Learning Objectives in this Part of the Lesson

• Understand the structure, functionality of the Java StampedLock class
• Know the key methods in Java StampedLock
• Recognize how to apply Java StampedLock in practice

class Point {

    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        }
    }
}
Applying Java Stamped Lock in Practice
Applying Java StampedLock in Practice

• The Point class shows how to program with StampedLock

```java
class Point {

    private double x;
    private double y;

    private final StampedLock sl =
        new StampedLock();
    ...

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/StampedLock.html
```
The Point class shows how to program with StampedLock

class Point {
    private double x;
    private double y;

    private final StampedLock sl =
        new StampedLock();
...
Applying Java StampedLock in Practice

• The Point class shows how to program with StampedLock

```java
class Point {

    private double x;
    private double y;

    private final StampedLock sl =
        new StampedLock();

    ...
}
```

State that must be protected
The Point class shows how to program with StampedLock

class Point {

    private double x;
    private double y;

    private final StampedLock sl =
        new StampedLock();

    ...

    StampedLock that does the protecting
Applying Java StampedLock: Writing Mode
Performing an exclusive write with a StampedLock

```java
class Point {
    ...  
    void move(double deltaX, double deltaY) {
        long stamp = sl.writeLock();
        try {
            x += deltaX;
            y += deltaY;
        } finally {
            sl.unlockWrite(stamp);
        }
    }
    ...  
}
```

This method atomically moves a point to a new location.
Performing an exclusive write with a StampedLock

```java
class Point {
    ...

    void move(double deltaX, double deltaY) {
        long stamp = sl.writeLock();
        try {
            x += deltaX;
            y += deltaY;
        } finally {
            sl.unlockWrite(stamp);
        }
    }

    ...
```
Performing an exclusive write with a StampedLock

```java
class Point {
    ...

    void move(double deltaX, double deltaY) {
        long stamp = sl.writeLock();
        try {
            x += deltaX;  // Modify the state atomically
            y += deltaY;
        } finally {
            sl.unlockWrite(stamp);
        }
    }
    ...
}
```
Performing an exclusive write with a StampedLock

class Point {
...

void move(double deltaX, double deltaY) {
    long stamp = sl.writeLock();
    try {
        x += deltaX;
        y += deltaY;
    }
    finally {
        sl.unlockWrite(stamp);
    }
}

Release the write lock
Applying Java StampedLock: Optimistic & Reading Mode
Performing a optimistic read with a StampedLock

```java
class Point {
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
}
```

A read-only method

Applying Java StampedLock: Optimistic & Reading Mode
Performing an optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
}
```

Applying Java StampedLock: Optimistic & Reading Mode

- Attempt to get an "observation" stamp

15
Performing a optimistic read with a StampedLock

class Point {

    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }

    ...

“Optimistically” read state into local variables

Code using optimistic reading mode typically copies the values of fields & holds them in local variables for use after they are validated
• Performing a optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
}
```

Check if another thread acquired the lock for writing after earlier call to tryOptimisticRead()
Performing an optimistic read with a StampedLock

class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
}
Performing an optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
```

Make copies of x & y via “pessimistic” reads

Applying Java StampedLock: Optimistic & Reading Mode
Performing an optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
```

Applying Java StampedLock: Optimistic & Reading Mode
Performing an optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally {
                sl.unlockRead(stamp);
            }
        }
    }  // No lock to release if validate() succeeded
    return Math.sqrt(currX * currX + currY * currY);
    }
    ...

```
Performing a optimistic read with a StampedLock

```java
class Point {
    ...
    double distanceFromOrigin() {
        long stamp = sl.tryOptimisticRead();
        double currX = x, currY = y;
        if (!sl.validate(stamp)) {
            stamp = sl.readLock();
            try {
                currX = x; currY = y;
            } finally
            { sl.unlockRead(stamp); }
        }
        return Math.sqrt(currX * currX + currY * currY);
    }
    ...
}
```

Applying Java StampedLock: Optimistic & Reading Mode

- Do computation with the copied values
Applying Java Stamped Lock: Conditional Write
Performing a conditional write with a StampedLock

class Point {
    ... Move a point only if it’s current at the origin
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } finally {
            ...
Performing a conditional write with a StampedLock

```java
class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();  // Acquire a read lock
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } catch (Error e) {
            ...
        }
    }
    ...
```
Performing a conditional write with a StampedLock class Point {

    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
Performing a conditional write with a StampedLock

```java
class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } catch (Exception e) {
            ...
        }
        ...
    }
}
```

Try to upgrade to a write lock w/out blocking

`tryConvertToWriteLock()` atomically releases the read lock & acquires the write lock if there are no other readers
Applying Java StampedLock: Conditional Write

- Performing a conditional write with a StampedLock

```java
class Point {

    ...

    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    Upgrade succeeded w/out blocking!
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        }
        ...
    }
```
Performing a conditional write with a StampedLock

```java
class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } catch (InterruptedException e) {
        }
        ...
    }
}
```

Applying Java StampedLock: Conditional Write
Performing a conditional write with a StampedLock

class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;  // Exit the loop
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
    }
    ...
}
Performing a conditional write with a StampedLock

class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        ...
        }
        ...
    }

    
    The x & y field values may change between unlockRead() & writeLock()!
Applying Java StampedLock: Conditional Write

• Performing a conditional write with a StampedLock

```java
class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } finally {
            ...
        }
    }
}
```

Must retest loop condition since x & y field values may change between unlockRead() & writeLock()!
Performing a conditional write with a StampedLock

```java
class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                long ws = sl.tryConvertToWriteLock(stamp);
                if (ws != 0L) {
                    stamp = ws;
                    x = newX; y = newY;
                    break;
                } else {
                    sl.unlockRead(stamp);
                    stamp = sl.writeLock();
                }
            }
        } catch (InterruptedException e) {
            Thread.currentThread().interrupt();
        }
    }
    ...
}
```

This conversion will always succeed since stamp is now a write lock.
Performing a conditional write with a StampedLock

class Point {
    ...
    void moveIfAtOrigin(double newX, double newY) {
        long stamp = sl.readLock();
        try {
            while (x == 0.0 && y == 0.0) {
                ...
                stamp = ws;
                ...
                stamp = sl.writeLock();
            }
        } finally {
            sl.unlock(stamp); } } }
End of Java Stamped Lock: Example Application