Structure & Functionality of Java Phaser

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 Phaser barrier synchronizer

Class Phaser

java.lang.Object
java.util.concurrent.Phaser

public class Phaser
extends Object

A reusable synchronization barrier, similar in functionality to CyclicBarrier and CountDownLatch but supporting more flexible usage.

Registration. Unlike the case for other barriers, the number of parties registered to synchronize on a phaser may vary over time. Tasks may be registered at any time (using methods register(), bulkRegister(int), or forms of constructors establishing initial numbers of parties), and optionally deregistered upon any arrival (using arriveAndDeregister()). As is the case with most basic synchronization constructs, registration and deregistration affect only internal counts; they do not establish any further internal bookkeeping, so tasks cannot query whether they are registered. (However, you can introduce such bookkeeping by subclassing this class.)
Overview of Java Phaser
Overview of Java Phaser

• Implements yet another Java barrier synchronizer

public class Phaser {
  ...

Class Phaser

java.lang.Object
  java.util.concurrent.Phase

public class Phaser
extends Object

A reusable synchronization barrier, similar in functionality to CyclicBarrier and CountDownLatch but supporting more flexible usage.

Registration. Unlike the case for other barriers, the number of parties registered to synchronize on a phaser may vary over time. Tasks may be registered at any time (using methods register(), bulkRegister(int), or forms of constructors establishing initial numbers of parties), and optionally deregistered upon any arrival (using arriveAndDeregister()). As is the case with most basic synchronization constructs, registration and deregistration affect only internal counts; they do not establish any further internal bookkeeping, so tasks cannot query whether they are registered. (However, you can introduce such bookkeeping by subclassing this class.)

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/Phaser.html
Overview of Java Phaser

• Implements yet another Java barrier synchronizer

• Allows a variable (or fixed) # of threads to wait for all operations performed in other threads to complete before proceeding

public class Phaser {

...}

A reusable synchronization barrier, similar in functionality to CyclicBarrier and CountDownLatch but supporting more flexible usage.

Registration. Unlike the case for other barriers, the number of parties registered to synchronize on a phaser may vary over time. Tasks may be registered at any time (using methods register(), bulkRegister(int), or forms of constructors establishing initial numbers of parties), and optionally deregistered upon any arrival (using arriveAndDeregister()). As is the case with most basic synchronization constructs, registration and deregistration affect only internal counts; they do not establish any further internal bookkeeping, so tasks cannot query whether they are registered. (However, you can introduce such bookkeeping by subclassing this class.)

One human known use is different work-crews with different #’s of workers coordinating to build a house
Overview of Java Phaser

- Implements yet another Java barrier synchronizer
- Allows a variable (or fixed) number of threads to wait for all operations performed in other threads to complete before proceeding
- Well-suited for variable-size "cyclic", "entry", and/or "exit" barriers

**Class Phaser**

```java
class Phaser extends Object {
    ...  
}
```

A reusable synchronization barrier, similar in functionality to `CyclicBarrier` and `CountDownLatch` but supporting more flexible usage.

**Registration.** Unlike the case for other barriers, the number of parties `registered` to synchronize on a phaser may vary over time. Tasks may be registered at any time (using methods `register()`, `bulkRegister(int)`, or forms of constructors establishing initial numbers of parties), and optionally deregistered upon any arrival (using `arriveAndDeregister()`). As is the case with most basic synchronization constructs, registration and deregistration affect only internal counts; they do not establish any further internal bookkeeping, so tasks cannot query whether they are registered. (However, you can introduce such bookkeeping by subclassing this class.)
Overview of Java Phaser

- Implements yet another Java barrier synchronizer
- Allows a variable (or fixed) # of threads to wait for all operations performed in other threads to complete before proceeding
- Well-suited for variable-size “cyclic”, “entry”, and/or “exit” barriers

# of parties can vary dynamically

```
public class Phaser {
...
```

A Phaser may be overkill for fixed-sized barriers.
Overview of Java Phaser

- Implements yet another Java barrier synchronizer
- Allows a variable (or fixed) # of threads to wait for all operations performed in other threads to complete before proceeding
- Well-suited for variable-size “cyclic”, “entry”, and/or “exit” barriers
- # of parties can vary dynamically

Class Phaser

```java
public class Phaser {
    ...
}
```

Does not implement an interface

**Class Phaser**

java.lang.Object
    java.util.concurrent.Phase

public class Phaser
extends Object

A reusable synchronization barrier, similar in functionality to CyclicBarrier and CountDownLatch but supporting more flexible usage.

**Registration.** Unlike the case for other barriers, the number of parties registered to synchronize on a phaser may vary over time. Tasks may be registered at any time (using methods register(), bulkRegister(int), or forms of constructors establishing initial numbers of parties), and optionally deregistered upon any arrival (using arriveAndDeregister()). As is the case with most basic synchronization constructs, registration and deregistration affect only internal counts; they do not establish any further internal bookkeeping, so tasks cannot query whether they are registered. (However, you can introduce such bookkeeping by subclassing this class.)
Overview of Java Phaser

• Does not apply the *Bridge* pattern

```
public class Phaser {
...
```

See share/classes/java/util/concurrent/Phaser.java
Overview of Java Phaser

- Does not apply the *Bridge* pattern
- Nor does it use the Abstract QueuedSynchronizer framework

```java
public class Phaser {
    ...
}
```
Overview of Java Phaser

• Instead, it defines a # of fields that implement a phaser

```java
public class Phaser {
    private volatile long state;
    ...
}
```

See src/share/classes/java/util/concurrent/Phaser.java
Overview of Java Phaser

- Instead, it defines a # of fields that implement a phaser
- Primary state representation, holding four bit-fields

```java
public class Phaser {
    private volatile long state;
}
```

See [en.wikipedia.org/wiki/Bit_field](en.wikipedia.org/wiki/Bit_field)
Overview of Java Phaser

• Instead, it defines a # of fields that implement a phaser

• Primary state representation, holding four bit-fields:
  • *Unarrived*
    • the # of parties yet to hit barrier (bits 0-15)

```java
public class Phaser {
    private volatile long state;
}
```
Overview of Java Phaser

• Instead, it defines a # of fields that implement a phaser

• Primary state representation, holding four bit-fields:
  • Unarrived
  • Parties
  • the # of parties to wait for before advancing to the next phase (bits 16-31)

```java
public class Phaser {
    private volatile long state;
```
Overview of Java Phaser

• Instead, it defines a # of fields that implement a phaser

• Primary state representation, holding four bit-fields:
  • Unarrived
  • Parties
  • Phase
  • the generation of the barrier (bits 32-62)
Overview of Java Phaser

• Instead, it defines a # of fields that implement a phaser

• Primary state representation, holding four bit-fields:
  • Unarrived
  • Parties
  • Phase
  • Terminated
    • set if barrier is terminated (bit 63 / sign)

```java
public class Phaser {
    private volatile long state;
```
Instead, it defines a # of fields that implement a phaser

- Primary state representation, holding four bit-fields:
  - *Unarrived* • the # of parties yet to hit barrier (bits 0-15)
  - *Parties* • the # of parties to wait (bits 16-31)
  - *Phase* • the generation of the barrier (bits 32-62)
  - *Terminated* • set if barrier is terminated (bit 63 / sign)

To efficiently maintain atomicity, these values are packed into a single (atomic) long that is updated via CAS operations

```java
public class Phaser {
    private volatile long state;
```
Structure & Functionality of Java Phaser
1. What of the following are benefit of the Java Phaser over the CyclicBarrier?

a. *It supports fixed-size “cyclic” & “entry” and/or “exit” barriers who # of parties match the # of threads*

b. *It supports variable-size “cyclic” & “entry” and/or “exit” barriers whose # of parties can vary dynamically*

c. *It uses the AbstractQueuedSynchronizer framework to enhance reuse*

d. *They provide better support for fixed-sized # of parties*