Hashed Wheel Timer

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1. 简介

Hashed Wheel Timer 主要用来高效处理大量定时任务， 可以对任务进行高效的schedule和unschedule操作。

在Netty, Kafka中都有应用。

- Kafka Timer
- Netty Timer

2. 复杂度分析

ScheduledThreadPoolExecutor

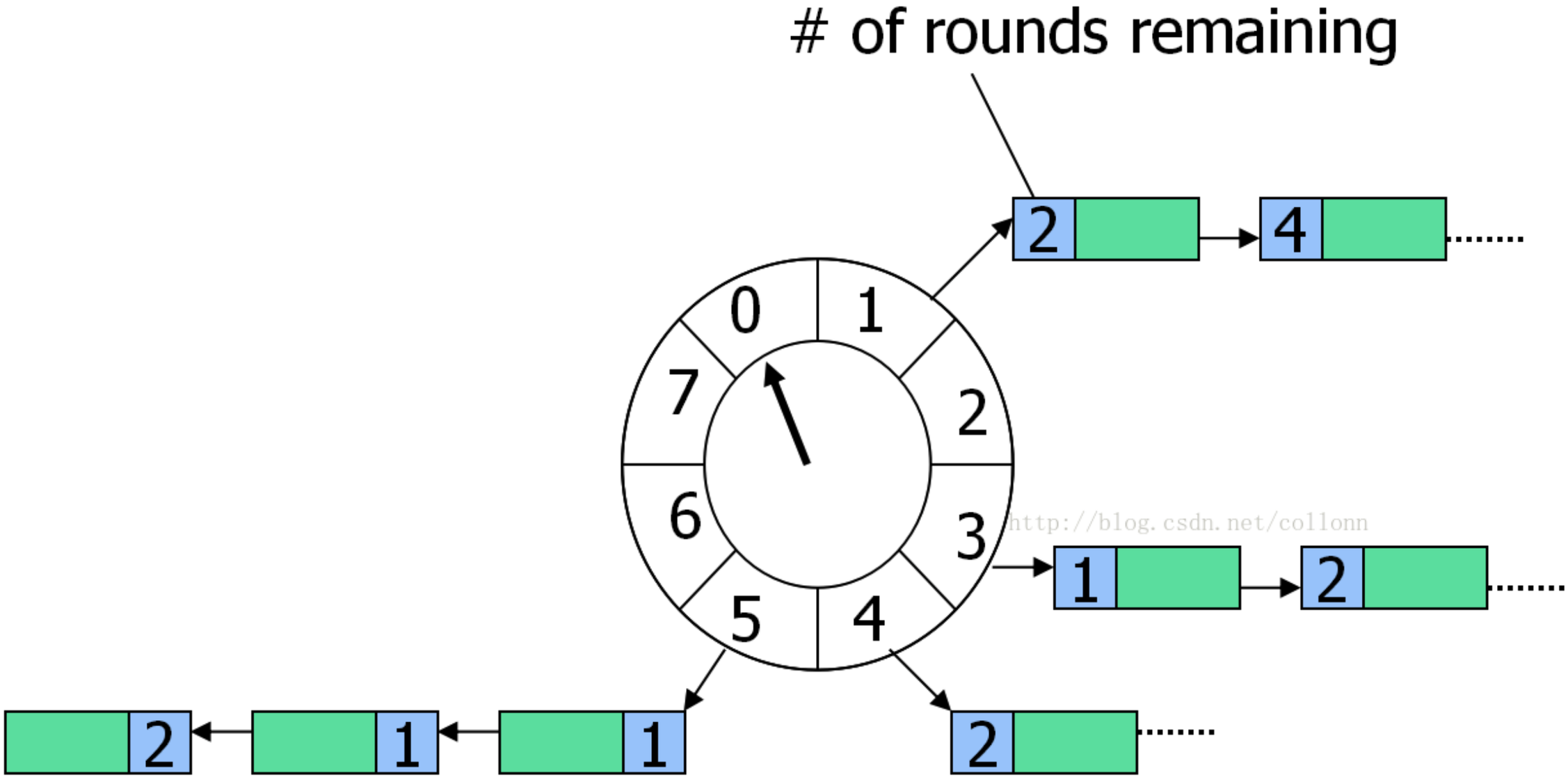
- O(log N) for adding new task
- O(1) per each timer tick
- O(log N) cancelling the task

HashedWheelTimer

- O(1) for adding new task
- O(m) per each timer tick（m = bucket.size）
- O(1) for cancelling a task

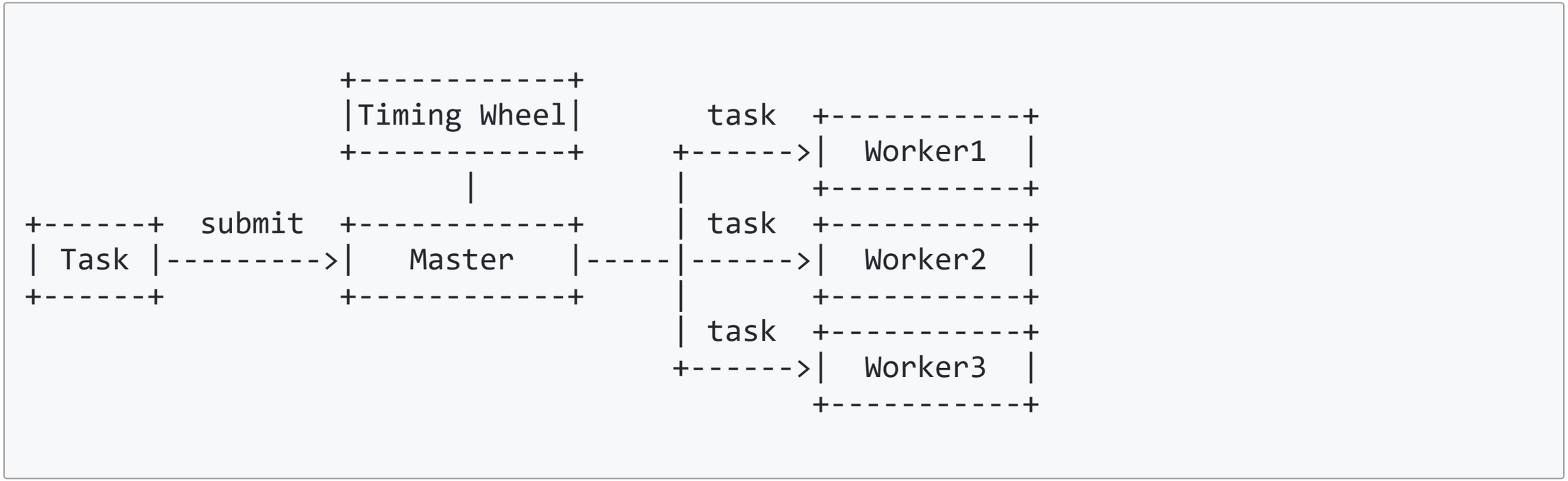
3. 数据结构

-


# of rounds remaining
0
1
2
3
4
5
6
7
2
4
1
2
2
1
1
2
http://blog.csdn.net/collonn

4. 实现细节

4.1. 线程模型



4.2. 实现细节

4.2.1. Timing wheel

```
while (running.get()) {
    Set<Task<?>> bucket = ring[cursor];
    for (Task<?> task : bucket) {
        if (task.isCancelled()) {
            bucket.remove(task);
        } else if (task.rounds == 0) {
            execute(task); // submit to worker thread
            bucket.remove(task);
            if (task.isReschedule()) // scheduleAtFixedRate
                task.reschedule();
        } else {
            task.rounds--
        }
    }
    this.idle.delay(tick);
    cursor = (cursor + 1) & (size - 1)
}
```

4.2.2. Task

```
public interface Task<T> extends ScheduledFuture<T>, Runnable {
        boolean isReschedule(); void reschedule();
}
```

4.2.3. schedule

```
public <T> ScheduledFuture<T> schedule(Callable<T> callable, long delay, TimeUnit u) {
    final int offset1 = (int) (delay / tick), rounds1 = (offset1 / size);
    Task<T> task = new OneShotTask<T>(rounds1, offset1, callable)
    ring[(cursor+offset1) & (size-1)].add(task);
    return task;
}
```

```
public boolean isReschedule() {
    return false;
}

public void reschedule() {
    throw new UnsupportedOperationException();
}
```

4.2.4. scheduleAtFixedRate

```
public ScheduledFuture<?> scheduleAtFixedRate(Runnable r, long d, long p, TimeUnit u){
    final int offset1 = (int) (d / tick), rounds1 = (offset1 / size);
    final int offset2 = (int) (p / tick), rounds2 = (offset2 / size);
    Task<T> task = new FixedRateTask(rounds1, offset1, r, rounds2, offset2);
    ring[(cursor+offset1) & (size-1)].add(task);
    return task;
}
```

```
public boolean isReschedule() {
    return true;
}

public void reschedule() {
    this.canceled.set(false);
    this.rounds1 = this.rounds2;
    this.offset1 = this.offset2;
    ring[(cursor+offset1) & (size-1)].add(task);
}
```

4.2.5. scheduleWithFixedDelay

```
public ScheduledFuture<?> scheduleWithFixedDelay(Runnable r, long d, long p, TimeUnit u)
    final int offset1 = (int) (d / tick), rounds1 = (offset1 / size);
    final int offset2 = (int) (p / tick), rounds2 = (offset2 / size);
    Task<T> task = new FixedDelayTask(rounds1, offset1, r, rounds2, offset2);
    ring[(cursor+offset1) & (size-1)].add(task);
    return task;
}
```

```
public boolean isReschedule() {
    return false; // see #run()
}

public void run() {
    super.run(); reschedule();
}

public void reschedule() {
    this.canceled.set(false);
    this.rounds1 = this.rounds2;
    this.offset1 = this.offset2;
    ring[(cursor+offset1) & (size-1)].add(task);
}
```

5. 性能

```
Benchmark                          Mode  Cnt        Score         Error  Units
benchmarkScheduledExecutor        thrpt  200   795377.428 ± 176042.240  ops/s
benchmarkXScheduledExecutor       thrpt  200  7452524.500 ±  79330.412  ops/s
(100ms tick, 512 wheel size)
```

6. Hashed Hierarchical Timing Wheel