Thread Synchronization

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Thread Synchronization

Examples
Example 1

- **Make program**
  - 5 Reader + 1 Writer
  - Writer updates value 1,000,000 times
  - Each reader reads value 10,000,000 times

- **Use pthread_mutex**
Example 2

- Implement same thing using `pthread_spinlock`
  - `pthread_spinlock_t s`
  - `pthread_spin_init(&s, PTHREAD_PROCESS_PRIVATE)`
  - `pthread_spin_[un]lock(&s)`
  - `pthread_spin_destroy(&s)`

- What is the difference?
Readers-Writer Lock

- **Reader blocks other reader**
  - Do we need this?

- **Implementation**
  - Using two mutexes
  - Using a condition variable and a mutex
Readers-Writer Lock(1)

- **Two mutex**

<table>
<thead>
<tr>
<th>Begin Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lock $r$.</td>
</tr>
<tr>
<td>- Increment $b$.</td>
</tr>
<tr>
<td>- If $b = 1$, lock $g$.</td>
</tr>
<tr>
<td>- Unlock $r$.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lock $r$.</td>
</tr>
<tr>
<td>- Decrement $b$.</td>
</tr>
<tr>
<td>- If $b = 0$, unlock $g$.</td>
</tr>
<tr>
<td>- Unlock $r$.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Begin Write</th>
</tr>
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<tbody>
<tr>
<td>- Lock $g$.</td>
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<table>
<thead>
<tr>
<th>End Write</th>
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<tr>
<td>- Unlock $g$.</td>
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</table>
Readers-Writer Lock(2)

- A condition variable and a mutex
  - Lock for read
    - Input: mutex \( m \), condition variable \( c \), integer \( r \) (number of readers waiting), flag \( w \) (writer waiting).
    - Lock \( m \) (blocking).
    - While \( w \):
      - wait \( c, m \)
      - Increment \( r \).
      - Unlock \( m \).
  - Lock for write
    - Lock \( m \) (blocking).
    - While \( w \):
      - wait \( c, m \)
    - Set \( w \) to true.
    - While \( r > 0 \):
      - wait \( c, m \)
    - Unlock \( m \).
Example 3-4

- **Example 3**
  - Implement program with readers-writer lock (Using mutex)

- **Example 4**
  - Implement program with readers-writer lock (Using condition variables)

- What is the difference?