CMSC 330: Organization of Programming Languages

Project 2
Multithreaded Space Simulation
Space Simulation

You are given
• List of starports & their sizes
• List of starships & their sizes
• List of travelers & their stops
• Parser for reading simulation parameters / events
• Code for printing simulation events

You need to simulate
• Starships moving between ports (in a fixed circle)
• Travelers boarding / exiting starships
Simulation Parameters

Format

=== Starports ===
<name> <size>

=== Starships ===
<name> <size>

=== Passengers ===
<name> <port1> <port2>...

=== Output ===
<event>
Simulation Parameters

Example

=== Starports ===
Earth 2
Vulcan 1

=== Starships ===
Enterprise 2

=== Passengers ===
Kirk Earth Vulcan Earth
Spock Vulcan Earth

=== Output ===
Simulation Events

Format

- <starship> docking at <starport>
- <starship> departing from <starport>
- <traveler> boarding <starship> at <starport>
- <traveler> departing <starship> at <starport>
Simulation Events

Example

Enterprise docking at Earth
  Kirk boarding Enterprise at Earth
Enterprise departing from Earth
Enterprise docking at Vulcan
  Spock boarding Enterprise at Vulcan
  Kirk departing Enterprise at Vulcan
Enterprise departing from Vulcan
Enterprise docking at Earth
  Spock departing Enterprise at Earth
Enterprise departing from Earth
Goals

1. Implement simulation display
   - Examine log file of simulation events
   - Display state of simulation

2. Implement simulation verifier
   - Examine log file of simulation events
   - Discover illegal / missing simulation events

3. Implement multithreaded simulation
   - Separate threads for starships, travelers
   - Use synchronization to avoid data races
   - Use wait / notify for efficiency
Simulation Display

- Read simulation events & display state
- Example

<table>
<thead>
<tr>
<th>Earth</th>
<th>Kirk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulcan</td>
<td>Spock</td>
</tr>
</tbody>
</table>

Enterprise docking at Earth

<table>
<thead>
<tr>
<th>Earth</th>
<th>Kirk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise</td>
<td></td>
</tr>
<tr>
<td>Vulcan</td>
<td>Spock</td>
</tr>
</tbody>
</table>
Simulation Verifier

- Read simulation events
- Check for data race & logic errors
  - Starships are traveling between starports in correct order
  - Starships always dock at a starport before leaving it
  - Starships do not exceed the capacity of a starport
  - Travelers follow their itinerary
  - Travelers only board /leave starship while it is at starport
  - Travelers do not exceed the capacity of a starship
  - All travelers have reached their final destination when simulation ends
Space Simulation

- Multithreading
  - One thread per starship
  - One thread per traveler

- Synchronization
  - Starships dock at starport if size permits
  - Travelers only board / exit starship when in port
  - Use enough locks to permit concurrent execution
  - Use wait / notify to avoid busy waiting
Notes

- **Multithreaded simulation**
  - Without using conditional variables, simulation may run very slowly and timeout due to busy waiting
  - Initially you may use a single monitor and conditional variable for the entire simulation
  - Later for more efficient implementation you should have a separate monitor for each starport, and multiple conditional variables for each monitor

- **Simulation output**
  - Need not be identical to example output provided
  - Lines beginning with % are ignored by submit server