Manual for Running the Program

This manual provides a step-by-step guide to run and test the program. If you encounter issues, ensure that the configuration and file generation scripts are correct.

1. Program Overview

The program implements a hierarchical P2P system with super-peers and leaf nodes, using push-based and pull-based mechanisms to maintain file consistency. It supports testing different TTR values for the pull-based approach and collecting statistics on query results.

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3. Configuration Files

1. system_config.txt:

Define system-wide settings, including enabling/disabling push/pull mechanisms and the default TTR value.

Example:

```
PUSH_ENABLED=true
PULL_ENABLED=true
TTR=30000
```

2. network_config.txt:

Define the network topology for super-peers and their connections with leaf nodes.

Example:

```
super-peer1: super-peer2,super-peer3
super-peer2: super-peer1,super-peer4
super-peer3-leaves: leaf1,leaf2
super-peer4-leaves: leaf3
```

4. Test Case

- Setup:
  - Place files file1.txt, file2.txt in shared/leaf1/.
  - Place files file3.txt, file4.txt in shared/leaf2/.

- Testing:
  - Test the system with the following steps:
    1. Test push-based invalidation by enabling PUSH_ENABLED=true.
    2. Test pull-based polling with varying TTR values:

- TTR = 30 seconds
- TTR = 60 seconds
- TTR = 120 seconds

3. Observe logs for query results, invalidations, and modifications.

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5. Running the Program

1. Compile all Java files:

```
javac src/*.java
```

2. Run the Main program:

```
bash
java src.Main
```

3. Monitor the terminal for output logs.

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6. Example Output

Terminal output will include:

1. Super-peer initialization:

```
plaintext
super-peer1 is running...
super-peer2 is running...
```

2. Leaf node activity:

```
leaf1: Loaded owned file file1.txt
leaf1: Registered file file1.txt with super-peer super-peer1
```

Push based results

```
super-peer10: Received POLL for file: file2.txt from leaf10
super-peer3: Received POLL for file: file7.txt from leaf3
super-peer9: Received POLL for file: file7.txt from leaf9
super-peer10: Received POLL for file: file7.txt from leaf10
super-peer3: Received POLL for file: file8.txt from leaf3
super-peer9: Received POLL for file: file8.txt from leaf9
super-peer10: Received POLL for file: file8.txt from leaf10
super-peer3: Received POLL for file: file10.txt from leaf3
super-peer9: Received POLL for file: file10.txt from leaf9
```

super-peer10: Received POLL for file: file10.txt from leaf10
super-peer3: Received POLL for file: file9.txt from leaf3
super-peer9: Received POLL for file: file9.txt from leaf9
super-peer10: Received POLL for file: file9.txt from leaf10
leaf3: Total Queries: 31, Invalid Results: 0, Invalid Percentage: 0.0%
leaf3: Total Queries: 64, Invalid Results: 0, Invalid Percentage: 0.0%
leaf2: Total Queries: 31, Invalid Results: 0, Invalid Percentage: 0.0%
leaf8: Total Queries: 30, Invalid Results: 0, Invalid Percentage: 0.0%
leaf9: Total Queries: 63, Invalid Results: 0, Invalid Percentage: 0.0%
leaf10: Total Queries: 60, Invalid Results: 0, Invalid Percentage: 0.0%
leaf1: Total Queries: 87, Invalid Results: 0, Invalid Percentage: 0.0%
leaf5: Total Queries: 87, Invalid Results: 0, Invalid Percentage: 0.0%
leaf3: Total Queries: 87, Invalid Results: 0, Invalid Percentage: 0.0%
leaf6: Broadcast invalidation for file file10.txt

3. Polling and query results:

=== Testing with TTR: 30 seconds ===
leaf1: Polling for file file1.txt at super-peer1
leaf1: Response from server: VALID:file1.txt:30000

4. Statistics:
=== Statistics for TTR: 30 seconds ===
leaf1: Total Queries: 40, Invalid Results: 2, Invalid Percentage: 5.0%
leaf2: Total Queries: 42, Invalid Results: 3, Invalid Percentage: 7.1%

To match the output:
- Ensure at least 2-3 querying leaf nodes and 1-2 modifying nodes.
- Generate files of varying sizes (e.g., file1.txt to file10.txt with sizes 1KB to 10KB)

8. Verifying Output
super-peer1 is running...
super-peer2 is running...
leaf1: Polling for file file1.txt at super-peer1
leaf1: Response from server: VALID:file1.txt:60000
leaf1: File file1.txt remains valid. New TTR: 60000ms
leaf2: Polling for file file3.txt at super-peer2
leaf2: Response from server: VALID:file3.txt:60000
leaf2: File file3.txt remains valid. New TTR: 60000ms
leaf1: Total Queries: 50, Invalid Results: 1, Invalid Percentage: 2.0%
leaf2: Total Queries: 52, Invalid Results: 2, Invalid Percentage: 3.8%

leaf3: Total Queries: 49, Invalid Results: 5, Invalid Percentage: 10.2%

9. Troubleshooting
- Invalid Configuration:
  - Ensure system_config.txt and network_config.txt are correctly formatted.
- Files Not Found:
  - Verify that the files exist in the appropriate shared/ directories.
- Port Conflicts:
  - Check that no other applications are using ports in the 8000+ range.