

## Fault Tolerant Server Cluster

This project is a multi-threaded fault tolerant server cluster which provides a serverless Java execution service. The cluster implementation includes a public gateway, leader node, and follower nodes. Clients send java source code to the gateway, and the gateway sends work to the leader node, which then distributed the work among worker nodes in a round robin fashion. System out and System err results of compilation and running of Java code are returned from workers to the client via the gateway node. Leader elections are used, as well as queues, all-to-all heartbeats and gossip, to provide resilience in the face of leader or worker death. HTTP, TCP and UDP protocols are employed as appropriate.

The **demo.sh** script runs a demo in which several servers are started locally in separate JVMs, at which point some sever processes are killed to demonstrate the fault tolerance processes.

The classes used by this project are as follows:

### **TCPSender**

Used by a server to send TCP messages. Outgoing messages are added to a LinkedBlockingQueue which is passed to the constructor, along with a ConcurrentHashMap of server ID numbers to their InetAddress, and a reference to the server this instance of TCPSender is being used by, in order to access any relevant state information, as well as information about other servers, from the server using this TCPSender.

### **TCPReceiver**

This class listens on a specified port for incoming TCP messages, and adds them to a server's LinkedBlockingQueue of incoming messages.

### **UDPMessageSender**

This class is used to send UDP messages, taken from a LinkedBlockingQueue of outgoing messages.

### **UDPMessageReceiver**

This class listens on a specified port for incoming UDP messages. Bodies of incoming messages are split on comma separations. This allows the message to be classified based on certain headers, and action is taken depending on the nature of the incoming message, which may be gossip, a heartbeat or leader election related messages.

### **HeartbeatScanner**

This class constantly loops over a map of server ID numbers to the last time a heartbeat was received by the UDPMessageReceiver. If a heartbeat has not been receiver after ten seconds, the server is assumed dead.

### **HeartbeatSender**

This class sends a heartbeat broadcast for a server every two seconds, as well as the full gossip table of the server to one random other server in the cluster.

### **JavaRunnerImpl**

This class compiles and runs java source code received via an InputStream. The System.out and System.err values are temporarily redirected to OutputStreams which can then be used to return the outputs. The output redirection is synchronized across all JavaRunnerImpl instances on a single machine by synchronizing on the JavaRunnerImpl class object's monitor.

### **ClientImpl**

This is the client to the server cluster. It sends source code to the public gateway, and returns the response.

### **Driver**

This class starts a cluster of servers locally, and keeps them alive through a while(true) loop in the main method.

### **Gateway**

This class implements the server acting as a public gateway, and sends information back and forth between the leader node and clients.

### **ZooKeeperPeerServerImpl**

This class implements the leader and worker nodes, using the previously mentioned classes to communicate, send and receive work, and compile and run Java source code sent from the leader node. Servers elect a leader using instances of the **ZookeeperLeaderElection** class.