

Configuration Manual

MSc Research Project
Cloud Computing

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Configuration Manual

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1 Introduction

1.1 Purpose of the document

The NCI research study set of rules was followed in the design of this manual. The application, methods, and tools employed in this project are detailed in this document. This is done by using spring boot microservices . In these services each services is for specific purpose. In addition we have implemented Apache Kafka messaging services to get the utilization status of virtual machines.

2 System Requirements

The system requirements to run the project

- Operating System: Windows 10
- System Processor: Intel i5 core CPU @ 2.30GHz
- RAM: 4 GB
- System type: 64-bit operating system, x64-based processor

3 Installations

3.1 JAVA installation

It is possible to simulate the cloud environment using the Eclipse IDE with an integrated JAVA development plugin. Installing it is as simple as following these first few steps:

- Install the Java Development Toolkit (JDK), which is required because the simulation is written in the Java programming language. <https://dist.springsource.com/release/STS/index.html>
- Install the spring tool suite IDE to run <https://spring.io/tools3/sts/all>
- Open STS IDE by unzipping the downloaded folder and running the executable file (.exe).

3.2 Cloudsim Plus Installation:

CloudSim Plus is a simulation framework that is used for simulating the cloud computing environment.

The following are the second set of steps to implement the simulation in the Spring tool suite IDE:

- In maven repository and get the dependency of cloudsim plus .
- Just copy maven repository into pom.xml and then it added that dependency to the class path.

3.3 Apache Kafka Installation:

- Apache Kafka binaries will be used for the installation of Apache Kafka. Go the link <https://kafka.apache.org/downloads>
- After that create kafka folder and place the unzipped inside that folder.
- In the "config/zookeeper.Properties" configuration file, change the path to the zookeeper data directory.

```
# distributed under the license is distributed on an "AS IS" BASIS,  
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.  
# See the license for the specific language governing permissions and  
# limitations under the license.  
# the directory where the snapshot is stored.  
dataDir=C:/kafka/zookeeper-data  
# the port at which the clients will connect  
clientPort=2181  
# disable the per-ip limit on the number of connections since this is a non-production config  
maxClientCnxns=0  
# Disable the adminserver by default to avoid port conflicts.  
# Set the port to something non-conflicting if choosing to enable this  
admin.enableServer=false  
# admin.serverPort=8080
```

Figure 1: Zookeeper configuration

- In the "config/server.properties" file, change the Apache Kafka log file path.

```
# distributed under the license is distributed on an "AS IS" BASIS,  
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.  
# See the license for the specific language governing permissions and  
# limitations under the license.  
# the directory where the snapshot is stored.  
dataDir=C:/kafka/zookeeper-data  
# the port at which the clients will connect  
clientPort=2181  
# disable the per-ip limit on the number of connections since this is a non-production config  
maxClientCnxns=0  
# Disable the adminserver by default to avoid port conflicts.  
# Set the port to something non-conflicting if choosing to enable this  
admin.enableServer=false  
# admin.serverPort=8080
```

Figure 2: Kafka server configuration

4 Implementation

This sections about the implementation part of the proposed system. Initially, the implementation starts with Kafka zoo keeper followed by the creating zookeeper server where we need to execute to commands to run Kafka server. After that data center virtualization component is being started. After starting it is followed by the tracking of the resource service. Then for under loading purpose a block under load defection service is present and after under loading the overload detection is there. Finally the live virtual machine migration is obtained as the result of implementation of all these steps.

The Figure3 shows the execution of zoo keeper server which is the very beginning of the programming.

```
[2021-12-16 04:15:07,016] INFO Using org.apache.zookeeper.server.NIOServerCnxnFactory as server connection factory (org.apache.zookeeper.server.ServerCnxnFactory)
[2021-12-16 04:15:07,026] INFO Configuring NIO connection handler with 10s sessionless connection timeout, 2 selector thread(s), 16 worker threads, and 64 kB direct buffers. (org.apache.zookeeper.server.NIOServerCnxnFactory)
[2021-12-16 04:15:07,042] INFO binding to port 0.0.0.0/0.0.0.0:2181 (org.apache.zookeeper.server.NIOServerCnxnFactory)
[2021-12-16 04:15:07,077] INFO zookeeper.snapshotSizeFactor = 0.33 (org.apache.zookeeper.server.ZKDatabase)
[2021-12-16 04:15:07,253] INFO Reading snapshot C:\kafka\zookeeper-data\version-2\snapshot.29e (org.apache.zookeeper.server.persistence.FileSnap)
[2021-12-16 04:15:07,296] INFO Snapshotting: 0x2b6 to C:\kafka\zookeeper-data\version-2\snapshot.2b6 (org.apache.zookeeper.server.persistence.FileTxnSnapLog)
[2021-12-16 04:15:07,339] INFO Using checkIntervalMs=60000 maxPerMinute=10000 (org.apache.zookeeper.server.ContainerManager)
```

Figure 3: Zookeeper server

After this successful creation of zoo keeper server in a secured environment. Kafka server is to be initiated and for this following command is executed as shown in Figure 4.

```
[2021-12-16 04:16:29,302] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-8 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,303] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-43 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,304] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-15 in 1 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,305] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-30 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,306] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-9 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,306] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-35 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,312] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-5 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,313] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-20 in 1 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,313] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-27 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,314] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-42 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,315] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-12 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,316] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-21 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,316] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-36 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,317] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-6 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,318] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-43 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,319] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-13 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
[2021-12-16 04:16:29,319] INFO [GroupMetadataManager brokerId=0] Finished loading offsets and group metadata from _consumer_offsets-28 in 0 milliseconds. (kafka.coordinator.group.GroupMetadataManager)
```

Figure 4: Kafka server

Figure 5 represents the code in which the simulation process is done in order to ensure the distribution of workload among cloudlets and later this data is sent to the Kafka consumer. So by all this we can say that the system is acting as the Kafka producer.

Tracking resource service is the next service which acts like a Kafka consumer and in which the data is taken from the Kafka producer in equal intervals of time. This is represented in the Figure 6.

In Figure 7 we can see how the overloaded services work. It's working is to take the data from tracking resource service in a particular interval of times and it intends to prepare list of overloaded services by considering the CPU utilization of the virtual machines.

Similarly in Figure 8 it is observed that how the under loaded services work the same way as or lead services like taking data from tracking resource services and making their list of under loaded services by considering the same parameter like CPU utilization.

Finally, by completing all these services like tracking research service, overloading and under loading services. the data is collected from all these resources and the migration of

```

for(Cloudlet cloud:cloudletList) {
    if(size==noOfCloudlets) {
        break;
    }
    else {
        finalCloudlets.add(cloud);
        size++;
    }
}

broker0.submitVmList(vmlist);
broker0.submitCloudletList(finalCloudlets);
simulation.terminateAt(1000000);

simulation.startSync();
try {
    while(simulation.isRunning()){
        // tryDestroyVmAndResubmitCloudlets();

        simulation.runFor(INTERVAL);
        printVmCpuUtilization();
        DatacenterModel datacenterData=getDataCenterDetails();
        //datacenterData.setDatacenter(datacenter0);
        ProducerRecord<String, DatacenterModel> record=new ProducerRecord<String, DatacenterModel>("fourth_topic",datacenterData);
        producer.send(record);

    }
    producer.flush();
    producer.close();
}
catch(Exception e) {
    e.printStackTrace();
}
}

```

Figure 5: Data Center Virtualization

```

public static DatacenterModel getDatacenterDeatils() {
    System.out.println("Subscribed to topic " + TOPIC);
    int i = 0;
    int counter=1;
    while (counter<=3) {
        ConsumerRecords<String, DatacenterModel> records = consumer.poll(100);
        for (ConsumerRecord<String, DatacenterModel> record : records) {

            // print the offset,key and value for the consumer records.
            /*
             * System.out.printf("offset = %d, key = %s, value = %s\n", record.offset(),
             * record.key(), record.value());
             */
            datacenterModel=record.value();

            for (final VMModel vm : record.value().getVmList()) {
                System.out.printf(" Vm %5d |", vm.getVmId());

            } System.out.println();

            for (final VMModel vm : record.value().getVmList()) {
                System.out.printf(" %7.0f%% |", vm.getVmCPUUtilization()*100);
            }

        }
        counter++;
    }
    return datacenterModel;
}
}

```

Figure 6: Tracking resources services

```

public List<HostList> getOverloadHostList() {
    HashMap<Integer, List<VMModel>> hostPerVm=new HashMap<Integer,List<VMModel>>(); // It contains map of host per VM
    List<HostList> overloadHostPerVm=new ArrayList<HostList>();

    for (VMModel vm:OverloadDetectionServicesApplication.datacenterModel.getVmList()) { // setting into to each vm to host as a key
        if(!hostPerVm.containsKey(vm.getHostId())) {
            List<VMModel> vmListPerHost=hostPerVm.get(vm.getHostId());
            vmListPerHost.add(vm);
            hostPerVm.put(vm.getHostId(), vmListPerHost);
        }
        else {
            List<VMModel> vmListPerHost=new ArrayList<VMModel>();
            vmListPerHost.add(vm);
            hostPerVm.put(vm.getHostId(),vmListPerHost);
        }
    }

    for (Map.Entry<Integer, List<VMModel>> hostVmList : hostPerVm.entrySet()) { // computing average of each host
        List<VMModel> vmList=hostVmList.getValue();
        double sumOfCPUUtilization=0.0,averageCPUUtilization=0.0;
        for (VMModel vm:vmList) {
            sumOfCPUUtilization=sumOfCPUUtilization+vm.getVmCPUUtilization();
        }
        averageCPUUtilization=sumOfCPUUtilization/vmList.size(); // computing the average CPU utilization
        System.out.println("Average CPUUtilization of hostId"+hostVmList.getKey()+" is "+averageCPUUtilization+" with an number Of VMs: "+ vmList.size());
        if( averageCPUUtilization>OverloadDetectionServicesApplication.slaContract.getCpuUtilizationMetric().getMaxDimension().getValue()) { // It will check the whether the given host is over
            HostList overloadModel=new HostList();
            overloadModel.setAverageCPUUtilization(averageCPUUtilization);
            overloadModel.setHostId(hostVmList.getKey());
            overloadModel.setVmList(hostVmList.getValue());
            overloadHostPerVm.add(overloadModel);
        }
    }

    return overloadHostPerVm;
}

```

Figure 7: Overloaded Detection services

```

// This will throw UnderloadedHost
public List<HostList> getUnderloadHostList() {
    HashMap<Integer, List<VMModel>> hostPerVm=new HashMap<Integer,List<VMModel>>();
    List<HostList> underloadHostPerVm=new ArrayList<HostList>();

    for (VMModel vm:UnderloadedDetectionServicesApplication.datacenterModel.getVmList()) { // setting into to each vm to host as a key
        if(!hostPerVm.containsKey(vm.getHostId())) {
            List<VMModel> vmListPerHost=hostPerVm.get(vm.getHostId());
            vmListPerHost.add(vm);
            hostPerVm.put(vm.getHostId(), vmListPerHost);
        }
        else {
            List<VMModel> vmListPerHost=new ArrayList<VMModel>();
            vmListPerHost.add(vm);
            hostPerVm.put(vm.getHostId(),vmListPerHost);
        }
    }

    for (Map.Entry<Integer, List<VMModel>> hostVmList : hostPerVm.entrySet()) { // computing average of each host
        List<VMModel> vmList=hostVmList.getValue();
        double sumOfCPUUtilization=0.0,averageCPUUtilization=0.0;
        boolean isHostActive=false;
        for (VMModel vm:vmList) {
            sumOfCPUUtilization=sumOfCPUUtilization+vm.getVmCPUUtilization();
        }
        averageCPUUtilization=sumOfCPUUtilization/vmList.size();
        if(averageCPUUtilization>0) {
            isHostActive=true;
        }

        System.out.println("Average CPUUtilization of hostId"+hostVmList.getKey()+" is "+averageCPUUtilization);
        //It will check the given host is underloaded or not
        if( isHostActive &&(averageCPUUtilization<UnderloadedDetectionServicesApplication.slaContract.getCpuUtilizationMetric().getMinDimension().getValue())) {
            HostList underloadModel=new HostList();
            underloadModel.setAverageCPUUtilization(averageCPUUtilization);
            underloadModel.setHostId(hostVmList.getKey());
            underloadModel.setVmList(hostVmList.getValue());
            underloadHostPerVm.add(underloadModel);
        }
    }
}

```

Figure 8: UnderOverloaded Detection services

virtual machines takes place by using Ant colony optimization. And this is represented in the Figure 9.

```
for (int i = 0; i < noOfIterations; i++) {
    for (int ant = 0; ant < noOfAnts; ant++) {
        Set<Triple<HostList, VMModel, HostList>> currentAvailableTuples = new HashSet<>();
        currentAvailableTuples.addAll(finalTuples);
        Set<Triple<HostList, VMModel, HostList>> localMigrationPlaning = new HashSet<>();
        double localScoreing = 0;
        Set<VMModel> availableVms = new HashSet<>();
        availableVms.addAll(allVmlist);
        Optional<Triple<HostList, VMModel, HostList>> optional = chooseNextTriple(currentAvailableTuples);
        Triple<HostList, VMModel, HostList> nextTriple;

        while (optional.isPresent()) {
            if (availableVms.isEmpty())
                break;
            nextTriple = optional.get();
            currentAvailableTuples.remove(nextTriple);

            if (!availableVms.contains(nextTriple.getMiddle()) ) {
                // System.out.printf("Skipped %s.\n", nextTriple.getRight());
                optional = chooseNextTriple(currentAvailableTuples);
                continue;
            }
            updateLocalPheromone(nextTriple);
            localMigrationPlaning.add(nextTriple);
            // nextTriple.getLeft().addVmMigratingOut(nextTriple.getMiddle());
            double score = getRouteScore(localMigrationPlaning);
            if (score > localScoreing) {
                localScoreing = score;
                VMModel vmMigrated = nextTriple.getMiddle();
                availableVms.remove(vmMigrated);
                // LOGGER.debug("Tuple: {}", nextTriple);
                // LOGGER.debug("Score update: {}", localScore);
                currentAvailableTuples.removeIf(tuple -> tuple.getMiddle() == vmMigrated);
            } else {
                // LOGGER.info("Ant {} removing {}", ant, nextTriple);
                localMigrationPlaning.remove(nextTriple);
            }
            // LOGGER.info("Migration plan: {}", localMigrationPlan);
            optional = chooseNextTriple(currentAvailableTuples);
        }
    }
}
```

Figure 9: Live VM Migration