

Deploying a Fedora Cluster

Note: The clustering capability will likely be changed or removed based on future updates to the underlying Modeshape application. See: <https://developer.jboss.org/message/945504>

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To support horizontal scalability use cases as well as geographic distribution, Fedora 4 can be configured as a cluster of application servers.

Configuration

Fedora 4 is built in top of the JCR implementation [Modeshape](#). Modeshape uses [Infinispan](#) as a distributed datastore, which in turn uses the Messaging Toolkit [JGroups](#) to transfer state between nodes.

Therefore the following resources and documents contain a lot of important information about configuring Fedora 4's underlying projects.

- [Fedora configuration inventory](#)
- [Modeshape documentation](#)
- [Modeshape configuration section](#)
- [Infinispan documentation](#)
- [Infinispan configuration section](#)
- [JGroups documentation](#)
- [JGroups configuration section](#)

Step-By-Step guides for deploying Fedora 4 clusters

Deploy cluster using the UDP Multicast protocol for node discovery and the TCP protocol for replication

A few configuration options have to be set in order to have Fedora 4 work as a cluster on a local machine:

- **-Xmx1024m** Set the Java heap to 1GB
- **-XX:MaxPermSize=256m** Set the Java PermGen size to 256MB
- **-Dfcrepo.modeshape.configuration=file:///path/to/repository.json** The Modeshape configuration used for clustering
- **-Djava.net.preferIPv4Stack=true** Tell Java to use IPv4 rather than IPv6
- **fcrepo.ispn.jgroups.configuration=/path/to/jgroups-fcrepo-tcp.xml** Set the JGroups configuration file holding the TCP Transport definitions
- **jgroups.udp.mcast_addr=239.42.42.42** Set the UDP multicast address for the JGroups cluster
- **fcrepo.ispn.configuration=/path/to/infinispan.xml** Set the Infinispan configuration file holding the Infinispan cluster configuration

JGroups configuration

In order to use the UDP Multicasting for node discovery and TCP for replication the following JGroups example configuration can be used:

jgroups-fcrepo-tcp.xml

```
<config xmlns="urn:org:jgroups" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:org:jgroups http://www.jgroups.org/schema/JGroups-3.0.xsd">
  <TCP bind_port="7800"
    loopback="false"
    recv_buf_size="${tcp.recv_buf_size:5M}"
    send_buf_size="${tcp.send_buf_size:640K}"
    max_bundle_size="64K"
    max_bundle_timeout="30"
    use_send_queues="true"
    sock_conn_timeout="300"
    timer_type="new3"
    timer.min_threads="4"
    timer.max_threads="10"
    timer.keep_alive_time="3000"
    timer.queue_max_size="500"
    thread_pool.enabled="true"
    thread_pool.min_threads="1"
    thread_pool.max_threads="10"
    thread_pool.keep_alive_time="5000"
    thread_pool.queue_enabled="true"
    thread_pool.queue_max_size="10000"
    thread_pool.rejection_policy="discard"
    oob_thread_pool.enabled="true"
    oob_thread_pool.min_threads="1"
    oob_thread_pool.max_threads="8"
    oob_thread_pool.keep_alive_time="5000"
    oob_thread_pool.queue_enabled="false"
    oob_thread_pool.queue_max_size="100"
    oob_thread_pool.rejection_policy="discard"/>
  <MPING timeout="1000"
    num_initial_members="1"/>
  <MERGE2 max_interval="30000"
    min_interval="10000"/>
  <FD_ALL timeout="150000"/>
  <VERIFY_SUSPECT timeout="150000" />
  <BARRIER />
  <pbcast.NAKACK2 use_mcast_xmit="false"
    discard_delivered_msgs="true"/>
  <UNICAST timeout="600,900,2500"/>
  <pbcast.STABLE stability_delay="2000" desired_avg_gossip="50000"
    max_bytes="4M"/>
  <pbcast.GMS print_local_addr="true" join_timeout="6000"
    view_bundling="true"/>
  <MFC max_credits="2M"
    min_threshold="0.4"/>
  <FRAG2 frag_size="60K" />
  <pbcast.STATE_TRANSFER />
</config>
```

Infinispan configuration

The following example configuration has its replication timeout set to 10 minutes in order to mitigate the problem of SyncTimeouts when spanning one transaction over a lot of operations

infinispan.xml

```
<infinispan xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:infinispan:config:5.2 http://www.infinispan.org/schemas/infinispan-config-5.2.xsd"
  xmlns="urn:infinispan:config:5.2">
  <global>
    <globalJmxStatistics enabled="true" allowDuplicateDomains="true"/>
    <transport clusterName="modeshape-cluster">
```

```

        <properties>
        <property name="configurationFile" value="\${fcrepo.ispn.jgroups.configuration:config/jgroups-fcrepo-tcp.
xml}"/>
        </properties>
    </transport>
</global>
<default>
    <clustering mode="distribution">
        <sync replTimeout="600000"/>
        <l1 enabled="false" lifespan="0" onRehash="false"/>
        <hash numOwners="\${fcrepo.ispn.numOwners:2}"/>
        <stateTransfer chunkSize="100" fetchInMemoryState="true"/>
    </clustering>
</default>
<namedCache name="FedoraRepository">
    <clustering mode="replication">
        <sync replTimeout="600000"/>
        <l1 enabled="false" lifespan="0" onRehash="false"/>
        <stateTransfer chunkSize="100" fetchInMemoryState="true" timeout="120000"/>
    </clustering>
    <locking isolationLevel="READ_COMMITTED" writeSkewCheck="false" lockAcquisitionTimeout="150000"
useLockStriping="true" />
    <transaction transactionMode="TRANSACTIONAL" lockingMode="PESSIMISTIC"/>
    <loaders passivation="false" shared="false" preload="false">
        <loader class="org.infinispan.loaders.file.FileCacheStore" fetchPersistentState="true"
            purgeOnStartup="false">
            <properties>
                <property name="location" value="\${fcrepo.ispn.repo.CacheDirPath:target/FedoraRepository/storage}"/>
                <property name="fsyncMode" value="perWrite"/>
            </properties>
        </loader>
    </loaders>
</namedCache>
<namedCache name="FedoraRepositoryMetaData">
    <clustering mode="distribution">
        <sync replTimeout="600000"/>
        <l1 enabled="false" lifespan="0" onRehash="false"/>
        <hash numOwners="\${fcrepo.ispn.numOwners:2}"/>
        <stateTransfer chunkSize="100" fetchInMemoryState="true"/>
    </clustering>
    <locking concurrencyLevel="1000" lockAcquisitionTimeout="150000" useLockStriping="false" />
    <deadlockDetection enabled="true" spinDuration="1000"/>
    <eviction maxEntries="500" strategy="LIRS" threadPolicy="DEFAULT"/>
    <transaction
        transactionManagerLookupClass="org.infinispan.transaction.lookup.GenericTransactionManagerLookup"
        transactionMode="TRANSACTIONAL" lockingMode="PESSIMISTIC"/>
    <loaders passivation="false" shared="false" preload="false">
        <loader class="org.infinispan.loaders.file.FileCacheStore" fetchPersistentState="true"
            purgeOnStartup="false">
            <properties>
                <property name="location" value="\${fcrepo.ispn.CacheDirPath:target/FedoraRepositoryMetaData/storage}"/>
                <property name="fsyncMode" value="perWrite"/>
            </properties>
        </loader>
    </loaders>
</namedCache>
<namedCache name="FedoraRepositoryBinaryData">
    <clustering mode="distribution">
        <sync replTimeout="600000"/>
        <l1 enabled="false" lifespan="0" onRehash="false"/>
        <hash numOwners="\${fcrepo.ispn.numOwners:2}"/>
        <stateTransfer chunkSize="100" fetchInMemoryState="true"/>
    </clustering>
    <locking concurrencyLevel="1000" lockAcquisitionTimeout="150000" useLockStriping="false" />
    <deadlockDetection enabled="true" spinDuration="1000"/>
    <eviction maxEntries="100" strategy="LIRS" threadPolicy="DEFAULT"/>
    <transaction
        transactionManagerLookupClass="org.infinispan.transaction.lookup.GenericTransactionManagerLookup"
        transactionMode="TRANSACTIONAL" lockingMode="PESSIMISTIC"/>
    <loaders passivation="false" shared="false" preload="false">

```

```

<loader class="org.infinispan.loaders.file.FileCacheStore" fetchPersistentState="true"
  purgeOnStartup="false">
  <properties>
    <property name="location" value="${fcrepo.ispn.binary.CacheDirPath:target/FedoraRepositoryBinaryData
/storage}" />
    <property name="fsyncMode" value="perWrite" />
  </properties>
</loader>
</loaders>
</namedCache>
</infinispan>

```

Modeshape configuration

The following configuration has indexing disabled completely in order to increase ingest performance

repository.json

```

{
  "name" : "repo",
  "jndiName" : "",
  "workspaces" : {
    "predefined" : ["default"],
    "default" : "default",
    "allowCreation" : true
  },
  "clustering" : {
    "clusterName" : "modeshape-cluster"
  },
  "query" : {
    "enabled" : "false",
  },
  "storage" : {
    "cacheName" : "FedoraRepository",
    "cacheConfiguration" : "${fcrepo.ispn.configuration:config/infinispan/clustered/infinispan.xml}",
    "binaryStorage" : {
      "type" : "cache",
      "dataCacheName" : "FedoraRepositoryBinaryData",
      "metadataCacheName" : "FedoraRepositoryMetaData"
    }
  },
  "security" : {
    "anonymous" : {
      "roles" : ["readonly", "readwrite", "admin"],
      "useOnFailedLogin" : false
    },
    "providers" : [
      { "classname" : "org.fcrepo.http.commons.session.BypassSecurityServletAuthenticationProvider" }
    ]
  },
  "node-types" : ["fedora-node-types.cnd"]
}

```

Using Tomcat7

1. Build the fcrepo war file or download the prebuilt fcrepo war file
 - a. Build the War file as described on [this page](#)
 - b. Fetch the WAR file from the [download page](#)
2. Get [Tomcat](#)
 - a. Download Tomcat 7 and unpack it (Tomcat 7.0.50 is used in this example)

```
#> wget http://mirror.synyx.de/apache/tomcat/tomcat-7/v7.0.50/bin/apache-tomcat-7.0.50.tar.gz
#> tar -zxvf apache-tomcat-7.0.50.tar.gz
#> mv apache-tomcat-7.0.50 tomcat7
```

3. Put the WAR file into tomcat's webapp directory or create a symbolic link
 - a. Copy the fcrepo-webapp-VERSION.war file

```
#> cp fcrepo-webapp-VERSION.war tomcat7/webapps/fcrepo.war
```

4. Set the send/rcv buffer sizes if necessary
 - a. Use the following commands to set the buffer size. To persist these settings between reboots, also put them in */etc/sysctl.conf*.

```
#> sysctl net.core.rmem_max=26214400
#> sysctl net.core.wmem_max=5242880
```

5. Start instances
 - a. Using a custom configuration by pointing Fedora 4 to custom configuration files:

```
#> CATALINA_OPTS="-Xmx1024m -XX:MaxPermSize=256m -Djava.net.preferIPv4Stack=true -Djgroups.udp.mcast_addr=239.42.42.42 -Dfcrepo.modeshape.configuration=file:///path/to/repository.json -Dfcrepo.ispn.jgroups.configuration=/path/to/jgroups-fcrepo-tcp.xml -Dfcrepo.ispn.configuration=/path/to/infinispan.xml" bin/catalina.sh run
```

Deploy cluster using the UDP Multicast protocol for node discovery and replication

Issues with UDP Multicasting

 Currently there are still issues using UDP Multicasting for replication, while using UDP for node discovery works as intended.

A couple of configuration options have to be set in order to have Fedora 4 work as a cluster on a local machine:

- **Xmx1024m** Set the Java heap to 1GB
- **XX:MaxPermSize=256m** Set the Java PermGen size to 256MB
- **fcrepo.modeshape.configuration=file:///path/to/repository.json** The Modeshape configuration used for clustering
- **java.net.preferIPv4Stack=true** Tell Java to use IPv4 rather than IPv6
- **fcrepo.ispn.jgroups.configuration=/path/to/jgroups-fcrepo-udp.xml** Set the JGroups configuration file holding the UDP Transport definitions
- **jgroups.udp.mcast_addr=239.42.42.42** Set the UDP multicast address for the JGroups cluster
- **fcrepo.ispn.configuration=/path/to/infinispan.xml** Set the Infinispan configuration file holding the Infinispan cluster configuration

Using Tomcat7

1. Build the fcrepo war file or download the prebuilt fcrepo war file
 - a. Build the War file as described on [this page](#)
 - b. Fetch the WAR file from the [download page](#)
2. Get [Tomcat](#)
 - a. Download Tomcat 7 and unpack it (Tomcat 7.0.50 is used in this example)

```
#> wget http://mirror.synyx.de/apache/tomcat/tomcat-7/v7.0.50/bin/apache-tomcat-7.0.50.tar.gz
#> tar -zxvf apache-tomcat-7.0.50.tar.gz
#> mv apache-tomcat-7.0.50 tomcat7
```

3. Put the WAR file into tomcat's webapp directory or create a symbolic link
 - a. Copy the fcrepo-webapp-VERSION.war file

```
#> cp fcrepo-webapp-VERSION.war tomcat7/webapps/fcrepo.war
```

4. Setup the cluster configuration (Optional)
 - a. This [github project](#) contains a sample configuration for a cluster in distributed mode.
 - b. Change the configuration as required. Description is available at the [JGroups](#), [Infinispan](#) and [Modeshape](#) documentations

- c. Make sure to point Fedora 4 to the configuration files by updating the file `$TOMCAT_HOME/bin/setenv.sh` (create if necessary) using the properties `fcrepo.modeshape.configuration`, `fcrepo.ispn.jgroups.configuration` and `fcrepo.ispn.configuration`

5. Set the send/recv buffer sizes if necessary

- a. Use the following commands to set the buffer size

```
#> sysctl net.core.rmem_max=5242880
#> sysctl net.core.wmem_max=5242880
```

6. Start instance

- a. Using the default clustered configuration (Replication mode):

```
#> CATALINA_OPTS="-Xmx1024m -XX:MaxPermSize=256m -Dfcrepo.modeshape.configuration=config/clustered/
repository.json -Djava.net.preferIPv4Stack=true -Djgroups.udp.mcast_addr=239.42.42.42" bin/
catalina.sh run
```

- b. Using a custom configuration by pointing Fedora 4 to custom configuration files:

```
#> CATALINA_OPTS="-Xmx1024m -XX:MaxPermSize=256m -Djava.net.preferIPv4Stack=true -Djgroups.udp.
mcast_addr=239.42.42.42 -Dfcrepo.modeshape.configuration=file:///path/to/repository.json -Dfcrepo.
ispn.jgroups.configuration=/path/to/jgroups-fedora-udp.xml -Dfcrepo.ispn.configuration=/path/to
/infinispan.xml" bin/catalina.sh run
```

Deploy cluster using the UDP Multicast protocol for node discovery and replication on a single machine

Issues with UDP Multicasting



Currently there are still issues using UDP Multicasting for replication, while using UDP for node discovery works as intended.

A couple of configuration options have to be set in order to have Fedora 4 work as a cluster on a local machine:

- **Xmx1024m** Set the Java heap to 1GB
- **XX:MaxPermSize=256m** Set the Java PermGen size to 256MB
- **fcrepo.modeshape.configuration=file:///home/ruckus/dev/tomcat7-8081/repository.json** The Modeshape configuration used for clustering
- **java.net.preferIPv4Stack=true** Tell Java to use IPv4 rather than IPv6
- **fcrepo.ispn.jgroups.configuration=/home/ruckus/dev/tomcat7-8081/jgroups-fcrepo-udp.xml** Set the JGroups configuration file holding the UDP Transport definitions
- **jgroups.udp.mcast_addr=239.42.42.42** Set the UDP multicast address for the JGroups cluster
- **fcrepo.ispn.configuration=/home/ruckus/dev/tomcat7-8081/infinispan.xml** Set the Infinispan configuration file holding the Infinispan cluster configuration
- **fcrepo.jms.port=61617** The port used by ActiveMQ's JMS protocol. This needs to be distinct for every instance of fcrepo4
- **fcrepo.stomp.port=61614** The port used by ActiveMQ Stomp protocol. This needs to be distinct for every instance of fcrepo4

Using Tomcat7

1. Build the fcrepo war file or download the prebuilt fcrepo war file
 - a. Build the War file as described on [this page](#)
 - b. Fetch the WAR file from the [download page](#)
2. Get [Tomcat](#)
 - a. Download Tomcat 7 and unpack it (Tomcat 7.0.50 is used in this example)

```
#> wget http://mirror.synyx.de/apache/tomcat/tomcat-7/v7.0.50/bin/apache-tomcat-7.0.50.tar.gz
#> tar -zxvf apache-tomcat-7.0.50.tar.gz
#> mv apache-tomcat-7.0.50 tomcat7-8080
```

3. Put the WAR file into tomcat's webapp directory or create a symbolic link
 - a. Copy the fcrepo-webapp-VERSION.war file

```
#> cp fcrepo-webapp-VERSION.war tomcat7-8080/webapps/fcrepo.war
```

4. Get the [Infinispan XML configuration file](#)

- a. Download from github and put it into tomcat7-8080

```
#> wget -O infinispan.xml https://gist.github.com/fasseg/8646707/raw
#> mv infinispan.xml tomcat7-8080/
```

5. Get the [Modeshape JSON configuration file](#)

- a. Download from Github and put into tomcat7-8080

```
#> wget -O repository.json https://gist.github.com/fasseg/8646727/raw
#> mv repository.json tomcat7-8080/
```

6. Get the [JGroups UDP Transport configuration file](#)

- a. Download from Github and put into tomcat7-8080

```
#> wget -O jgroups-fedora-udp.xml https://gist.github.com/fasseg/8646743/raw
#> mv jgroups-fedora-udp.xml tomcat7-8080/
```

7. Set the send/rcv buffer sizes if necessary

- a. Use the following commands to set the buffer size

```
#> sysctl net.core.rmem_max=5242880
#> sysctl net.core.wmem_max=5242880
```

8. Copy the whole tomcat folder in order to create a second instance

- a. #> cp -R tomcat7-8080/ tomcat7-8081

9. Change the connector ports of the second Tomcat instance to 8081, 8006 and 8010

- a. #> sed -i 's/8080/8081/g' tomcat7-8081/conf/server.xml
#> sed -i 's/8005/8006/g' tomcat7-8081/conf/server.xml
#> sed -i 's/8009/8010/g' tomcat7-8081/conf/server.xml

10. Start the first instance

- a. #> CATALINA_OPTS="-Xmx1024m -XX:MaxPermSize=256m -Dfcrepo.modeshape.configuration=file:///path/to/repository.json -Djava.net.preferIPv4Stack=true -Dfcrepo.ispn.jgroups.configuration=/path/to/jgroups-fedora-udp.xml -Djgroups.udp.mcast_addr=239.42.42.42 -Dfcrepo.ispn.configuration=/path/to/infinispan.xml" tomcat7-8080/bin/catalina.sh run

11. Start the second instance

- a. #> CATALINA_OPTS="-Xmx1024m -XX:MaxPermSize=256m -Dfcrepo.modeshape.configuration=file:///path/to/repository.json -Djava.net.preferIPv4Stack=true -Dfcrepo.ispn.jgroups.configuration=/path/to/jgroups-fedora-udp.xml -Djgroups.udp.mcast_addr=239.42.42.42 -Dfcrepo.ispn.configuration=/path/to/infinispan.xml -Dfcrepo.jms.port=61617 -Dfcrepo.stomp.port=61614" tomcat7-8081/bin/catalina.sh run

12. Check that the instances are reachable and that the clustersize is '2':

- a. #> wget http://localhost:8080/fcrepo/rest
#> wget http://localhost:8081/fcrepo/rest

- b. Navigate to http://localhost:8080/fcrepo/rest

Using TCP for Discovery and Sync

If you cannot use UDP, which is recommended for larger clusters, then TCP can be used. There are some things to watch out for when configuring TCP.

TCPPING Element

Each host has a different TCPPING configuration. This can be tricky to configure:

- The `initial_hosts` attribute should only include remote hosts for the local node, not itself.
- The `num_initial_members` should match the count of remote hosts, i.e. it does not include the local node either.
- If you are running just one port on each host, then `port_range` will be 0.
- IP resolution is important if you use DNS names. The locally resolved IP of each remote host must match the `TCP@bind_addr` in the remote host config.

TCP Element

If you use a hostname for `bind_addr`, make sure that it resolved to the local, but network-facing IP you want, probably an external one and not the loopback IP. This is easy to miss.

Deploying in AWS

Java options for Tomcat or Jetty

```
JAVA_OPTS="$JAVA_OPTS -Xmx1024m -XX:MaxPermSize=256m -Dfcrepo.modeshape.configuration=file:///config/clustered/
/repository.json"
JAVA_OPTS="$JAVA_OPTS -Dfcrepo.ispn.configuration=config/infinispan/clustered/infinispan.xml"

JAVA_OPTS="$JAVA_OPTS -Dfcrepo.home=/tmp/wherever"

JAVA_OPTS="$JAVA_OPTS -Djgroups.tcp.address=<private-ip-address-of-ec2-instance>"

JAVA_OPTS="$JAVA_OPTS -Dfcrepo.ispn.numOwners=2 -Djava.net.PreferIPv4Stack=true"

# The jgroups-ec2.xml file is included in ispn's jars
JAVA_OPTS="$JAVA_OPTS -Dfcrepo.ispn.jgroups.configuration=jgroups-ec2.xml"

# This property overwrites the S3 bucketname variable in jgroups-ec2.xml
JAVA_OPTS="$JAVA_OPTS -Djgroups.s3.bucket=<some-bucket-that-you-have-already-created>"
```

See this example on [Fedora Cluster Installation in AWS](#)

Load Balancing Fedora 4 using Apache and mod_jk

Load balancing can be achieved by using an [Apache server](#) with [mod_jk](#) in front of the Fedora 4 cluster. Using `mod_jk` one has to create as many workers in the `workers.properties` configuration file as there are Fedora 4 nodes.

See [this example on the RedHat pages](#)

Firewall Notes

If your cluster has a firewall between nodes, you'll need to open the following ports:

- UDP multicast source address and port for JGroups messaging

Example: if your nodes are on the 192.168.47.x network, then this would be your iptables rule:

UDP multicast firewall rule

```
-A INPUT -m pkttype --pkt-type multicast -s 192.168.47.0/24 -j ACCEPT
```

- TCP replication: TCP bind address and port (source)

Example: if your nodes are on the 192.168.47.x network, and the TCP `bind_port` is 7800, then this would be your iptables rule:

TCP replication firewall rule

```
-A INPUT -m state --state NEW -m tcp -p tcp -s 192.168.47.0/24 --dport 7800 -j ACCEPT
```

- UDP replication: UDP bind address and port (source)
Example: if your nodes are on the 192.168.47.x network, and the UDP bind_port is 47788, then this would be your iptables rule:

UDP replication firewall rule

```
-A INPUT -m state --state NEW -m udp -p udp -s 192.168.47.0/24 --dport 47788 -j ACCEPT
```

Simple Shell script to coordinate a cluster

For pushing configurations and wars/jars, start, stop, restart and purge the Ubuntu 12.04 LTS cluster this small script gets used on the FIZ cluster.

- In order to make this work without having to input passwords all the time for the sudo and ssh calls on the cluster nodes, I distributed a public ssh key on the cluster nodes for ssh auth and allowed the fcrepo user to execute sudo calls to rm, cp, service calls without a password.
- The configuration of the FIZ cluster can be accessed here: <https://github.com/fasseg/fiz-fcrepo-cluster-config>. There is also a setenv.sh file in there which we symlinked to \$TOMCAT_HOME/bin/setenv.sh, that sets the environment variables for the repository, jgroups and infinispn configuration.
- So on each node the layout on the file system looks like this:
 - /data/fcrepo (the exploded war file, owned by fcrepo)
 - /home/fcrepo/fiz-cluster-config (the configuration and setenv.sh file, owned by fcrepo)
 - /var/lib/tomcat7/webapps/fedora (owned by root) symlinks to /data/fcrepo
- Using this setup jar updates can be pushed by the shell script to /data/fcrepo/WEB-INF/lib directly.
- Pushing a new WAR file to the nodes requires unpacking the WAR to /data/fcrepo therefore access to /tmp is required.
- The script is setup for six nodes with know IPs. So the node[] array will have to change for different configurations, as should the range defined in the for statements in start_cluster() purge_cluster() and stop_cluster().

cluster

```
#!/bin/bash
nodes[0]=192.168.42.101
nodes[1]=192.168.42.102
nodes[2]=192.168.42.103
nodes[3]=192.168.42.104
nodes[4]=192.168.42.105
nodes[5]=192.168.42.106
start_node() {
    if [[ -z "$1" ]]; then
        echo "No node argument supplied [1-6]"
        exit 1
    fi
    nodeip=${nodes[(( $1 - 1 ) )]}
    echo -n "Starting node $nodeip..."
    ssh -qt fcrepo@$nodeip "sudo service tomcat7 start > /dev/null"
    curl -sf http://$nodeip:8080/fcrepo/rest > /dev/null
    until [ $? -eq 0 ]
    do
        curl -sf http://$nodeip:8080/fcrepo/rest > /dev/null
    done
    echo "done."
}
stop_node() {
    if [[ -z "$1" ]]; then
        echo "No node argument supplied [1-6]"
        exit 1
    fi
}
```

```

        fi
        nodeip=${nodes[(($1 - 1))]}
        echo -n "Stopping node $nodeip..."
        ssh -qt fcrepo@$nodeip "sudo service tomcat7 stop > /dev/null"
        curl -sf http://${nodeip}:8080/fcrepo/rest > /dev/null
        until [ $? -gt 0 ]
        do
            curl -sf http://${nodeip}:8080/fcrepo/rest > /dev/null
        done
        echo "done."
    }
    restart_node() {
        stop_node $1
        start_node $1
    }
    start_cluster() {
        echo "Starting cluster"
        for node in 1 2 3 4 5 6
        do
            start_node $node
        done
    }
    stop_cluster() {
        echo "Stopping cluster"
        for node in 1 2 3 4 5 6
        do
            stop_node $node
        done
    }
    restart_cluster() {
        stop_cluster
        start_cluster
    }
    status() {
        echo "Status of FIZ Fedora 4 cluster"
        for nodeip in "${nodes[@]}"
        do
            curl -sf http://${nodeip}:8080/fcrepo/rest > /dev/null
            if [ $? -gt 0 ];then
                echo "$nodeip is OFFLINE"
            else
                echo "$nodeip is online"
            fi
        done
    }
    purge() {
        echo "purging cluster"
        for nodeip in "${nodes[@]}"
        do
            echo -n "purging ${nodeip}..."
            ssh -qt fcrepo@$nodeip "sudo rm -Rf /var/lib/tomcat7/fcrepo4-data/* /var/lib/tomcat7/work
/Catalina/localhost/*"
            echo "done"
        done
    }
    push_config() {
        for nodeip in "${nodes[@]}"
        do
            echo "pushing config file $2 to $nodeip"
            scp $1 fcrepo@$nodeip:fcrepo-config/
        done
    }
    restart_purge() {
        stop_cluster
        purge
        start_cluster
    }
    push_war() {
        stop_cluster
        purge
        rm -Rf /tmp/fcrepo
    }

```

```

mkdir /tmp/fcrepo
unzip -qq $1 -d /tmp/fcrepo
for nodeip in "${nodes[@]}"
do
    echo -n "pushing WAR file to ${nodeip}..."
    ssh -qt fcrepo@${nodeip} "sudo rm -Rf /tmp/fcrepo"
    scp -qr /tmp/fcrepo fcrepo@${nodeip}:/tmp
    ssh -qt fcrepo@${nodeip} "sudo rm -Rf /opt/fcrepo/*"
    ssh -qt fcrepo@${nodeip} "sudo mv /tmp/fcrepo /opt/"
    echo "done.";
done
}
push_jar() {
    stop_cluster
    purge
    for nodeip in "${nodes[@]}"
    do
        echo -n "pushing JAR to ${nodeip}..."
        scp -q $1 fcrepo@${nodeip}:/opt/fcrepo/WEB-INF/lib
        echo "done."
    done
}
case "$1" in
    start)
        start_cluster
        ;;
    stop)
        stop_cluster
        ;;
    restart)
        restart_cluster
        ;;
    stop-node)
        stop_node $2
        ;;
    start-node)
        start_node $2
        ;;
    restart-node)
        restart_node $2
        ;;
    status)
        status
        ;;
    purge)
        purge
        ;;
    push-config)
        push_config $2
        ;;
    restart-purge)
        restart_purge
        ;;
    push-war)
        push_war $2
        ;;
    push-jar)
        push_jar $2
        ;;
    *)
        echo $"Usage: $0 {start|stop|restart|restart-purge|start-node|stop-node|restart-node|status|purge|push-
config|push-war|push-jar}"
        exit 1
esac

```