

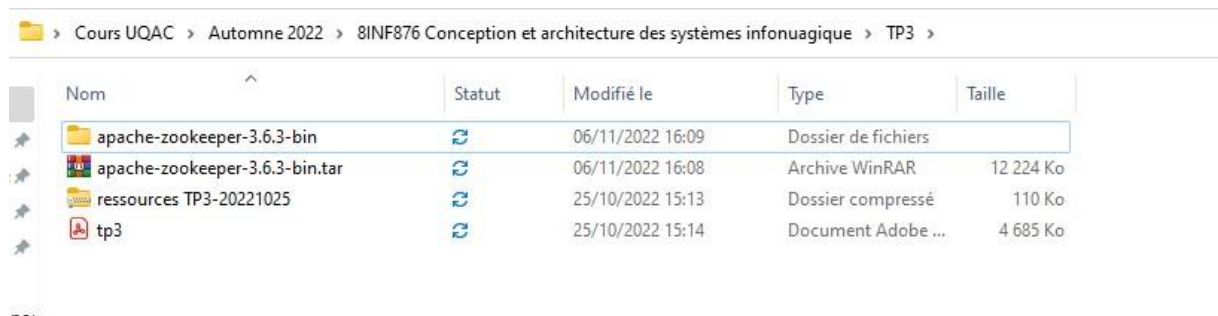
Zookeeper, distributed systems & cloud

I) Introduction

ZooKeeper is a centralized service for maintaining configuration information, naming, providing distributed synchronization, and providing group services. All these kinds of services are used in some form or another by distributed applications. Each time they are implemented there is a lot of work that goes into fixing the bugs and race conditions that are inevitable. Because of the difficulty of implementing these kinds of services, applications initially usually skimp on them, which make them brittle in the presence of change and difficult to manage.

ZooKeeper architecture supports high availability through redundant services. The clients can thus ask another ZooKeeper leader if the first fails to answer. ZooKeeper nodes store their data in a hierarchical name space, much like a file system or a tree data structure. Clients can read from and write to the nodes and in this way have a shared configuration service. ZooKeeper can be viewed as an atomic broadcast system, through which updates are totally ordered. The **ZooKeeper Atomic Broadcast**¹(ZAB) protocol is the core of the system.

Zookeeper installation and configuration



Cours UQAC > Automne 2022 > 8INF876 Conception et architecture des systèmes infonuagique > TP3					
	Nom	Statut	Modifié le	Type	Taille
	apache-zookeeper-3.6.3-bin		06/11/2022 16:09	Dossier de fichiers	
	apache-zookeeper-3.6.3-bin.tar		06/11/2022 16:08	Archive WinRAR	12 224 Ko
	ressources TP3-20221025		25/10/2022 15:13	Dossier compressé	110 Ko
	tp3		25/10/2022 15:14	Document Adobe ...	4 685 Ko

We first installed **Apache Zookeeper** bin.

¹ **ZooKeeper Atomic Broadcast** : messaging system that keeps all the servers in sync

```
C:\Users\moadb>Javac -version
javac 17.0.1
```

```
C:\Users\moadb>echo %JAVA_HOME%.
C:\Program Files\Java\jdk-17.0.1.
```

There are **Java Development Kit**² and **Java Home**³.

« Automne 2022 » 8INF876 Conception et architecture des systèmes infonuagique » TP3 » apache-zookeeper-3.6.3-bin »

Nom	Statut	Modifié le	Type	Taille
bin	🔗	06/11/2022 16:09	Dossier de fichiers	
conf	🔗	06/11/2022 16:09	Dossier de fichiers	
docs	🔗	06/11/2022 16:09	Dossier de fichiers	
lib	🔗	06/11/2022 16:09	Dossier de fichiers	
logs	🔗	06/11/2022 16:09	Dossier de fichiers	
LICENSE	🔗	08/04/2021 12:34	Document texte	12 Ko
NOTICE	🔗	08/04/2021 12:34	Document texte	1 Ko
README	🔗	08/04/2021 12:34	Fichier source Mar...	2 Ko
README_packaging	🔗	08/04/2021 12:34	Fichier source Mar...	4 Ko

Then, we create **logs** folder.

« Automne 2022 » 8INF876 Conception et architecture des systèmes infonuagique » TP3 » apache-zookeeper-3.6.3-bin » conf »

Nom	Statut	Modifié le	Type	Taille
configuration.xml	🔗	08/04/2021 12:34	xsifile	1 Ko
log4j	🔗	08/04/2021 12:34	Fichier source Pro...	4 Ko
zoo	🔗	08/04/2021 12:34	Fichier source Co...	2 Ko

We rename the file **zoo_sample.cfg** by **zoo.cfg**.

²**Java Development Kit** : is a distribution of *Java* Technology by Oracle Corporation. It implements the *Java* Language Specification

³**Java Home** : is an operating system (OS) environment variable which can optionally be set after either the Java Development Kit (JDK)

```
zoo.cfg
C:\Users\moadb> OneDrive > Bureau > Cours UQAC > Automne 2022 > 8INF876 Conception et architecture des systèmes infonuagique > TP3 > apache-zookeeper-3.6.3-bin > conf > zoo.cfg
1 # The number of milliseconds of each tick
2 tickTime=2000
3 # The number of ticks that the initial
4 # synchronization phase can take
5 initLimit=10
6 # The number of ticks that can pass between
7 # sending a request and getting an acknowledgement
8 syncLimit=5
9 # the directory where the snapshot is stored.
10 # do not use /tmp for storage, /tmp here is just
11 # example sake.
12 dataDir=/Users/moadb/OneDrive/Bureau/Cours UQAC/Automne 2022/8INF876 Conception et architecture des systèmes infonuagique/TP3/apache-zookeeper-3.6.3-bin/logs
13 # the port at which the clients will connect
14 clientPort=2181
15 # the maximum number of client connections.
16 # increase this if you need to handle more clients
17 #maxClientCnxns=60
```

We modify of the **zoo.cfg** file : (modification of the logs directory).

```
CA\Windows\System32\cmd.exe - zkServer.cmd
C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin>zkServer.cmd

C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin>call "C:\Program
Files\Java\jdk-17.0.1\bin\java "-Dzookeeper.log.dir=C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique
\TP3\apache-zookeeper-3.6.3-bin\bin\..logs" "-Dzookeeper.root.logger=INFO,CONSOLE" "-Dzookeeper.log.file=zookeeper-moadb-server-LAPTOP-KCMLGLMO.log" "-XX:+HeapDumpOnOu
tOfMemoryError" "-XX:OnOutOfMemoryError=cmd /c taskkill /pid %pp /t /f" -cp "C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture d
es systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..build\classes;C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture d
es systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..build\lib\*;C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des
systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..*;C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes in
fonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..lib\*;C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagiq
ue\TP3\apache-zookeeper-3.6.3-bin\bin\..conf" org.apache.zookeeper.server.quorum.QuorumPeerMain "C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
tion et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..conf\zoo.cfg"
2022-11-06 16:11:29,639 [myid:] - INFO [main:QuorumPeerConfig@174] - Reading configuration from: C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
tion et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..conf\zoo.cfg
2022-11-06 16:11:29,661 [myid:] - WARN [main:VerifyingFileFactory@65] - \Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des sys
tèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\logs is relative. Prepend .\ to indicate that you're sure!
2022-11-06 16:11:29,682 [myid:] - INFO [main:QuorumPeerConfig@460] - clientPortAddress is 0.0.0.0:2181
2022-11-06 16:11:29,688 [myid:] - INFO [main:QuorumPeerConfig@464] - secureClientPort is not set
2022-11-06 16:11:29,690 [myid:] - INFO [main:QuorumPeerConfig@480] - observerMasterPort is not set
2022-11-06 16:11:29,692 [myid:] - INFO [main:QuorumPeerConfig@497] - metricsProvider.className is org.apache.zookeeper.metrics.impl.DefaultMetricsProvider
2022-11-06 16:11:29,697 [myid:] - INFO [main:DatadirCleanupManager@78] - autopurge.snapRetainCount set to 3
2022-11-06 16:11:29,698 [myid:] - INFO [main:DatadirCleanupManager@79] - autopurge.purgeInterval set to 0
2022-11-06 16:11:29,700 [myid:] - INFO [main:DatadirCleanupManager@181] - Purge task is not scheduled.
2022-11-06 16:11:29,702 [myid:] - WARN [main:QuorumPeerMain@138] - Either no config or no quorum defined in config, running in standalone mode
2022-11-06 16:11:29,715 [myid:] - INFO [main:ManagedUtil@44] - Log4j 1.2 jmx support found and enabled.
2022-11-06 16:11:29,940 [myid:] - INFO [main:QuorumPeerConfig@174] - Reading configuration from: C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
tion et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..conf\zoo.cfg
2022-11-06 16:11:29,943 [myid:] - WARN [main:VerifyingFileFactory@65] - \Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des sys
tèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\logs is relative. Prepend .\ to indicate that you're sure!
2022-11-06 16:11:29,944 [myid:] - INFO [main:QuorumPeerConfig@460] - clientPortAddress is 0.0.0.0:2181
2022-11-06 16:11:29,945 [myid:] - INFO [main:QuorumPeerConfig@464] - secureClientPort is not set
2022-11-06 16:11:29,946 [myid:] - INFO [main:QuorumPeerConfig@480] - observerMasterPort is not set
2022-11-06 16:11:29,949 [myid:] - INFO [main:QuorumPeerConfig@497] - metricsProvider.className is org.apache.zookeeper.metrics.impl.DefaultMetricsProvider
2022-11-06 16:11:29,951 [myid:] - INFO [main:ZooKeeperServerMain@122] - Starting server
2022-11-06 16:11:29,979 [myid:] - INFO [main:ServerMetrics@62] - ServerMetrics initialized with provider org.apache.zookeeper.metrics.impl.DefaultMetricsProvider@5fdb
6f9
2022-11-06 16:11:29,984 [myid:] - INFO [main:FileTxnSnapLog@124] - zookeeper.snapshot.trust.empty : false
2022-11-06 16:11:30,006 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,006 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,007 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,008 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,008 [myid:] - INFO [main:ZooKeeperBanner@42] -
```

```
CA\Windows\System32\cmd.exe - zkServer.cmd
2022-11-06 16:11:29,702 [myid:] - WARN [main:QuorumPeerMain@138] - Either no config or no quorum defined in config, running in standalone mode
2022-11-06 16:11:29,715 [myid:] - INFO [main:ManagedUtil@44] - Log4j 1.2 jmx support found and enabled.
2022-11-06 16:11:29,940 [myid:] - INFO [main:QuorumPeerConfig@174] - Reading configuration from: C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
tion et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..conf\zoo.cfg
2022-11-06 16:11:29,943 [myid:] - WARN [main:VerifyingFileFactory@65] - \Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des sys
tèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\logs is relative. Prepend .\ to indicate that you're sure!
2022-11-06 16:11:29,944 [myid:] - INFO [main:QuorumPeerConfig@460] - clientPortAddress is 0.0.0.0:2181
2022-11-06 16:11:29,945 [myid:] - INFO [main:QuorumPeerConfig@464] - secureClientPort is not set
2022-11-06 16:11:29,946 [myid:] - INFO [main:QuorumPeerConfig@480] - observerMasterPort is not set
2022-11-06 16:11:29,949 [myid:] - INFO [main:QuorumPeerConfig@497] - metricsProvider.className is org.apache.zookeeper.metrics.impl.DefaultMetricsProvider
2022-11-06 16:11:29,951 [myid:] - INFO [main:ZooKeeperServerMain@122] - Starting server
2022-11-06 16:11:29,979 [myid:] - INFO [main:ServerMetrics@62] - ServerMetrics initialized with provider org.apache.zookeeper.metrics.impl.DefaultMetricsProvider@5fdb
6f9
2022-11-06 16:11:29,984 [myid:] - INFO [main:FileTxnSnapLog@124] - zookeeper.snapshot.trust.empty : false
2022-11-06 16:11:30,006 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,006 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,007 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,008 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,009 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,010 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,012 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,014 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,014 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,015 [myid:] - INFO [main:ZooKeeperBanner@42] -
2022-11-06 16:11:30,039 [myid:] - INFO [main:Environment@98] - Server environment:zookeeper.version=3.6.3--6401e4ad2087061cb6b9f80dec2d69f2e3c8660a, built on 04/08/202
1 16:35 GMT
2022-11-06 16:11:30,040 [myid:] - INFO [main:Environment@98] - Server environment:host.name=LAPTOP-KCMLGLMO
2022-11-06 16:11:30,041 [myid:] - INFO [main:Environment@98] - Server environment:java.version=17.0.1
2022-11-06 16:11:30,043 [myid:] - INFO [main:Environment@98] - Server environment:java.vendor=Oracle Corporation
2022-11-06 16:11:30,046 [myid:] - INFO [main:Environment@98] - Server environment:java.home=C:\Program Files\Java\jdk-17.0.1
2022-11-06 16:11:30,046 [myid:] - INFO [main:Environment@98] - Server environment:java.class.path=C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
tion et architecture des systèmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin\..build\classes;C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Concep
```

We launch **zkServer.cmd**.

```
C:\Windows\System32\cmd.exe - zkCli.cmd
2022-11-06 16:14:19,007 [myid:] - INFO [main:Environment@98] - Client environment:user.dir=C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systPmes infonuagique\TP3\apache-zookeeper-3.6.3-bin\bin
2022-11-06 16:14:19,008 [myid:] - INFO [main:Environment@98] - Client environment:os.memory.free=88MB
2022-11-06 16:14:19,010 [myid:] - INFO [main:Environment@98] - Client environment:os.memory.max=1516MB
2022-11-06 16:14:19,011 [myid:] - INFO [main:Environment@98] - Client environment:os.memory.total=96MB
2022-11-06 16:14:19,018 [myid:] - INFO [main:ZooKeeper@1006] - Initiating client connection, connectString=localhost:2181 sessionTimeout=30000 watcher=org.apache.zookeeper.ZooKeeperMain$MyWatcher@1efbd816
2022-11-06 16:14:19,026 [myid:] - INFO [main:X509Util@77] - Setting -D jdk.tls.rejectClientInitiatedRenegotiation=true to disable client-initiated TLS renegotiation
2022-11-06 16:14:19,199 [myid:] - INFO [main:ClientCnxnSocket@239] - jute.maxbuffer value is 1048575 Bytes
2022-11-06 16:14:19,211 [myid:] - INFO [main:ClientCnxn@1736] - zookeeper.request.timeout value is 0. feature enabled=false
Welcome to ZooKeeper!
2022-11-06 16:14:19,230 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThread@1181] - Opening socket connection to server localhost/[0:0:0:0:0:0:1]:2181.
2022-11-06 16:14:19,231 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThread@1183] - SASL config status: Will not attempt to authenticate using SASL (unknown error)
2022-11-06 16:14:19,242 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThread@1013] - Socket connection established, initiating session, client: [/0:0:0:0:0:0:1]:55013, server: localhost/[0:0:0:0:0:0:1]:2181
JLine support is enabled
2022-11-06 16:14:19,279 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThread@1448] - Session establishment complete on server localhost/[0:0:0:0:0:0:1]:2181, session id = 0x1000a63890e0000, negotiated timeout = 30000

WATCHER::
WatchedEvent state:SyncConnected type:None path:null
[zookeeper: localhost:2181(CONNECTED) 0]
```

Then, we **launchzkCli.cmd** in another terminal.

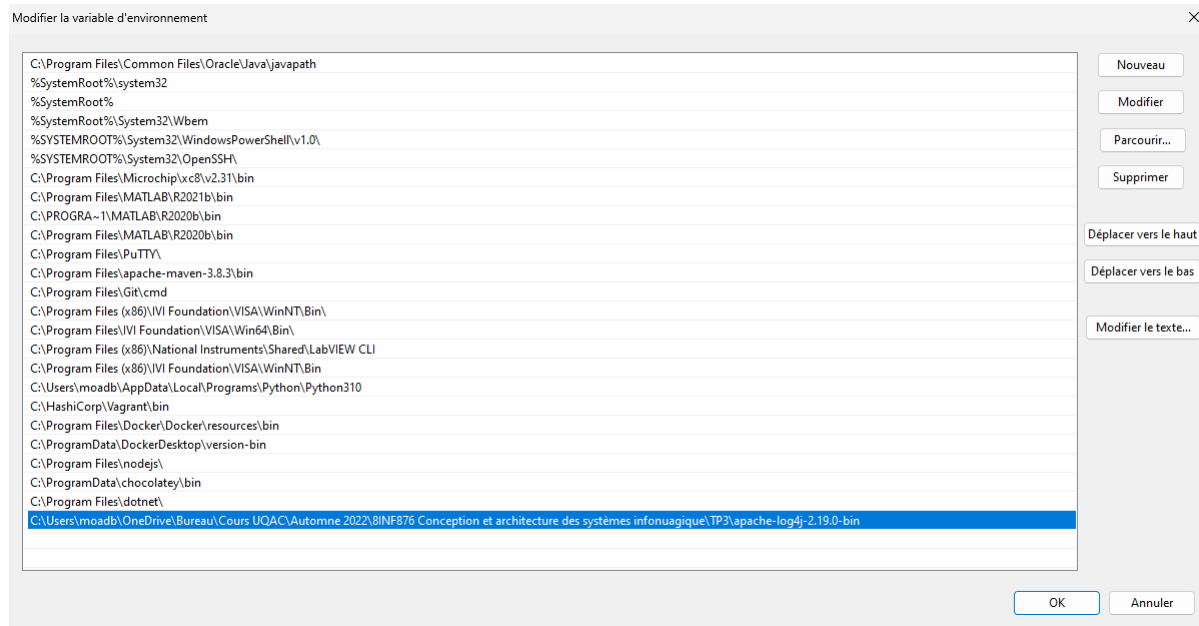
II) Part 1

Section : Zookeeper Client Threading Model

Step 1 : Installation log4j

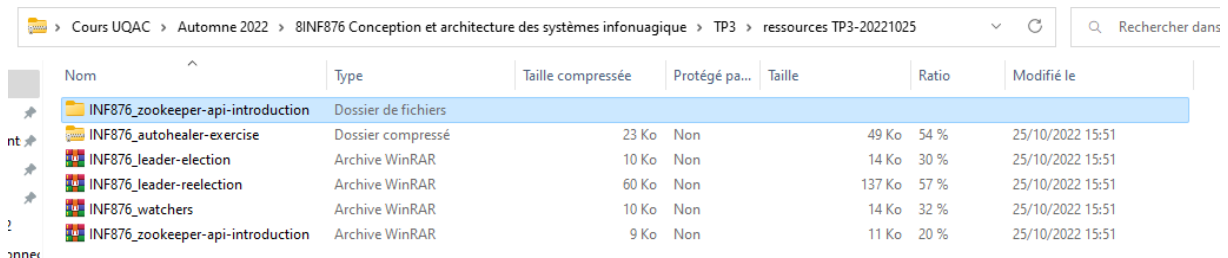
Cours UQAC > Automne 2022 > 8INF876 Conception et architecture des systèmes infonuagique > TP3					
	Nom	Statut	Modifié le	Type	Taille
	apache-log4j-2.19.0-bin	🔓	06/11/2022 16:18	Dossier de fichiers	
	apache-zookeeper-3.6.3-bin	🔓	06/11/2022 16:09	Dossier de fichiers	
	ressources TP3-20221025	🔓	25/10/2022 15:13	Dossier compressé	110 Ko
	tp3	🔓	25/10/2022 15:14	Document Adobe ...	4 685 Ko

We downloaded **Apache-log4j-2.19.0**.

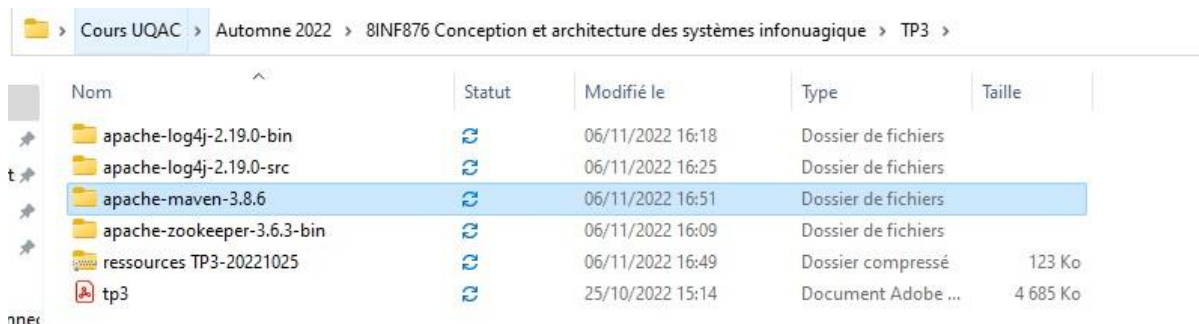


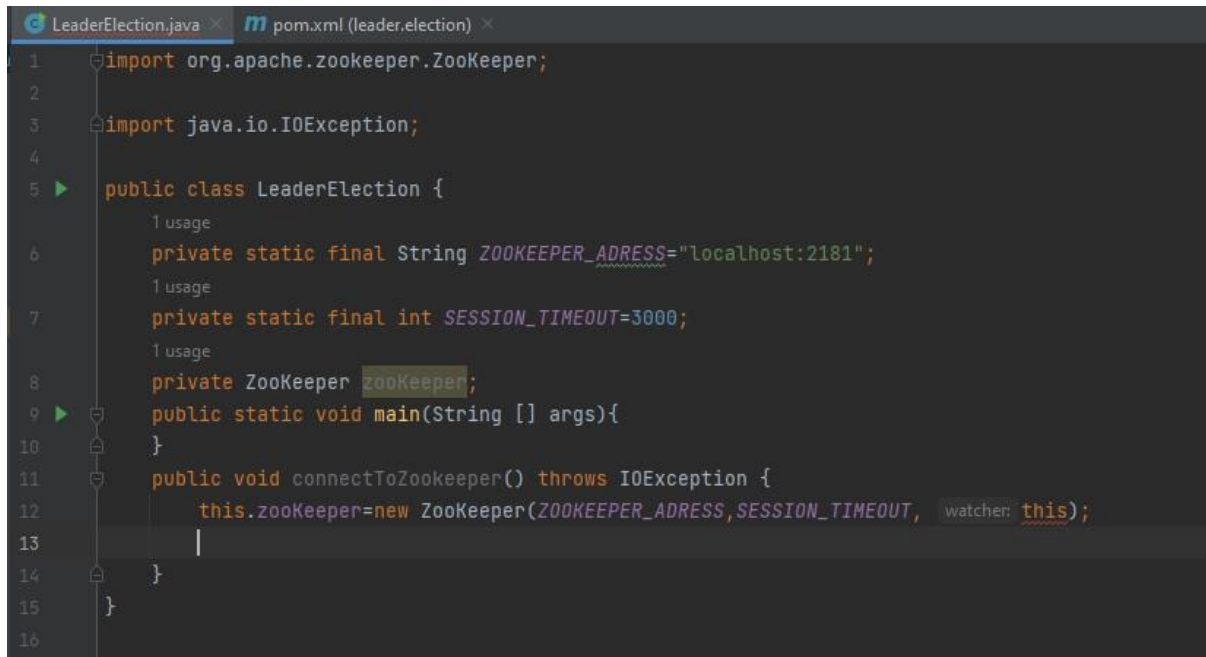
There is the **environment variable**.

Step 2 : Installation Zookeeper API and Unzip



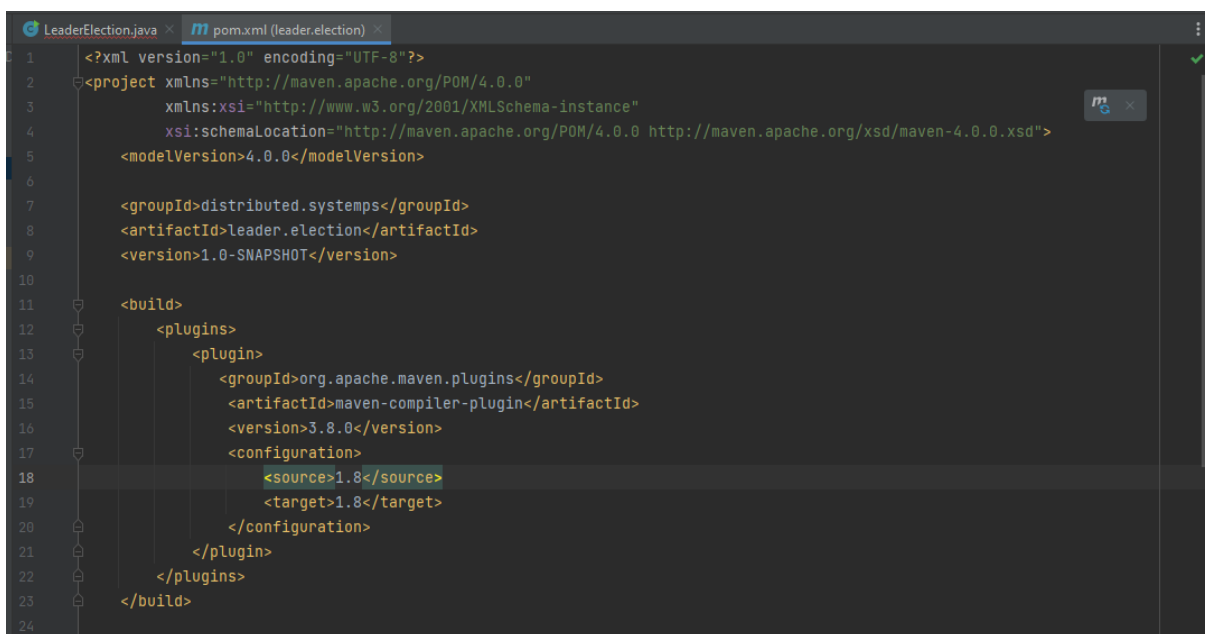
Step 3 : Installation Maven





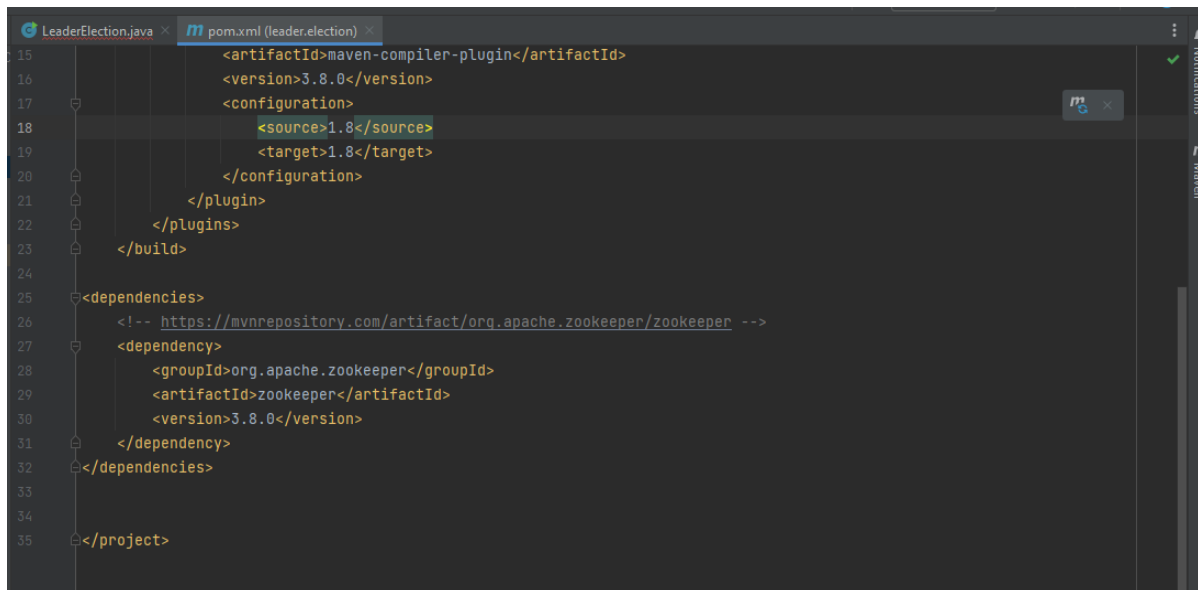
```
1 import org.apache.zookeeper.ZooKeeper;
2
3 import java.io.IOException;
4
5 public class LeaderElection {
6     private static final String ZOOKEEPER_ADRESS="localhost:2181";
7     private static final int SESSION_TIMEOUT=3000;
8     private ZooKeeper zooKeeper;
9     public static void main(String [] args){
10    }
11     public void connectToZooKeeper() throws IOException {
12         this.zooKeeper=new ZooKeeper(ZOOKEEPER_ADRESS,SESSION_TIMEOUT, watcher: this);
13     }
14 }
15
16 }
```

There is the project on IntelliJ ⁴: **ZooKeeper Java API**



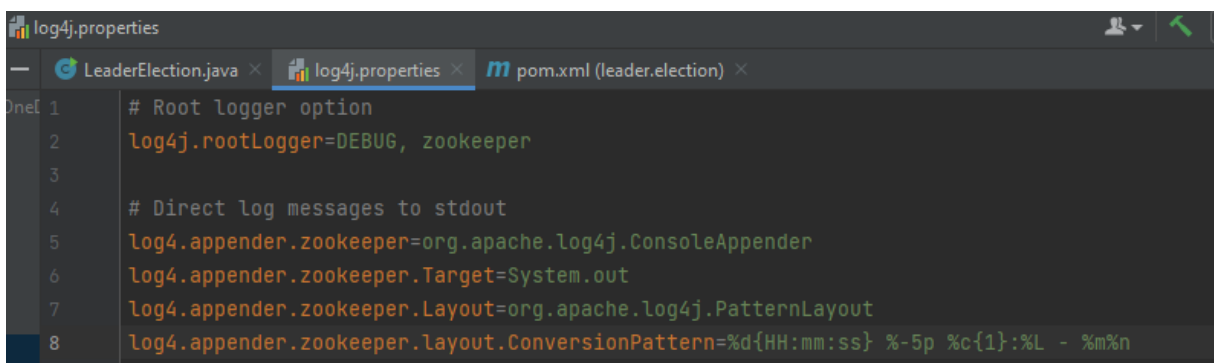
```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <project xmlns="http://maven.apache.org/POM/4.0.0"
3     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
4     xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
5     <modelVersion>4.0.0</modelVersion>
6
7     <groupId>distributed.systems</groupId>
8     <artifactId>leader.election</artifactId>
9     <version>1.0-SNAPSHOT</version>
10
11     <build>
12         <plugins>
13             <plugin>
14                 <groupId>org.apache.maven.plugins</groupId>
15                 <artifactId>maven-compiler-plugin</artifactId>
16                 <version>3.8.0</version>
17                 <configuration>
18                     <source>1.8</source>
19                     <target>1.8</target>
20                 </configuration>
21             </plugin>
22         </plugins>
23     </build>
24 }
```

⁴IntelliJ : IDE for Java



```
15 <artifactId>maven-compiler-plugin</artifactId>
16 <version>3.8.0</version>
17 <configuration>
18   <source>1.8</source>
19   <target>1.8</target>
20 </configuration>
21 </plugin>
22 </plugins>
23 </build>
24
25 <dependencies>
26   <!-- https://mvnrepository.com/artifact/org.apache.zookeeper/zookeeper -->
27   <dependency>
28     <groupId>org.apache.zookeeper</groupId>
29     <artifactId>zookeeper</artifactId>
30     <version>3.8.0</version>
31   </dependency>
32 </dependencies>
33
34
35 </project>
```

There is the **pom.xml**.



```
log4j.properties
# Root logger option
log4j.rootLogger=DEBUG, zookeeper

# Direct log messages to stdout
log4j.appender.zookeeper=org.apache.log4j.ConsoleAppender
log4j.appender.zookeeper.Target=System.out
log4j.appender.zookeeper.Layout=org.apache.log4j.PatternLayout
log4j.appender.zookeeper.layout.ConversionPattern=%d{HH:mm:ss} %-5p %c{1}:%L - %m%n
```

There are the **log4j.properties** folder : PAGE 17

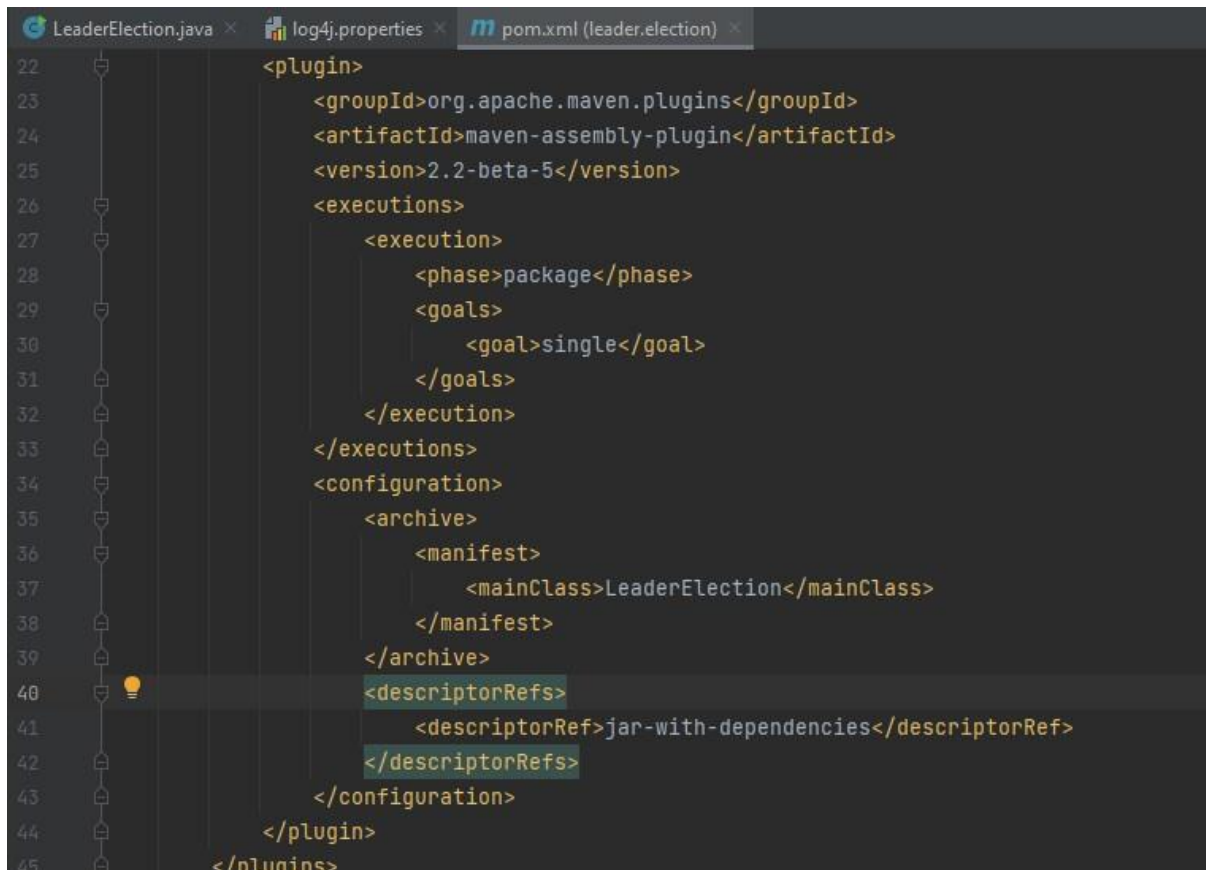
III) PART 2

Section : Leader election implementation

Package and test our first distributed application : page 26

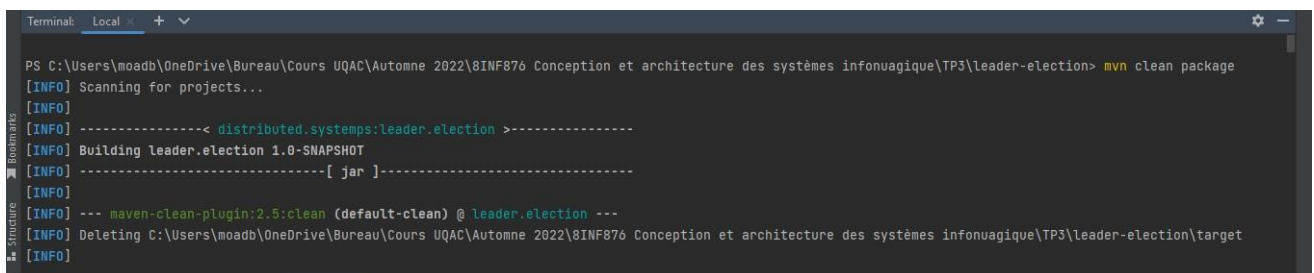
1.1. Add the volunteer for leadership method inside that method, and define the **znode**⁵ prefix which is going to be the election namespace /c underscore C stands for candidate

⁵ **Znode** : Every node in a *ZooKeeper* tree is referred to as a *znode*. It maintains a stat structure that includes version numbers for data changes, acl changes



```
22 |
23 |     <plugin>
24 |         <groupId>org.apache.maven.plugins</groupId>
25 |         <artifactId>maven-assembly-plugin</artifactId>
26 |         <version>2.2-beta-5</version>
27 |         <executions>
28 |             <execution>
29 |                 <phase>package</phase>
30 |                 <goals>
31 |                     <goal>single</goal>
32 |                 </goals>
33 |             </execution>
34 |         </executions>
35 |         <configuration>
36 |             <archive>
37 |                 <manifest>
38 |                     <mainClass>LeaderElection</mainClass>
39 |                 </manifest>
40 |             <descriptorRefs>
41 |                 <descriptorRef>jar-with-dependencies</descriptorRef>
42 |             </descriptorRefs>
43 |         </configuration>
44 |     </plugin>
45 | </plugins>
```

1.2. We call Zookeeper create method which takes znode prefix then the data we want to put inside the znode which is an empty byte array in this case

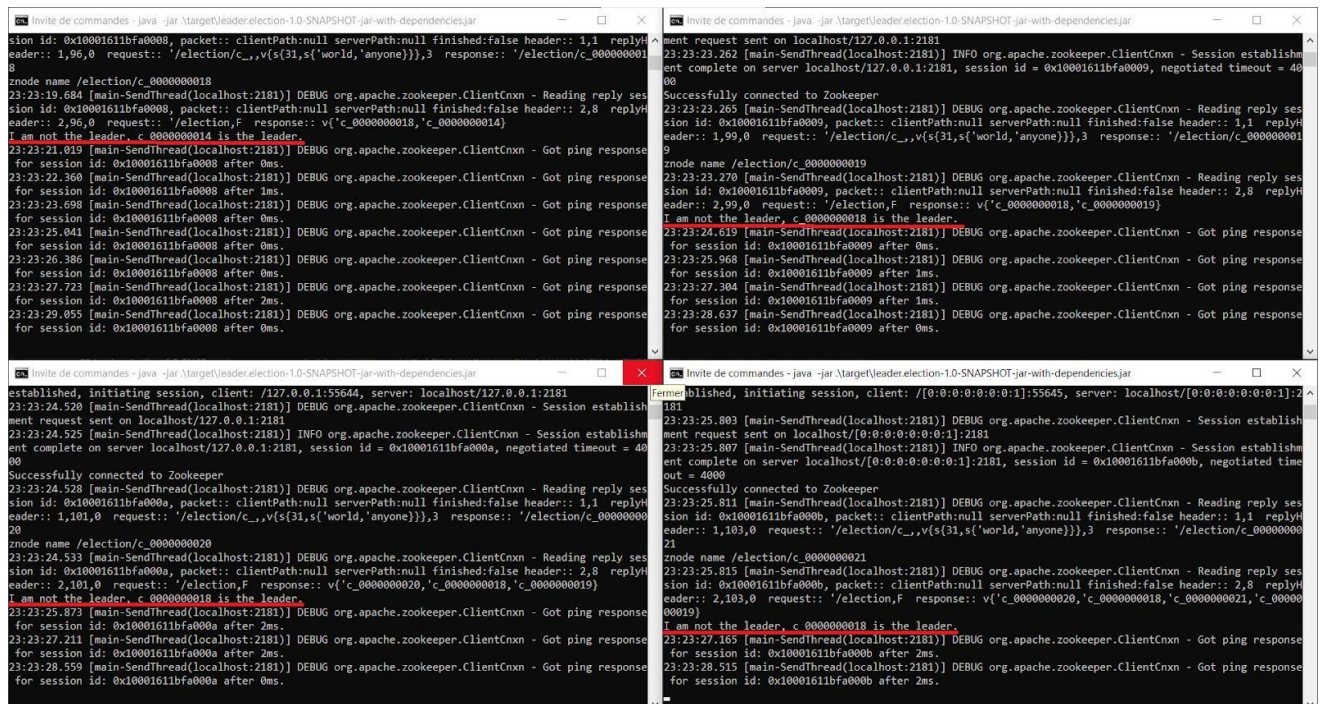


```
Terminal: Local x + v
PS C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique\TP3\leader-election> mvn clean package
[INFO] Scanning for projects...
[INFO] -----< distributed.systems:leader.election >-----
[INFO] Building leader.election 1.0-SNAPSHOT
[INFO] -----[ jar ]-----
[INFO] --- maven-clean-plugin:2.5:clean (default-clean) @ leader.election ---
[INFO] Deleting C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique\TP3\leader-election\target
[INFO]
```



```
Terminal: Local x + v
[INFO] META-INF/ already added, skipping
[INFO] org/ already added, skipping
[INFO] org/apache/ already added, skipping
[INFO] META-INF/maven/ already added, skipping
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 12.070 s
[INFO] Finished at: 2022-11-12T17:34:57-05:00
[INFO] -----
PS C:\Users\moadb\OneDrive\Bureau\Cours UQAC\Automne 2022\8INF876 Conception et architecture des systèmes infonuagique\TP3\leader-election>
```


1.3. Next parameter is the access control list



```
Invite de commandes - java -jar \target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
sion id: 0x1000161bfa0008, packet:: clientPath:null serverPath:null finished:false header:: 1,1 replyH
eader:: 1,96,0 request:: '/election/c_0000000018',3 response:: '/election/c_0000000018'
znode name /election/c_0000000018
23:23:19.684 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa0008, packet:: clientPath:null serverPath:null finished:false header:: 2,8 replyH
eader:: 2,96,0 request:: '/election,F response:: v{'c_0000000018','c_0000000014'}
I am not the leader, c_0000000014 is the leader.
23:23:21.019 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 0ms.
23:23:22.360 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 1ms.
23:23:23.698 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 0ms.
23:23:25.041 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 0ms.
23:23:26.386 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 0ms.
23:23:27.723 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 2ms.
23:23:29.055 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0008 after 0ms.

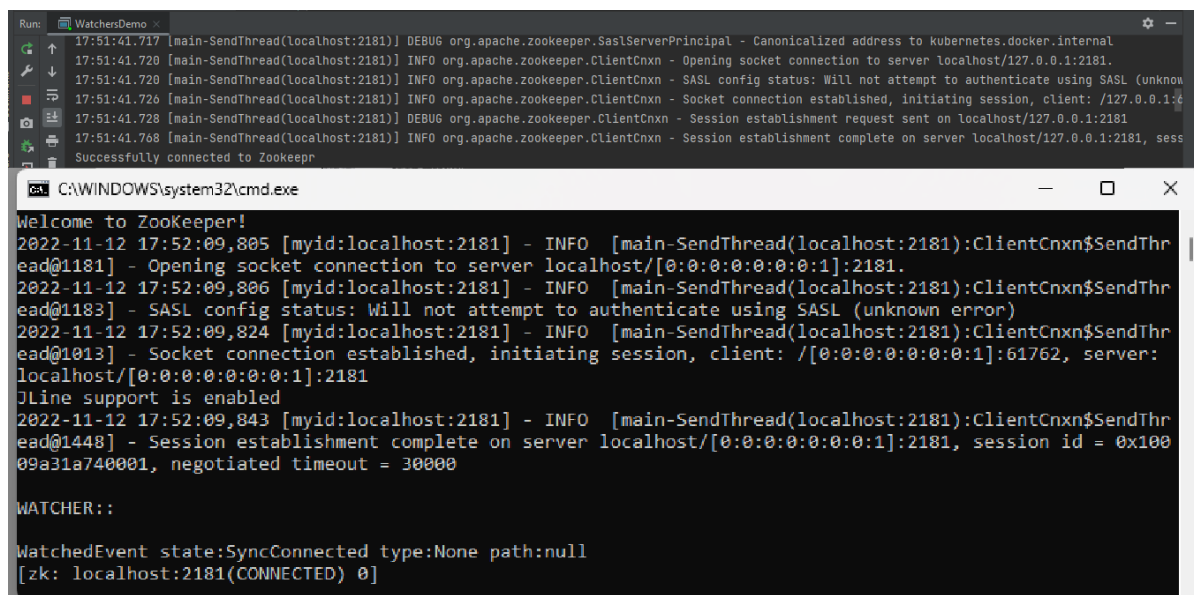
Invite de commandes - java -jar \target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
ment request sent on localhost/127.0.0.1:2181
23:23:23.262 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Session establish
ment complete on server localhost/127.0.0.1:2181, session id = 0x1000161bfa0009, negotiated timeout = 40
00
Successfully connected to Zookeeper
23:23:23.270 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa0009, packet:: clientPath:null serverPath:null finished:false header:: 1,1 replyH
eader:: 1,99,0 request:: '/election/c_0000000018',3 response:: '/election/c_0000000018'
znode name /election/c_0000000018
23:23:23.265 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa0009, packet:: clientPath:null serverPath:null finished:false header:: 2,8 replyH
eader:: 2,99,0 request:: '/election,F response:: v{'c_0000000018','c_0000000019'}
I am not the leader, c_0000000018 is the leader.
23:23:24.619 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0009 after 0ms.
23:23:25.968 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0009 after 1ms.
23:23:27.304 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0009 after 1ms.
23:23:28.637 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa0009 after 0ms.

Invite de commandes - java -jar \target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
established, initiating session, client: /127.0.0.1:55644, server: localhost/127.0.0.1:2181
23:23:24.520 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Session establish
ment request sent on localhost/127.0.0.1:2181
23:23:24.525 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Session establish
ment complete on server localhost/127.0.0.1:2181, session id = 0x1000161bfa000a, negotiated timeout = 40
00
Successfully connected to Zookeeper
23:23:24.528 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa000a, packet:: clientPath:null serverPath:null finished:false header:: 1,1 replyH
eader:: 1,101,0 request:: '/election/c_0000000018',3 response:: '/election/c_0000000018'
znode name /election/c_0000000018
23:23:24.533 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa000a, packet:: clientPath:null serverPath:null finished:false header:: 2,8 replyH
eader:: 2,101,0 request:: '/election,F response:: v{'c_0000000018','c_0000000019'}
I am not the leader, c_0000000018 is the leader.
23:23:25.873 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa000a after 2ms.
23:23:27.211 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa000a after 2ms.
23:23:28.559 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa000a after 0ms.

Invite de commandes - java -jar \target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
established, initiating session, client: /[0:0:0:0:0:0:1]:55645, server: localhost/[0:0:0:0:0:0:1]:2
181
23:23:25.803 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Session establish
ment request sent on localhost/[0:0:0:0:0:0:1]:2181
23:23:25.807 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Session establish
ment complete on server localhost/[0:0:0:0:0:0:1]:2181, session id = 0x1000161bfa000b, negotiated time
out = 4000
Successfully connected to Zookeeper
23:23:25.811 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa000b, packet:: clientPath:null serverPath:null finished:false header:: 1,1 replyH
eader:: 1,103,0 request:: '/election/c_0000000018',3 response:: '/election/c_0000000018'
znode name /election/c_0000000018
23:23:25.815 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa000b, packet:: clientPath:null serverPath:null finished:false header:: 2,8 replyH
eader:: 2,103,0 request:: '/election,F response:: v{'c_0000000018','c_0000000021','c_00000
00019'}
I am not the leader, c_0000000018 is the leader.
23:23:27.165 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa000b after 2ms.
23:23:28.515 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa000b after 2ms.
```

IV) PART 3

Section : Watchers, triggers, and introduction to failure detection



```
Run: WatchersDemo
17:51:41.717 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.SaslServerPrincipal - Canonicalized address to kubernetes.docker.internal
17:51:41.720 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Opening socket connection to server localhost/127.0.0.1:2181.
17:51:41.720 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - SASL config status: Will not attempt to authenticate using SASL (unknown
17:51:41.726 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Socket connection established, initiating session, client: /127.0.0.1:2181
17:51:41.728 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Session establishment request sent on localhost/127.0.0.1:2181
17:51:41.768 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Session establishment complete on server localhost/127.0.0.1:2181, sess
Successfully connected to Zookeeper

C:\WINDOWS\system32\cmd.exe
Welcome to ZooKeeper!
2022-11-12 17:52:09,805 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
ead@1181] - Opening socket connection to server localhost/[0:0:0:0:0:0:1]:2181.
2022-11-12 17:52:09,806 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
ead@1183] - SASL config status: Will not attempt to authenticate using SASL (unknown error)
2022-11-12 17:52:09,824 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
ead@1013] - Socket connection established, initiating session, client: /127.0.0.1:2181
2022-11-12 17:52:09,843 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
ead@1448] - Session establishment complete on server localhost/[0:0:0:0:0:0:1]:2181, session id = 0x100
09a31a740001, negotiated timeout = 30000

WATCHER::

WatchedEvent state:SyncConnected type:None path:null
[zk: localhost:2181(CONNECTED) 0]
```

We can see our application successfully connected to Zookeeper, and we have nothing yet since we haven't created the target znode.

```
C:\WINDOWS\system32\cmd.exe
head@1183] - SASL config status: Will not attempt to authenticate using SASL (unknown error)
2022-11-12 17:52:09,824 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
head@1013] - Socket connection established, initiating session, client: /:[0:0:0:0:0:0:1]:61762, server:
localhost/[0:0:0:0:0:0:1]:2181
JLine support is enabled
2022-11-12 17:52:09,843 [myid:localhost:2181] - INFO [main-SendThread(localhost:2181):ClientCnxn$SendThr
head@1448] - Session establishment complete on server localhost/[0:0:0:0:0:0:1]:2181, session id = 0x100
09a31a740001, negotiated timeout = 30000

WATCHER::

WatchedEvent state:SyncConnected type:None path:null
[zk: localhost:2181(CONNECTED) 0] ls /
[election, workers_service_registry, zookeeper]
[zk: localhost:2181(CONNECTED) 1] create /target_znode "some test data"
Created /target_znode
[zk: localhost:2181(CONNECTED) 2] _
```

Create a target znode with "some test data" in it.

```
[zk: localhost:2181(CONNECTED) 2] create /target_znode "some data test"
Created /target_znode
[zk: localhost:2181(CONNECTED) 3] set /target_znode "some new data"
cZxid = 0x6e
ctime = Fri Nov 11 23:35:48 EST 2022
mZxid = 0x6f
mtime = Fri Nov 11 23:36:51 EST 2022
pZxid = 0x6e
cversion = 0
dataVersion = 1
aclVersion = 0
ephemeralOwner = 0x0
dataLength = 13
numChildren = 0
[zk: localhost:2181(CONNECTED) 4]

23:36:51.279 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got notification sess
23:36:51.279 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got WatchedEvent stat
/target_znode data changed
23:36:51.279 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session
23:36:51.281 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session
23:36:51.282 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session
Data : some new data children : []
```

We get notified about a new data.

```
[zk: localhost:2181(CONNECTED) 1] set /target_znode "some new data"
[zk: localhost:2181(CONNECTED) 2] create /target_znode/child_znode " "
Created /target_znode/child_znode
[zk: localhost:2181(CONNECTED) 3]

break;
case NodeDataChanged:
    /** TODO **/
    System.out.println(TARGET_ZNODE+" DATA

Run: WatchersDemo x
18:01:51.300 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - 0
/target_znode children changed
18:01:51.302 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - 0
18:01:51.302 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - F
18:01:51.306 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - F
18:01:51.310 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - F
Data : some new data, children : [child_znode]
```

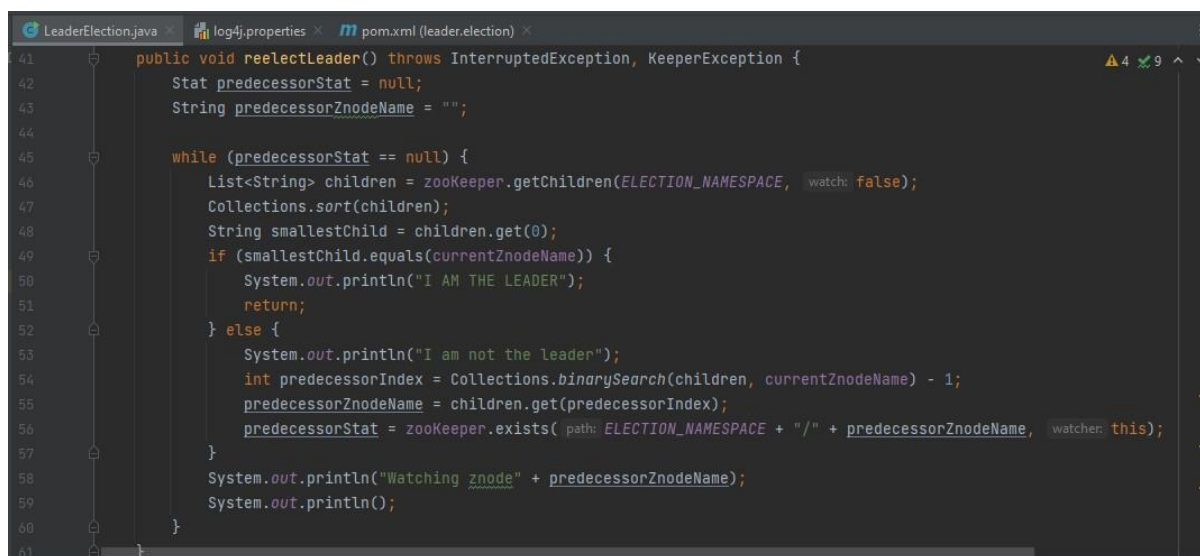
We then create a children znode.

```
[zk: localhost:2181(CONNECTED) 7] rmr /target_znode
[zk: localhost:2181(CONNECTED) 8]
23:38:53.687 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn -
23:38:53.688 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn -
23:38:53.688 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn -
/target_znode was deleted
```

We delete the **target znode**.

V) Part 4

Section: Leader Reelection Implementation



```
LeaderElection.java x log4j.properties x pom.xml (leader.election) x
41 public void reelectLeader() throws InterruptedException, KeeperException {
42     Stat predecessorStat = null;
43     String predecessorZnodeName = "";
44
45     while (predecessorStat == null) {
46         List<String> children = zooKeeper.getChildren(ELECTION_NAMESPACE, watcher: false);
47         Collections.sort(children);
48         String smallestChild = children.get(0);
49         if (smallestChild.equals(currentZnodeName)) {
50             System.out.println("I AM THE LEADER");
51             return;
52         } else {
53             System.out.println("I am not the leader");
54             int predecessorIndex = Collections.binarySearch(children, currentZnodeName) - 1;
55             predecessorZnodeName = children.get(predecessorIndex);
56             predecessorStat = zooKeeper.exists(path: ELECTION_NAMESPACE + "/" + predecessorZnodeName, watcher: this);
57         }
58         System.out.println("Watching znode" + predecessorZnodeName);
59         System.out.println();
60     }
61 }
```

we update the "**electLeader()**" method.

The image displays four terminal windows showing the output of a ZooKeeper command. The first two windows show a 'Warning: Ignoring non-absolute path' message, which is repeated in the last two windows. The logs are for a ZooKeeper instance running on a Windows machine. The first two windows show a 'Warning: Ignoring non-absolute path' message, which is repeated in the last two windows. The logs are for a ZooKeeper instance running on a Windows machine.

WATCHERs kill leader - reelection first child.

⁶**Watchers** : The Zookeeper Watcher utility class is a circuit breaker design pattern around Apache Zookeeper that allows you to watch a one or two files in order to be notified when they are updated. The circuit breaker allows your application the ability to function normally while your connection is interrupted to Zookeeper, and reestablish the connection and watches automatically


```
for session id: 0x1000161bfa002d after 0ms.
00:18:47.371 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:48.714 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:50.056 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:51.399 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:52.731 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:54.075 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:55.416 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:56.753 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:58.090 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:59.428 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
^C
C:\Users\Yannis\Documents\zookeeper-api-introduction>

Invite de commandes - java -jar target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
for session id: 0x1000161bfa002f [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:19:42.328 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:19:43.664 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:19:45.000 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:19:45.578 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got notification
session id: 0x1000161bfa002f
00:19:45.578 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got MatchedEvent
state:SyncConnected type:NodeDeleted path:/election/c_0000000054 for session id 0x1000161bfa002f
/target_znode was deleted
00:19:45.572 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa002f, packet:: clientPath:null serverPath:null finished:false header:: 13,8 reply
Header:: 13,22,0 request: /election,F response:: v(c_0000000055,c_0000000056)
I'm the leader
00:19:45.573 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply ses
sion id: 0x1000161bfa002f, packet:: clientPath:null serverPath:null finished:false header:: 14,3 reply
Header:: 14,221,-101 request: /target_znode,T response::
00:19:46.917 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 1ms.
^C
C:\Users\Yannis\Documents\zookeeper-api-introduction>
```

WATCHERS kill next leader - reelect first child.

```
for session id: 0x1000161bfa002d after 0ms.
00:18:47.371 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:48.714 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:50.056 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:51.399 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:52.731 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:54.075 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:55.416 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:56.753 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
00:18:58.090 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 1ms.
00:18:59.428 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002d after 0ms.
^C
C:\Users\Yannis\Documents\zookeeper-api-introduction>

Invite de commandes - java -jar target\leader-election-1.0-SNAPSHOT-jar-with-dependencies.jar
for session id: 0x1000161bfa002f [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 1ms.
00:21:09.985 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 1ms.
00:21:11.325 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:12.662 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:14.000 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:15.342 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:16.682 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 1ms.
00:21:18.021 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 1ms.
00:21:19.364 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:20.708 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
00:21:22.052 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response
for session id: 0x1000161bfa002f after 0ms.
^C
C:\Users\Yannis\Documents\zookeeper-api-introduction>
```

WATCHERS kill next leader - reelect last child.

The image displays four screenshots of a Java console window showing the logs of a ZooKeeper client (jmx-jar) during a leader election process. The logs are arranged in a 2x2 grid. Red and blue arrows highlight specific messages across the different screenshots.

Top Left Screenshot:

- 00:21:57.786 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 3, 8 reply session id: 3,226,-101 request: /election,F response: v\c_0000000057,c_0000000058,c_0000000059
- 00:21:57.792 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 4, 3 reply session id: 4,228,0 request: /election,c_0000000057,F response: s(226,226,1668230516421,1668230516421,0,0,72059118630752306,0,0,226)
- 00:21:57.794 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 5, 3 reply session id: 5,228,-101 request: /Target_znode,T response:
- 00:21:59.130 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a033 after 0ms.
- 00:22:00.468 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a033 after 0ms.

Top Right Screenshot:

- 00:21:56.436 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 4, 3 reply session id: 4,228,0 request: /election,c_0000000057,F response: s(224,224,1668230514627,1668230514627,0,0,72059118630752306,0,0,224)
- 00:21:56.437 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 5, 3 reply session id: 5,228,-101 request: /Target_znode,T response:
- 00:21:59.113 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a032 after 1ms.
- 00:22:00.453 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a032 after 0ms.

Bottom Left Screenshot:

- 00:21:54.635 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 3, 8 reply session id: 3,226,-101 request: /election,F response: v\c_0000000057,c_0000000058,c_0000000059
- 00:21:54.642 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a033, packet: clientPathNull serverPathNull finished=false header: 4, 3 reply session id: 4,224,0 request: /election,c_0000000056,F response: s(218,218,1668230164195,1668230164195,0,0,72059118630752304,0,0,218)
- 00:21:54.645 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x1000161bf0a031, packet: clientPathNull serverPathNull finished=false header: 5, 3 reply session id: 5,224,-101 request: /Target_znode,T response:
- 00:21:55.993 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a031 after 0ms.
- 00:21:57.338 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a031 after 0ms.
- 00:21:58.674 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a031 after 0ms.
- 00:22:00.415 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a031 after 0ms.

Bottom Right Screenshot:

- 00:21:46.353 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:49.003 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 1ms.
- 00:21:50.876 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:51.707 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:53.044 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:54.375 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:55.712 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:57.096 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:58.394 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.
- 00:21:59.735 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id: 0x1000161bf0a030 after 0ms.

WATCHERs - launch new children - Same leader, and watching list.

The image displays two side-by-side terminal windows showing ZooKeeper logs. The left window shows a sequence of log messages where a node with ID 0x10001611bf0a031 is elected as the leader. The right window shows log messages where a node with ID 0x10001611bf0a032 receives ping responses from other nodes, indicating it is not the leader. A large red 'X' is drawn over the right window, suggesting it is not the primary focus or is being marked as incorrect/irrelevant in the context of the document.

WATCHERS - Kill leader - Reelect again first child in list.

VI) Part 5

Section : practice- cluster auto-healer using zookeeper

```
@Override
public void process(WatchedEvent event) {
    switch (event.getType()) {
        case None:
            if (event.getState() == Event.KeeperState.SyncConnected) {
                System.out.println("Successfully connected to Zookeeper");
            } else {
                synchronized (zooKeeper) {
                    System.out.println("Disconnected from Zookeeper event");
                    zooKeeper.notifyAll();
                }
            }
            break;
        case NodeChildrenChanged, NodeDeleted, NodeCreated, NodeDataChanged:
            try {
                launchWorkersIfNecessary();
            } catch (InterruptedException e) {
                throw new RuntimeException(e);
            } catch (KeeperException e) {
                throw new RuntimeException(e);
            } catch (IOException e) {
                throw new RuntimeException(e);
            }
    }
}
```

2 usages

```
private void launchWorkersIfNecessary() throws InterruptedException, KeeperException, IOException {
    /**
     * Implement this method to watch and launch new workers if necessary
     */
    List<String> children;
    do {
        startNewWorker();
        Thread.sleep( millis: 1000);
        children = this.zooKeeper.getChildren(AUTOHEALER_ZNODES_PATH, watcher: this);
        System.out.println(children);
        System.out.println(children.size()<=this.numberOfWorkers);
    } while (children.size()<=this.numberOfWorkers);
}
```

```
C:\Windows\System32\cmd.e X + -
21:23:59.381 [main] INFO org.apache.zookeeper.ClientCnxn - zookeeper.request.timeout value is 0. feature enabled=false
21:23:59.389 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.SaslServerPrincipal - Canonicalized address to
localhost
21:23:59.393 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Opening socket connection to serve
r localhost/[0:0:0:0:0:0:1]:2181.
21:23:59.393 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - SASL config status: Will not attem
pt to authenticate using SASL (unknown error)
21:23:59.399 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Socket connection established, ini
tiating session, client: [/0:0:0:0:0:0:1]:60105, server: localhost/[0:0:0:0:0:0:1]:2181
21:23:59.401 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Session establishment request sen
t on localhost/[0:0:0:0:0:0:1]:2181
21:23:59.427 [main-SendThread(localhost:2181)] INFO org.apache.zookeeper.ClientCnxn - Session establishment complete on
server localhost/[0:0:0:0:0:0:1]:2181, session id = 0x100002e22470000, negotiated timeout = 4000
Successfully connected to Zookeeper
21:23:59.438 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x10000
2e22470000, packet:: clientPath:null serverPath:null finished:false header:: 1,3 replyHeader:: 1,132,-101 request:: '/
workers,F response::
21:23:59.464 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Reading reply session id: 0x10000
2e22470000, packet:: clientPath:null serverPath:null finished:false header:: 2,1 replyHeader:: 2,133,0 request:: '/wor
kers,vis{31,sf{world,'anyone'}}.0 response:: '/workers
21:24:00.795 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id:
0x100002e22470000 after 2ms.
21:24:02.132 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id:
0x100002e22470000 after 2ms.
21:24:03.470 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id:
0x100002e22470000 after 2ms.
21:24:04.806 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id:
0x100002e22470000 after 2ms.
21:24:06.148 [main-SendThread(localhost:2181)] DEBUG org.apache.zookeeper.ClientCnxn - Got ping response for session id:
0x100002e22470000 after 2ms.
```

As you can see, there is the result of the project completed.

CONCLUSION :

Apache ZooKeeper is a coordination service for distributed application. It has become the solution for high availability for many other projects. Some of Apache's well known open-source distributed services include:

- Apache Hadoop (an umbrella of projects including many components for Big Data processing such as Hadoop Common, Hadoop Distributed File System (HDFS), Hadoop YARN (yet another resource negotiator) and Hadoop MapReduce)
- Apache HBase: non-relational database on top of HDFS
- Apache Hive: data warehouse with SQL-like interface
- Apache Kafka: stream processing
- Apache Nifi: automated data flow processing.

Some of them, such as Nifi, has an embedded implementation of ZooKeeper ensemble if there isn't a separate ensemble. There is some limitation with embedded Zookeeper ensemble. First, we cannot start ZooKeeper without starting Nifi service on the same server. Second, we need to orchestrate the configuration so that the ZooKeeper ensemble does not grow too large. We need to keep in mind that the ZooKeeper ensemble is a separate cluster of its own, and it is not recommended to have more than 7 nodes on ZooKeeper.