A Smart-Contract-Based Adaptive Security Governance Architecture for Smart City Service Interoperations

➢ Blockchain network configuration

This guide provides step-by-step instructions to configure the MultiChain blockchain architecture in four different machine , allowing you to set up both global and local instances of the blockchain for interoperable services

1. Setup Four Different Machine based on Linux Machine Configuration

Physical Machines 1, 2, 3, 4	
CPU (Processor)	Intel® 6th Gen Intel® Core™ i7 (6700)
Memory	16 GB DDR
Chipset	Intel® H110 Chipset
Hardrive	256 GB Solid State Drive SATA

2. Installation of Multichain Web Demo

MultiChain Web Demo is a simple web interface for MultiChain blockchains, written in PHP.

https://github.com/MultiChain/multichain-web-demo

Install MultiChain Web Demo in all Four different machine inorder to visualize the transaction information in GUI interface when interoperable service Sharing data with each other

A. System Requirements

- A computer running web server software such as Apache.
- PHP 5.x or later with the curl and JSON extensions.
- MultiChain 1.0 alpha 26 or later, including MultiChain 2.x.

3. Create and launch a MultiChain Blockchain

Download MultiChain to install MultiChain on four different setup machines and create a chain named as Localchain1, Localchain2, Localchain3 For (Smart Service1, Smart Service2, Smart Service3) inorder to work as decentralized application as follows:

- ➢ **multichain-util create LocalChain //For creation**
- ➢ **multichaind** LocalChain **–daemon //For Running**
- ➢ **multichain-util create GlobalChain**
- ➢ **multichaind GlobalChain –daemon**

4. Configure the Web Demo For both Local and Global Blockchain

```
cat ~/.multichain/chain1/multichain.conf
grep rpc-port ~/.multichain/chain1/params.dat
```

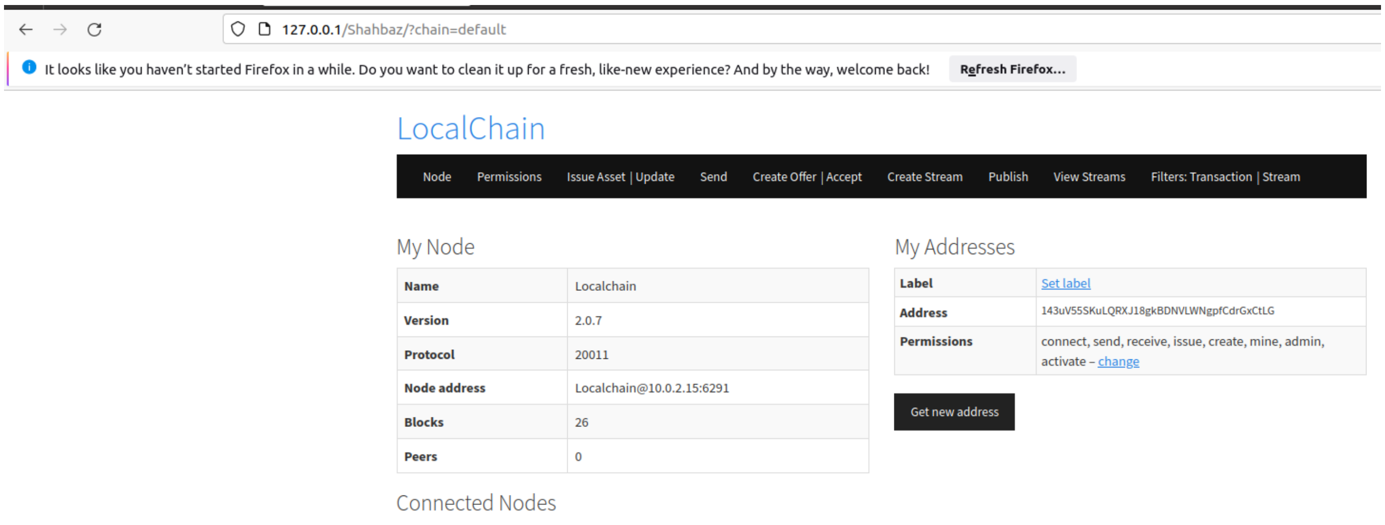
In the web demo directory, copy the config-example.txt file to config.txt:

```
cp config-example.txt config.txt
```

In the demo website directory, enter chain details in config.txt e.g.:

```
default.name=Default                # name to display in the web interface
default.rpchost=127.0.0.1           # IP address or domain of MultiChain node
default.rpcsecure=0                 # set to 1 to access RPC via https (e.g. for MultiChain on Azure)
default.rpcport=12345               # usually default-rpc-port from params.dat
default.rpcuser=multichainrpc       # username for RPC from multichain.conf
default.rpcpassword=mnBh8aHp4mun... # password for Local and Global Blockchain
```

LocalBlockchain Screen (Application-1)



127.0.0.1/Shahbaz/?chain=default

It looks like you haven't started Firefox in a while. Do you want to clean it up for a fresh, like-new experience? And by the way, welcome back! Refresh Firefox...

LocalChain

My Node

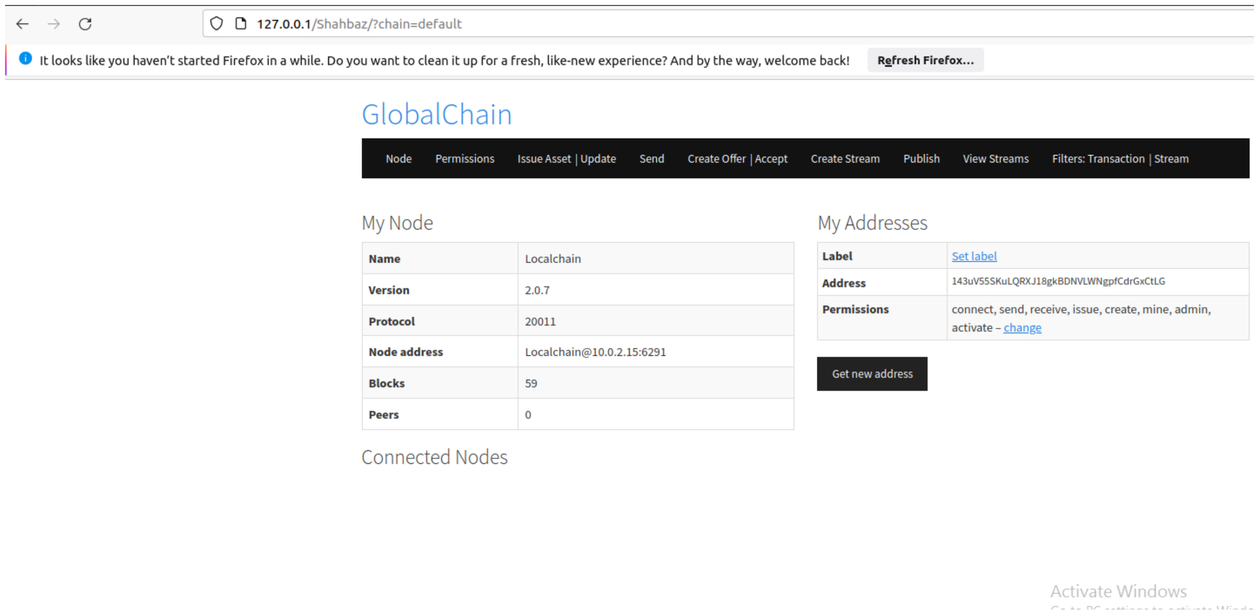
Name	Localchain
Version	2.0.7
Protocol	20011
Node address	Localchain@10.0.2.15:6291
Blocks	26
Peers	0

My Addresses

Label	Set label
Address	143uV55SKuLQRXJ18gkBDNVLWNgpfCdrGxCtLG
Permissions	connect, send, receive, issue, create, mine, admin, activate – change

Connected Nodes

Global Blockchain Screen



127.0.0.1/Shahbaz/?chain=default

It looks like you haven't started Firefox in a while. Do you want to clean it up for a fresh, like-new experience? And by the way, welcome back! Refresh Firefox...

GlobalChain

My Node

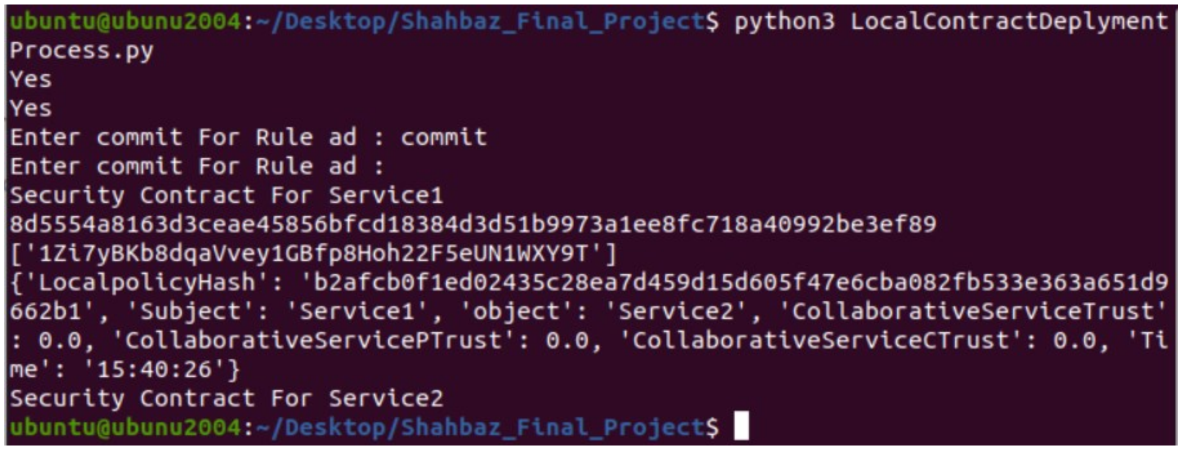
Name	Localchain
Version	2.0.7
Protocol	20011
Node address	Localchain@10.0.2.15:6291
Blocks	59
Peers	0

My Addresses

Label	Set label
Address	143uV55SKuLQRXJ18gkBDNVLWNgpfCdrGxCtLG
Permissions	connect, send, receive, issue, create, mine, admin, activate – change

Connected Nodes

5. **Deploy Default ServiceSecurity Smart Contract in all 3 interoperable services inorder to load the basic ServiceSecurity Contract For interoperable services in local blockchain for this perform the Following steps in all machines**



```
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project$ python3 LocalContractDeplyment
Process.py
Yes
Yes
Enter commit For Rule ad : commit
Enter commit For Rule ad :
Security Contract For Service1
8d5554a8163d3ceae45856bfcd18384d3d51b9973a1ee8fc718a40992be3ef89
['1Zi7yBKb8dqaVvey1GBfp8Hoh22F5eUN1WXY9T']
{'LocalpolicyHash': 'b2afcb0f1ed02435c28ea7d459d15d605f47e6cba082fb533e363a651d9
662b1', 'Subject': 'Service1', 'object': 'Service2', 'CollaborativeServiceTrust'
: 0.0, 'CollaborativeServicePTrust': 0.0, 'CollaborativeServiceCTrust': 0.0, 'Ti
me': '15:40:26'}
Security Contract For Service2
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project$
```

✓ This will create a Rule repository in the Local machine and deploy the contract on the local Blockchain also update the smart contract in the Rule Data Stream of the Local Blockchain

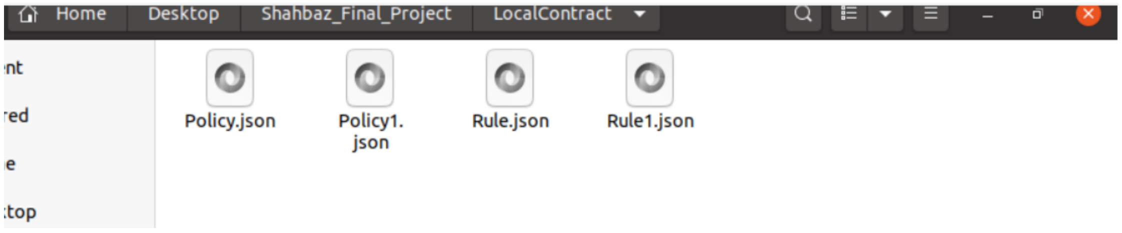
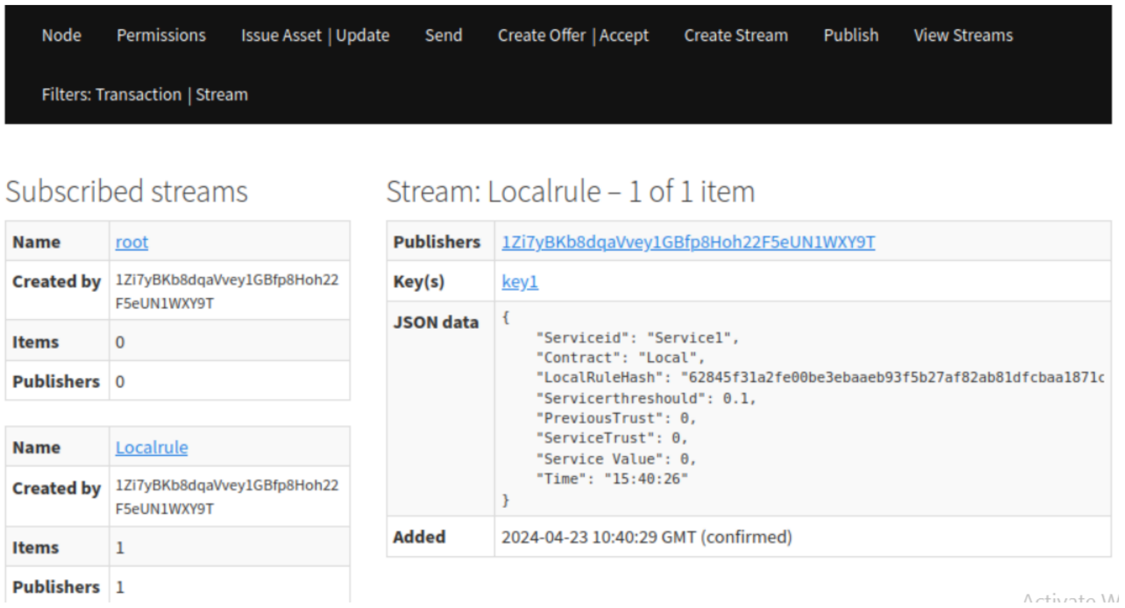


Figure of Local Blockchain Repository



Subscribed streams

Name	root
Created by	1Zi7yBKb8dqaVvey1GBfp8Hoh22F5eUN1WXY9T
Items	0
Publishers	0

Name	Localrule
Created by	1Zi7yBKb8dqaVvey1GBfp8Hoh22F5eUN1WXY9T
Items	1
Publishers	1

Stream: Localrule – 1 of 1 item

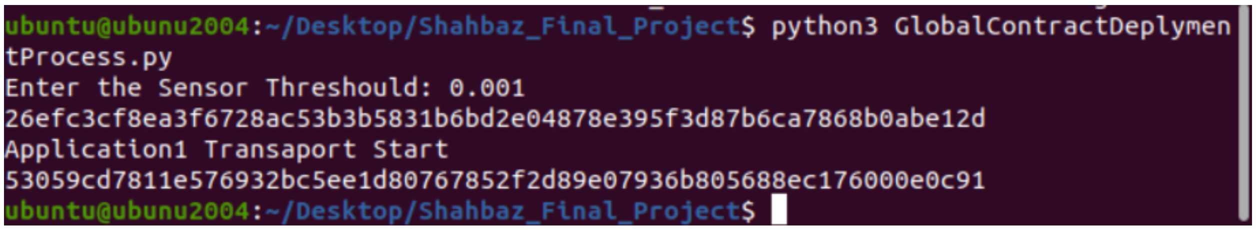
Publishers	1Zi7yBKb8dqaVvey1GBfp8Hoh22F5eUN1WXY9T
Key(s)	key1

JSON data

```
{
    "Serviceid": "Service1",
    "Contract": "Local",
    "LocalRuleHash": "62845f31a2fe00be3ebaaeb93f5b27af82ab81dfcbaa1871c
    "Servicerthreshould": 0.1,
    "PreviousTrust": 0,
    "ServiceTrust": 0,
    "Service Value": 0,
    "Time": "15:40:26"
}
```

Added	2024-04-23 10:40:29 GMT (confirmed)

6. **Deploy Default ServiceSecurity Smart Contract Format in Administrative Global Blockchain Node inorder to load the basic Global ServiceSecurity Contract**



```
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project$ python3 GlobalContractDeplymen
tProcess.py
Enter the Sensor Threshould: 0.001
26efc3cf8ea3f6728ac53b3b5831b6bd2e04878e395f3d87b6ca7868b0abe12d
Application1 Transaport Start
53059cd7811e576932bc5ee1d80767852f2d89e07936b805688ec176000e0c91
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project$
```

➤ Start the Client Nodes of Interoperable Services

To implement the clients of these interoperable smart decentralized applications in a simulated environment, we're utilizing Cooja along with SDN_WISE controller called as **SDIoT layer** , is a popular simulator. Cooja allows us to emulate a network of IoT devices, providing a realistic testing ground for our decentralized applications. To connect these simulated client nodes with our Python-based decentralized application, we've developed a bridge that interfaces between Cooja and our Python code. This bridge ensures seamless communication and interaction between the simulated IoT client nodes and our decentralized application, enabling us to evaluate its performance, reliability, and interoperability in a controlled setting before real-world deployment.

1. **SDN Installation**
   For Installation of contiki operating system follow the link and install the SDNWISEcontroller
   https://sdnwiselab.github.io/docs/guides/GetStarted.html

2. Management Repository of SDIoT layer

In all Machine the management repository of SDIoT layer is present in following path that

\Ada-Framework-Shahbaz1\GetStarted\

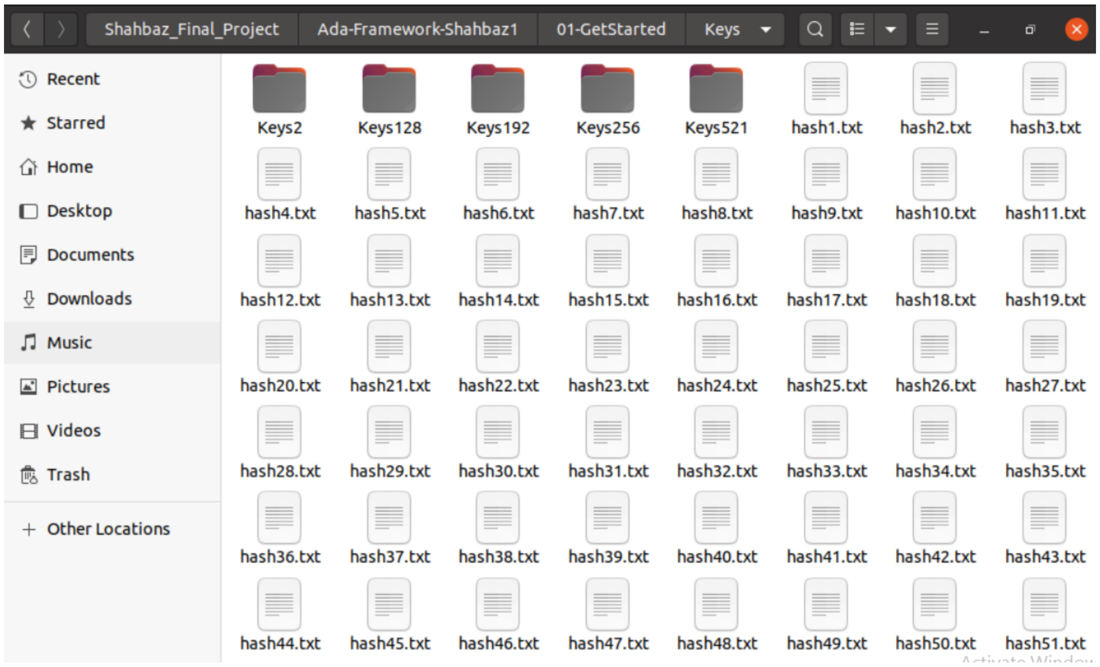
Following are the Management repository of individual application in different machine are

1. Keys (Responsible to manage the Key pair of Client nodes and SDN controller)
2. Trust management (Responsible to manage the Trust of Client nodes and SDN controller)
3. Policy Management (Responsible to manage the policies of Client nodes and SDN controller)

3. KeyManagement Execution

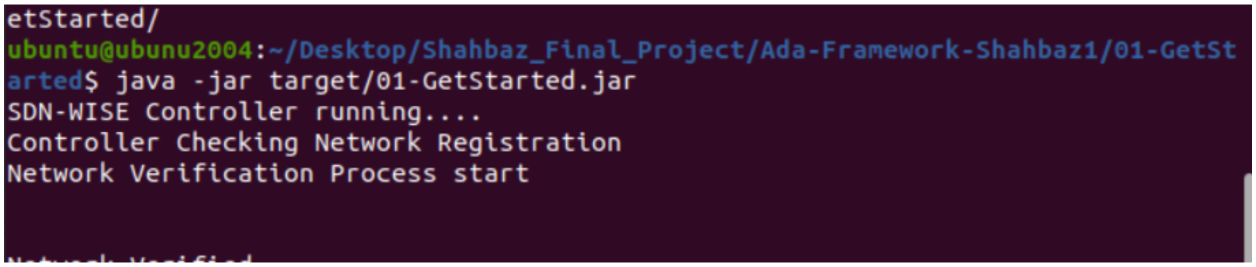
Run the Script Keys_sh that work as Key Management algorithm to Generate the Key pairs for SDN controller and the Client Nodes of the Interoperable Service

Location:



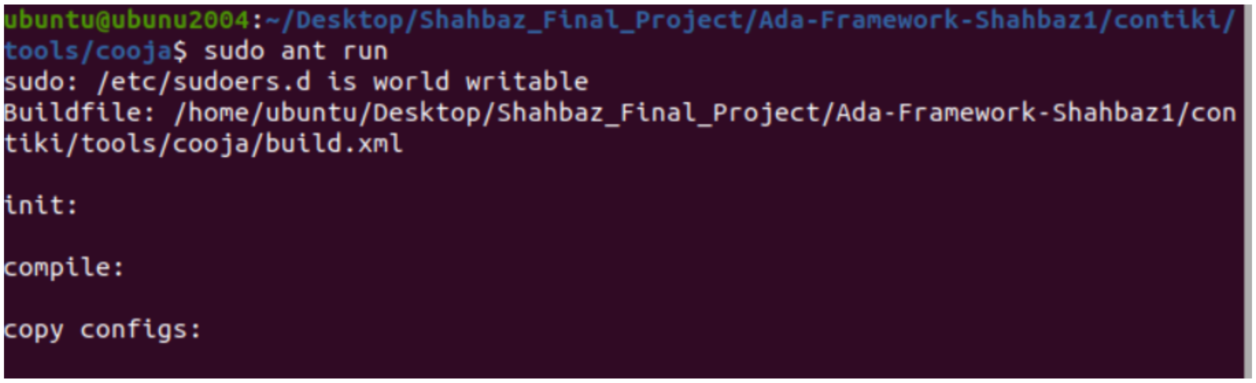
4. Run Client Nodes

Inorder to Run the Client First Start the SDNController First with the help of the following commands

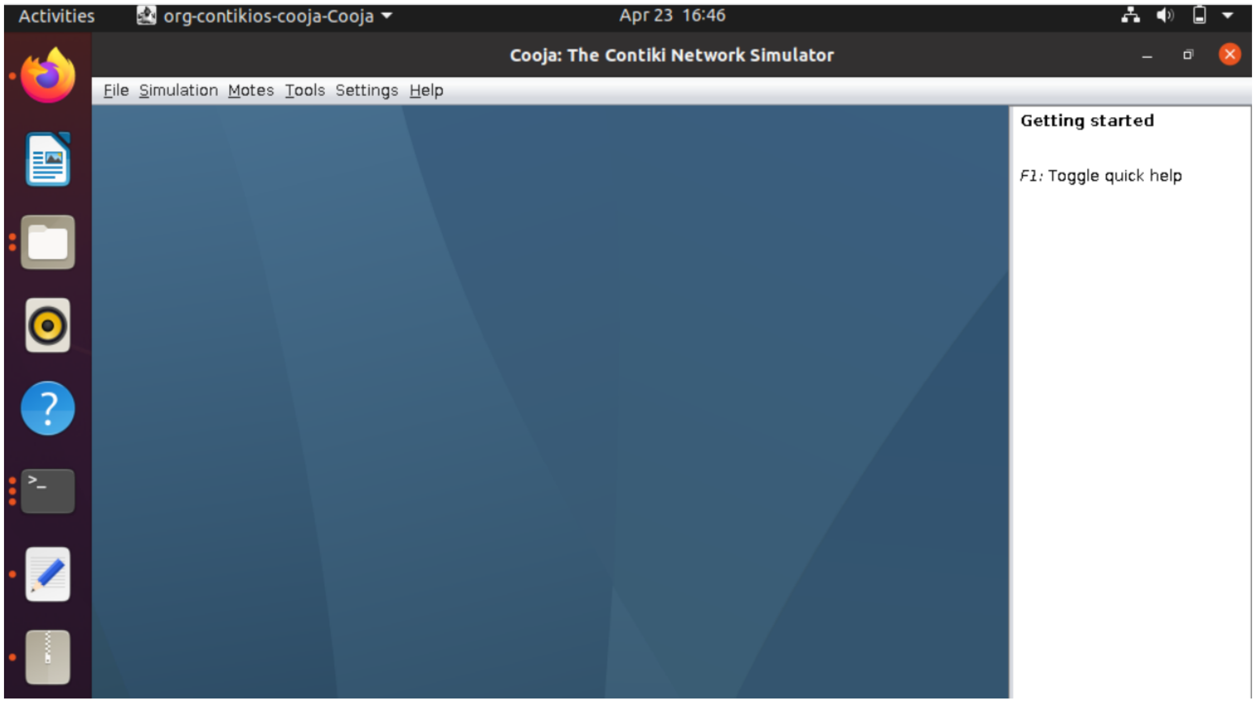


```
etStarted/
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project/Ada-Framework-Shahbaz1/01-GetSt
arted$ java -jar target/01-GetStarted.jar
SDN-WISE Controller running....
Controller Checking Network Registration
Network Verification Process start
```

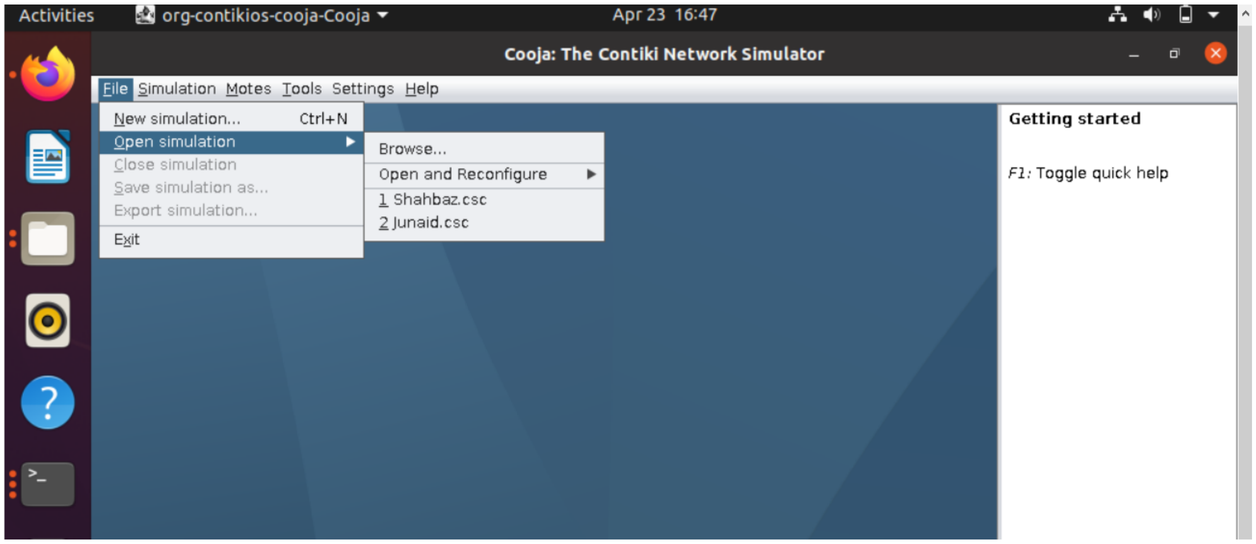
Then Run the Client Node

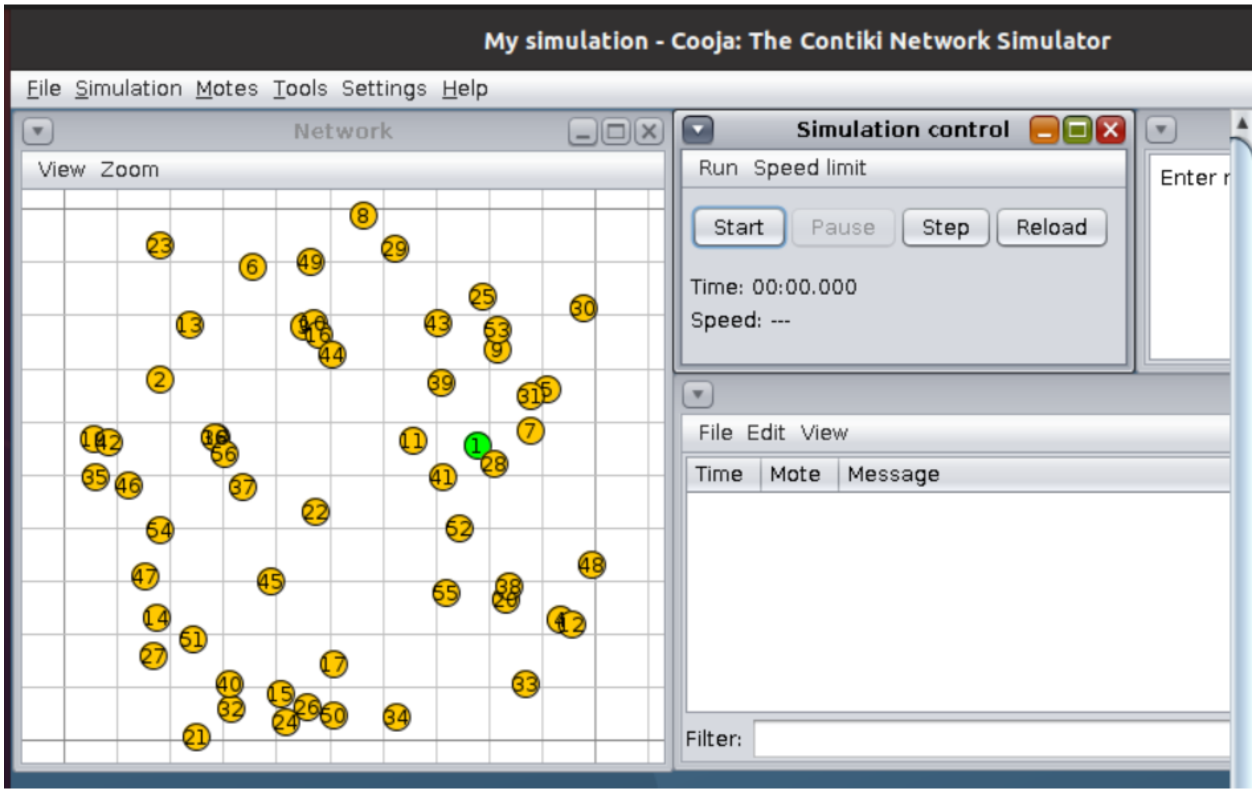


```
ubuntu@ubunu2004:~/Desktop/Shahbaz_Final_Project/Ada-Framework-Shahbaz1/contiki/
tools/cooja$ sudo ant run
sudo: /etc/sudoers.d is world writable
Buildfile: /home/ubuntu/Desktop/Shahbaz_Final_Project/Ada-Framework-Shahbaz1/con
tiki/tools/cooja/build.xml

init:

compile:

copy configs:
```

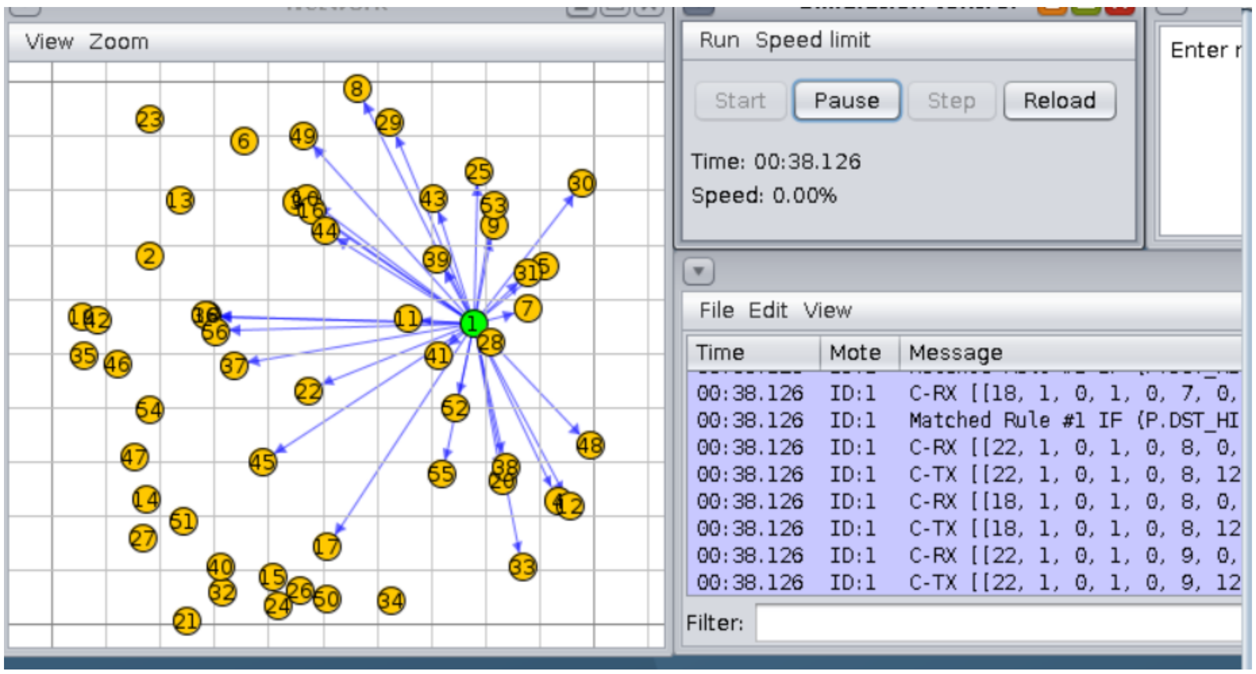

Activities
org-contikios-cooja-Cooja
Apr 23 16:46
Cooja: The Contiki Network Simulator
File Simulation Motes Tools Settings Help
Getting started
F1: Toggle quick help

Load Shahbaz.csv File For environment loading


Activities
org-contikios-cooja-Cooja
Apr 23 16:47
Cooja: The Contiki Network Simulator
File Simulation Motes Tools Settings Help
New simulation... Ctrl+N
Open simulation
Close simulation
Save simulation as...
Export simulation...
Exit
Browse...
Open and Reconfigure
1 Shahbaz.csc
2 Junaid.csc
Getting started
F1: Toggle quick help


My simulation - Cooja: The Contiki Network Simulator
File Simulation Motes Tools Settings Help
Network
View Zoom
Simulation control
Run Speed limit
Start
Pause
Step
Reload
Time: 00:00.000
Speed: ---
Enter r
File Edit View
Time
Mote
Message
Filter:

➢ Start the Simulation



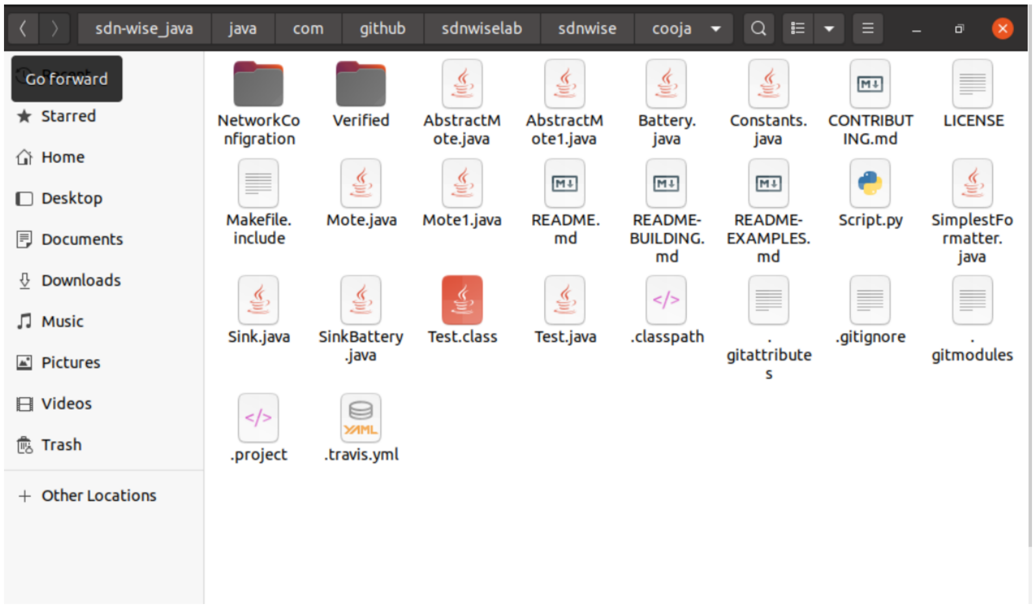
```
Time: 00:38.126
Speed: 0.00%
```

```
Time       Mote  Message
00:38.126  ID:1  C-RX [[18, 1, 0, 1, 0, 7, 0,
00:38.126  ID:1  Matched Rule #1 IF (P.DST_HI
00:38.126  ID:1  C-RX [[22, 1, 0, 1, 0, 8, 0,
00:38.126  ID:1  C-TX [[22, 1, 0, 1, 0, 8, 12
00:38.126  ID:1  C-RX [[18, 1, 0, 1, 0, 8, 0,
00:38.126  ID:1  C-TX [[18, 1, 0, 1, 0, 8, 12
00:38.126  ID:1  C-RX [[22, 1, 0, 1, 0, 9, 0,
00:38.126  ID:1  C-TX [[22, 1, 0, 1, 0, 9, 12
```

5. Service Management

Service Management Script is embedded in Client node (AbstractMote.java) code as a sub function reside in the following Folder

/home/Ubuntu/Desktop/Shahbaz_Final_Project/Conitki/…..



Application Design Demonstration

In this section, we demonstrate the integration of our Python-based decentralized applications with the client nodes of the SDNIoT. We showcase how these applications interact seamlessly with the client nodes to facilitate various functionalities within the SDIoT ecosystem. By connecting the client nodes to our Python applications, we aim to highlight the adaptability and interoperability of our decentralized solutions. This demonstration serves to illustrate the potential of Python in developing robust and efficient decentralized applications that can effectively manage and control SDIoT networks

1. Implementation Discussion

In this section, we will delve into the implementation of a Python client-serverbased application for weather disaster response management, leveraging the power of standard APIs

- ✓ **Smart Ambulance Service**

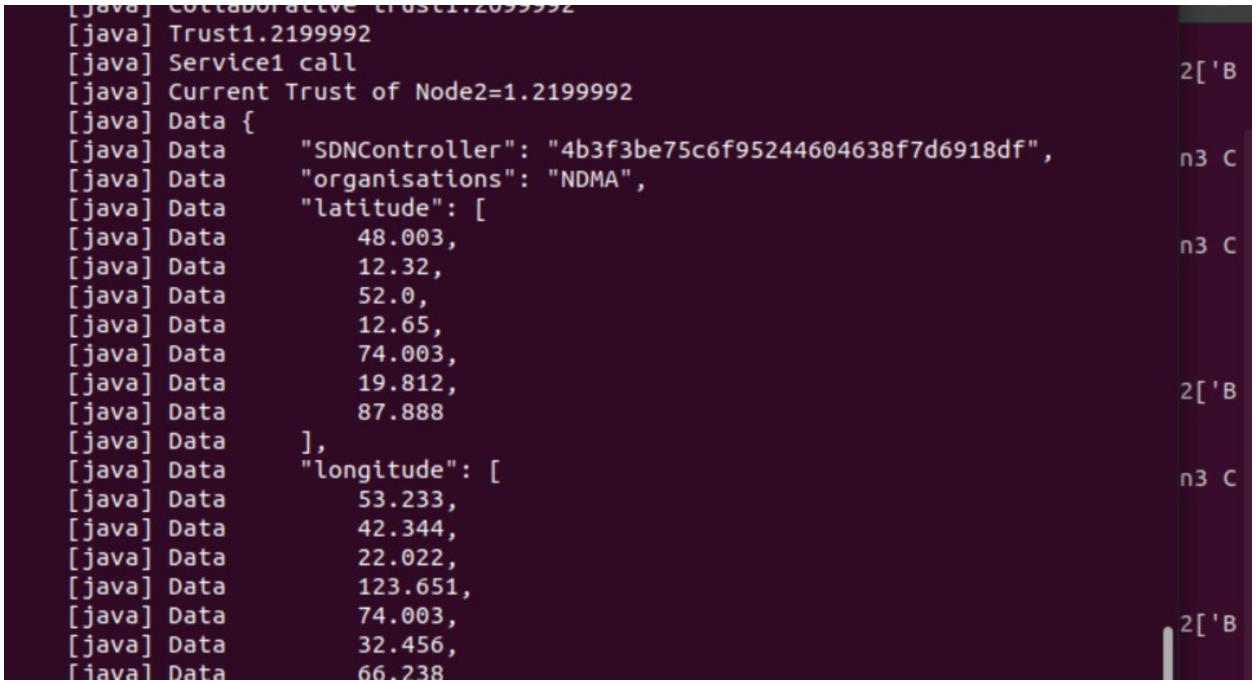
The smart ambulance service plays a crucial role in our interoperable service ecosystem within smart cities. It has been implemented using Python socket programming in a server-client code framework. As a client node, the Smart Ambulance service connects not only with its own server but also with other administrative servers of smart services, such as disaster and smart weather services. This enables it to execute collaborative task requests seamlessly. Additionally, as a server node, the Smart Ambulance service allows its clients and other smart services to establish connections with it, facilitating smooth communication and seamless integration between different services.

- ✓ **Start Smart Ambulance Service**

Run the Interoperable Smart Ambulance Service in PC-1 with the help this command

Command =python3 SmartAmbulance.Py

The Access Level Security Code is embedded within all Smart Interoperable Service Codes. The Smart Ambulance Algorithm focuses solely on the implementation of the Smart Interoperable Service Code, while the Access Level Security verification is integrated within this code



```
[java] Collaborative trust1.2099992
[java] Trust1.2199992
[java] Service1 call                                                    2['B
[java] Current Trust of Node2=1.2199992
[java] Data {
[java] Data     "SDNController": "4b3f3be75c6f95244604638f7d6918df",    n3 C
[java] Data     "organisations": "NDMA",
[java] Data     "latitude": [
[java] Data         48.003,                                             n3 C
[java] Data         12.32,
[java] Data         52.0,
[java] Data         12.65,
[java] Data         74.003,
[java] Data         19.812,                                             2['B
[java] Data         87.888
[java] Data     ],
[java] Data     "longitude": [                                          n3 C
[java] Data         53.233,
[java] Data         42.344,
[java] Data         22.022,
[java] Data         123.651,
[java] Data         74.003,                                             2['B
[java] Data         32.456,
[java] Data         66.238
```

```
Smart Ambulance
Require: (Disaster Alert Message), Weather Alert Message,Host, Port
Ensure: Best Route Broadcast

    As Server Node
 1: while True do
 2:     Hostname="Smart AMbulance"
 3:     Port="123"
 4:     Listen(1)
 5:     Bind(Port,Host)
 6:     connect(Port,HOST) –For Disaster Service
 7:     Received Message1[]=(Disaster Alert Message) –For Disaster Service
 8:     connect(Port,HOST) –For Weather Service
 9:     Received Message2[]=(Weather Alert Message)–For Weather Service
10:     Recieved Message3[]=(Current Location) –For Local Client
11:     Extract the word the ALert from Message1 and Message 2
12:     Bool Message=Message1['Alert']=="True" || Message2['Alert']=="True"
13:     if (Message=='True') then
14:         BestRoute(Message[Position],Message3[Position])
15:         Store Result in Disaster Collaborative Service.Json
16:     end if
17: end while
```

A. Smart Weather Service

The smart weather service plays a vital role in our interconnected service ecosystem in smart cities. Implemented using Python socket programming in a serverclient framework, it acts as a client node, connecting not only with its own server but also with administrative servers of other smart services like smart disaster and smart ambulance services. This seamless integration allows the Smart Weather service to execute collaborative tasks efficiently. Furthermore, as a server node, the Smart Weather service enables its clients and other smart services to establish connections with it, ensuring smooth communication and effective coordination among the various services.

- ✓ **Start Smart Weather Service**

Run the Interoperable Smart Ambulance Service in PC-2 with the help this command

Command =python3 SmartWeather.Py

The Access Level Security Code is embedded within all Smart Interoperable Service Codes. The Smart Ambulance Algorithm focuses solely on the implementation of the Smart Interoperable Service Code, while the Access Level Security verification is integrated within this code

```
Smart Weather Service
Require: (Disaster Alert Message), Weather Alert Message
Ensure: Best Route Broadcast
    As Server Node
 1: while True do
 2:     Hostname="Smart Weather Service"
 3:     Port="1234"
 4:     Listen(1)
 5:     Bind(Port,Host)
 6:     connect(Port,HOST) –For Disaster Service
 7:     connect(Port,HOST) –For Ambulance Service
 8:     Message[Rain,drizzling,fLood]=Received values
 9:     if (Message[Rain]>=800||Message[drizzling]>=900)||Message[flood]>=1000)
    then
10:         Send(Alert Message,Location)
11:         Store Result in Weather Collaborative Service..Json
12:     end if
13: end while
```

B. Smart Disaster Service

The Smart Disaster Management service is implemented using Python socket programming within a server-client framework. This service is exclusively implemented as a client node. The service is responsible for receiving communications from other interconnected services and subsequently searching for indicators of natural and global disasters. For instance, the weather service can transmit to the disaster client service of a smart city weather conditions containing rain and flood prediction values. The client nodes receive the message and examine the conditional parameters for alert messages. The response is then returned to the connected service, which relays the alert. The Smart Disaster Management service is crucial to the coordination and administration of the emergency response. By seeking out natural and global disaster conditions, the service is able to provide early warning and situational awareness to other interconnected services, enabling a more coordinated and effective emergency response.

- ✓ **Start Smart Weather Service**

Run the Interoperable Smart Ambulance Service in PC-3 with the help this command

```
Command =python3 SmartDiasater.Py
```

The Access Level Security Code is embedded within all Smart Interoperable Service Codes. The Smart Ambulance Algorithm focuses solely on the implementation of the Smart Interoperable Service Code, while the Access Level Security verification is integrated within this code