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BCDV 1025 – Enterprise Blockchain Development

FINAL GROUP PROJECT

Terrarium IoT Hyperledger project integration with Front end

Summary

This a terrarium IoT (internet of Things) project, where Hyperledger fabric blockchain is being implemented on the back end for user data and pet data is being stored on the blockchain as user buys the pet and the tank. Once tank is purchased by the customer from shopowner, the shopowner provides tank setup services for the end customer. The shopowner inventory is updated and manufacturer has received a transaction signature.

Business Use Case

Our blockchain services cater to shop owners and terrarium manufacturers, utilizing Hyperledger Fabric for seamless business operations. A simple use case involves a purchase transaction between a shop owner and a customer. Through the blockchain, the customer can securely place an order for a terrarium and make the payment. The transaction details are recorded on the blockchain, providing transparency and trust. The manufacturer receives the order information and prepares the terrarium for shipment. The blockchain enables efficient communication between the shop owner and manufacturer, ensuring a smooth purchasing process while enhancing the customer's experience.

Solutions implementation Design

This section covers the solution implementation steps, technologies and platforms undertaken to deploy the project. Our main development and deployment tools and technologies include the following

-Hyperledger Fabric Blockchain

- Visual Studio

-Microsoft AZURE virtual machines

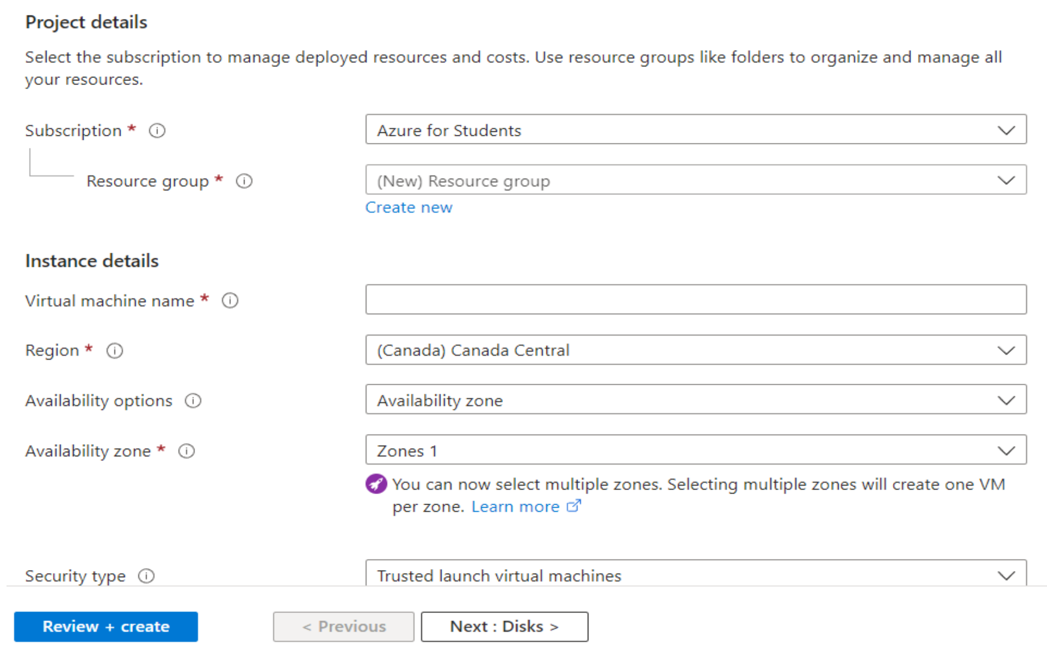
- ERN (Express.js, React.js, Node.js) application STACK

These sub sections are covered below

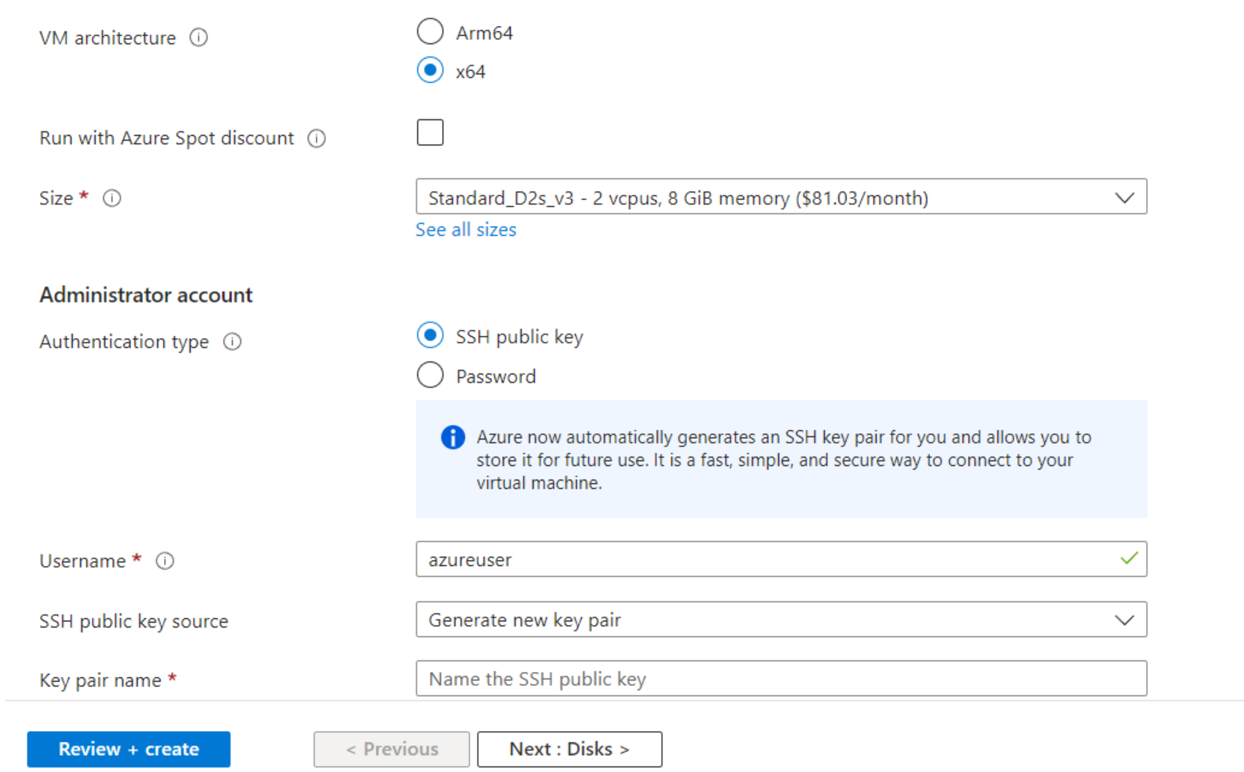
AZURE:

On this platform, a Linux virtual machine is being created where Hyperledger fabric blockchain would be deployed.

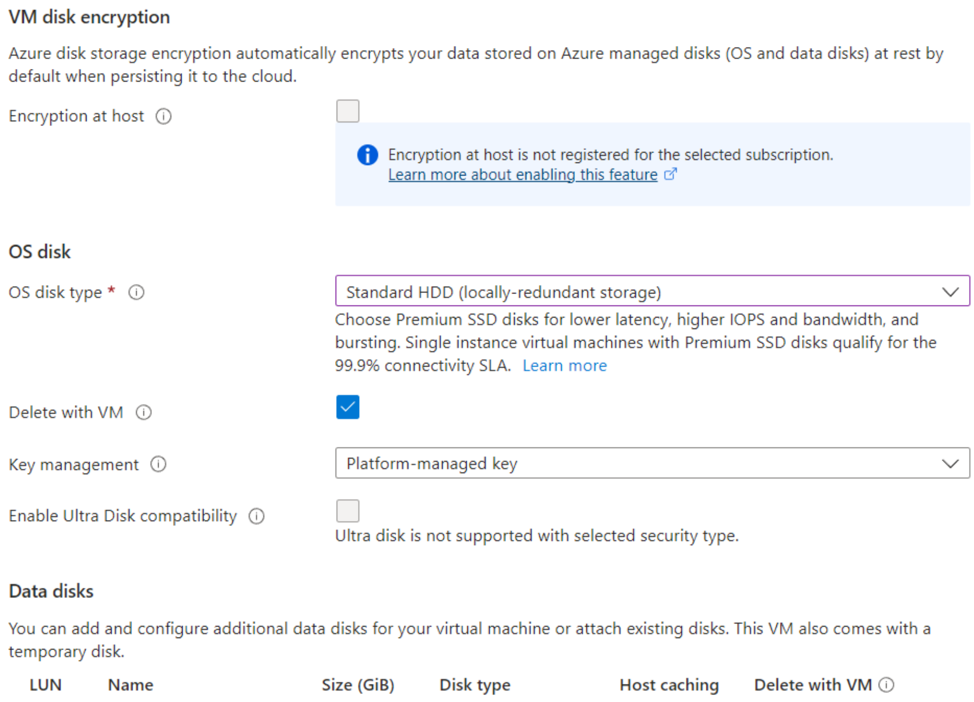
Step 1: Here we create a virtual machine with selecting parameters best fit required for the project



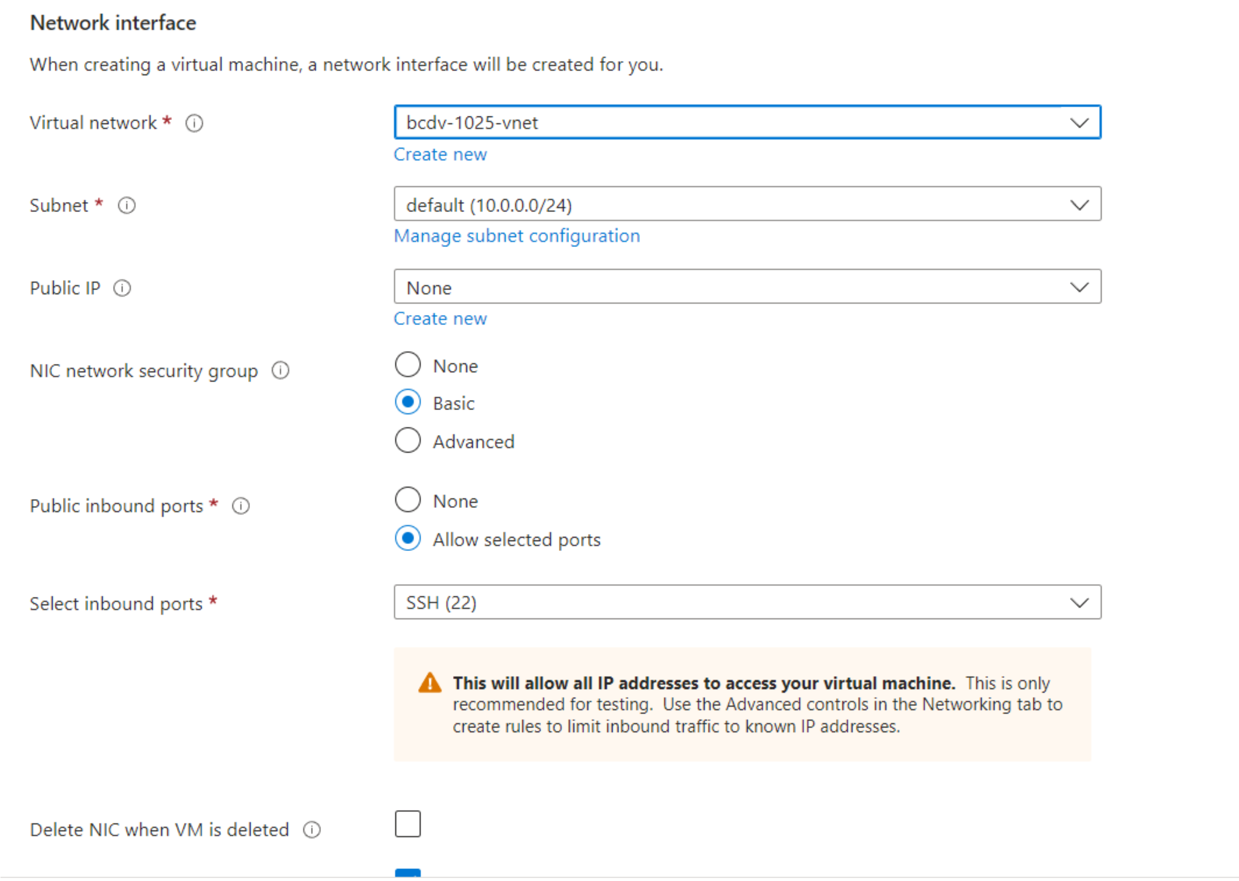
Step 2: Selecting ssh connection authentication to connect to the vm remotely



Step 3 : Create and attach virtual disk to the vm



Step 4: Setting up network interface and IP address configuration for the VM



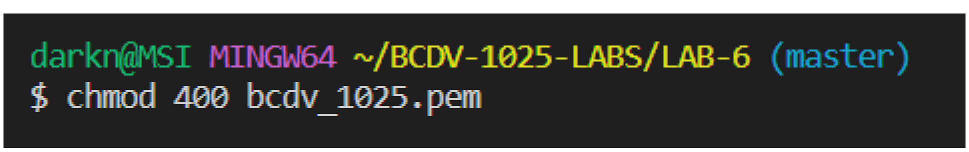
Step 5: After all validation checks passed deploy the machine and download the pem file

VISUAL STUDIO CODE

Here we would connect to the vm we created earlier above

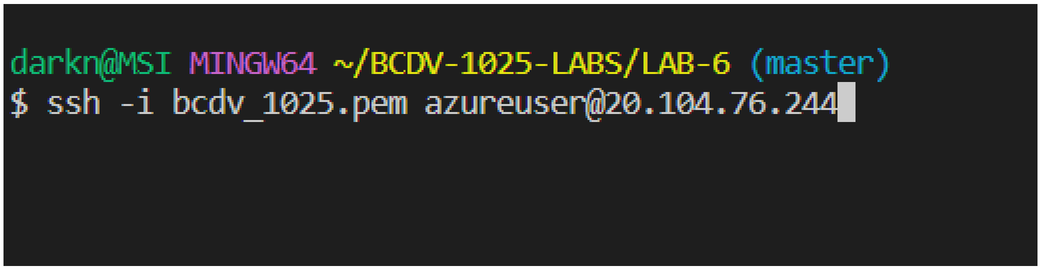
Step 6: this is the pem file downloaded from azure vm platform for the vm created above. It allows us to connect to our vm using ssh

```
chmod 400 <keyname>.pem
```



Step 7: Connect to vm using ssh and key pem file

```
ssh -i <private key path >.pem vmname@vm_ip_address
```



System Setup: Prerequisites

Update package lists:

```
sudo apt update
```

Upgrade installed packages:

```
sudo apt -y upgrade
```

Install curl:

```
sudo apt install curl
```

Install git:

```
sudo apt install git
```

Install python:

```
sudo apt install python
```

Install Go and jq:

```
Sudo apt-get install jq

Sudo apt-get install golang
```

Install additional dependencies:

```
sudo apt install apt-transport-https ca-certificates gnupg-agent
software-properties-common
```

Install Docker:

Import Docker's GPG key:

```
curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key
add -
```

Add Docker repository:

```
sudo add-apt-repository "deb [arch=amd64]
https://download.docker.com/linux/ubuntu $(lsb_release -cs)
stable"
```

Update package lists:

```
sudo apt update
```

Install Docker:

```
sudo apt -y install docker-ce
```

Add user to the docker group:

```
sudo usermod -aG docker <username>
```

Install Docker Compose:

Download Docker Compose:

```
sudo curl -L
https://github.com/docker/compose/releases/download/1.27.4/docke
r-compose-$(uname -s)-$(uname -m) -o /usr/local/bin/docker-
compose
```

Set executable permissions: `sudo chmod +x /usr/local/bin/docker-compose`

Clone Hyperledger Fabric Samples:

Clone the repository:

```
git clone https://github.com/hyperledger/fabric-samples.git
```

Change to the cloned directory:

```
cd fabric-samples
```

Set up the Test Network:

Run the bootstrap script:

```
curl -sSL
https://raw.githubusercontent.com/hyperledger/fabric/main/script
s/bootstrap.sh | bash -s
```

Change to the test network directory:

```
cd fabric-samples/test-network
```

Deploy the Chaincode:

Bring down the network:

```
./network.sh down
```

Bring up the network and create a channel:

```
./network.sh up createChannel -ca -s couchdb
```

Deploy the chaincode:

```
./network.sh deployCC -ccn autorium_monitor_ -ccv 1.0 -ccp
../../autorium/autorium_monitor -ccl javascript
```

Our Chaincode

The code:

```
"use strict";

const { Contract } = require("fabric-contract-api");

class TerrariumMonitor extends Contract {
  // Initialize the ledger with sample device data
  async initLedger(ctx) {
    console.info("============= START : Initialize Ledger
===========");
    const devices = [
      {
        docType: "device",
        deviceId: "device1",
        owner: "Client",
        sensorData: [
          { temperature: 22.5, humidity: 40, timestamp: Date.now() },
          { temperature: 23.1, humidity: 42, timestamp: Date.now() },
        ],
      },
      // Add more devices here
    ];

    // Store the devices in the ledger
    for (let i = 0; i < devices.length; i++) {
      await ctx.stub.putState(
        "DEVICE" + i,
        Buffer.from(JSON.stringify(devices[i]))
```

```
      );
      console.info("Added <--> ", devices[i]);
    }
    console.info("============= END : Initialize Ledger ===========");
  }

  // Query a device by its deviceId
  async queryDevice(ctx, deviceId) {
    const deviceAsBytes = await ctx.stub.getState(deviceId);
    if (!deviceAsBytes || deviceAsBytes.length === 0) {
      throw new Error(`${deviceId} does not exist`);
    }
    console.log(deviceAsBytes.toString());
    return deviceAsBytes.toString();
  }

  // Create a new device with the given deviceId and owner
  async createDevice(ctx, deviceId, owner) {
    console.info("============= START : Create Device ===========");

    const device = {
      docType: "device",
      deviceId,
      owner,
      sensorData: [],
    };

    await ctx.stub.putState(deviceId,
Buffer.from(JSON.stringify(device)));
    console.info("============= END : Create Device ===========");
  }

  // Record sensor data for a device
```

```
  async recordSensorData(ctx, deviceId, data) {
    console.info("============= START : Record Sensor Data
===========");

    const deviceAsBytes = await ctx.stub.getState(deviceId);
    if (!deviceAsBytes || deviceAsBytes.length === 0) {
      throw new Error(`${deviceId} does not exist`);
    }
    const device = JSON.parse(deviceAsBytes.toString());
    device.sensorData.push(data);

    await ctx.stub.putState(deviceId,
Buffer.from(JSON.stringify(device)));
    console.info("============= END : Record Sensor Data
===========");
  }

  // Get all devices stored in the ledger
  async getAllDevices(ctx) {
    console.info("============= START : Get All Devices ===========");

    const startKey = "";
    const endKey = "";

    const iterator = await ctx.stub.getStateByRange(startKey, endKey);

    const allDevices = [];
    while (true) {
      const result = await iterator.next();

      if (result.value && result.value.value.toString()) {
        console.log(result.value.value.toString());
        allDevices.push(JSON.parse(result.value.value.toString()));
      }
```

```
      if (result.done) {
        await iterator.close();
        console.info("============= END : Get All Devices
===========");
        return JSON.stringify(allDevices);
      }
    }
  }
}

module.exports = TerrariumMonitor;
```

The functionality of the code:

The code defines a custom contract named MyContract, which extends the Contract class from the fabric-contract-api package.

The initLedger function initializes the ledger with sample device data. It creates and stores device objects with their respective device IDs, owners, and sensor data.

The queryDevice function allows querying for a specific device by its device ID. It retrieves the device's data from the ledger and returns it.

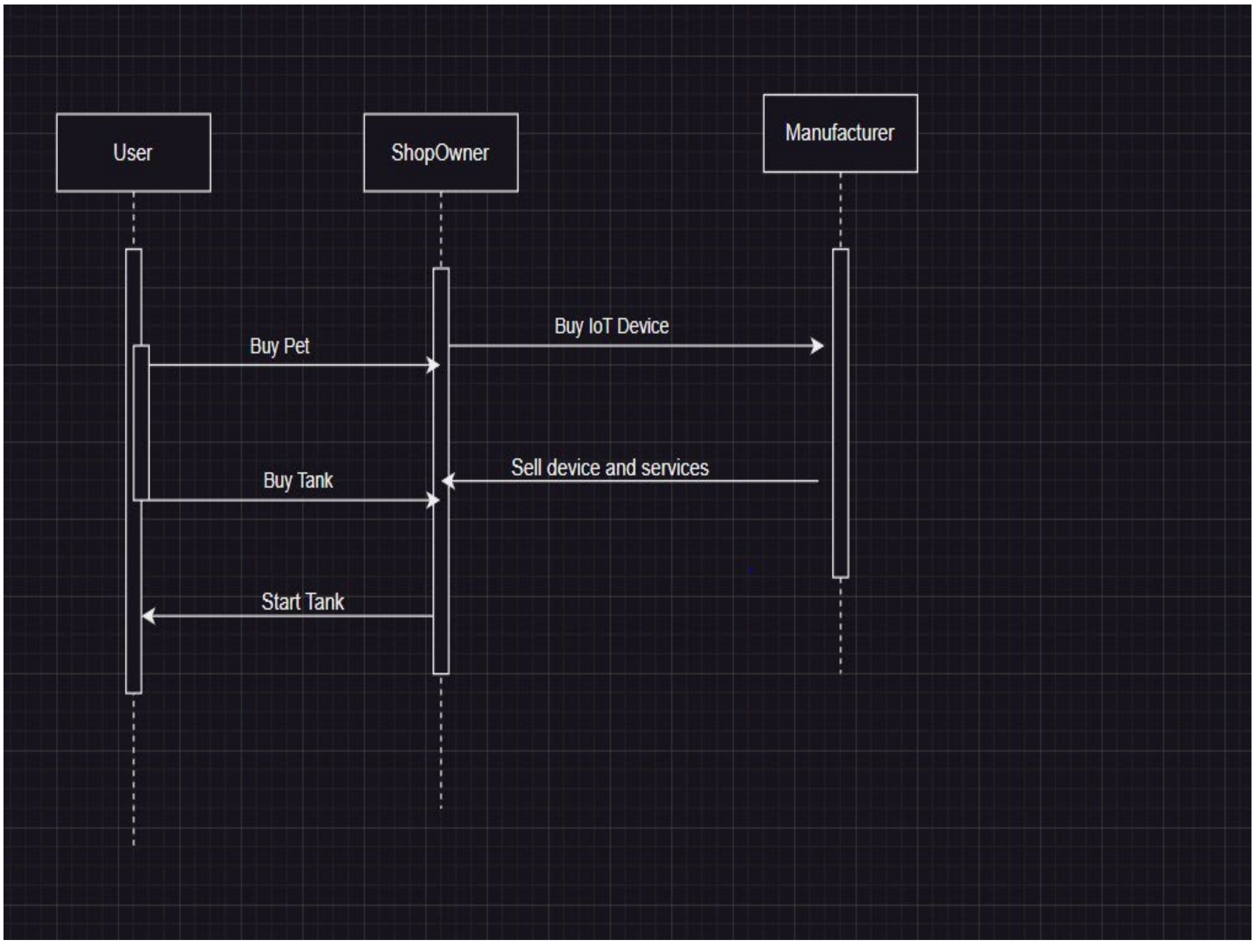
The createDevice function creates a new device by providing a device ID and owner. It creates a device object with empty sensor data and stores it in the ledger.

The recordSensorData function allows recording sensor data for a specific device. It retrieves the device's data from the ledger, appends the new sensor data to the existing data, and updates the ledger with the modified device object.

The getAllDevices function retrieves all devices stored in the ledger. It iterates over the range of keys in the ledger and retrieves each device's data, collecting them into an array. The array of devices is then returned as a JSON string.

These functions collectively enable the management of devices and sensor data in the Terrarium Monitoring system on the Hyperledger Fabric blockchain

LOGICAL ILLUSTRATION OF OUR SMART CONTRACT



References

https://github.com/hyperledger/fabric-samples

https://hyperledger-fabric.readthedocs.io/en/release-2.5/prereqs.html

https://hyperledger-fabric.readthedocs.io/en/release-2.5/install.html

https://hyperledger-fabric.readthedocs.io/en/release-2.5/test_network.html

https://hyperledger-fabric.readthedocs.io/en/release-2.5/test_network.html#bring-up-the-test-network