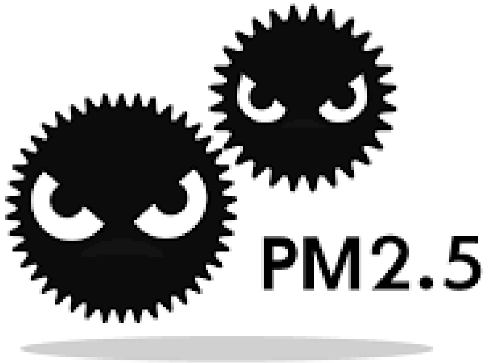
IOT-BASED PLATFORM AIR QUALITY (PM2.5) MONITORING SYSTEM

Big Data Tool with Apache Kylin



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Submitted to :

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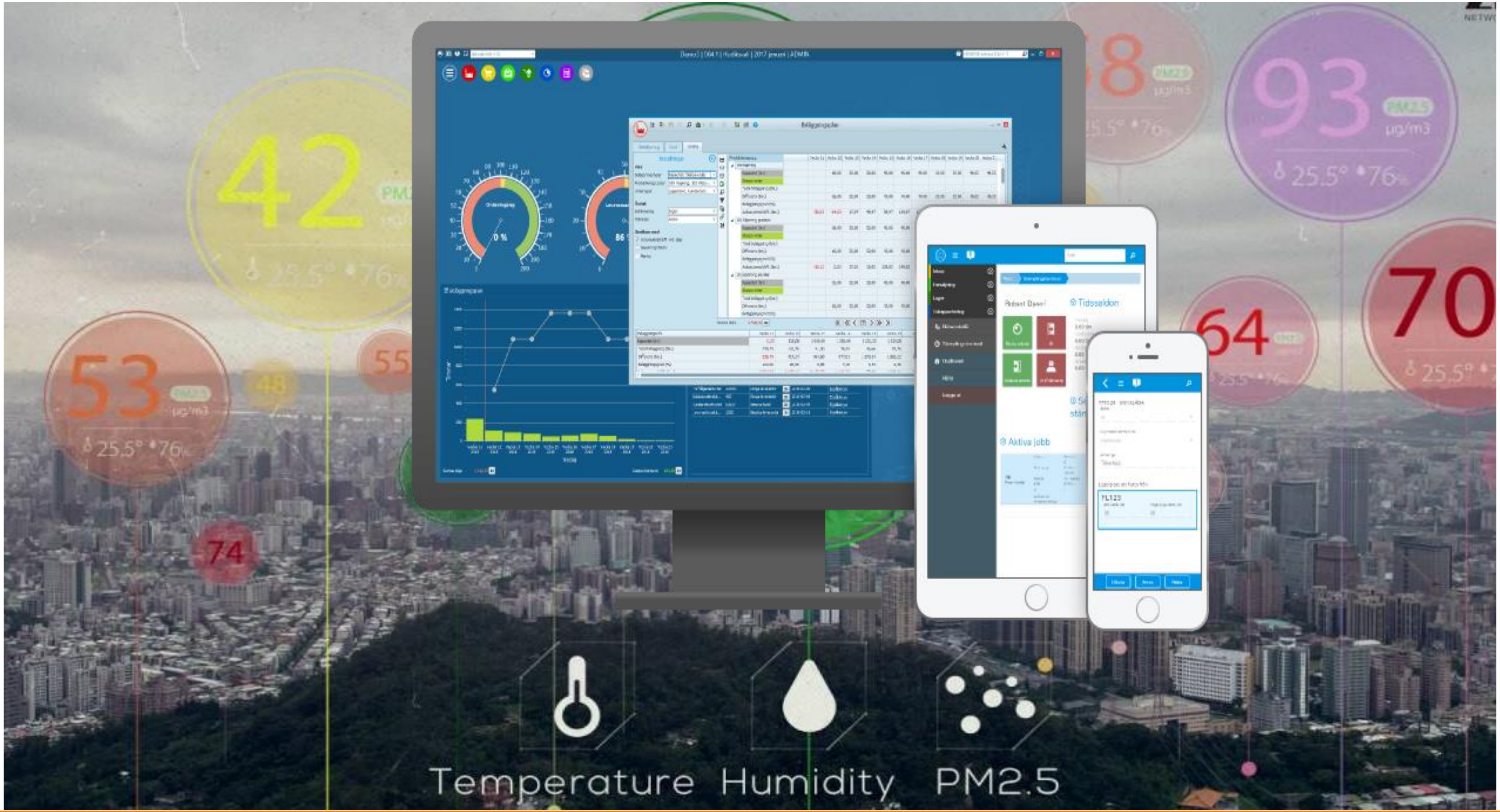
AT70.19 Software Development and Quality Improvement

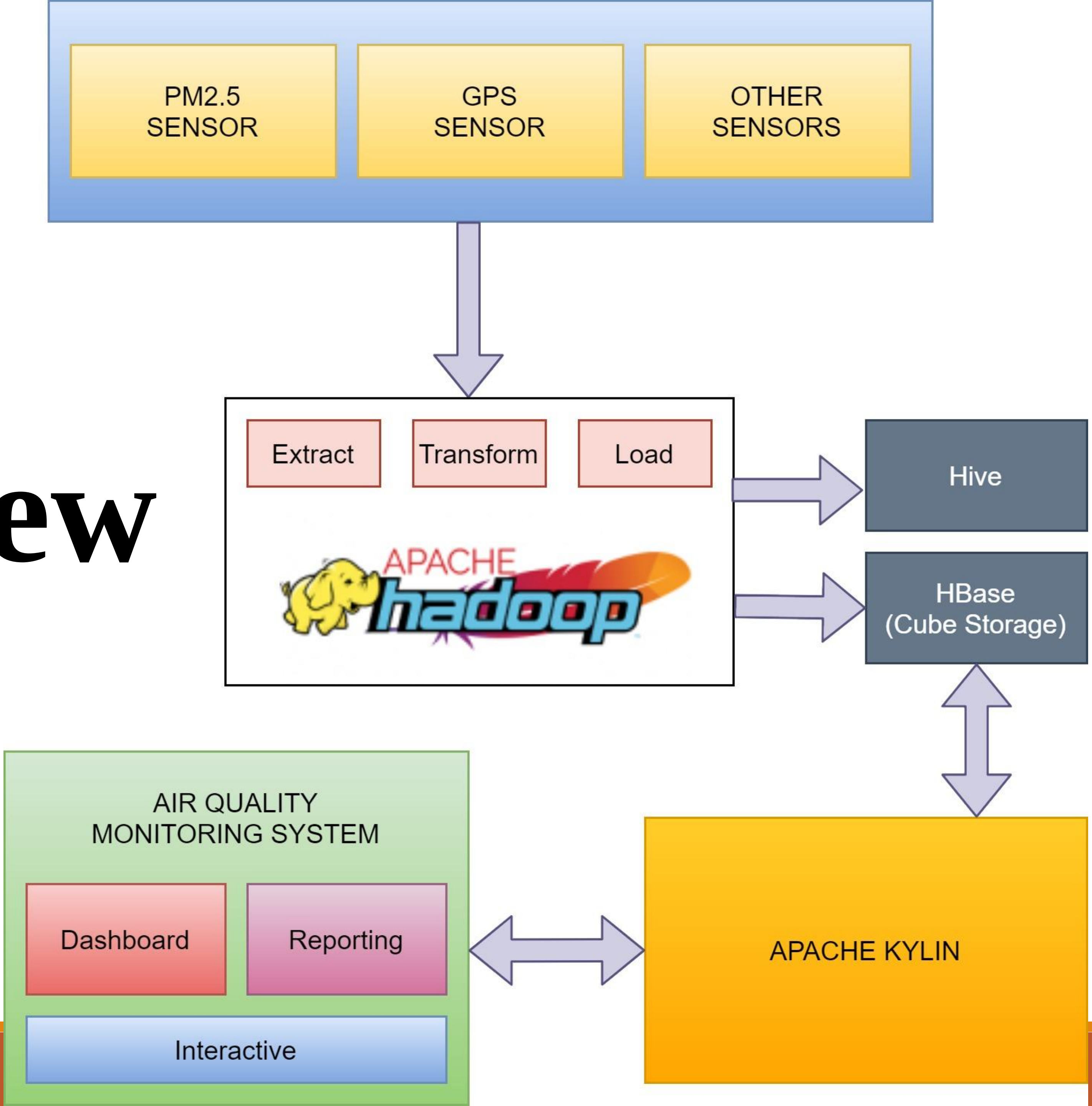
Outlines

1. Introduction
2. Software architecture
3. Design goals and trade-offs
4. Access Matrix
5. Framework/Library
6. User Acceptance Test Report
7. The status of the implementation
8. Real Demo

Introduction



Overview


PM2.5
SENSOR
GPS
SENSOR
OTHER
SENSORS
Extract
Transform
Load
APACHE
hadoop
Hive
HBase
(Cube Storage)
AIR QUALITY
MONITORING SYSTEM
Dashboard
Reporting
Interactive
APACHE KYLIN

Functional requirements

Visualization Module

- The end users should be able to **view** an interactive dashboard of air quality monitoring with different forecasts and insights.
- The system should be able to **stream** real-time data from different nodes and stations.

System Admin Module

- The admin should be able to **login, logout** to the system and **modify** the system parameters and toggle dashboard controls.
- The admin should be able to register new sensors and **manage** the sensors in system.
- The admin should be able to **generate** reports of specific time periods and export those in varies formats.

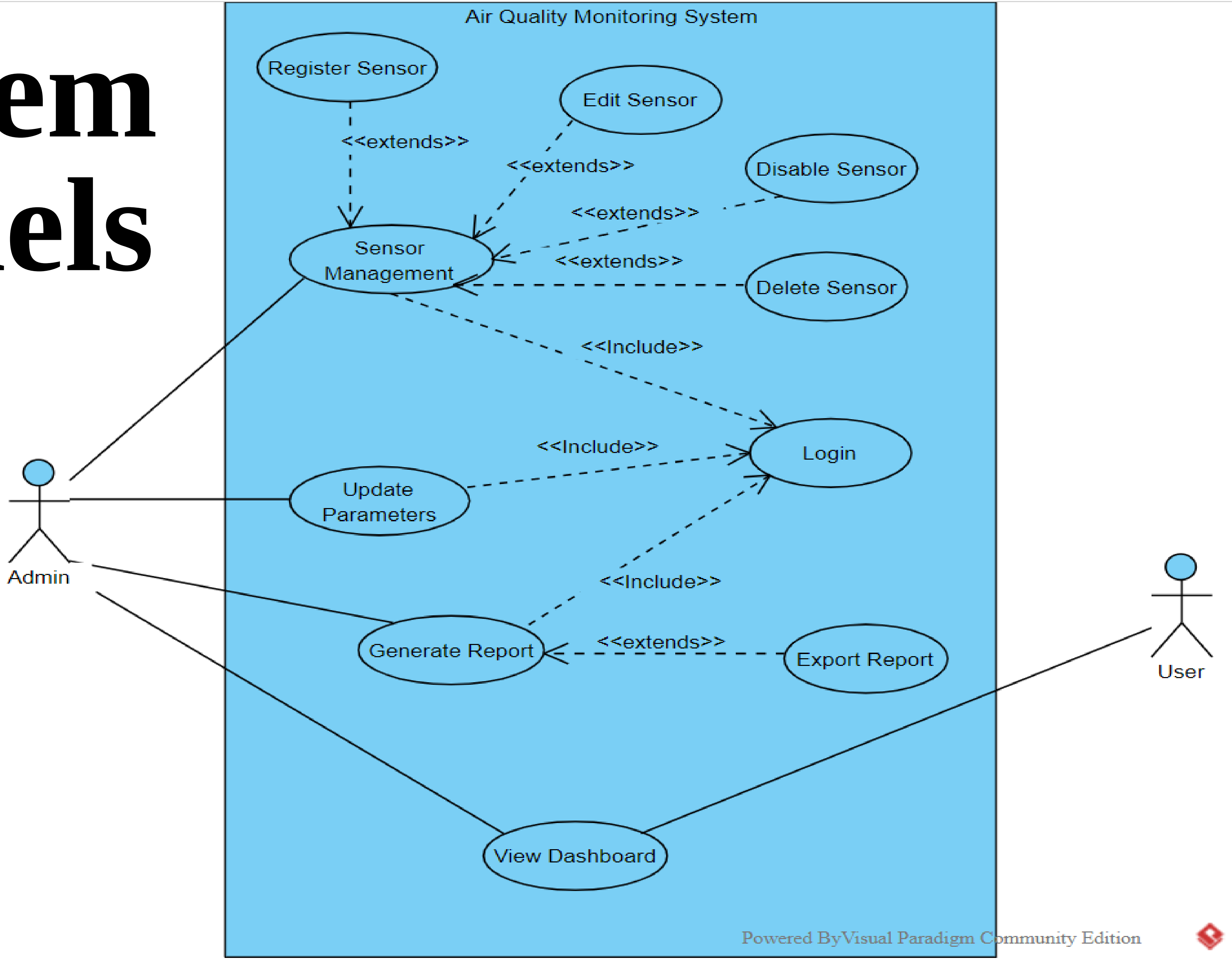
Data Collection Module

- Data will be extracted from sensors and stored in **Hadoop** which is acting as data warehouse using Hive.
- **Kylin** does aggregation functions on cube (HBase) and provide the required parameters to the system.

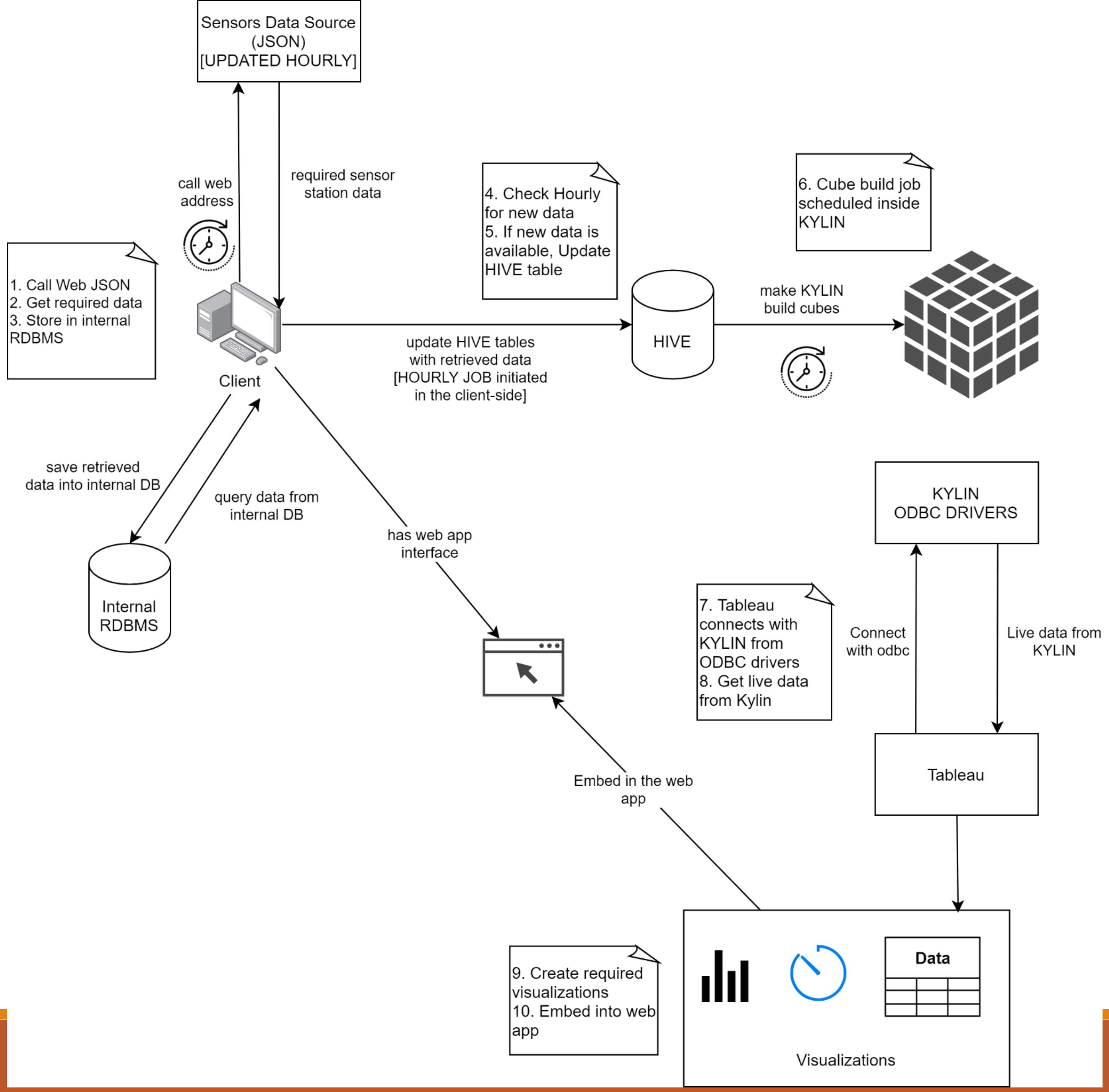
Nonfunctional requirements

- Performance
- Reliability
- Interoperability
- Portability
- Scalability
- Reusability

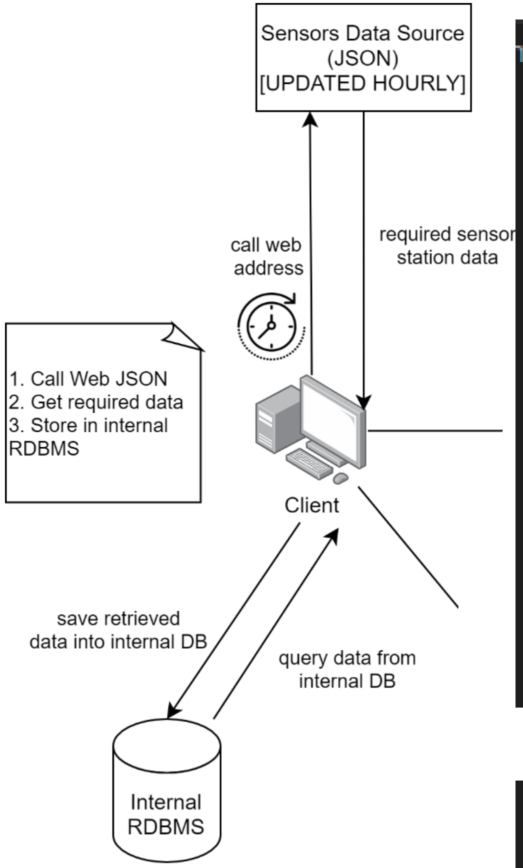
System models



Software Architecture



Data retrieval

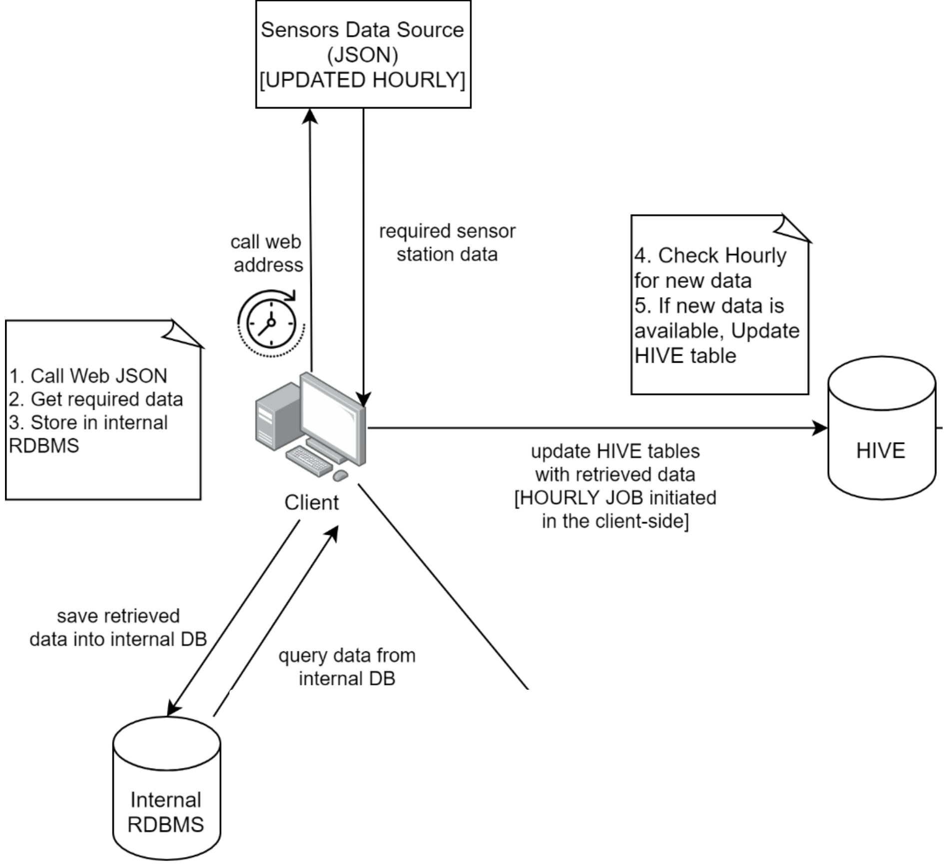


ome > srt > Documents > PythonTests > import.py > ...

```python
import csv, json, urllib, sys
from datetime import datetime
import os

# Fetch JSON from URL
url = "http://www.air4thai.com/services/getNewAQI_JSON.php"
response = urllib.urlopen(url)
web_data = json.loads(response.read())
web_data = web_data["stations"]


# Create our custom dictionary
data = []
for wd in web_data:
```

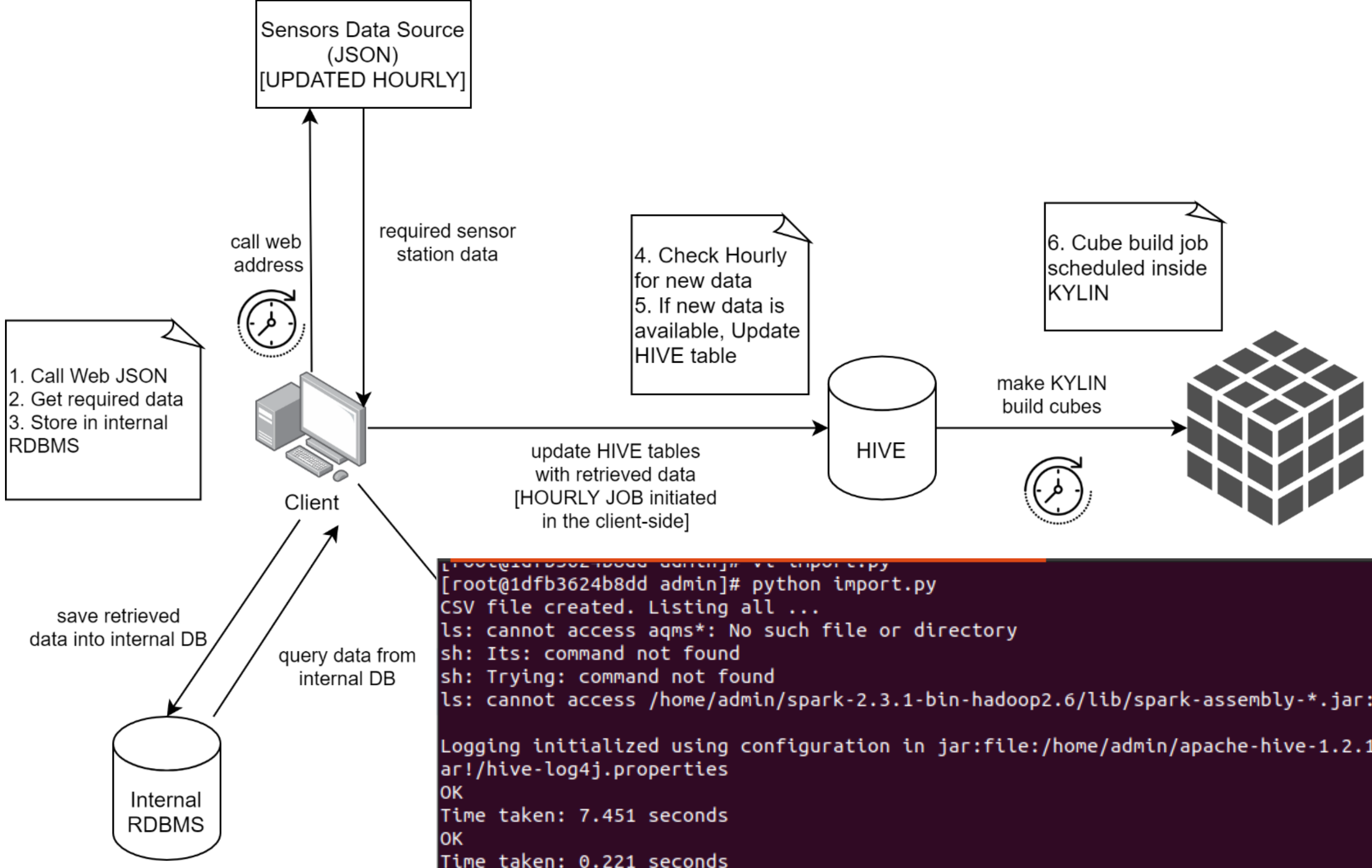
```python

# output.writerow(data[0].keys()) # Header row

for row in data:
    output.writerow(row.values()) # Values row


# Run shell script to run this file
os.system("echo CSV file created. Listing all ...")
os.system("ls -l aqms*")
os.system("Its time to connect to hive and copy this file into it")

# Load data into HIVE
os.system("Trying to load this generated file into HIVE TABLE")
os.system("hive -f load_aqms.sql")
os.system("hive")
```

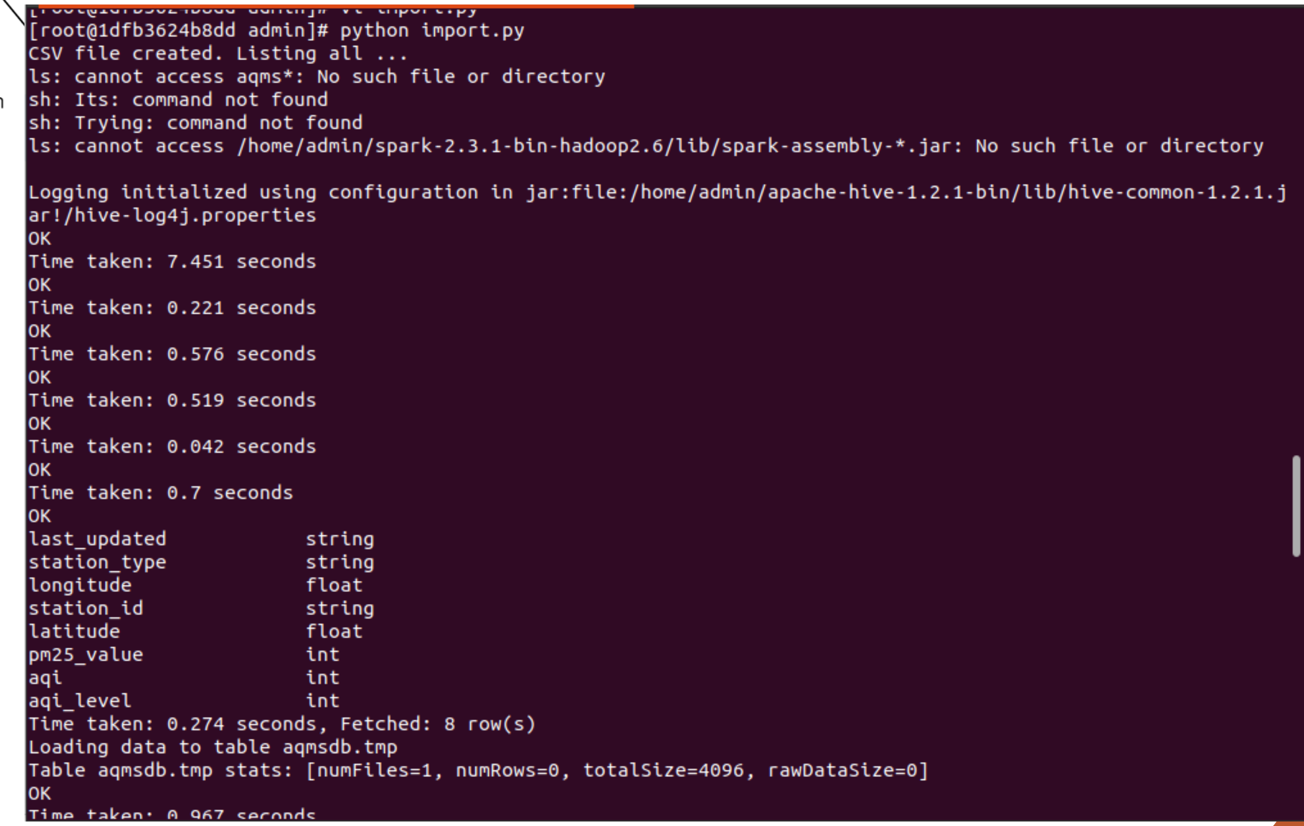
Data Loading and Transformation



```sql
CREATE TABLE IF NOT EXISTS aqmsdb.tmp (
    last_updated STRING,
    station_type STRING,
    longitude FLOAT,
    station_ID STRING,
    latitude FLOAT,
    PM25_value INT,
    AQI INT,
    AQI_level INT
)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
STORED AS TEXTFILE;

describe aqmsdb.tmp;

load data local inpath '/home/admin/test_data.csv' overwrite into table aqmsdb.tmp;

CREATE TABLE IF NOT EXISTS aqmsdb.aqms (
    last_updated TIMESTAMP,
    station_type STRING,
    longitude FLOAT,
    station_ID STRING,
    latitude FLOAT,
    PM25_value INT,
    AQI INT,
    AQI_level INT
);

describe aqmsdb.aqms;

INSERT INTO TABLE aqmsdb.aqms
SELECT from_unixtime(unix_timestamp(last_updated, 'yyyy-MM-dd HH:mm')), station_type, longitude, s

select * from aqmsdb.aqms LIMIT 5;
```

Building Cube





Search hive tables and view permissions

127.0.0.1:50070/explorer.html#/user/hive/warehouse/aqmsdb.db

Hadoop Overview Datanodes Snapshot Startup Progress Utilities

Browse Directory

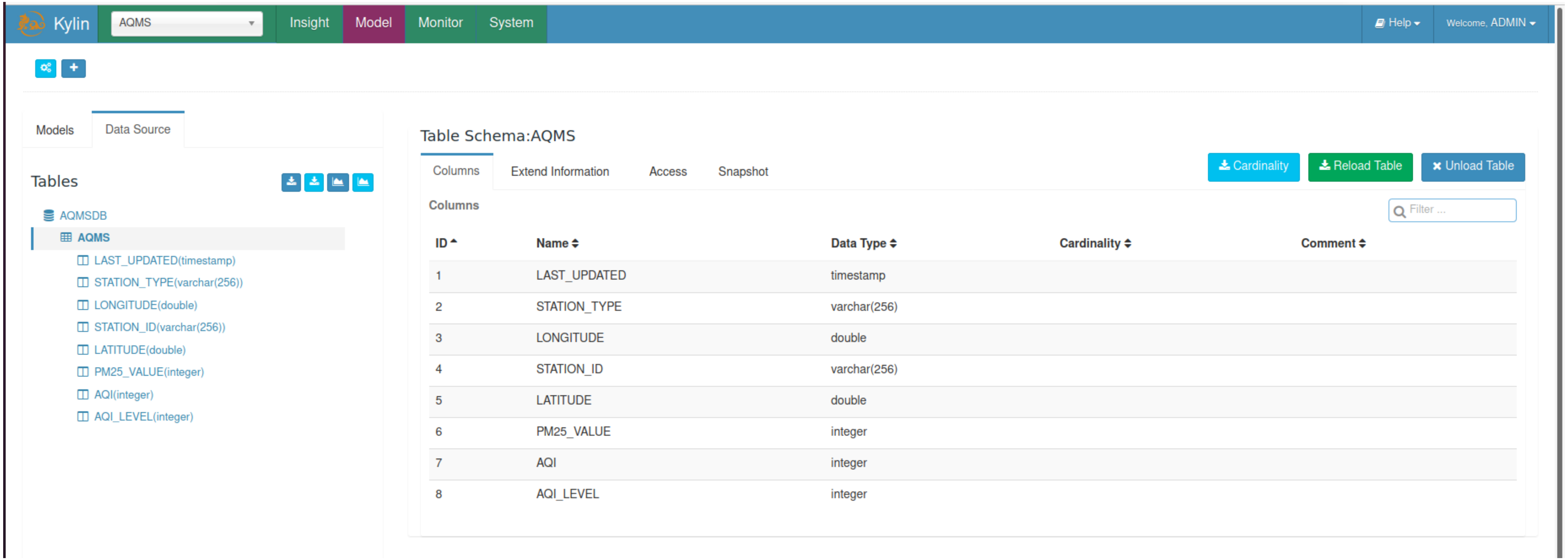
/user/hive/warehouse/aqmsdb.db Go!

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
drwxr-xr-x	root	supergroup	0 B	4/29/2021, 12:48:21 PM	0	0 B	aqms
drwxr-xr-x	root	supergroup	0 B	4/29/2021, 12:47:41 PM	0	0 B	tmp

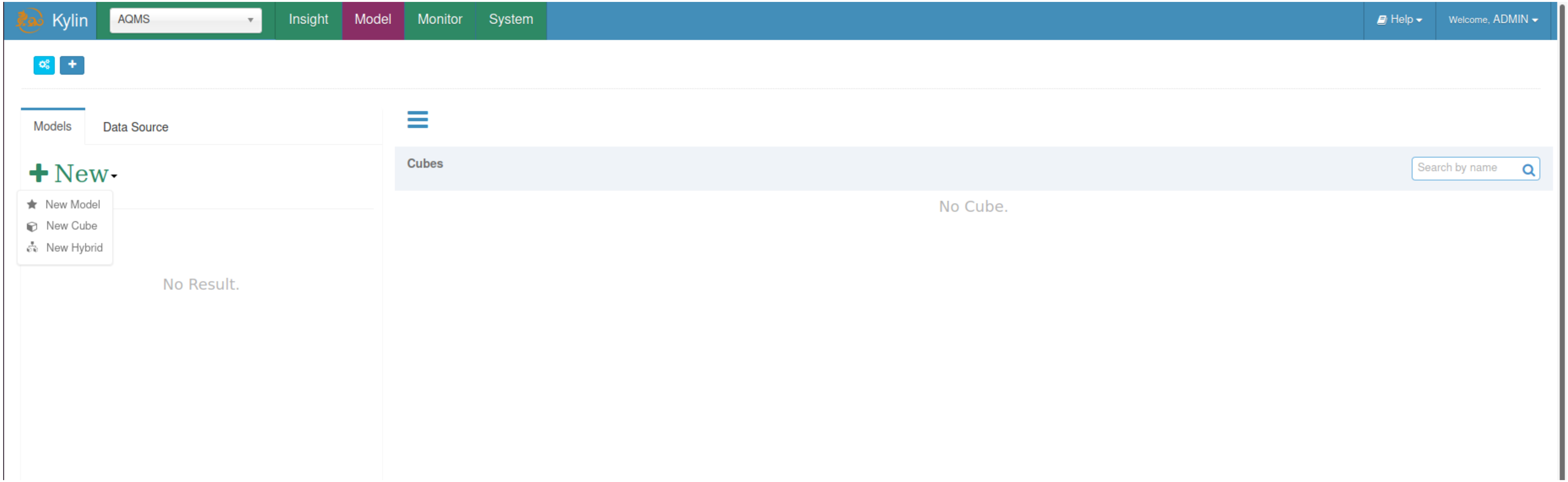
Hadoop, 2014.

Load the table in Kylin from HIVE by navigating to data source

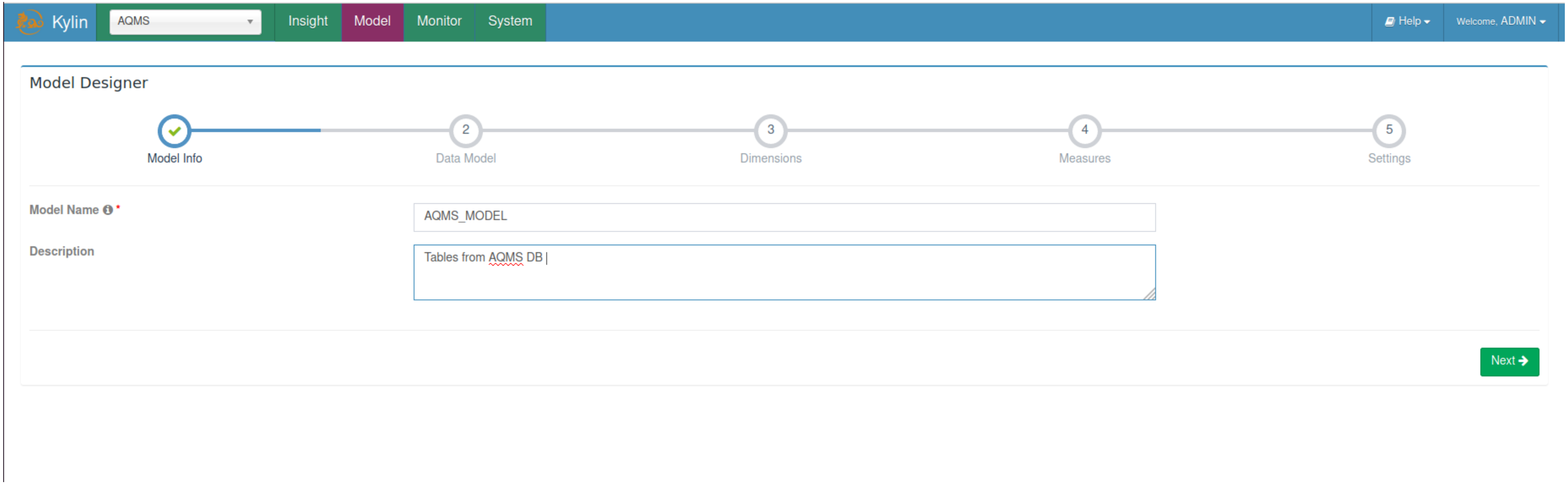
Table Schema displayed after the table is synced from HIVE



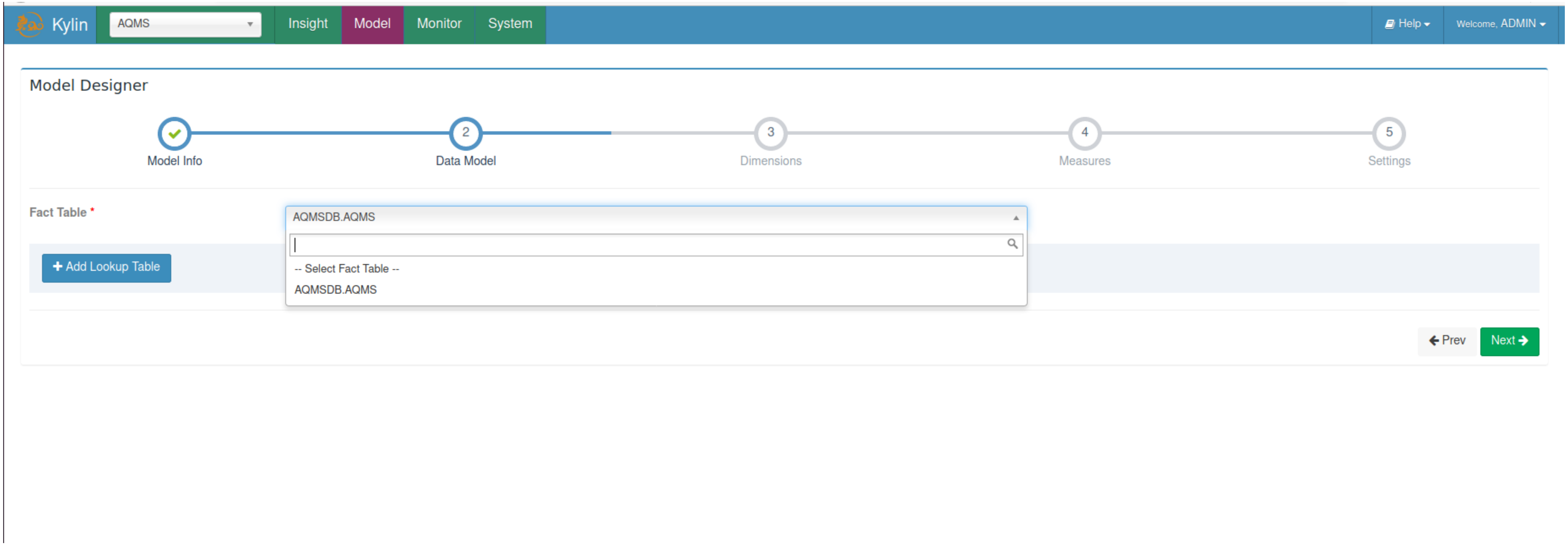
Create new Model



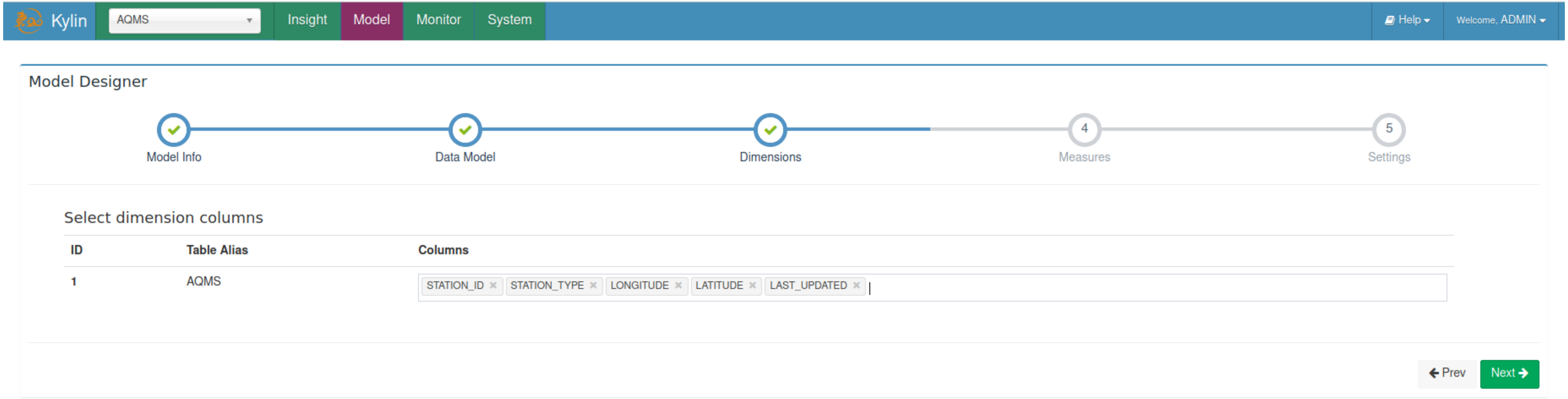
Enter model info



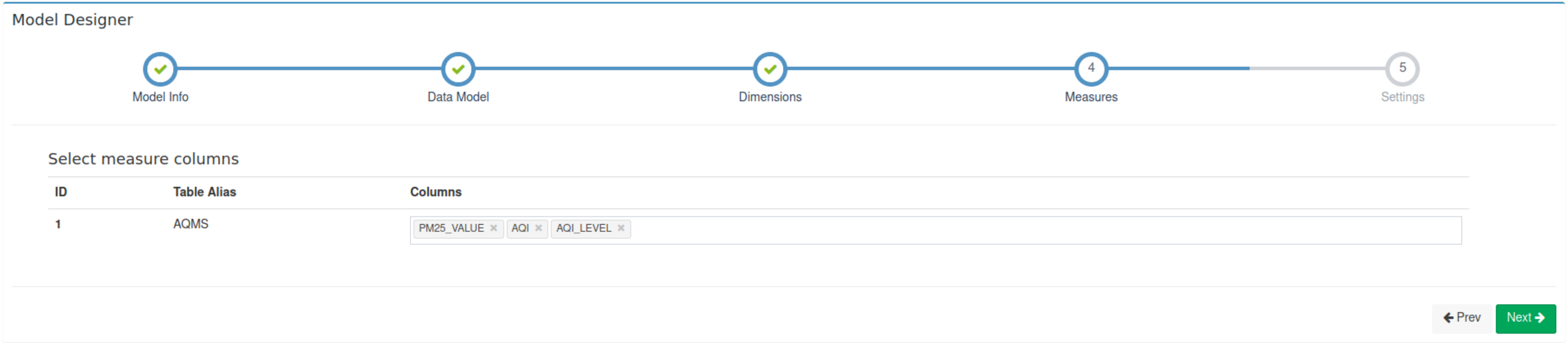
Add the fact table or base table from where all the dimension and measures are set



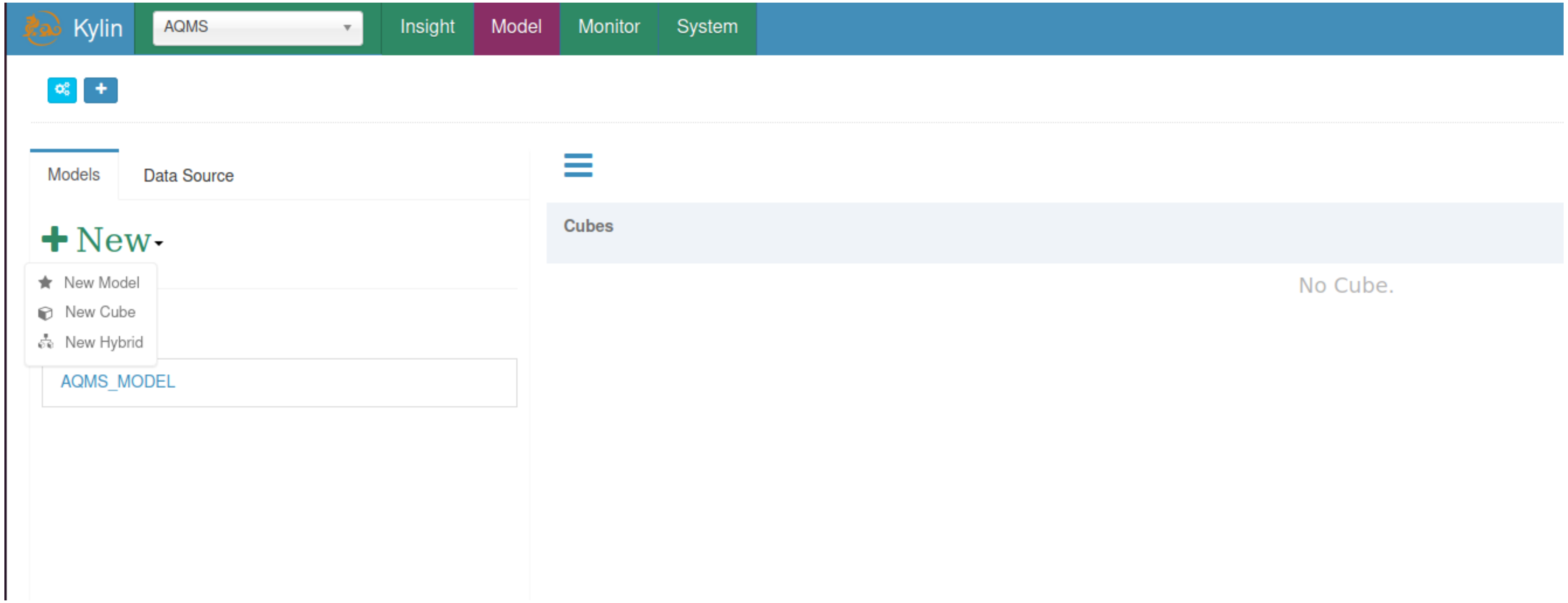
Set dimensions for the model



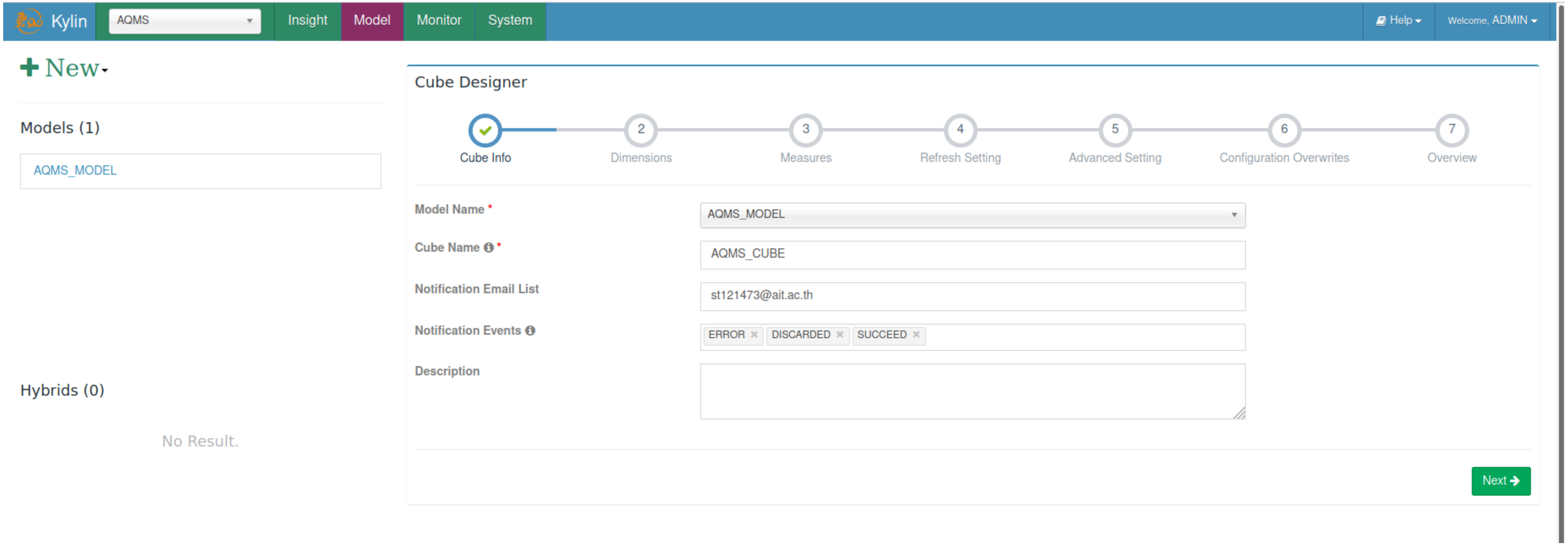
Set measure columns for the model



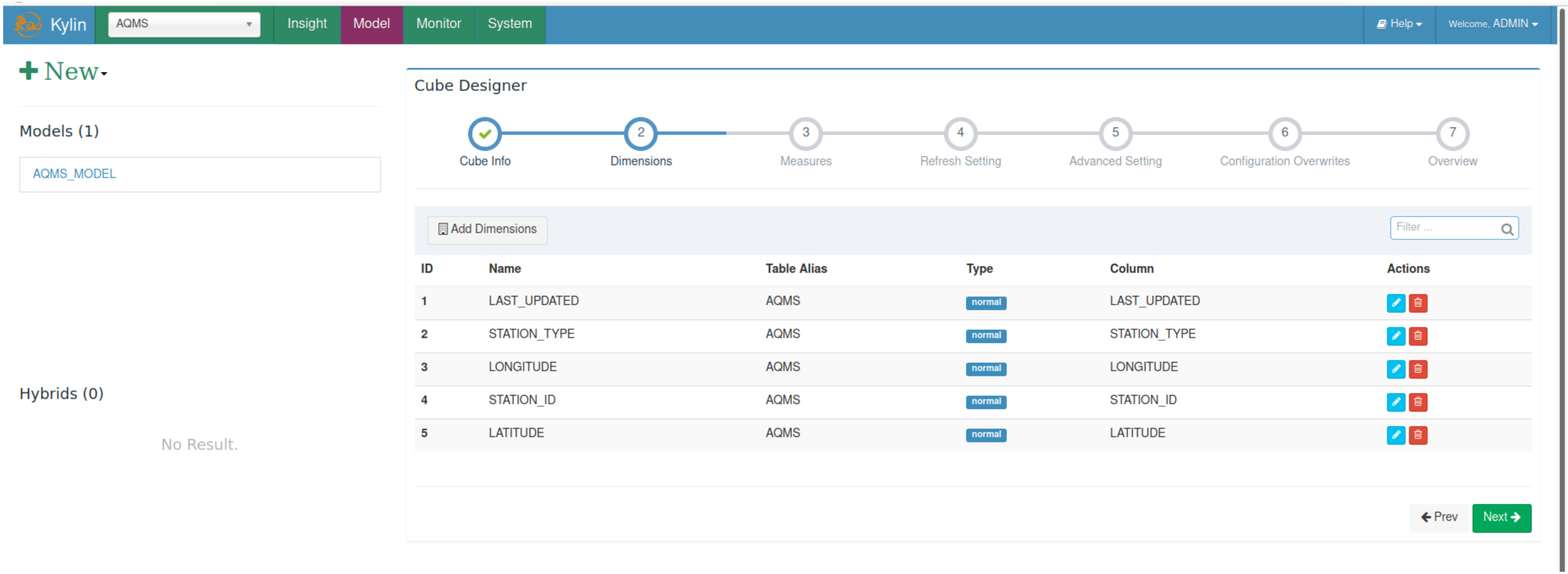
Create a new cube once the model is created



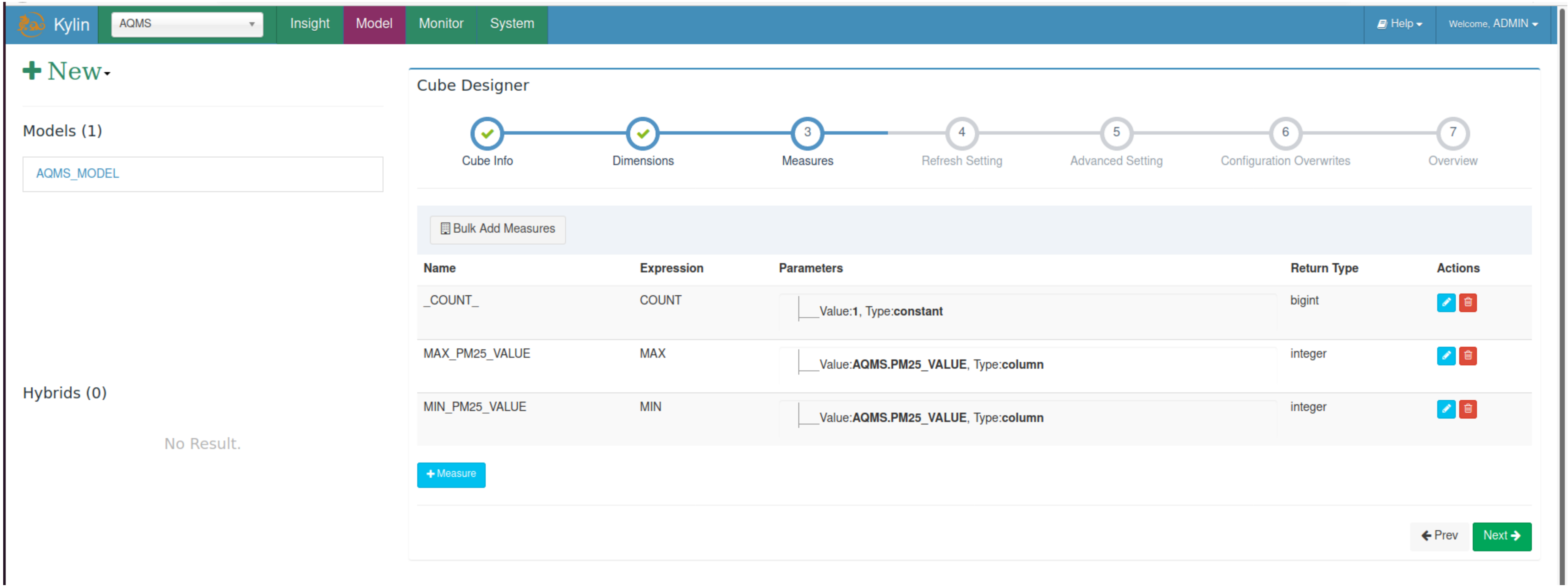
Set cube info



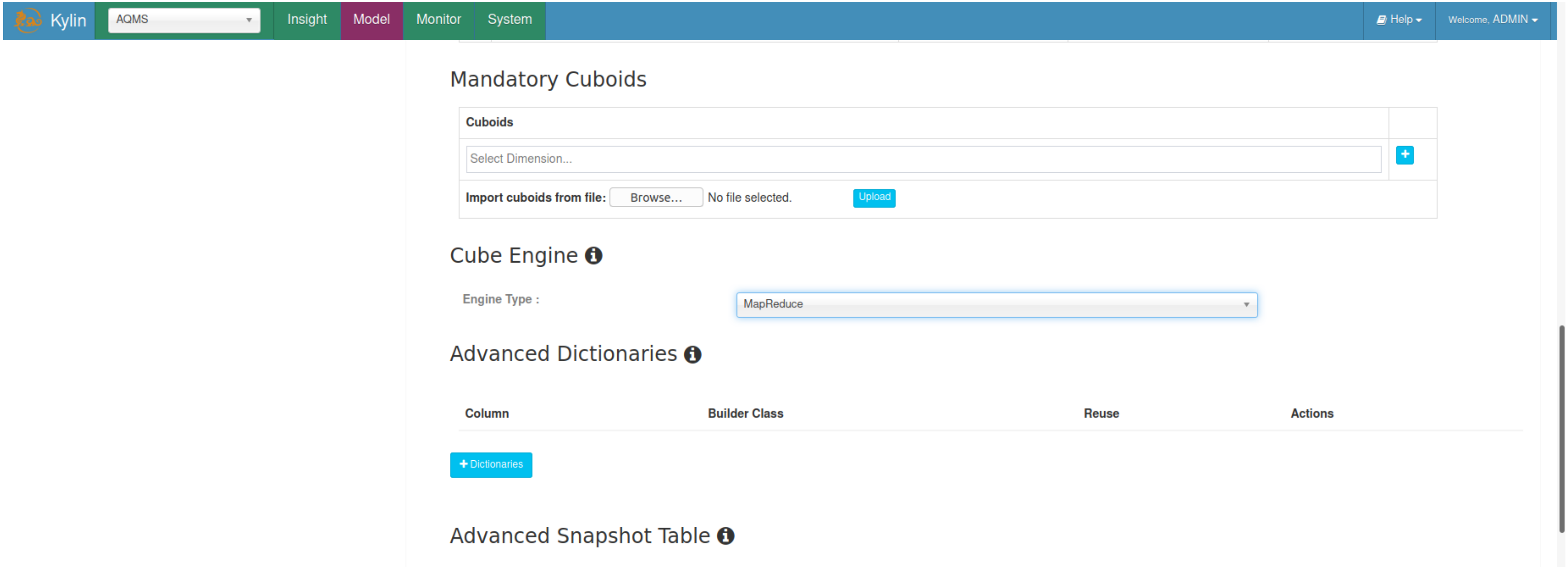
Select the dimension from the set dimension of the model



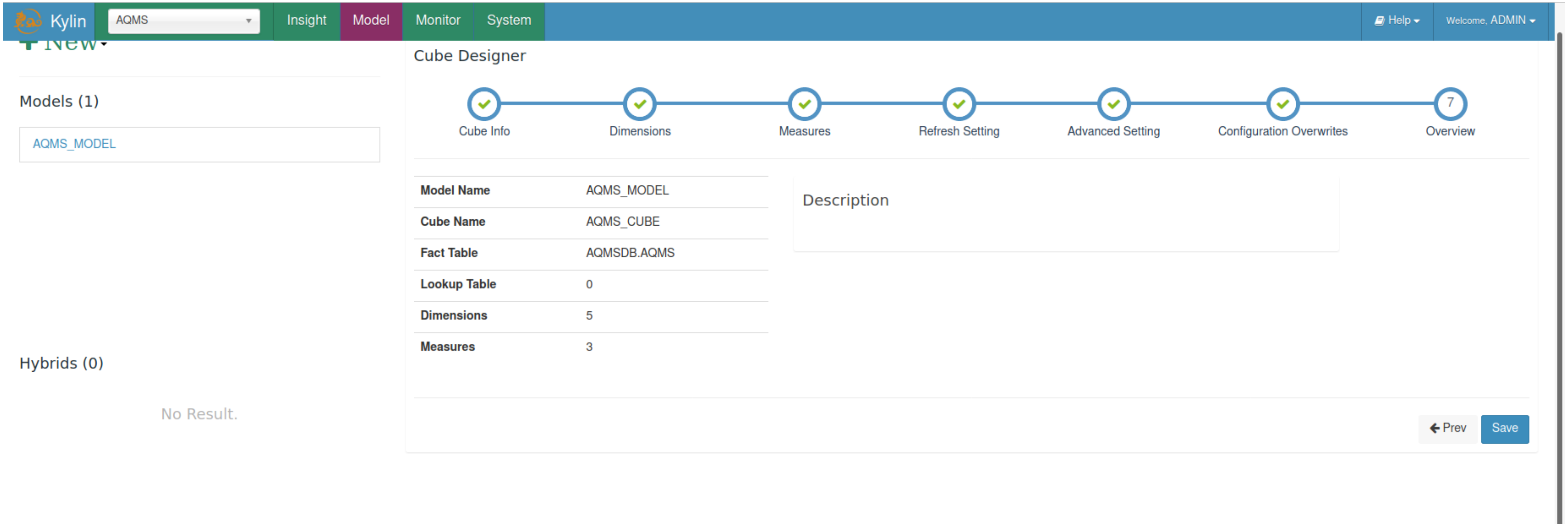
Select bulk measure for the measures



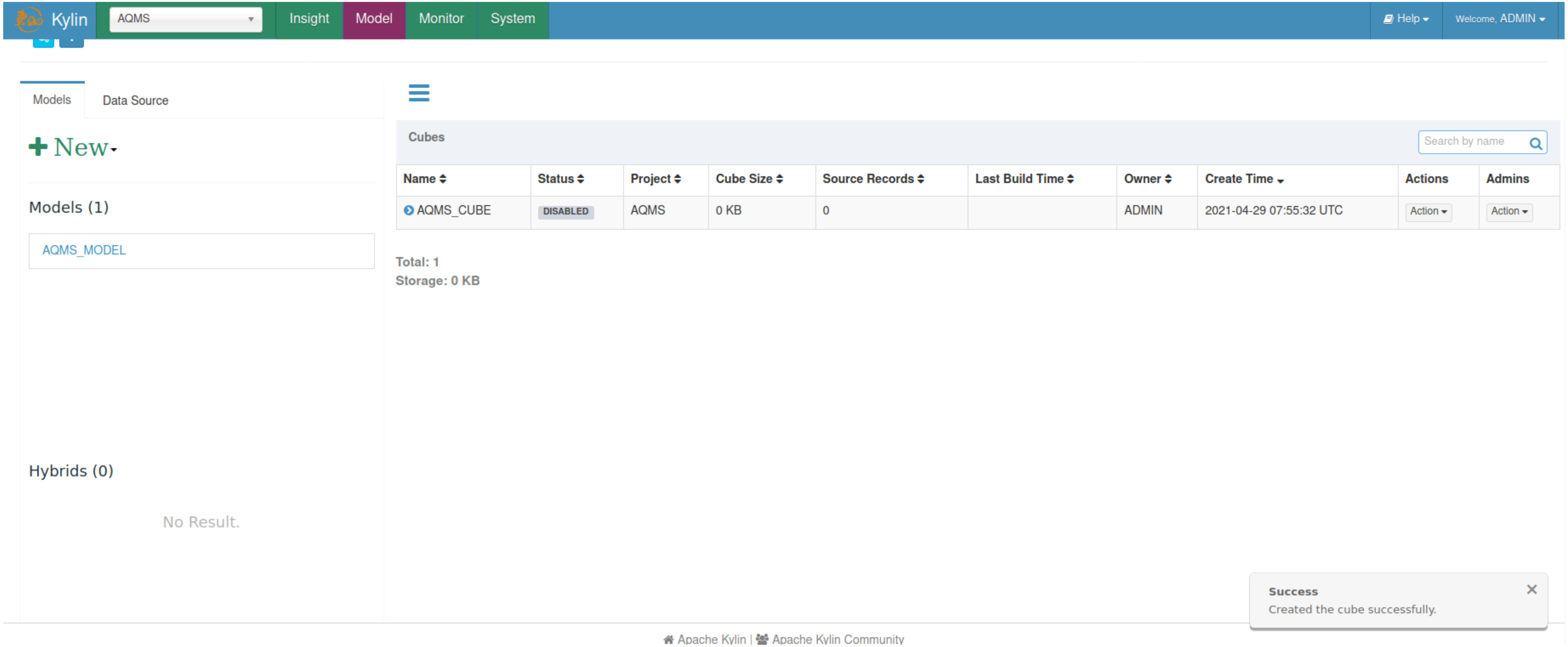
Select cube engine for the cube data



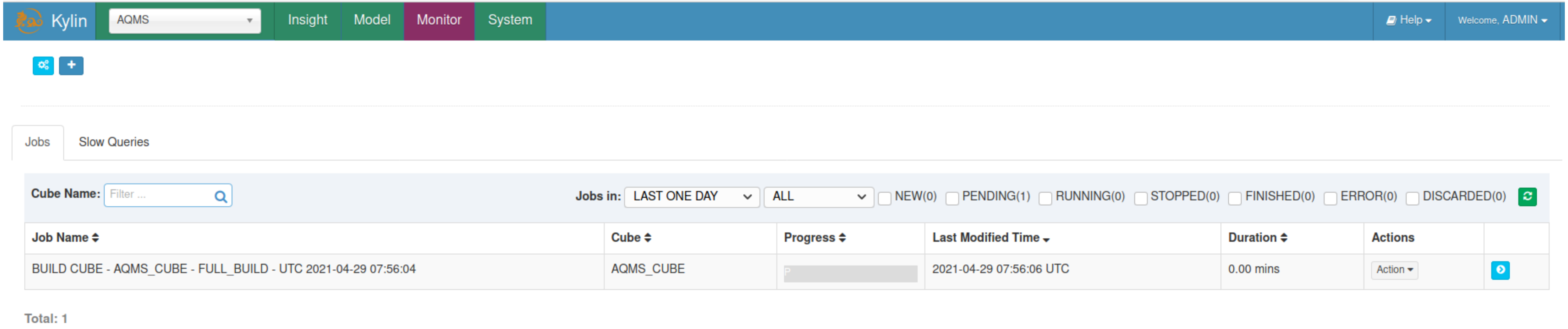
Cube info preview



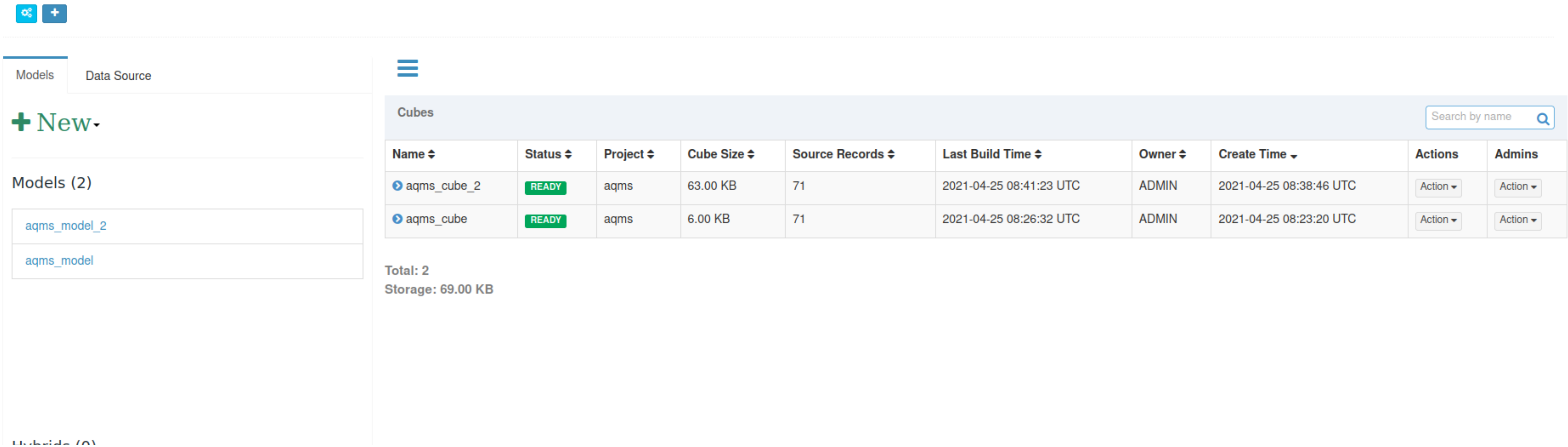
Cube is created and is in disabled status



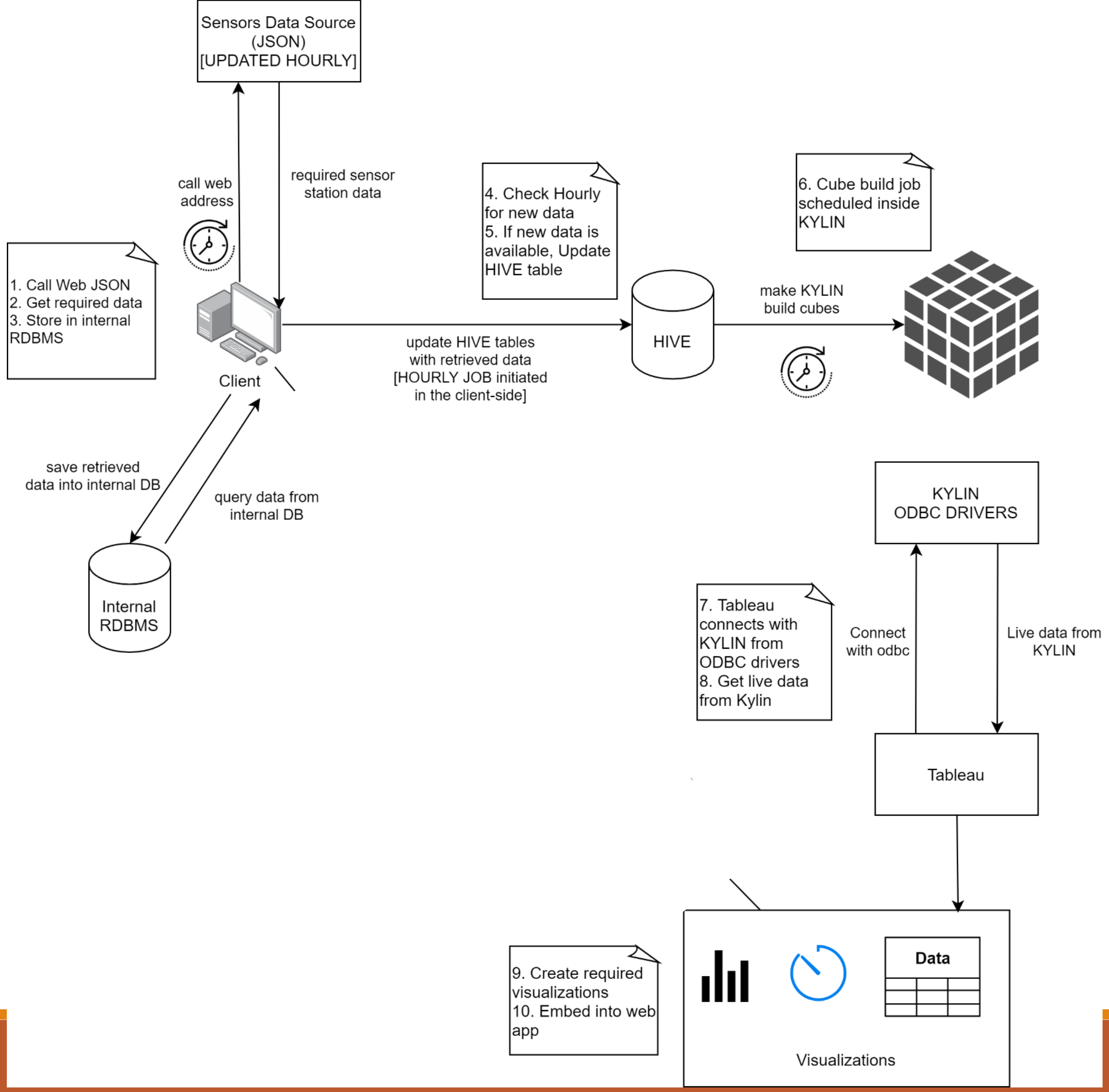
Start build process for cube and track in monitor tab



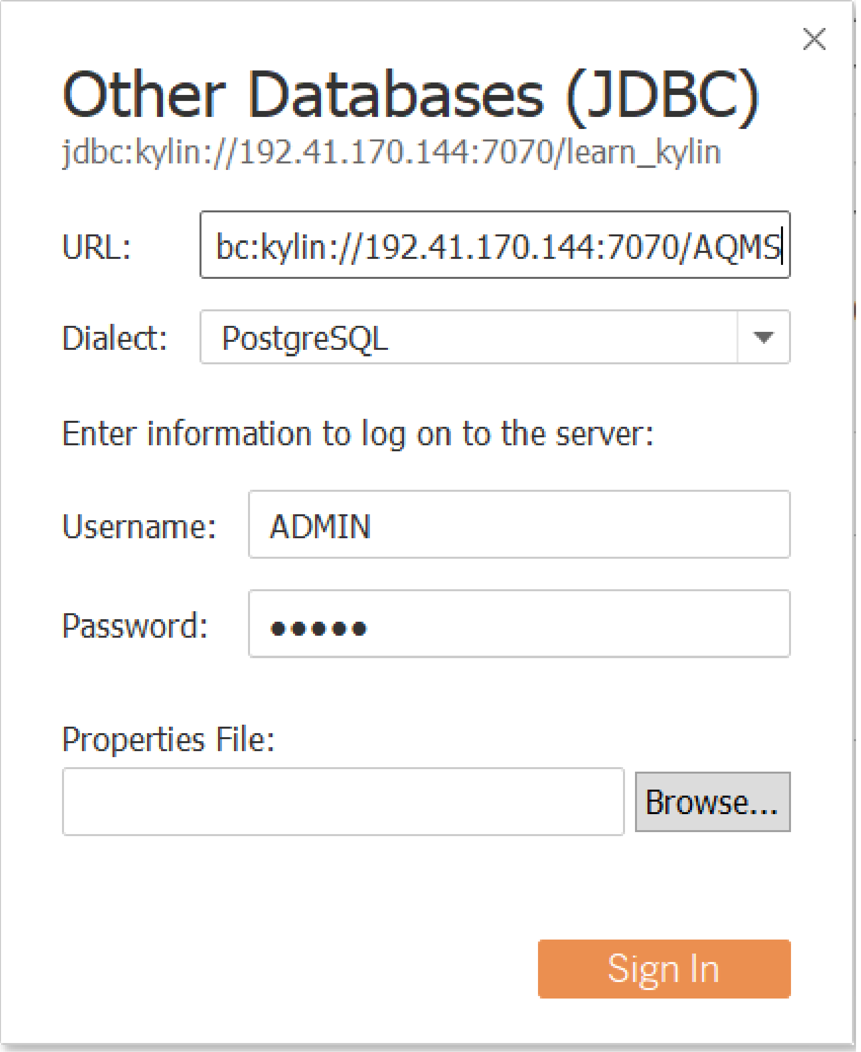
Once the cube is building is completed it’s in ready status



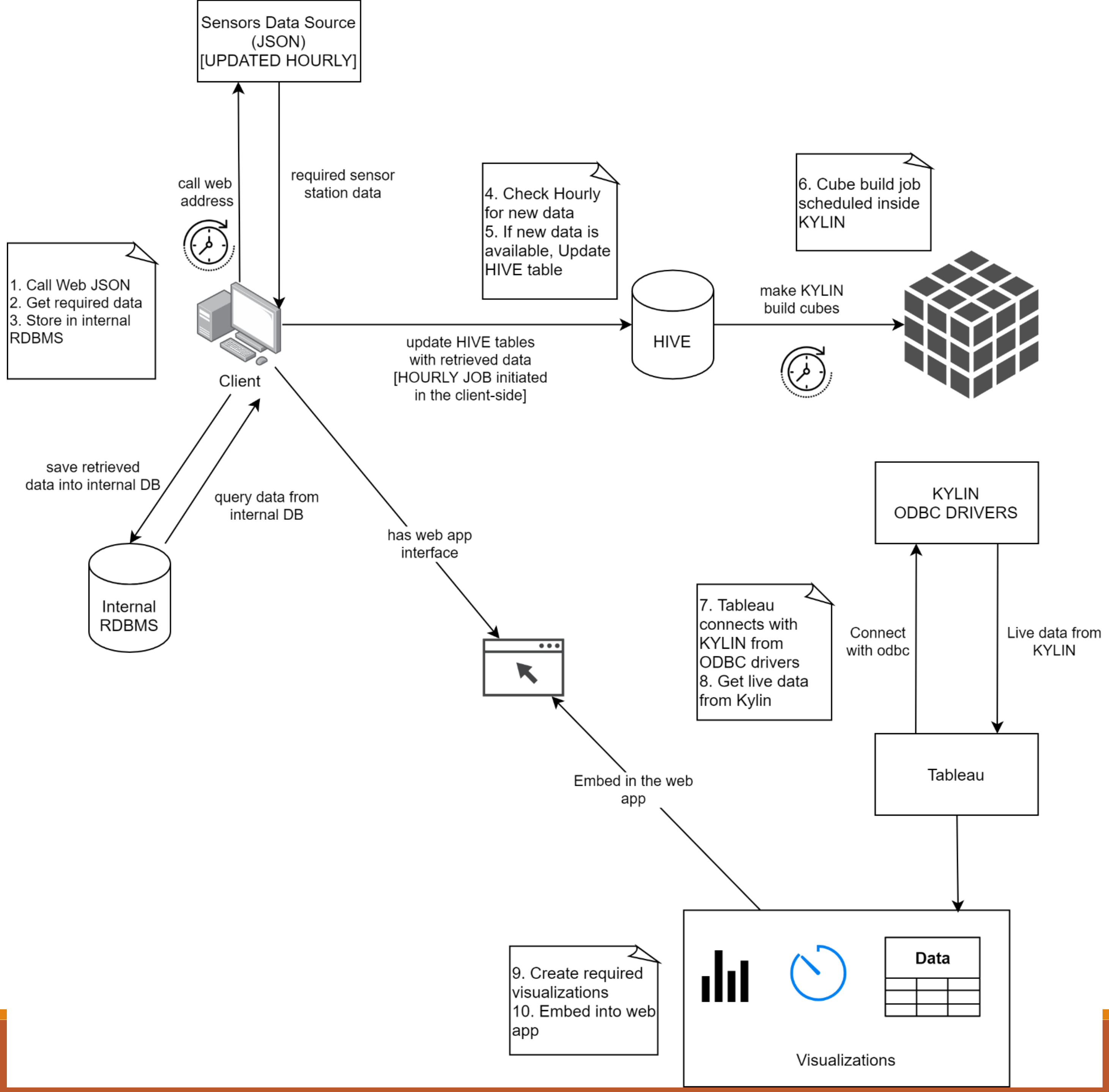
Connecting Kylin and Tableau



```
shubhi@shubhi-VirtualBox:~$ docker exec -it ts bash
[root@da9a4c6d8313 /]# ls
anaconda-post.log  dev  home  lib64  mnt  proc  run   srv  tmp  var
bin                etc  lib   media  opt  root  sbin  sys  usr
[root@da9a4c6d8313 /]# cd opt
[root@da9a4c6d8313 opt]# ls
tableau
[root@da9a4c6d8313 opt]# cd tableau
[root@da9a4c6d8313 tableau]# ls
docker_build  tableau_driver  tableau_server
[root@da9a4c6d8313 tableau]# cd tableau_driver
[root@da9a4c6d8313 tableau_driver]# lls
bash: lls: command not found
[root@da9a4c6d8313 tableau_driver]# ls
jdbc  postgresql-odbc
[root@da9a4c6d8313 tableau_driver]# cd jdbc
[root@da9a4c6d8313 jdbc]# ls
kylin-jdbc-3.1.0.jar
[root@da9a4c6d8313 jdbc]#
```

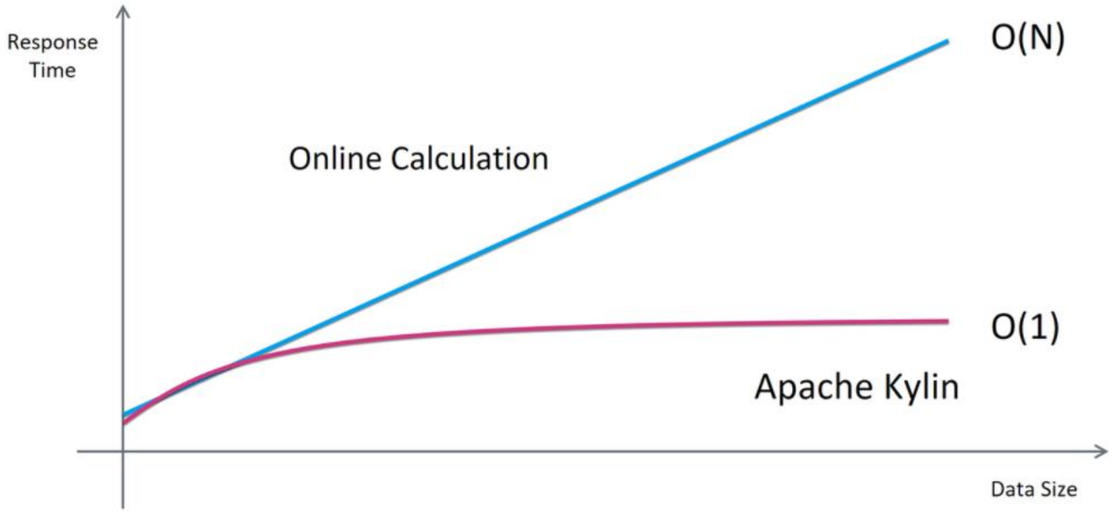

Other Databases (JDBC)
jdbc:kylin://192.41.170.144:7070/learn_kylin
URL:
bc:kylin://192.41.170.144:7070/AQMS
Dialect:
PostgreSQL
Enter information to log on to the server:
Username:
ADMIN
Password:
Properties File:
Browse...
Sign In

Software Architecture



Apache Kylin

- Run Kylin with Docker
- Connecting Tableau Desktop and Tableau Server with Apache Kylin



Framework/Library

spring
SECURITY

HIBERNATE

JDBC

Maven™

spring
BOOT

ROBOT
FRAMEWORK

APACHE
JMeter™

Design goals and trade-offs

Quality attributes	Priority Rating (L, M, H)	Priority Justification
Performance	H	The system shall be designed with high performance level to handle concurrent or multiple information from sensors which are placed at different locations in real time. Large numbers of data collected from the sensor should be displayed on the responsive web application and we need to focus on concurrency, response time and block time. ✓ The application should respond to a user within 2 seconds. ✓ The application should be able to handle **100 transactions per second in the peak load time**.
Usability	H	Once the system is deployed, the maintenance of the system including tasks such as monitoring the system, repairing problems that arise, updating or upgrading software components, should be easy to be sufficiently performed by any person with a basic understanding of the dashboard system. ✓ The web app should be **easy to operate by users with a certain navigation menu or option**. No need for a user manual.

Design goals and trade-offs

Portability	M	The system shall be designed in a way that allows it to be run on multiple computers with different browsers. As it is a web application, mobile phone web browsers can also access the application. ✓ The web app must support latest Web browsers for any OS. ✓ The web app should be responsive.
Reliability	M	Reliability is one of the key attributes of the system. Back-ups will be made regularly so that restoration with minimal data loss is possible in the event of unforeseen events. The system will also be thoroughly tested to ensure reliability. ✓ The system should be able to restore backward data of 24 hours (maximum 3 Days) within 2 hours as a recovery function.
Scalability	L	With data, the storage size will increase but can be managed with time. This app can be made horizontally scalable when there are issues of memory storage.

Access Matrix

Access Rights

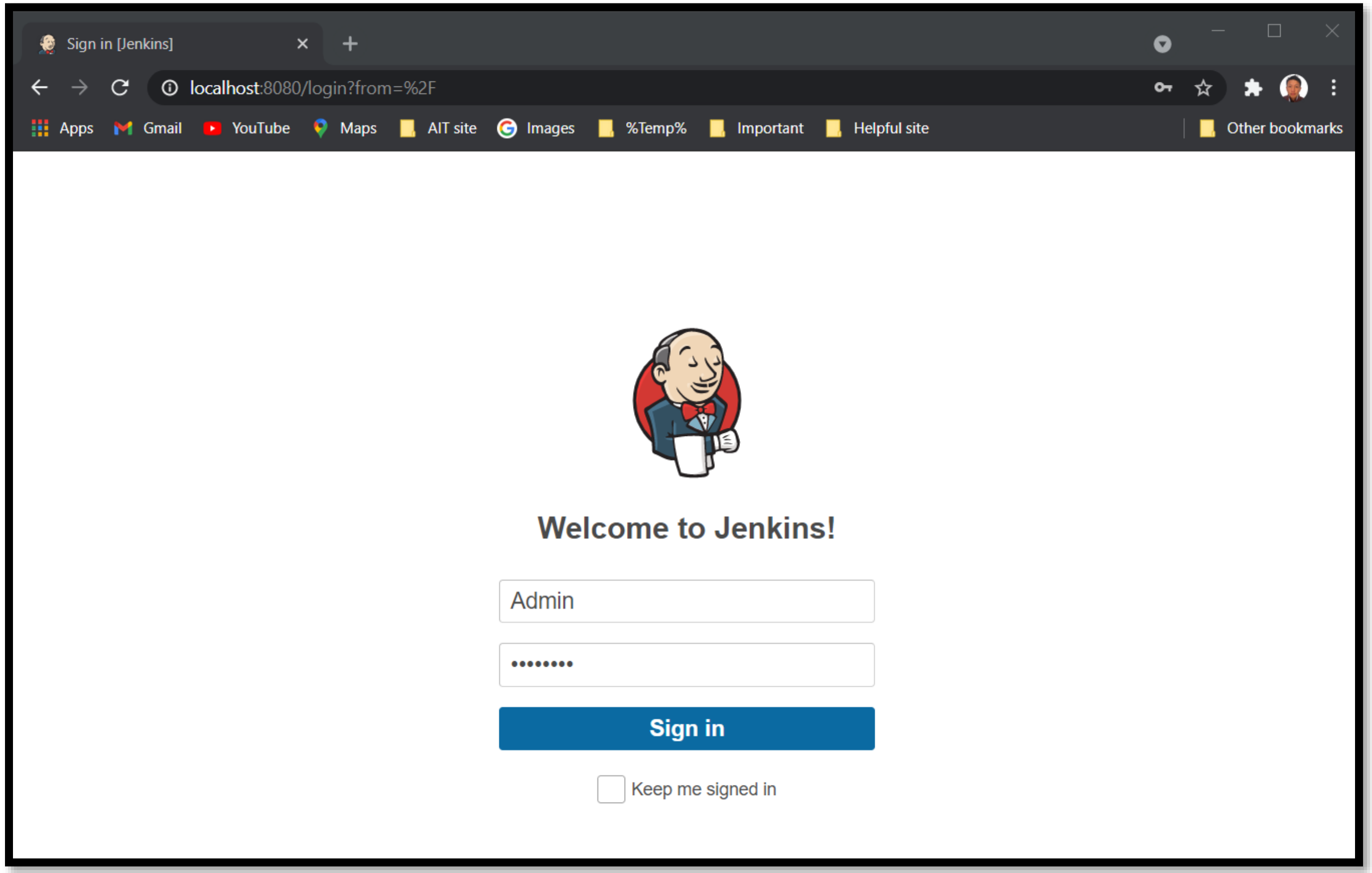
Classes

Table 1. Access Matrix

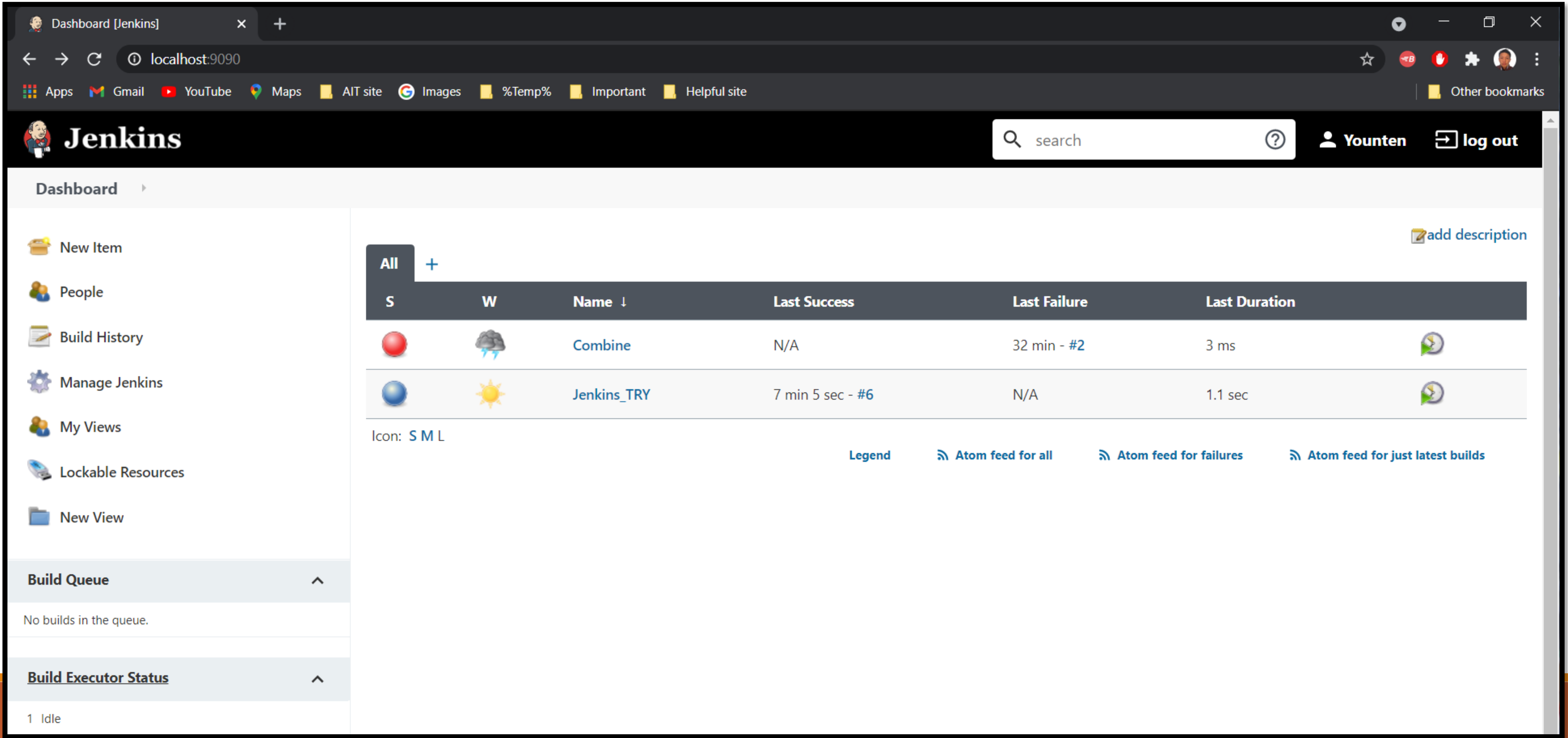
Actors

	Dashboard	System Setting
Admin	viewDashboard () generateReport ()	registerSensor () updateParameter () activateSensor ()
Users (Public)	viewDashboard ()	

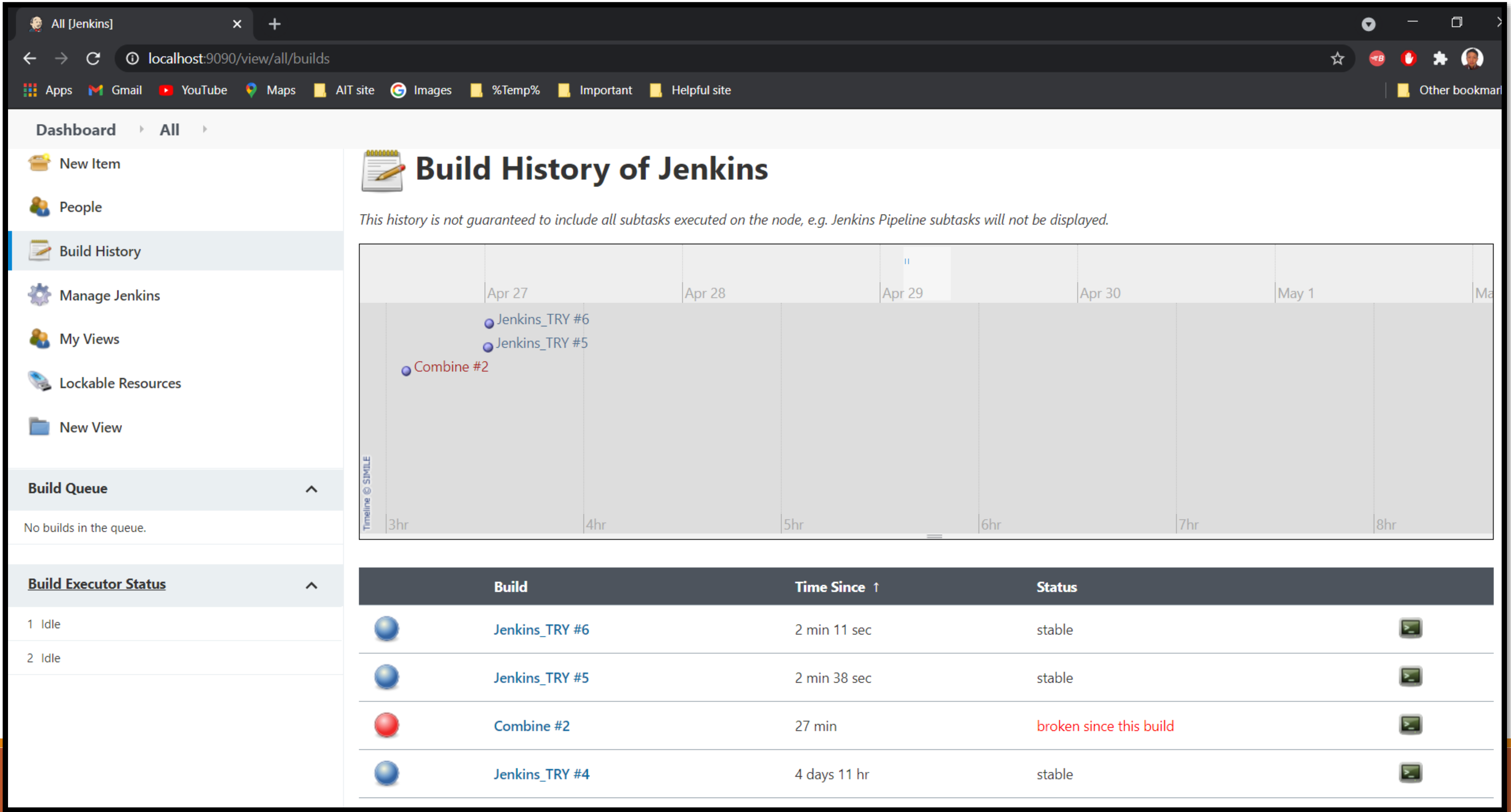
Continuous integration



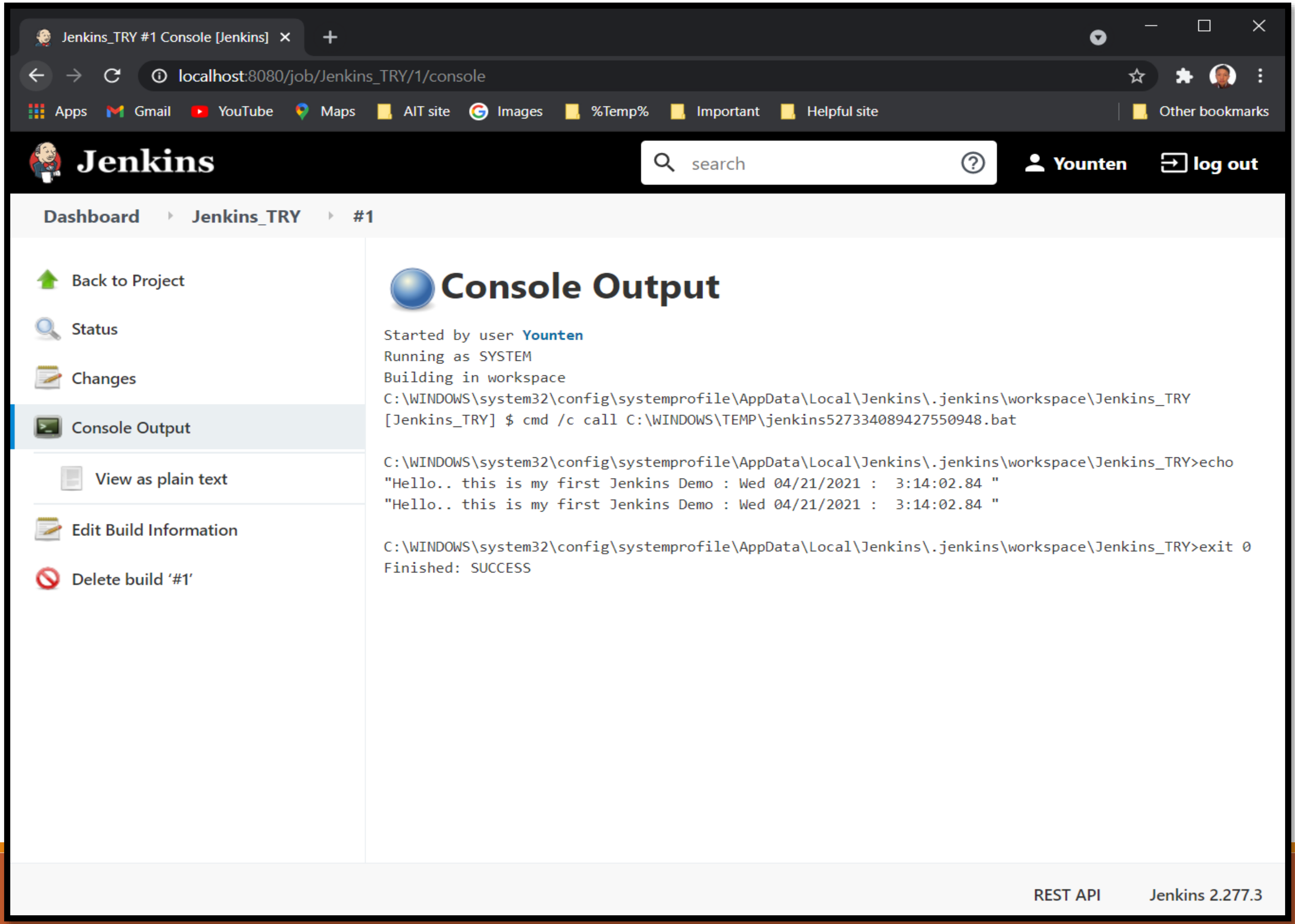
Creating Pipeline



Build and Build History



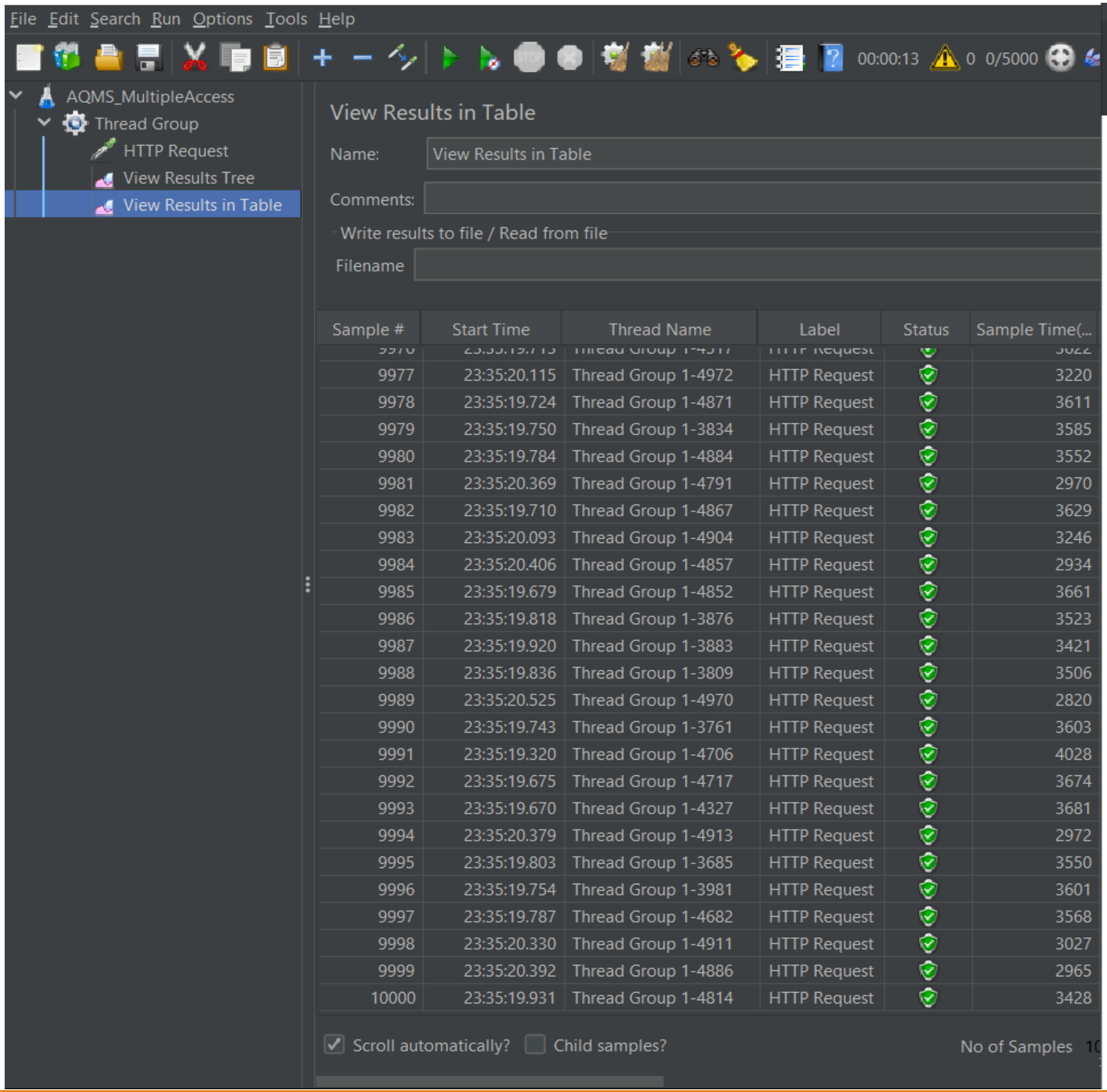
Result

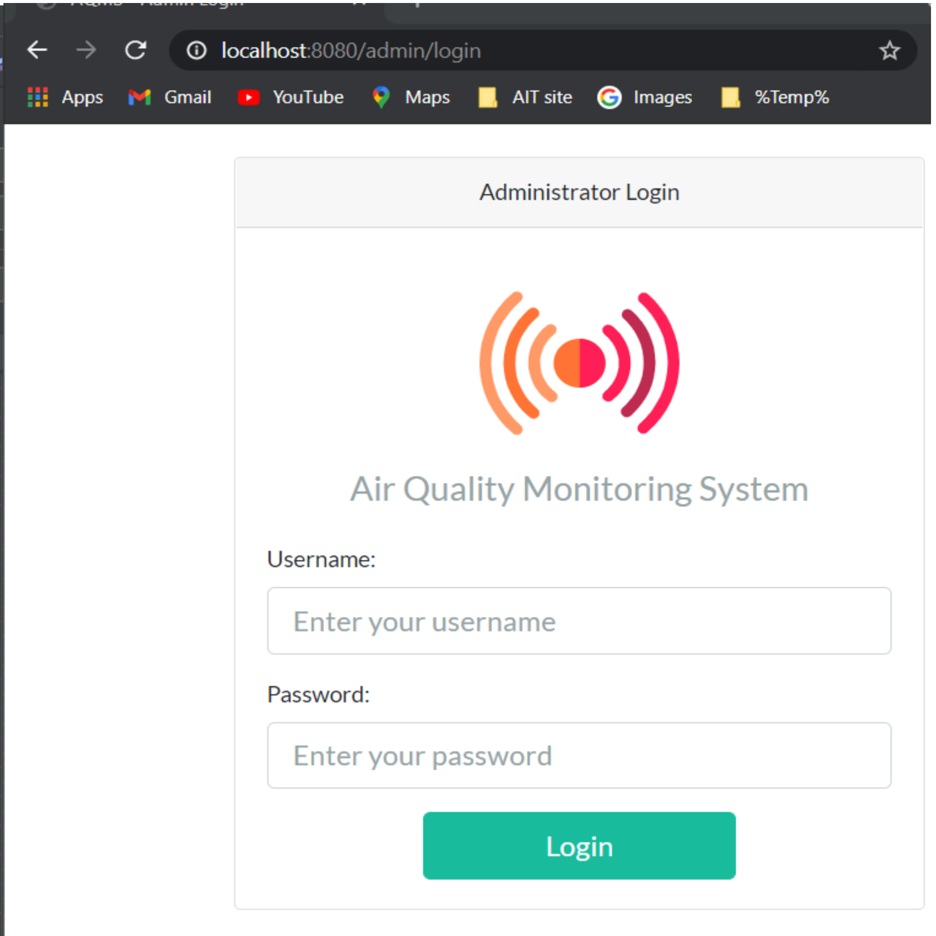

Jenkins_TRY #1 Console [Jenkins]
localhost:8080/job/Jenkins_TRY/1/console
Apps Gmail YouTube Maps AIT site Images %Temp% Important Helpful site Other bookmarks
Jenkins
search
Younten
log out
Dashboard
Jenkins_TRY
#1
Back to Project
Status
Changes
Console Output
View as plain text
Edit Build Information
Delete build '#1'
Console Output
Started by user Younten
Running as SYSTEM
Building in workspace
C:\WINDOWS\system32\config\systemprofile\AppData\Local\Jenkins\.jenkins\workspace\Jenkins_TRY
[Jenkins_TRY] $ cmd /c call C:\WINDOWS\TEMP\jenkins527334089427550948.bat
C:\WINDOWS\system32\config\systemprofile\AppData\Local\Jenkins\.jenkins\workspace\Jenkins_TRY>echo
"Hello.. this is my first Jenkins Demo : Wed 04/21/2021 : 3:14:02.84 "
"Hello.. this is my first Jenkins Demo : Wed 04/21/2021 : 3:14:02.84 "
C:\WINDOWS\system32\config\systemprofile\AppData\Local\Jenkins\.jenkins\workspace\Jenkins_TRY>exit 0
Finished: SUCCESS
REST API
Jenkins 2.277.3

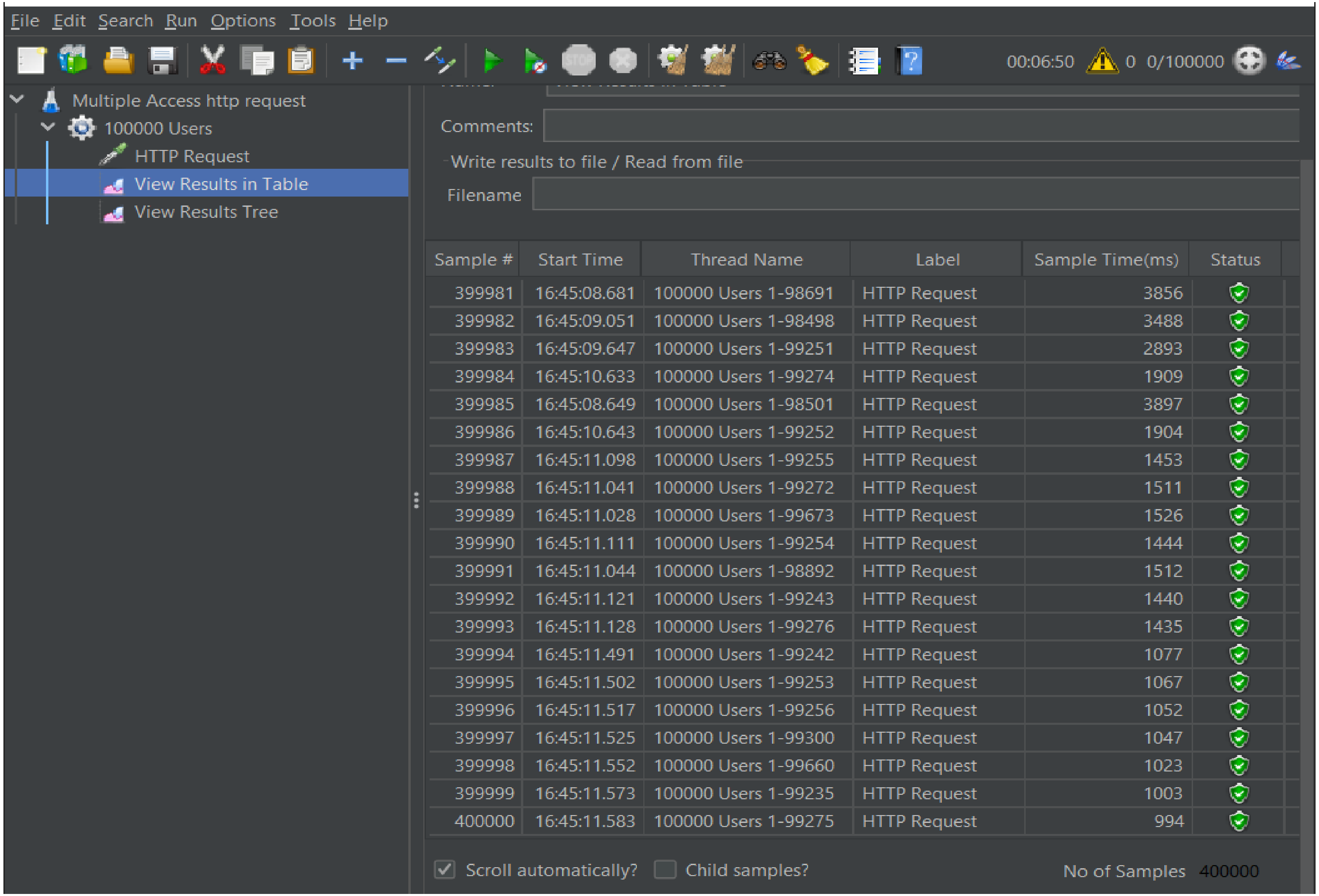
User Acceptance Test Report

- With **JMeter**, we can increase the number of concurrent users slowly or quickly throughout our test to record how performance is affected under continuous load.
- The idea behind concurrent user testing is to **identify the response of a web app for a specified number of concurrent users** making requests to our website. A concurrent user test is often used to identify bottlenecks in the performance of a website – *basically to find out how many concurrent users can make requests of a website until the performance of the site is significantly degraded.*
- **Robot Framework** is a **test automation framework** that is Python-based. Test Robot with simple webapp access by writing the script in VS Code with robot file extension and running will **show test case pass or fail**.

Test multiple access

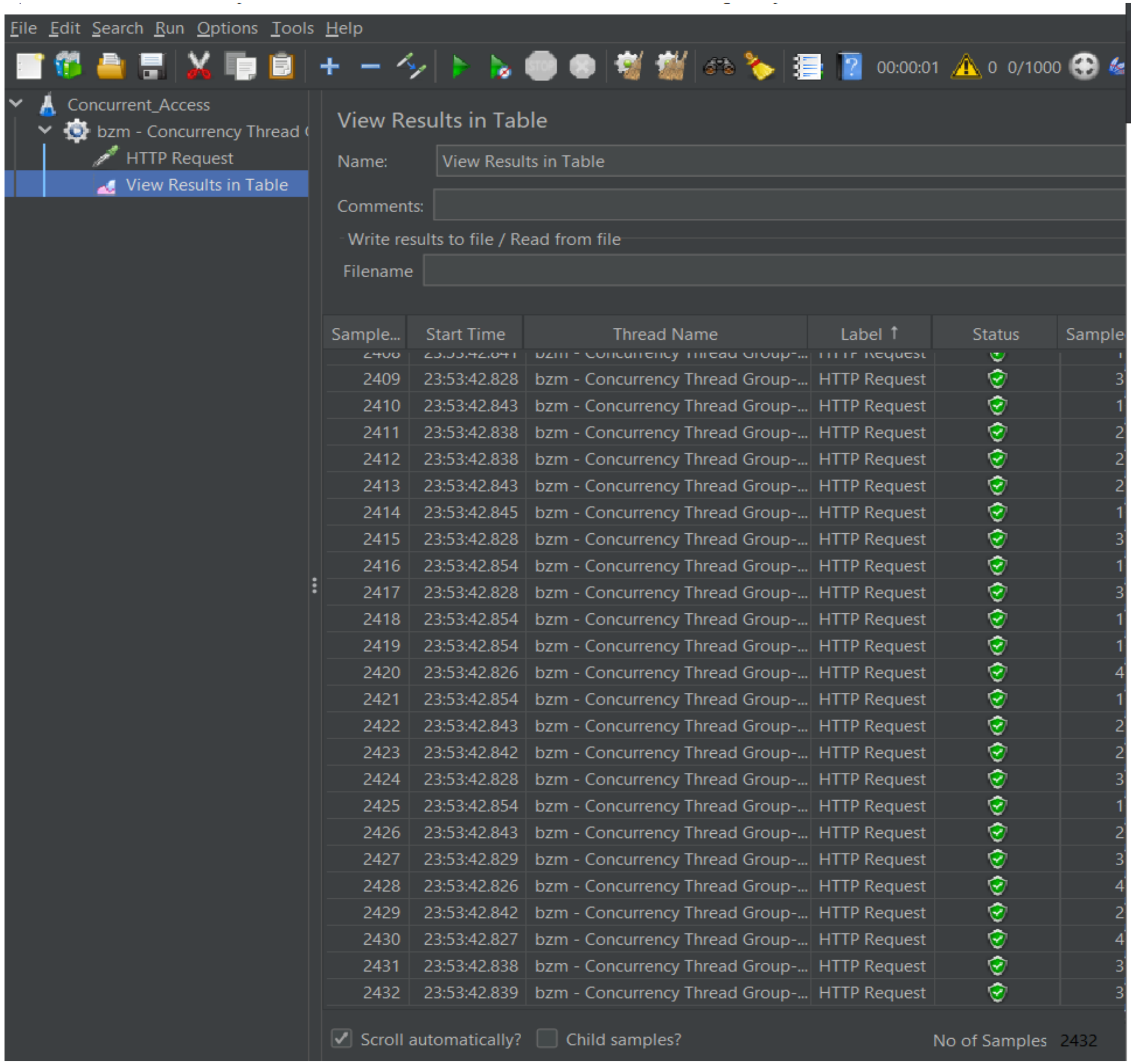


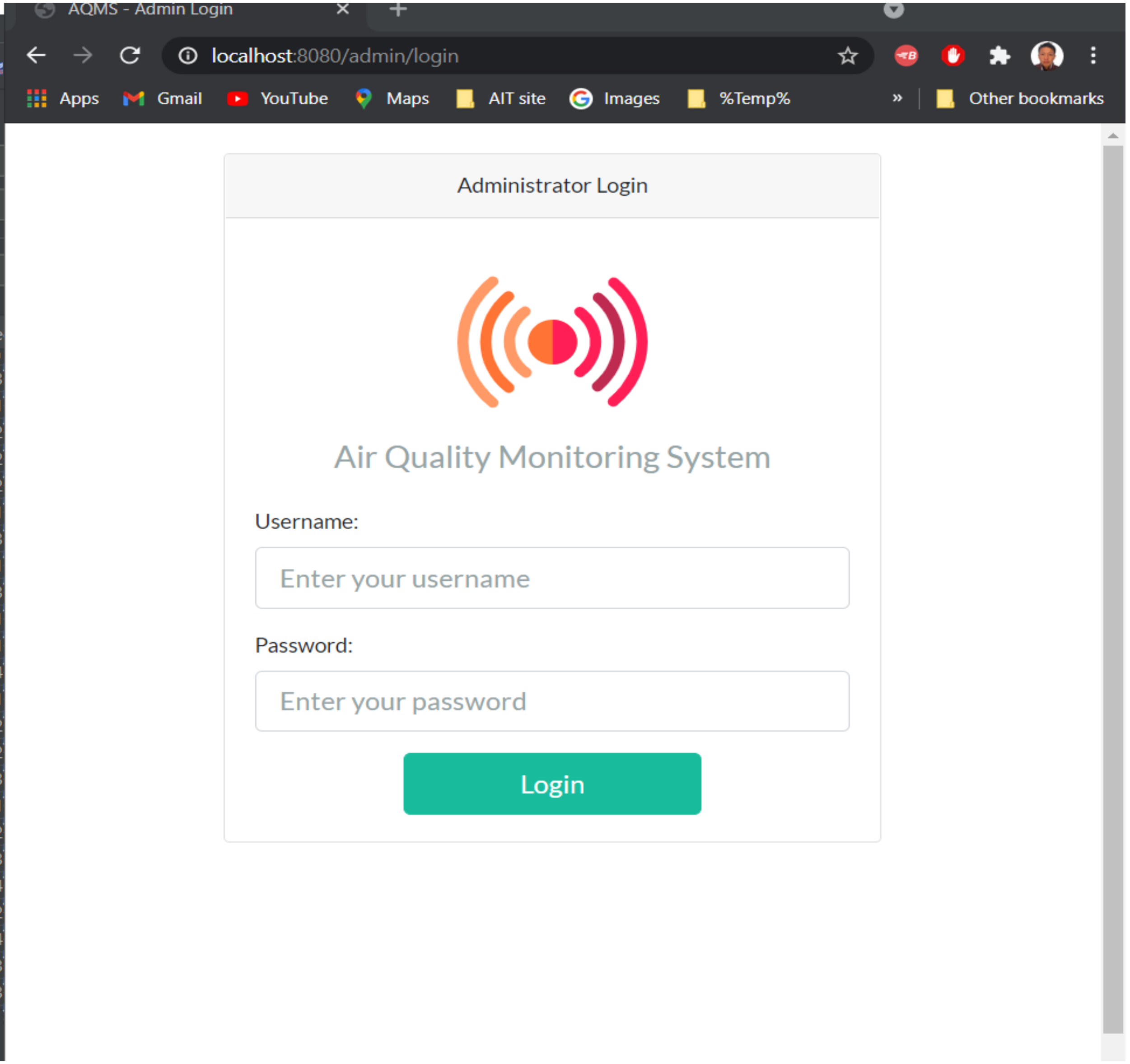




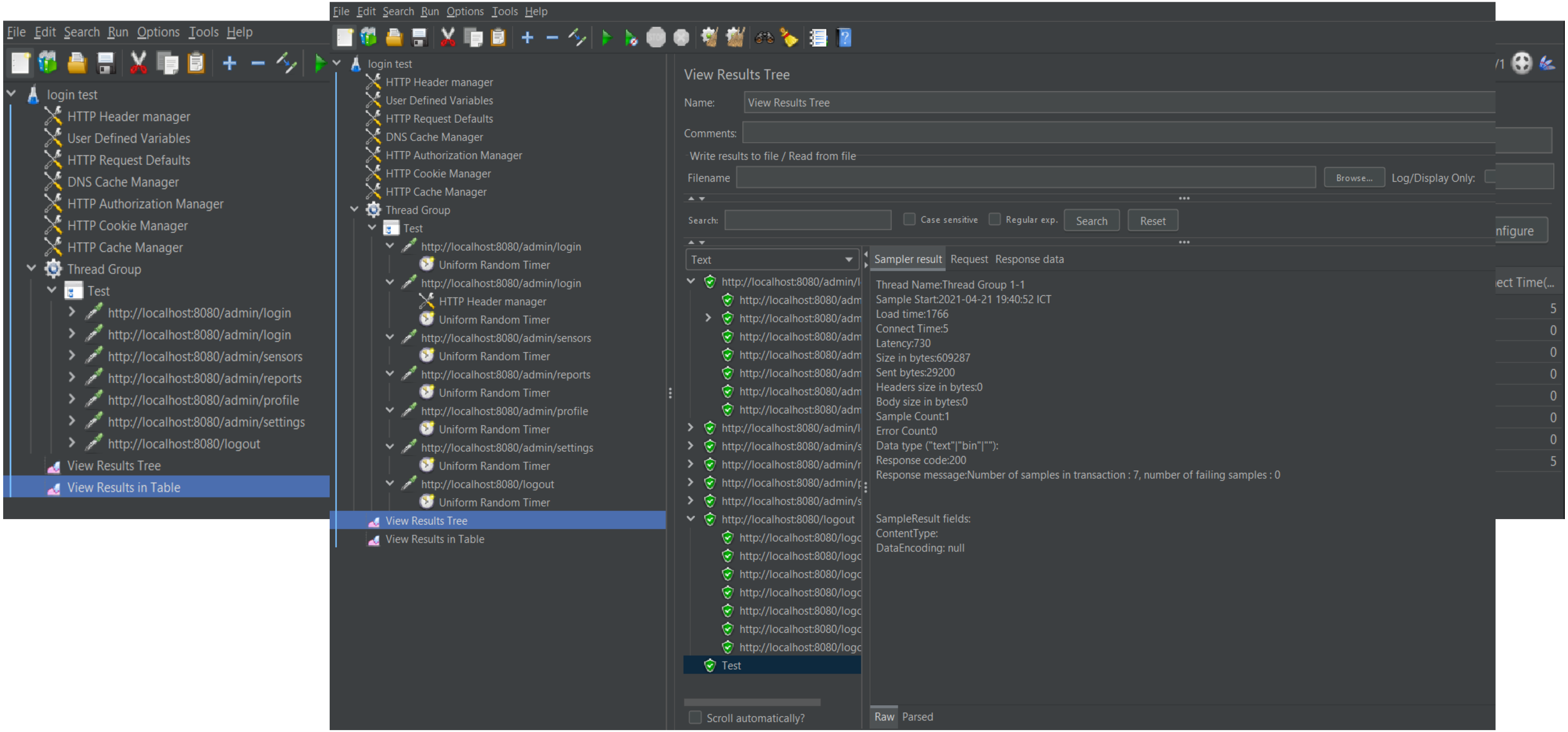
Sample #	Start Time	Thread Name	Label	Sample Time(ms)	Status
399981	16:45:08.681	100000 Users 1-98691	HTTP Request	3856	
399982	16:45:09.051	100000 Users 1-98498	HTTP Request	3488	
399983	16:45:09.647	100000 Users 1-99251	HTTP Request	2893	
399984	16:45:10.633	100000 Users 1-99274	HTTP Request	1909	
399985	16:45:08.649	100000 Users 1-98501	HTTP Request	3897	
399986	16:45:10.643	100000 Users 1-99252	HTTP Request	1904	
399987	16:45:11.098	100000 Users 1-99255	HTTP Request	1453	
399988	16:45:11.041	100000 Users 1-99272	HTTP Request	1511	
399989	16:45:11.028	100000 Users 1-99673	HTTP Request	1526	
399990	16:45:11.111	100000 Users 1-99254	HTTP Request	1444	
399991	16:45:11.044	100000 Users 1-98892	HTTP Request	1512	
399992	16:45:11.121	100000 Users 1-99243	HTTP Request	1440	
399993	16:45:11.128	100000 Users 1-99276	HTTP Request	1435	
399994	16:45:11.491	100000 Users 1-99242	HTTP Request	1077	
399995	16:45:11.502	100000 Users 1-99253	HTTP Request	1067	
399996	16:45:11.517	100000 Users 1-99256	HTTP Request	1052	
399997	16:45:11.525	100000 Users 1-99300	HTTP Request	1047	
399998	16:45:11.552	100000 Users 1-99660	HTTP Request	1023	
399999	16:45:11.573	100000 Users 1-99235	HTTP Request	1003	
400000	16:45:11.583	100000 Users 1-99275	HTTP Request	994	

Test Concurrent access





Testing login and other options



Test using Robot Framework

AQMS.robot M

AQMS > AQMS.robot > ...

```
*** Settings ***
Library  Selenium2Library

*** Variables ***
${expect}  LocationMind
${url}  http://localhost:8080
${Browser}  chrome
${delay}  1

*** Test Cases ***
1. Open Website
    Open Browser  ${url}  ${Browser}  options=add_experimental_option("excludeSwitches", ["enable-logging"])
    Maximize Browser Window
    Set Selenium Speed   0.5

2. Click on login link
   Click Link  //a[contains(text(),'Login')]

3. Input username and password
   Input Text  name=username  admin
   Input Text  name=password  admin

4. Login
   Click Button  name=submit

5. Check page info
   Click Link  //a[contains(text(),'Sensors')]

6. Start and Stop service
   Click Button  name=Stop
   Click Button  name=Start
   Click Link  //a[contains(text(),'Map View')]

7. Logout
   Click Link  //a[contains(text(),'Logout')]
8. close Browser
   Close Browser
```

Test using Robot Framework

PROBLEMS 9 OUTPUT DEBUG CONSOLE TERMINAL

```
PS C:\Users\Younten Tshering\Documents\GitHub\SDQI2021_G1\AQMS> robot .\AQMS.robot
==============================================================================
AQMS
==============================================================================
1. Open Website                                                       | PASS |
------------------------------------------------------------------------------
2. Click on login link                                                | PASS |
------------------------------------------------------------------------------
3. Input username and password                                        | PASS |
------------------------------------------------------------------------------
4. Login                                                              | PASS |
------------------------------------------------------------------------------
5. Check page info                                                    | PASS |
------------------------------------------------------------------------------
6. Start and Stop service                                             | PASS |
------------------------------------------------------------------------------
7. Logout                                                             | PASS |
------------------------------------------------------------------------------
8. close Browser                                                      | PASS |
------------------------------------------------------------------------------
AQMS                                                                  | PASS |
8 tests, 8 passed, 0 failed
==============================================================================
Output:  C:\Users\Younten Tshering\Documents\GitHub\SDQI2021_G1\AQMS\output.xml
Log:     C:\Users\Younten Tshering\Documents\GitHub\SDQI2021_G1\AQMS\log.html
Report:  C:\Users\Younten Tshering\Documents\GitHub\SDQI2021_G1\AQMS\report.html
```

The status of the implementation

- ❑ Link to our GitHub with readme file about the project and status of the implementation.
https://github.com/shubhanginigon/SDQI2021_G1

- ❑ Link to our JIRA project with tasks and roadmap:
https://sqdi2021g1.atlassian.net/jira/software/c/projects/AQMS/boards/4/roadmap

- ❑ Link to folder having installation and usage instruction as System Documentation and User Documentation, respectively.
- ❑ Updated Software Requirement Specification and Design Documents(Final Document)
https://github.com/shubhanginigon/SDQI2021_G1/tree/main/Related%20Documents/Final%20Report%20Document

CONCLUSION

- The system ‘Air Quality (PM2.5) Monitoring System’ will be especially designed to be used by any user who are cautious about their health.

Future Scope:

1. Add more sensor data sources and test
2. Deploy in real servers

Real Demo

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Questions and Feedback