Case_Study_1: IOT Data Processing

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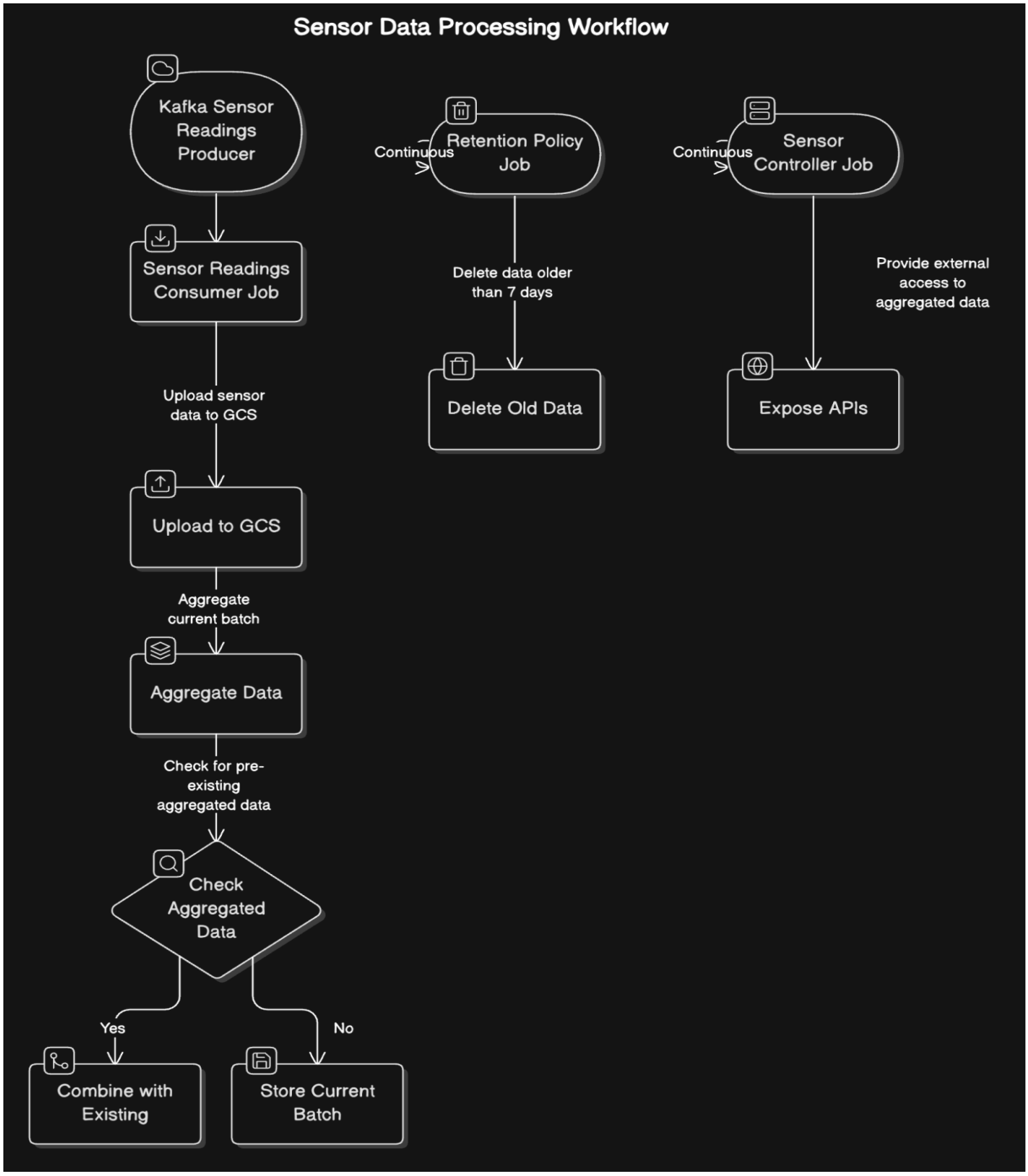
Detailed Code Workflow

The workflow consists of the following steps:

1. **Kafka Sensor Readings Producer**: This component produces sensor readings as JSON messages.
2. **Sensor Readings Consumer Job**: This job handles the following tasks:
    - Uploading the sensor data into a Google Cloud Storage (GCS) bucket under the path `raw/sensor-data` in Protobuf format, partitioned by the timestamp.
    - Aggregating the current batch of data.
    - Checking for any pre-existing aggregated data in the `aggregated/protobuf` folder. If previous aggregated data exists, it combines it with the current batch's aggregated data. If no previous data exists, it stores the current batch's aggregated data.
3. **Retention Policy Job**: This job runs continuously to delete folders in the `raw/sensor-data` path that are older than 7 days, ensuring data retention compliance.
4. **Sensor Controller Job**: This job runs continuously and exposes APIs related to the aggregated data, allowing external access to the processed information.

Flow Chart



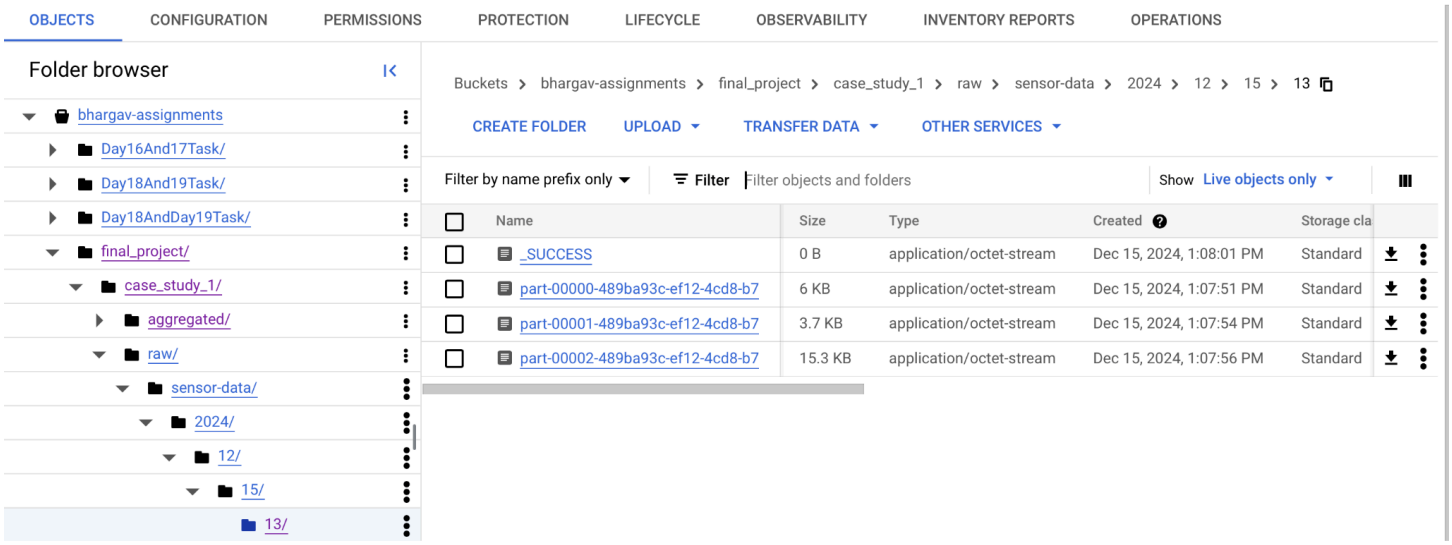
Below are the proof of execution and the resulting images showcasing the outcomes of the process.

Execution Proof and Resulting Images

Kafka - Sensor Readings Produced messages

```
Created topic sensor-readings.
bhargavjangam@apple-ka-MacBook-Pro config % kafka-console-consumer.sh --bootstrap-server localhost:9092 -topic sensor-readings --group consumer-group-2  --from-beginning
{"sensorId":77,"timestamp":1734247992109,"temperature":138.23384,"humidity":97.050644}
{"sensorId":64,"timestamp":1734247992228,"temperature":77.046844,"humidity":50.77436}
{"sensorId":15,"timestamp":1734247992349,"temperature":58.22834,"humidity":61.393143}
{"sensorId":10,"timestamp":1734247992467,"temperature":62.755905,"humidity":19.628292}
{"sensorId":12,"timestamp":1734247992589,"temperature":46.531174,"humidity":20.904022}
{"sensorId":99,"timestamp":1734247992709,"temperature":-12.388466,"humidity":68.10223}
{"sensorId":52,"timestamp":1734247992829,"temperature":28.304817,"humidity":62.89461}
{"sensorId":49,"timestamp":1734247992949,"temperature":44.60669,"humidity":73.36029}
{"sensorId":1,"timestamp":1734247993069,"temperature":101.1277,"humidity":68.22141}
{"sensorId":45,"timestamp":1734247993189,"temperature":77.69631,"humidity":90.87563}
{"sensorId":12,"timestamp":1734247993309,"temperature":37.35888,"humidity":26.069016}
{"sensorId":22,"timestamp":1734247993430,"temperature":-19.744896,"humidity":67.54745}
{"sensorId":86,"timestamp":1734247993549,"temperature":-20.581604,"humidity":31.041777}
{"sensorId":72,"timestamp":1734247993669,"temperature":-20.452166,"humidity":8.7509575}
{"sensorId":66,"timestamp":1734247993789,"temperature":73.27059,"humidity":44.32997}
{"sensorId":34,"timestamp":1734247993909,"temperature":-22.265076,"humidity":95.37437}
{"sensorId":60,"timestamp":1734247997388,"temperature":-2.0162125,"humidity":41.20615}
{"sensorId":10,"timestamp":1734247997507,"temperature":52.593872,"humidity":45.53692}
{"sensorId":54,"timestamp":1734247997630,"temperature":-8.243908,"humidity":94.725426}
{"sensorId":75,"timestamp":1734247997750,"temperature":-8.754467,"humidity":90.95502}
{"sensorId":30,"timestamp":1734247997869,"temperature":125.334946,"humidity":31.077433}
{"sensorId":74,"timestamp":1734247997989,"temperature":60.930824,"humidity":32.009792}
{"sensorId":55,"timestamp":1734247998108,"temperature":45.437256,"humidity":46.98705}
{"sensorId":47,"timestamp":1734247998228,"temperature":-32.51921,"humidity":61.223526}
{"sensorId":93,"timestamp":1734247998350,"temperature":-6.595146,"humidity":73.37569}
{"sensorId":62,"timestamp":1734247998469,"temperature":105.17395,"humidity":56.7289}
{"sensorId":20,"timestamp":1734247998590,"temperature":97.76599,"humidity":69.836266}
{"sensorId":47,"timestamp":1734247998709,"temperature":-11.792339,"humidity":55.22512}
{"sensorId":76,"timestamp":1734247998829,"temperature":44.995407,"humidity":89.01199}
{"sensorId":50,"timestamp":1734247998948,"temperature":55.539978,"humidity":2.4913132}
{"sensorId":60,"timestamp":1734247999069,"temperature":138.19638,"humidity":75.98818}
{"sensorId":83,"timestamp":1734247999188,"temperature":-8.153854,"humidity":83.104866}
{"sensorId":57,"timestamp":1734247999309,"temperature":64.438736,"humidity":87.46969}
```

GCS uploaded Proof for Raw Sensor Data



Current Batch Data

```
Current Batch Data
+--------+-------------+-----------+---------+
|sensorId|    timestamp|temperature| humidity|
+--------+-------------+-----------+---------+
|      12|1734248059789|  75.684525| 69.08004|
|      97|1734248059908|    48.3256|36.445694|
|      11|1734248060029|  49.931396| 41.39127|
|      16|1734248060149|  136.62585| 82.22545|
|      64|1734248060268|   64.32188|11.170721|
+--------+-------------+-----------+---------+
only showing top 5 rows
```

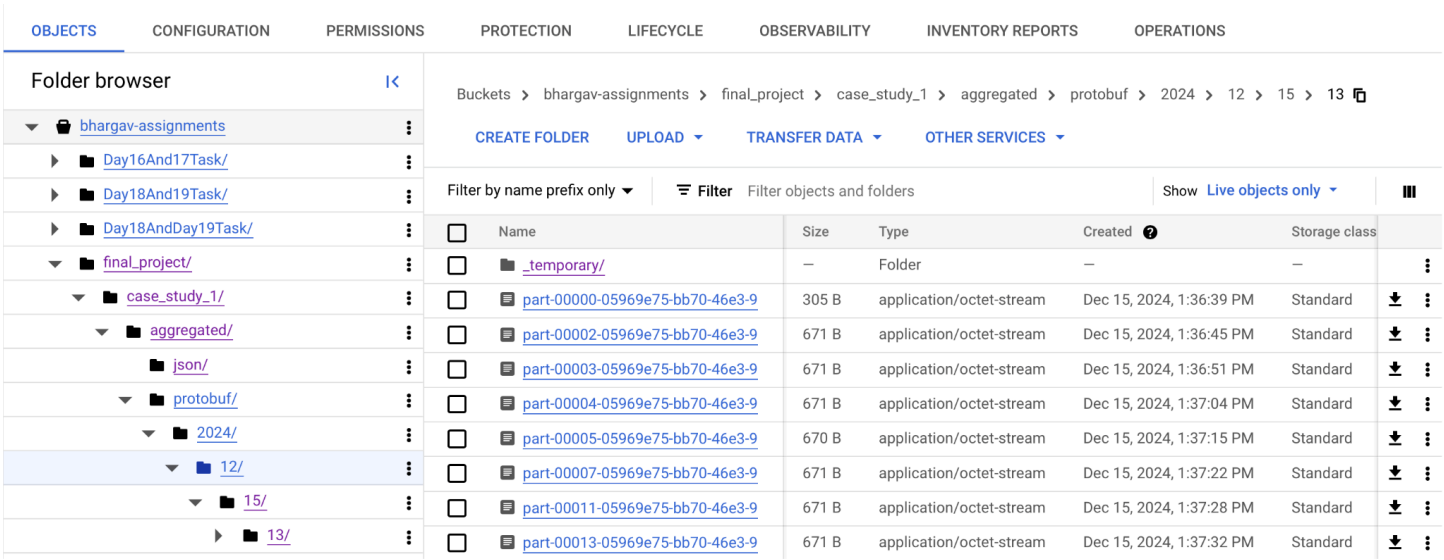
Current Batch Aggregated Data

```
Current Batch Aggregated Data
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
|sensorId|averageTemperature|averageHumidity|minimumTemperature|maximumTemperature|minimumHumidity|maximumHumidity|noOfRecords|
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
|      31|        46.962433|      53.987217|        -49.560177|         148.95181|     3.2515109|       99.51542|         85|
|      85|        54.726604|        48.5518|         -43.64445|         149.59799|     1.0321617|      97.400085|        103|
|      65|         42.58269|      46.316166|        -47.757866|         148.44275|      2.135229|       94.33407|         97|
|      53|        55.427742|      47.603973|        -48.458908|         149.87958|    0.20794272|       99.81757|         98|
|      78|        51.478294|      46.518616|        -49.199722|         149.36684|     0.5998552|       99.80707|        101|
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
only showing top 5 rows
```

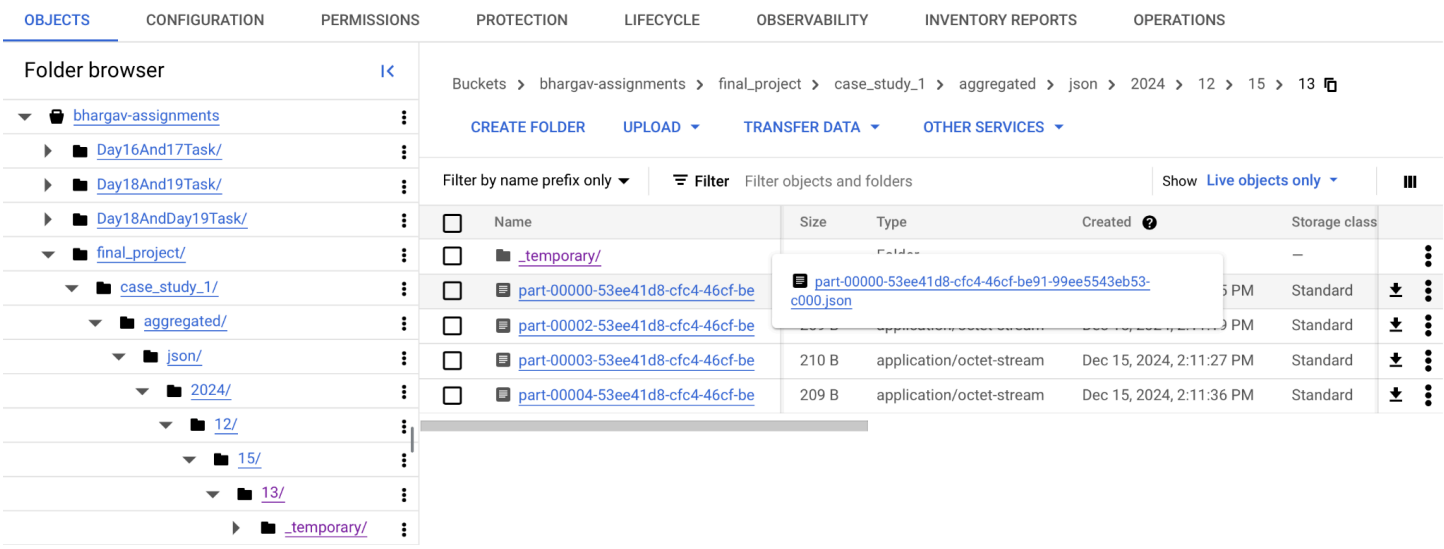
New Aggregated Data

```
New Aggregated Data
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
|sensorId|averageTemperature|averageHumidity|minimumTemperature|maximumTemperature|minimumHumidity|maximumHumidity|noOfRecords|
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
|       1|        50.898552|       53.89796|        -49.882008|          148.9321|     1.4179289|      99.301315|        144|
|       2|         48.99007|      55.650764|        -49.765682|         147.50931|     1.0541439|       99.40332|        114|
|       3|        55.502296|       51.44175|         -49.82182|         148.44707|     1.1851907|       99.25376|        162|
|       4|         49.54507|      50.719257|        -49.553013|         148.68245|      3.654939|       99.40032|        153|
|       5|        51.615704|      49.743484|         -47.71577|         148.81497|     2.0555258|       99.62398|        146|
+--------+-----------------+--------------+-----------------+-----------------+--------------+--------------+-----------+
only showing top 5 rows
```

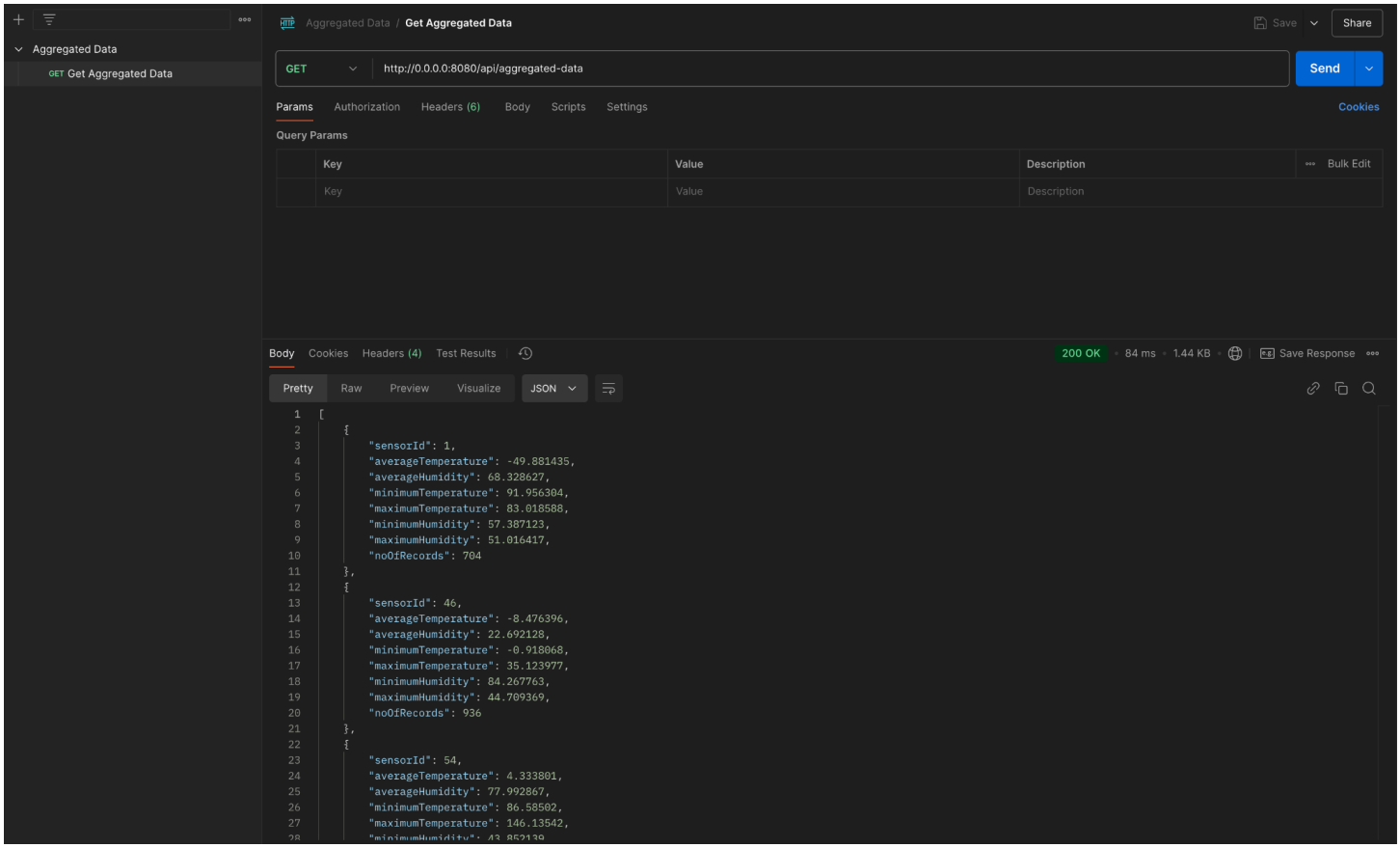
GCS upload proof for aggregated protobuf format



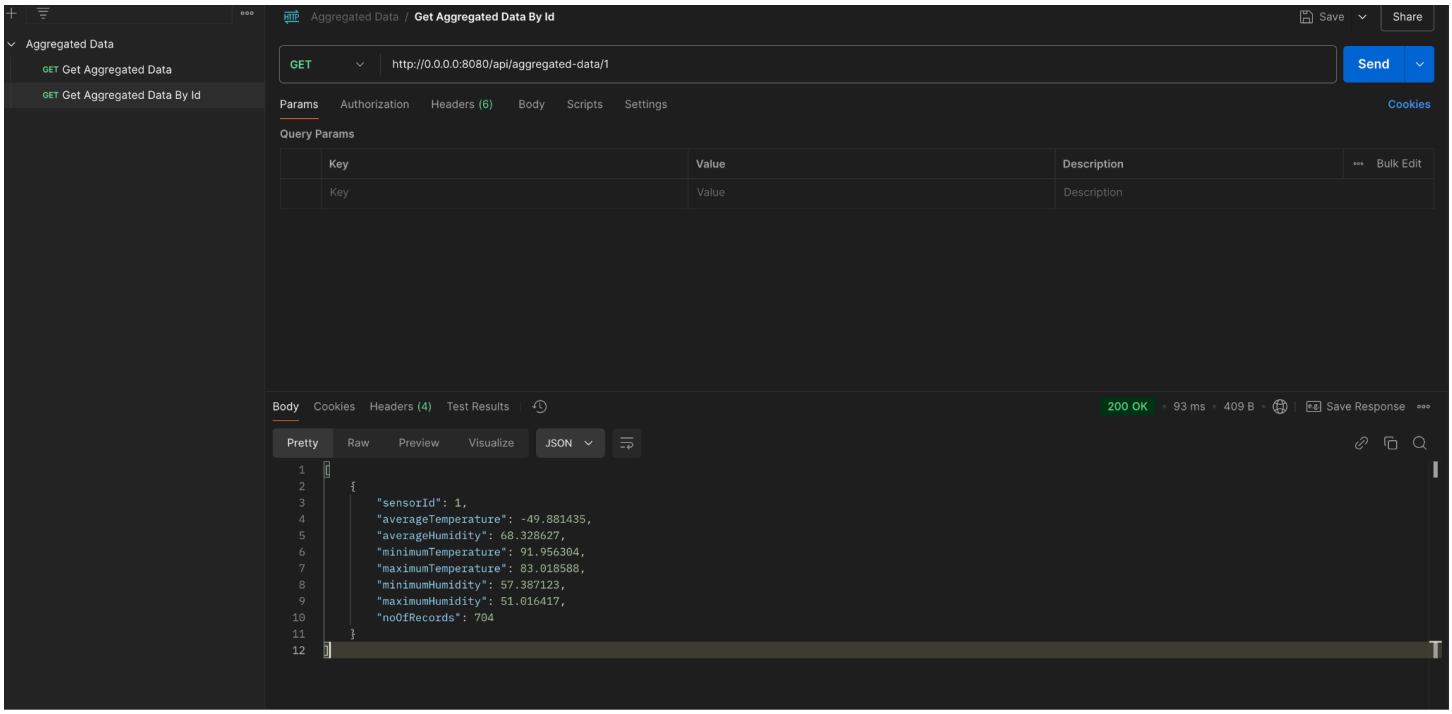
GCS upload proof for aggregated Json format



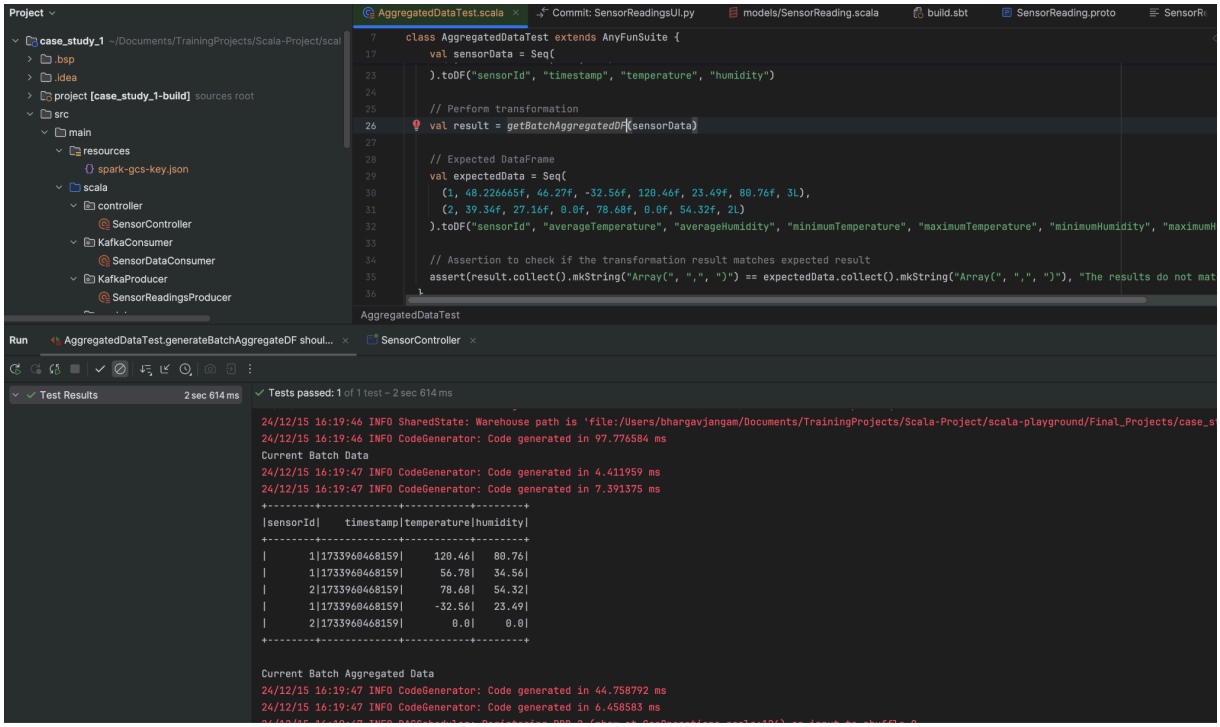
API Response for aggregated Data



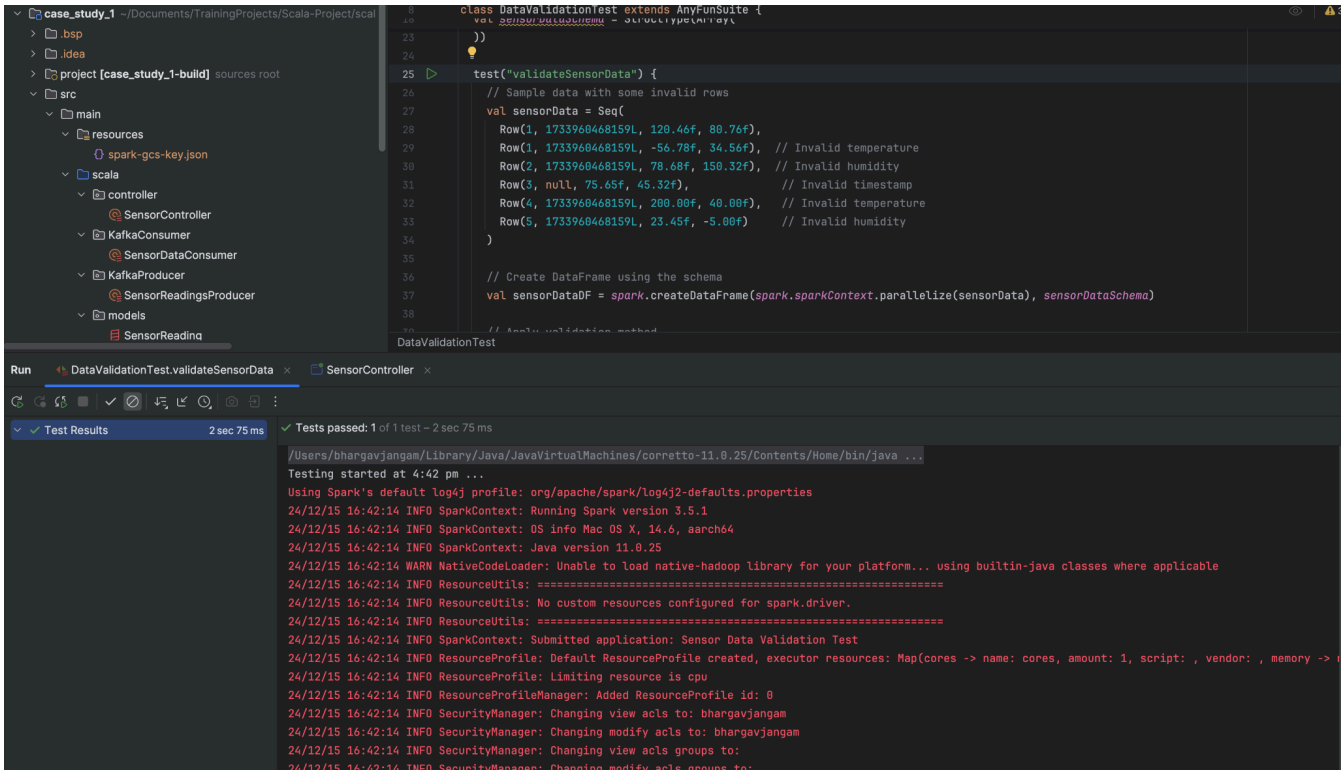
API Response for aggregated Data by Id



Aggregation Test



Validation Test



UI (api/aggregated-data)

Sensor Metrics Viewer

Search by Sensor ID

Enter Sensor ID here

Search

Refresh Data

	averageHumidity	averageTemperature	maximumHumidity	maximumTemperature	minim
0	53.945107	51.061460	99.954920	149.152130	
1	44.019104	43.699970	98.505720	149.915180	
2	45.997738	57.308464	99.817570	149.879580	
3	48.550945	49.871838	99.931595	147.816590	
4	50.906960	45.097115	97.654686	149.779920	
5	46.408936	49.638275	99.266780	147.020320	
6	46.320564	49.522880	99.623955	149.357790	
7	47.706680	54.111317	97.400085	149.597990	
8	47.455930	50.012287	99.807070	149.366840	
9	47.414455	43.261375	97.716820	148.388290	
10	52.796066	45.482204	98.776070	140.506820	
11	54.572510	53.773540	96.247670	147.440320	
12	53.810770	47.671890	99.515420	148.951810	
13	45.546080	44.550194	94.334070	148.442750	
14	49.340298	45.143800	99.460110	145.434160	
15	50.819630	48.898464	99.862220	149.547850	

✅ Fetched 16 records successfully!

Sensor Metrics Viewer

Search by Sensor ID

Enter Sensor ID here

Search

Refresh Data

dity	maximumTemperature	minimumHumidity	minimumTemperature	noOfRecords	sensorId
920	149.152130	0.376070	-48.555340	170	26
720	149.915180	0.510061	-49.165474	165	27
570	149.879580	0.207943	-48.458908	156	53
.595	147.816590	0.131553	-47.956690	168	81
686	149.779920	1.255494	-49.871754	160	76
780	147.020320	1.185304	-48.724556	141	44
955	149.357790	0.754827	-47.800290	160	93
085	149.597990	1.032162	-43.644450	161	85
070	149.366840	0.599855	-49.199722	160	78
820	148.388290	1.001364	-49.578728	156	28
070	140.506820	1.250297	-49.949410	162	12
670	147.440320	0.388360	-49.774887	161	91
420	148.951810	3.251511	-49.560177	138	31
070	148.442750	2.135229	-47.757866	155	65
110	145.434160	3.186470	-47.849346	150	34
220	149.547850	2.712959	-49.956383	184	22

✅ Fetched 16 records successfully!

UI (api/aggregated-data/{sensorId})