



# **Milestone 1**

## **Traffic Data Simulation and Ingestion**

## Overview

This system simulates real-world vehicle traffic data and streams it to Microsoft Azure for real-time processing and analysis.

This milestone consists of:

1. Data Generation (Python Simulator)
2. Data Ingestion (Azure Event Hub)

## Data Generation

- Implemented in a Python script (traffic\_data\_simulator.py)
- Generates simulated traffic events with realistic parameters such as:
  - Vehicle type, model, color
  - Speed, direction, and location
  - Sensor and road information (ID, coordinates, road type, city, etc.)
- Each event is represented as a JSON object.
- Events are both:
  - Saved locally to data/events.json for offline backup.
  - Sent in real time to Azure Event Hub using the azure-eventhub SDK.

# Generating Events

```
C:\> Project_1 > test > test.py > ...
11 from datetime import datetime
12 from faker import Faker
13 from azure.eventhub import EventHubProducerClient, EventData
14
15 fake = Faker()
16
17 # ----- CONFIG -----
18 NUM_LOCATIONS = 1000
19 SENSOR_COVERAGE_RATIO = 0.55
20 NUM_VEHICLES = 2000
21 TOTAL_EVENTS = 150_000
22 EVENT_INTERVAL_SECONDS = 0
23 DATA_DIR = "data"
24 LOCATIONS_FILE = os.path.join(DATA_DIR, "locations.json")
25 SENSORS_FILE = os.path.join(DATA_DIR, "sensors.json")
26 VEHICLES_FILE = os.path.join(DATA_DIR, "vehicles.json")
27 EVENTS_FILE = os.path.join(DATA_DIR, "events.json")
28
29 # ===== AZURE EVENT HUB CONFIG =====
30 # ♦ Replace these with your actual values
31 EVENTHUB_CONNECTION_STR = (
32     "Endpoint=sb://Traffic.servicebus.windows.net/;"
33     "SharedAccessKeyName=RootManageSharedAccessKey;"
34     "SharedAccessKey=UGoejj9CUi2MT0iNg0oe+W6oUF8Zpybd9+AEhdCTfv4="
35 )
36 EVENTHUB_NAME = "events"
37 # =====
38
39 ROAD_TYPE_WEIGHTS = {
40     "Highway": 0.20,
41     "Main Road": 0.30,
42     "Intersection": 0.25,
43     "Bridge": 0.10,
44     "Urban Road": 0.15
45 }
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```

# A view from the files that have been created

```
C:\Users> abidal > data > sensors.json > ...
1 {
2   {
3     "sensor_id": "TrafficCounter_El_Nasr_Road_0001",
4     "numeric_id": 1,
5     "lat": 29.750803,
6     "lon": 31.372785,
7     "location_id": 604,
8     "install_date": "2024-02-17",
9     "status": "Active",
10    "sensor_type": "TrafficCounter"
11  },
12  {
13    "sensor_id": "TrafficCounter_El_Tayaran_segment_657_0002",
14    "numeric_id": 2,
15    "lat": 29.886803,
16    "lon": 31.497808,
17    "location_id": 657,
18    "install_date": "2024-10-23",
19    "status": "Inactive",
20    "sensor_type": "TrafficCounter"
21  },
22  {
23    "sensor_id": "CCIV_El_Omraniya_segment_922_0003",
24    "numeric_id": 3,
25    "lat": 29.995359,
26    "lon": 31.057975,
27    "location_id": 922,
28    "install_date": "2022-09-25",
29    "status": "Active",
30    "sensor_type": "CCIV"
31  },
32  {
33    "sensor_id": "MultiSensor_El_Nozza_0004",
34    "numeric_id": 4,
35    "lat": 30.168251,
36    "lon": 31.498424,
37    "location_id": 350,
38    "install_date": "2022-02-22",
39    "status": "Active",
40    "sensor_type": "MultiSensor"
41  },
42  {
43    "sensor_id": "Radar_Corniche_El_Nil_segment_248_0005",
44    "numeric_id": 5,
45    "lat": 29.956072,
46    "lon": 31.363056,
47    "location_id": 248,
48    "install_date": "2022-07-21",
49    "status": "Under Maintenance",
50    "sensor_type": "Radar"
51  },
52 }
```

```
C:\Users> abidal > data > vehicles.json > ...
1 {
2   {
3     "owner_id": "09e76b59-967f-458e-bd3d-7bfee68a08cd",
4     "plate_number": "3SW 787",
5     "vehicle_type": "Truck",
6     "model": "Volvo FH16",
7     "color": "Black"
8   },
9   {
10    "owner_id": "414a9d93-44a9-456d-8fdf-f78d16e34d20",
11    "plate_number": "ZQM-887",
12    "vehicle_type": "Car",
13    "model": "BYD F3",
14    "color": "Silver"
15  },
16  {
17    "owner_id": "d0d379bf-368a-4405-9824-ec5cfe4d4cae",
18    "plate_number": "DMB 187",
19    "vehicle_type": "Bus",
20    "model": "Isuzu City Bus",
21    "color": "Silver"
22  },
23  {
24    "owner_id": "7cf66343-4b7d-4a51-89a1-574ef93c82a7",
25    "plate_number": "GTN 406",
26    "vehicle_type": "Car",
27    "model": "Hyundai Elantra",
28    "color": "Blue"
29  },
30  {
31    "owner_id": "a7eb2237-c7a0-4140-b8a6-9066e35c4627",
32    "plate_number": "7HIS1",
33    "vehicle_type": "Motorcycle",
34    "model": "Bajaj Pulsar",
35    "color": "Gray"
36  },
37  {
38    "owner_id": "e0f46bd2-609e-448f-adda-68a97c189b15",
39    "plate_number": "POX 564",
40    "vehicle_type": "Car",
41    "model": "Volkswagen Passat",
42    "color": "Orange"
43  },
44  {
45    "owner_id": "61d3e444-3009-4b6b-b47e-1100ffe344bb",
46    "plate_number": "J38-536",
47    "vehicle_type": "Bus",
48    "model": "Isuzu City Bus",
49    "color": "Black"
50  },
51 }
```

```
C:\Users> abidal > data > sensorlog.json > ...
1 {
2   {
3     "event_id": 1, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
4     "MultiSensor_El_Nasr_Road_0001", "sensor_numeric_id": 156, "sensor_lat": 29.750803,
5     "sensor_lon": 31.372785, "plate_number": "3SW 787", "owner_id":
6     "09e76b59-967f-458e-bd3d-7bfee68a08cd", "vehicle_type": "Truck", "model": "Volvo FH16",
7     "color": "Black", "speed": 125, "direction": "N", "location_id": 353,
8     "location_name": "El Nasr Road", "location_lat": 29.750803, "location_lon": 31.372785,
9     "road_type": "Main Road", "street_direction": "N", "intersection": "El Nasr Road",
10    "street_name": "El Nasr Road", "city": "Giza", "lat": 29.750803, "lon": 31.372785,
11    "speed_limit": 40, "direction": "CIRCULAR"
12  },
13  {
14    "event_id": 2, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
15    "TrafficCounter_El_Ohour_Road_0005", "sensor_numeric_id": 395, "sensor_lat": 29.906702,
16    "sensor_lon": 31.236424, "plate_number": "722 5807", "owner_id":
17    "7029f976-1551-4ff0-8064-387a8f32baf8", "vehicle_type": "Van", "model": "Mercedes Sprinter",
18    "color": "Gray", "speed": 79, "direction": "S", "location_id": 902, "location_name": "El
19    Hour Road", "location_lat": 29.906702, "location_lon": 31.236424, "road_type":
20    "Main Road", "street_direction": "S", "intersection": "El Hour Road", "street_name": "El
21    Hour Road", "city": "Giza", "lat": 29.906702, "lon": 31.236424, "speed_limit": 40,
22    "direction": "CIRCULAR"
23  },
24  {
25    "event_id": 3, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
26    "MultiSensor_El_Tayaran_segment_657_0002", "sensor_numeric_id": 215, "sensor_lat": 29.886803,
27    "sensor_lon": 31.497808, "plate_number": "ZQM-887", "owner_id":
28    "414a9d93-44a9-456d-8fdf-f78d16e34d20", "vehicle_type": "Car", "model": "BYD F3",
29    "color": "Silver", "speed": 122, "direction": "N", "location_id": 517, "location_name": "T6
30    July (segment 517)", "location_lat": 29.886803, "location_lon": 31.497808, "road_type":
31    "Main Road", "street_direction": "N", "intersection": "T6 July (segment 517)", "street_name":
32    "T6 July (segment 517)", "city": "Giza", "lat": 29.886803, "lon": 31.497808, "speed_limit":
33    40, "direction": "CIRCULAR"
34  },
35  {
36    "event_id": 4, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
37    "Radar_Nasr_Road_segment_532_0003", "sensor_numeric_id": 129, "sensor_lat": 29.872807,
38    "sensor_lon": 31.289839, "plate_number": "721G 058", "owner_id":
39    "6f4ee75f-6bda-4f81-a905-57788a0e0b65", "vehicle_type": "Van", "model": "Freight Boxer",
40    "color": "Yellow", "speed": 103, "direction": "N", "location_id": 332, "location_name": "Nasr
41    Road (segment 532)", "location_lat": 29.872807, "location_lon": 31.289839, "road_type":
42    "Main Road", "street_direction": "N", "intersection": "Nasr Road (segment 532)", "street_name":
43    "Nasr Road (segment 532)", "city": "Giza", "lat": 29.872807, "lon": 31.289839, "speed_limit":
44    40, "direction": "CIRCULAR"
45  },
46  {
47    "event_id": 5, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
48    "Radar_Nasr_Road_segment_573_0005", "sensor_numeric_id": 310, "sensor_lat": 29.877842,
49    "sensor_lon": 31.289839, "plate_number": "721G 058", "owner_id":
50    "6f4ee75f-6bda-4f81-a905-57788a0e0b65", "vehicle_type": "Motorcycle", "model": "Kawasaki
51    Ninja 400", "color": "Black", "speed": 58, "direction": "N", "location_id": 573,
52    "location_name": "Nasr Road (segment 573)", "location_lat": 29.877842, "location_lon": 31.289839,
53    "road_type": "Main Road", "street_direction": "N", "intersection": "Nasr Road (segment 573)",
54    "street_name": "Nasr Road (segment 573)", "city": "Giza", "lat": 29.877842, "lon": 31.289839,
55    "speed_limit": 40, "direction": "CIRCULAR"
56  },
57  {
58    "event_id": 6, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
59    "Radar_El_Nasr_Corniche_segment_448_0007", "sensor_numeric_id": 207, "sensor_lat": 30.168251,
60    "sensor_lon": 31.292095, "plate_number": "7275 170", "owner_id":
61    "1b359909-bd25-4704-9d7f-c015172c0c5a", "vehicle_type": "Motorcycle", "model": "Kawasaki
62    Ninja 400", "color": "Black", "speed": 39, "direction": "N", "location_id": 644,
63    "location_name": "El Nasr Corniche (segment 448)", "location_lat": 30.168251,
64    "location_lon": 31.292095, "road_type": "Main Road", "street_direction": "N",
65    "intersection": "El Nasr Corniche (segment 448)", "street_name": "El Nasr Corniche (segment 448)",
66    "city": "Giza", "lat": 30.168251, "lon": 31.292095, "speed_limit": 40, "direction": "CIRCULAR"
67  },
68  {
69    "event_id": 7, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
70    "MultiSensor_El_Tayaran_segment_450_0003", "sensor_numeric_id": 343, "sensor_lat": 29.886803,
71    "sensor_lon": 31.497808, "plate_number": "ZQM-887", "owner_id":
72    "414a9d93-44a9-456d-8fdf-f78d16e34d20", "vehicle_type": "Car", "model": "BYD F3",
73    "color": "Silver", "speed": 89, "direction": "N", "location_id": 450, "location_name": "El
74    Tayaran (segment 450)", "location_lat": 29.886803, "location_lon": 31.497808, "road_type":
75    "Main Road", "street_direction": "N", "intersection": "El Tayaran (segment 450)", "street_name":
76    "El Tayaran (segment 450)", "city": "Giza", "lat": 29.886803, "lon": 31.497808, "speed_limit":
77    40, "direction": "CIRCULAR"
78  },
79  {
80    "event_id": 8, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
81    "CCIV_Mohandessin_0001", "sensor_numeric_id": 21, "sensor_lat": 29.728742, "sensor_lon": 31.236424,
82    "plate_number": "722 5807", "owner_id": "a7eb2237-c7a0-4140-b8a6-9066e35c4627",
83    "vehicle_type": "Motorcycle", "model": "Bajaj Pulsar", "color": "Gray", "speed": 79,
84    "direction": "S", "location_id": 902, "location_name": "El Hour Road", "location_lat": 29.906702,
85    "location_lon": 31.236424, "road_type": "Main Road", "street_direction": "S",
86    "intersection": "El Hour Road", "street_name": "El Hour Road", "city": "Giza", "lat": 29.906702,
87    "lon": 31.236424, "speed_limit": 40, "direction": "CIRCULAR"
88  },
89  {
90    "event_id": 9, "timestamp": "2025-10-13T11:09:11.830018Z", "sensor_id":
91    "Radar_Nasr_Road_segment_532_0003", "sensor_numeric_id": 129, "sensor_lat": 29.872807,
92    "sensor_lon": 31.289839, "plate_number": "721G 058", "owner_id":
93    "6f4ee75f-6bda-4f81-a905-57788a0e0b65", "vehicle_type": "Van", "model": "Freight Boxer",
94    "color": "Yellow", "speed": 103, "direction": "N", "location_id": 332, "location_name": "Nasr
95    Road (segment 532)", "location_lat": 29.872807, "location_lon": 31.289839, "road_type":
96    "Main Road", "street_direction": "N", "intersection": "Nasr Road (segment 532)", "street_name":
97    "Nasr Road (segment 532)", "city": "Giza", "lat": 29.872807, "lon": 31.289839, "speed_limit":
98    40, "direction": "CIRCULAR"
99  },
100 }
```

```
C:\Users> abidal > data > location.json > ...
1 {
2   {
3     "location_id": 1,
4     "street_name": "Al Haram",
5     "city": "Giza",
6     "lat": 29.910028,
7     "lon": 31.199200,
8     "road_type": "Main Road",
9     "speed_limit": 40,
10    "direction": "CIRCULAR"
11  },
12  {
13    "location_id": 2,
14    "street_name": "Smart Village Road",
15    "city": "6th October",
16    "lat": 30.180200,
17    "lon": 31.427007,
18    "road_type": "Main Road",
19    "speed_limit": 70,
20    "direction": "EW"
21  },
22  {
23    "location_id": 3,
24    "street_name": "El Obour Road",
25    "city": "Cairo",
26    "lat": 29.903127,
27    "lon": 31.23318,
28    "road_type": "Main Road",
29    "speed_limit": 60,
30    "direction": "NS"
31  },
32  {
33    "location_id": 4,
34    "street_name": "Al Haram (segment 4)",
35    "city": "Giza",
36    "lat": 29.910028,
37    "lon": 31.199200,
38    "road_type": "Main Road",
39    "speed_limit": 40,
40    "direction": "CIRCULAR"
41  },
42  {
43    "location_id": 5,
44    "street_name": "October Corridor",
45    "city": "6th October",
46    "lat": 29.910028,
47    "lon": 31.427007,
48    "road_type": "Main Road",
49    "speed_limit": 40,
50    "direction": "EW"
51  },
52 }
```

# Azure event hub tables for the data that is being sent

