



# 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

The screenshot shows a code editor interface with a dark theme. On the left is a vertical file tree for 'Project\_1 > test > test.py'. The main area contains the following Python code:

```
C:\> Project_1 > test > test.py > ...
11  from faker import Faker
12  from azure.eventhub import EventHubProducerClient, EventData
13
14  fake = Faker()
15
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=UGoejj9CUi2MToINGOoe+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  }
```

The code defines constants for locations, sensors, vehicles, and events, along with Azure Event Hub configuration. It also defines a dictionary for road type weights.

Below the code editor is a terminal window showing the output of the script:

```
Event 6936 sent: VUB 817 - 50 km/h
Event 6937 sent: QLN 483 - 64 km/h
Event 6938 sent: 4BM96 - 67 km/h
Event 6939 sent: 897476 - 53 km/h
Event 6940 sent: 313-VSH - 80 km/h
Event 6941 sent: RR 21768 - 59 km/h
Event 6942 sent: SI-2487 - 54 km/h
Event 6943 sent: 200-MVQ - 149 km/h
Event 6944 sent: 15W•196 - 89 km/h
Event 6945 sent: 4246 - 99 km/h
Event 6946 sent: 9-Y7013 - 54 km/h
Event 6947 sent: IWN 772 - 51 km/h
Event 6948 sent: 6N 4E7MGZ - 68 km/h
Event 6949 sent: I99 2LD - 100 km/h
Event 6950 sent: RU3 MBN - 83 km/h
```

The terminal also displays status information at the bottom:

```
Ln 34, Col 66  Spaces: 4  UTF-8  CRLF  () Python  3.13.7
```

# A view from the files that have been created

```
C:\> Users > abdal > data > sensors.json > ...
1  [
2    {
3      "sensor_id": "TrafficCounter_El_Nasr_Road_0001",
4      "numeric_id": 1,
5      "lat": 29.750803,
6      "lon": 31.377785,
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": 20,
15     "lat": 29.750803,
16     "lon": 31.497008,
17     "location_id": 657,
18     "install_date": "2024-10-23",
19     "status": "Inactive",
20     "sensor_type": "TrafficCounter"
21   },
22   {
23     "sensor_id": "CCTV_El_Omraniya_segment_922_0003",
24     "numeric_id": 3,
25     "lat": 29.995359,
26     "lon": 31.377785,
27     "location_id": 922,
28     "install_date": "2021-09-25",
29     "status": "Active",
30     "sensor_type": "CCTV"
31   },
32   {
33     "sensor_id": "MultiSensor_El_Nozha_0004",
34     "numeric_id": 4,
35     "lat": 30.168251,
36     "lon": 31.394024,
37     "location_id": 360,
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": 31.304050,
47     "location_id": 248,
48     "install_date": "2022-07-21",
49     "status": "Under Maintenance",
50     "sensor_type": "Radar"
51   }
],
```

```
C:\> Users > abdal > data > vehicles.json > ...
1  [
2    {
3      "owner_id": "09e76b59-967f-458e-bd3d-7bfee68a08cd",
4      "plate_number": "35M 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": "J0d579bf-368a-4405-9824-ecc5cef0d4cae",
18     "plate_number": "QWV 487",
19     "vehicle_type": "Bus",
20     "model": "Isuzu City Bus",
21     "color": "Silver"
22   },
23   {
24     "owner_id": "7cf66343-4b7d-4a51-574ef93c82a7",
25     "plate_number": "GTM 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": "HTS1"
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   }
],
```

```
C:\> Users > abdal > data > events.json > timestamp
1  [
2    {
3      "event_id": 1, "timestamp": "2025-10-13T13:09:11.8380192", "sensor_id": "MultiSensor_Abdel_Aziz_Fahmy_B156", "sensor_numeric_id": 156, "sensor_lat": 30.149295, "sensor_lon": 31.523269, "plate_number": "65-AE007", "owner_id": "2b45daa-f2d-408b-95f6-bab106a77510", "vehicle_type": "Motorcycle", "model": "Honda Click", "color": "Yellow", "speed": 50, "direction": "W", "location_id": 365, "location_name": "Abdel Aziz Fahmy", "location_lat": 30.149295, "location_lon": 31.523264, "road_type": "Intersection", "street_direction": "SW"
4    },
5    {
6      "event_id": 2, "timestamp": "2025-10-13T13:09:11.3542027", "sensor_id": "TrafficCounter_El_Omour_Road_0395", "sensor_numeric_id": 385, "sensor_lat": 29.986752, "sensor_lon": 31.26624, "plate_number": "722-SAB07", "owner_id": "0879f07f-1551-4ff8-8164-387a032be0fa", "vehicle_type": "Van", "model": "Mercedes Sprinter", "color": "Grey", "speed": 75, "direction": "S", "location_id": 362, "location_name": "El Omour Road", "location_lat": 29.986752, "location_lon": 31.26624, "road_type": "Intersection", "street_direction": "N"
7    },
8    {
9      "event_id": 3, "timestamp": "2025-10-13T13:09:11.4193912", "sensor_id": "MultiSensor_24-Adel_Mahdy_517_0215", "sensor_numeric_id": 215, "sensor_lat": 29.819269, "sensor_lon": 31.070104, "plate_number": "556-KXT", "owner_id": "b54d21c6-944d-47d8-a327-7ba84d9e729", "vehicle_type": "Car", "model": "Skoda Octavia", "color": "Green", "speed": 122, "direction": "N", "location_id": 517, "location_name": "24 July (segment 517)", "location_lat": 29.819269, "location_lon": 31.069925, "road_type": "Urban Road", "street_direction": "CIRCULAR"
10   },
11   {
12     "event_id": 4, "timestamp": "2025-10-13T13:09:11.4761562", "sensor_id": "Radar_Mahat_Road_segment_512_0129", "sensor_numeric_id": 129, "sensor_lat": 30.078867, "sensor_lon": 31.280609, "plate_number": "21G-VK5", "owner_id": "074e60a-66d4-4000-9778-0a0a0a0a0a0a", "vehicle_type": "Van", "model": "Peugeot Boxer", "color": "White", "speed": 80, "direction": "S", "location_id": 512, "location_name": "Mahat Road (segment 512)", "location_lat": 30.078867, "location_lon": 31.280609, "road_type": "Highway", "street_direction": "CIRCULAR"
13   },
14   {
15     "event_id": 5, "timestamp": "2025-10-13T13:09:11.5155462", "sensor_id": "Radar_Mahat_Road_segment_573_0130", "sensor_numeric_id": 130, "sensor_lat": 30.077842, "sensor_lon": 31.287032, "plate_number": "AEHF077", "owner_id": "d712e7e-4d92-42ef-bb01-8de04f3ae33", "vehicle_type": "Motorcycle", "model": "Kawasaki Ninja 400", "color": "Black", "speed": 90, "direction": "W", "location_id": 673, "location_name": "Mahat Road (segment 573)", "location_lat": 30.077842, "location_lon": 31.287032, "road_type": "Urban Road", "street_direction": "CIRCULAR"
16   },
17   {
18     "event_id": 6, "timestamp": "2025-10-13T13:09:11.5315656", "sensor_id": "Radar_El_Maadi_Corridor_the segment_044_0207", "sensor_numeric_id": 207, "sensor_lat": 30.168332, "sensor_lon": 31.292995, "plate_number": "865-TNN", "owner_id": "1b35909-b205-4784-907-cf1512c6564", "vehicle_type": "Motorcycle", "model": "Kawasaki Ninja 400", "color": "Black", "speed": 30, "direction": "W", "location_id": 644, "location_name": "El Maadi Corridor (segment 044)", "location_lat": 30.168332, "location_lon": 31.292995, "road_type": "Urban Road", "street_direction": "NS"
19   },
20   {
21     "event_id": 7, "timestamp": "2025-10-13T13:09:11.6570702", "sensor_id": "MultiSensor_El_Tayaran_segment_450_0343", "sensor_numeric_id": 343, "sensor_lat": 29.886072, "sensor_lon": 31.498045, "plate_number": "PMX707", "owner_id": "1b35909-b205-4784-907-cf1512c6564", "vehicle_type": "Van", "model": "Mercedes Sprinter", "color": "Silver", "speed": 60, "direction": "E", "location_id": 450, "location_name": "El Tayaran (segment 450)", "location_lat": 29.886072, "location_lon": 31.498045, "road_type": "Intersection", "street_direction": "EW"
23   },
24   {
25     "event_id": 8, "timestamp": "2025-10-13T13:09:11.7385772", "sensor_id": "CCTV_Hokandessin_8077", "sensor_numeric_id": 71, "sensor_lat": 29.779827, "sensor_lon": 31.377785,
```

```
C:\> Users > abdal > data > locations.json > ...
1  [
2    {
3      "location_id": 1, "street_name": "Al Haram", "city": "Cairo", "lat": 29.910828, "lon": 31.195926, "road_type": "Main Road", "speed_limit": 40, "direction": "CIRCULAR"
4    },
5    {
6      "location_id": 2, "street_name": "Smart Village Road", "city": "New Cairo", "lat": 30.160209, "lon": 31.347797, "road_type": "Main Road", "speed_limit": 70, "direction": "Eu"
7    },
8    {
9      "location_id": 3, "street_name": "El Obour Road", "city": "Cairo", "lat": 29.905327, "lon": 31.236357, "road_type": "Main Road", "speed_limit": 60, "direction": "NS"
10   },
11   {
12     "location_id": 4, "street_name": "Al Haram (segment 4)", "city": "Cairo", "lat": 29.910761, "lon": 31.198892, "road_type": "Main Road", "speed_limit": 50, "direction": "CIRCULAR"
14   },
15   {
16     "location_id": 5, "street_name": "October corridor", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
18   },
19   {
20     "location_id": 6, "street_name": "Al Maadi", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
21   },
22   {
23     "location_id": 7, "street_name": "Al Maadi (segment 4)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
24   },
25   {
26     "location_id": 8, "street_name": "Al Maadi (segment 5)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
27   },
28   {
29     "location_id": 9, "street_name": "Al Maadi (segment 6)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
30   },
31   {
32     "location_id": 10, "street_name": "Al Maadi (segment 7)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
33   },
34   {
35     "location_id": 11, "street_name": "Al Maadi (segment 8)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
36   },
37   {
38     "location_id": 12, "street_name": "Al Maadi (segment 9)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
39   },
40   {
41     "location_id": 13, "street_name": "Al Maadi (segment 10)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
42   },
43   {
44     "location_id": 14, "street_name": "Al Maadi (segment 11)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
45   },
46   {
47     "location_id": 15, "street_name": "Al Maadi (segment 12)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
48   },
49   {
50     "location_id": 16, "street_name": "Al Maadi (segment 13)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
51   },
52   {
53     "location_id": 17, "street_name": "Al Maadi (segment 14)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
54   },
55   {
56     "location_id": 18, "street_name": "Al Maadi (segment 15)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
57   },
58   {
59     "location_id": 19, "street_name": "Al Maadi (segment 16)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
60   },
61   {
62     "location_id": 20, "street_name": "Al Maadi (segment 17)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
63   },
64   {
65     "location_id": 21, "street_name": "Al Maadi (segment 18)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
66   },
67   {
68     "location_id": 22, "street_name": "Al Maadi (segment 19)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
69   },
70   {
71     "location_id": 23, "street_name": "Al Maadi (segment 20)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
72   },
73   {
74     "location_id": 24, "street_name": "Al Maadi (segment 21)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
75   },
76   {
77     "location_id": 25, "street_name": "Al Maadi (segment 22)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
78   },
79   {
80     "location_id": 26, "street_name": "Al Maadi (segment 23)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
81   },
82   {
83     "location_id": 27, "street_name": "Al Maadi (segment 24)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
84   },
85   {
86     "location_id": 28, "street_name": "Al Maadi (segment 25)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
87   },
88   {
89     "location_id": 29, "street_name": "Al Maadi (segment 26)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
90   },
91   {
92     "location_id": 30, "street_name": "Al Maadi (segment 27)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
93   },
94   {
95     "location_id": 31, "street_name": "Al Maadi (segment 28)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
96   },
97   {
98     "location_id": 32, "street_name": "Al Maadi (segment 29)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
99   },
100  {
101    "location_id": 33, "street_name": "Al Maadi (segment 30)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
102  },
103  {
104    "location_id": 34, "street_name": "Al Maadi (segment 31)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
105  },
106  {
107    "location_id": 35, "street_name": "Al Maadi (segment 32)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
108  },
109  {
110    "location_id": 36, "street_name": "Al Maadi (segment 33)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
111  },
112  {
113    "location_id": 37, "street_name": "Al Maadi (segment 34)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
114  },
115  {
116    "location_id": 38, "street_name": "Al Maadi (segment 35)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
117  },
118  {
119    "location_id": 39, "street_name": "Al Maadi (segment 36)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
119  },
120  {
121    "location_id": 40, "street_name": "Al Maadi (segment 37)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
122  },
123  {
124    "location_id": 41, "street_name": "Al Maadi (segment 38)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
125  },
126  {
127    "location_id": 42, "street_name": "Al Maadi (segment 39)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
128  },
129  {
130    "location_id": 43, "street_name": "Al Maadi (segment 40)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
131  },
132  {
133    "location_id": 44, "street_name": "Al Maadi (segment 41)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
134  },
135  {
136    "location_id": 45, "street_name": "Al Maadi (segment 42)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
137  },
138  {
139    "location_id": 46, "street_name": "Al Maadi (segment 43)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
139  },
140  {
141    "location_id": 47, "street_name": "Al Maadi (segment 44)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
142  },
143  {
144    "location_id": 48, "street_name": "Al Maadi (segment 45)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
145  },
146  {
147    "location_id": 49, "street_name": "Al Maadi (segment 46)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
148  },
149  {
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176    "location_id": 60, "street_name": "Al Maadi (segment 56)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
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216    "location_id": 74, "street_name": "Al Maadi (segment 70)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
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218  {
219    "location_id": 75, "street_name": "Al Maadi (segment 71)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
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234    "location_id": 82, "street_name": "Al Maadi (segment 78)", "city": "Cairo", "lat": 29.770008, "lon": 31.342403, "road_type": "Main Road", "speed_limit": 40, "direction": "Eu"
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# Azure event hub tables for the data that is being sent

