Milestone Comprehensive Description

Cairo Real-Time Traffic Data Simulator

Digital Egypt Pioneers Initiative – Real-Time Traffic Analytics Platform

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Overview

This milestone delivers a **production-grade, realistic traffic simulation system** for Greater Cairo that continuously generates high-fidelity traffic events and streams them in real time to **Azure Event Hubs**. The simulator serves as the primary data source for the entire real-time analytics pipeline:

Event Hubs → Stream Analytics → Power BI / Azure SQL Dashboard

Key Features Implemented

1. Realistic Cairo-Specific Traffic Modeling

7 strategically selected high-traffic locations with real GPS coordinates and estimated lane capacities:

- Tahrir Square
- Ramses Square
- 6th October Bridge
- Nasr City – Abbas El Akkad
- Heliopolis – Uruba Street
- Maadi Corniche
- Ahmed Orabi Square

Time-of-day aware rush hour modeling reflecting actual Cairo commuting patterns:

- Morning peak (7–10 AM): ×1.5 traffic intensity
- Evening peak (6–9 PM): ×1.4 intensity
- Night hours (10 PM–6 AM): ×0.4 baseline
- Normal hours: baseline intensity

Dynamic vehicle count bounded by location capacity and rush-hour multipliers

2. Rich, Analytics-Ready Data Schema

Every event contains **13 fields** exactly aligned with the downstream Azure SQL Database and Stream Analytics schema:

Timestamp (UTC ISO 8601)

LocationID, LocationName, Latitude, Longitude

VehicleCount, AverageSpeedKMH (km/h), CongestionPercentage (%)

DominantVehicleType (Car, Taxi, Bus, Microbus, Truck, Motorcycle, Delivery Van)

WeatherCondition (Clear, Rain, Fog, Sandstorm, etc.)

TrafficIncident (None, Minor/Major Accident, Breakdown, Construction, etc.)

IsRushHour flag & RushFactor (decimal)

3. Realistic Anomaly Injection for Testing

5% probability of artificial congestion spikes

5% probability of speed anomalies (severe congestion <15 km/h or unrealistic high speed >85 km/h)

10% chance of traffic incidents — ideal for testing alert rules in Stream Analytics and Power BI

4. Seamless Azure Cloud Integration

Direct streaming to Azure Event Hubs using official Python SDK

Connection string and Event Hub name fully parameterized

Graceful fallback to local-only mode if Azure connectivity fails (perfect for development and demonstrations)

Batch sending with robust error handling and automatic retry behavior

5. Production-Ready Operational Design

5-second event generation interval → 5,900 events/hour across all locations

Clean, structured console output with real-time event visualization

Graceful shutdown via Ctrl+C with connection cleanup and final statistics

Comprehensive logging and status messages