

Cloud-Based Smart Traffic Management System

1. Aim

Design and implement a cloud-based smart traffic management system using Google Cloud Platform (GCP) to monitor traffic conditions in real-time, simulate traffic data, store it in BigQuery, and visualize it in Looker Studio.

2. Description

Traffic management is critical in urban areas to reduce congestion, improve road safety, and optimize travel time. In this experiment, we simulate traffic at multiple intersections and use cloud technologies to:

1. Stream traffic data in real-time using Pub/Sub.
2. Store traffic events in BigQuery for analysis.
3. Visualize traffic trends and detect congestion using Looker Studio.

This basic cloud-based system provides a foundation for real-time traffic monitoring and future enhancements, like alerts and predictive traffic management.

3. Prerequisites

- Software:
 - Python 3.x
 - Git
- Cloud Platform:
 - Google Cloud Platform (GCP) account
 - Service Account JSON key with Pub/Sub Admin / Publisher and BigQuery Admin permissions
- Libraries:
 - google-cloud-pubsub
 - google-cloud-bigquery

4. Procedure

Step 1: Set up GCP Project

- Go to GCP Console and create a new project (e.g., smart-traffic-basic).
- Enable Pub/Sub API and BigQuery API.

Step 2: Create Pub/Sub Topic

- Go to Pub/Sub -> Topics -> Create Topic, name it traffic-data.
- Note topic path: projects/YOUR_PROJECT_ID/topics/traffic-data

Step 3: Create BigQuery Table

- Dataset: traffic_demo
- Table: traffic_events with schema:
intersection: STRING, vehicle_count: INT64, avg_speed: INT64, timestamp: TIMESTAMP

Step 4: Setup Local Environment

- Create project folder and requirements.txt with google-cloud-pubsub and google-cloud-bigquery.
- Install dependencies: pip install -r requirements.txt

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- Set GCP credentials: export  
GOOGLE_APPLICATION_CREDENTIALS='path/to/service-account.json'
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Step 5: Python Traffic Simulator

- Create traffic_simulator.py (publishes random traffic data to Pub/Sub every 2 seconds).

Step 6: Run Traffic Simulator

- python traffic_simulator.py
- Check data in BigQuery table traffic_events.

Step 7: Visualize Data

- Open Looker Studio -> Connect BigQuery -> traffic_demo.traffic_events
- Create charts: line chart for vehicle count, table for average speed, conditional formatting for congestion.

Step 8: Optional GitHub Integration

- git init, add files, commit, add remote, push to GitHub.

5. Result

- Live traffic data is streamed to BigQuery.
- Looker Studio dashboard displays:
 - Vehicle count trends per intersection
 - Average speed per intersection
 - Highlighted congestion areas (avg_speed < 10)
- Demonstrates a working basic cloud-based smart traffic monitoring system.

6. Conclusion

The experiment successfully demonstrates the integration of cloud services (Pub/Sub, BigQuery, Looker Studio) for real-time traffic monitoring. Forms a foundation for future enhancements like real-time alerts, machine learning-based prediction, and integration with IoT devices.

7. References

- Google Cloud Pub/Sub Documentation: <https://cloud.google.com/pubsub/docs>
- Google Cloud BigQuery Documentation: <https://cloud.google.com/bigquery/docs>
- Looker Studio: <https://lookerstudio.google.com/>