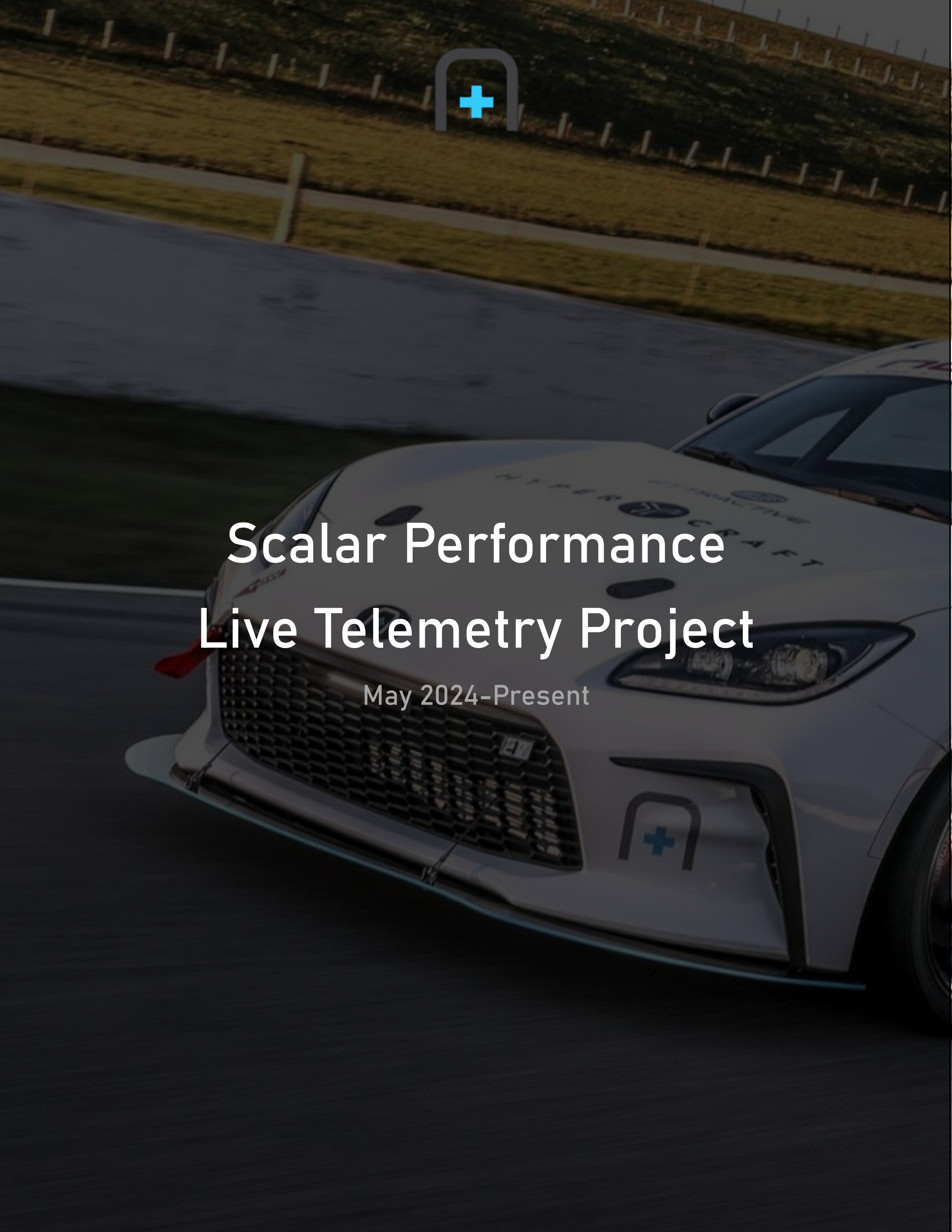
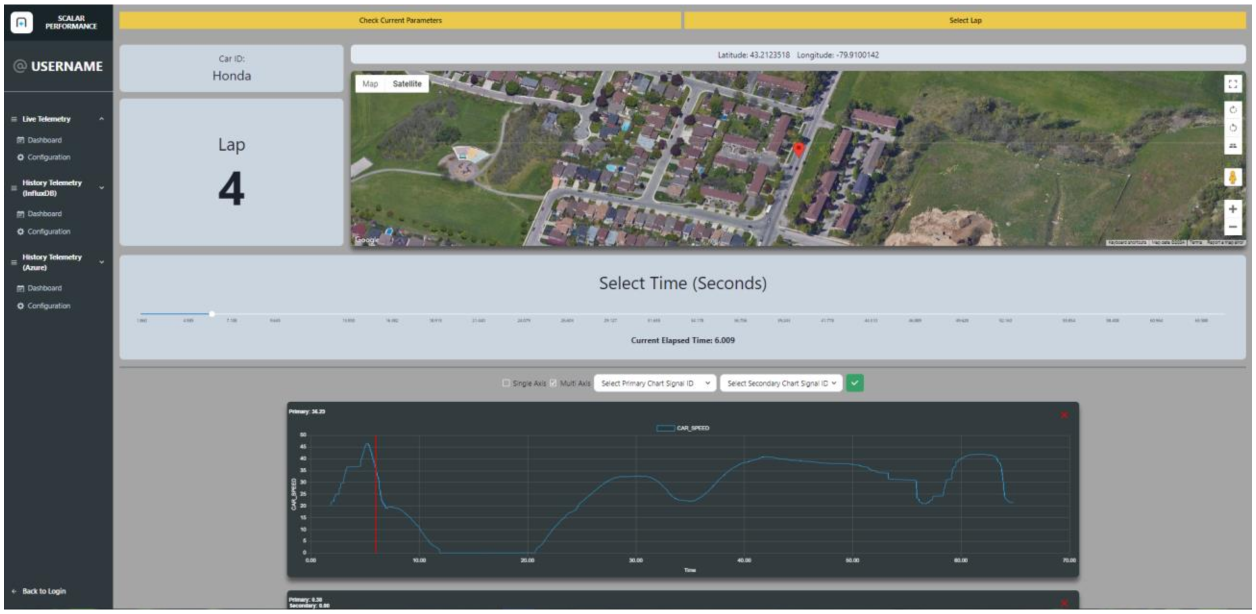


Scalar Performance Live Telemetry Project

May 2024-Present

Table of Contents

1. General Features



Historical Data Dashboard for a lap

1.1 Data Collection and Processing Pipeline

- **MQTT Source**
  - Send CANBUS messages from a local Raspberry Pi to a data processing pipeline
- **Quix (Kafka-based)**
  - Decode CANBUS messages and send data to a WebSocket to view live data and an SQL storage system.

1.2 Front UI

- **JavaScript, CSS, HTML**
  - Select live vehicles sending data, and select/view any CAN signals in real-time via graphs or gauges
  - Select historic vehicles, and select/view any historical CAN signals via graphs between periods
  - Select GPS Coordinates for placeholders of start lines (to reset lap counts and elapsed time)
  - (In Development) Login system to view data on Front UI

1.3 SQL Storage System

- **InfluxDB**

  - Store data of every CANBUS Signal sent through the data pipeline, organized by tags of Car Id's
  - Store GPS Coordinates of all start lines
- **Azure SQL Database**
  - Store data of every CANBUS Signal sent through the data pipeline
  - Store GPS Coordinates of all start lines

2. Hardware Integration

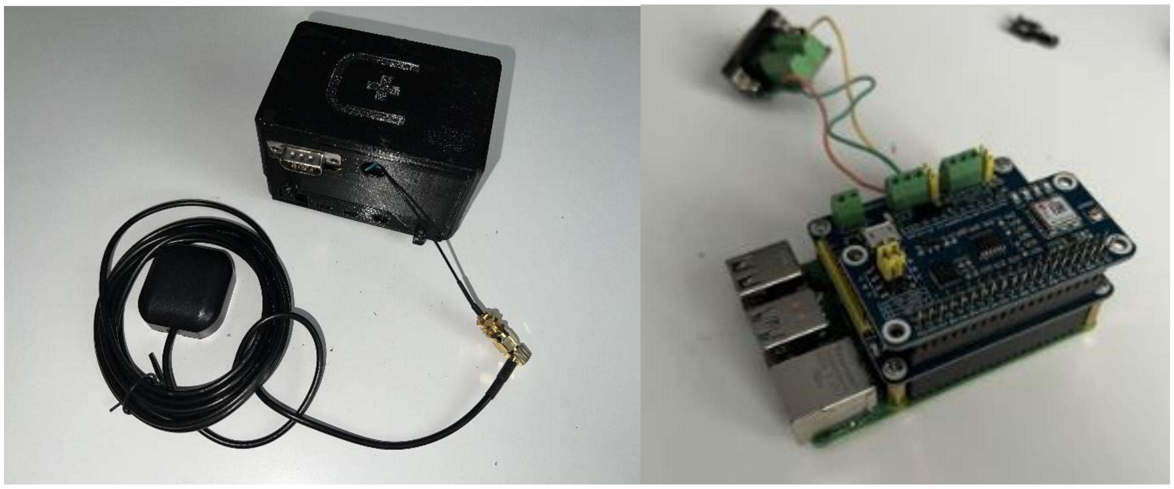


Figure 1: Final Assembly of Hardware

2.1 Hardware Components

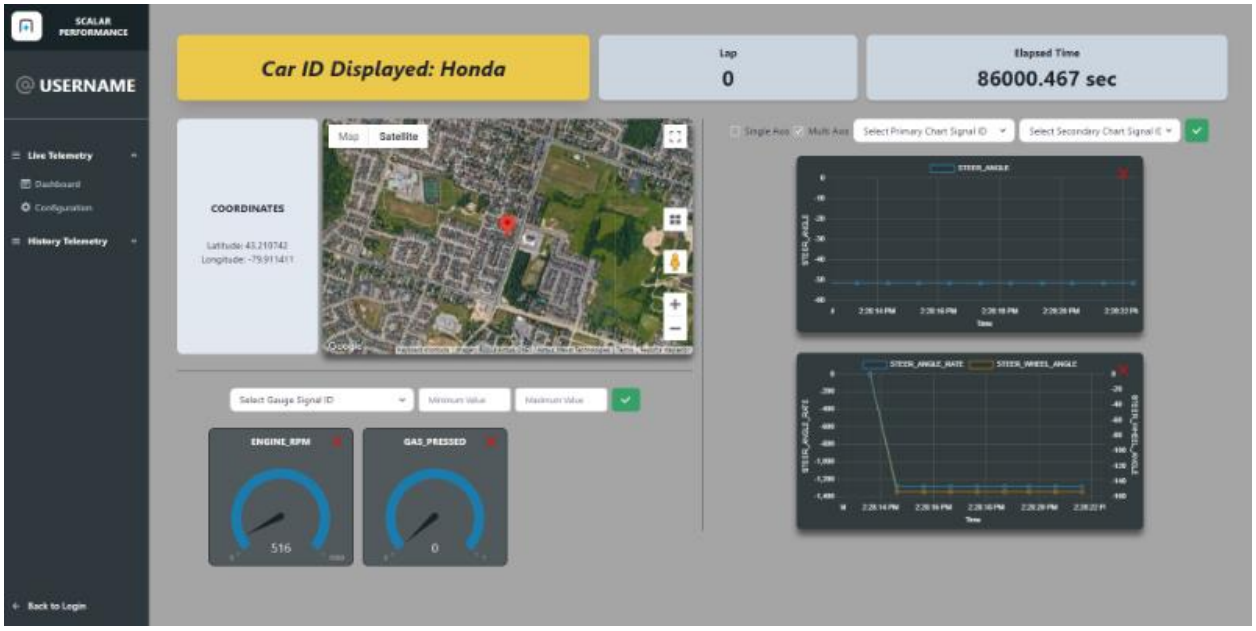
- Raspberry Pi 4 Model B (at least 2 GB RAM) (Link)
- MicroSD Card (at least 8 GB storage)
- 2-Channel Isolated CAN FD Expansion HAT (Link)
- MAX-M8Q GNSS HAT (Link)
- CANBUS Connection from vehicle
  - Option 1: CAN High and Low wires (connect straight to the CANHAT)
  - Option 2: DB9 Connector (Link) connecting CAN High, Low, and Ground
- Custom Raspberry Pi Case

2.2 CANBus Wiring Harness

- Custom wiring harnesses throughout the SCR1 (race vehicle) were created to tap into specific modules, with corresponding DBC files to translate within Quix

3. Software – Front UI & Backend Server

3.1 Live Dashboard



Car ID Displayed: Honda

Lap
0

Elapsed Time
86000.467 sec

COORDINATES

Latitude: 43.210742
Longitude: -79.911411

ENGINE_RPM 516

GAS_PRESSED 0

Figure 2: Live Dashboard Recording Data

3.11 Live Dashboard Features

- See current Car ID you receive information from (Refer to Live Configuration for set up)
- See current lap and elapsed time the vehicle is on
- See current coordinates (latitude and longitude) of vehicle, including google maps API
- Set 1 or 2 y axis graphs to visualize CAN Signal ID's
- Set gauges, with minimum and maximum values, to see CAN Signal ID's

3.2 Live Configuration

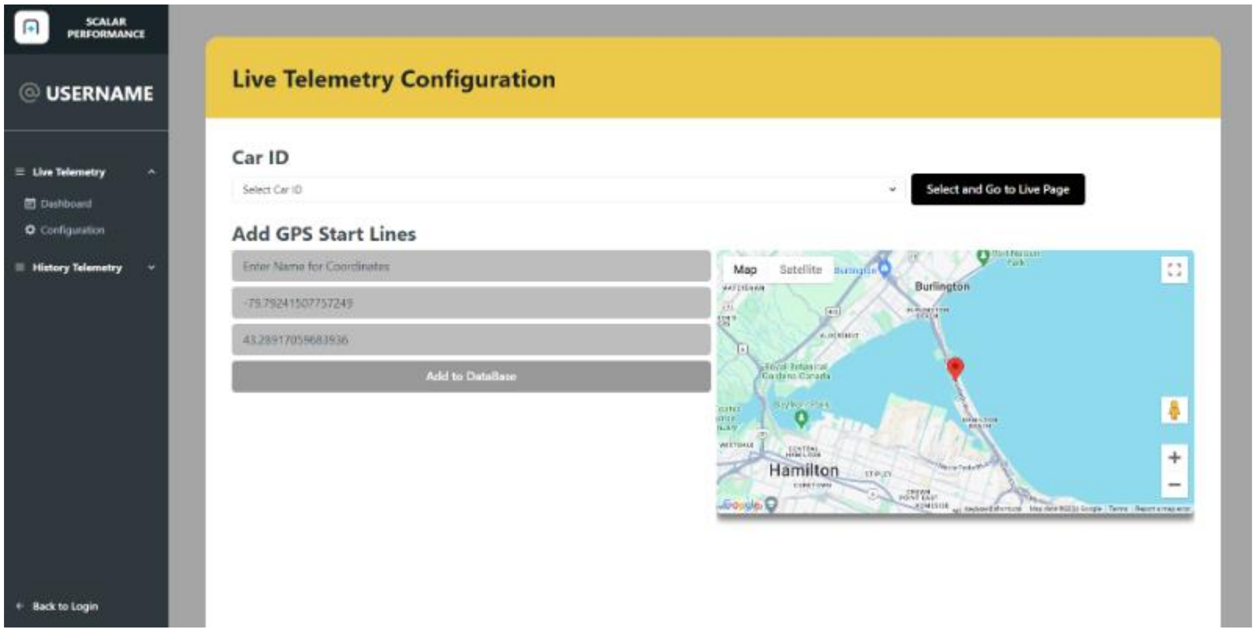


Figure 2: Live Configuration, setting GPS Start Lines into Azure SQL Database

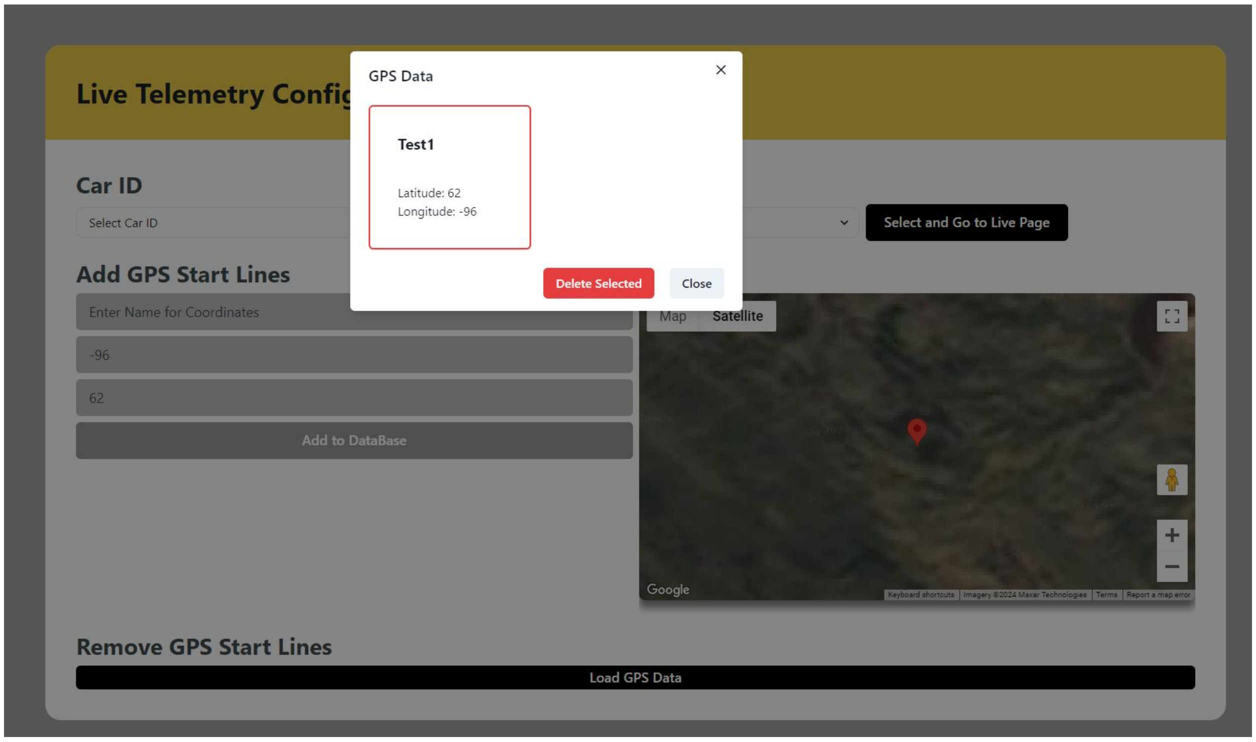


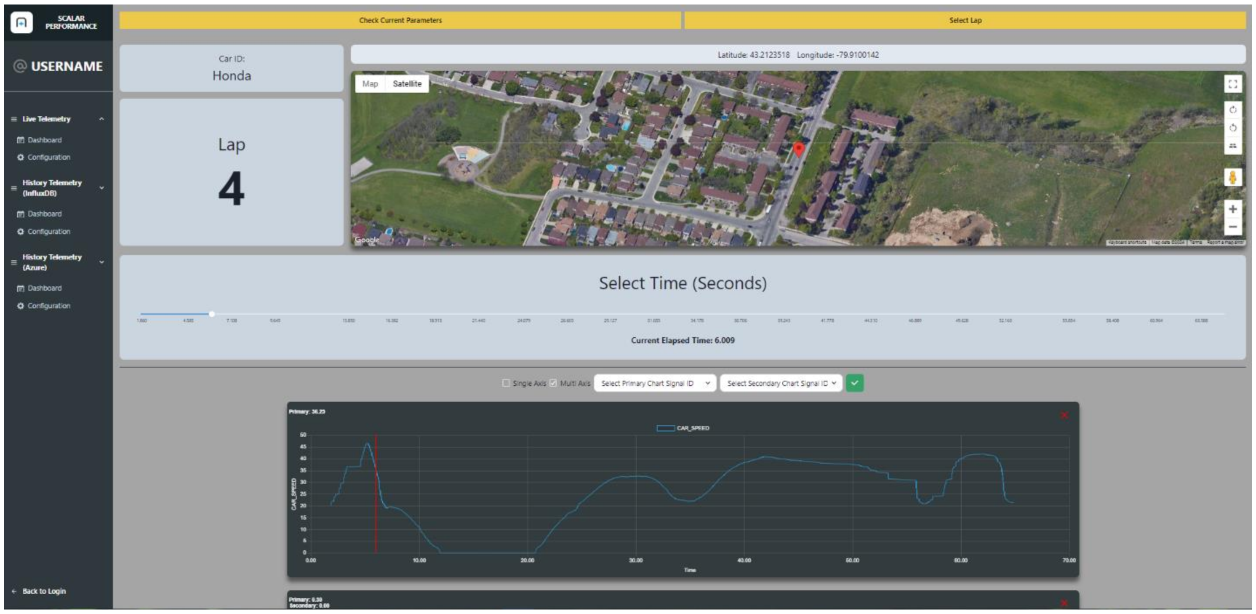
Figure 3: Querying and deleting GPS Start Lines in Azure SQL Database

3.21 Live Configuration Features

- Select Car ID that you want to see live, options loaded from populated InfluxDB car ID tags or Azure Database

- Add GPS Coordinates for start line either by navigating placeholder on Google Maps API or manually enter coordinates
- Load and view all GPS Start Lines in database
- Delete GPS coordinates from database

3.3 Historic Dashboard



Car ID: Honda

Lap 4

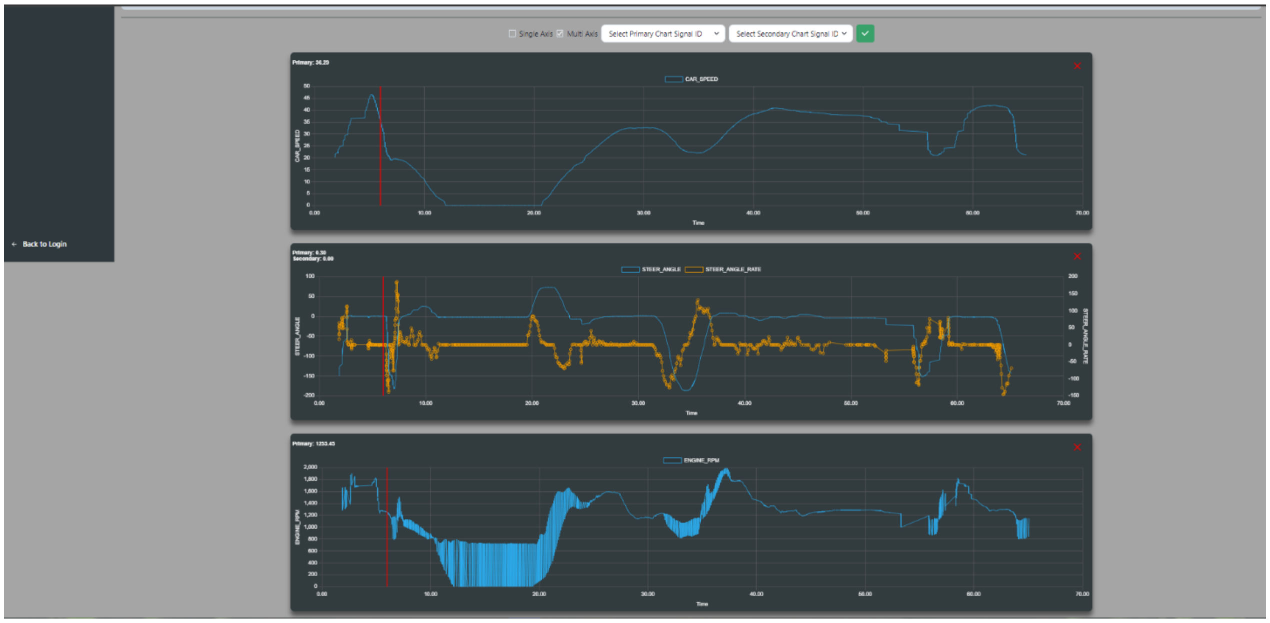
Latitude: 43.2123518 Longitude: -79.9100142

Select Time (Seconds)

Current Elapsed Time: 6.009

Primary: 26.25

Figure 4: Historic Dashboard with CANBus data collection of a lap (Ex. GPS & Car Speed)



Primary: 26.25

Primary: 8.30
Secondary: 0.00

Primary: 1253.45

Figure 5: Historic Dashboard with CANBus data collection of a lap continued (Ex. Steer Angle, Steer Angle Rate, Engine RPM)

3.31 Historical Dashboard Features

- View current parameters set on the historic dashboard, including car ID, measurement (InfluxDB), start and end time
- Select any lap stored within that time period to query data
- Scroll through the elapsed time of the lap
- Set 1 or 2 y axis graphs to visualize CAN Signal ID's, along with annotated line and value (based on scrolled elapsed time value)
- Auto scaling for graphs and time scroller time stamps (elapsed_time axis)
- See current lap and elapsed time the vehicle is on
- See current coordinates (latitude and longitude) of vehicle, including google maps API (based on scrolled elapsed time value)

3.4 Historic Configuration

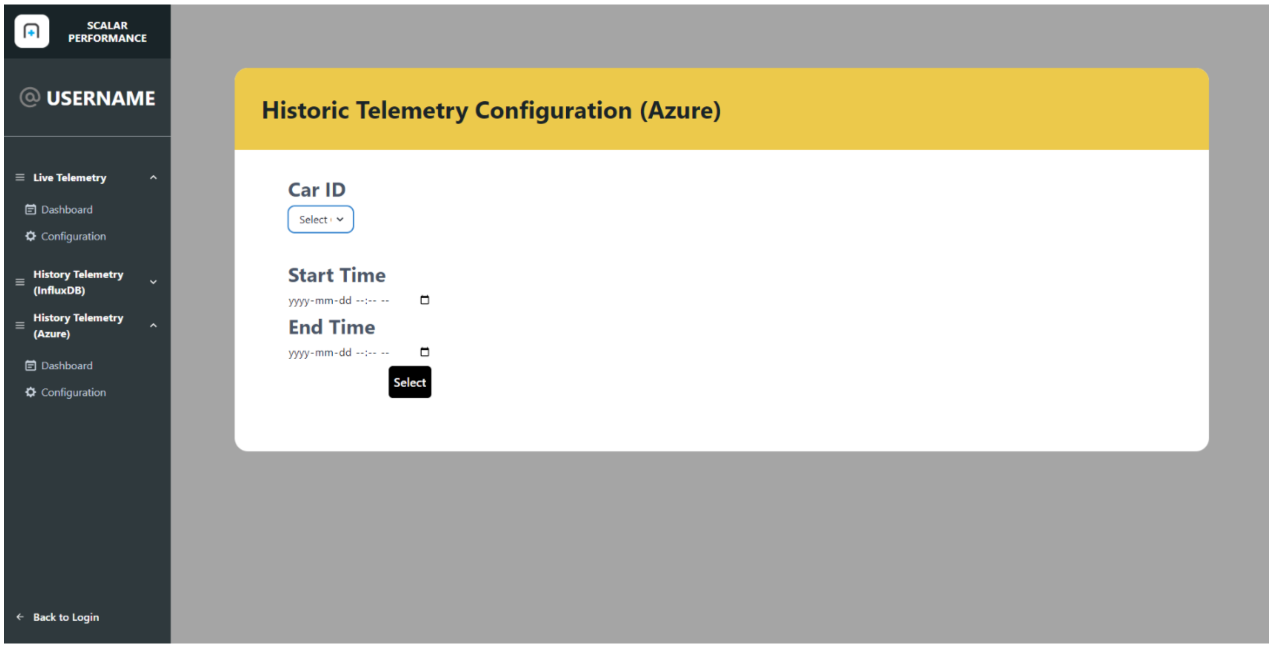


Figure 6: Historic Configuration with selection of Car ID, Start and End Time

3.41 Historical Configuration Features

- Select Car ID, start and end time of the historic data you want to view

3.5 Backend Server

3.51 Backend Server Features

- The backend server holds all the Azure functionalities, and the front UI simply makes API calls to the backend

- The backend allows for better performance, security (the Azure access information is not in the front end at all), scalability of querying through large databases without the front end significantly slowing down

4. Software – Quix (Kafka-based Data Pipeline)

4.1 Quix Deployment Features

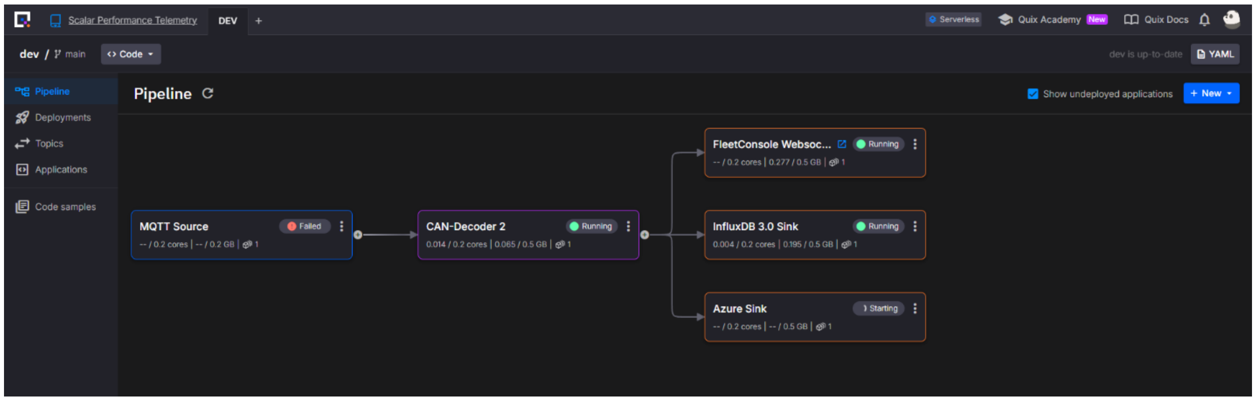
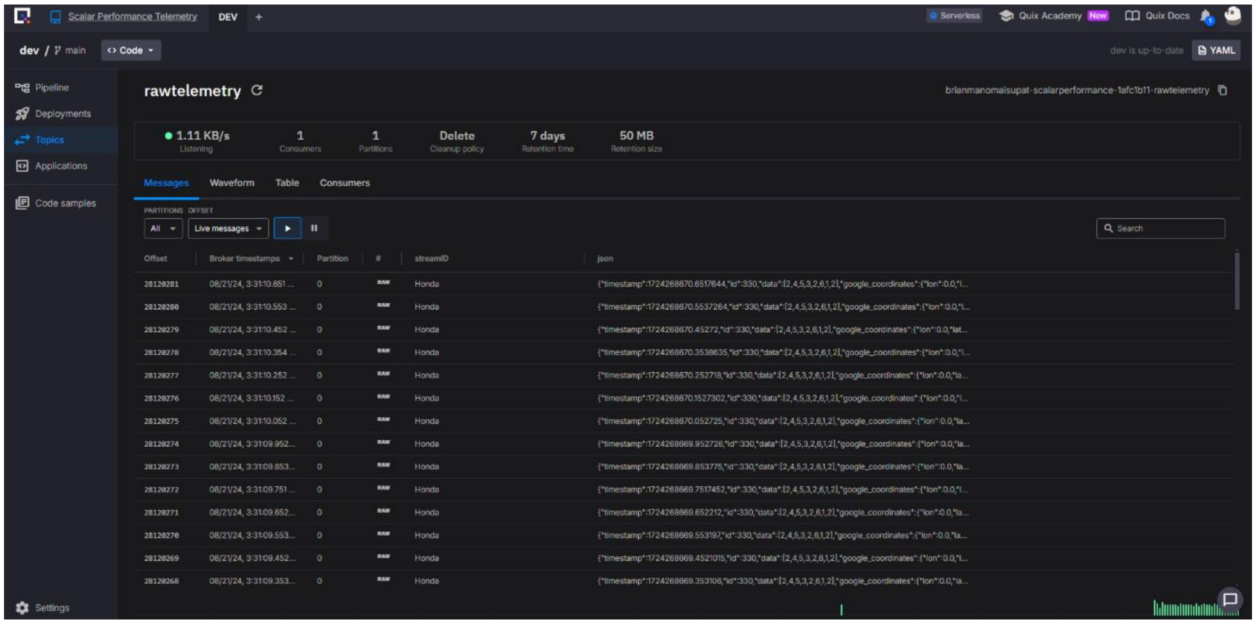


Figure 7: Quix Data Pipeline with Deployments

- **MQTT Source:** Local Raspberry Pi deployment that sends CANBus messages and GPS Coordinates (normal for it to have status "Failed" since it is local)
- **CAN-Decoder 2:** Queries through a database of DBC's to translate CANBus messages based on the name of the car id (specific cross-correlation between Car IDs and DBC files, so canIDs are not mistranslated between different types of vehicles)
- **FleetConsole Websockets:** Websocket that connects to front UI and send live CANBus messages depending on car id selected
- **InfluxDB 3.0 Sink:** Sends all CANBus messages to InfluxDB, sorted by tags of car id
- **Azure Sink:** Sends all CANBus messages to Azure SQL Database

4.2 Quix Topic Features



rawtelemetry

brianmanomaisupat-scalarperformance-1afc1b11-rawtelemetry

1.11 KB/s	1	1	Delete	7 days	50 MB
Listening	Consumers	Partitions	Cleanup policy	Retention time	Retention size

PARTITIONS: All OFFSET: Live messages

Offset	Broker timestamps	Partition	#	streamID	json
28120281	08/21/24, 3:31:10.651 ...	0	RAW	Honda	{"timestamp":1724268670.6517644,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"l...
28120280	08/21/24, 3:31:10.553 ...	0	RAW	Honda	{"timestamp":1724268670.5537264,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"l...
28120279	08/21/24, 3:31:10.452 ...	0	RAW	Honda	{"timestamp":1724268670.45272,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"lat...
28120278	08/21/24, 3:31:10.354 ...	0	RAW	Honda	{"timestamp":1724268670.3538635,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"l...
28120277	08/21/24, 3:31:10.252 ...	0	RAW	Honda	{"timestamp":1724268670.252718,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"la...
28120276	08/21/24, 3:31:10.152 ...	0	RAW	Honda	{"timestamp":1724268670.1527302,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"l...
28120275	08/21/24, 3:31:10.052 ...	0	RAW	Honda	{"timestamp":1724268670.052725,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"la...
28120274	08/21/24, 3:31:09.952...	0	RAW	Honda	{"timestamp":1724268669.952726,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"la...
28120273	08/21/24, 3:31:09.853...	0	RAW	Honda	{"timestamp":1724268669.853775,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"la...
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28120271	08/21/24, 3:31:09.652...	0	RAW	Honda	{"timestamp":1724268669.652212,"id":330,"data":[2,4,5,3,2,6,1,2],"google_coordinates":{"lon":0.0,"la...
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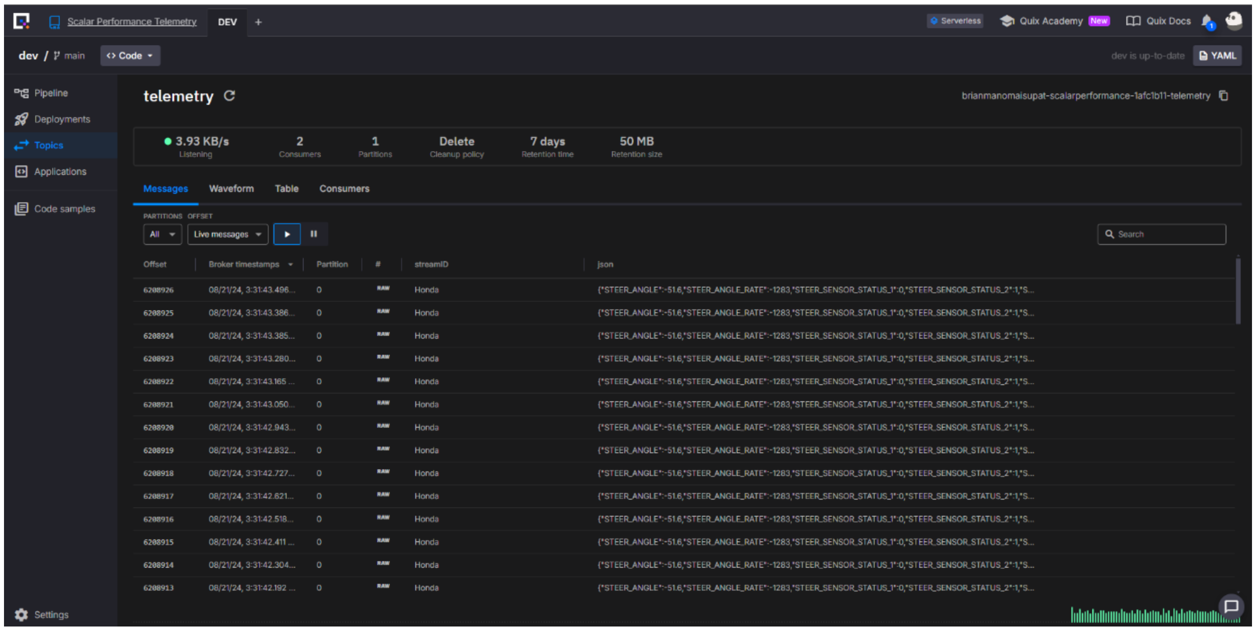

telemetry

brianmanomaisupat-scalarperformance-1afc1b11-telemetry

3.93 KB/s	2	1	Delete	7 days	50 MB
Listening	Consumers	Partitions	Cleanup policy	Retention time	Retention size

PARTITIONS: All OFFSET: Live messages

Offset	Broker timestamps	Partition	#	streamID	json
6208926	08/21/24, 3:31:43.496...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208925	08/21/24, 3:31:43.386...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208924	08/21/24, 3:31:43.385...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208923	08/21/24, 3:31:43.280...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208922	08/21/24, 3:31:43.165 ...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208921	08/21/24, 3:31:43.050...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208920	08/21/24, 3:31:42.943...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208919	08/21/24, 3:31:42.832...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208918	08/21/24, 3:31:42.727...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208917	08/21/24, 3:31:42.621...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208916	08/21/24, 3:31:42.518...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208915	08/21/24, 3:31:42.411 ...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208914	08/21/24, 3:31:42.304...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...
6208913	08/21/24, 3:31:42.192 ...	0	RAW	Honda	{"STEER_ANGLE":-51.6,"STEER_ANGLE_RATE":-1283,"STEER_SENSOR_STATUS_1":0,"STEER_SENSOR_STATUS_2":1,"S...

Figure 8: rawtelemetry and telemetry topics

- **Rawtelemetry topic:** receives raw CANbus messages from various "MQTT Source" deployments
- **Telemetry topic:** receives translated CANbus messages from the "CAN Decoder 2" deployment

5. Software – Azure SQL and InfluxDB

5.1 Azure SQL and InfluxDB Features

- Both databases hold the historical data for all fleet vehicles, including all CANBus messages, GPS coordinates, elapsed time, and lap count.