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Topic : "SMART FLEET MANAGEMENT SERVICES WITH POWER OF IOT & 5G",
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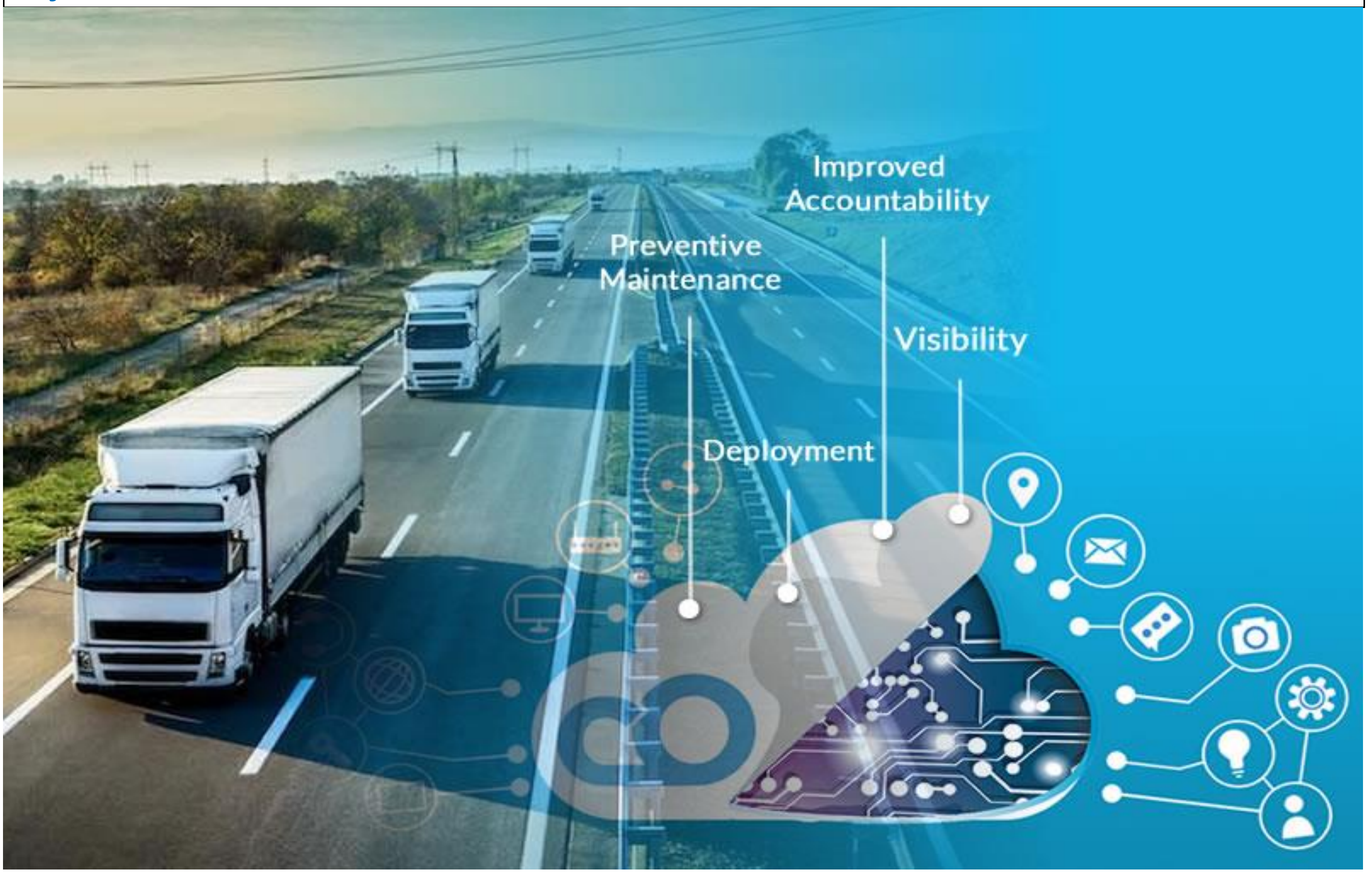
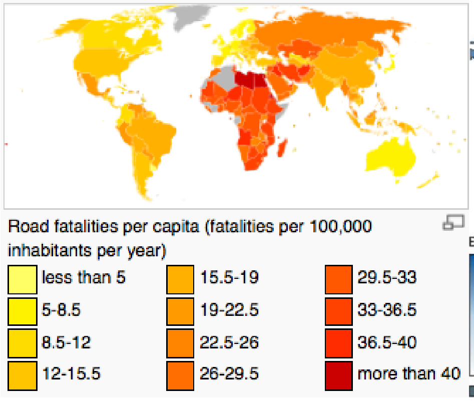
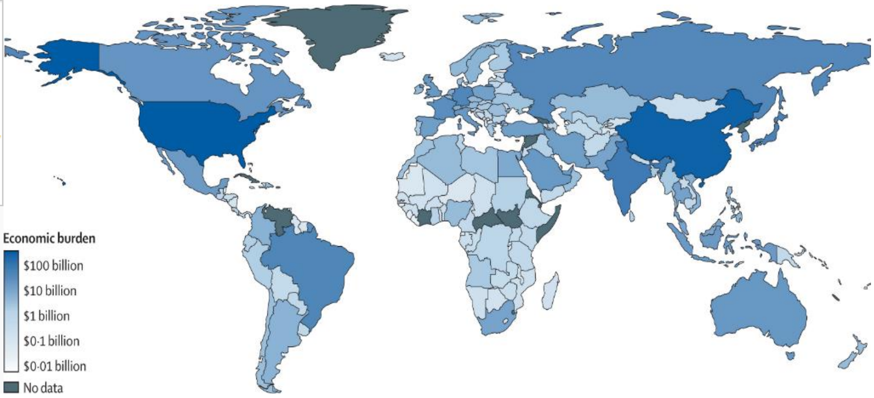


Executive Summary:

The world is changing and so we are. Day in and out new models of extraordinary fleets are emerging in the markets with lot of super cool features. But if we see the following statistics, it generates a notion that despite this super-efficient fleet quality, how do we fill the dark yellow and orange colours by white. Also, at the right side if we see the global Macro economic burden of road injuries, the figures are shocking.



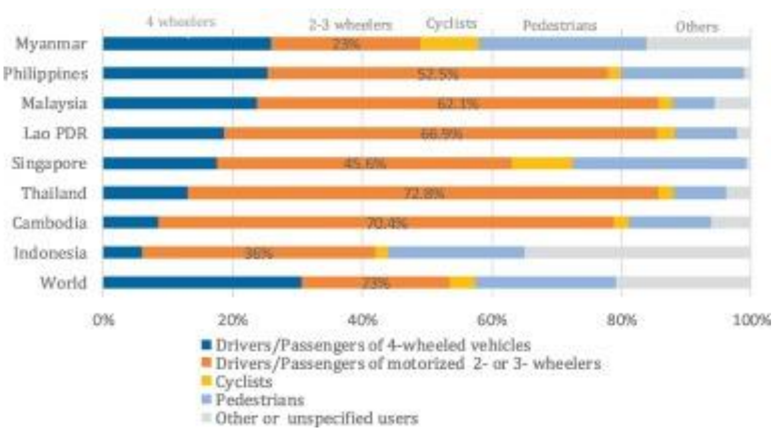


Mostly 80% of the incidents takes place because these 5 major reasons.

- Rash driving due to last hour hurry.
- Unexpected extreme Traffic congestion.
- Non-Maintenance of the fleets for longer period.
- No real time control over fleet health.
- Quality of the drivers.

This is the context that encourages the service providers to come up with a smart Fleet management solution to tackle some of the issues at certain extent with the power of AI, IoT and 5G.

The following study is based specifically on APAC regions to tackle the following mortality issues because of different types road accidents.

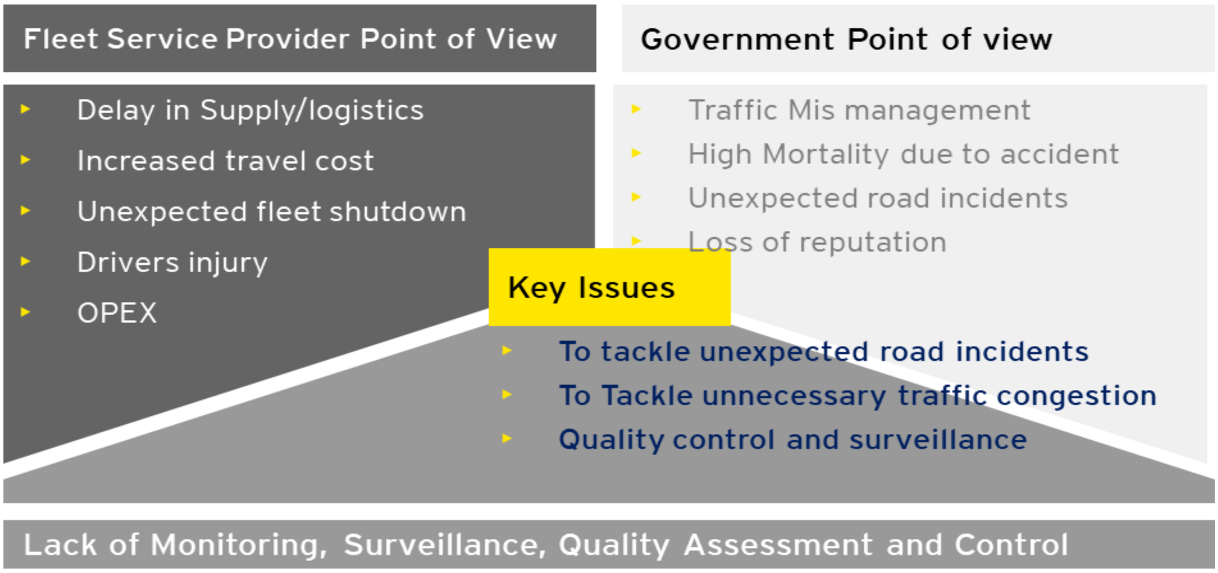


What is FMS and why its required?

Fleet management Services (FMS) signifies the holistic actions that take place to keep a fleet running efficiently, on time and within budget. Otherwise, it can be framed as the processes used by fleet managers to monitor fleet activities and make decisions from asset management, dispatch and routing, and vehicle acquisition and disposal. It helps companies ensure compliance, improve efficiency, and reduce costs. This FMS concept applies to any organization that uses five or more vehicles.

Problem statement and concerns of related parties?

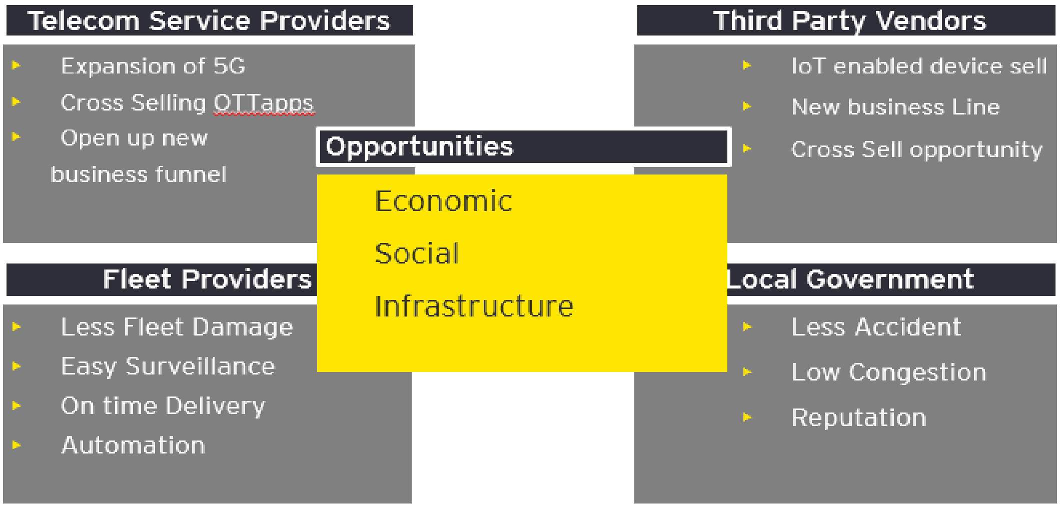
Here are the glimpses of the current problem landscape and how the related parties have been impacted.



Opportunities - Urge of the Solution Development:

Telecom service providers used to connect lot of enterprises and corporates for selling the services and products which are part of their core services and related products. Few Enterprises also used their connectivity and network as a part of their own solution and services. Out of them one of the most prominent business is Surveillance and Tracking management. They incorporate the SIM card in their IoT enabled devices and create a real time surveillance and monitoring of the respective Fleet providers. This has been a win-win situation for the respective Fleet management organization as well as the Telecom service providers to garner some business by selling the products to the end users, here the products and services has been created by the Fleet management service providers with the enablement through telecom service providers. Now few telecom service providers decide to create their own proprietary solutions and reach out to the end users other than procuring the Sensor devices from the manufacturers/service providers.
Here one of the Telecom leaders from APAC region has developed a smart Fleet management product through their newly launched 5G integration and collaboration with some third-party vendors from whom they get the real time Telemetry Data from their sensors.
They are approaching all their existing enterprise and corporate partners to test the solution and enabled under their network connectivity, thereby extending a milestone of creating Smart city project by local Govt by 2025. They just need to setup the vendor provided sensor device into the fleets and connected via Telecom

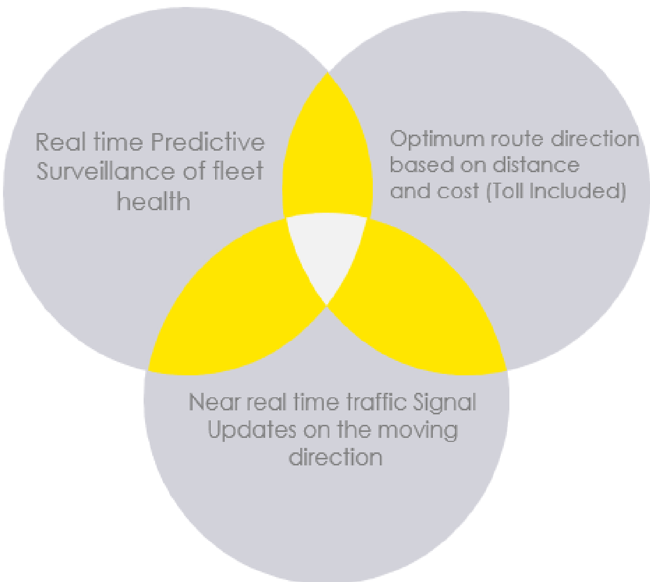
service provider SIM card. The solution can be accessed via an OTT apps from Android/Apple Mobile devices or Fleet inbuilt screens.



Solution provided by the product:

There are three main services provided by the product to cater the above-mentioned challenges.

1. Real time Predictive Surveillance of fleet health
2. Optimum route direction based on distance and cost (Toll Included)
3. Near real time traffic Signal Updates on the moving direction



All these three solutions have overlapped to each other at some extend and well connected to create a holistic solution at scale to cater the larger chunk of the mentioned problems.

Data Acquisition:

following are the some Key KPIs captured by the Sensor for each fleet.

Parameters:

Name	Data Type	Required / Optional	Description
senderIdentifier	String	Required	To identify who is sending the data
deviceId	Long	Required	Unique Identifier for the GPS tracking device. Usually the IMEI number or Serial Number.
driverId	Int	Optional	A unique identifier of the driver (for e.g. National Identification Number)
assetName	String	Required	The name of the asset or the vehicle registration number / license plate number.
timestamp	Long	Required	Unix timestamp
odometer	Long	Required	Vehicle's running odometer in km
ignition	Bool	Required	Ignition status of the vehicle (Ign. On = True | Ign Off = False)
latitude	Decimal	Required	Latitude in decimal degrees
longitude	Decimal	Required	Longitude in decimal degrees
altitude	Decimal	Required	Altitude from the GPS
accuracy	Decimal	Optional	Accuracy of the GPS usually measured by the number of satelites (first digit) and the current HDOP value (second digit).
heading	Decimal	Required	GPS heading in degree from North
speed	Decimal	Required	GPS speed in km/h
internalBatteryVoltage	Int	Optional	Battery Voltage of the GPS tracking device in mV.
sensors	Array	Optional	Sensors and its status in array.
temperatures	Array	Optional	Temperature in array.
fuelLevel	Decimal	Optional	Fuel Level in percentage
totalFuelUsed	Long	Optional	Total accumulated amount of fuel used during vehicle operation in litres.

All these data have been injected on a frequency of every 10 seconds by the sensors. On the top of that few other information has also been shared by the device such as

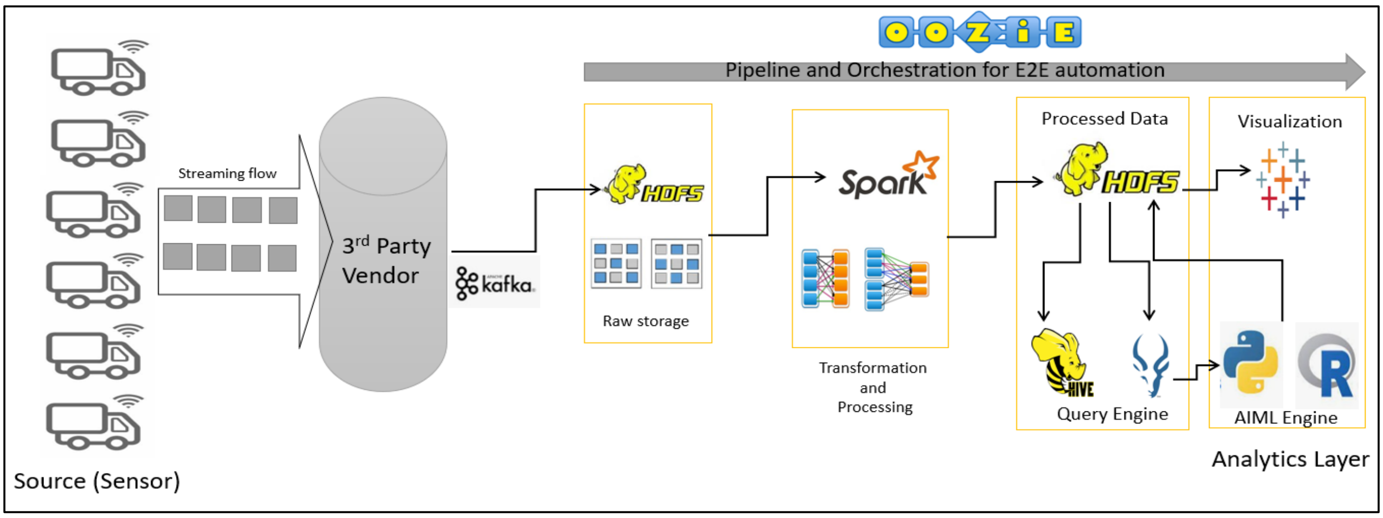
- Speed exceeding incidents
- Speed exceeding timeframe
- Speed exceeding location identification.
- Device faults
- Device shutdown

And Few static details also help to develop the solution at good extend such as Mileage of respective Fleets (homogeneous types), Diesel or Petrol car, Toll Plaza locations with Accurate Latitude and Longitude, price of Petrol or Diesel at local currency.

Technical Architecture:

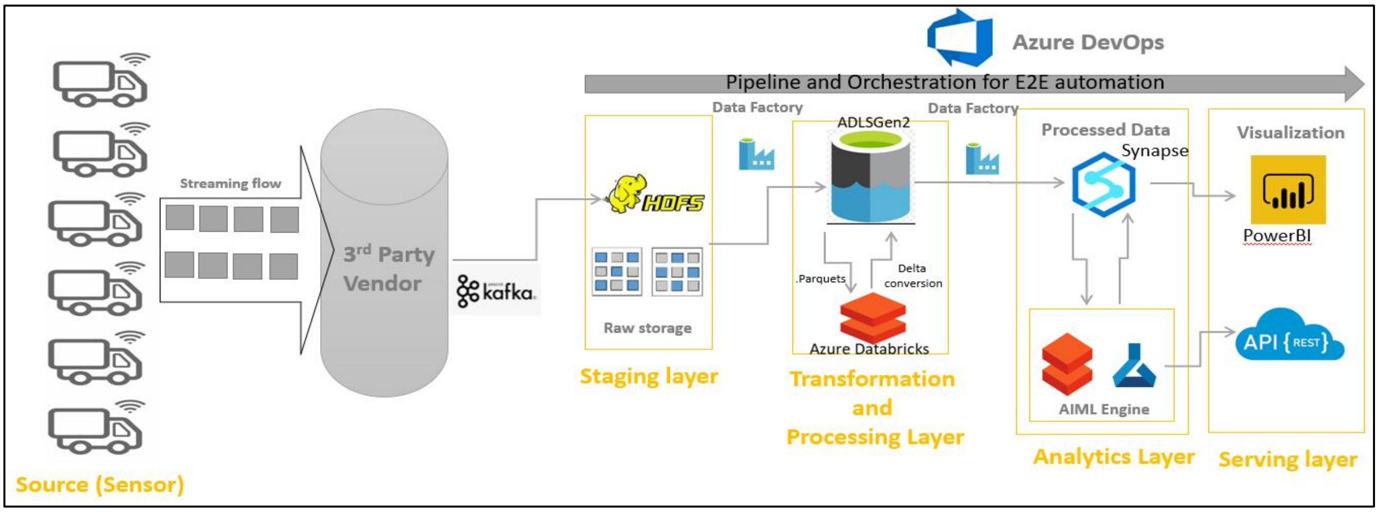
Let's discuss how the data will be ingested and consumed by the platform and solution has been designed. The steps also talk about the evolution of the integration from on premises to Cloud platform.

Step -1: Hadoop Architecture:



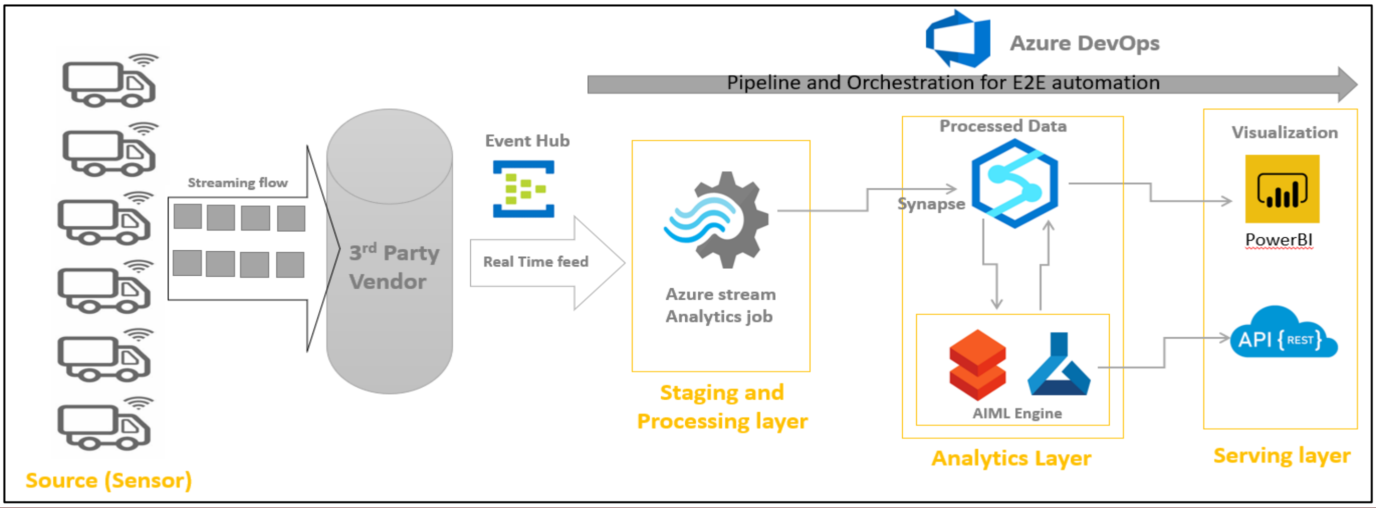
Initially, the first two solutions have been designed on Hadoop platform where the Sensors generates the data in every 10 seconds and captured by the third-party vendor but finally the Kafka broker consumes the feed and load in on premise stagging layer on every 30 seconds. Then the Spark job transformed the data and load the same in OLAP Database for further query and analysis. The Data Science and Data Analyst team then consume the data from Hive or Impala and create the first layer data and feed the data in AIML engine for final recommendation and share the results back in some Temp table which would finally visualize by any visualization tool or consumed by any other application through an API. But using this platform there is a significant latency with low throughput. Hence the requirement of a cloud comes into the picture.

Step-2: Hadoop Integrated with Azure:



In the new design the data has still consumed by the Cloudera platform and ingest the same to Azure data lake through a Data factory copy function. This was an interim solution before making a fully Azure integration and decommission the Cloudera integration from the solution. For the higher throughput the raw data has been converted in Delta format for the ease of Data Scientist or Data Analyst's access. Finally, the raw data will get loaded in Synapse table and consumed by Data bricks or ML studio for further ML solution creation. Here the conversion is quite easy but still facing some good amount of latency because of the integration of Hadoop Layer in the solution. Finally, the latest design overcomes the hindrance and able to provide a seamless high throughput data ingestion and processing.

Step-3: Fully Migrated at Azure:



Finally, the live stream has been consumed by the Azure Event Hub and by processing of Azure steaming analytics and thereby loading the data in Synapse table. This is a most optimized and high throughput data loading and enablement for the data scientist and data analyst to create a scalable solution for following three services. Because the latency and processing capability the third solution was not included in earlier two designs but now this has been included in this current design.

Release -1 Details of the product:

The following details have been described based on the first release and only caters 5 Fleets each of 3 different categories:

Category 1: Private Car: Proton, Perudua, Toyota, Hyundai, Honda
Category 2: Bus: 5 different buses from MAN
Category 3: Truck: 5 different trucks from HINO.

Also, the same has been deployed for few specific locations and routes and test the accuracy of the entire solutions. Initially lot of hindrances and bugs has been raised. In subsequent release the issues would get resolved and by Dec 2023 the provider wants the deploy the 100% services to the entire country and would looking for expand the footprint to other APAC regions with the success story of that launch.

We can now discuss the solutions in detail.

Solution 1: Predictive Maintenance:

A real time scalable Predictive maintenance solution is really a very powerful indicator to monitor any devices health and avoid any possibility of unexpected shutdown, thereby hampering the services. From the same context, these gives a holistic view of the overall health of the Fleets and also indicate the irregularities of key indicators for better understanding to the respective drivers. In this service there are two solutions:

- **Anomaly detector** – A Recommender meter that gives a signal on few Key Indicators based on identification of the contextual anomaly.
- **Predictive Health Indicator** – Based on the historic data of respective fleet classes a predictive engine has been provisioned which can generate a health score in a scale of 1-100 to depict the overall health of the fleet at that point of time. Features like Igniometer, Engine temperature, Outside temperature, Fuel level, accelerator, humidity, speed, altitude and few other relevant calculated fields.

Solution: A series of scalable Deep neural Net based classification model has been deployed which is capable of generating online prediction of Fleet Health index and the result has been consumed by the Edge devices/OTTapps.

Example:
POST /event/sendevent/ HTTP/1.1
Content-Type: application/json
X-Api-Key: [redacted]

{
"senderIdentifier": "gpsProviderA",
"deviceId": 1101,
"driverId": "1234567890",
"assetName": "ABC123",
"timestamp": "1529456457131",
"odometer": "150458",
"ignition": "true",
"latitude": 21.115688835270703,
"longitude": 105.9881474543629,
"altitude": 21.115688835270703,
"accuracy": 22,
"heading": 286,
"speed": 2.21,
"internalBatteryVoltage": 51,
"sensors":
[
{"name": "door1", "value": "open"},
{"name": "door2", "value": "close"},
{"name": "door3", "value": "open"}
]
"temperatures":
[
{"name":"temp1", "value": 22.5},
{"name":"temp2", "value": 28},
{"name":"temp3", "value": 18}
]
"fuelLevel": 89.5,
"totalFuelUsed": 30955
}

The JSON format request calls the REST API for the prediction.

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Solution 2: Optimum Route calculation:

This is a solution which help the fleet owners or drivers to find out the most optimum route based on the following factors:

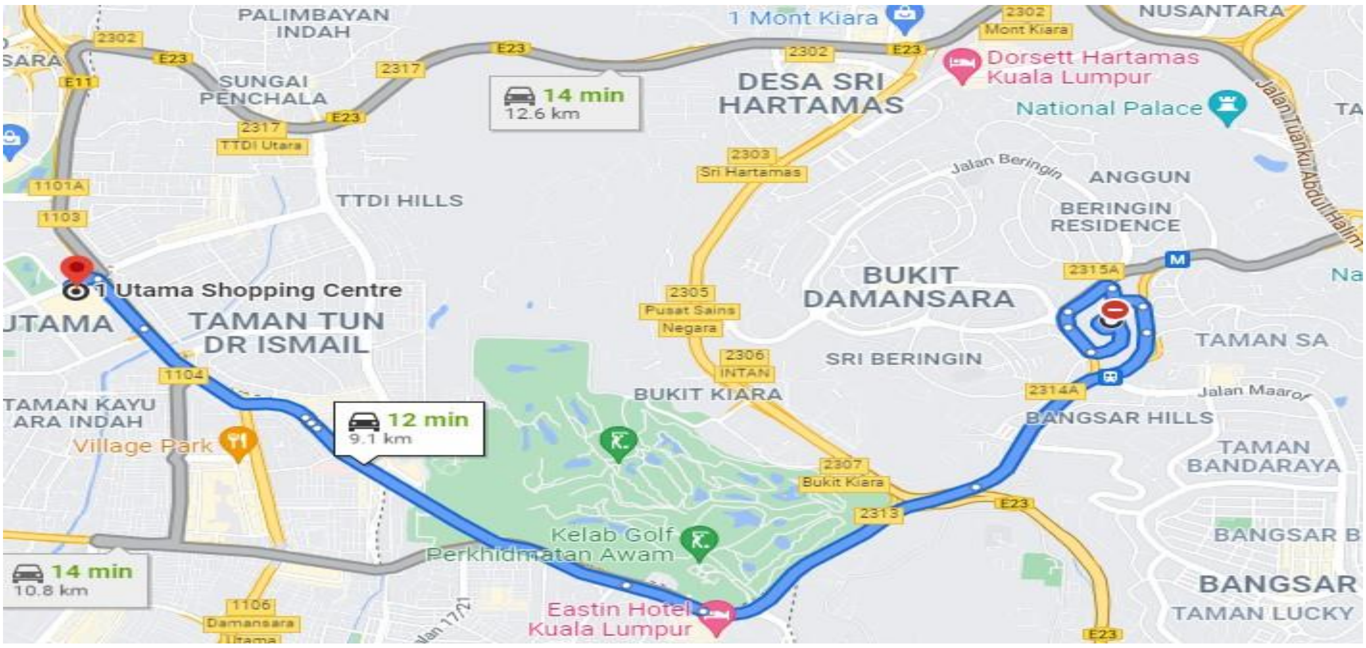
- Distance (Source to Destination)
- Cost of Travel (Includes the Toll Charges)

$$COT = \left\{\left(\frac{d}{M} \times c\right) + Cost_{T_O} + Cost_{T_C}\right\}$$

where COT is cost of travel
d is the distance
M is the Mileage of the Fleet
c is the cost of fuel/litre
Cost (To) – Open Toll Cost
Cost (Tc) – Closed Toll Cost

- Average Speed
- DCR (Distance to Cost Ratio)

NOTE: This data is based on the specific type of Fleets and based on historic travel records of the same fleet class on the same route. In the first release the Closed Toll cost has not been included because 80% of the tolls are Open Toll. This will be included in subsequent releases.



Here calculating the distance between two points using any Pythonic distance measurement would give a wrong estimation, hence the data has been captured either from historic route details or from Google map with geospatial analytics.

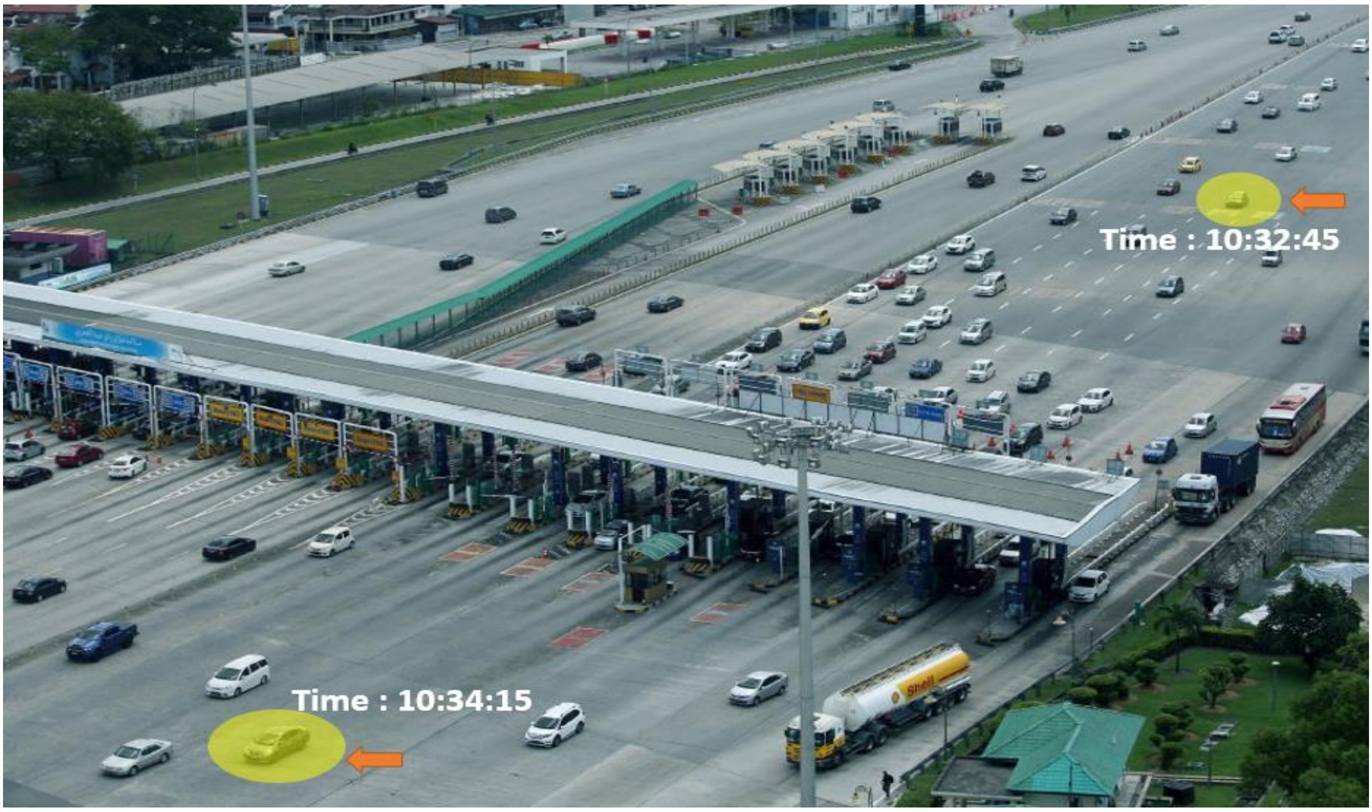
Solution - A ranking measurement (dense rank()) has been provisioned for all the available routes from one source location and destination. Based upon the above-mentioned parameters individual ranking has been assigned and each parameter caters equal weightage, hence based on that a final score will come which is again convert to a rank. Finally, always the rank no -1 for this particular route will shared in the screen.

Now the critical part of the calculation is how to include the toll cost in the overall cost calculation.

Here is a snippet of the static toll plaza information across the location. Also, there is another static data which shares the respective toll cost in local currency for different Fleet class.

REGION	TOLL PLAZA	ABB.	CODE	GPS Coordinates
NORTHERN				
	JITRA	JTR	110	6.252051, 100.435160
	HUTAN KAMPUNG	HKG	112	6.160108, 100.405642
	ALOR SETAR (U)	ASU	113	6.138179, 100.394117
	ALOR SETAR (S)	ALS	114	6.082543, 100.374124
	PENDANG	PDG	121	5.978284, 100.444097
	GURUN	GRN	122	5.815324, 100.488744
	SG. PETANI (U)	SPU	123	5.676150, 100.511307
	SG. PETANI (S)	SPS	124	5.615128, 100.485397

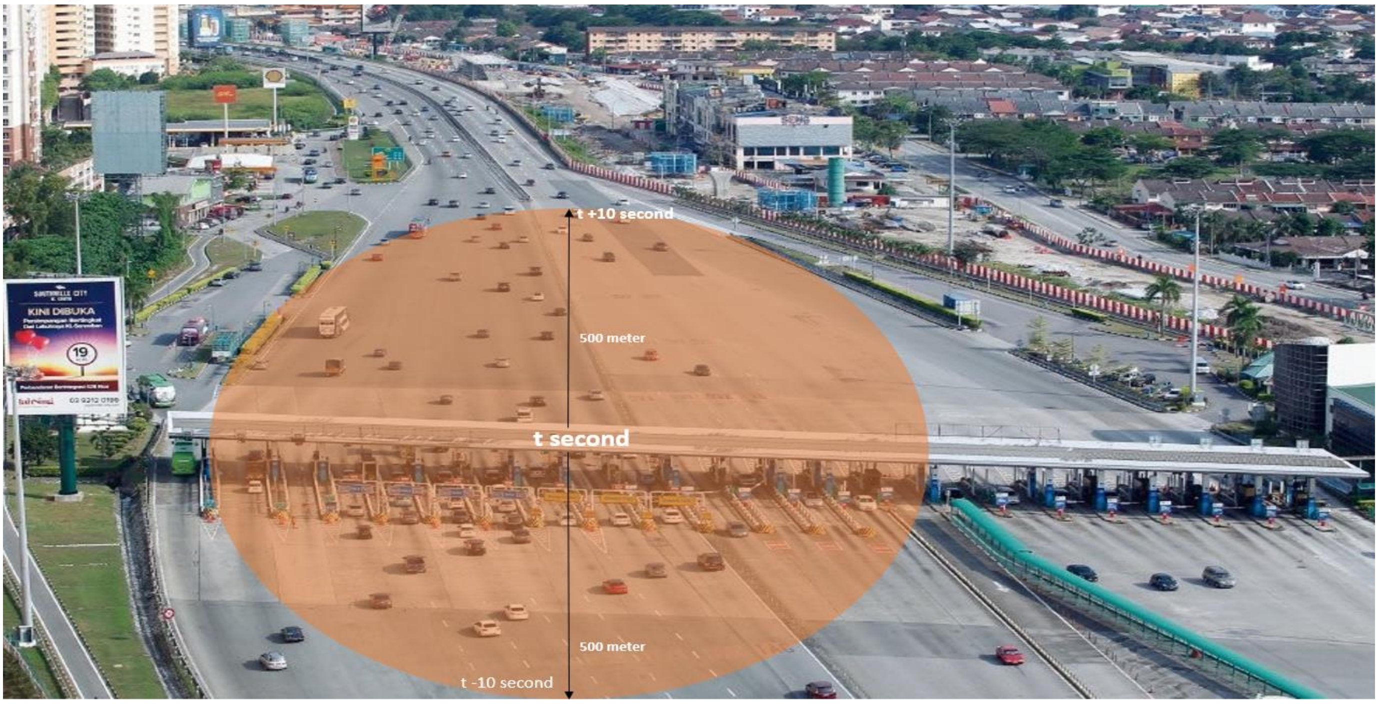
Using the respective fleet location and the Toll Plaza location and based on the concept of geo fencing the toll cost has been assigned to the respective fleets on the course of the journey.
Let's explain the concept with the following example. Consider the car marked by yellow circle has positioned somewhere before the toll plaza at 10:32:45. We have a geo location of the fleet at that time frame. Now as per the design we are expecting a new data point after every 10 seconds. Practically based upon the queue and traffic it cannot be assumed that all the fleets could cross the Toll within these 10 seconds. As per the below picture again the car has been identified at 10:34:15 with some different Geo location details. But how do we conclude that the car has passed through the Toll plaza?



There is couple of assumptions:
As per the country traffic management, within 3 KM before any toll plaza any fleet cannot bypass the road, there is no connecting roads. The fleet must pass by the Toll.
Secondly, the concept of geo fencing. We consider a geo fencing of radius 500 meters considering the toll plaza at the centre. Now any position of the fleet at t-10 time frame and its subsequent position (any of the

t+10, t+20, t+30……….) captures within the geo fencing (either side) would be considered as the fleet crossed the Toll and the respective Toll Fee would be added to its journey.

$$dd\{Toll_{(lat,long)} - Fleet_{(lat,long)}\} \leq 500 \text{ meter}$$



It means if the calculated distance of the fleet and the toll plaza at t time frame and the distance between toll plaza and the fleet after minimum t+10 time frame considers less than equal to 500 meters, then it's been confirmed that the fleet has passed by the Toll.
Now considering 100KM/hr is equivalent to 28m/sec. Hence in 10 second with 100KM/hr a fleet can cross 280 meters only. For safer calculation we keep the geo fencing radius as 500 meter and also its quite common that on both side of the toll its very un-realistic that a fleet can cross the Toll at a speed of 100KM/hr. Hence using the logic, the precision would be always100%.

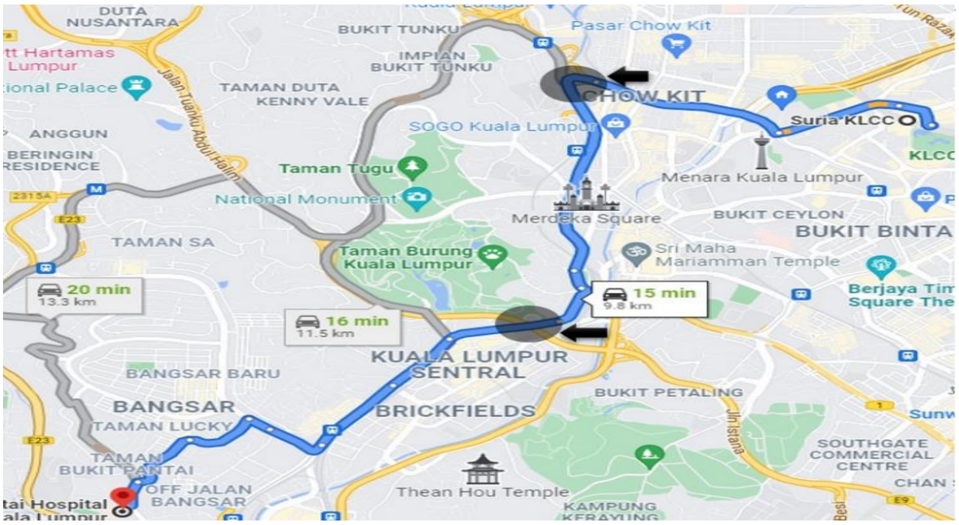
Solution 3: Real time traffic Updates

The core objective of the solution is to provide a near real time traffic update based on Image recognition of the traffic lights on respective traffic signals on the way where Fleet is moving on. It's a use of advanced image recognition base on Deep Learning Cognitive Vision solutions with high scalability and near accurate precision.

Let's discuss about the concept of the solution. The Telecom service provider is including the services with a collaboration of another third-party vendor who is working for the government for maintaining all CCTV cameras on major traffic signals. The Telecom service provider arrange to provision IoT enabled CCTV camera with their 5G network at few of the major traffic signals on specific routes at their major cities. This initiative has limited for the initial release to test the latency, throughput and effectiveness of the solution.

The Device will stream live video footage of the traffic at respective locations and the data-feed will re-route to the telecom service provider via the third party vendor who are responsible for maintaining the IoT enabled CCTV devices. The Yolo Enabled deep learning cognitive vision engine is able to detect the traffic signal object from the video frame and also able to detect the color of the signal at that time window to detect the traffic stand at that point of time. There could be multiple traffic signal boards which directs the traffic to respective direction. There are that many numbers of CCTV camera that identifies the traffic momentum at every direction from the signal crossing.

Let's explain the concept with an example. Consider the following diagram and during the journey there are two major signals that the fleet has to cover. Now once the Fleet reaches to the first signal, it has to take a left turn to maintain the right direction but there is another direction from the signal as well. Based on the optimum route solution (solution no -2) the fleet is maintaining the route and consider which direction it needs to go. Hence though there are two different traffic signals available at the point (one for left and one for right) but the fleet has to go for the optimum route and follow the right signal.

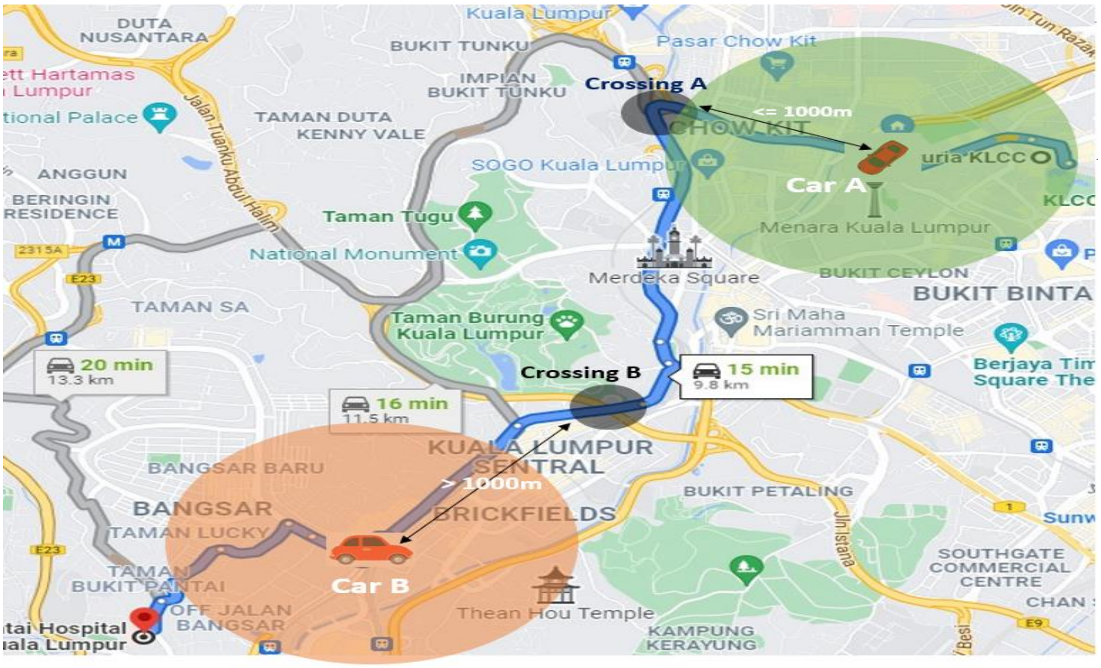


Now again there is another concept of geo fencing. And the applicable radius is 1000 meter. We already have a static data of geo footprints for all the available major signals where IoT enabled CCTV camera has provisioned. At every moment the engine will calculate a geo fencing based on the fleet's current position at that point of time and fetch what are the major crossing signal is available within a 1000 meter radius. At that point of time the solution will only fetch the traffic status of that particular signals and pops up at the apps screen to intimate the driver about the traffic status of the signal prior to 1 KM distance from the location. The pop up will get refreshed at every 10 second and the consecutive similar signal heads up for potential traffic congestion at that signal. At that same time, it also shared the traffic condition at nearby signals if its falls within the 1Km radius. In that case the fleet driver could have changed its route based upon his/her discretion.

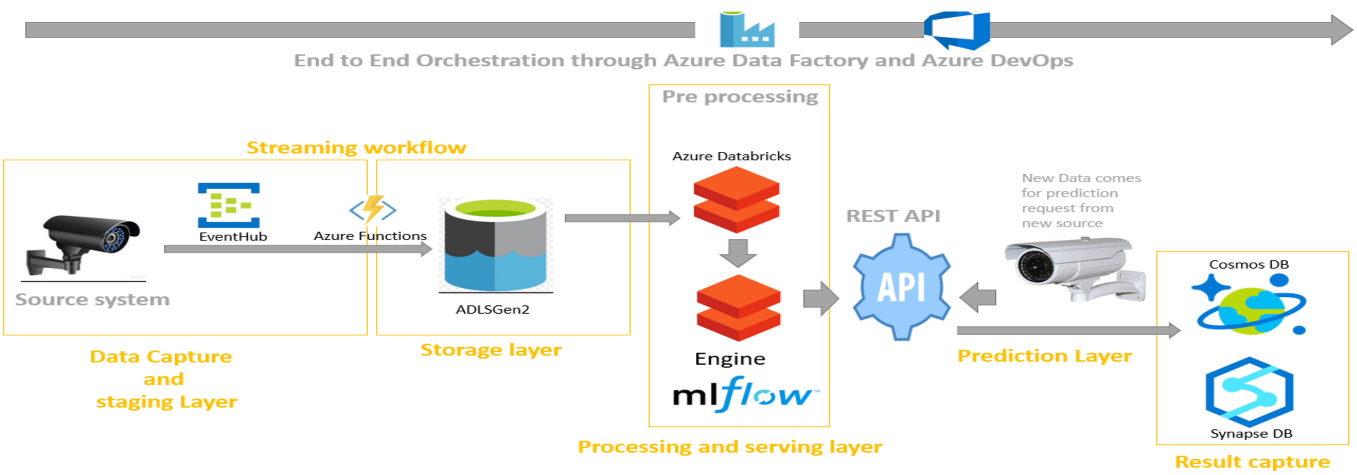
→ loop over all Signals → Signal[i]
@ time(t), $d\{ Signal[i]_{(lat,long)} - Fleet_{(lat,long)} \} \leq 1000m$

Consider the location of Car A which is getting the traffic signal updates of crossing A. Now as per the optimum route the Car A is supposed to take a left turn from the signal, hence it should consider that particular signal response at that moment. But by feature of the product, the fleet driver will also get the traffic momentum towards the right direction of the signal as well as a reference (in case driver wants to switch the route).

But in case of Car B, its yet to receive any traffic signal notification as there is no signal available within its 1 Km geo fencing. Hence it has to travel a few more time to get the respective signals for Crossing B.



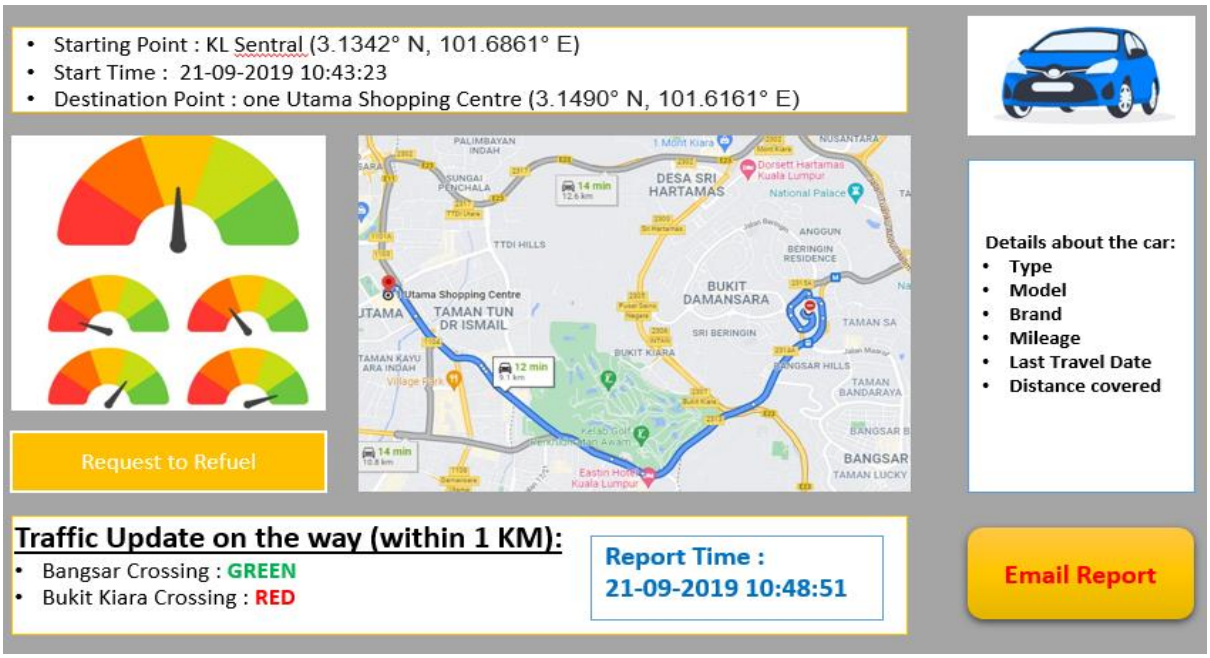
Solution : The Model gets trained with some historical data collected from the third party vendors for diversified scenario and create a nice augmentation and synthetic data generation before train the model. There are multiple models that trained parallelly based on YoloV3, TensorFlow RetinaNet, Inception ResnetV2, EfficientNet with a continuous training pipeline. Gradually the models pick up new data side by side and refresh the model. Based on the accuracy and precision the model has plugged into to the solution as a part of Blue Green Deployment. Still there is some latency and lag in the solution. The subsequent release will tackle the latency issues with upgraded infrastructure and highly scalable solution. The Model has served through a REST API which generates the object class prediction and store the result as a key value pair in Cosmos DB which push the result to the OTT Apps.



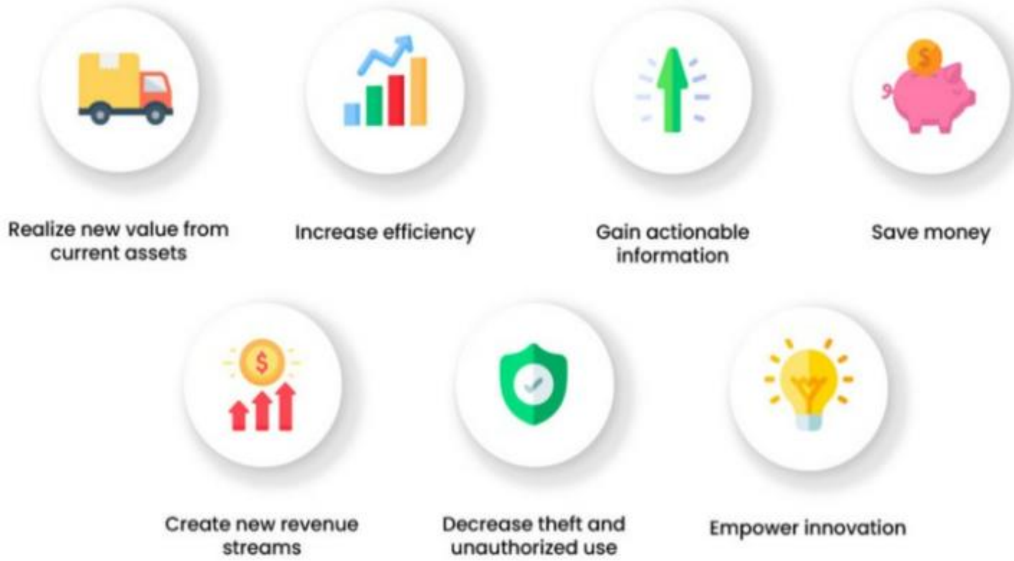
Final IDE look:

The proposed look of the IDE which comprises all three services.

- The topmost block Needs to put the destination location only and it detects the geo coordinates of that location.
- At the bottom of it, all the fleet health indicators and its immediate recommendation.
- In the middle it shows the optimum route.
- At the end the traffic signal notifications.
- Right side, the basic details of the fleet.



Benefits out of the solution:

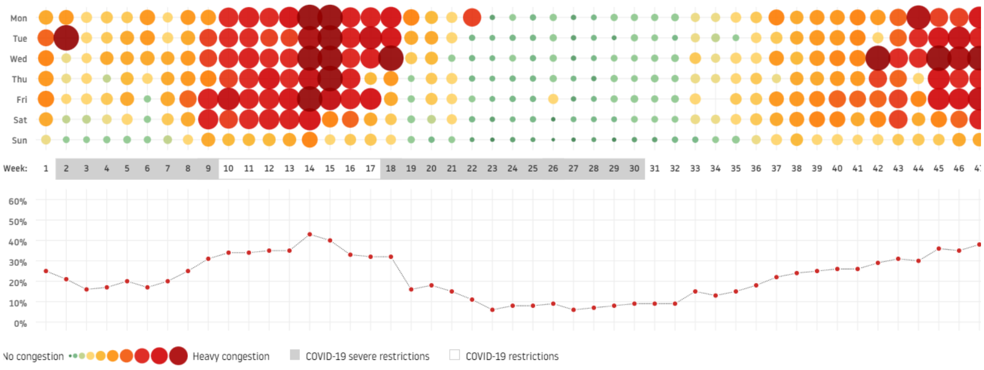


Release Details:

Conclusion:

A country with around 33.2 Million population and by Dec 2020 the number of registered vehicles is 17.46 million. The country recorded 4.94 million road accident cases in the last decade, with the number of road accidents increasing from 414,421 cases in 2010 to 567,516 ten years later in 2020 and the country recorded 7,152 deaths from road accidents in 2016 and 9,167 deaths in 2020.

Due to this Pandemic situation also, only its capital experiences such a pathetic traffic as per the below data.



The emerging trend of AI, 5G and IoT can surely help reducing the pain point at some extend where we can mitigate the KM of Congestion by recommending the right route and upcoming traffic details, No of traffic accidents by proper maintenance and surveillance of the fleet health. Hope we can save some valuable life by the implementation of such niche solutions.