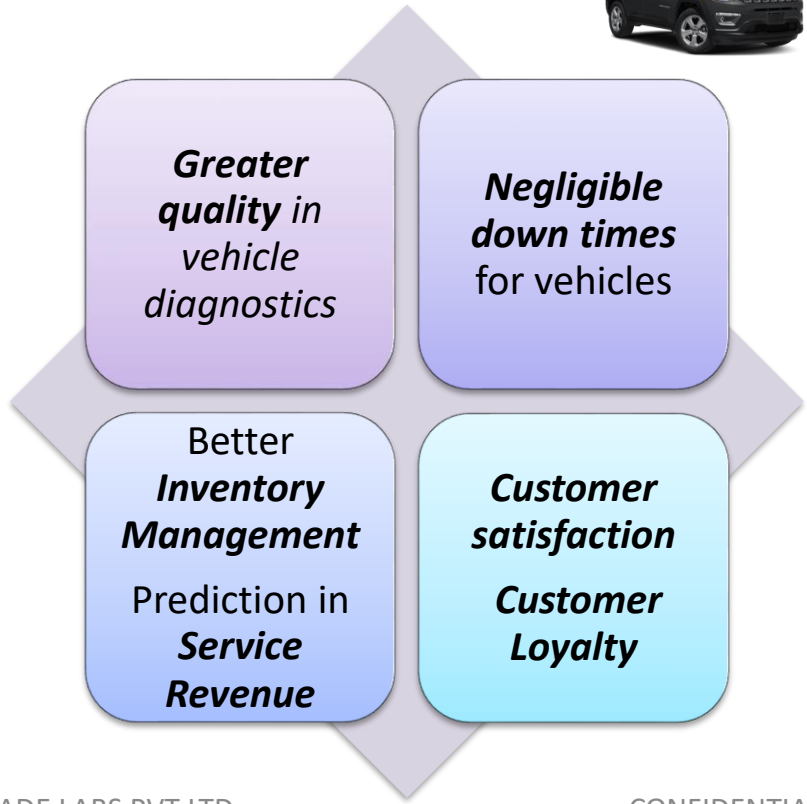
PREDICTIVE CARe

Proposed Solution for E-Tracker

What is PREDICTIVE CARe?

- **PREDICTIVE CARe** envisions to be a platform that enables **'Data driven car maintenance services'**
- Also act as an **automated real time data feedback** mechanism from vehicles to the manufacturer



How PREDICTIVE CARe Works?

Vehicle Service Data

Centralized Cloud Server Hub

Data

Predictive Analytics Engine

Insights

CAN BUS

OBDII

Add on Sensor Devices on OBD

For:

- Management
- Service Center
- Customer

How PREDICTIVE CARe Works?

- **Primary Requisite** for **PREDICTIVE CARe** – **Quality Data** from Vehicles
- Following data generating sources:-
  - **Vehicle Electronic Data** : from various microcontrollers in vehicles **(ECU)** and which are carried through the **CAN** bus (via OBD)
  - **Additional Sensor Data** : sensors for real time measurement of Acceleration & Braking, Terrain structures etc. can be attached to vehicle via OBD port or other mechanism
- Real time data updated to central **Cloud Server Hub**.
- Data processed by **PREDICTIVE ANALYTICS ENGINE** for insights
- Insights as Reports & Dashboards to Management, Service Centers & Owners

OPERATIONAL FLOW

Data Collection:

* Mechanism to collect **real time vehicle data**
* Aggregation of existing **historic data**

Problem Framing :

* **Define** the **problems**
* **Scope** of **components** to be in place for **prediction**
* **Set standard rules, threshold values** etc.

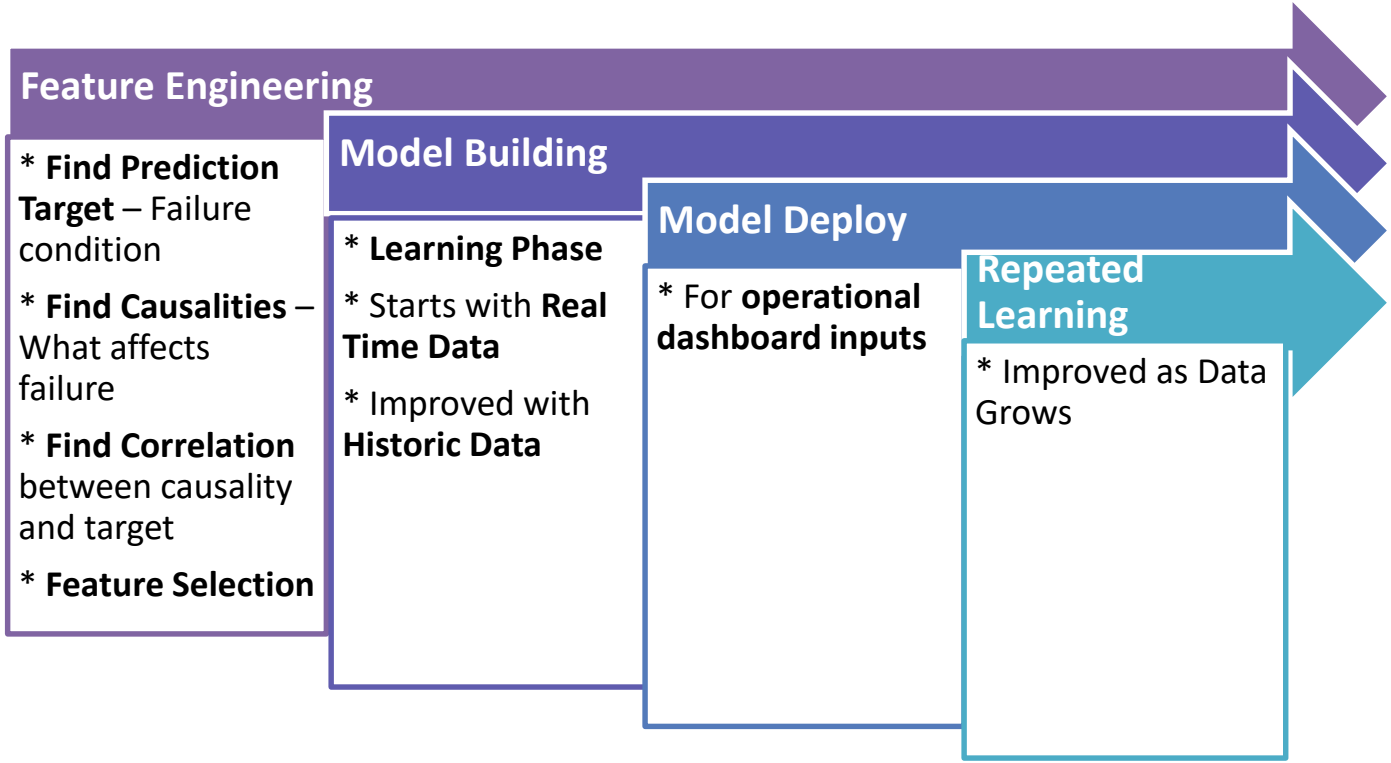
Model Building & Training :

* **Build** respective **models** for respective **components**
* **Train** the **model** with **available data.** Improve **model accuracy** with more data
* **Deploy** the model

Dashboard & Reporting

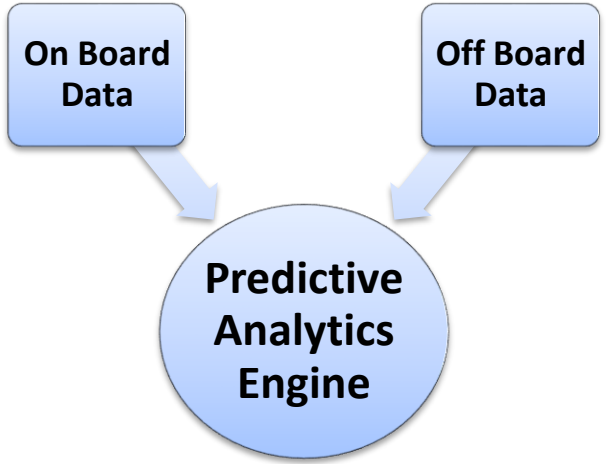
* Provide **insights** to respective users
* **Access Control** to be enabled

HOW ANALYTICS MODEL IS CREATED ?



PROPOSED METHODOLOGY –*Major Algorithms*

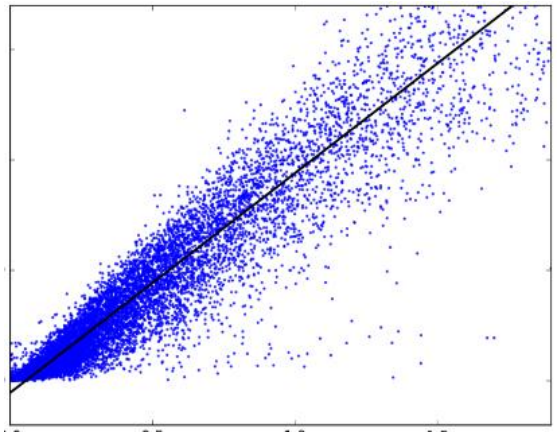
- **Combination** of ***ON-BOARD*** data (real time from Vehicle) & ***OFF-BOARD*** data (historic data maintained by the manufacturer)
- **PREDICTIVE ANALYTICS ENGINE - MACHINE LEARNING** Models to be built on top of the data
- **Reinforced Unsupervised Learning** methodology



Remaining Useful Life	Deviation Detection	Classification
• Regression	• Clustering	• Supervised Classification

PREDICTIVE ANALYTICS – RUL Model

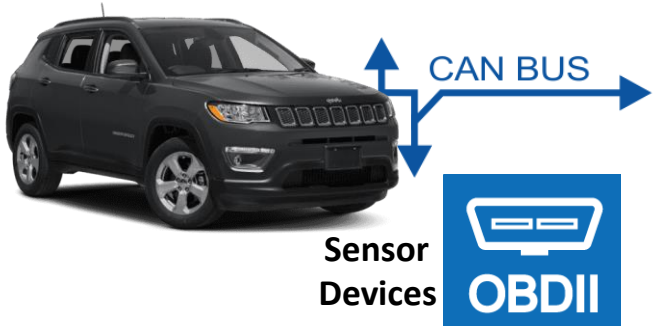
- **Regression model** which is useful in prediction of remaining life of a component.
- The life of components like brake pads, clutch pads etc depends heavily on **driving patterns like:**
  - **acceleration braking intensity, terrain, accuracy of service** etc.
- **RUL of Brake Pad = f (acceleration value, braking intensity g value, average daily driving distance ……)** would be the regression equation
- Based on this, RUL of the component would change **Day –to –Day** depending on the regression model results.
- **CONTINOUS MONITORING** of component life can be automated & ensured
- **Alerts** could be raised for quick variations or threshold violations



PREDICTIVE ANALYTICS – RUL Model

Brake Pad – Use Case

Data:
- **Acceleration**
- **Braking**
- **Total Distance**
- **Terrain etc.**



Sensor Devices

Predictive Analytics Engine

RUL of Brake Pad:
Regressed as a function of
- **Acceleration**
- **Braking**
- **Total Distance**
- **Terrain etc.**

Days to Replace Brake Pad – Updated Daily

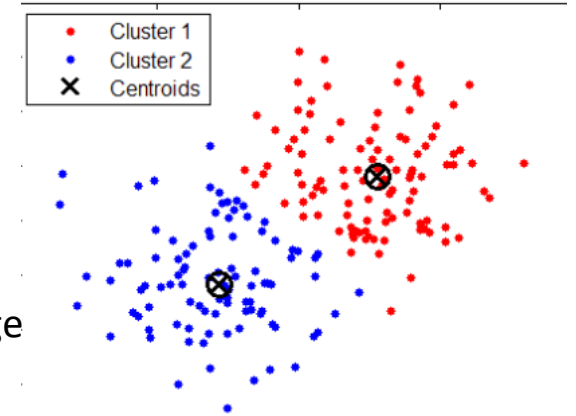
Daily/Weekly/Monthly Wear & Tear

Alerts based on threshold values

Usage Graph

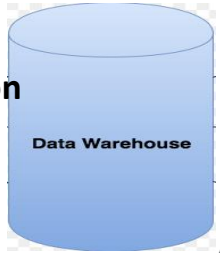
PREDICTIVE ANALYTICS – DEVIATION DETECTION & CLUSTERING MODEL

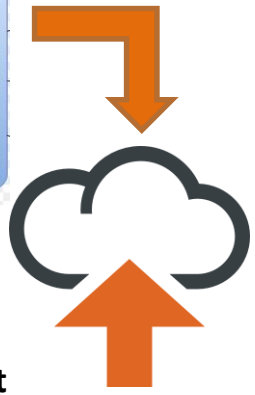
- **CLUSTERING Methodology**
- **Historic data** for **'HEALTHY VALUES'** of various **components** to be aggregated
- Average **'HEALTHY VALUE'** for each component to be measured
- **Real Time values** for component to be mapped against the average **HEALTHY VALUE**
- **Deviations** from normal or HEALTHY VALUE to be used to **predict the failure of components**
- Used when RUL doesn't get sufficient data to establish dependencies



PREDICTIVE ANALYTICS – DEVIATION DETECTION & CLUSTERING

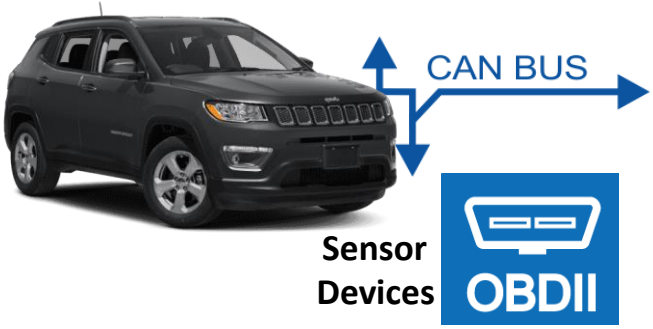
Historic Data on Component Values





Data:

- Real time Component performance values



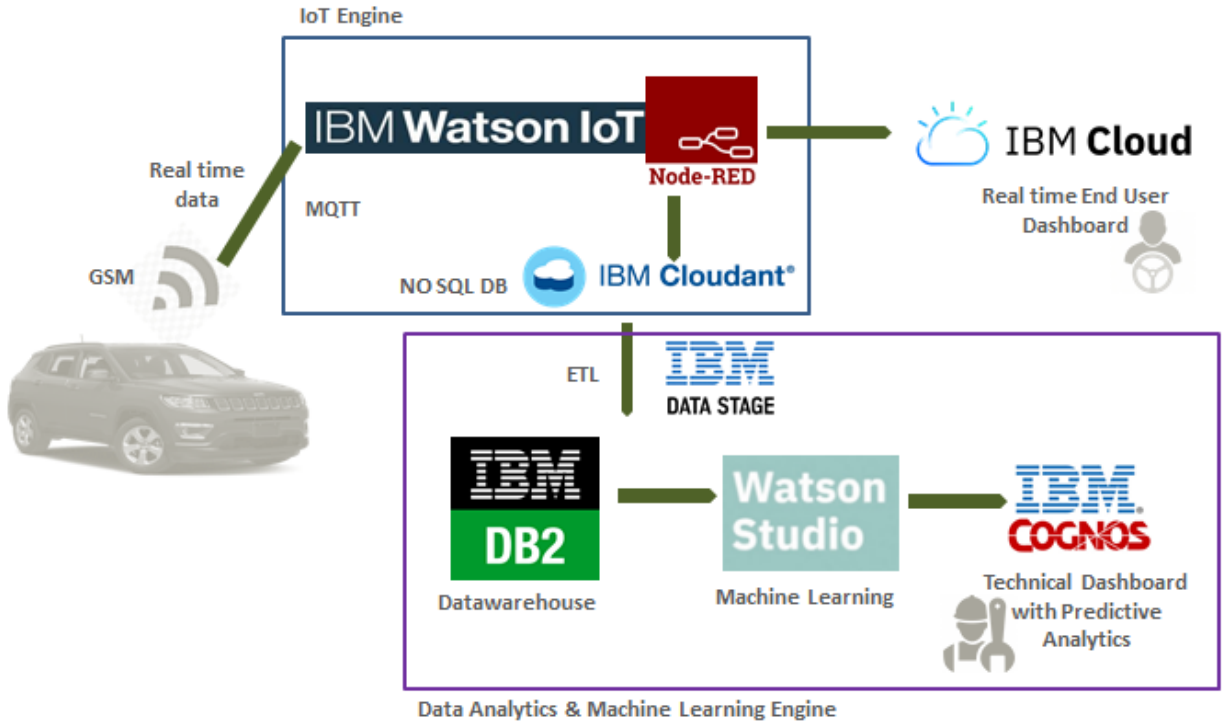
Sensor Devices

Predictive Analytics Engine

Deviation of real time values from Normal Values (based on historic values) :- PREDICTED FAILURE in near future

- Urgency for Component Replacement
- Alert on Component Replacement
- Usage Graph

Proposed Architecture



Analytics – Capability Overview

Every User to be mapped to a system generated **USER PROFILE** which records the **real time data from his vehicle & also patterns**

Component Drastic Failure Prediction

Component Remaining Life Prediction

Generic Service Prediction

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Analytics – Capability Overview

Component Drastic Failure Prediction

- **Clustering Based** – Deviation from Normal or Expected Behavior
- Real time data component performance via OBD device
- Alerts based on the deviation behavior
- Incident detection and related alerts (accidents/predicted damage)

- **Fuel Pump** replacement based on pressure values
- **Relay replacement** based on Voltage values

Component Remaining Life Prediction

- **Regression** – Model to be based on user real time data
- Model to gain better accuracy using data from other users/vehicles

- **Brake pad replacement** based on driving pattern and time since last replacement

Generic Service Prediction

- Based on analytics on user service schedule patterns & vehicle category service schedule patterns(historic data)
- Also based on threshold violation for components

- **Based on How Frequently a user service his car**

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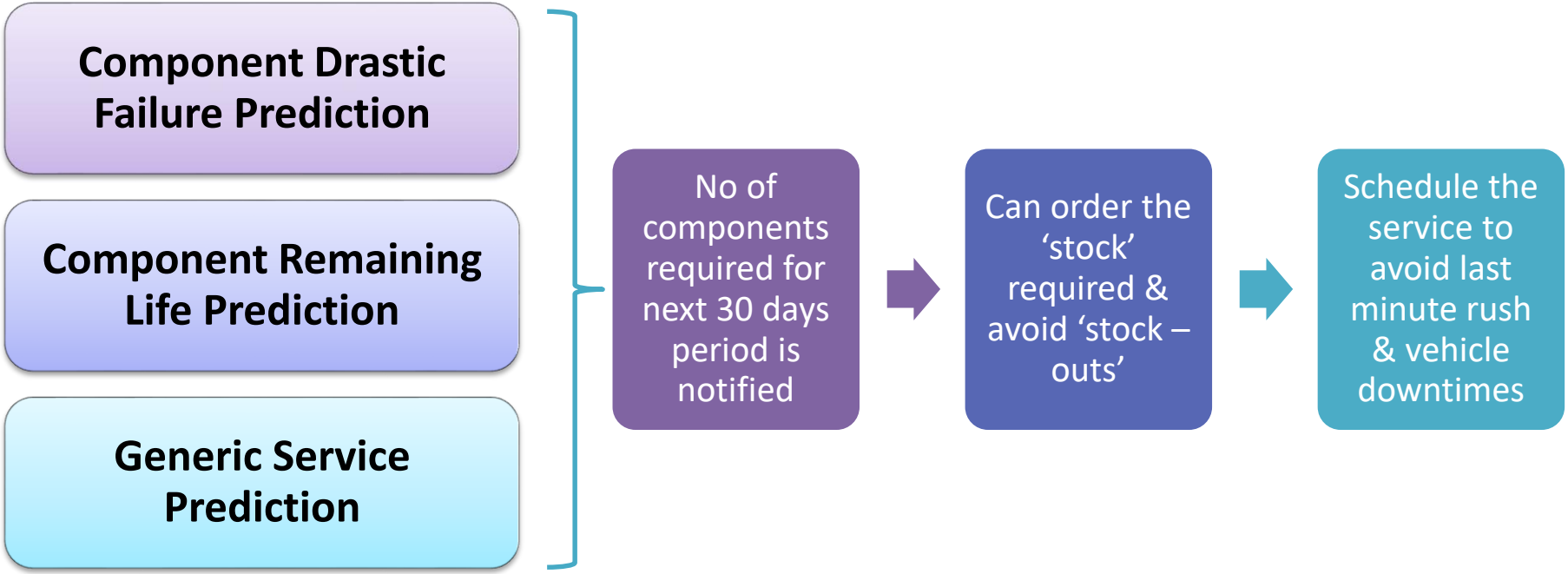
How **PREDICTIVE CARe** is utilized – *An example*



BATTERY ANALYTICS WITH ***PREDICTIVE CARe***

Clients : Leading Japanese Automaker &
Indian Electric Auto Startup

Predict Battery Replacement in Future

- Predict the time in future when the battery is probable to fail
- Plan Proactive Replacement of Battery

Why to Predict?

- Increase Battery Sales via Service Centers
- Increase Customer Trust on Brand (crucial for electric vehicles)
- Zero downtimes due to battery failure
- Overall CX improvement & Customer Satisfaction