

INTELLIGENT SOFTWARE FOR **EV AND AUTONOMY**

[www.eatron.com](http://www.eatron.com)

# Improving the Remaining Useful Lifetime estimation in EV batteries

FPC2022 – 02.03.2022



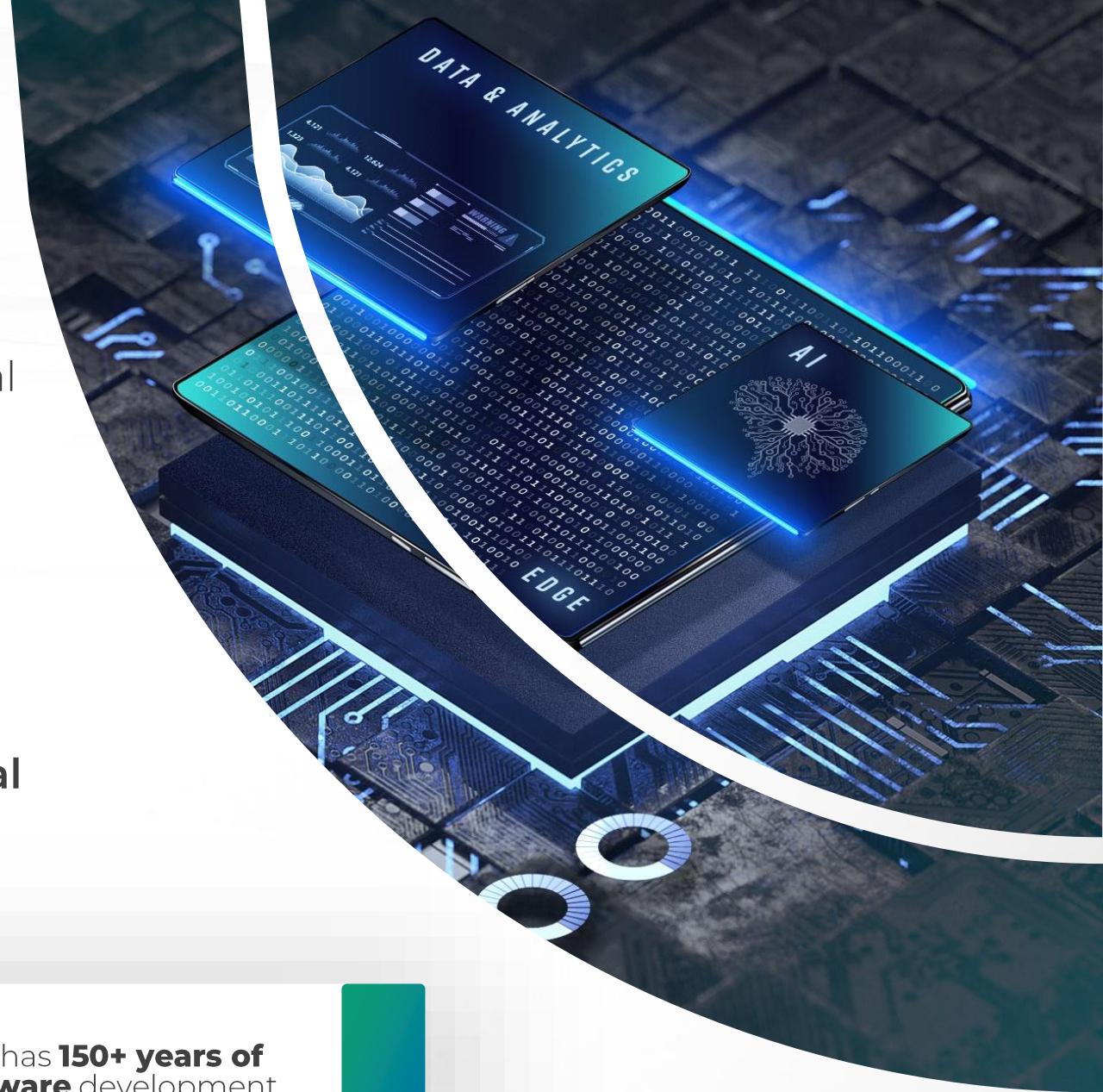


# EATRON TECHNOLOGIES

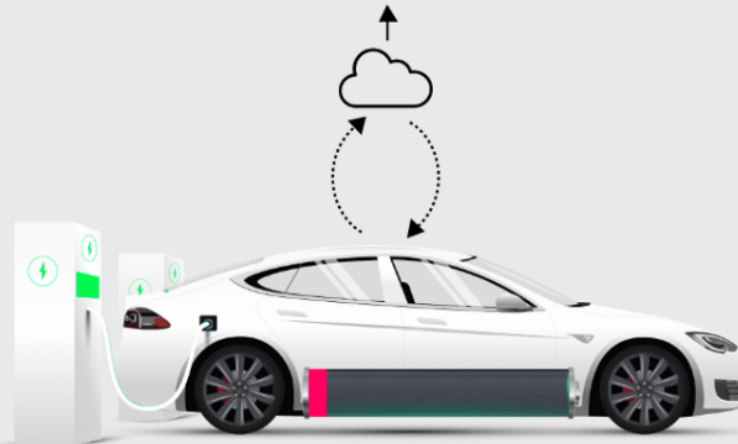
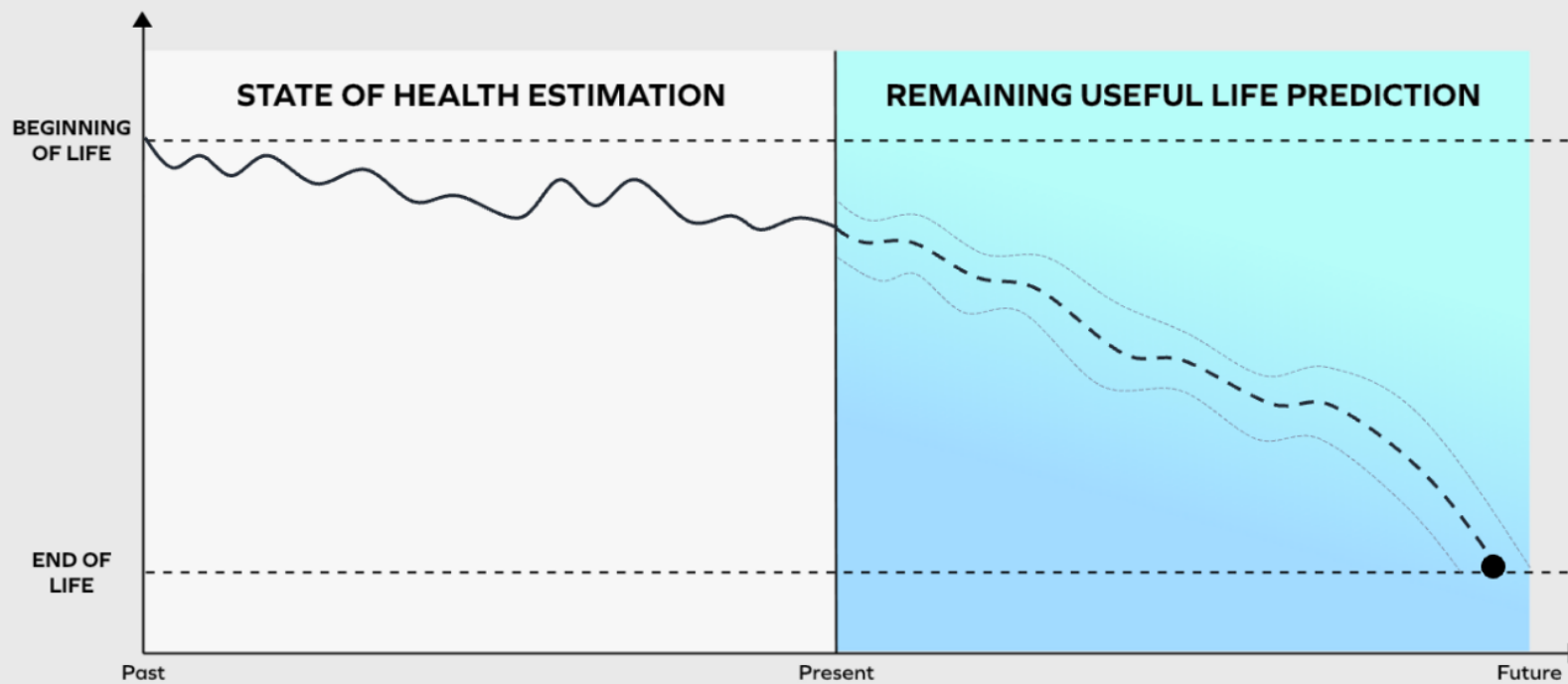
Eatron is a fast-growing, UK based, international technology company dedicated to making **'software-defined vehicles'** a reality for OEMs worldwide since its inception in 2018.

Eatron provides a **Connected Intelligent Safe automotive Software Platform** that brings together Edge, AI&ML and Cloud layers for **serial production** to achieve superior performance & reliability.

Eatron leadership team altogether has **150+ years of automotive technology and software** development experience.



# What is RUL?



## Why now?

- UK ICE ban is just 2 model cycles away
- Supply to 2<sup>nd</sup> life is expected to be over 200 GWh/year by 2030

Wide-scale adoption would provide benefits throughout the battery value chain, allowing:

- to manage and extend the operational life of EVs/Batteries
- to stimulate and sustain the 2<sup>nd</sup> hand EV market by increasing residual value
- to incentivize repurposing of batteries for 2<sup>nd</sup> life application.

# COBRA Project

COBRA - "Cloud/On-board Battery Remaining useful life Algorithm"

**Target** - development of new algorithms capable of accurately predicting the Remaining Useful Life (RUL) of a Lithium Ion battery pack, that can be integrated both in an automotive grade BMS and in the cloud.

**Technical Approach:** combining advanced battery ageing models and novel modelling techniques developed by Warwick Manufacturing Group (WMG) with Eaton's Machine Learning based approach to RUL.

**Deliverables:** RUL algorithms ready for demonstration to potential partners running on Eaton's BMS hardware and in the cloud to a TRL5/6 level.

- Project Ref: 10007474



# CONNECTED BATTERY ARCHITECTURE



## EATRON BMS CLOUD ARCHITECTURE

### CLOUD PLATFORM

- CELL DIAGNOSIS MODELS
- REMAINING USEFUL LIFE
- TREND ANALYSIS AND MAINTENANCE WARNINGS
- IDENTIFICATION OF WEAK PACK/MODULES/CELLS
- IDENTIFICATION OF CRITICAL USAGE PROFILE
- ADAPTIVE CALCULATION OF POWER/SOC LIMITATION TO INCREASE BATTERY LIFE
- OPTIMIZE EV FLEET OPERATION

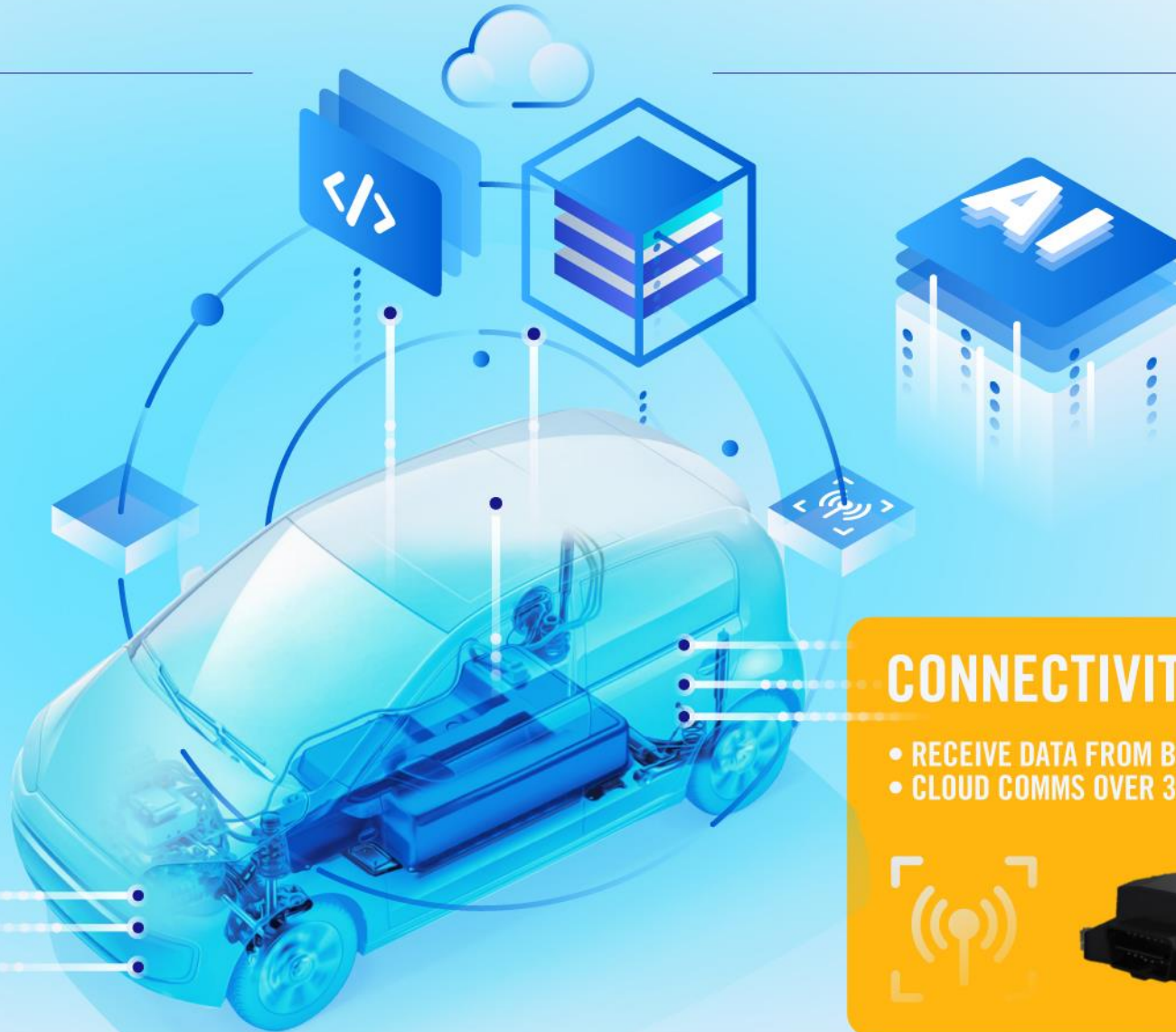
### BMS

- SIGNAL PROCESSING & EDGE ML MODELS
- SEND DATA TO CONNECTIVITY UNIT



### CONNECTIVITY UNIT

- RECEIVE DATA FROM BMS
- CLOUD COMMS OVER 3G/LTE



# Why Edge and Cloud together?

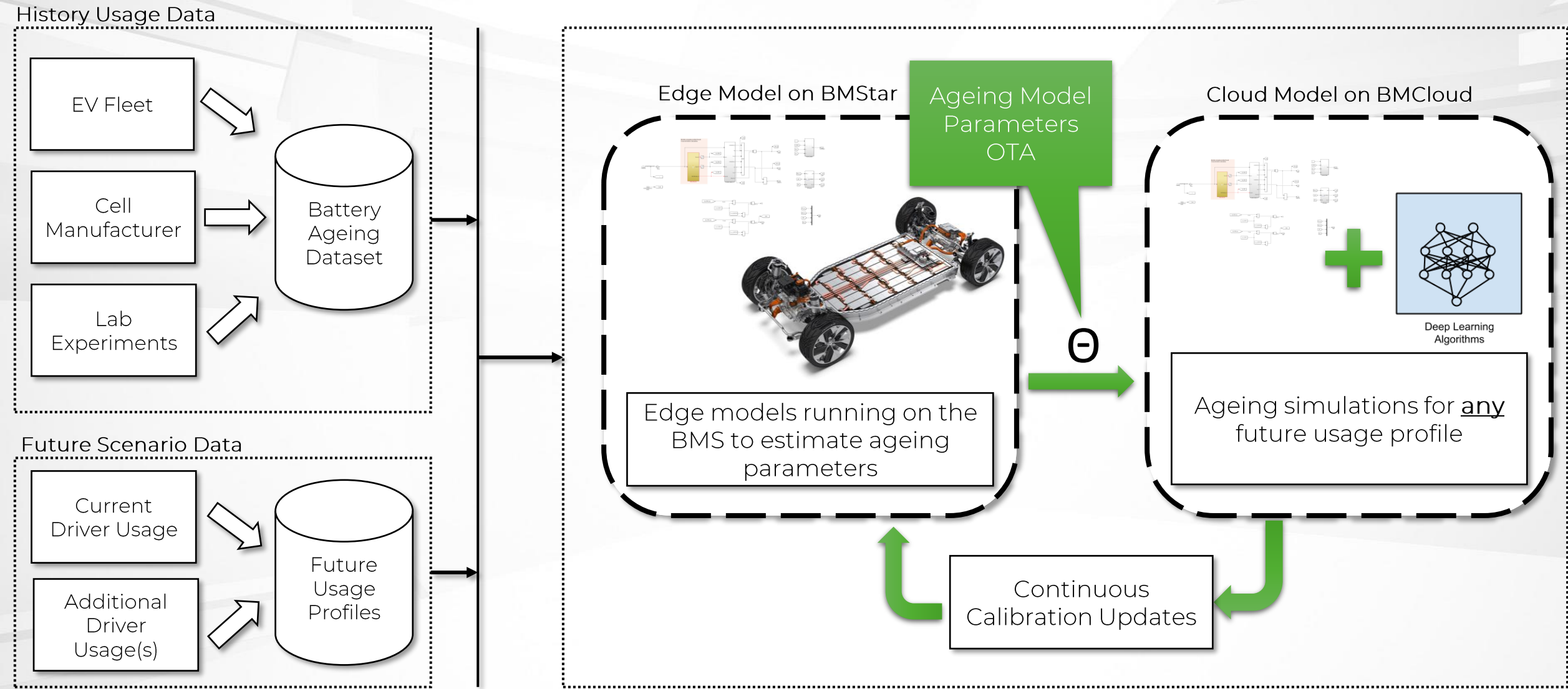


Processing “*Past*” data in a cumulative way to estimate current state happens in the edge as we have direct access to data source.

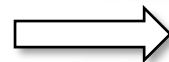
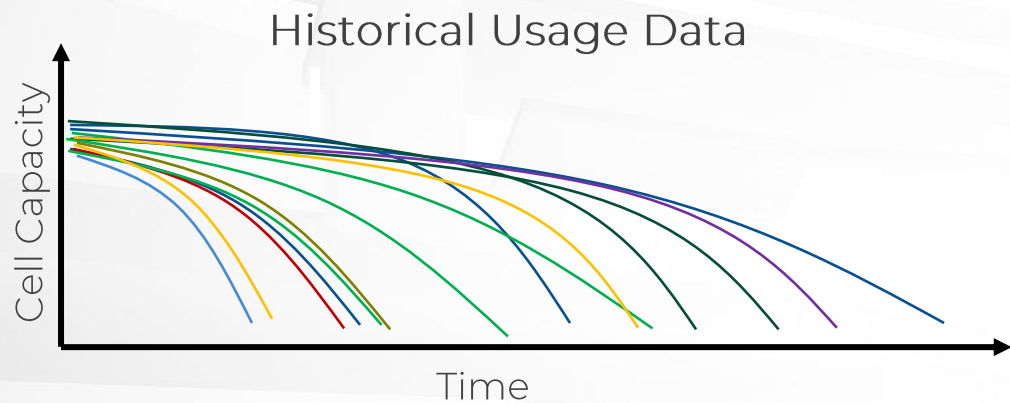
Processing “*Future*” data with various usage profiles to predict future state happens in the cloud as we require more computing resources.



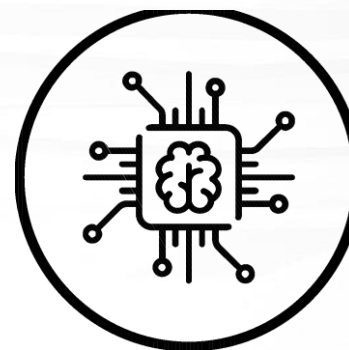
# Overview of RUL Architecture



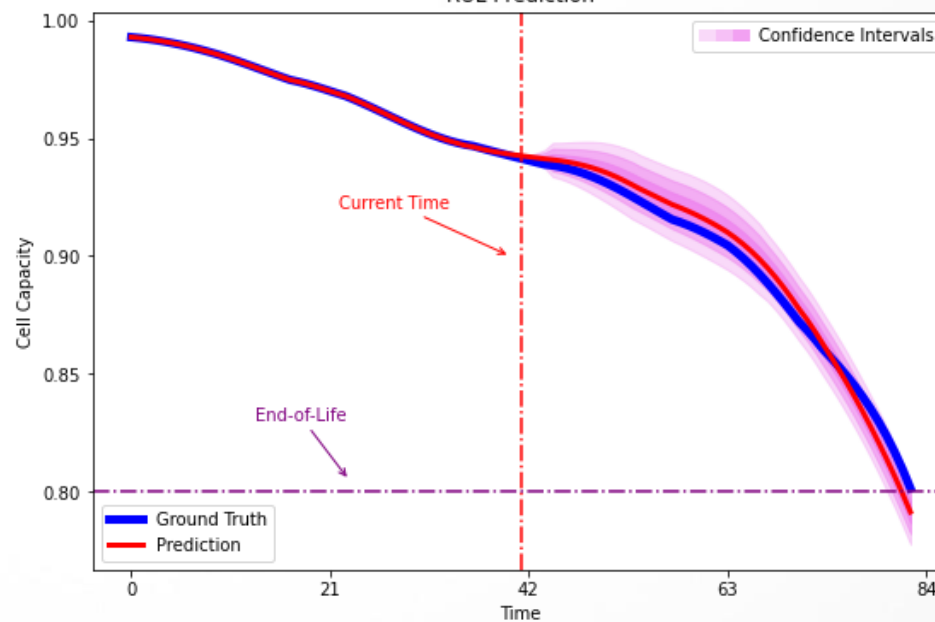
# RUL Prediction Performance



Train AI Model



RUL Prediction

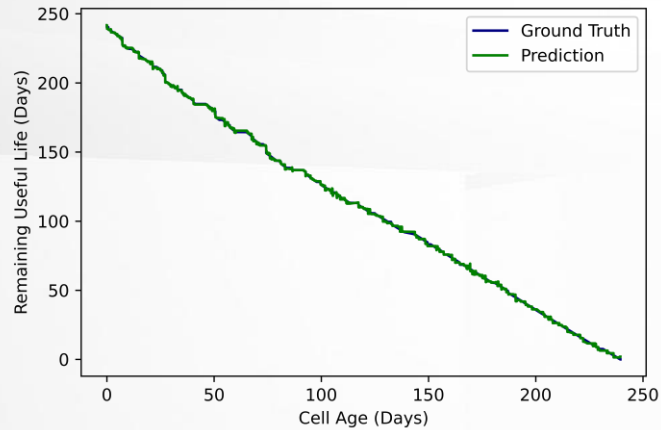


RUL Prediction  
Accuracy > 90%

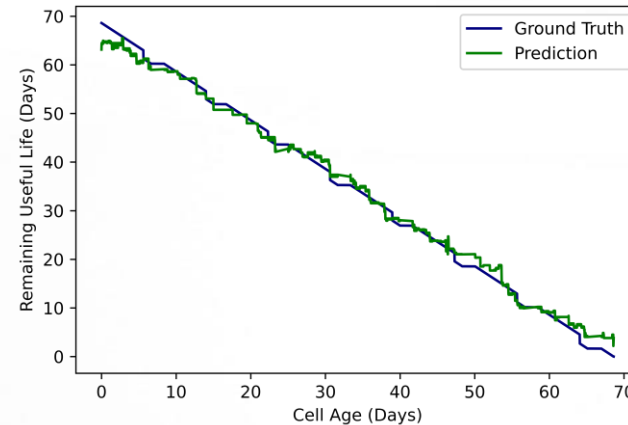
# RUL Prediction on Experimental Datasets

Prediction performance is shown on 3 different datasets obtained from lab experiments. The figure show the ground truth and RUL predictions in number of days while the table highlights the mean absolute error in number of days.

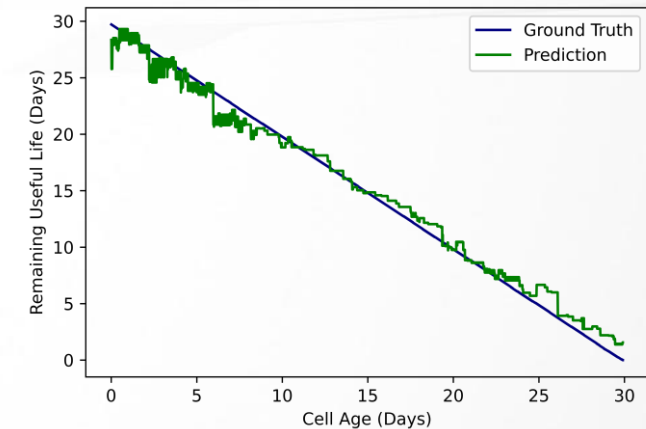
Dataset A (Uni. Warwick/COBRA): 5Ah NMC/gr cell



Dataset B: 2Ah NMC/gr cell



Dataset C: 1.1Ah LFP/gr cell

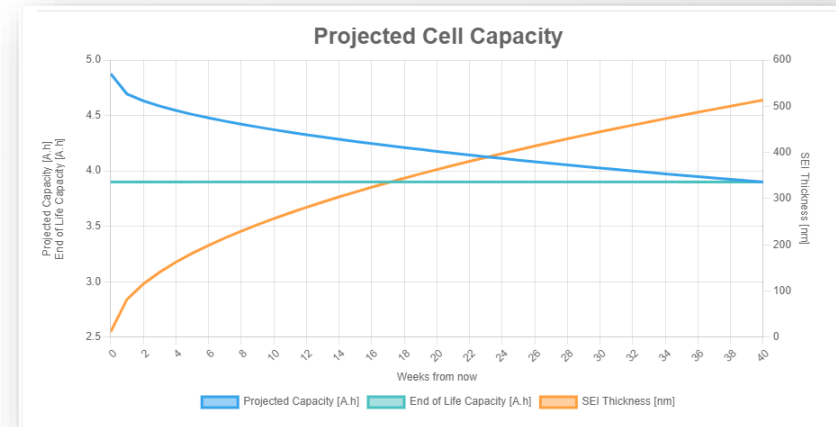
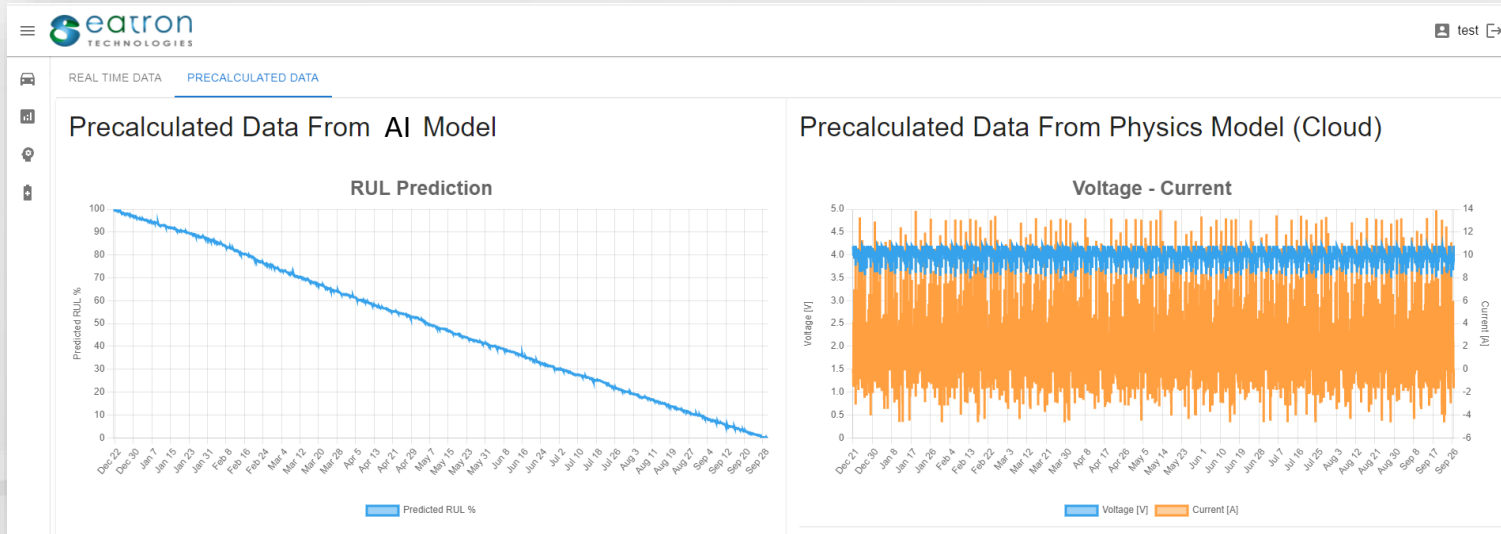
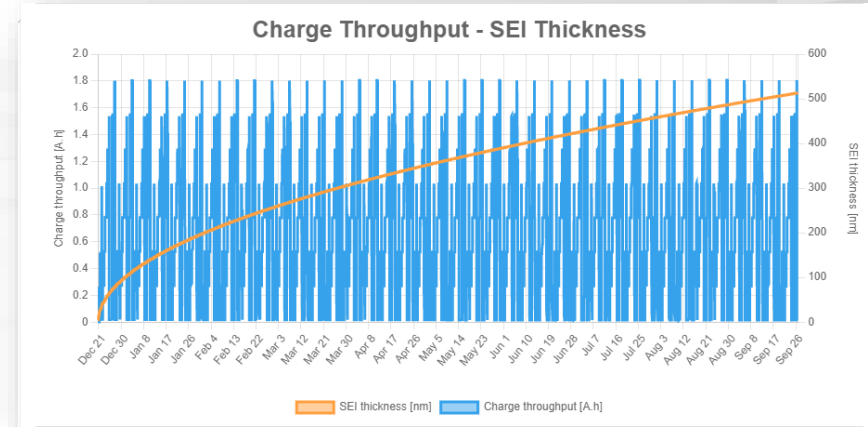


	Dataset A	Dataset B	Dataset C
MAE	0.58	1.72	1.7
RMSE	1.81	2.39	2.68



# Cloud Front-end

The screen captures show sections of Eatron cloud platform developed to enable visibility into details of each battery with respect to ageing and RUL. The cloud platform enables interactive analysis of data exchanged with BMS hardware.



## Final words..

Come talk to us, and let's understand how your batteries are going to perform in the real world together!