Intelligenza Artificiale e Nuovi Materiali: Nuovi Orizzonti per l'Industria

24th Feb 2022

About Us

brain Technologies

Imagines, Creates and Builds

Solutions, Processes and Products

to meet

Present and *Future* needs of customers

Our History

2008

Provides engineering services for the design of mechatronic systems, including embedded and control design

2015

95 Engineers employee

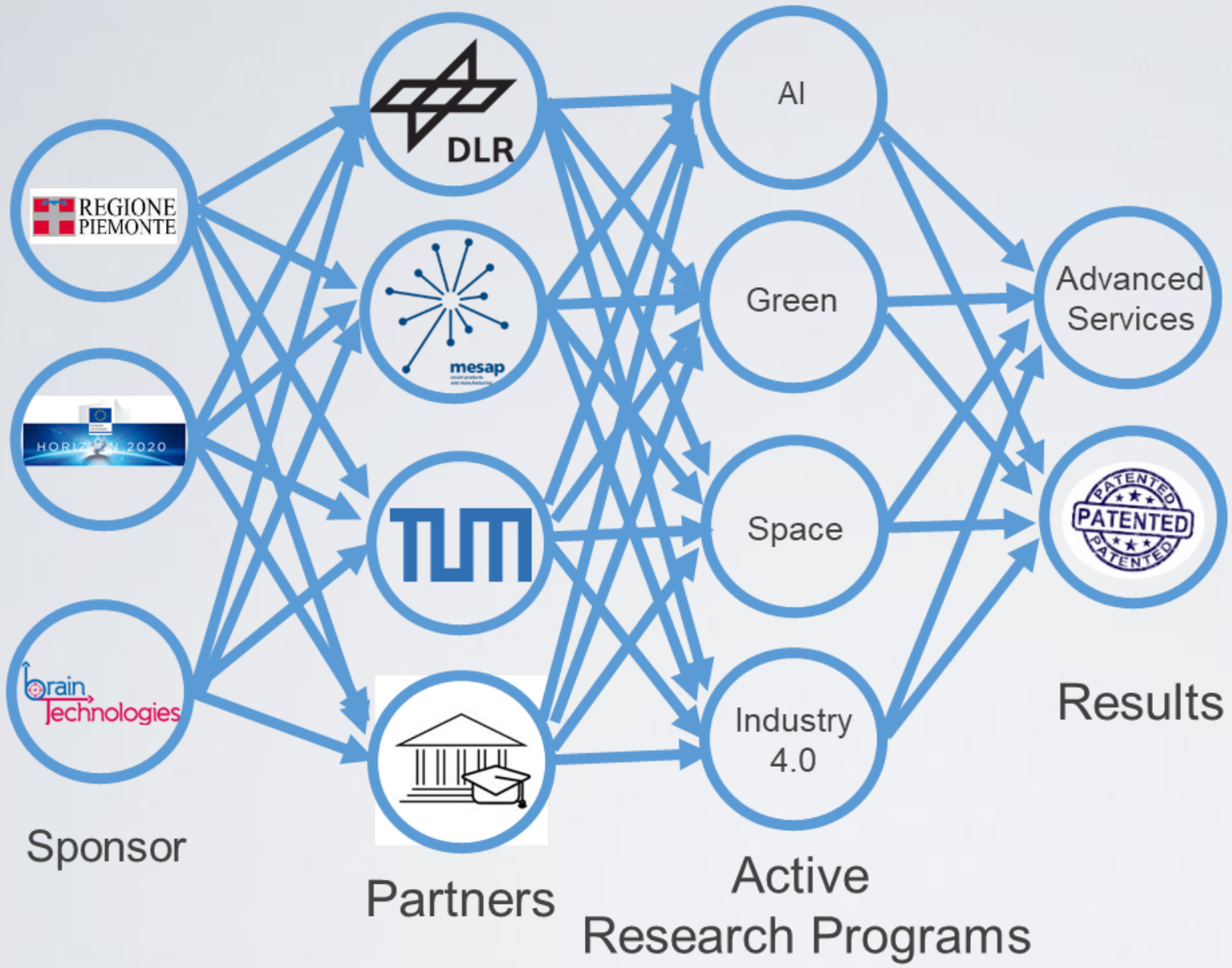
2018

Opened the new Innovation Center

2021

+200 Engineers employee
6 Engineering platforms
4 Research programs

Research & Innovation



We are preparing for new Technological Trends

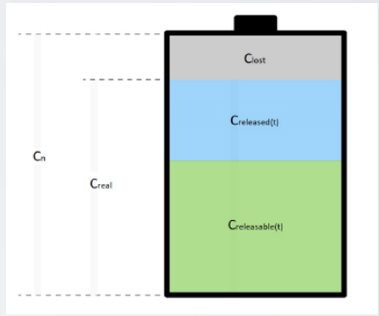
Research Programs in compliance
With Horizon Europe 2021-2027:

Artificial Intelligence
Climate, Energy and Mobility
Space and Earth observation
Industry 4.0

Artificial Intelligence for brain Technologies

Battery **State of Charge** is the electric charge contained in a battery

Battery **State of Health** is the maximum electric charge containable with respect nominal conditions

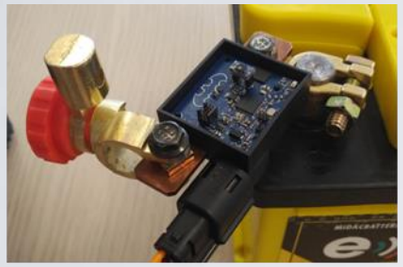


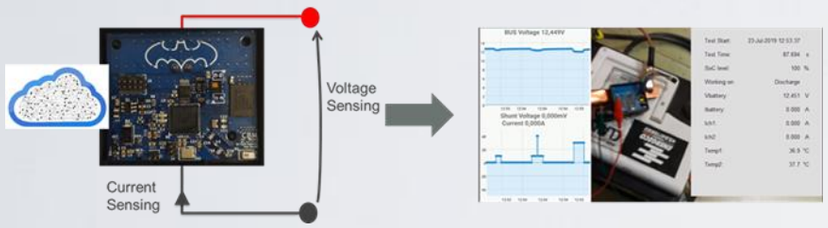
BAT-MAN Project

BAT-MAN applications market

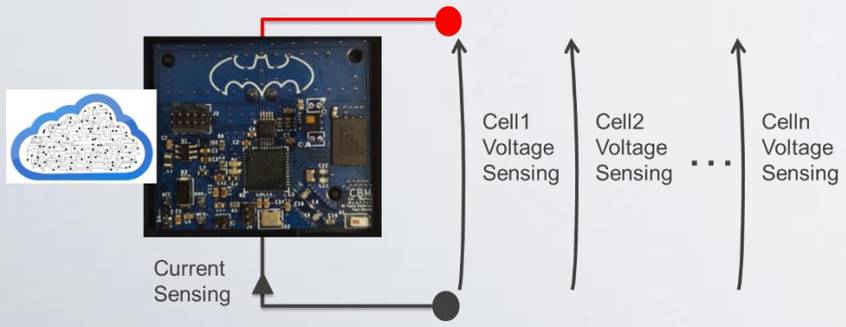
BAT-up!

BATMAN IBS or connected IBS





BATMAN as connected BMS (Li-on)

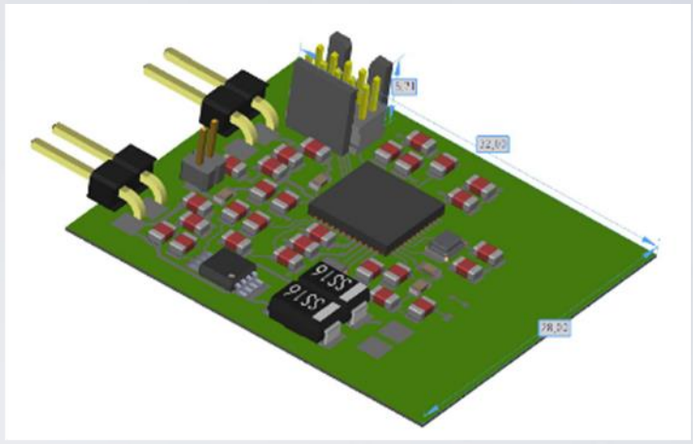


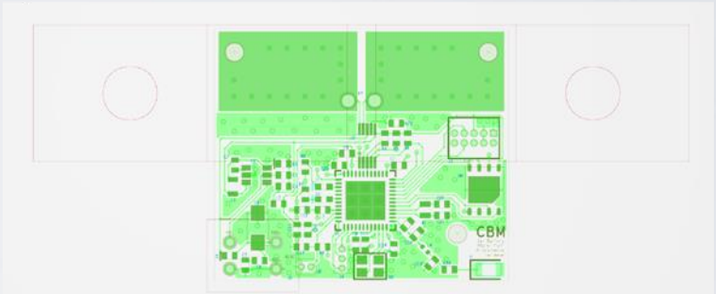
BAT-MAN development process

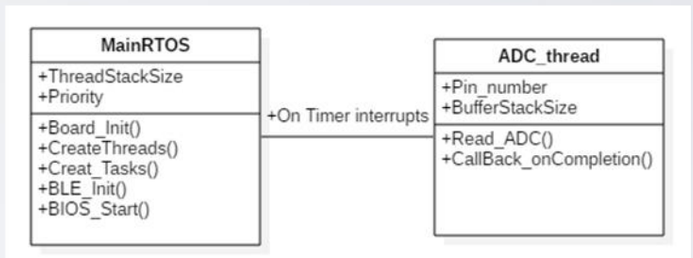
Laboratory Tests (Training Dataset)

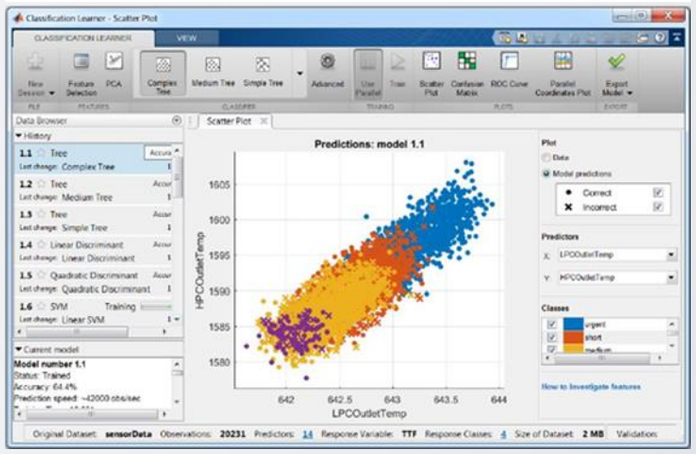
On vehicle Test (Validation Dataset)

System/Architecture Design



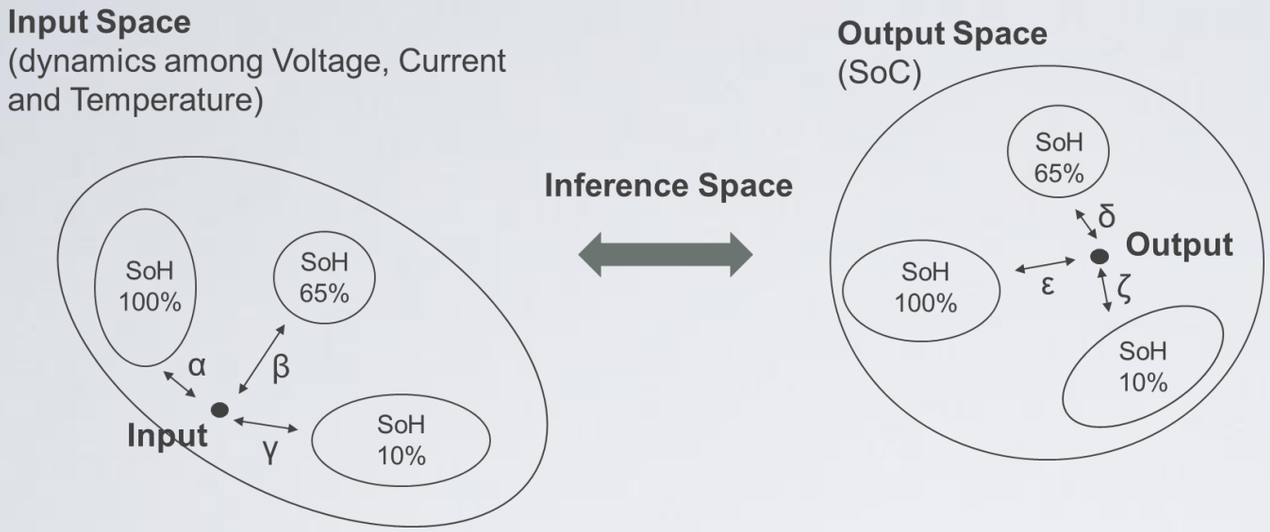






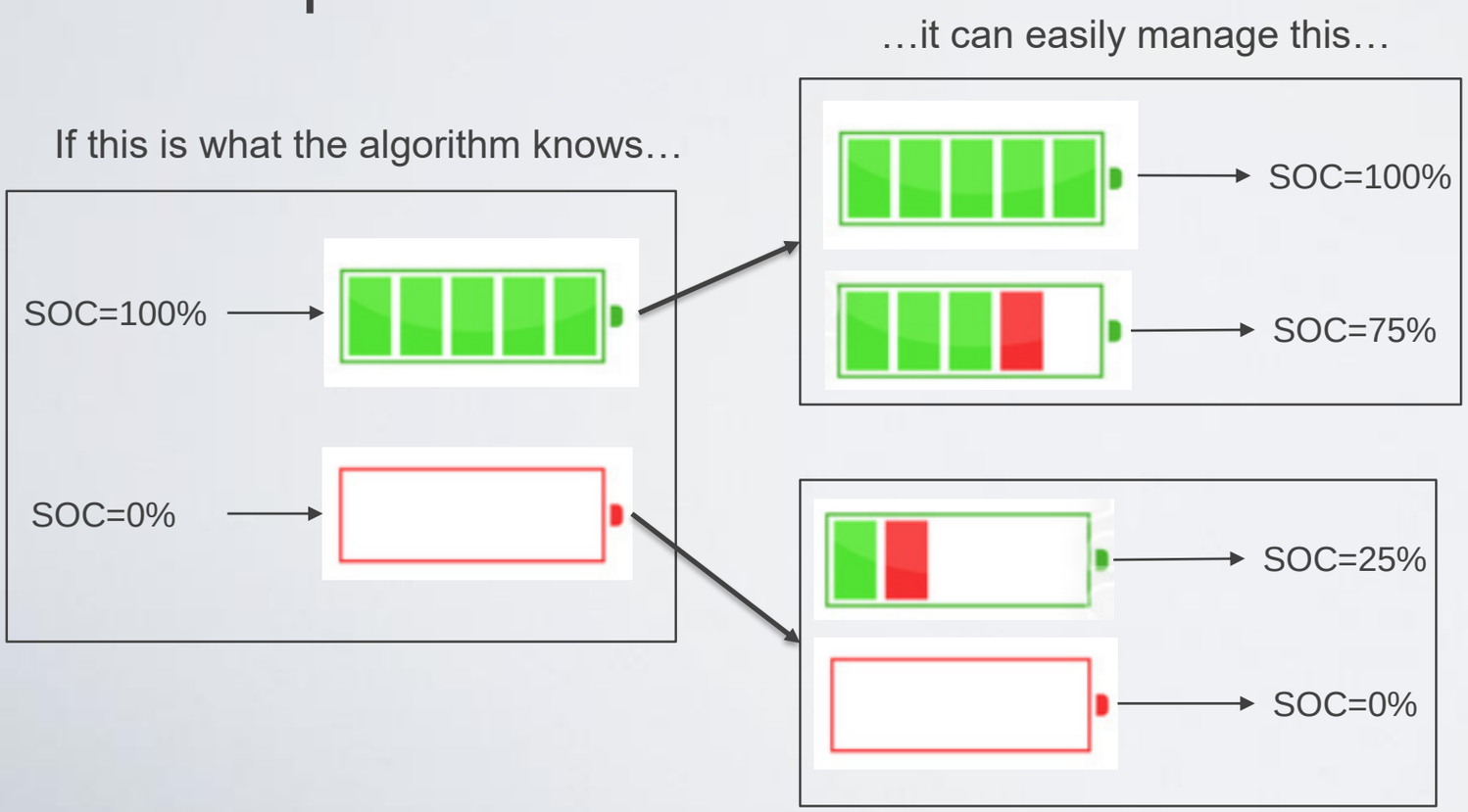
BAT-MAN Core-technology
Validation of the algorithm

In order to fix ideas…



We defined a norm in input space thanks to which there is a biunivocal relationship among this **Input Norm** (in the example, defined with respect the distances α, β, γ) and the **Output Norm** (in the example, defined with respect the distances δ, ε, ζ). So, the evaluation of the input norm could determine the accuracy of the output (how far the output will be from **the knowledge of the algorithm**)

In simpler terms…

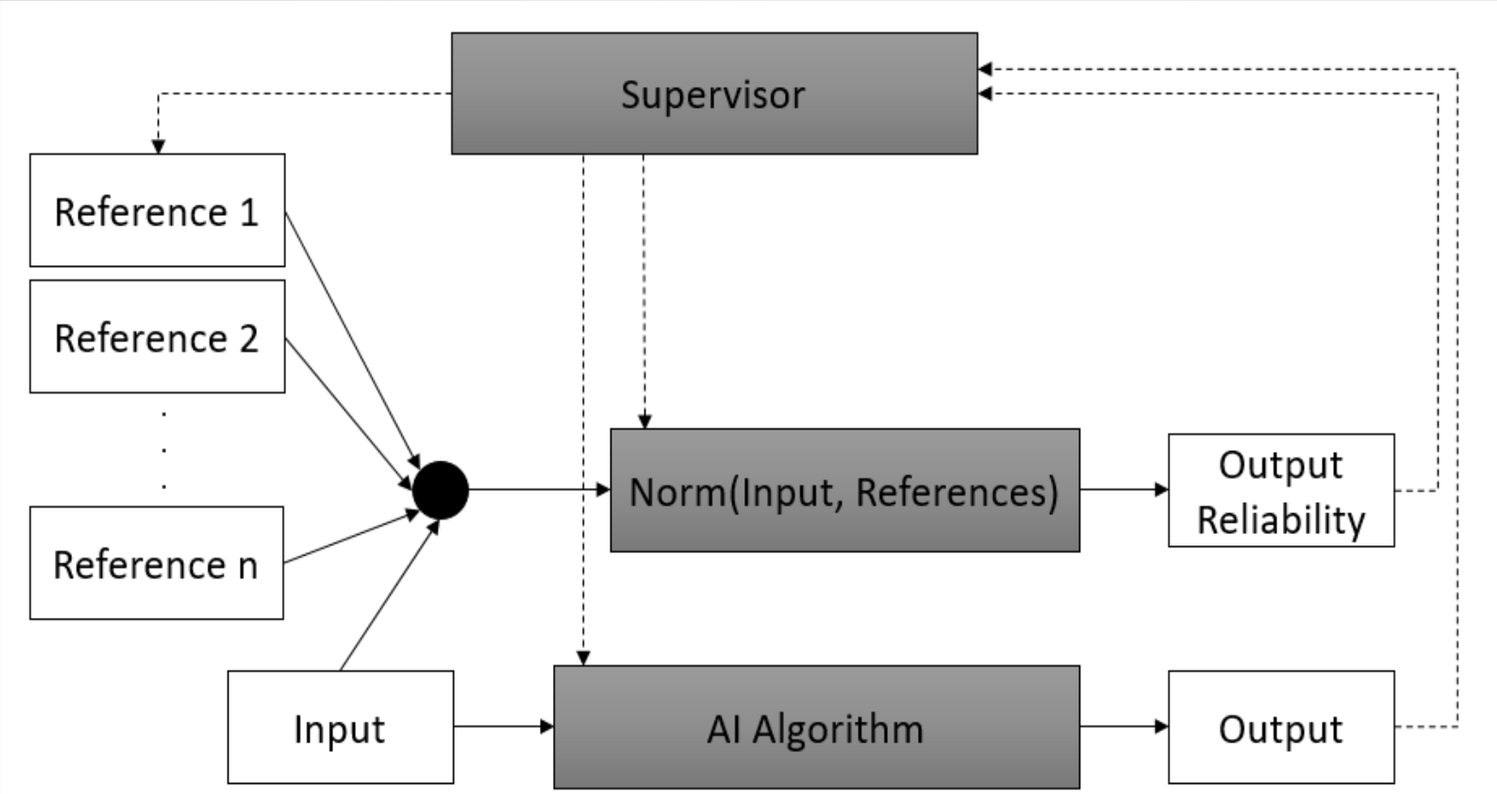


…but, what about this?

A middle-discharged battery is far from the «a-priori» knowledge of the algorithm. It can be managed in someway (SoC is 50% or 45%), but the algorithm answer should be labeled as «inaccurated».

BAT-MAN core-technology
Validation of the algorithm

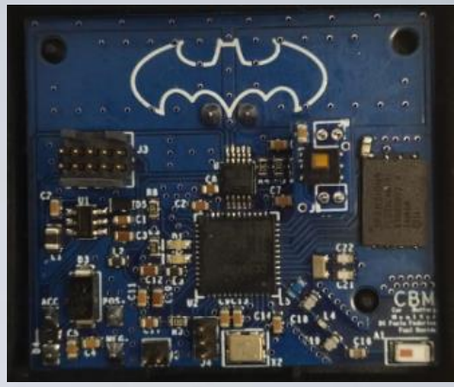
The formal validation of the algorithm could be performed considering a number n of references. In our case the «references» are some batteries in some SoH condition.
In run-time the algorithm evaluates the «distance» among each reference and the input (the battery under monitoring). This provides a figure of merit associable to the concept of **reliability** of the output.



The norm represents the algorithm's ability of describe the battery under monitoring.
This ability depends only on the training set chosen, and so it represents also the goodness of the training set!

Moreover, in the "architecture" we considered also a "Supervisor", that is an entity capable of modifying the "references" (it could be a "monitoring infrastructure", a "development process" or, in turn, an AI algorithm).

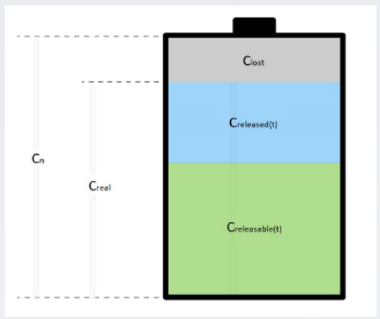
BAT-MAN: challenge description



Battery **State of Charge** is the electric charge contained in a battery

A no well known battery could produce an error on SoC estimation

Battery **State of Health** is the maximum electric charge containable with respect nominal conditions



A no well known external condition could produce an error on SoH estimation

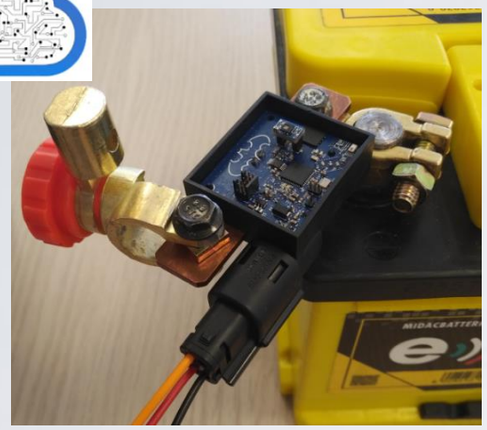
State of Uncertainty is the figure of merit related to the reliability of the SoC/SoH estimations.

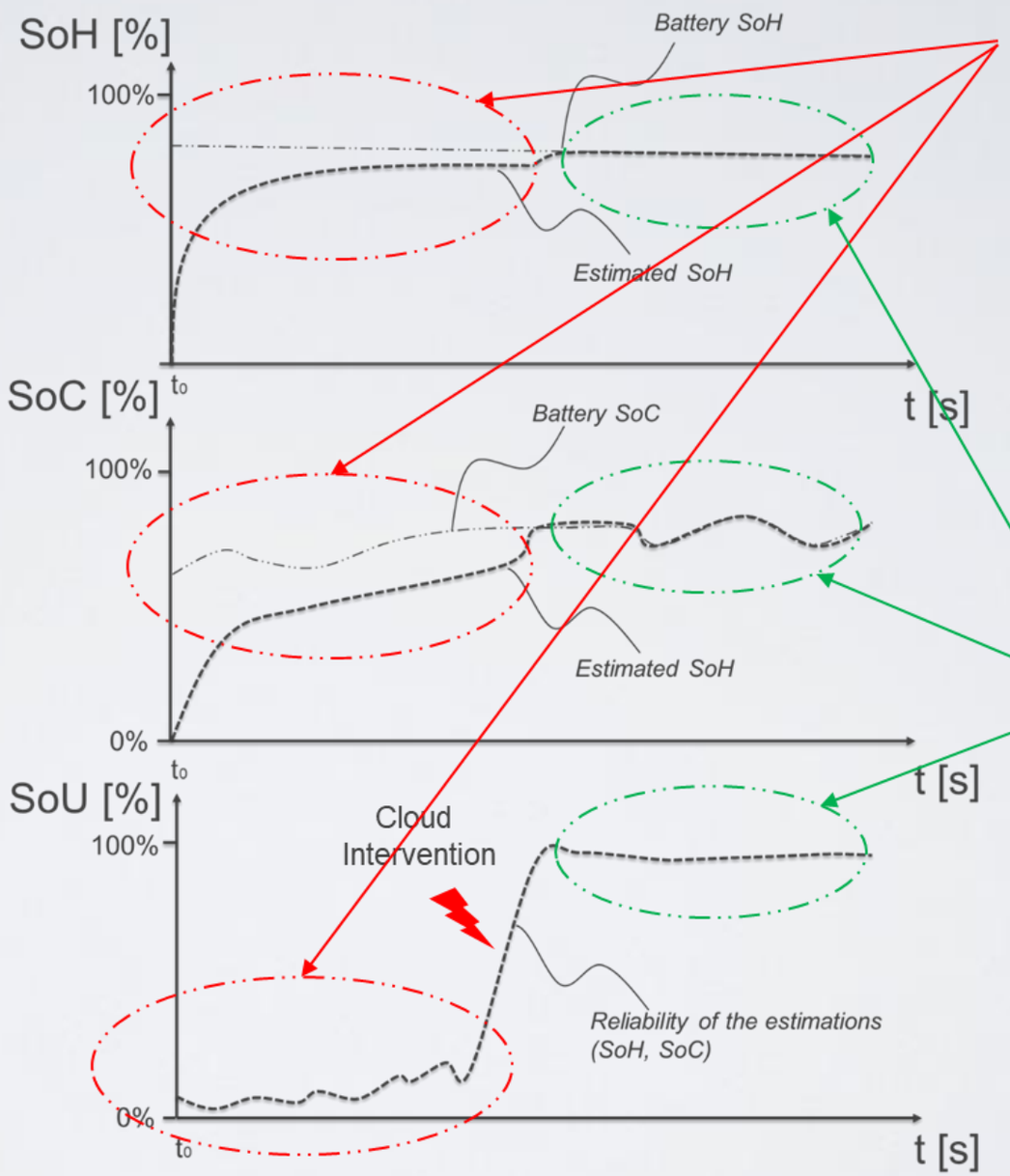
With a low level of SoU a cloud intelligence could change the local parameters in order to improve SoC/SoH estimations

ERMES

Extendible **R**ange **M**ulti-model **ES**timator

BAT-MAN applications devices Results





SoC/SoH reliability of the estimation is low (estimations could be not precise)

Cloud intelligence changes the parameters of the local device

brain Technologies

Gianluca Buonomo
Corso Tazzoli 215/12B - 10137 Torino (Italy)

gianluca.buonomo@brain-tech.it
www.brain-tech.it