# Technology Transfer in Computing Systems

## D3.37: Individual TTP37 abstract

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# TETRACOM D3.37: Cloud-based Monitoring and Analysis for Lithium-Ion Electrical Energy Storage Systems (cMALEESS)

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Lithium-ion battery systems consist of several individual cells (up to 7.300 in a Tesla Model S), together with an electronic battery management system (BMS) to protect the cells from operating outside safe regions and to provide state-of-charge (SOC) and state-of-health (SOH) estimates. During the last two years, University of Lübeck's institute ISP designed and developed a prototype of a cloud-based monitoring and analysis framework for lithium-ion electrical energy storage systems called ZELIM. The system allows to log and persistently store large volumes of battery data from different BMS simultaneously in a high-performance distributed data base, which is accessed and visualized in a web-based back-end. The cloud's computational power allows for advanced on-line monitoring and analysis of the battery data, including elaborate algorithms for precise SOC and SOH estimation, identification of potentially critical failures at early stages, and long-term tracking of cell aging. Results in the form of adapted cell parameters or susceptible components can be communicated back to the BMS, or presented to a human operator.

LION Smart GmbH is a SME engineering company specialized on testing, designing and prototyping high-performance lithium-ion battery packs, and developing a BMS especially for electric mobility applications. In this technology transfer project, ZELIM's prototypic framework was matured and adjusted towards LION Smart's BMS to have a capability for continuous monitoring and analysis of battery systems in the field.

For the University, the intensive collaboration with industry is essential in order to validate its academic concepts and prototypes in an industrial setting. Only the successful transfer of prototypes and the feedback obtained guarantees that a viable solution has been developed. Likewise, the joint development of systems with industry assures the flow of practical information from industry to academia. Finally, the University of Lübeck is also a so-called "Start-up University" and the technology transfer helps in strengthening the education in the study program "Entrepreneurship".

For LION Smart, the technology transfer had several positive economic impacts. The cloud-based monitoring and analysis framework offers a new, valuable feature to increase the customer value and satisfaction of their existing and commercially successful BMS family. Offering the BMS in combination with the ZELIM back-end will allow customers to monitor and analyze batteries during their lifetime for safe and efficient operation, creating a unique selling proposition. By offering cloud-based services as part of its portfolio, LION Smart will progress and expand from an electronic hardware provider towards a full service provider, opening up new profitable business areas and increasing customer retention. On a larger scale, the availability of battery usage and aging data is key for battery improvement and thus for Europe's battery industry both in electrical vehicles and stationary energy storage systems applications. As part of the project LION Smart plans to make a repository of battery data publicly available to benefit the research in this area.

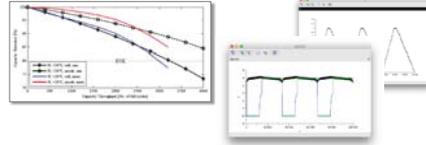Details of the problem as well as its solution are shown in the next figure.

## TTP Problem

**Lithium-Ion Battery Packs**
(Mobile and stationary applications)

**Computation- and Memory-intensive Tasks**
- Tracking of cell charge and health state
- OCV curve and parameter adaption

## TTP Solution

**Battery Applications**
- Machine-readable description
- Generic/extensible format

**Li-BMS Battery Management System**
- Modular, flexible architecture
- Sensing/control modules
- Open source platform

**cMALEESS Client Gateway**
- Buffering
- Preprocessing/Filtering
- Secure communication

**cMALEESS Cloud**
- Data logging
- Load balancing
- SOC-/SOH-Estimation
- Monitoring/Verification

## TTP Impact

**Capability for Continuous Monitoring and Analysis of Battery Systems in the Field**

- Monitor and analyze batteries during their lifetime for safe and efficient operation
- Identify potentially critical failures at early stages for increased safety and reliability
- Centralized control/supervision of batteries (e.g. formation of virtual power plants)
- Long-term tracking of cell aging and adaption of parameters (e.g. OCV curves) for increased precision of SOC estimation of BMS
- LION Smart plans to make repository of battery data publicly available to benefit the research in this area