ALBATTS WEBINAR

The role of BMS and Control Systems in Electric Vehicles

24.11.2022-Mika Kauppila

VALMET AUTOMOTIVE

VALMET AUTOMOTIVE – OUR HISTORIC LANDMARKS

Competence in building electric vehicles since 2009

50
1968–2018
VALMET AUTOMOTIVE

1968 1969 1986 1992 1995 1997 2009 2010 2011 2013 2017 2018 2019 2021

Founded as Saab-Valmet Joint Venture between Saab-Scania and Valmet

To become independent from Saab, fully owned by Valmet

Renamed to **Valmet Automotive**

Pontos and Tesi stepped in as new shareholders

Acquisition of Karmann Convertible Roof Systems

CATL as a new shareholder

New SALO plant SOP of high-volume battery systems

Uusi-kaupunki plant becomes EV batteries plant, too

THE FAST LANE TO FUTURE VEHICLES – VA GROUP

50 YEARS OF INNOVATION. AND NEWER THAN EVER

3.0
BEUR Gross Sales (2021)

4.900
Employees

3
Countries

3
Shareholders (Pontos, Tesi, CATL)

ELECTRIFYING

ACTUATING

MANUFACTURING

50
1968–2018
VALMET AUTOMOTIVE

1968 2009

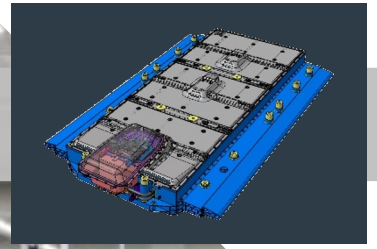
Mercedes-Benz, BMW, PORSCHE, MINI, VOLVO, BENTLEY, FISKER, THINK, NISSAN, GARIA, CHRYSLER, Ford, gm, SAAB

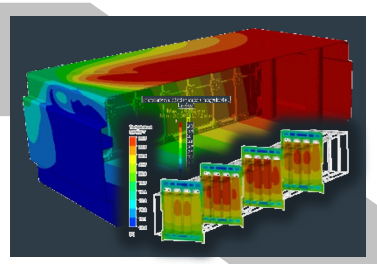
EV BATTERY SYSTEMS – COMPLETE VALUE CHAIN COVERAGE

ELECTRIC VEHICLES (EV) SYSTEMS

CONCEPT › DEVELOPMENT › PROTOTYPING › TESTING › PRODUCTION

48V & High-Voltage





PROJECT & PROCESS MANAGEMENT

Automotive & Off-Highway

System Supplier & Contract Manufacturer

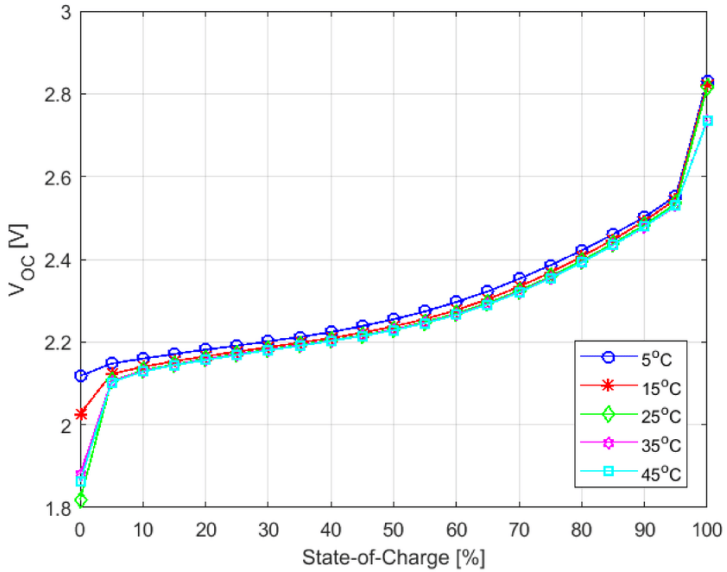
BMS FUNCTIONS AND SOFTWARE ELEMENTS

Measurement and monitoring
Cell temperature
Cell Voltage
Battery current
Insulation resistance
DC-link Voltage
Interlock signal

Algorithms
SOC
SOP
SOH
Charging
Power prediction

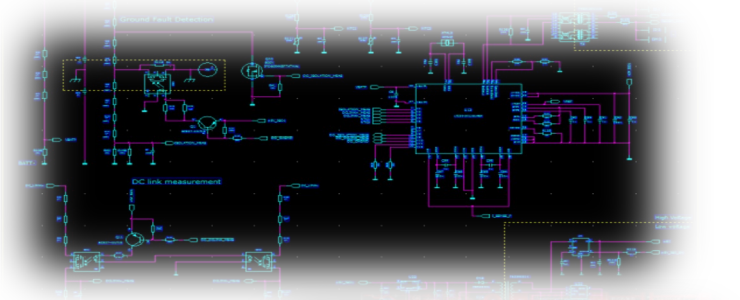
Functionality
Main contactor control
Charging interface
DC-link Pre-charge
Communication interfaces
Balancing

Safety
IEC 61508
ISO 26262



RELEVANT SKILL AREAS

- System design
  - Architecture
  - Requirement management
- Electronics design
  - Architecture
  - Schematic
  - Layout
- Software
  - Architecture
  - Autosar
  - C, C++
  - Simulink
  - Cloud
  - Data management



- Testing
  - HW
  - SW
  - System
- **Functional safety**
- Project management
- EMC design
- Processes
  - ASPICE
- Communication buses
  - CAN
  - IsoSPI
  - LIN

CONTACT

Mika Kauppila
Senior Electrical Engineering Manager
Product Development
EV Power

VALMET AUTOMOTIVE


FAST LANE TO FUTURE VEHIC
VALMET AUTOMOTIVE

Olife

Battery Management System

Re-skilling and Up-skilling Needs

About Us

Olife Corporation
Czech technology company

- **Established:** in 2014,
- **Core business:** Research and development of Lithium car starting battery
- **Target market segment**: Personal cars
- Olife group is producing chargers for electric cars, remote battery and battery maintenance.

About US

Josef Tichanek

Chairman of the Board

- Banking Backgroud – Credit Risk Management
- Consulting Deloitte and PwC – specialized at Risk
- Management for financial institutions and Enterprise Risk Management
- 2015 Joined Olife Corporation as a Board Member

About US

Josef Tichanek - Role in Technical development

Responsible for :

- Project management
- Functional Safety including risk assessment, safety goals, Functional safety and technical requirements and specifications
- Identification of suppliers
- Identification of OEM requirements
- Identification of testing requirements

3. Market and technology overview of the BMS and control systems

ECU (electronic Cotntol Units) Development

- On Board electronics in vehicles changes as we transition to Electric cars
- The Transmission ECU is replaced with battery management system and electric drive controller takes place of Engine ECU
- The primary focus is to maximize the energy saving in the ECUs and vehicle network.

Battery Management System

- faster decision making in the instance of a failure and effective remedial mechanisms.
- Reliability demands are increasing, very high-reliability standards need to be met at the same time.

Powertrain

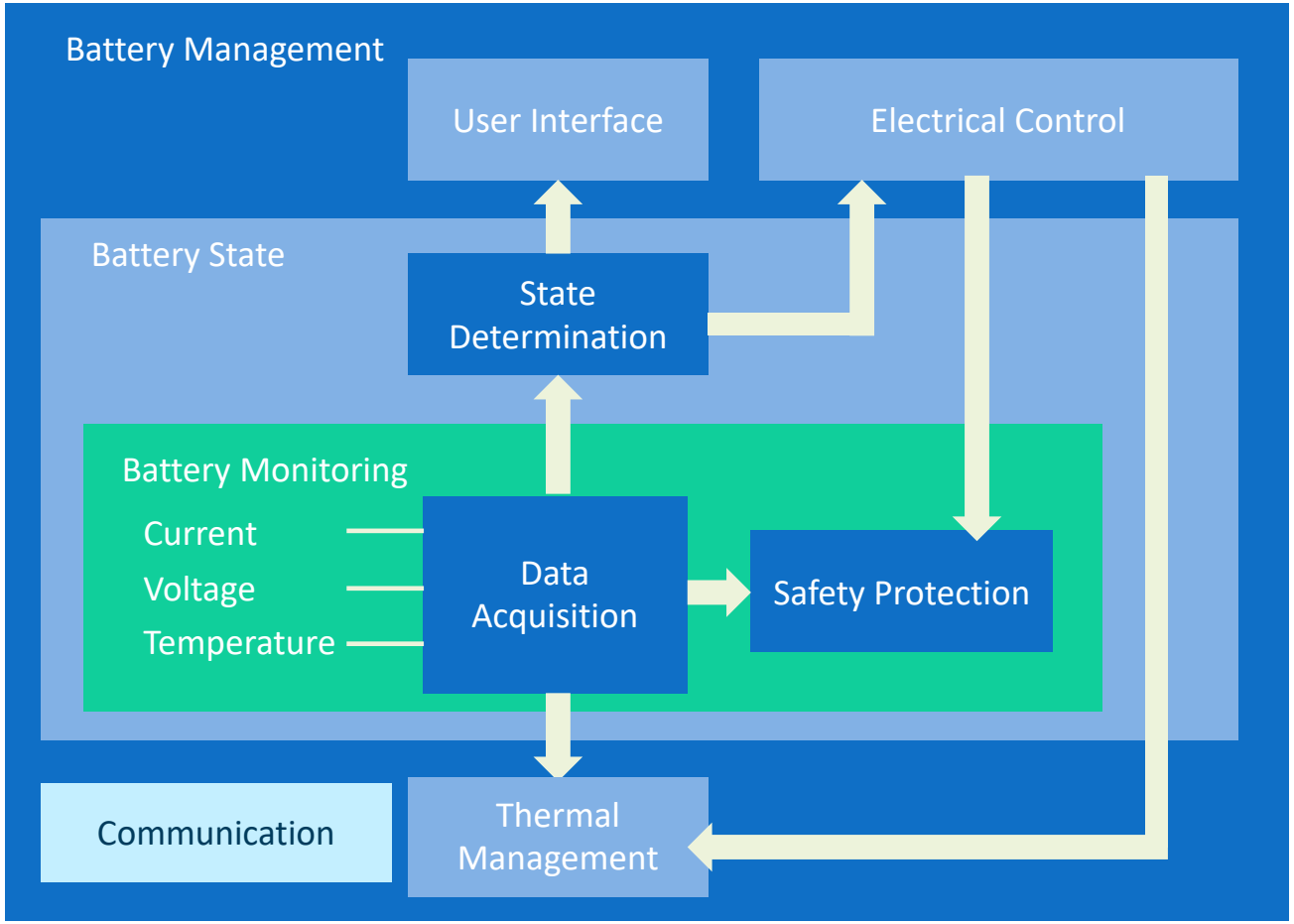
- It is not enough to understand battery characteristics, Thermal interactions need to be taken into account.

4. Main functions of the BMS and/or Control System

BMS is a brain of the battery

Basic BMS functions

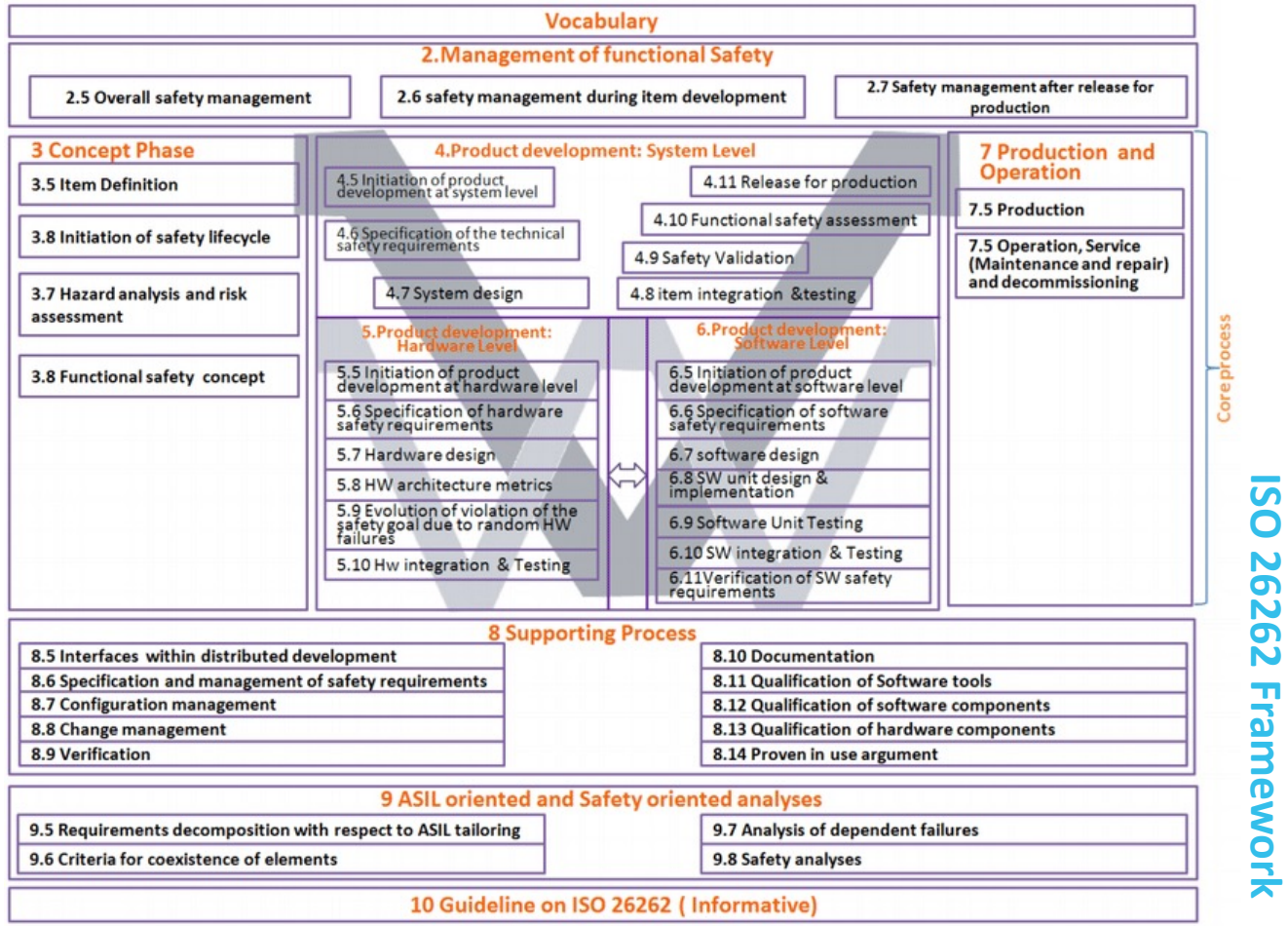
- Cell condition monitoring,
- Charge, and discharge control,
- States estimation,
- Protection and equalization,
- Temperature control and heat management,
- Battery fault diagnosis,
- Assessment aimed at enhancing the overall performance of the system



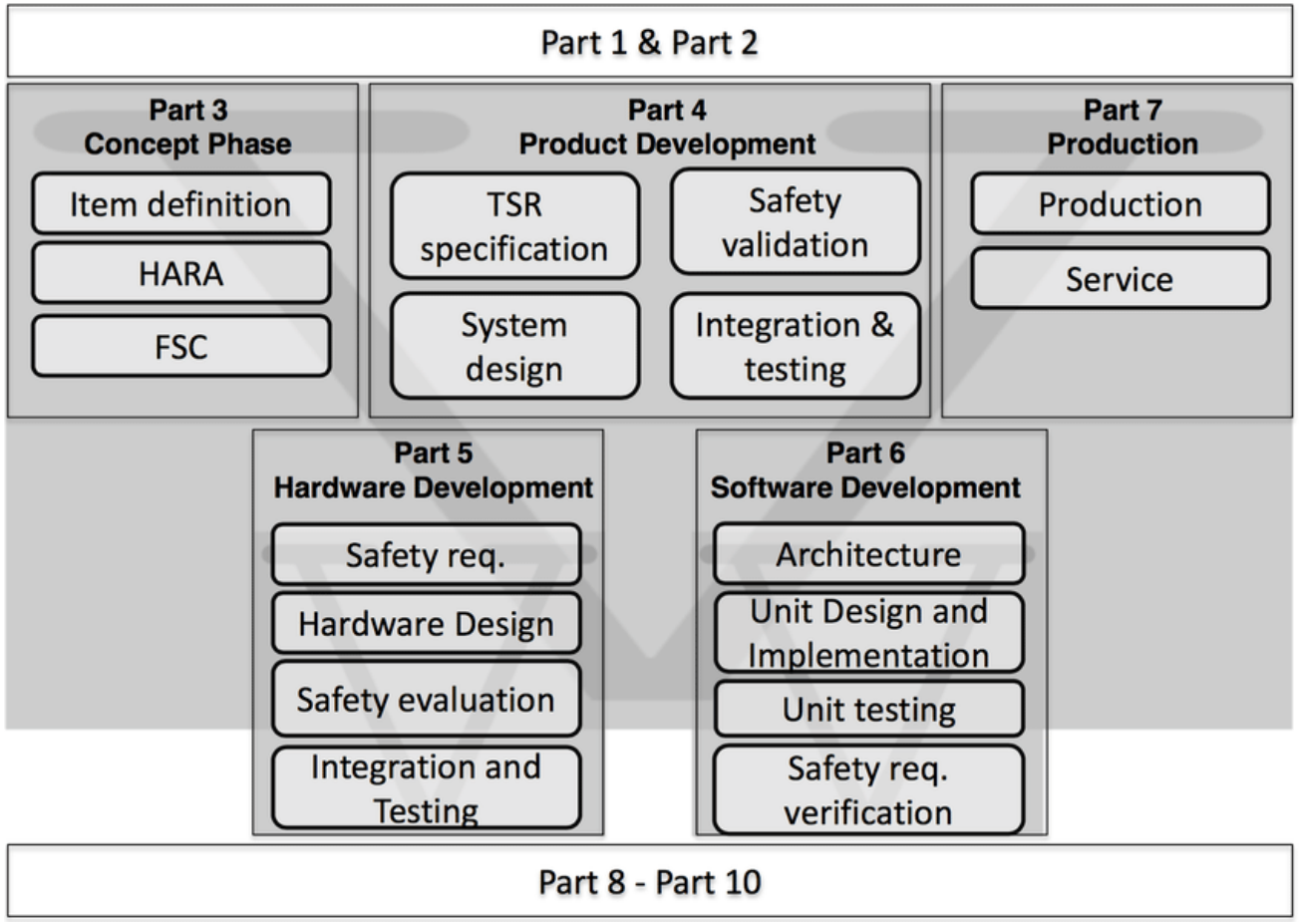
5. What is involved in delivering of the BMS and/or a control system

Main tasks

- Functional safety
- OEM Requirements
- Selection of components
- Testing requirements
- Manufacturing



5. What is involved in BMS and/or a control system



TSR - Technical Safety Requirements specification

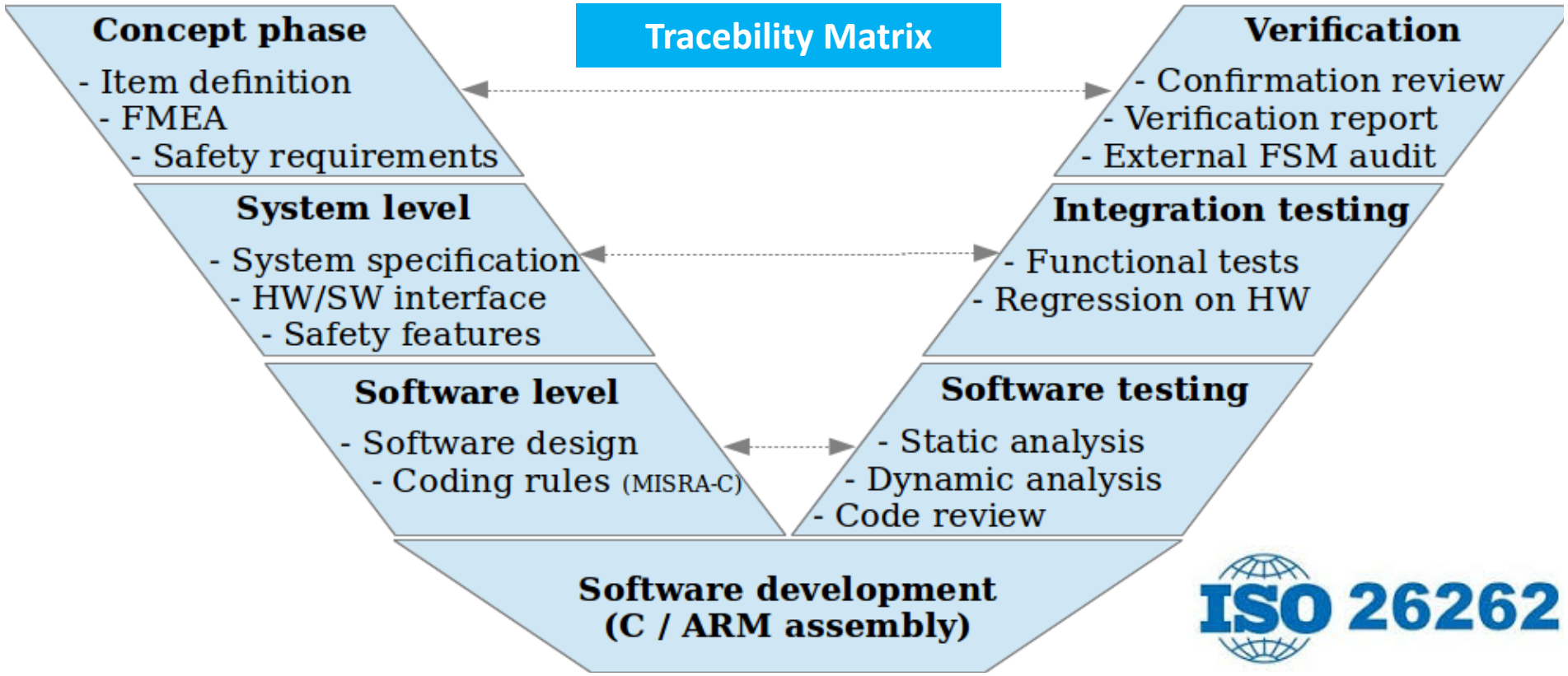
Programming

- The choice of a programming language - speed is crucial
- Standards e.g. Automotive SPICE (MISRA-C)
- setting up limits
- Safety actions must be done sufficiently fast
- Communication LinBus/CanBus

Challenges

- The difficulty - to find out technical standards and requirements required by the OEMs and automotive industry.
- Testing required by the OEMs.

5. What is involved in BMS and/or a control system



6. Job roles and skills involved in the field

Main job roles involved in BMS development

- **Battery Management System Engineer**
- **Functional Safety Manager**
- **Eletrical Engineeers and technicians**
- **Lithium Battery Specialists**
- **Programmers**
- **Technical managers – Documentation preparation**
- **Testing specialists**

The requirements in terms of experience depend on the complexity of the project and maturity of the organization.

6. Job roles and skills involved in the field

Senior Battery Management System Engineer

Basic

- Lead the design and development of lithium-ion battery management systems
- Effectively collaborate and communicate with the appropriate functional team members from quality, manufacturing, supply management and product support, as well as product development engineers, suppliers, customers, and leadership
- Work closely with battery cell and packing engineering team and vehicle integration team
- experience in product design and engineering
- experience in the design, development, testing, and integration of battery management systems in lithium-ion batteries
- experience in battery management system integration into electric vehicle applications

Nice to have

- Understanding of Lithium-Ion Battery technology trends, vehicle industry application trends, battery management system technology trends, and lithium-ion battery test approaches.
- Deep understanding of Battery Management System algorithms including state of charge (SOC), state of health (SOH) and Safety Functions
- Demonstrated ability to lead project teams meeting project performance, schedule, and budget goals.
- Familiarity with Chargers and charging methods
- Experience with battery management system testing

Education

- Ideally a degree or equivalent related work experience in the following:

- Bachelor’s degree in electrical engineering, mechanical engineering, or other related discipline with experience

6. Job roles and skills involved in the field

Functional Safety Manager - Ideal candidate

Key requirements

Project management capabilities

Producing, either directly or indirectly, all the necessary work products, including but not limited to:

- System Safety Program Plan
- Safety Manual
- Safety Concepts
- ASIL assignment/decomposition
- DIA
- HARA
- Safety Requirements
- FMEDA & FTA
- Safety Verification and Validation activities
- Conducting safety reviews

Education

- Minimum BSc or BEng (2:1) in Automotive / Electrical / Systems Engineering or a related field of study
- Expert knowledge of ISO26262
- A minimum of 5 years' experience working to ISO 26262, with strong knowledge of Functional Safety Theory and specific on-the-job experience
- expert knowledge and industry experience with safety concepts, hazard analysis and risk assessment, DFMEA, FTA for automotive embedded hardware and software, at both system and sub-system level.
- knowledge of systems engineering principles, hardware and software design concepts.
- Proven record of interpreting requirements from design to production
- demonstrated progressive responsibility and hands-on experience with vehicle system architectures and control systems.

7. Possible important soft skills

Subject matter

- Problem-solving
- Effective communication skills
- Self-direction
- Drive
- Research
- Creativity
- Adaptability/Flexibility

People skills

- Leadership
- Effective communication
- Teamwork
- Conflict resolution

Other

- Work ethic
- Integrity

8. Training/re-skilling challenges of people without a battery background

The requirements in terms of experience depend on the complexity of the project and maturity of the organization.

Easiest to reskill

Hardest to reskill

- **Technical managers – Documentation preparation**
- **Battery Management System Engineer**
- **Testing specialists**
- **Functional Safety Manager**
- **Lithium Battery Specialists**
- **Programmers**
- **Eletrical Engineeers and technicians**

- Another driver is the skill we are reskilling from, whether there has been some backgroud already.
- We found that Electrical engineers and technicians really need quite extensive knowledge and experience, therefore we placed them as hardest to reskill from no backgroud.

Thank you

Olife

NORTE2020 PROGRAMA OPERACIONAL REGIONAL DO NORTE
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VASCO DA GAMA COLAB
INNOVATION FOR A BETTER WORLD

BMS for Stationary Applications

24/11/2022

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Alliance for Batteries Technology, Training and Skills

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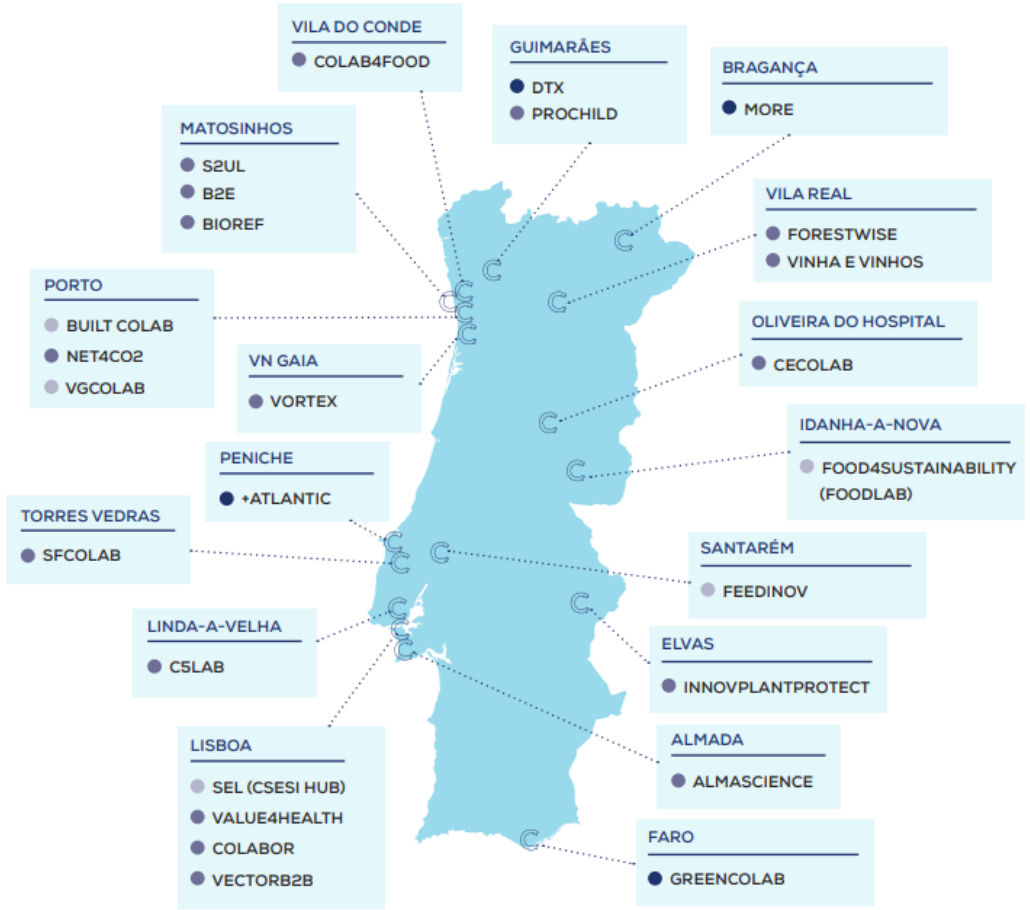
- **Vasco da Gama CoLAB** is 1 of 35+ recognized CoLABs in Portugal
- Focus on **Electrochemical storage systems**

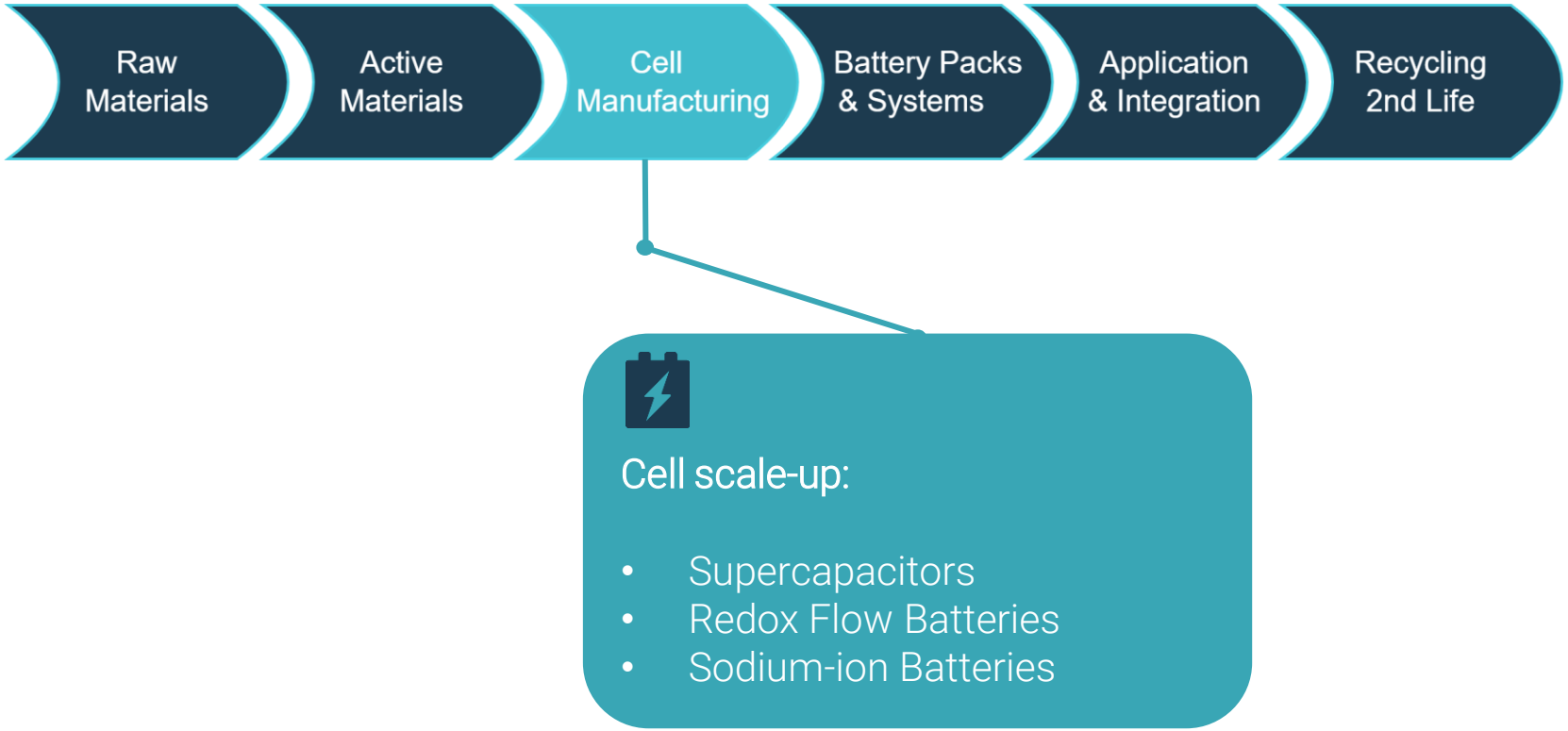
➢ Promote **high skill jobs**
➢ **Diversify research** by filling the gap between education and industry (TRLs 4-7)
➢ **Develop innovative prototypes** that can be adopted by industry



FCT
Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

ANI AGÊNCIA NACIONAL DE INOVAÇÃO

Competences in the scope of the battery value chain



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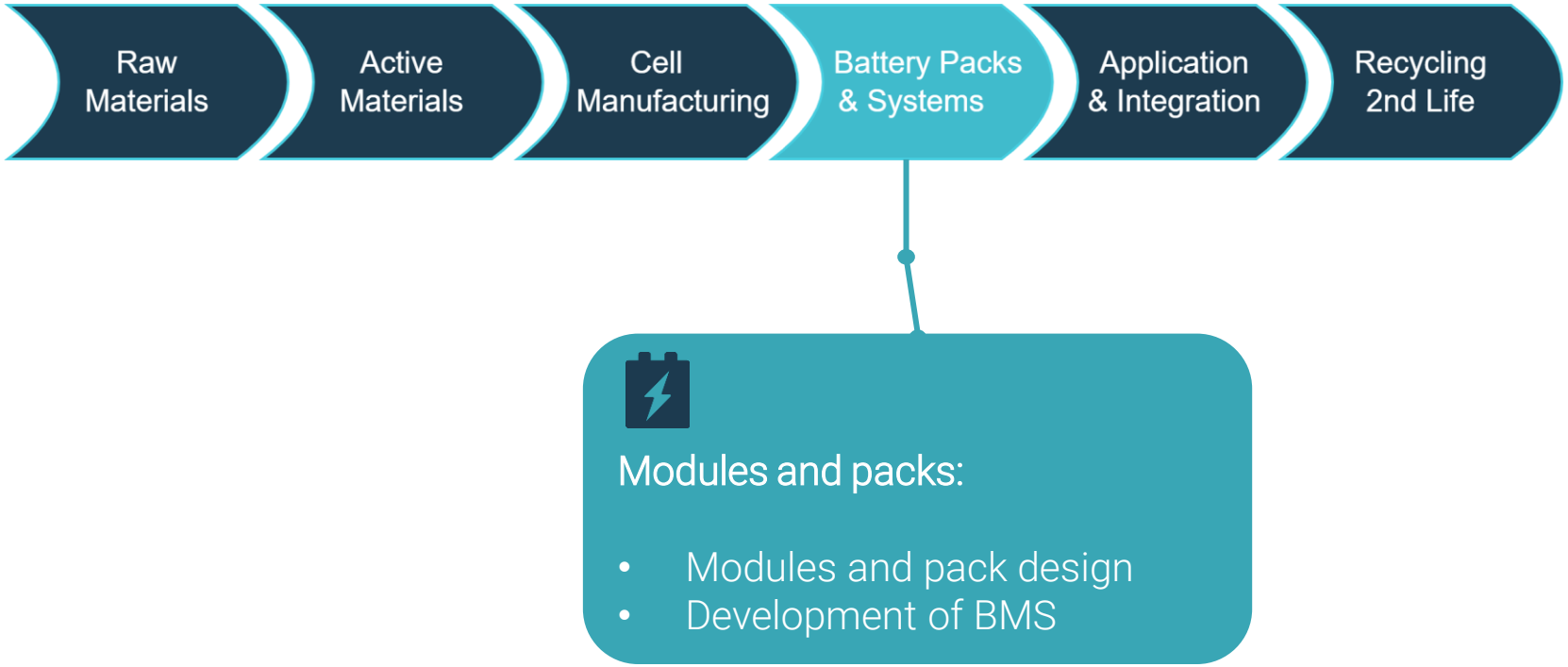
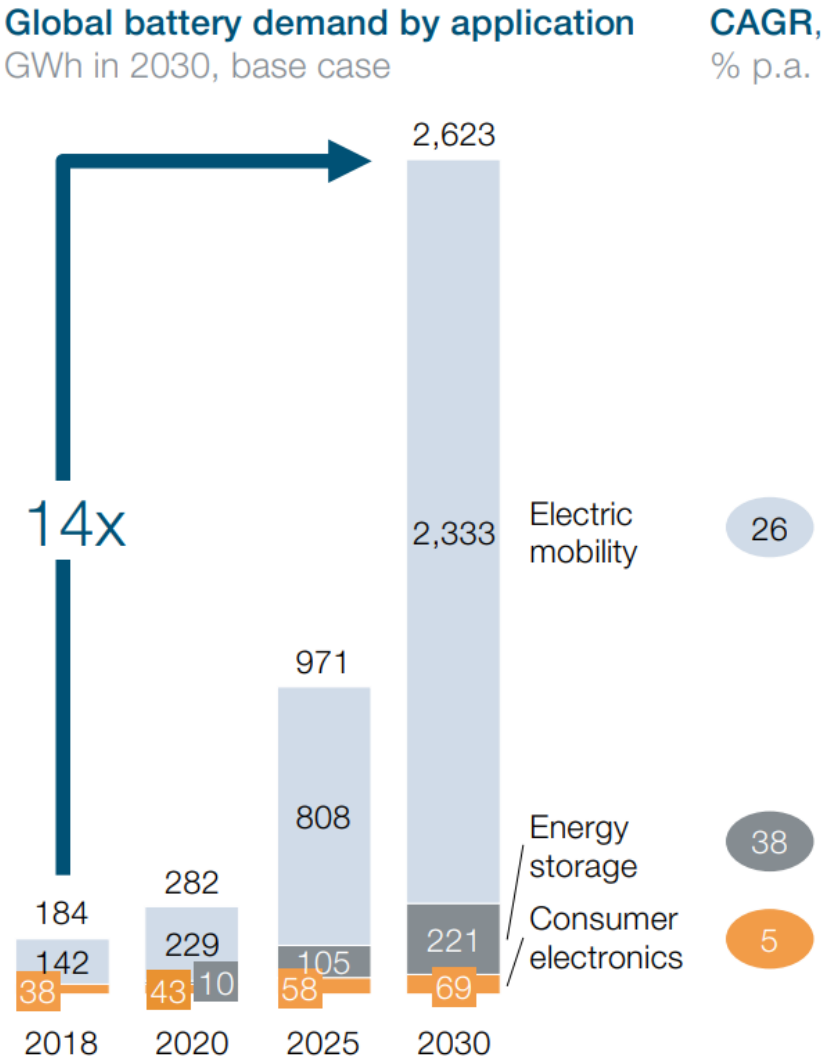


Competences in the scope of the battery value chain

Power converters and energy management systems:

- Multi-port converters (HESS)
- Modular power converters
- Microgrid control
- Operational and sizing tools

Battery market forecast

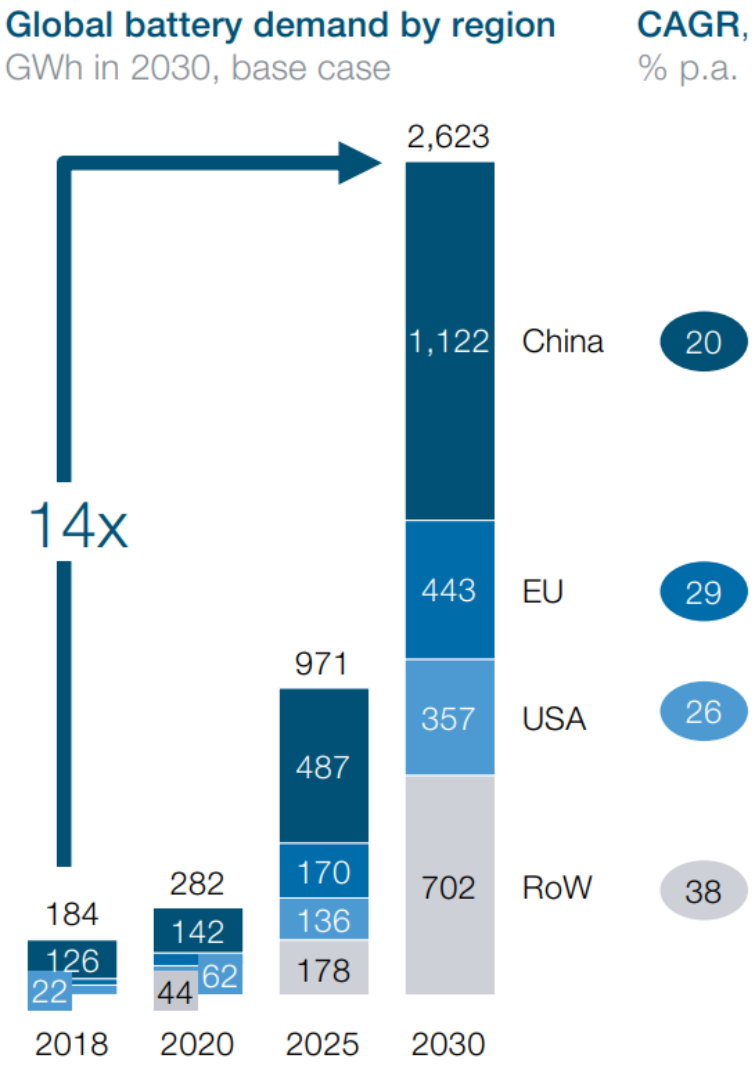


- 2020 – 2030 (Global):
  - 22x increase in Energy storage (10 GWh – 221 GWh)
  - 9x increase in Electric mobility (229 GWh – 2,333 GWh)

High potential for 2LB markets

Image from: Global Battery Alliance (2019), A Vision for a Sustainable Battery Value Chain in 2030: Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation

Battery market forecast



- 2020 – 2030 (Europe):
  - 13x increase in Energy storage (34 GWh – 443 GWh)

Image from: Global Battery Alliance (2019), A Vision for a Sustainable Battery Value Chain in 2030: Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation

Battery Pack and its main components

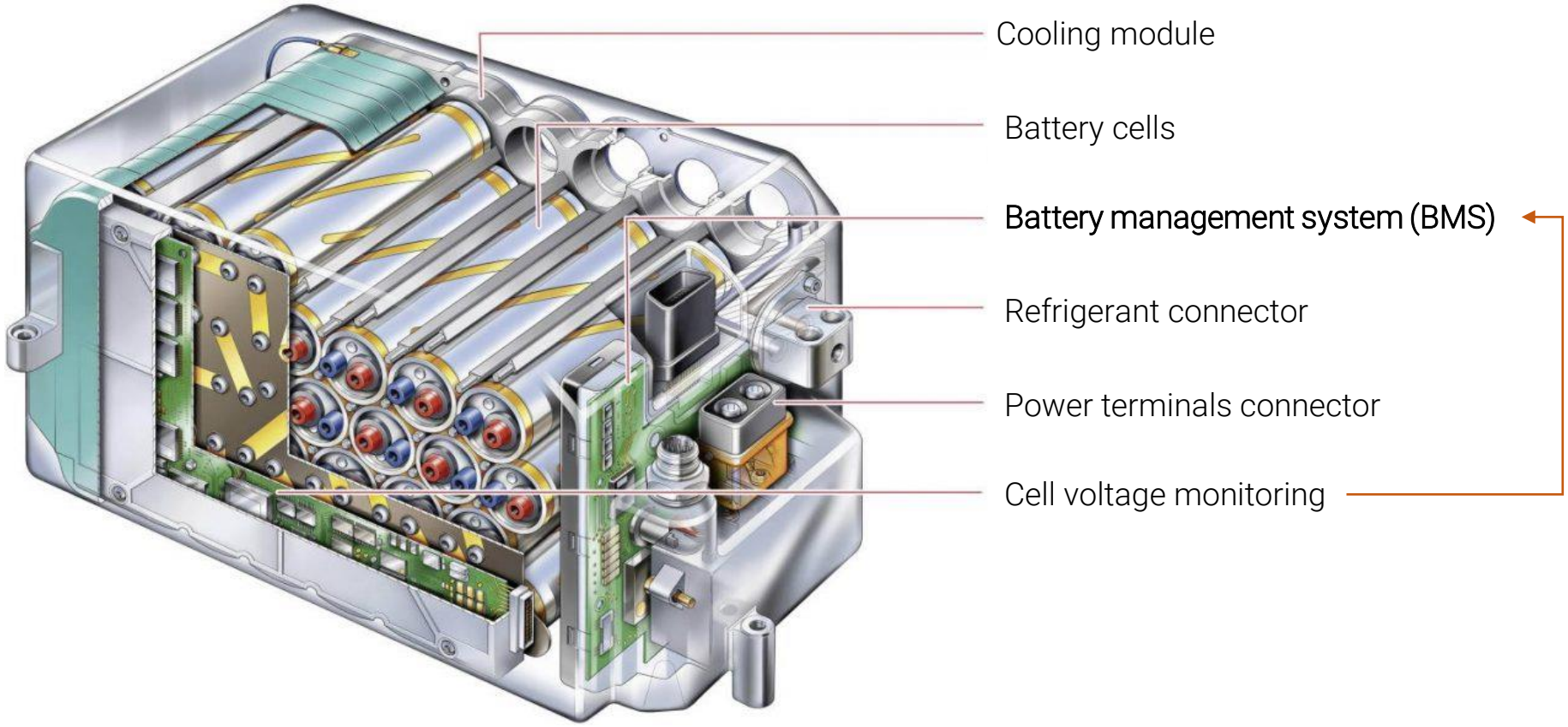


Image adapted from: https://www.batterydesign.net/cell-temperature-gradient/ Mercedes S400 Hybrid Battery Pack (2009)

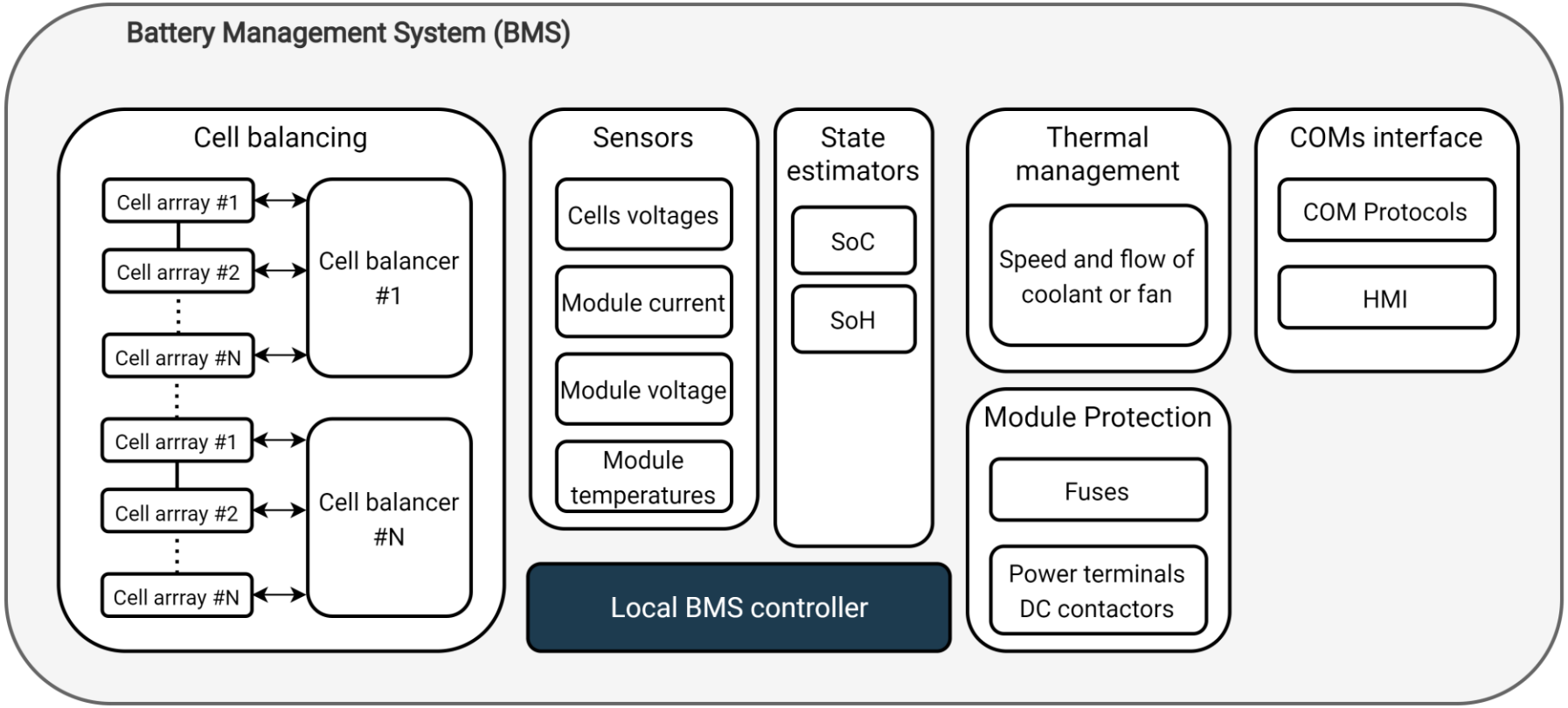
BMS - state of technology

- Basic requirements:
  - Protect the battery and user;
  - Ensure the safe operation of the battery – Safe Operation Area (SOA)

- Current technology (2022):
  - Optimization of the battery use
  - Increase battery lifespan

- Future requirements (2030):
  - Self-diagnosis (advanced sensors technologies)
  - Remaining useful life (RUL)
  - Adaptive state-space models
  - Integrate BMS functions in power electronics
  - Increased interoperability:
    - State-estimation standard models
    - Internal parameters transparency
    - Enable battery hybridization
    - Standard COMs protocols

BMS – system breakdown



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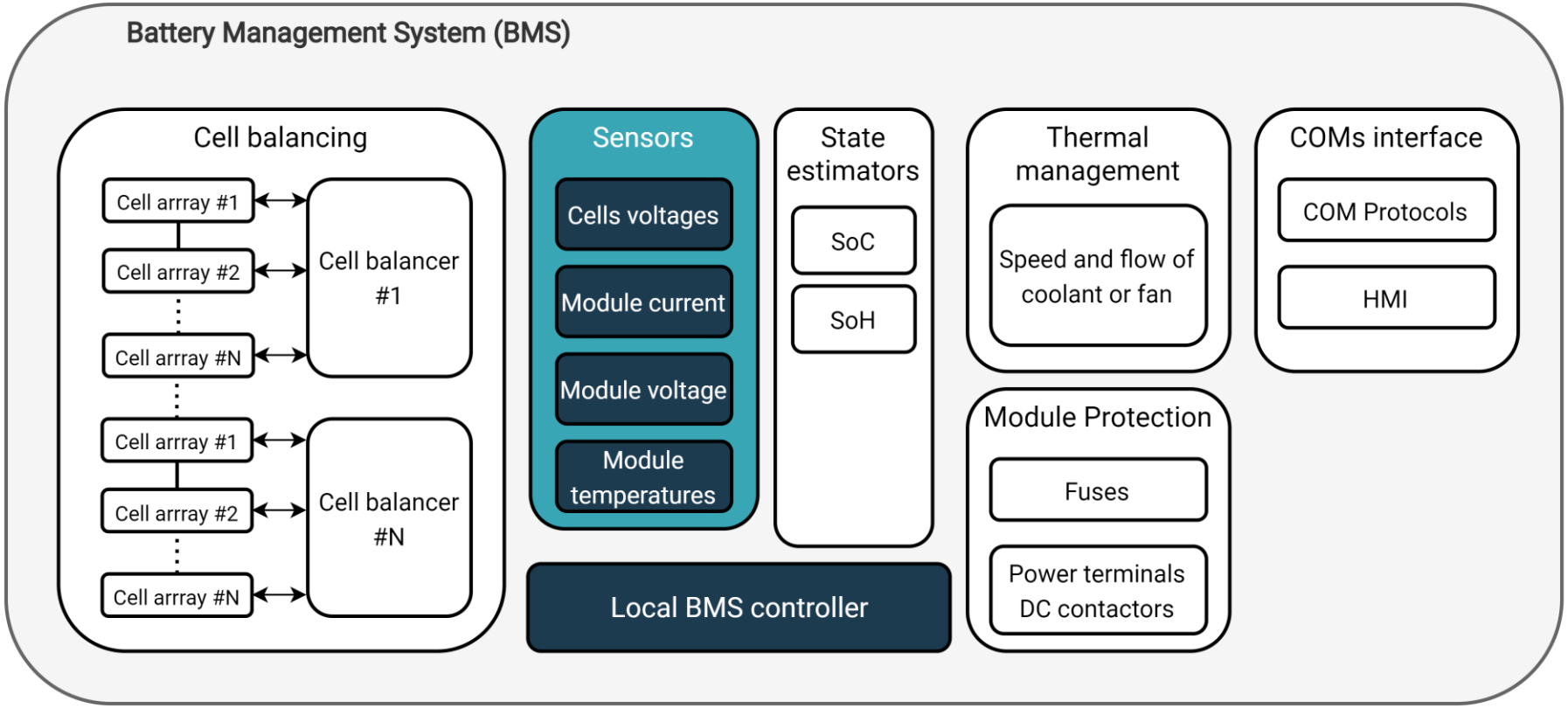

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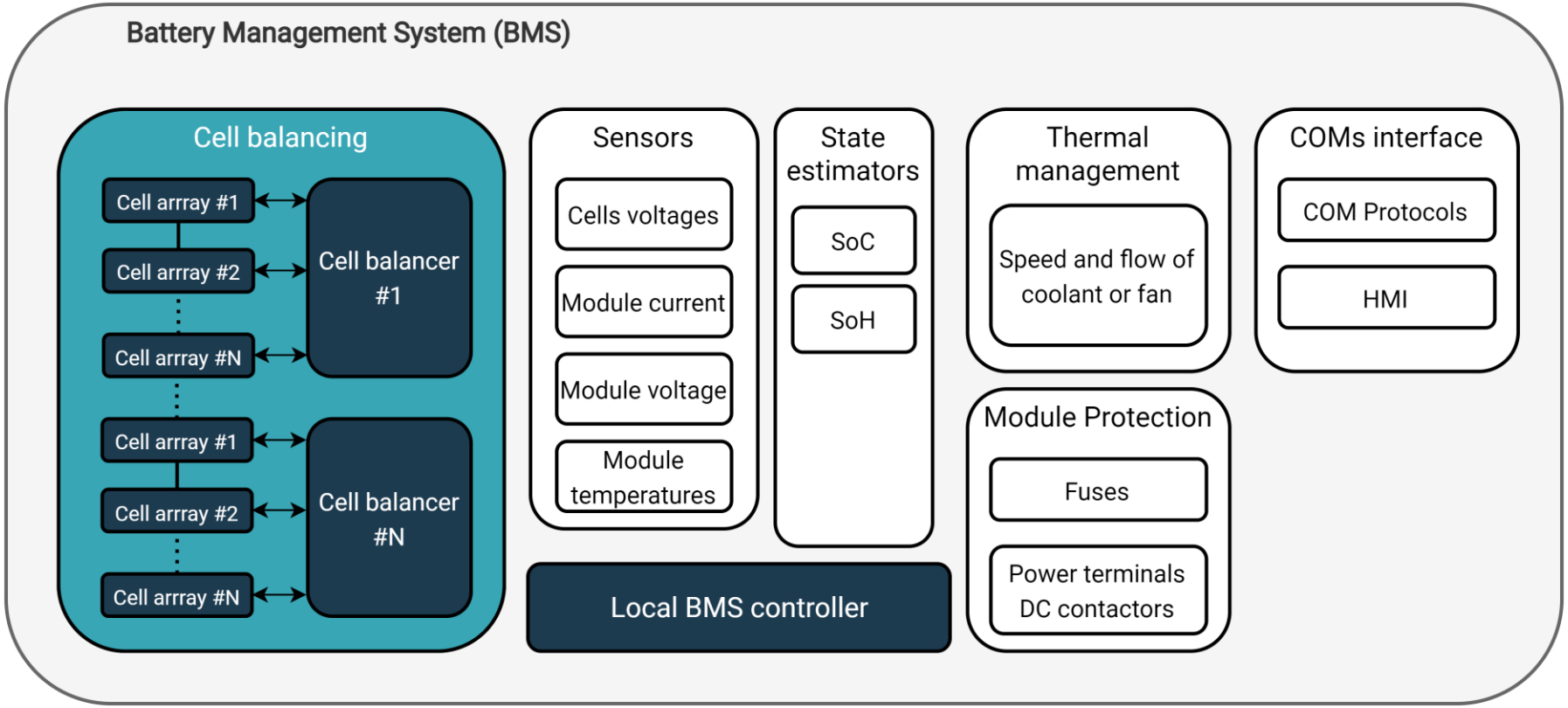
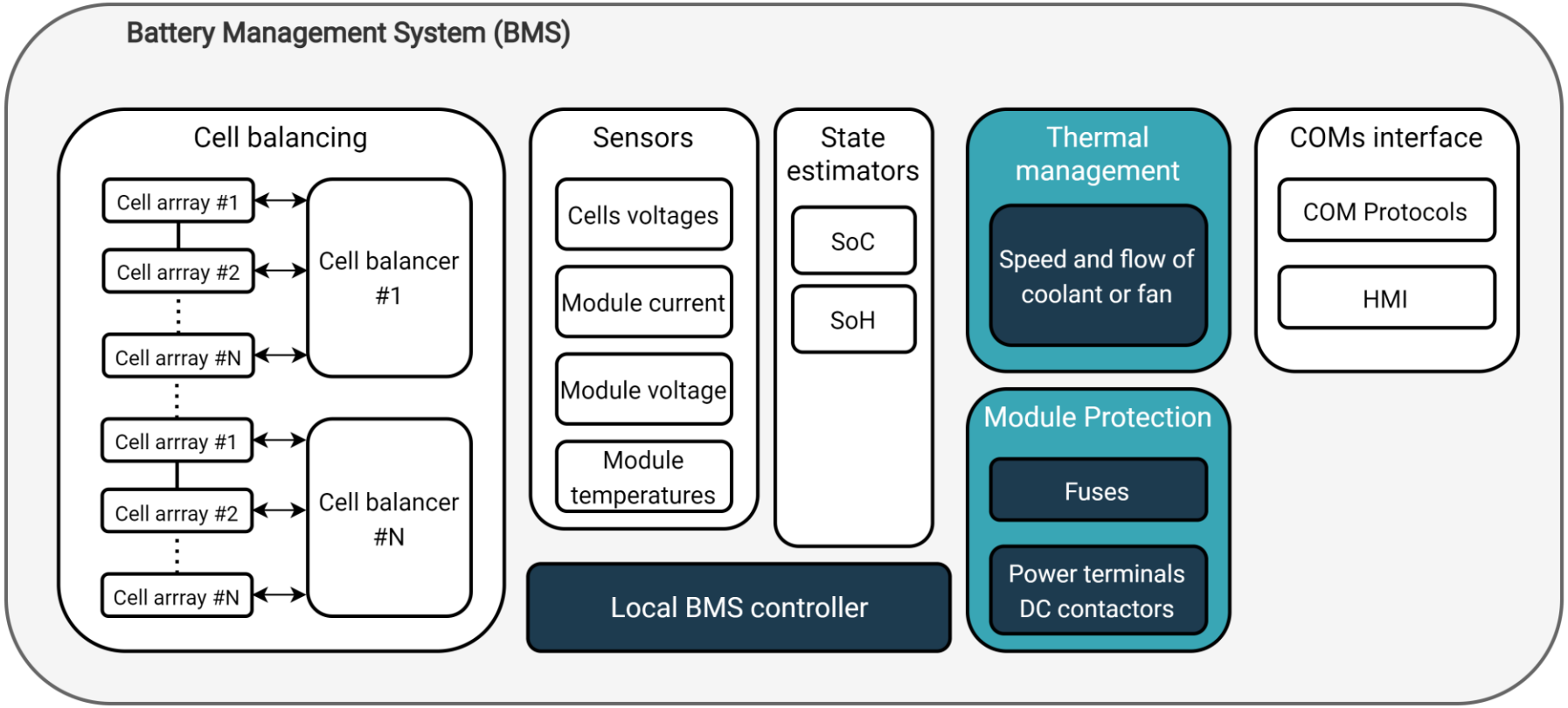
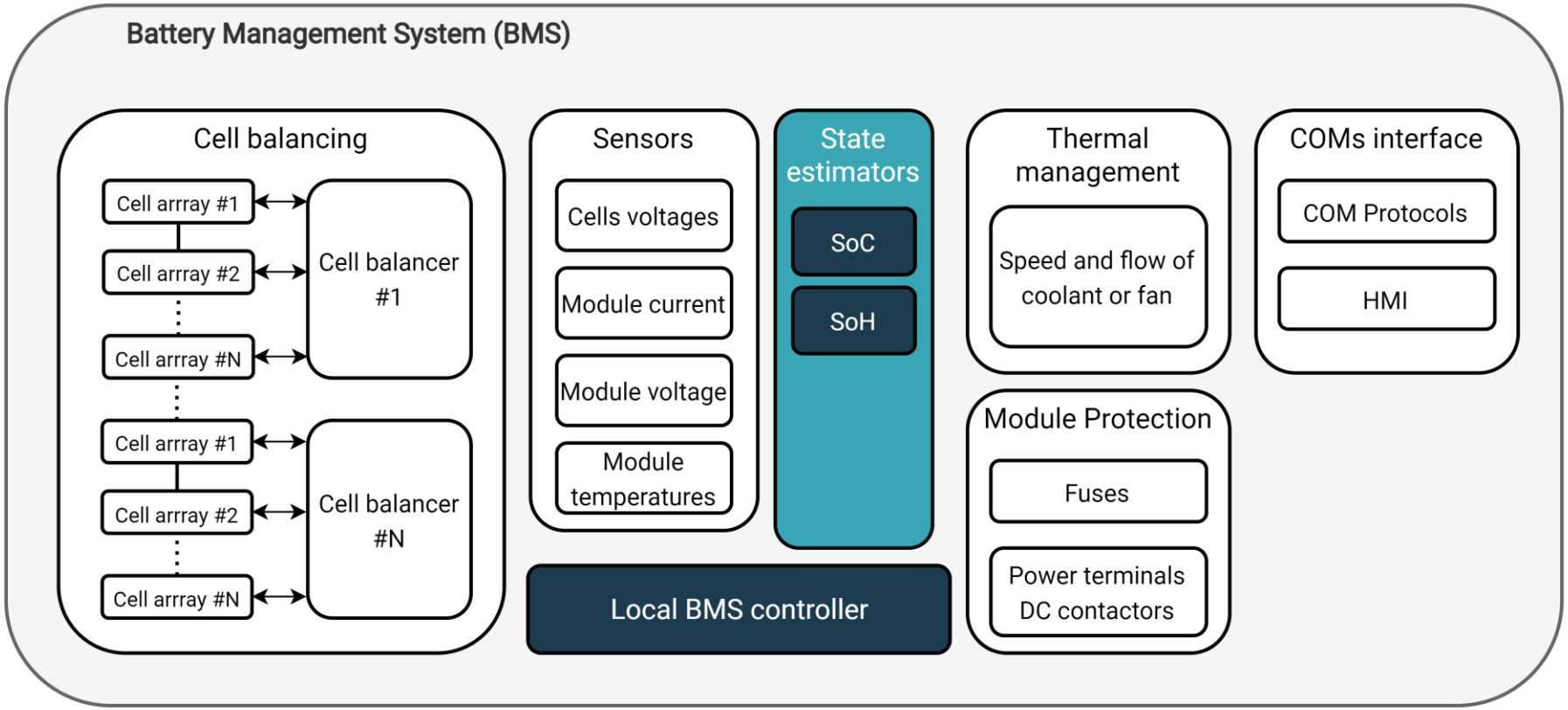


Passive balancing → Active balancing → Increase efficiency

BMS – system breakdown



BMS – system breakdown

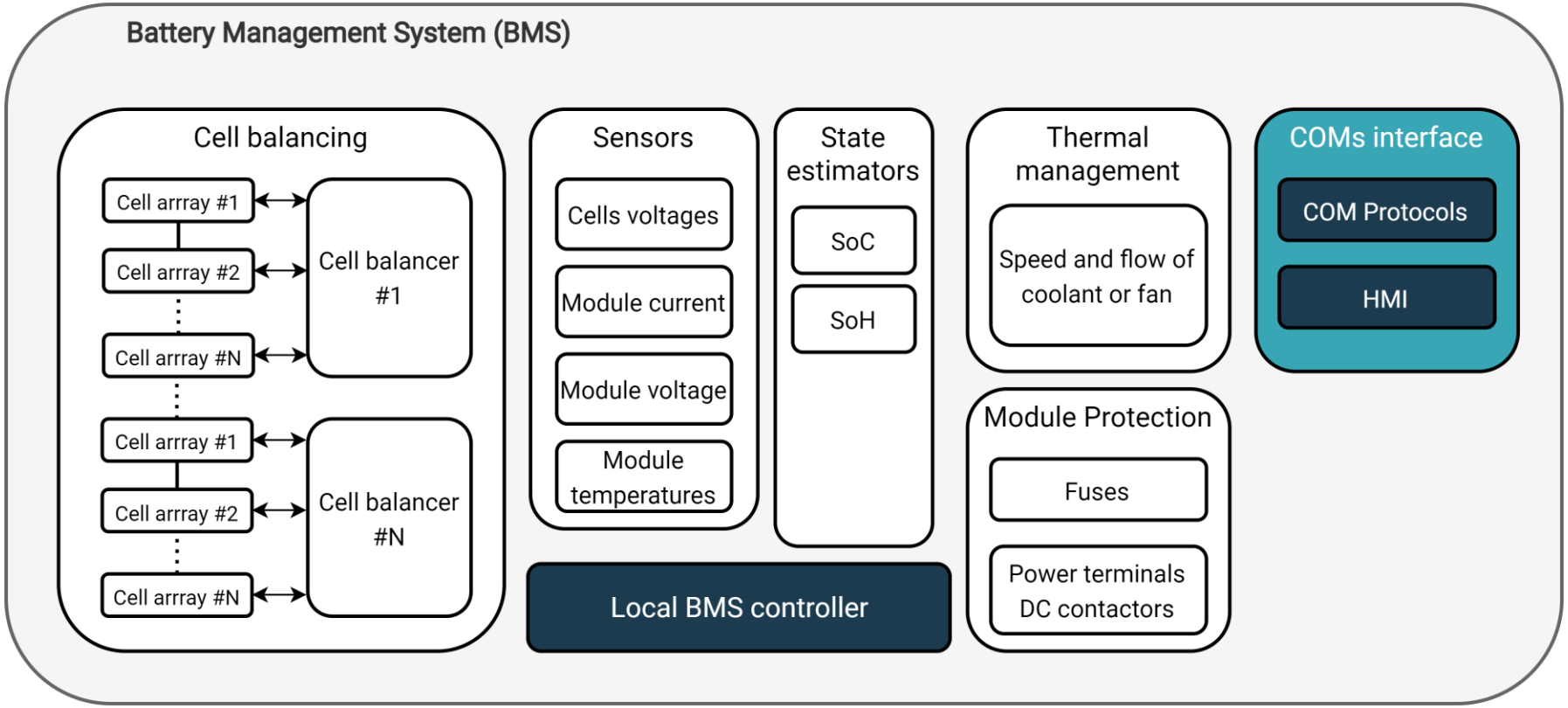


SoC: Coulomb counting

SoH: Cycle count

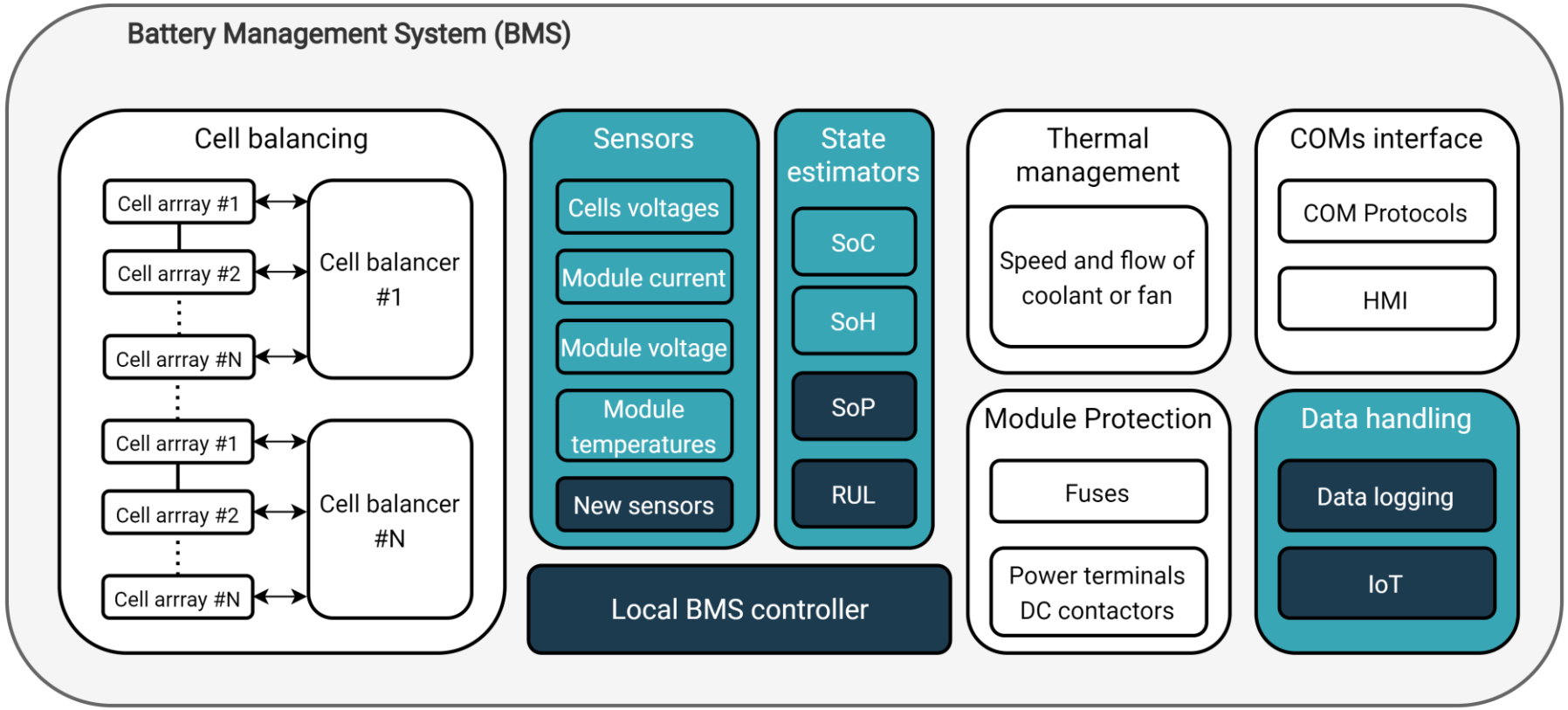
→ KF/ML/DM → Higher precision = Increased safety

BMS – system breakdown



Proprietary protocols / Undefined protocol standard → Open protocols / Standard parameters and communication protocol → Interoperability

BMS – system breakdown (future requirements)

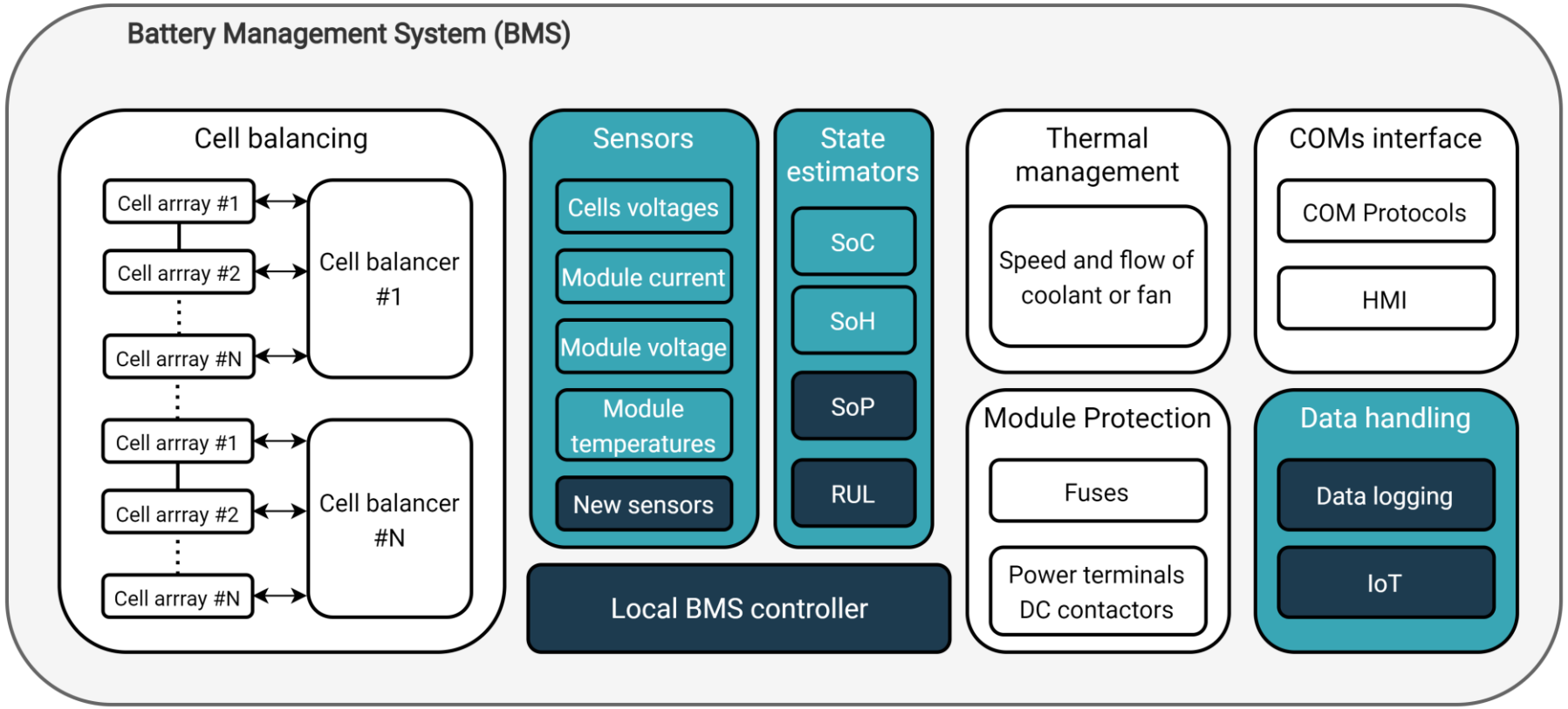


New sensors →

E.g.:

- Improve measurements noise
- Impedance measurement
- Cell internal temperature and pressure

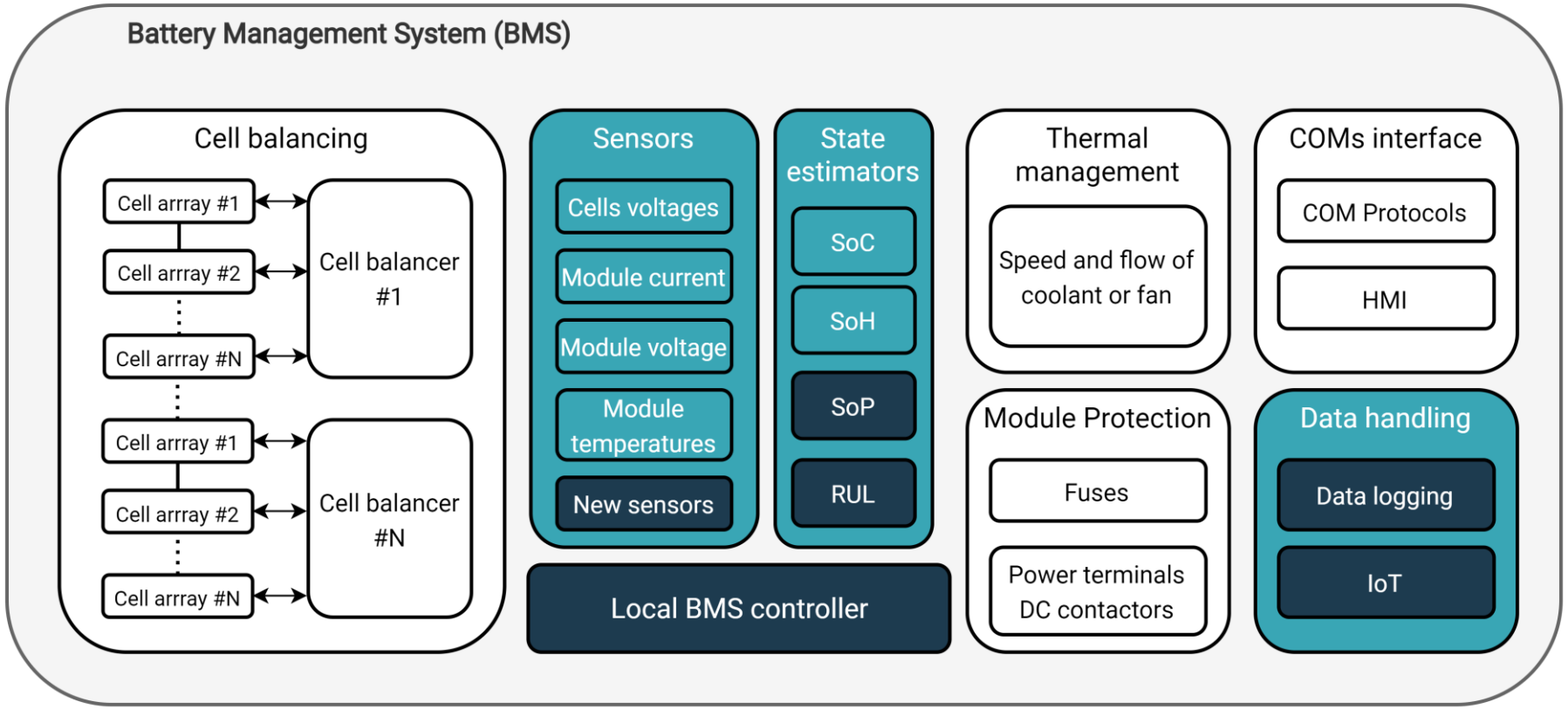
BMS – system breakdown (future requirements)



SoP → Flexibility / Peak shaving / Load levelling

RUL → Optimize operation

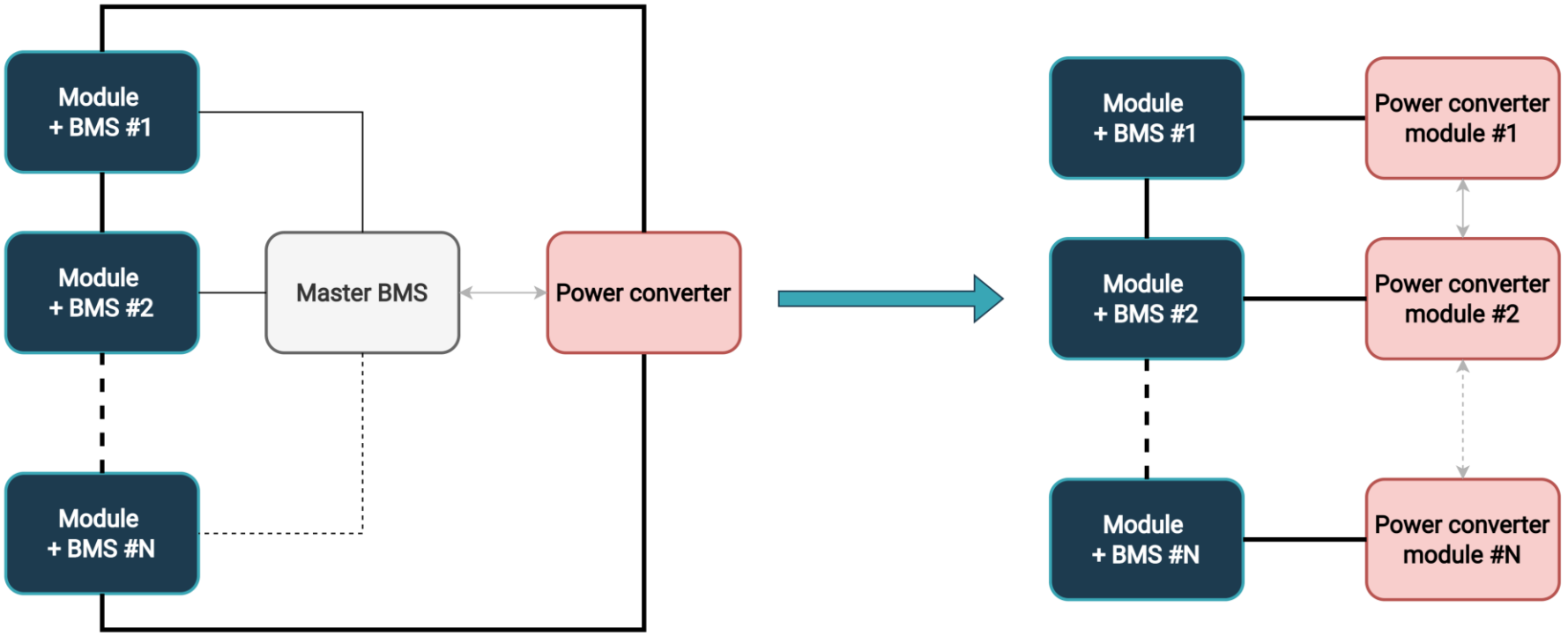
BMS – system breakdown (future requirements)



Data logging → Internal logging to support advanced state estimators algorithms

IoT → Enable offline AI training though cloud / remote BMS firmware update / battery passport (Blockchain)

BMS – system breakdown (future requirements)



Power converter with integrated:

- Inter-module balancing
- Thermal management

5. Required professional skills

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Electronics (MSc // PhD)	Materials Science (MSc // PhD)	Electrochemistry (MSc // PhD)	Dynamic modelling (MSc // PhD)	Data Science (MSc // PhD)	Thermodynamics (MSc // PhD)
Cell balancing	Thermal management	Sensors	State estimators	State estimators	Thermal management
Sensors	Sensors	State estimators		Data handling	
Module Protection					
COMs interface					

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Thank you

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