



NEWTWEEN

Embedded Intuition

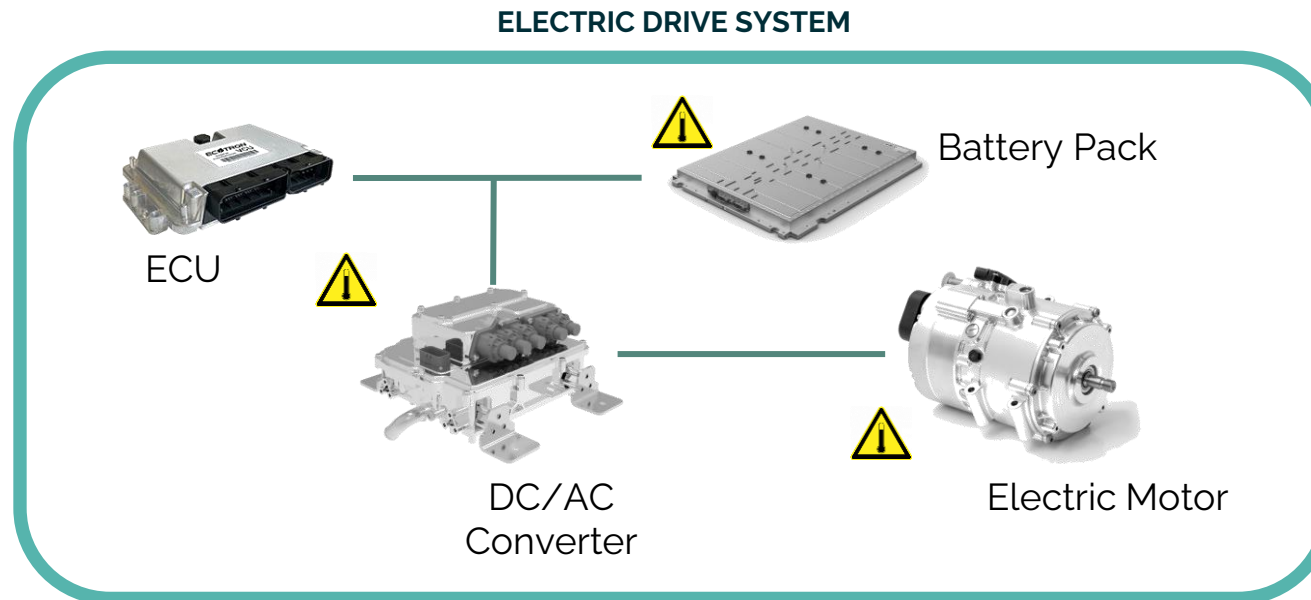


**ACCELERATE
SUSTAINABLE
INNOVATION**

CHALLENGE – Efficient E-powertrain thermal management

Competition among manufacturers has pushed the design of electric drivetrains to ever greater **power densities**, so much so that **a significant technological challenge** is emerging:

THE THERMAL MANAGEMENT OF SYSTEM COMPONENTS



Software will play a major role in overcoming this bottleneck

CHALLENGE – Efficient E-powertrain thermal management

How could this be achieved?

By placing numerous physical sensors inside the system and monitoring the electrothermal stress of the powertrain in real time.

...unfortunately, this would require:

- Over-engineering of components due to redundancy requirements
- High development and assembly costs
- Even more chips involved!

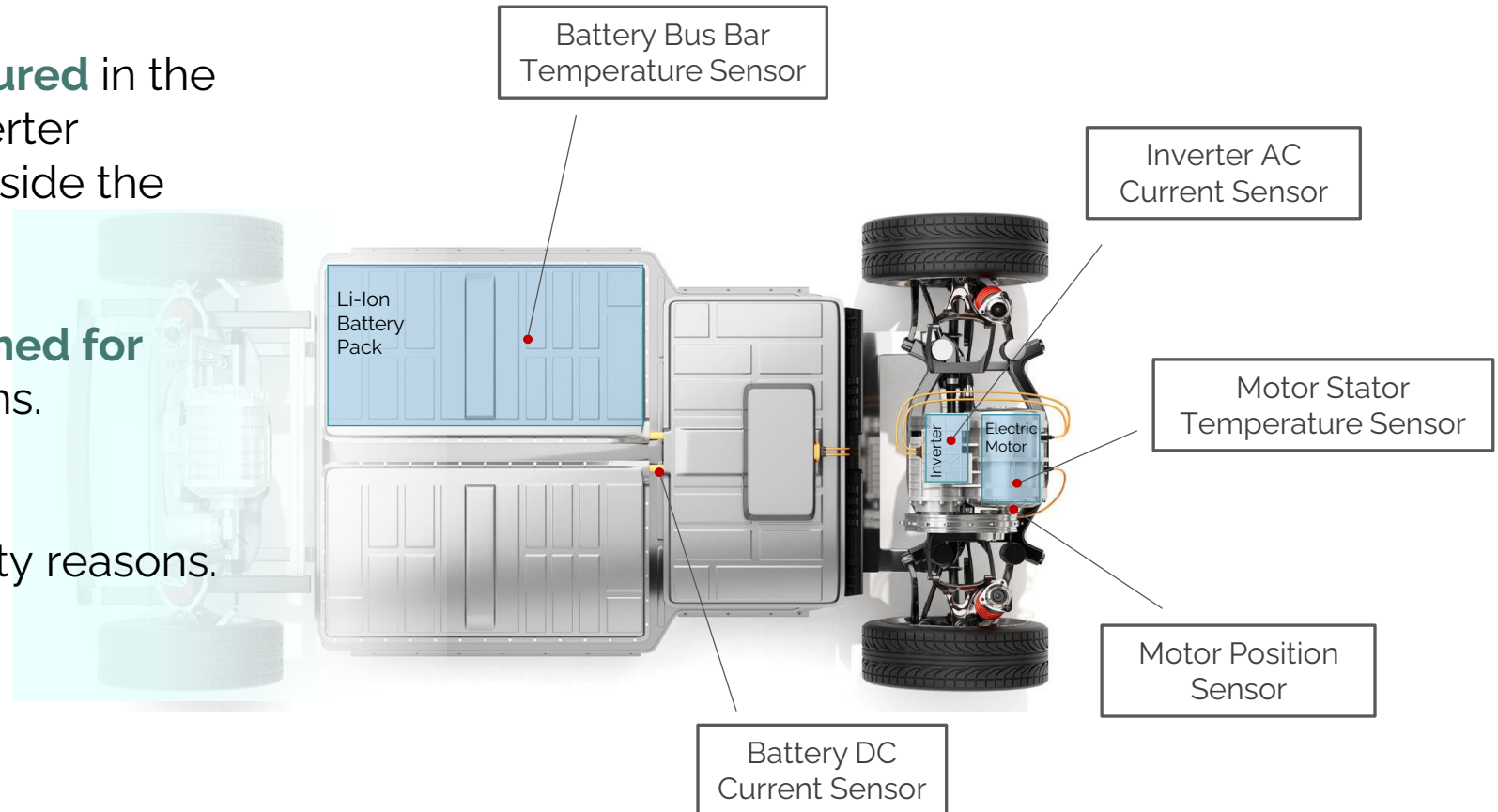
Not only that, but the **most critical points of components** to be monitored are physically inaccessible and thus **no sensor can be placed**.



CHALLENGE – Efficient E-powertrain thermal management

Precise temperature management at critical points in the system is key to increasing peak and continuous power and extending component lifespan. Today, the temperature is estimated or in many cases remains unknown, which is why **designers have no choice but to maintain *huge safety margins***.

- **Temperatures cannot be measured** in the motor **rotor magnets**, in the inverter **semiconductor junctions** and inside the **battery cells**.
- **Accurate models are not designed for real-time** embedded applications.
- **Redundant sensors** have been implemented for functional safety reasons.

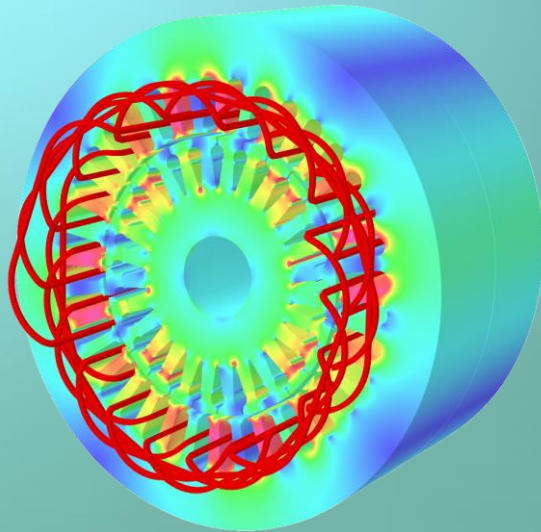


SOLUTION – Digital Twin on Chip

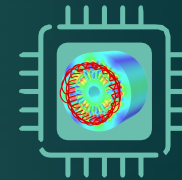
Highly accurate digital replicas of physical systems that provide **real-time state information** on system behavior under a wide range of operating conditions and on **physically inaccessible points**.

The bridge between complex 3D simulation and the embedded world

COMPLEX 3D SIMULATION MODELS



NEWTWEN
Digital Twin Technology



DIGITAL TWIN
ON-CHIP

HOURS

MICROSECONDS

PHYSICS BASED

REAL-TIME

PREDICTIVE

ADAPTIVE

SOLUTION – A unique mix of attributes

Our Digital Twins are **unique** because they are:

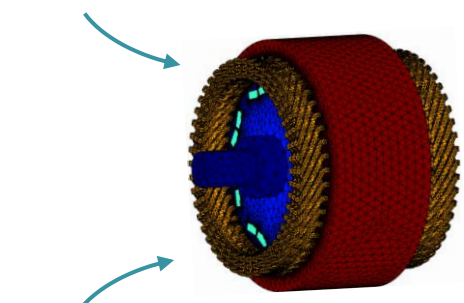
- **PYHSICS BASED:** They describe electrothermal behavior as a function of three-dimensional *geometry, material properties, and the fundamental laws of physics* governing electromagnetism and thermodynamics. They also optimize the most uncertain parameters with artificial intelligence algorithms.
- **REAL-TIME:** The ratio of *accuracy to computational complexity* is high enough to allow real-time simulation on any low-power hardware device.
- **PREDICTIVE:** The digital twin is a model, not a sensor. This allows *future scenarios* to be simulated in advance.
- **ADAPTIVE:** The digital twin is not a simple mathematical model: it is capable of autonomously *adapting its parameters over time*, with respect to manufacturing tolerances and degradation phenomena of component materials. This means that starting from a reference model implemented on each unit (on-chip), over time each digital twin will evolve differently.

NEWTWEN's vertical digital twin compiler generates **accurate real-time, adaptable and embeddable digital replica** of the component, ready for use in a simulation environment and easily integrated into embedded firmware.

1

HIGH FIDELITY VIRTUAL MODEL GENERATION

Design specifications



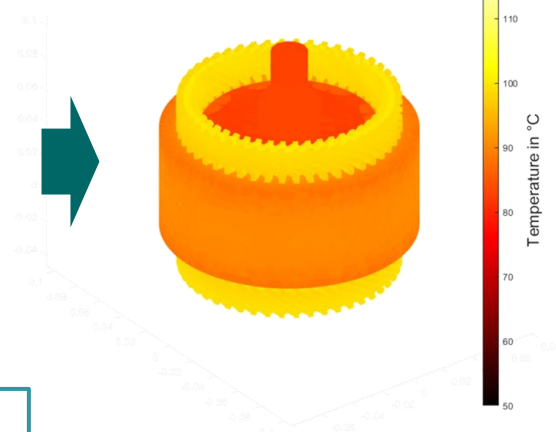
Material specifications

$Nr. DOF^* > 300000$

2

ELECTROTHERMAL ANALYSIS AND MODEL COMPRESSION

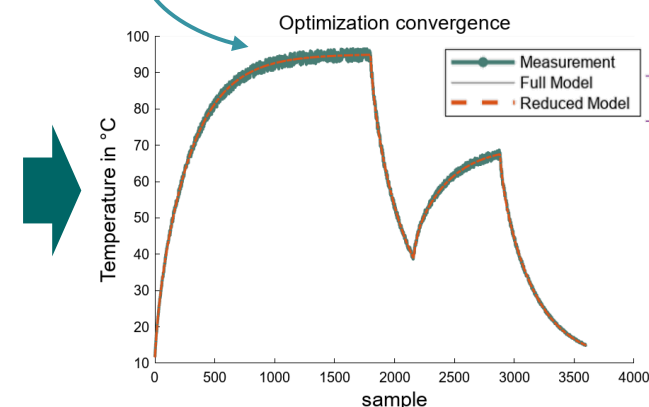
$Nr. DOF < 20$



3

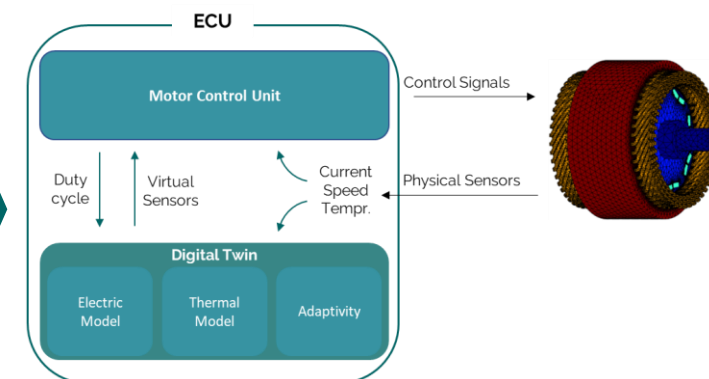
MODEL CALIBRATION WITH ARTIFICIAL INTELLIGENCE

Experimental measurements



4

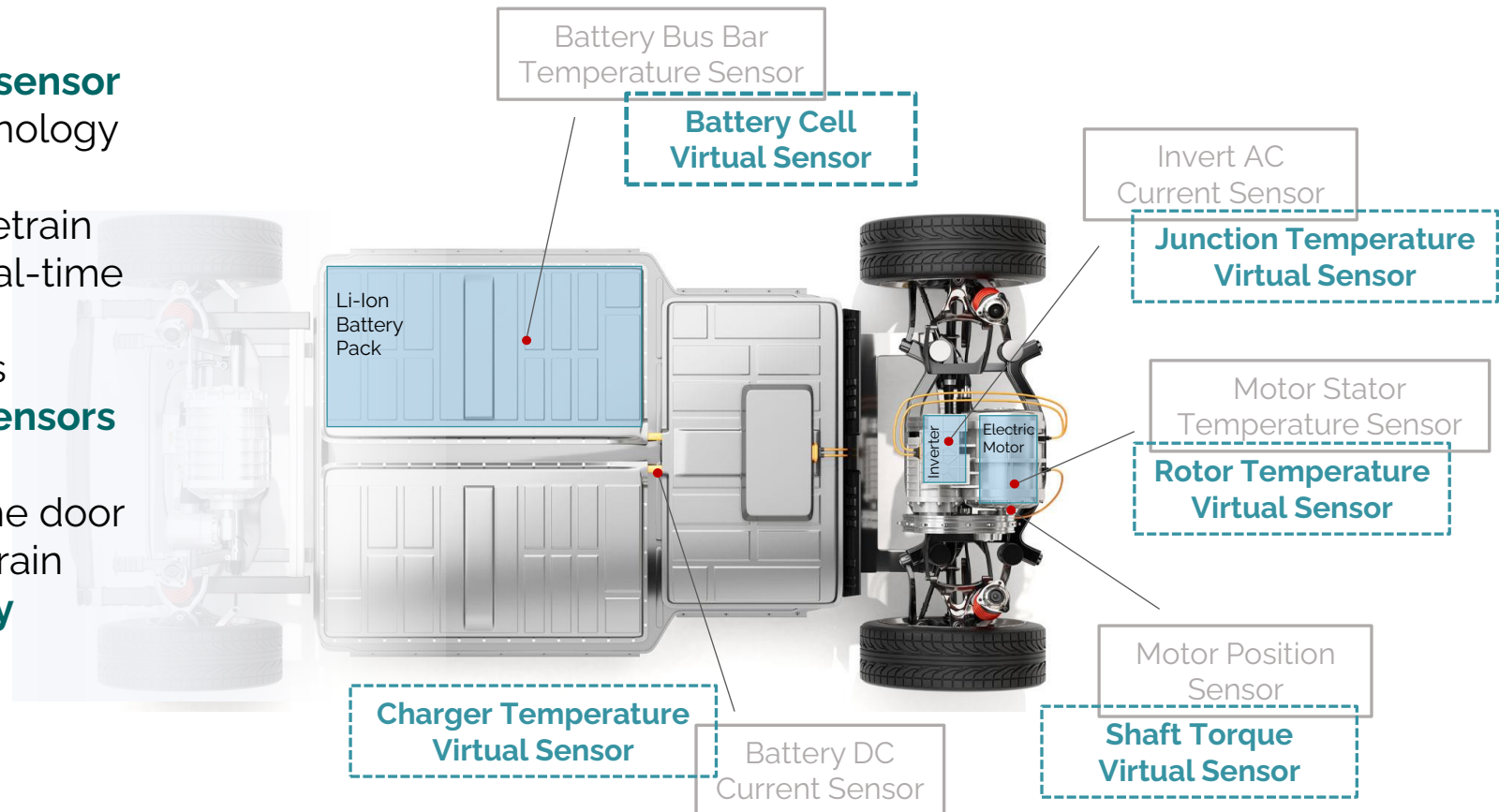
DIGITAL TWIN EMBEDDED CODE GENERATION



TECHNOLOGY – A new augmented sensor system on the edge

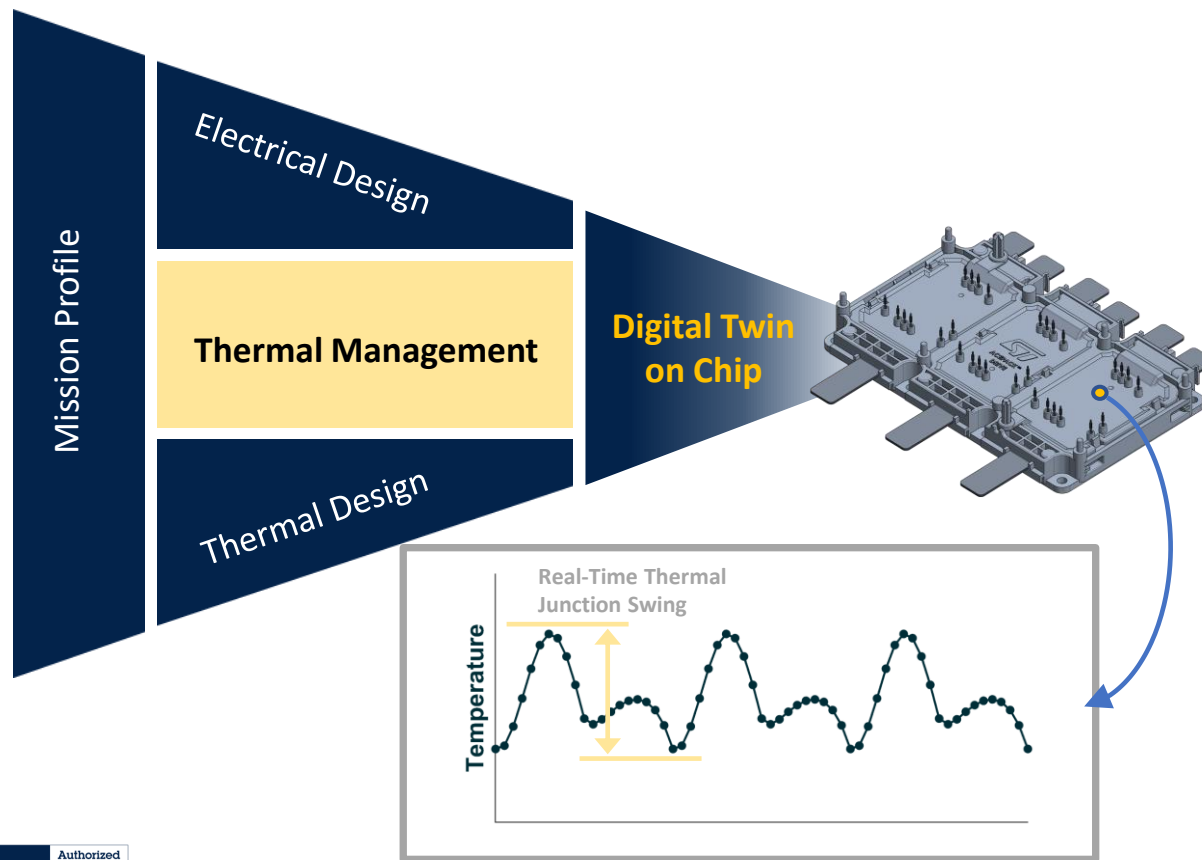
Our **proprietary mathematical approach** dramatically reduces the computational complexity of high-fidelity models—so much so that our Digital Twin can be integrated into the device itself to **compute in real-time, “on-chip,”** as part of an amazingly fast and accurate firmware solution.

- The result is an **augmented vehicle sensor system** via Digital Twin on Chip technology
- The **thermal interactions** of the drivetrain components can be **monitored** in real-time
- Early component **failure detection** is possible thanks to **redundant soft-sensors**
- This **additional information** opens the door to a whole range of **advanced drivetrain control and monitoring functionality**



APPLICATION – Digital twin for real-time performance monitoring

NEWTWEN'S DIGITAL TWIN ON-CHIP: A NEW **AUGMENTED** VEHICLE SENSOR SYSTEM FOR POWER ELECTRONICS



Digital twin running directly on the MCU

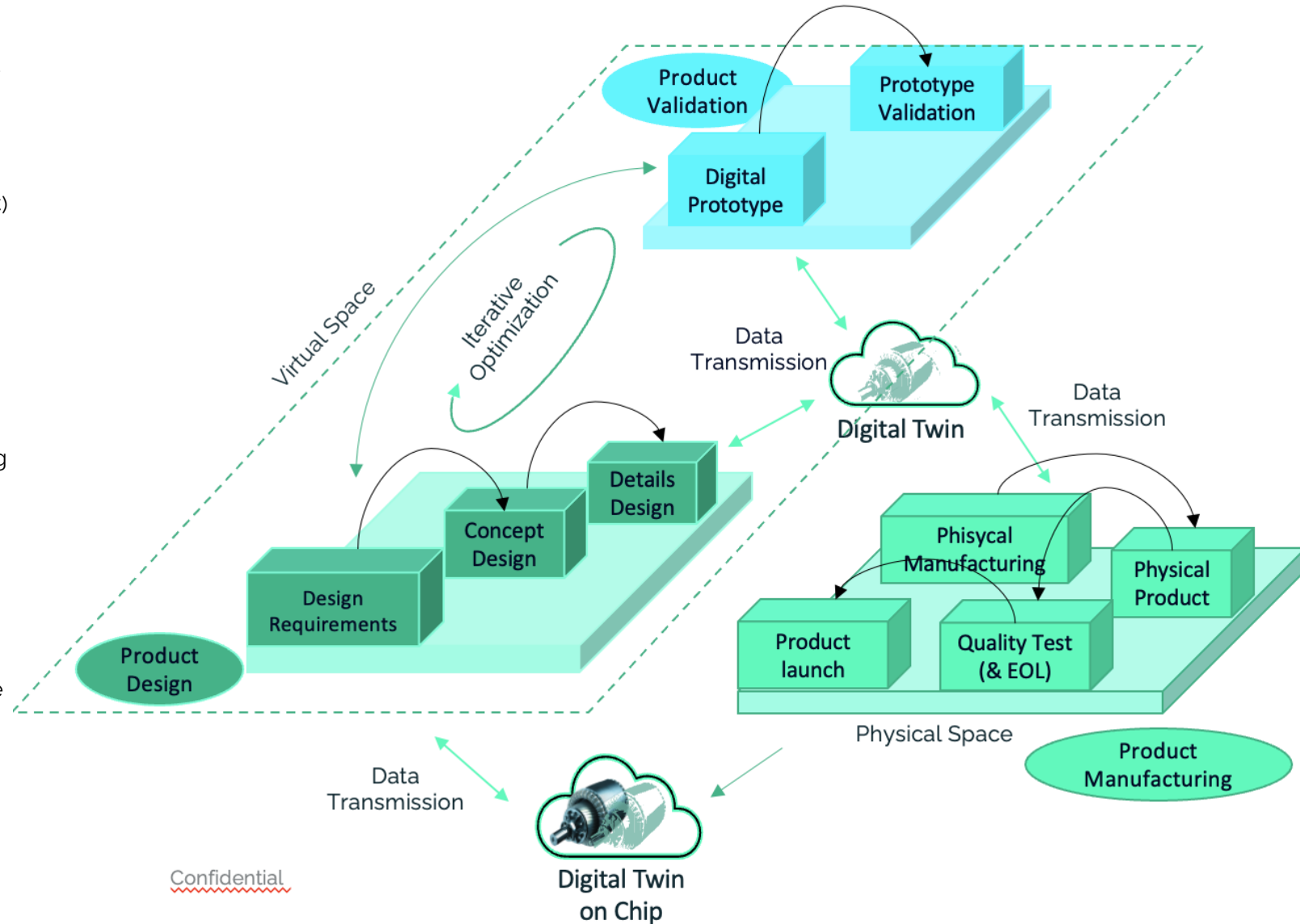
Real-time junction temperature of SiC MOSFETs

3D thermal coupling and cooling system effect

Overcome thermal network limitations

KEY BENEFITS – Digital twin factory

- **Product Design:**
 - Product Design can accelerate significantly, thanks to faster simulations in software of the physical product.
 - NEWTWEN's Reduced-Order Models are over 1000X faster to compute than standard high-fidelity Finite Element Models.
 - Flow of data from NEWTWEN's Digital Twin On-Chip (DTOC) of the physical product provides valuable info for new product design
- **Product Validation**
 - Digital prototyping and validation in the software space reduces the need for multiple iterations of costly hardware prototypes
 - Validation & Verification in the software space means testing is faster and cheaper
 - Results can be used to improve the design scheme of the new product and boost the corresponding manufacturing processes.
- **Product Manufacturing**
 - High fidelity replicas provide real time critical insights on the ongoing manufacturing process in the physical space
 - It provides immediate feedback and fasten EOL testing



KEY BENEFITS – Digital twin on chip

Digital Twin on Chip (DToC) solutions provide a baseline improvement that elevates the quality of work surrounding the operation of the physical object at every level



Real-time monitoring of parameters and temperatures which cannot be directly measured.



Predictive behavior and what if scenarios with virtual sensors, to predict behaviour and calculate the optimal control strategy.



Fault and detection predictive maintenance
accelerating 100x fault analysis and reducing data storage



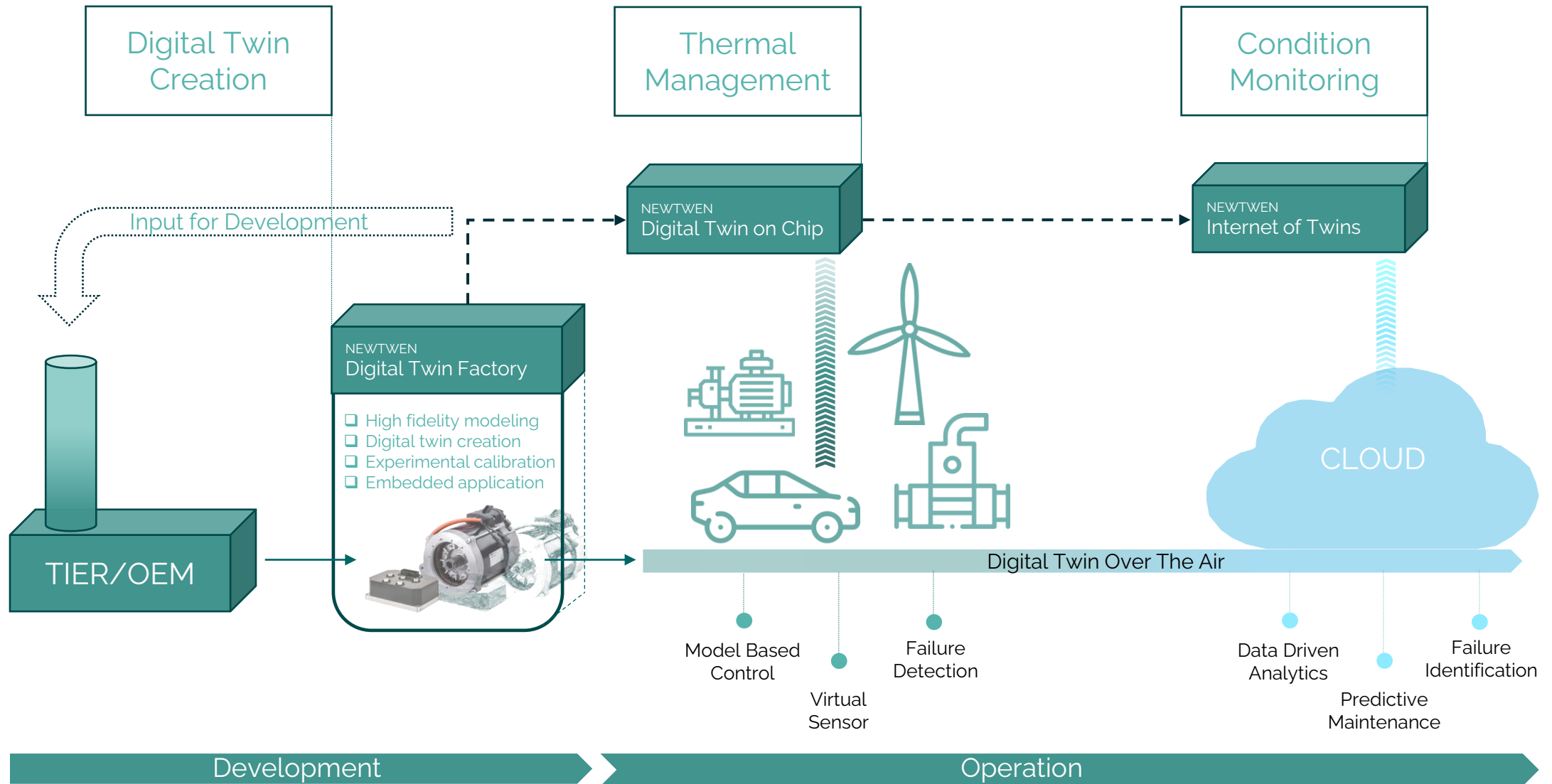
Optimal cooling and control management
Temperature estimation of rotor magnet and semiconductor junctions for power de-rating optimisation.



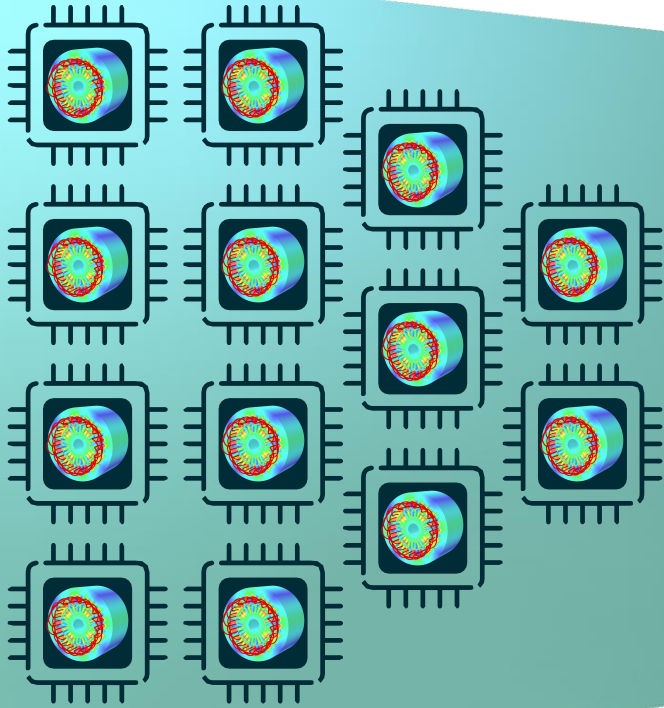
Lower production costs / BOM Reduction
Replacement of redundant HW sensors with the digital twin as virtual SW sensors integrated in series production.

VISION – An ecosystem based on Digital Twin on Chip

A new source of real-time data enriches the world of Cloud analytics



Predictive maintenance and fault identification powered by Digital Twin On-Chip Technology



We send **MODELS**, not data, to the cloud.
Each Model/TWIN will be **unique**.



DIGITAL TWIN
OVER THE AIR

This has much **greater intrinsic value than** collecting **raw sensor measurements**.

Key Info



When: 2020



Where: Padua, IT



of employees: 20



of customers: 10+



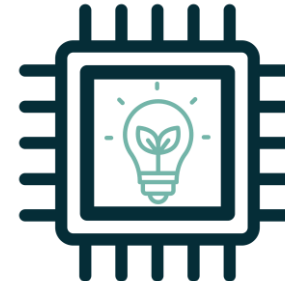
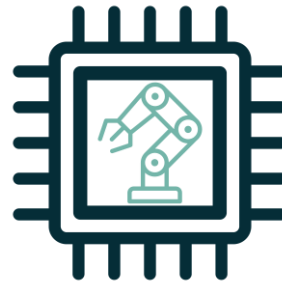
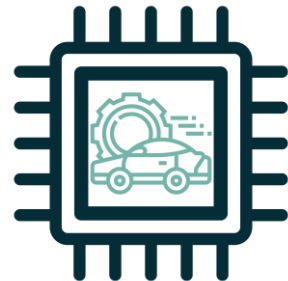
of funds raised: 7M+

Product Offering:

- Software as a Service (SaaS)
- Firmware as a Product (FaaS)

Core Value

NEWTWEN has created a **Digital Twin On-Chip** solution to address the thermal management challenge in electromechanical systems. Our technology allows for **real-time** temperature **monitoring** and improved performance, enabling the hardware industry to shift towards a **service-based model**



Investors



VERTIS SGR
Private Equity & Venture Capital

cdp 

PLUGANDPLAY



JOIN.
CAPITAL

Partners



UNIVERSITÀ DI PISA



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Real-time, physics-based, adaptive, embedded intuition

Thank you!

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