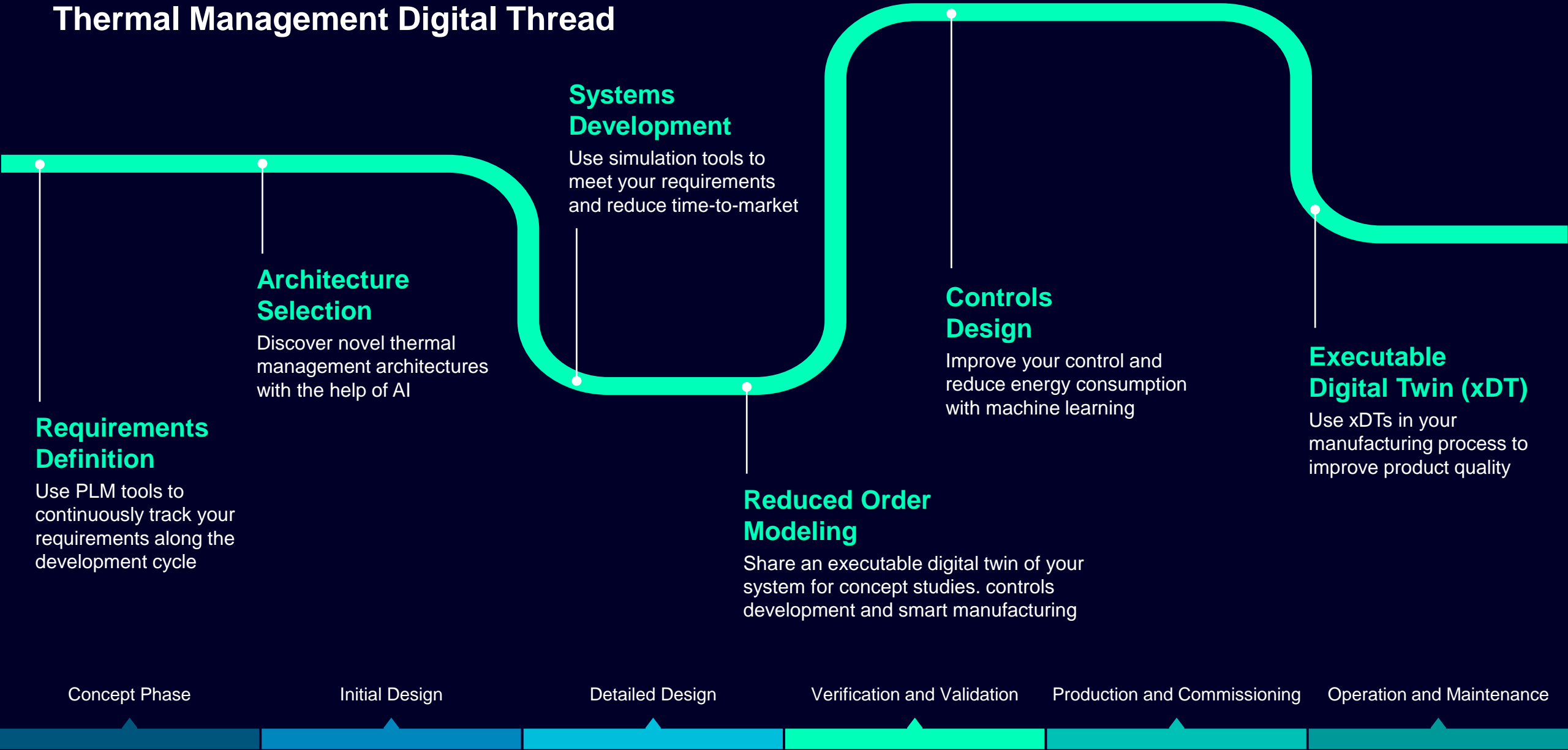


The Future of Thermal Management Design for Battery Electric Vehicles

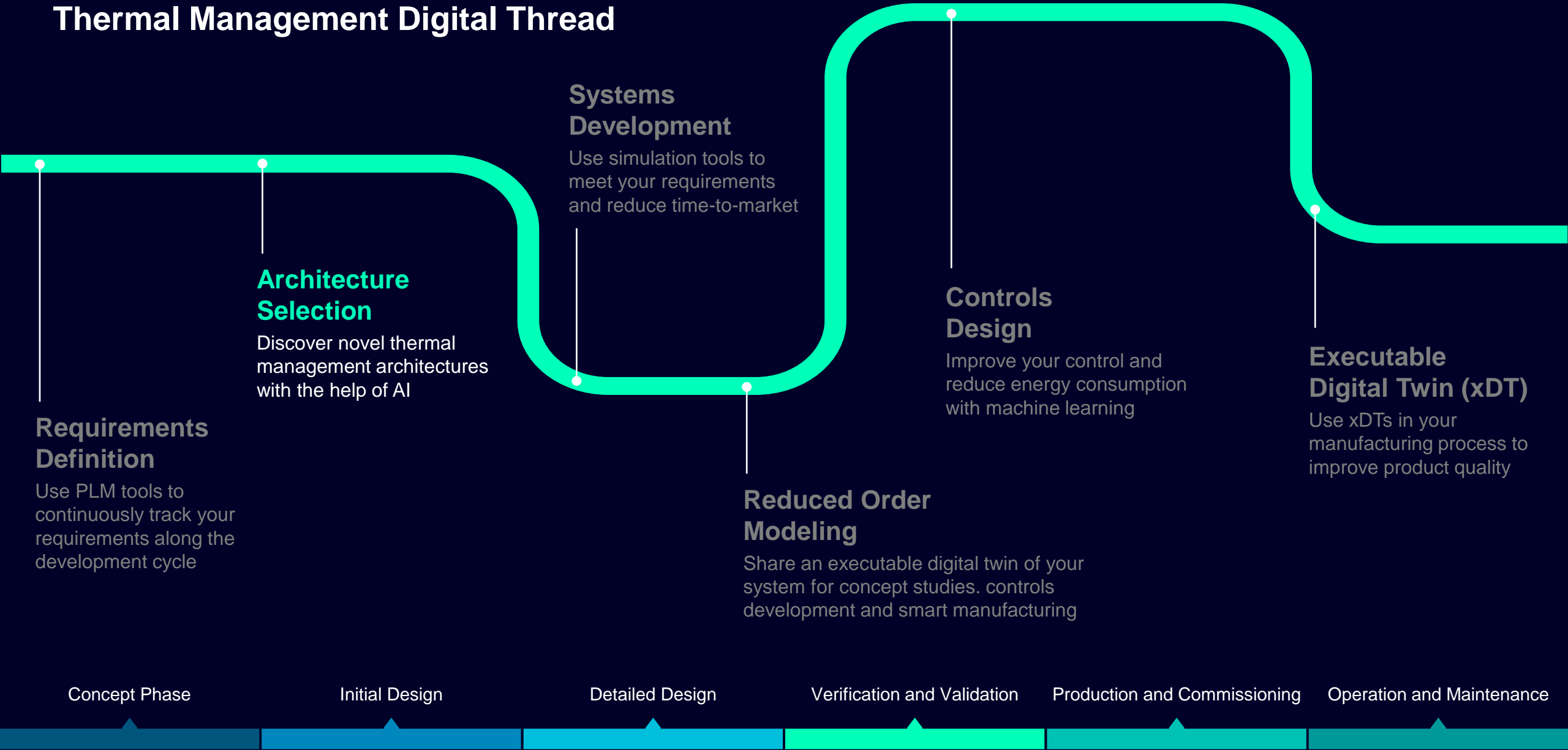
Discover innovative solutions and stay ahead of your competition



Thermal Management Digital Thread



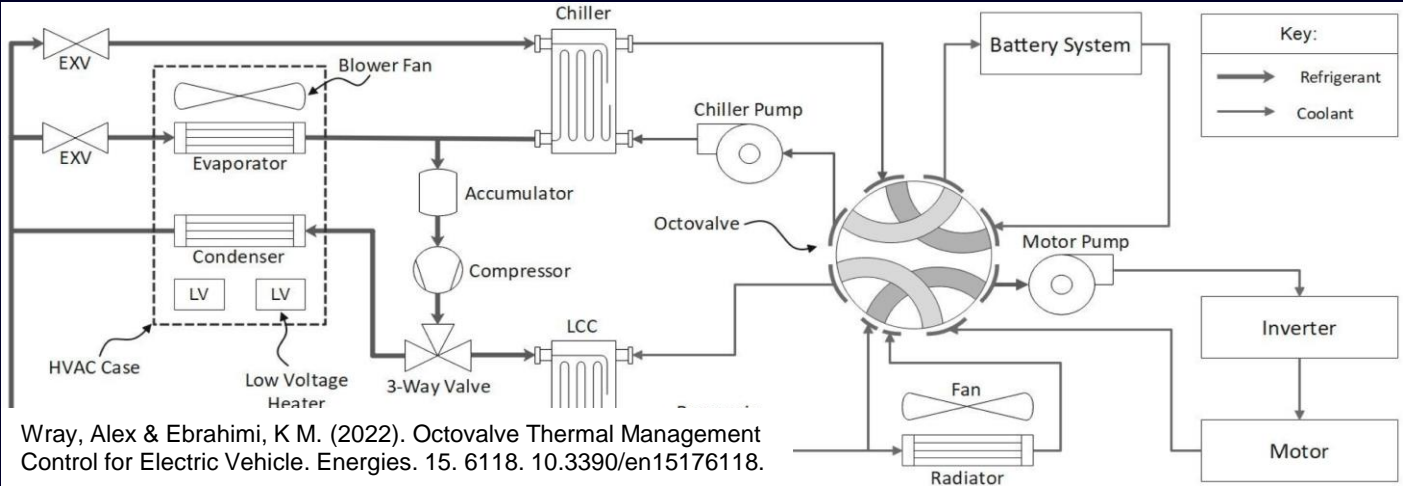
Thermal Management Digital Thread



Traditional Automotive OEMs trying to figure out Teslas Thermal Management



AI: Generated by Microsoft Copilot

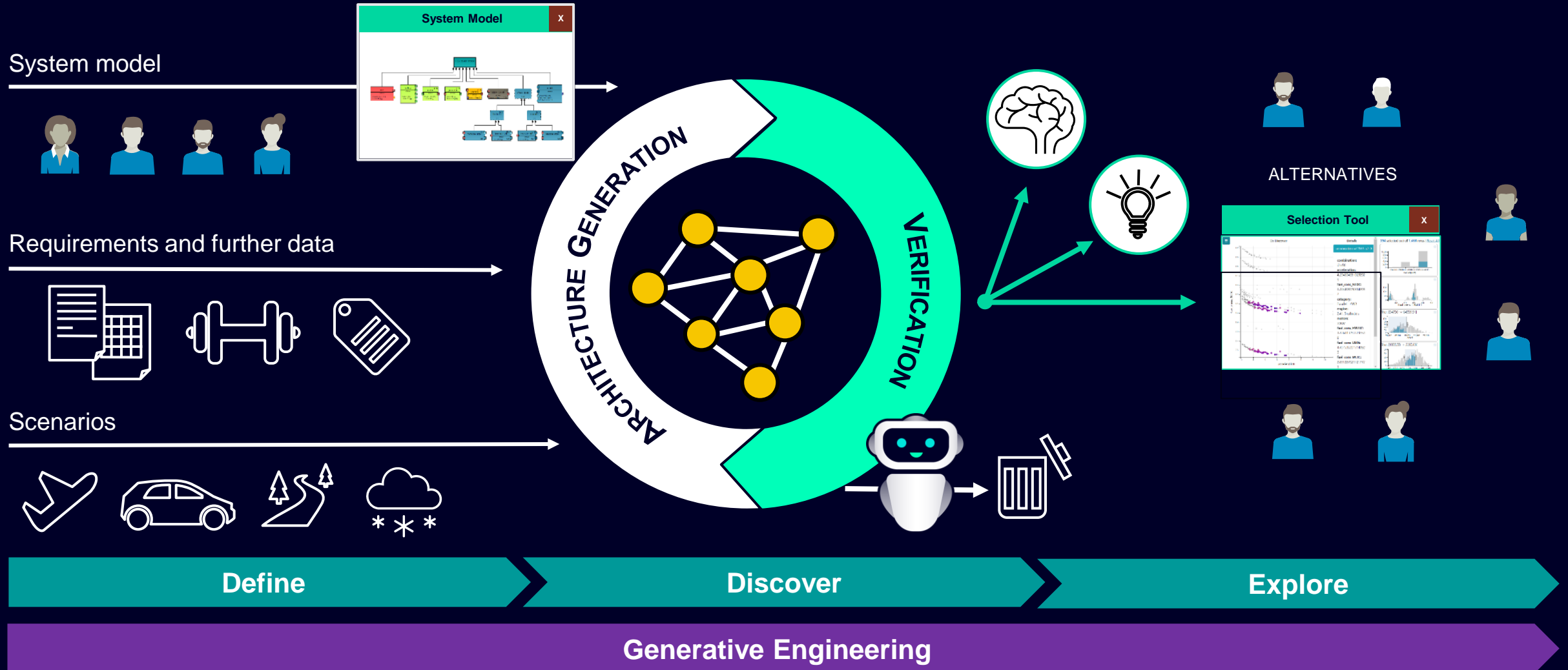


Wray, Alex & Ebrahimi, K M. (2022). Octovalve Thermal Management Control for Electric Vehicle. Energies. 15. 6118. 10.3390/en15176118.

Stay ahead of your competition with the help of Generative Engineering!

Discover novel Thermal Management Architectures

Generative Engineering Process

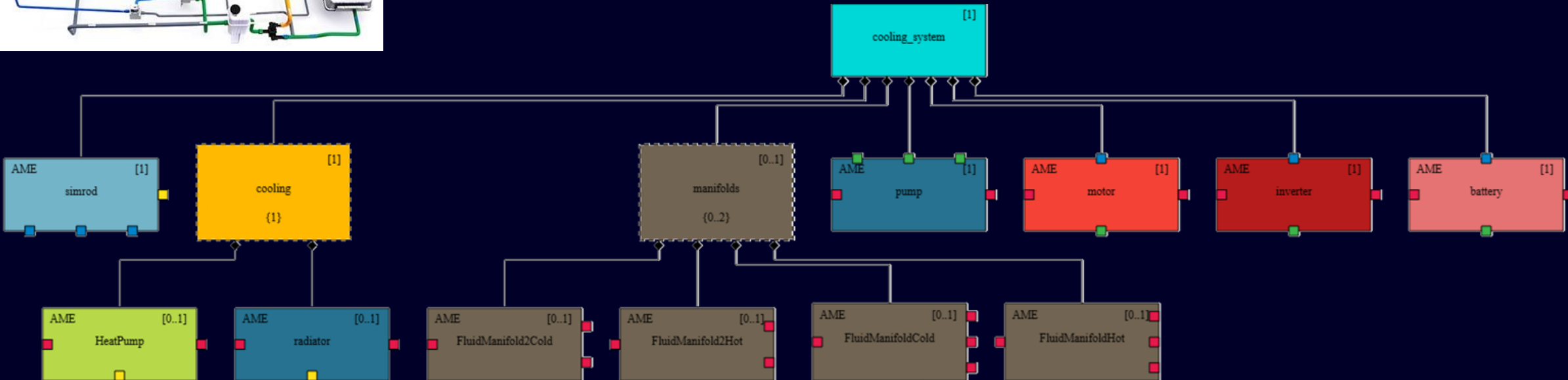
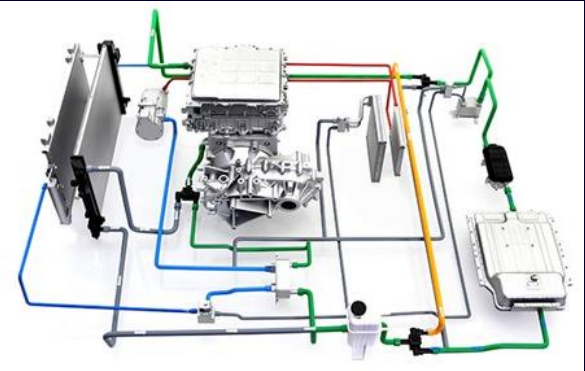


Discover novel Thermal Management Architectures

Demonstration



Definition of a thermal management system model in Simcenter Studio



Discover novel Thermal Management Architectures

Demonstration

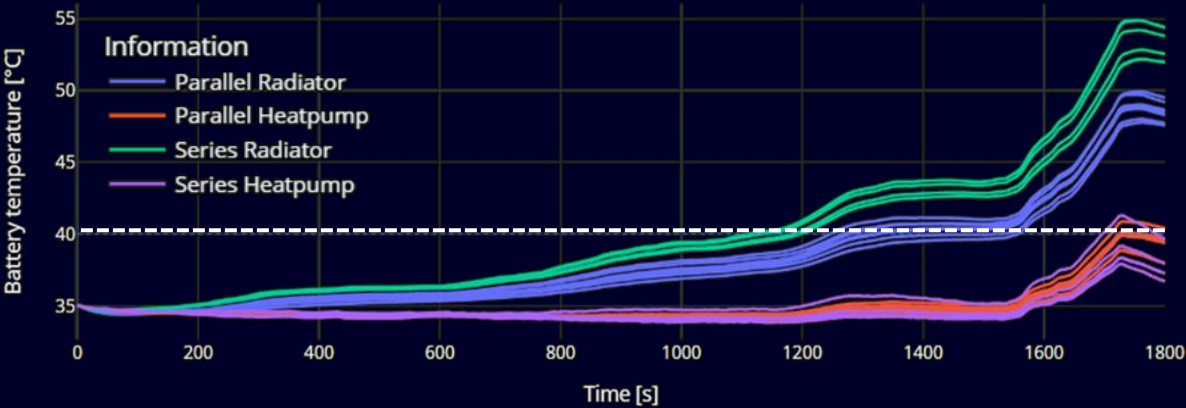
Creation of system architectures in seconds with the help of patented machine reasoning technology



Discover novel Thermal Management Architectures

Demonstration

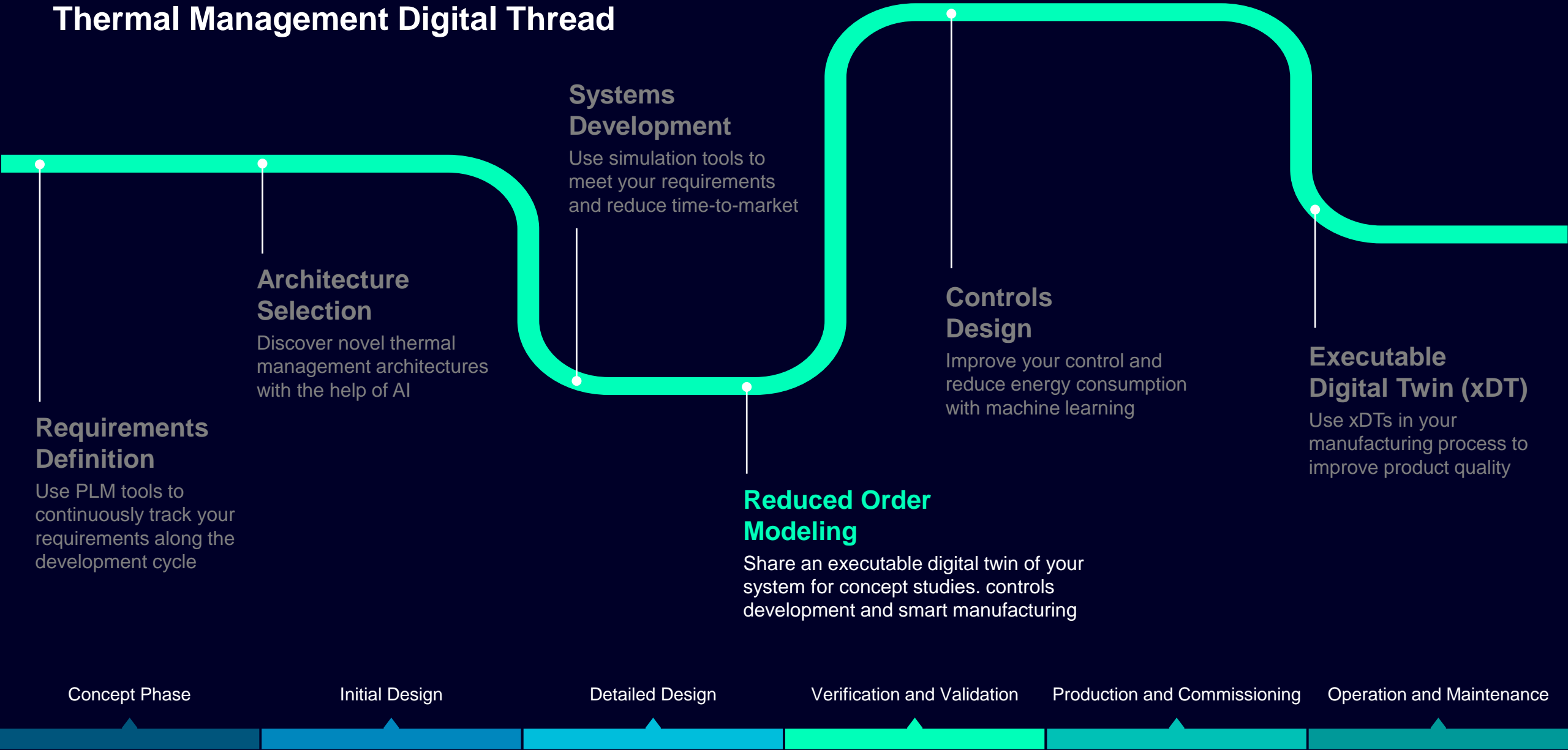
Automatically evaluate the performance of each cooling system architecture in a cloud based environment with high performance computing



Configuration	Architecture Type	Variant	Total Cost	Total Mass	Max Battery Temp WLTC
e0_a0_c0	Series Radiator	Battery 20 cells	11320 €	897 kg	53.96 °C
e0_a0_c1	Series Heatpump	Battery 30 cells	11480 €	927 kg	39.87 °C
e0_a0_c2	Series Radiator	Battery 40 cells	13240 €	917 kg	54.68 °C
...

Find the best architecture for your use case

Thermal Management Digital Thread



Simcenter Reduced Order Modeling



Challenge

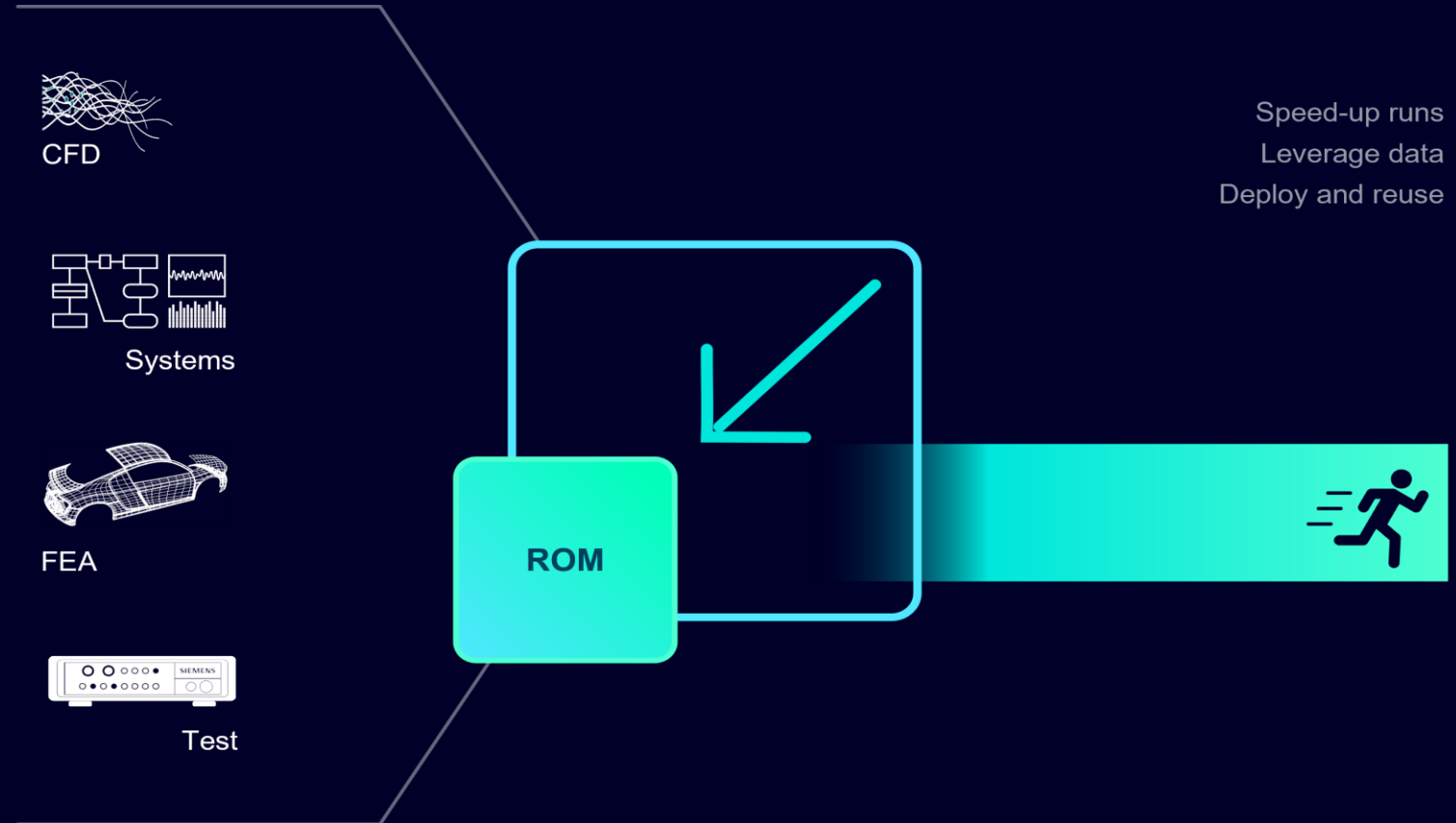
- Detailed 3D multi-physics models are too slow for integration with 1D
- Combining test data with simulation models is not straightforward

Solution

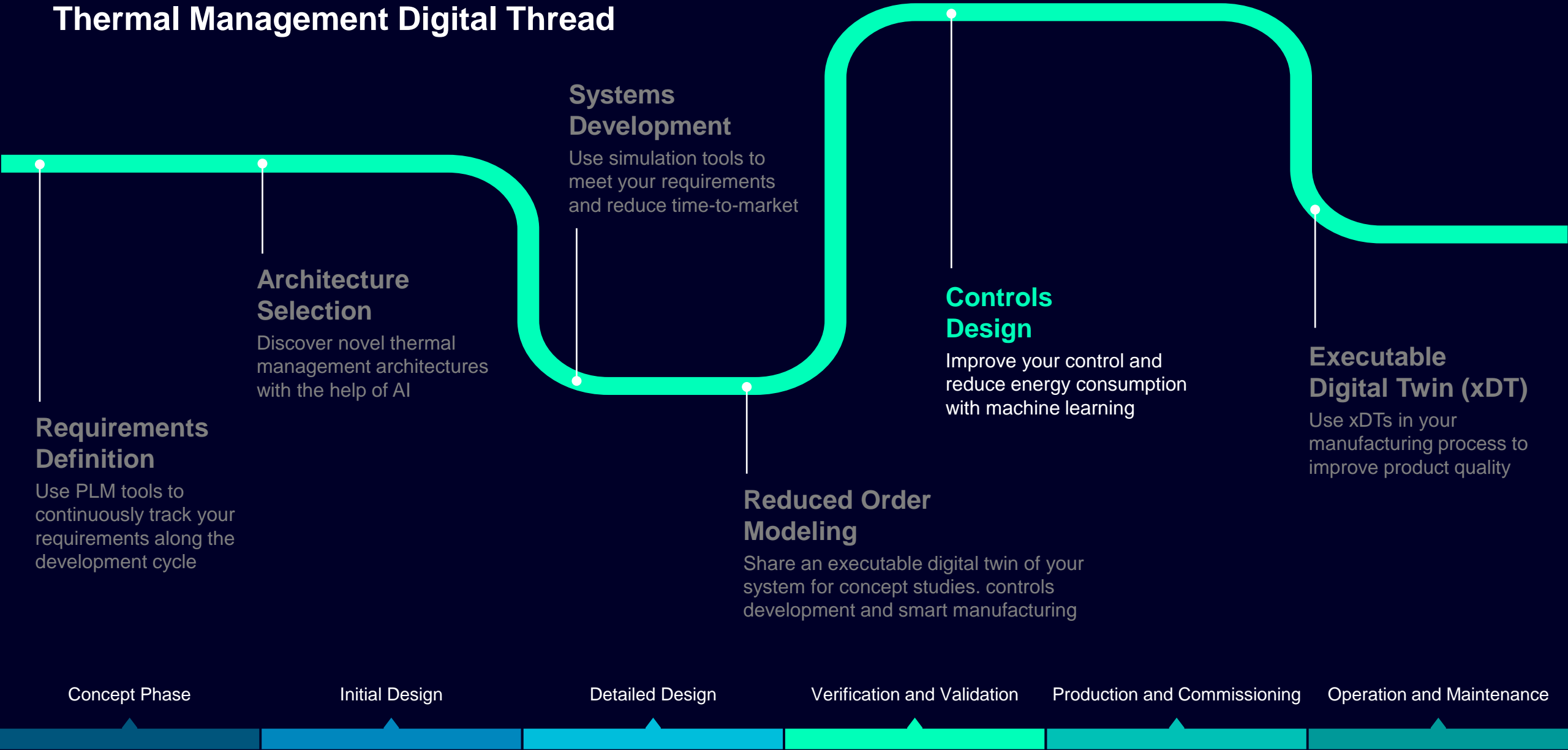
- AI-enabled no-code tool for creating simplified, tool-neutral models from simulation and test data

Benefit

- Enables executable digital twins to gain instantaneous insights
- Ability to reuse models and collaborate across environments whilst retaining IP



Thermal Management Digital Thread



Improve your Control with Machine Learning

Reduce the energy consumptions of your vehicle

In the old days...

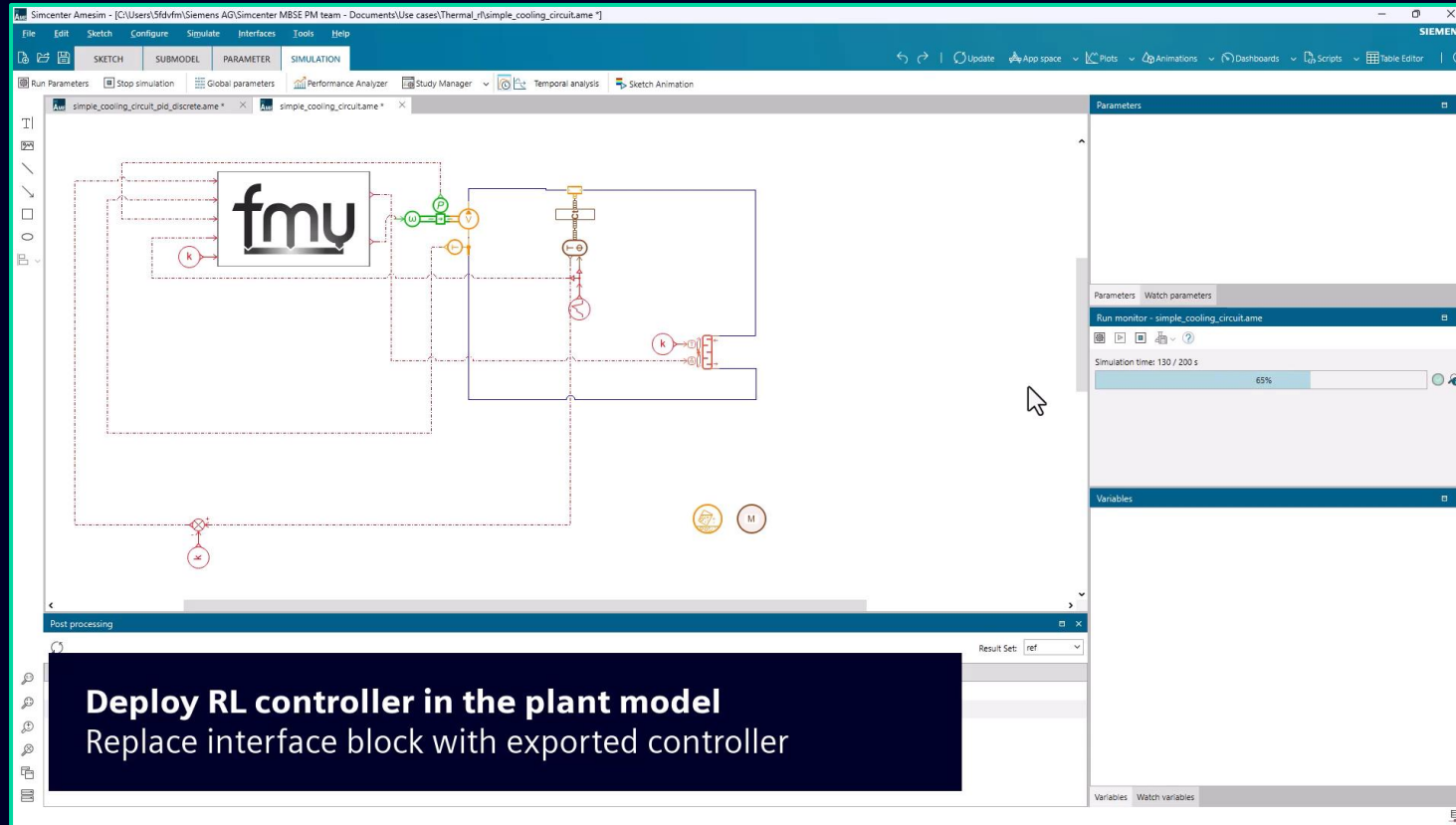


Challenge

Create a powerful high-level control strategy easily, such that control can be considered from the beginning of cooling systems design

Improve your Control with Machine Learning

Reduce the energy consumption of your vehicle



Challenge

Create a powerful high-level control strategy easily, such that control can be considered from the beginning of cooling systems design

Solution

Leveraging reinforcement learning on the simulation model for the cooling system, Simcenter Studio generates a control strategy

Benefit

- Better performance than a PID controller with reduced energy consumption
- Systematic and efficient process



Hyundai Motor Group

AI for BEV Thermal Management

Challenge

BEVs thermal management represents Multi-Input Multi-Output (MIMO) mixed-integer non-linear control problem involving multiple actuators and operating modes.

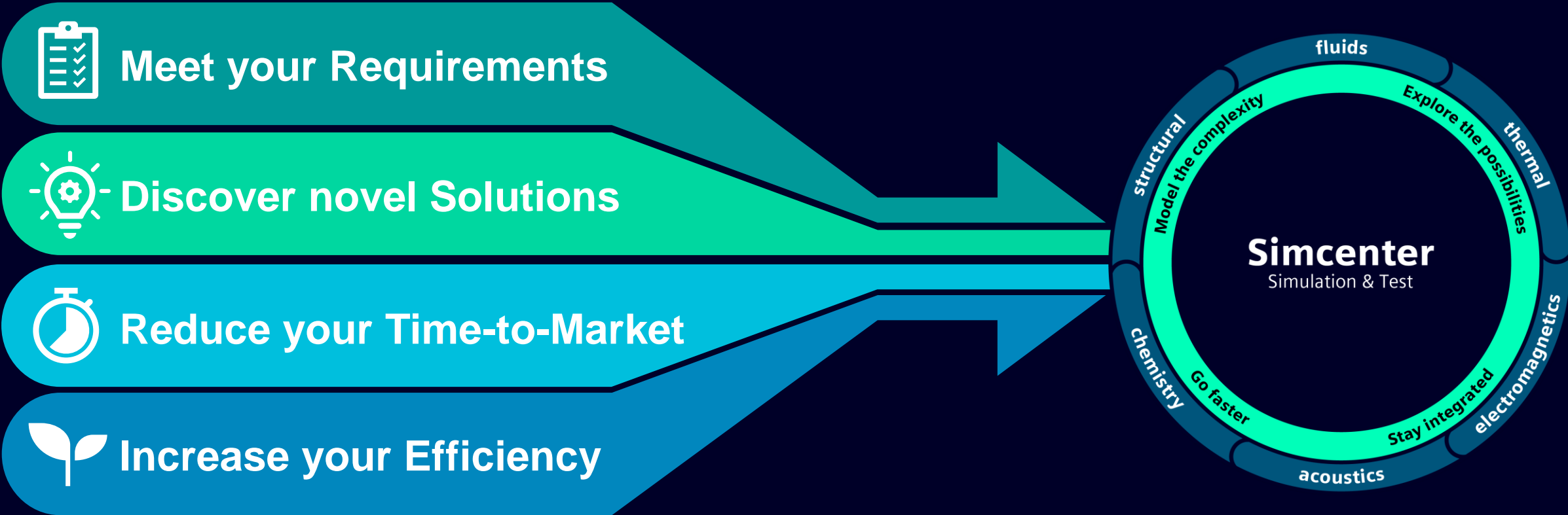
Solution

Simcenter Engineering Services combined Simcenter Amesim vehicle thermal management model with multi-agent reinforcement learning control for BEV range extension.

Benefit/ROI

- Up to **30%** energy saving compared to conventional rule-based control.
- Significant time saved in the setup of control logic and faster investigation of alternative control approaches.

The Future of Thermal Management Design with Siemens Simcenter





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