Performance models for transformer digital twin development

Study Committee D1

PS3 + question 3.1 Which models for performance could be suited for development into digital twin?

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Introducing the concept of digital twin

• The following definition is proposed:

"A scalable **virtual replica of a physical asset** that, through **automatically updated data** and **simulation tools**, can continuously monitor and predict the **condition and behaviour** of its real-life counterpart, with the goal of optimizing the latter's performance."
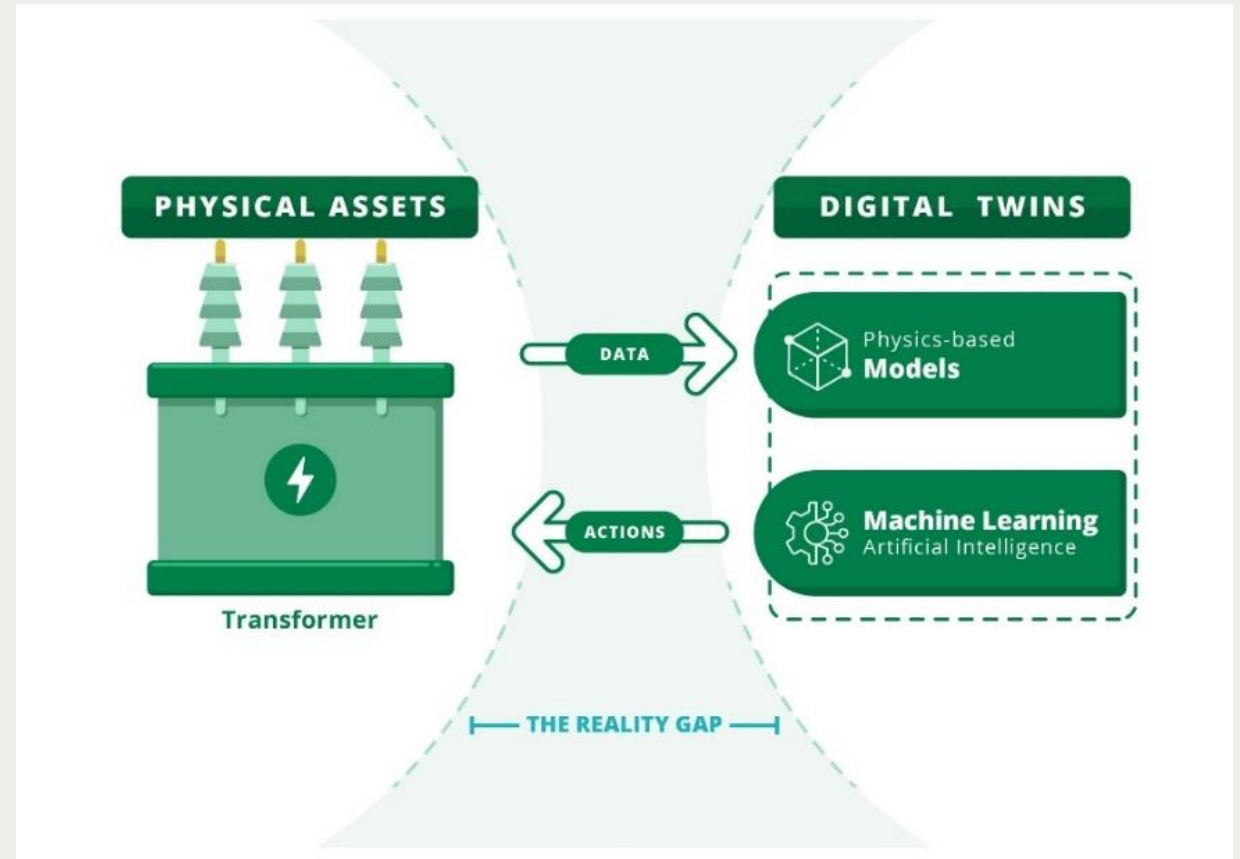
Models applicable for transformer digital twin developments (not an exhaustive list)

From CIGRE JWG A2/D2.65 ToR

- Thermal model
- Dielectric and mechanical models
- Paper-ageing model
- Moisture-migration model
- Bubbling model
- Anomaly-detection, diagnostic and prognostic models

Possible future use-case scenarios

"Digital twins are motivated by **outcomes**, tailored to **use cases**, powered by **integration**, built on **data**, guided by **domain knowledge**, and implemented in **IT/OT systems**."

- Failure of an asset = transformer overload
- Twin informs the operator on short-term and long-term emergency loadability
    - Quantifying impact of paper ageing ($) and risk of bubbling
    - Considering the overall state of the active part and components
    - Assessing in real time the cooling system performance
    - Checking gas-in-oil monitoring and its possible correlation with load
- Twin **interacts with other assets** to provide the operator a clear view of the power-transfer capabilities
- Twin assessed the **reliability** of its predictions by comparing
    - with measured values with its physical counterpart
    - with measurements and predictions from other transformers and twin

"Definition of a Digital Twin," *Digital Twin Consortium*.
https://www.digitaltwinconsortium.org/initiatives/the-definition-of-a-digital-twin/