HBM Prenscia Technology Day

Virtual Seminar Series

Digital Twin: Myth or Reality?

Presented by Dr.Ing. Prashant Khapane
Engineering Operations Manager
Jaguar Land Rover

Session #3: **Vehicle Testing & Simulation**

Digital Twin: Myth or Reality?

Abstract

Our products today are becoming complex, are becoming smart, our products are becoming hyperconnected. Thanks to smart, connected technology and the IoT, organizations are being buried under a flood of data from their products and processes. Digital Twin is often thrown at us as a solution to solve all the problems. This presentation will look at digital twin from automotive engineering perspective, discuss challenges involved and will ponder over the fact if we are asking the right question, does automotive engineering need a digital twin in its classical definition?

About the presenter, Dr.-Ing. Prashant Khapane

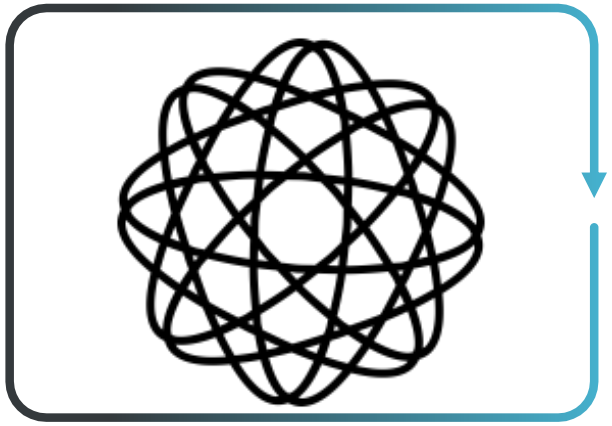
Dr.-Ing. Prashant Khapane is a strategist and a leader with demonstrable experience in leading multiple complex projects simultaneously in automotive, railway and aerospace Industries using agile principles. He has a PhD in Multi-body simulation from University of Braunschweig, Germany and Masters in computational fluid dynamics and Aero-acoustics from RWTH Aachen. He currently works at Jaguar Land Rover in digital transformation group.

HBK
HOTTINGER BRÜEL & KJÆR

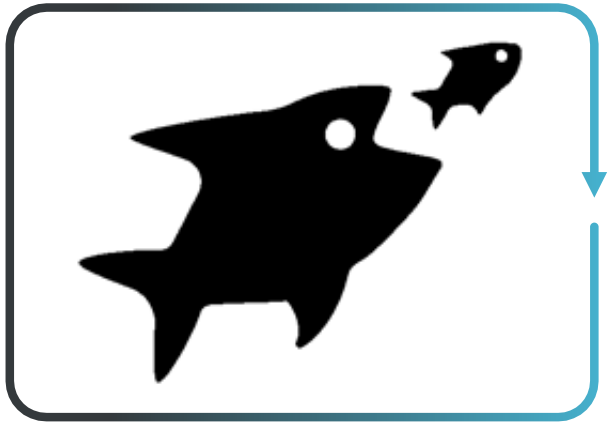

LAND ROVER


DEFENDER
AIRBAG
NAVIGATION
Calle Principal
Andorra
PHONE
Jo's XS
Sounds of Grey
Corvidee
14:56
Young Before Your Time
AUTO
A/C
AUTO

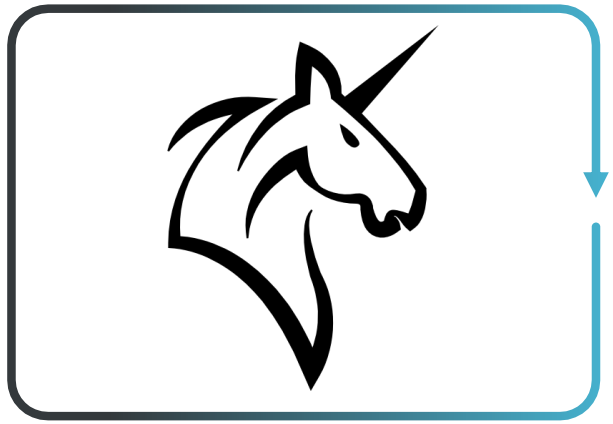

Search
FAVOURITES
PARKING
FUEL
MY COMMUTES
Home
13min faster going via Ocean Avenue
Go
15min
Work
25min faster going via Olympic Boulevard
Go
1hr 25m
Woodloes Park
Warwick
Warwick Hospital
Priory Park
St Nicholas Park
Myton Road
UWSP Innovation Centre Warwick
Olympic Blvd
Heathcote
Hampton on the Hill
START
STOP
AUTO
A/C
AUTO



COMPLEXITY
Smart & Connected products generating sea of data



COMPETITION
Tech companies are better placed to deliver 3E model



DIGITAL TWIN
Reality or Myth?
Are we asking the right question?

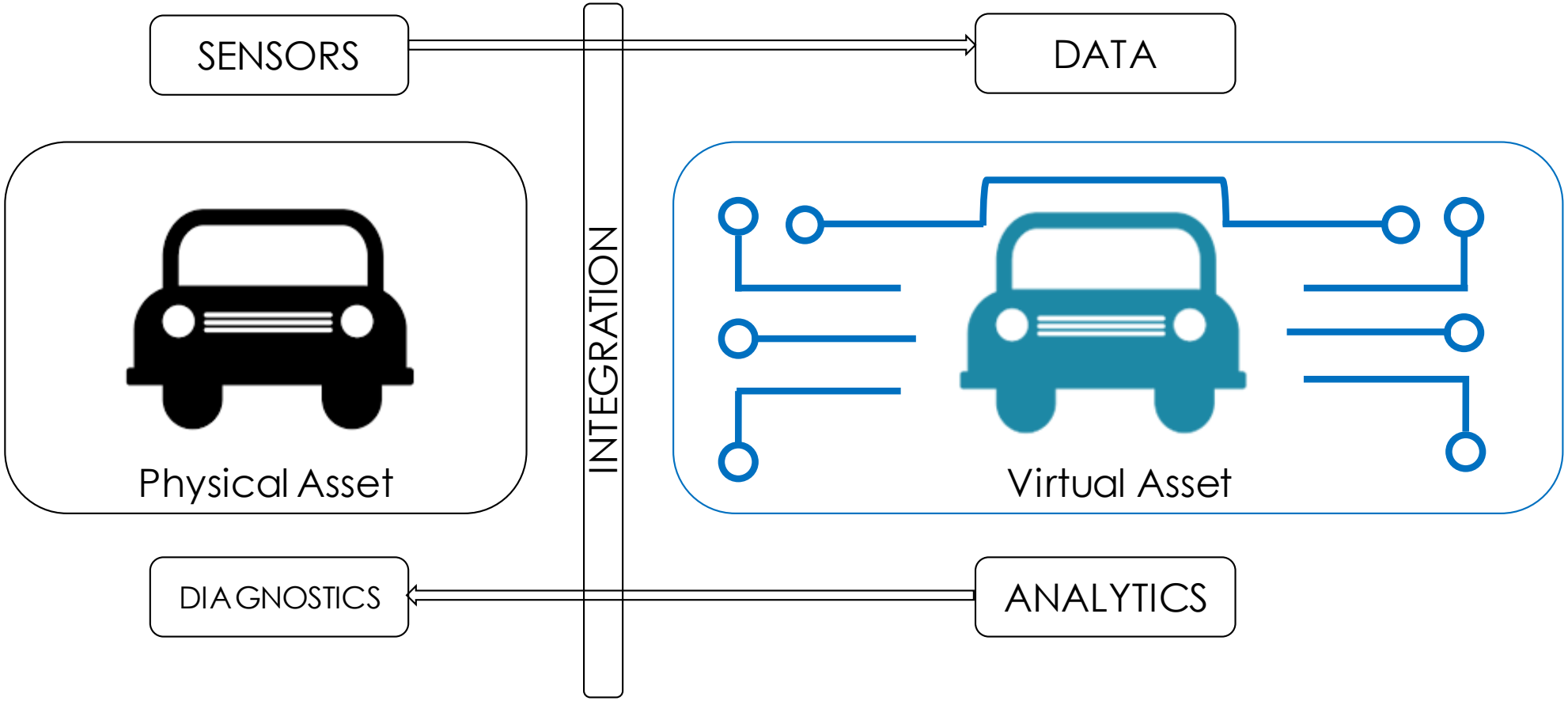
DIGITAL TWIN Reality or Myth?

Dr.-Ing. Prashant Khapane

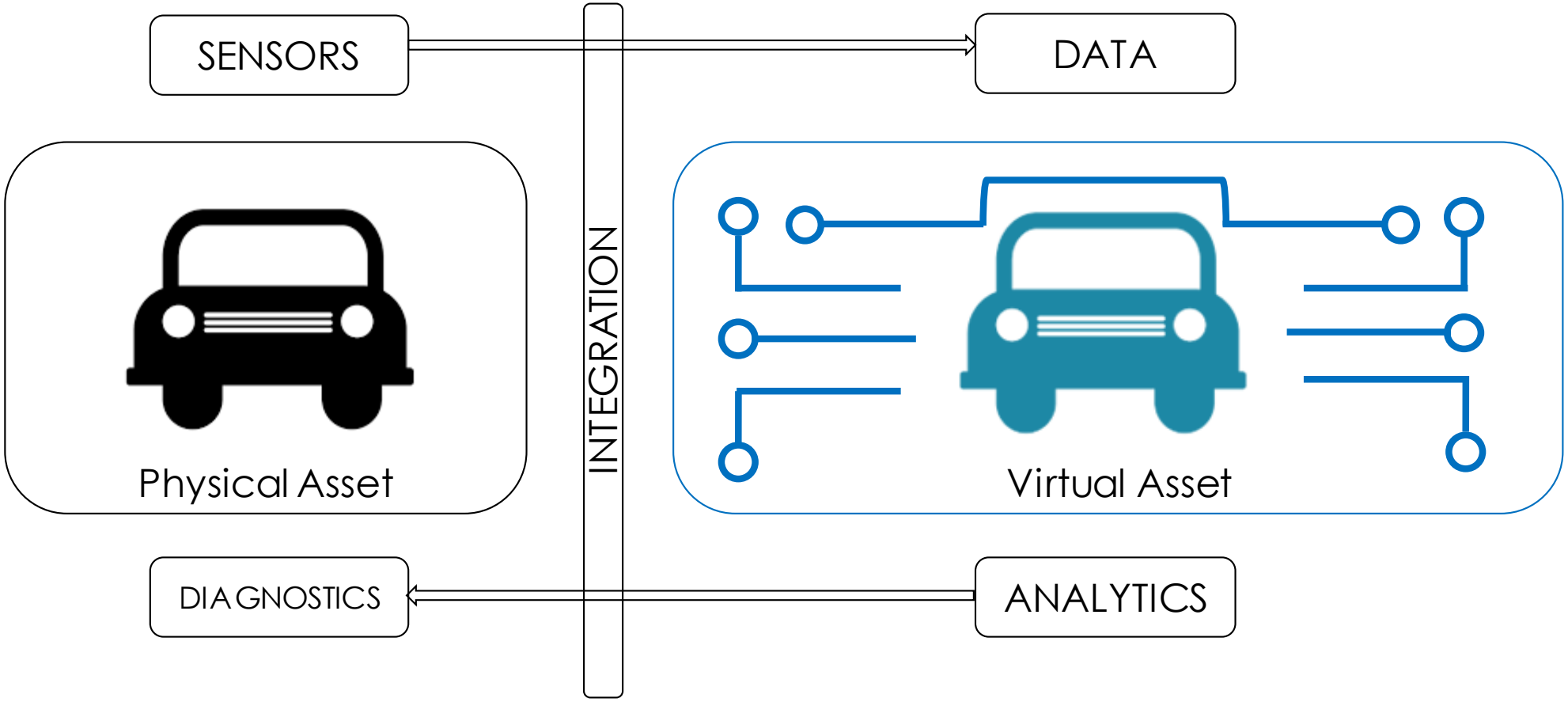
Advanced Simulation & Measurement Technology

Internet of Things

Industrial Internet of Things

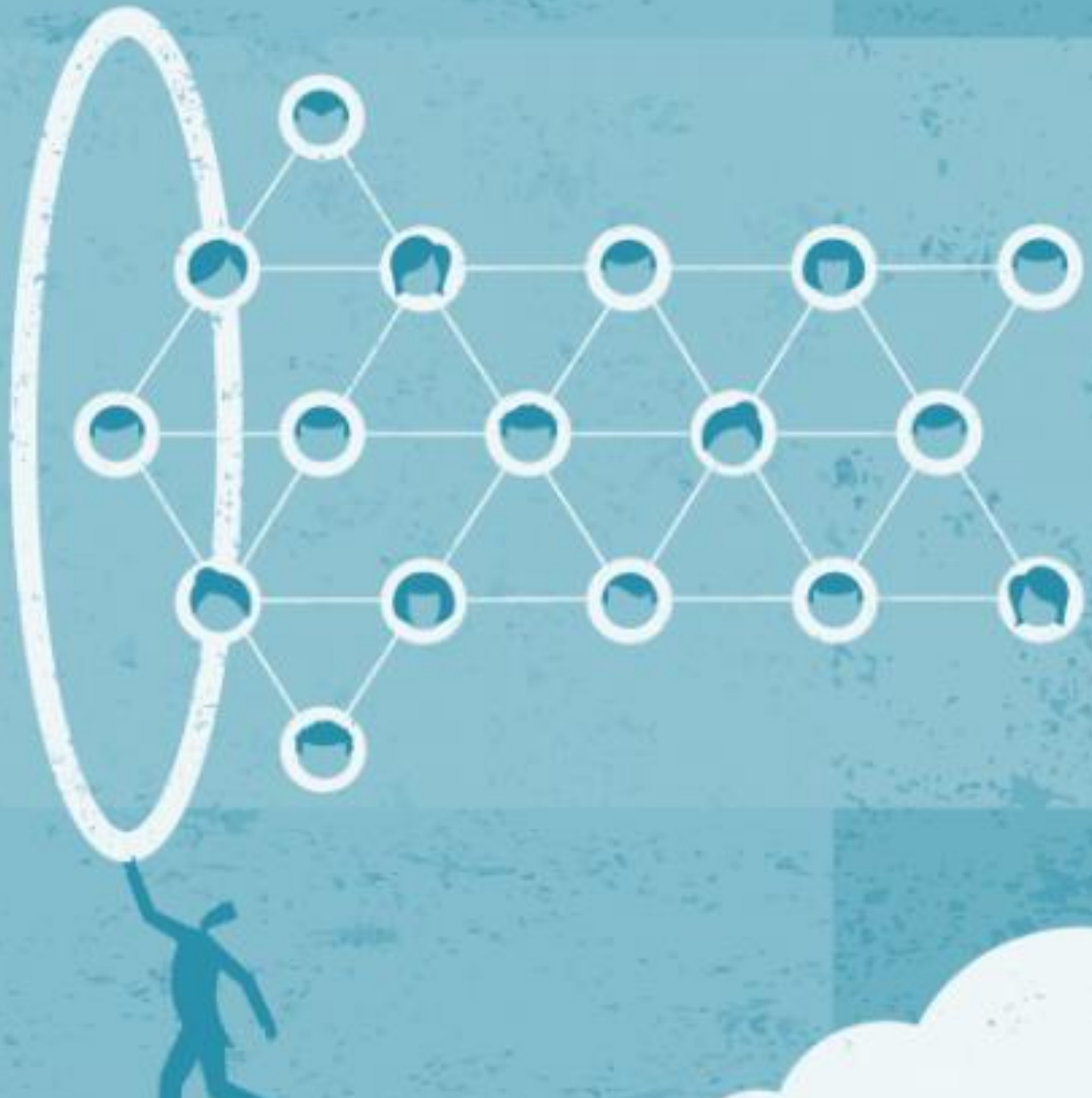


Industrial Internet of ~~Things~~
Physics/Simulation-based digital model



Contextualised Definition

We need contextualised definition of digital twin.
There is no one “twin” to rule them all.



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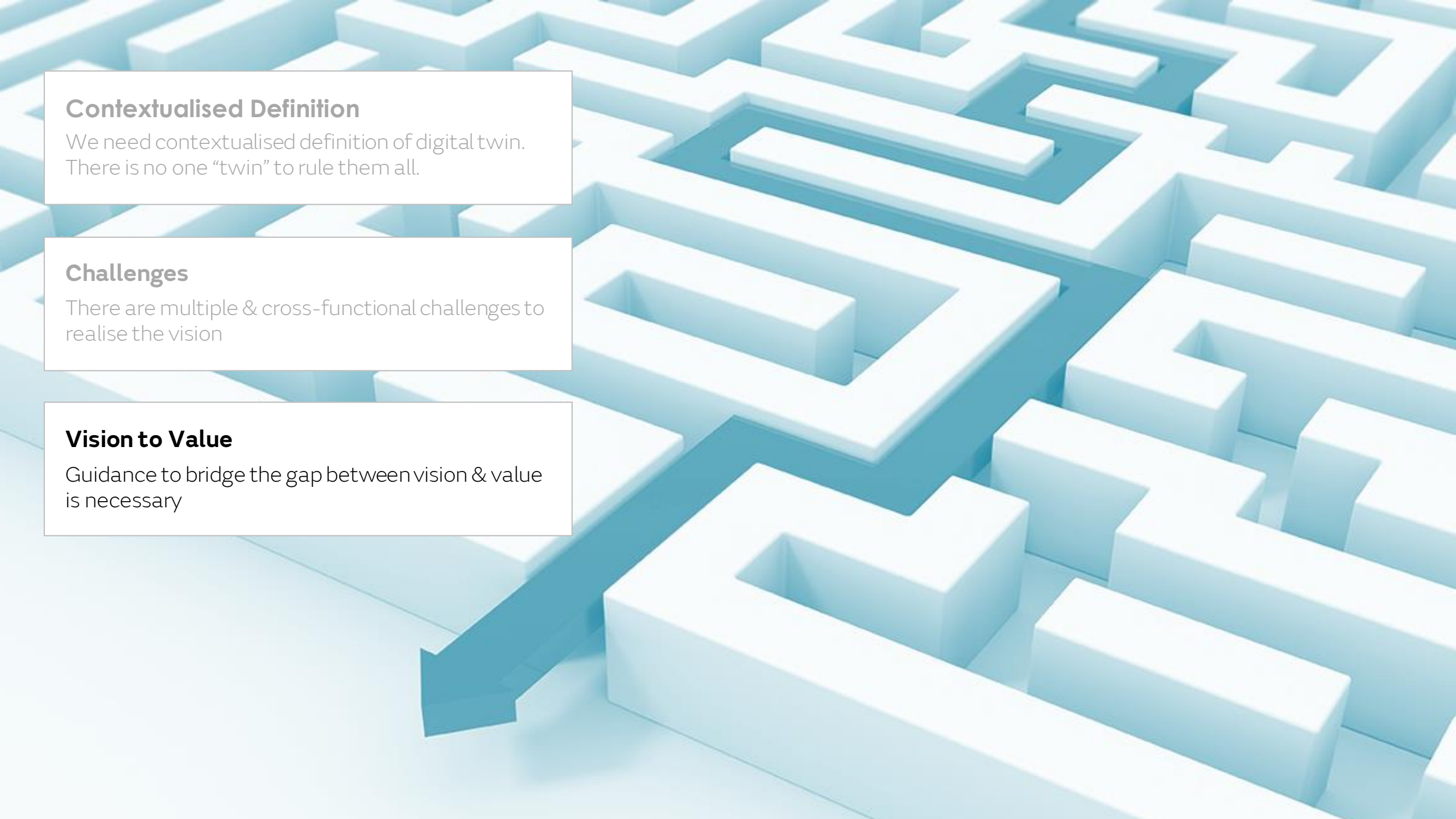
Challenges

There are multiple & cross-functional challenges to realise the vision



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Vision to Value

Guidance to bridge the gap between vision & value is necessary

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Should we perhaps ask ourselves if this is the right question?

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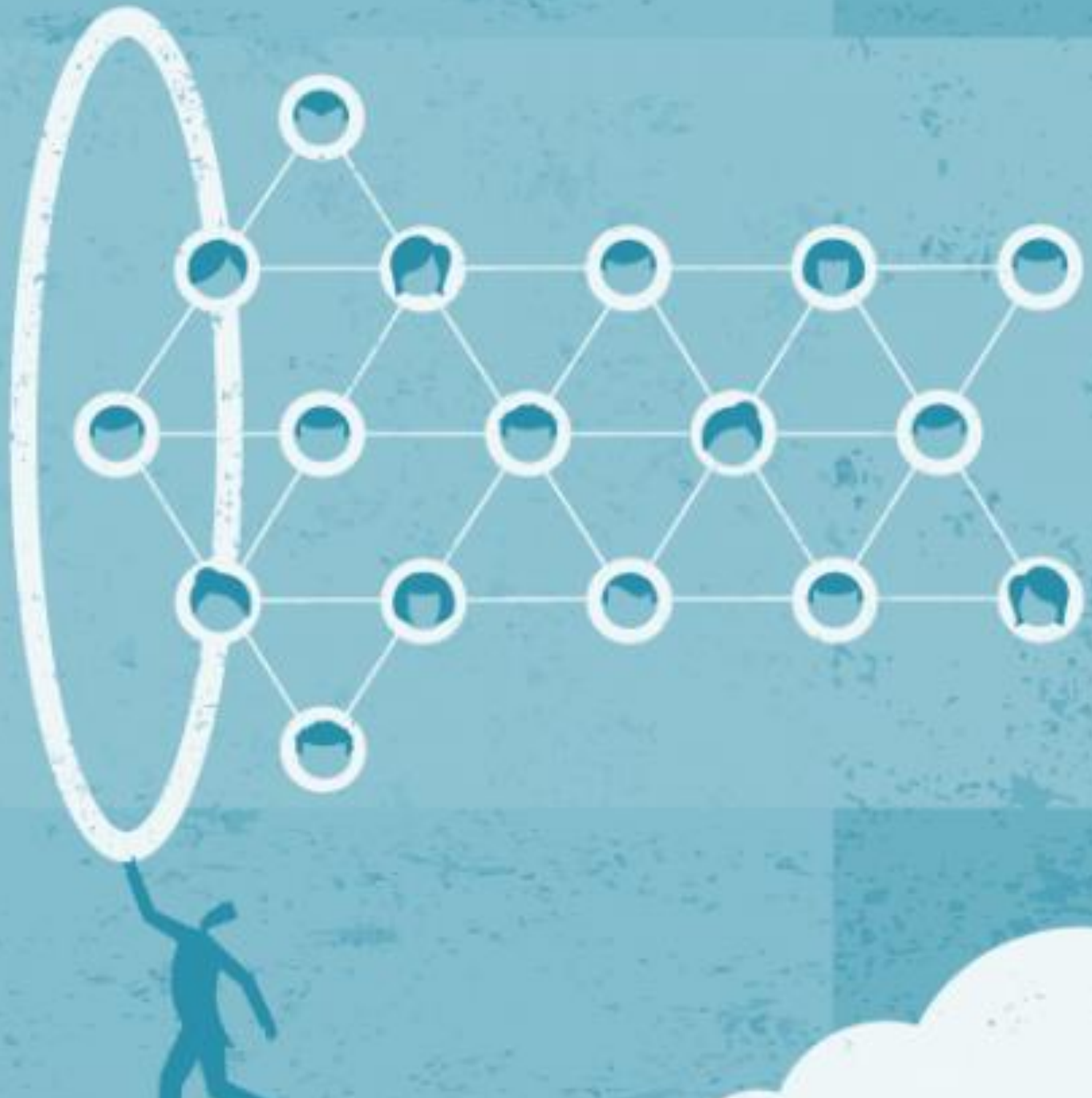
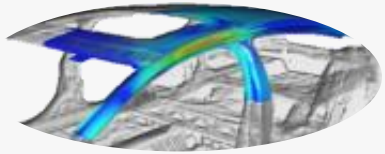


Concept



Design & Development

Manufacturing

In Service

Requirements & Targets

Attribute Balance

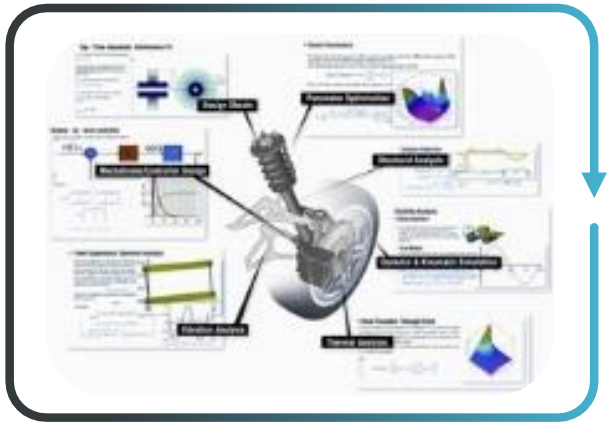
Data & Communication

Verification & Validation

Variability

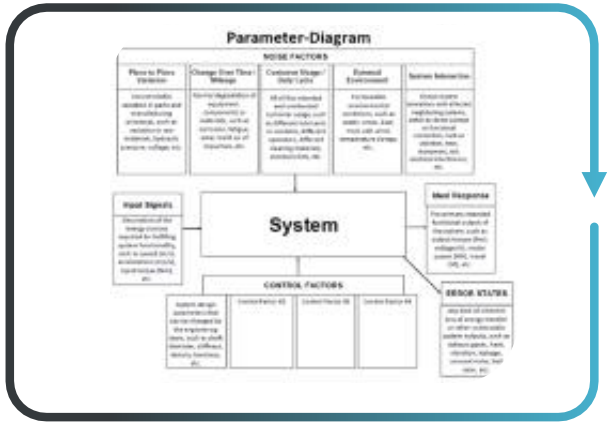
Environmental
Noise Factors

A simulation model capable of solving Multi-physics phenomenon in timely manner, also Multi-Attribute Optimisable, and giving insight of the effect of Multi-Noise Factors at play.



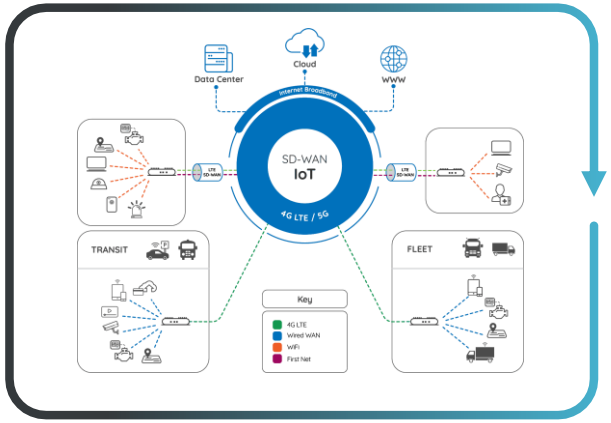
MODEL OF MODELS

There are numerous challenges in accurately representing any system



NOISE FACTORS

We must consider P-Diagram & effect of associated noise factors



DATA

BoM As designed
➔ As manufactured
➔ As-maintained

Reference : Reengineering Aircraft Structural Life Prediction Using a Digital Twin, Tuegel et al, 2011 Journal of Aerospace

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ENGAGEMENT

Supply chain agreement with appropriate IP protection and open standard is necessary

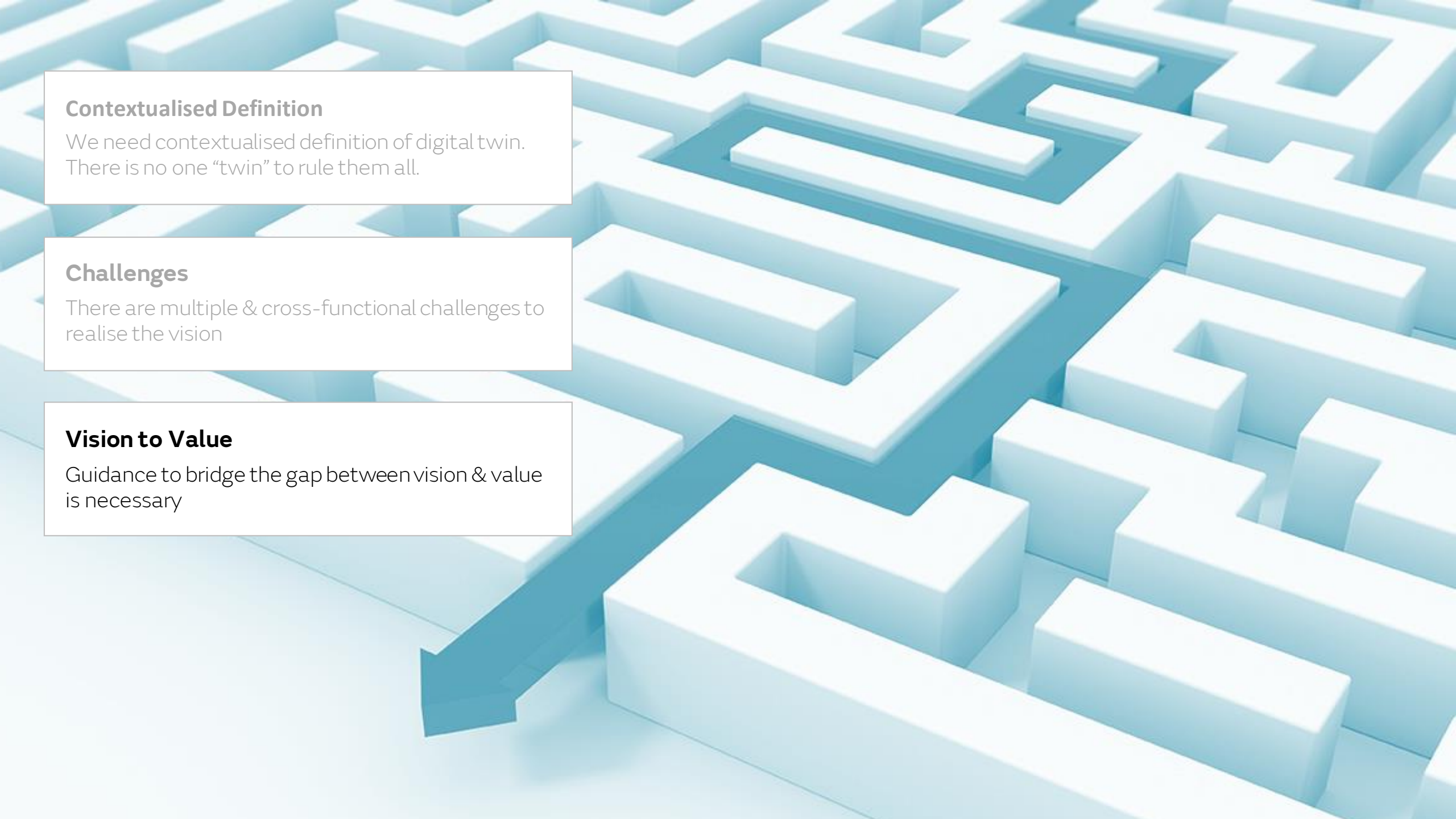
ANTIQUATED

Product twins must be always evolving and beware of single purpose twin

SKILLS & CULTURE

Insufficiently skilled resource, Rigid Organisation & Agile by proxy - a major impediment. In reverse order.

Reference : White papers from ptc and Gartener



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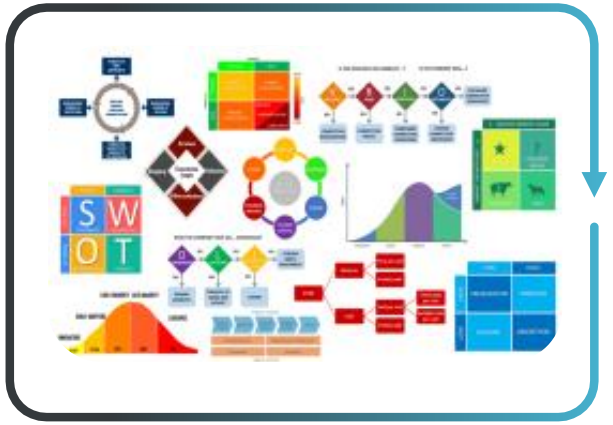
BUSINESS CASE

Fit for purpose contextualised product twin must be developed with – fail fast learn fast approach



FRAMEWORK

SOURCE
SORT
SYNTHESIZE
SET-UP

BUILDING BLOCKS

Contextualized twins must be robustly correlated and have quick turn around time

Reference : Reengineering Aircraft Structural Life Prediction, Tuegel et al, 2011 Journal of Aerospace, D.J.Wagg et al Digital Twins: State of the art and future directions ASME 2014, The myth of accuracy : Damian Harty

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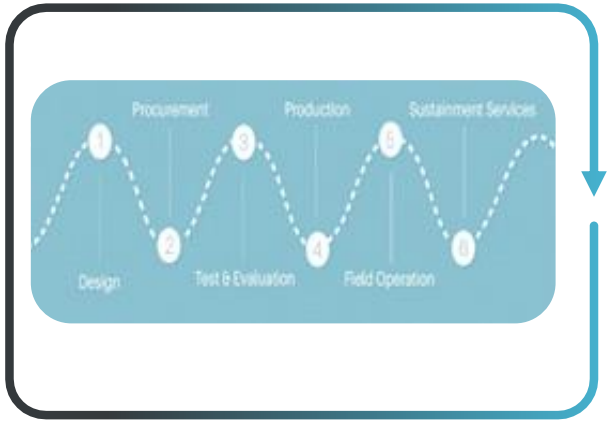
STATUS-QUO

Vendor specific and “in-house” tools to manage simulation and data has created a perfect storm

SPDM

Vendor agnostic framework, automation: simulation tool-chaining with automated hand-offs



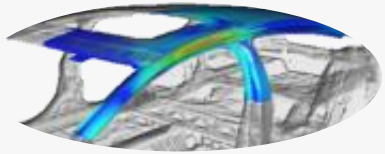
DIGITAL THREAD

Connections to critical information allowing you to track a product and its digital asset from concept to customer

The phrase “digital twin” seems to mean whatever people want it to mean. It’s frequently accompanied by the sort of verbal equivalent of anti-missile flares dispensed by aircraft, to offer distraction from the fact that the speaker doesn’t really understand the idea.

DAMIAN HARTY - Director of Chassis and Vehicle Dynamics, REE.

Concept



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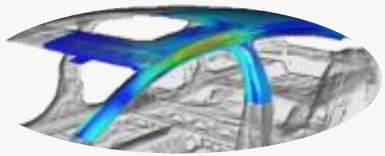

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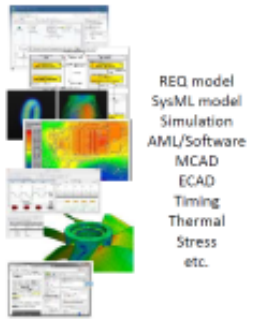
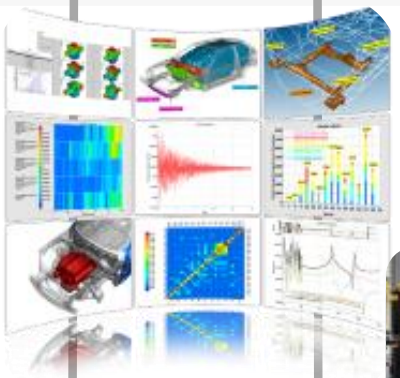


REQ model
SysML model
Simulation
AML/Software
MCAD
ECAD
Timing
Thermal
Stress
etc.



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Contextualised Product Twin, Robustly Validated.

Disciplined Digital Thread, Augmented Field Data.

Thank you! Dr.-Ing. Prashant Khapane

Q&A

- Eduardo Calixto (ECC, Germany)
  - Wwhat is the difference between the SCADA system used in control rooms in plants and the Digital Twins applied to the same plant?
    - *As far as I am aware, SCADA systems are much more used for instantaneous control and monitoring, whilst a Digital Twin could include both a record of operational usage, and be used as a modelling tool to predict future performance. So thinking about this from a holistic Digital Twin perspective, SCADA systems would be a sub-set of a Digital Twin. The Digital Twin needs to be aware of the SCADA system, the control inputs and response outputs, but is also modelling the system components in some way (between the control inputs and response outputs), and these models may be mechanical, durability, reliability or other appropriate model.*
  - Is the objective of Digital Twins also to control the plant and take actions to control the process or only perform analytics and predictions?
    - *My presentation considered Digital Twin from an automotive engineering perspective, in particular product development. However, based on three tenets, Digital Twin can be divided into - product, process, and/or performance twin. So yes, it can be used for both.*
  - What´s the main objective of Digital Twins applied to Automotive, Railways Vehicle and Aircrafts industry? - is it to simulate the cars performance and predict failures during the test burn-in phase? - or also during operation phase??
    - *Digital Twin as a concept in its classical definition, is very difficult or impractical for products with long design lifecycles and large-scale production quantity. For some bespoke vehicles and industries such as Aircraft it can be used as a product, process and performance twin.*
  - Digital Twins can use Big Data Analytics or Machine Learning models for predictions? - in your experience which are the best solution so far?
    - *That is a very big question. There is no one-model that solves all problems. I think that you have to focus on the purpose of your Digital Twin, and apply an appropriate model, with appropriate detail/accuracy for your purpose. I would recommend attending the first presentation in Session #6 “Grey Box Modelling for Structural Health Monitoring” by Prof. Elizabeth Cross, University of Sheffield | Dynamics Research Group. For automotive industry, and other vehicles (heavy equipment etc) the combination of a product/process twin, in-field data analytics and also ML is the way forward.*

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Q&A

- Muhammad Afzal (Omnicell, USA)
  - What simulation strategy do EV and Autonomous Vehicles use?
    - *Typically, the focus has been to use a mule or donor vehicle, instrument it and run various customer usage scenarios in the field to collect data. This applies to all the traditional vehicle attributes such as dynamics, NVH and Durability. Then use the data to perform accelerated testing on a bench or a rig. CAE has been also used however with more focus on downstream usage at system level, ie. Body NVH or durability analysis. There has been a lot of emphasis on using vehicle level models lately, say last decade or so.*

- David Blanchard (Horiba MIRA)
  - The model that you use to power the Digital Twin is a model derived by machine learning or is it a model derived from Engineering theory ? - If it is a combination of both, is it combined to validate one over the other or is it more like an ensemble of models?
    - *To use the terminology of the first presentation in Session #6, "a model derived by machine learning" is a black box model, "a model derived from Engineering theory" is a white box model, and a combination is a grey box model (https://en.wikipedia.org/wiki/Grey_box_model). I recommend attending the first presentation in Session #6 "Grey Box Modelling for Structural Health Monitoring" by Prof. Elizabeth Cross, University of Sheffield | Dynamics Research Group.*
    - *Digital Twin as a concept in its classical definition, is very difficult or impractical for products with long design lifecycles and large-scale production quantity. Speaking for automotive vehicles, I think product twin enhanced with in-field data acquisition is a practical approach. Based on where in the lifecycle you are, there is a place for black box, a white box or a grey box approach. I'm not discounting the usage of complex vehicle level models however they should be robustly correlated, something many companies fail to do. More emphasis/effort should be on the digital thread not digital twin.*

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