



Asset Management in the Digital Age

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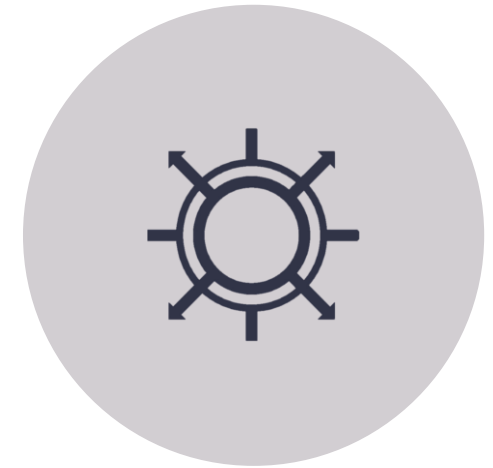
Agenda



INTRODUCTION



DIGITAL TWINS



STRETCHING THE
BOUNDARIES

My research

GOAL

Improve resilience of industrial systems through effective management and exploitation of data

RESEARCH QUESTIONS

- How can the behaviour of complex industrial systems be modelled?
- What algorithms are effective for detecting disruptions and predicting system performance?
- What decision frameworks and optimisation techniques are appropriate to deliver resilient system performance?



UNIVERSITY OF
CAMBRIDGE

Department of Engineering

INDUSTRY PARTNERS



IfM | Asset Management
Group

What is Asset Management?

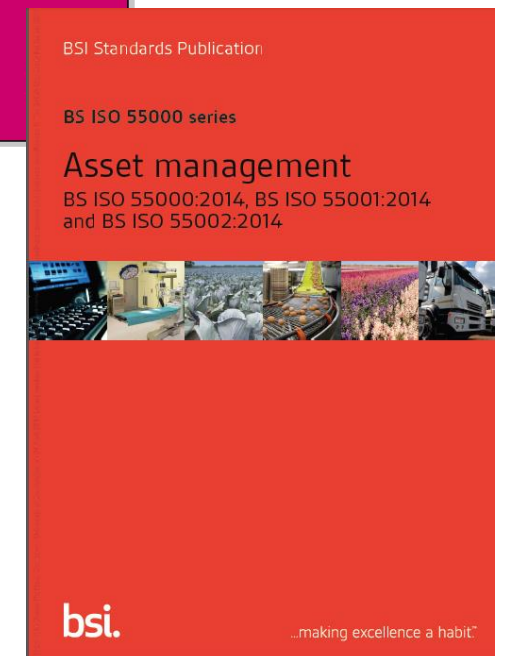
*The systematic and coordinated activities and practices through which an organization **optimally** and **sustainably** manages its assets and asset systems, their associated performance, risks and expenditures over their **lifecycles** for the purpose of achieving its **organizational strategic plan**.*

BSI PAS 55: 2008



*Asset Management is the **coordinated activity** of an organization to realise **value** from assets.*

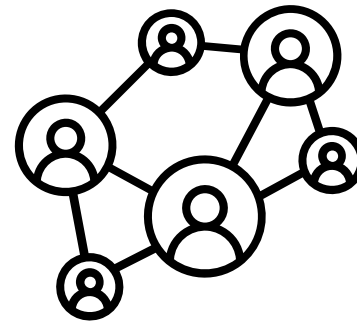
ISO 55000:2014



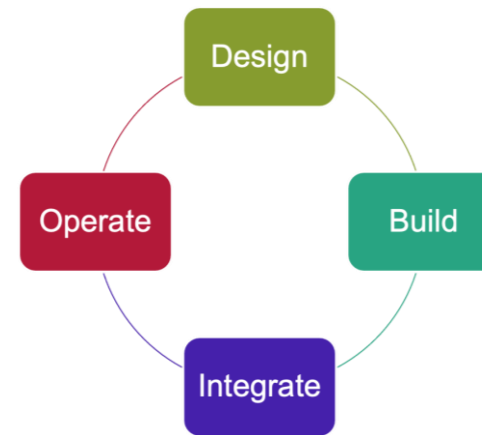
Asset Management demands a holistic approach for managing 'value'



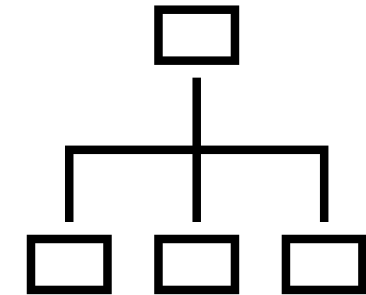
Value-driven



System-wide



Whole-Life



Strategic

What are Digital Twins?

“An integrated multi-physics, multi-scale, probabilistic simulation of a vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the life of its flying twin” – NASA (2012)

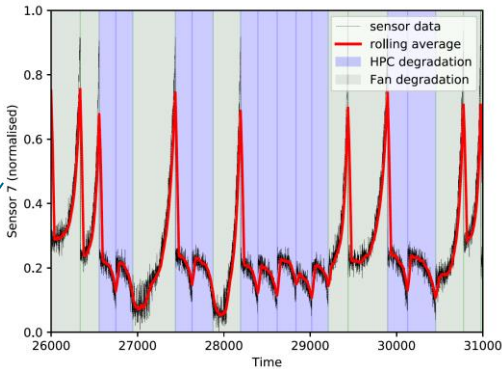
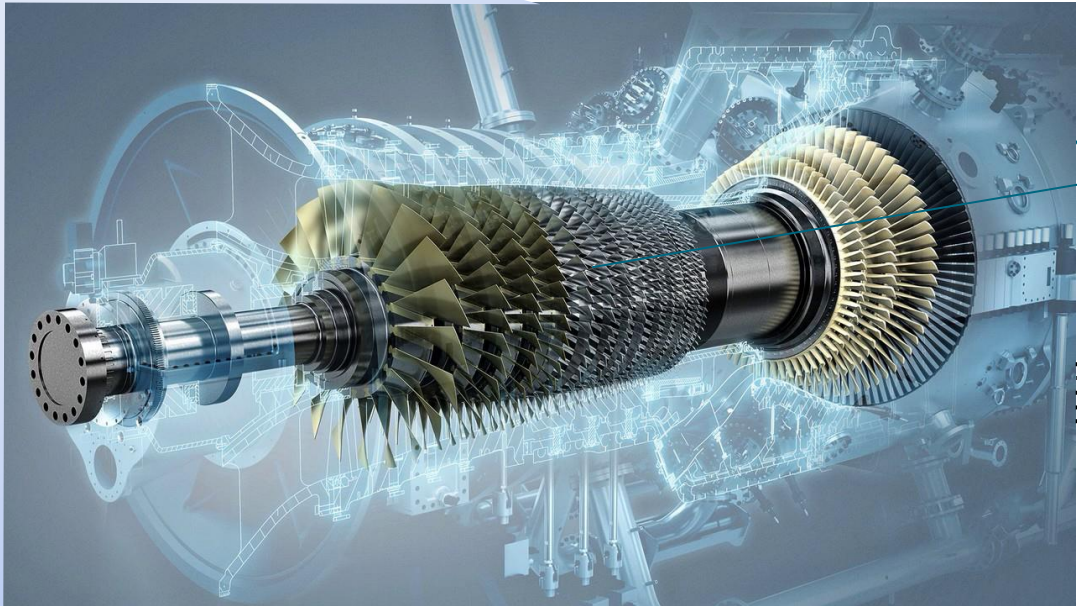
Digital replica of a physical entity or process

*“What distinguishes a digital twin from any other digital model is its **connection** to the physical twin. Based on **data** from the physical asset or system, a digital twin **unlocks value** principally by supporting improved **decision making**, which creates the opportunity for positive **feedback** into the physical twin.” - CDBB (2018)*

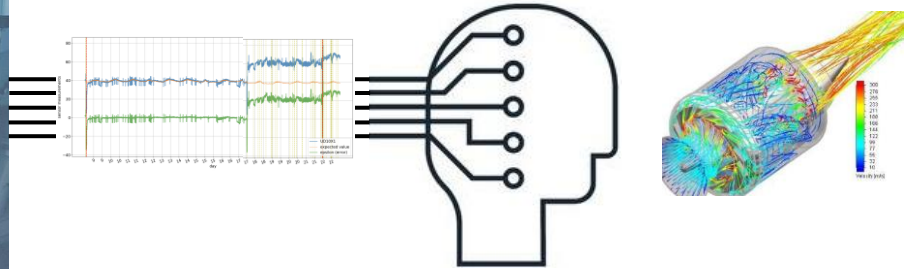
What should digital twins do?



DIGITAL TWIN



STATE: ON
POWER: 999 MW
HOURS: 934



ALERT: ABNORMAL OPERATION!
ALERT: SHUTDOWN IN 7 ± 2 MINS
ACTION: REDUCE LOAD BY 25%

Challenges



Merging asset behaviour
and operations/processes



Data integration –
disparate data
systems/standards/data
models

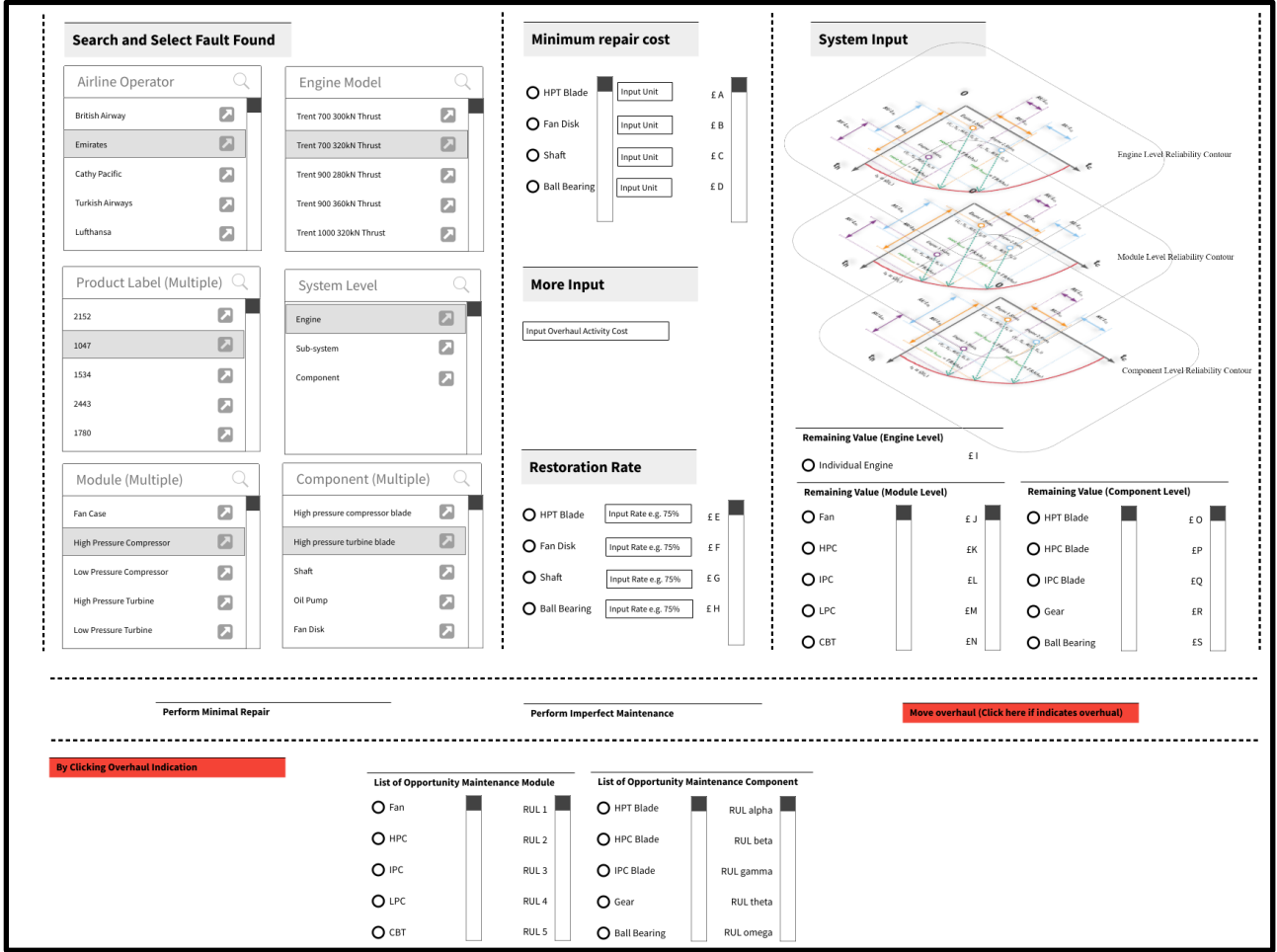
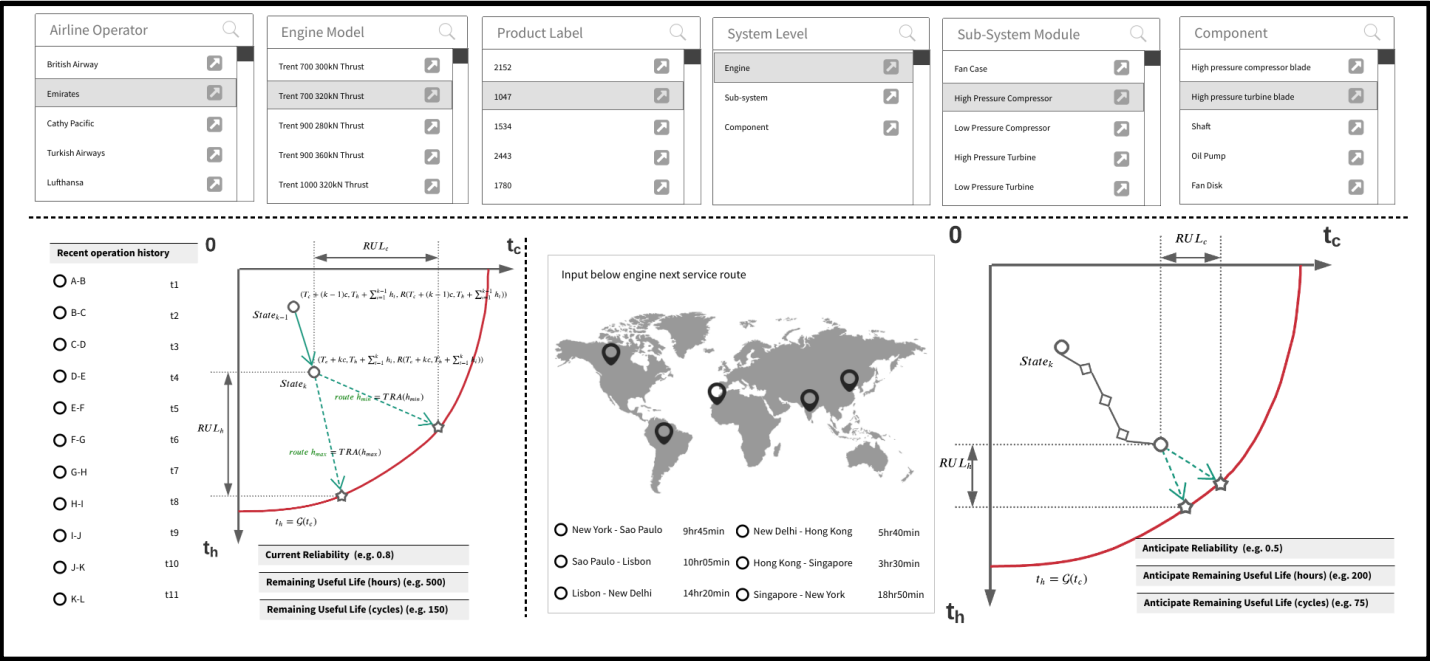
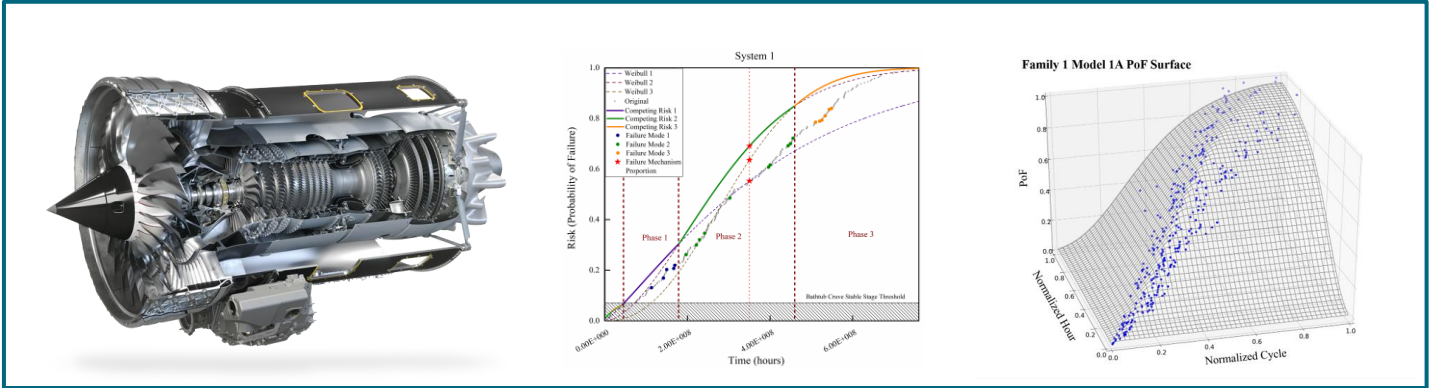


Incremental development

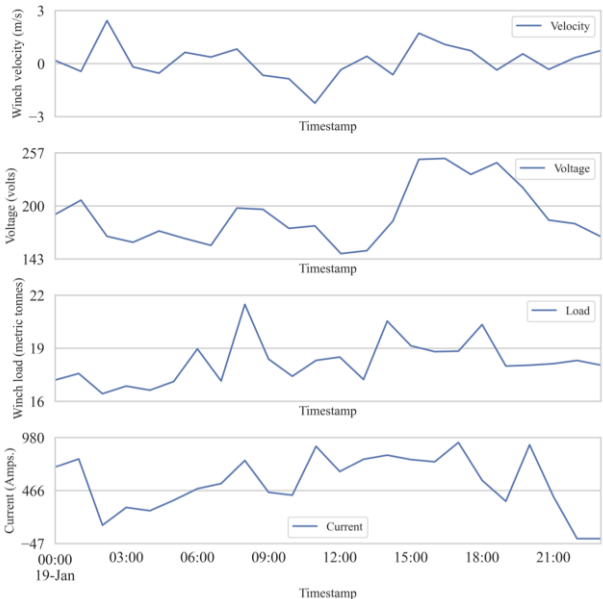
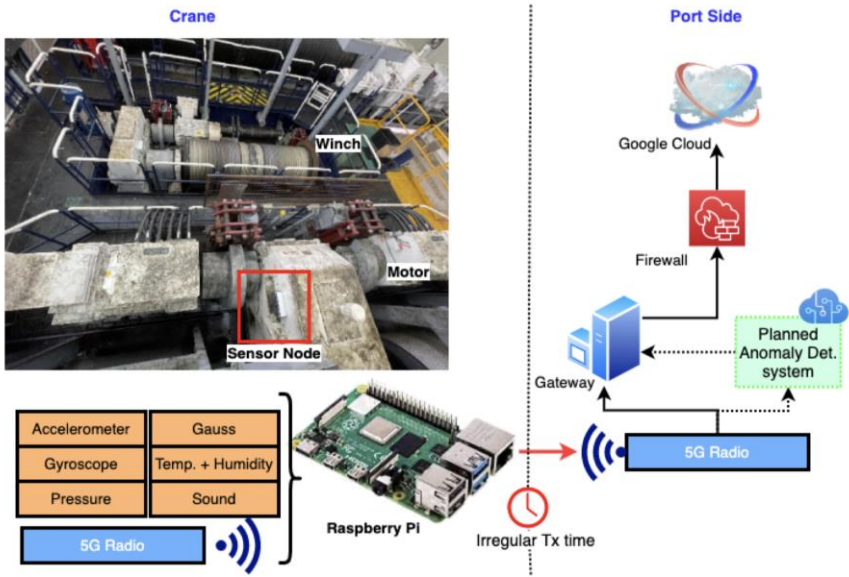
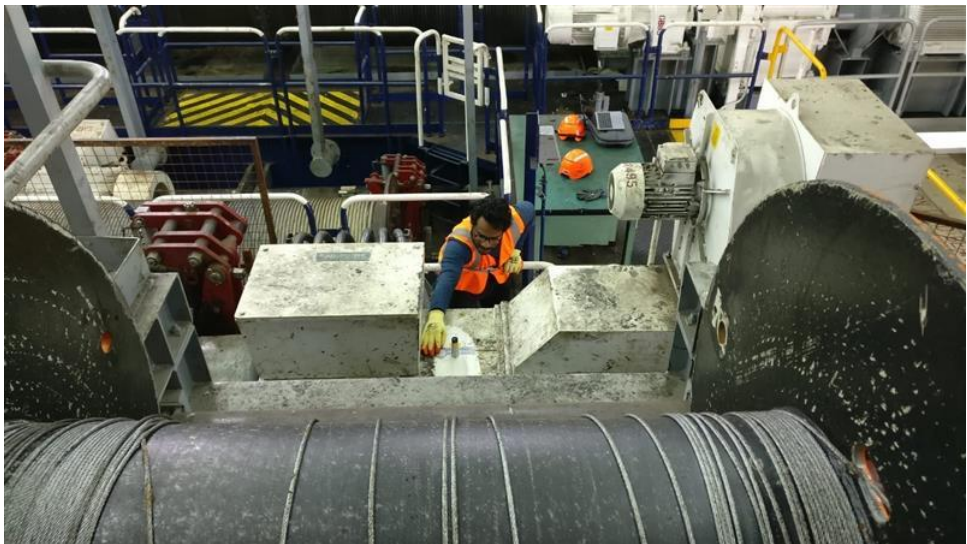
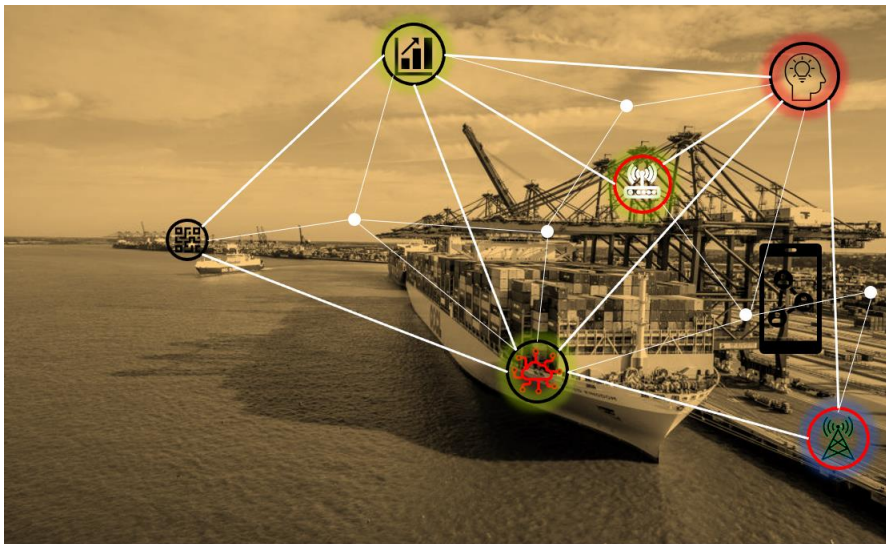


Complex systems as
system of systems

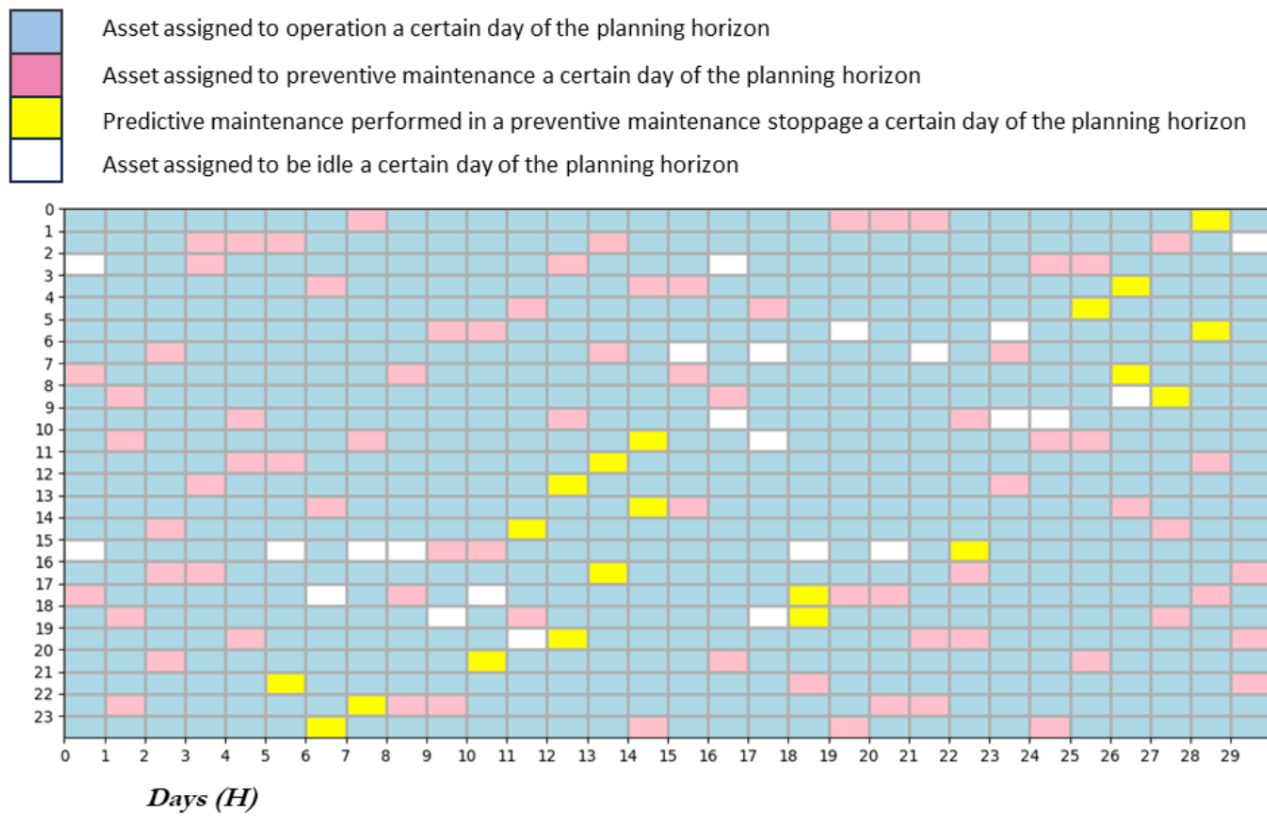
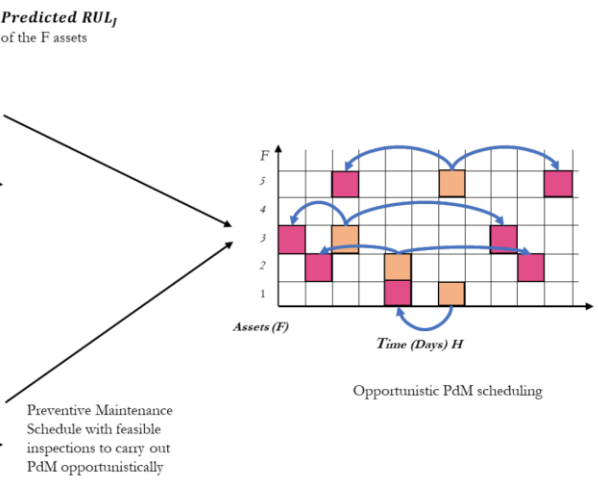
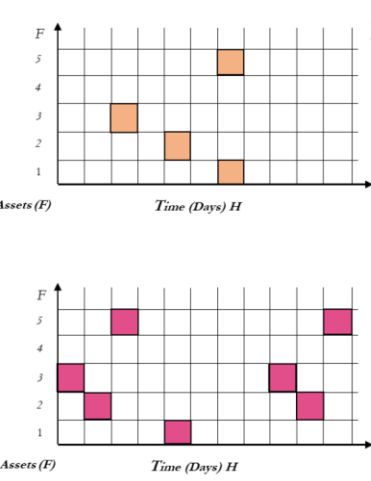
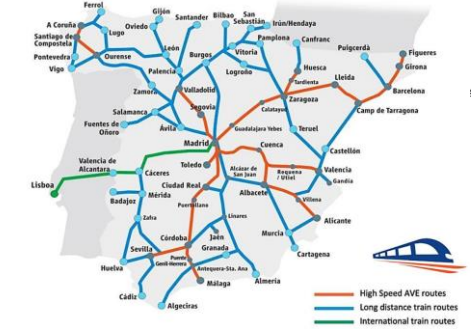
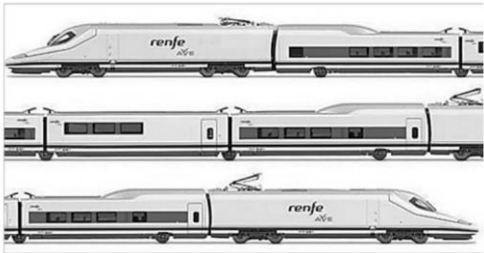
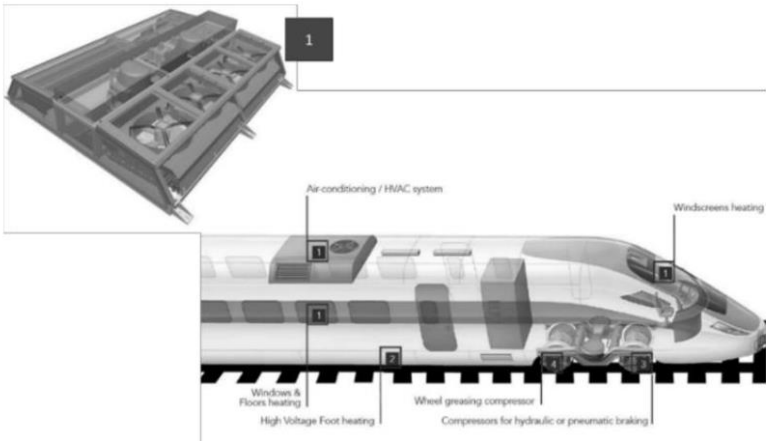
Data-driven reliability engineering can inform optimal asset usage and maintenance



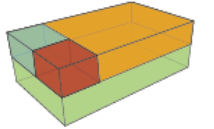
5G and IoT-enabled digital twins transforms productivity of logistics operations



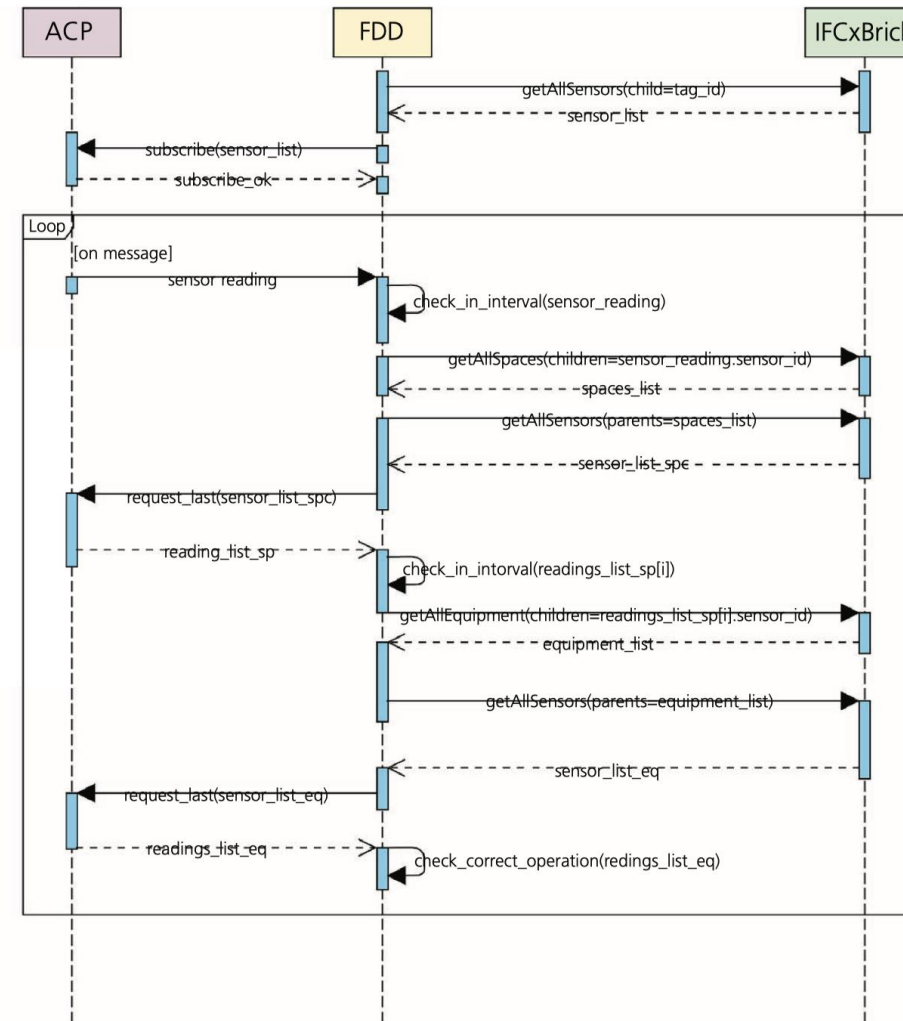
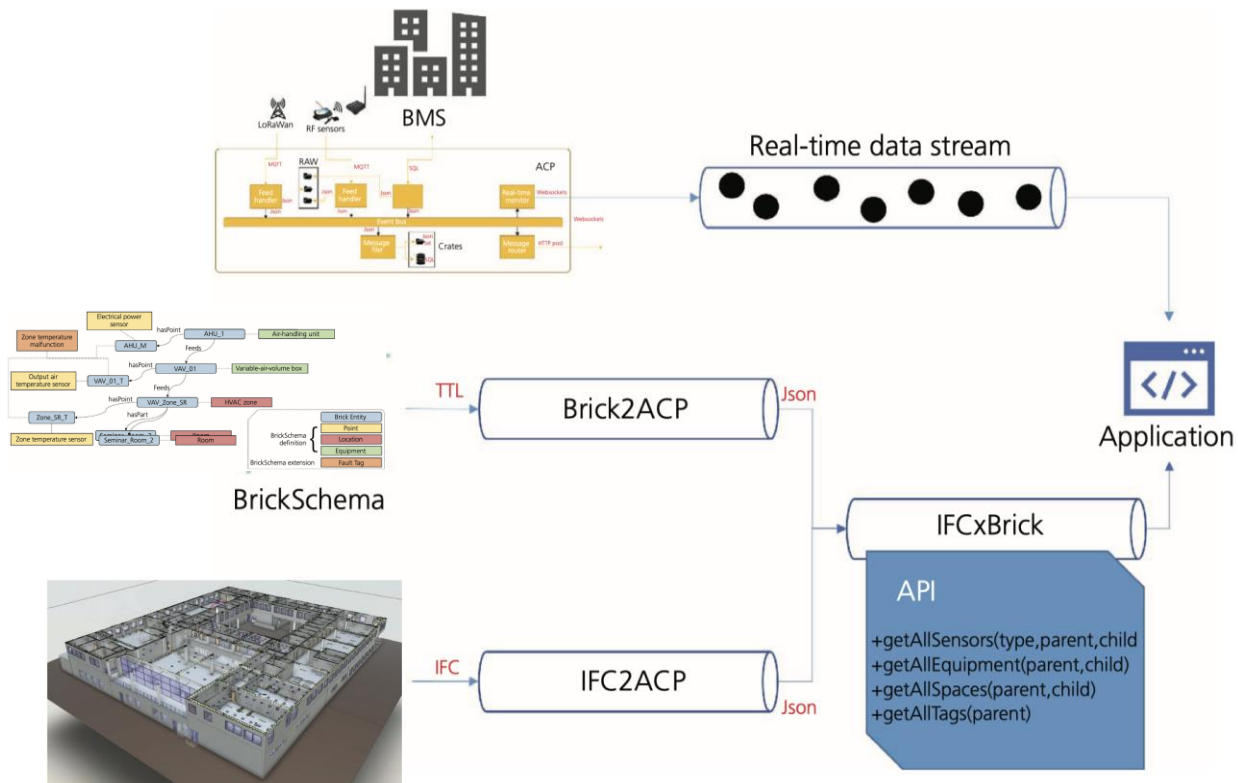
Digital twins help with dynamic fleet management



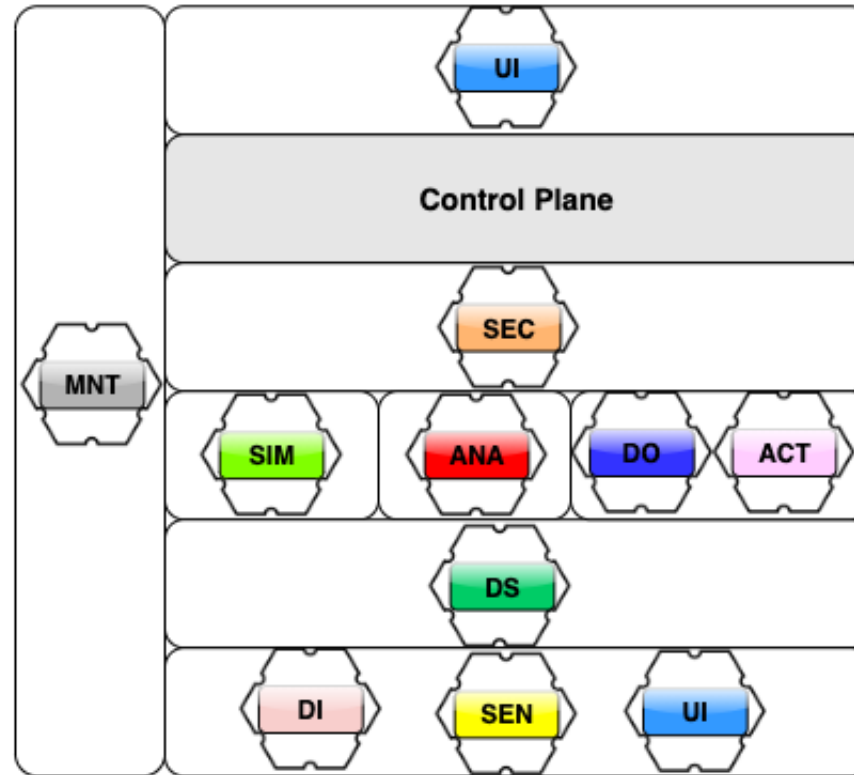
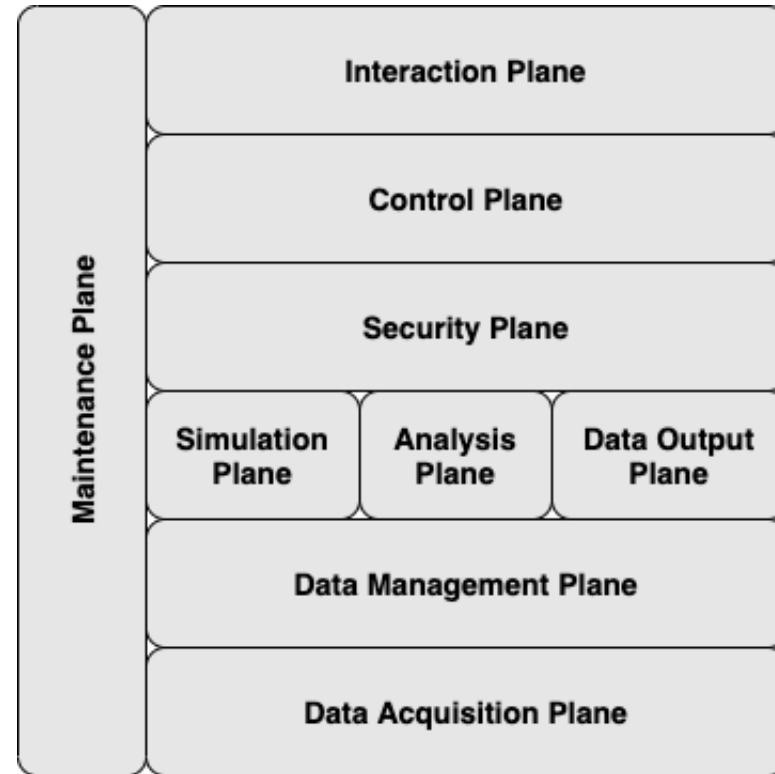
Data integration using federated data models



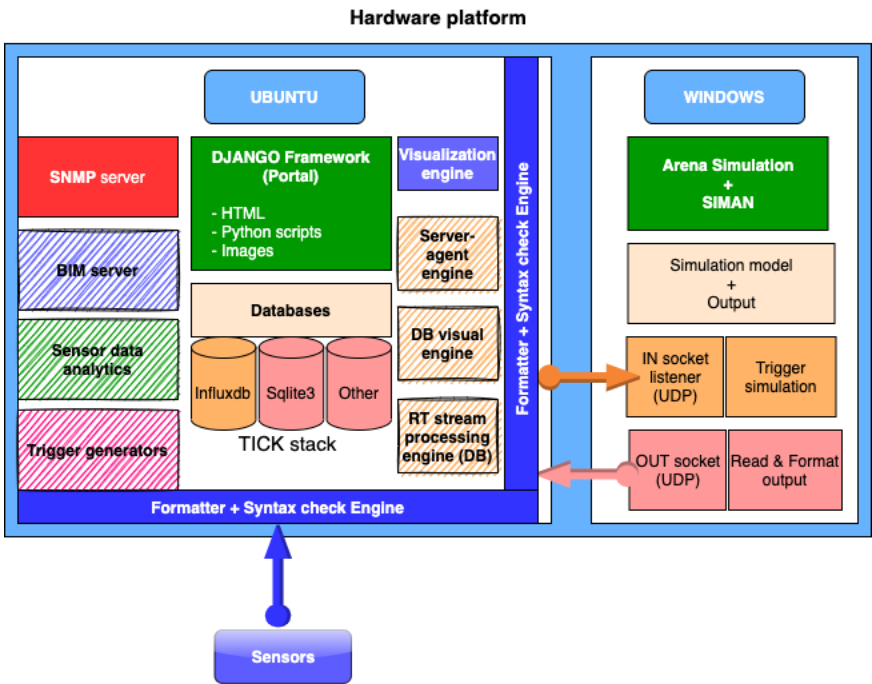
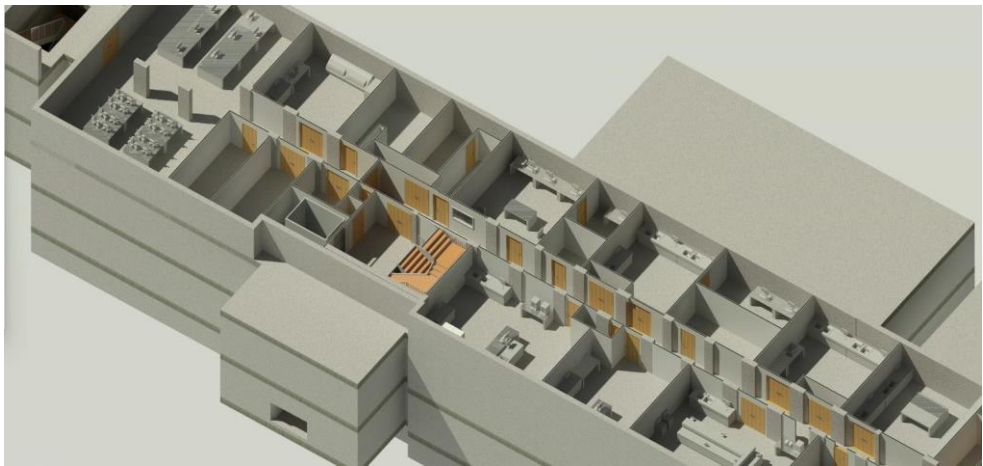
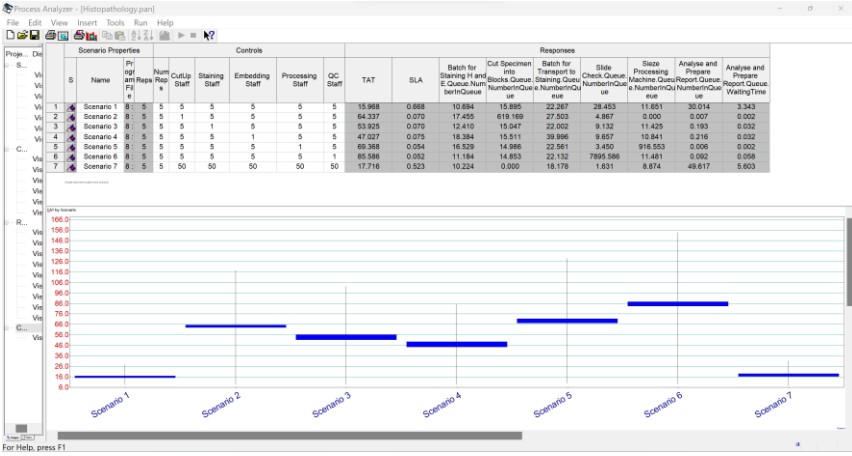
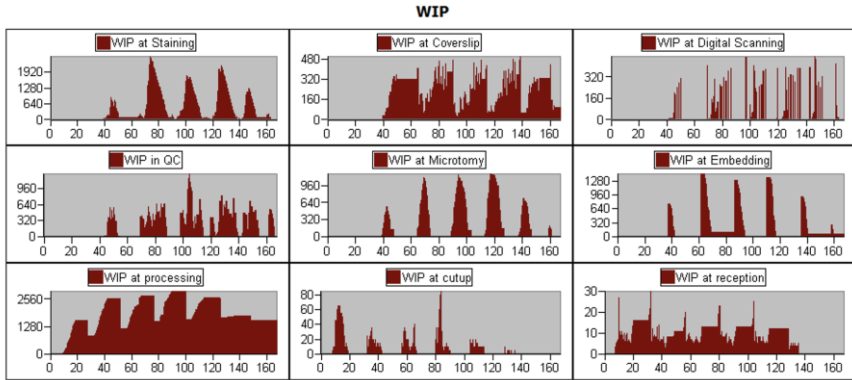
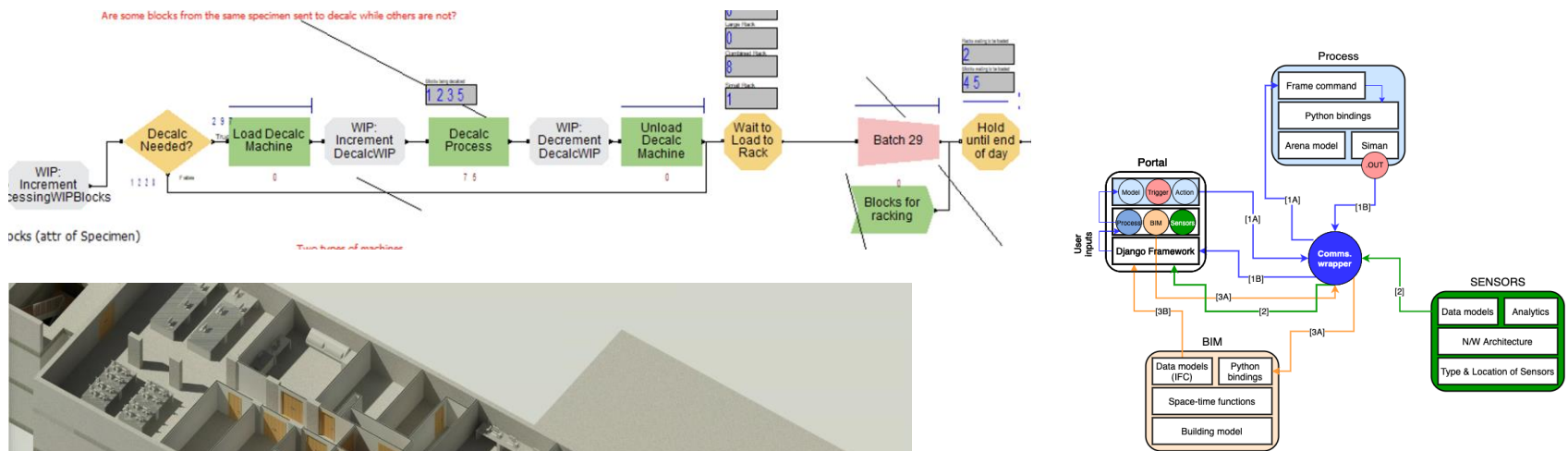
Rick Schema



Modular service-oriented digital twin architecture



Digital twins to transform healthcare operations



We can stretch the idea of digital twins further...



See



Learn



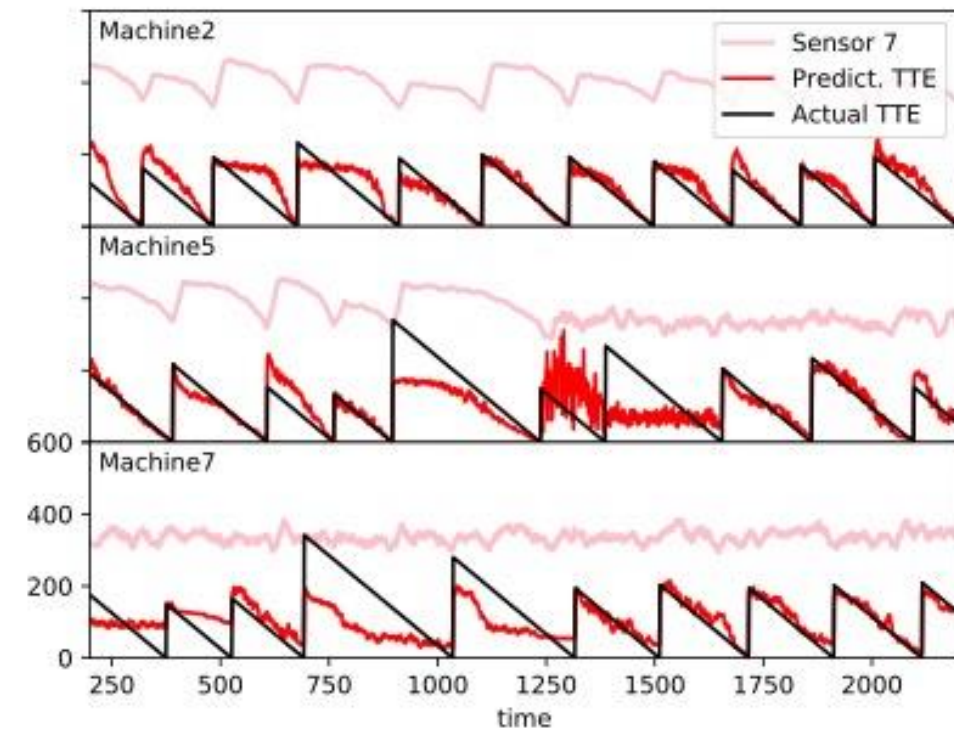
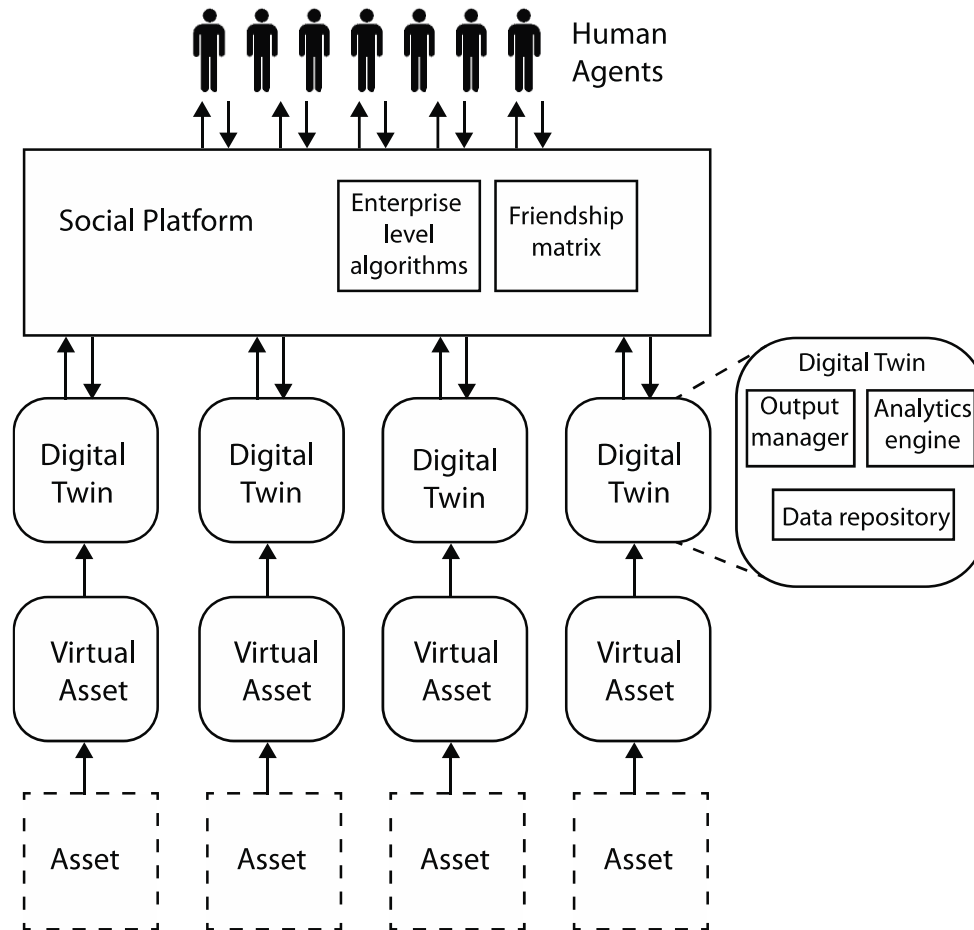
Think



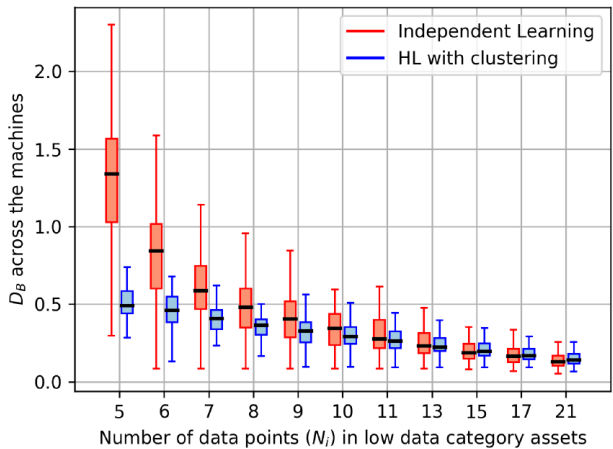
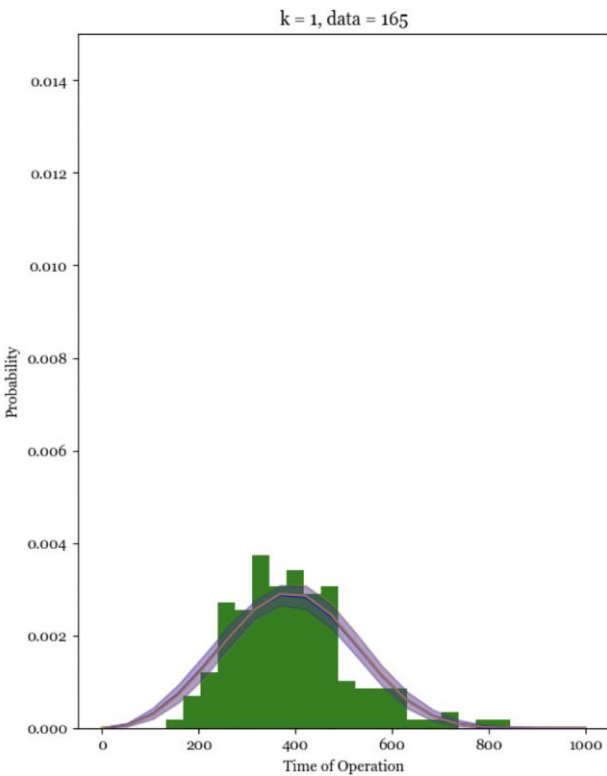
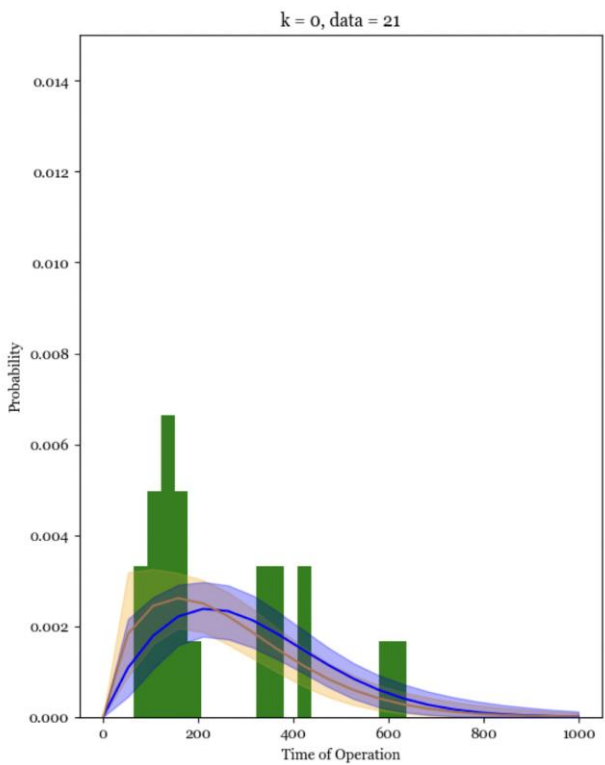
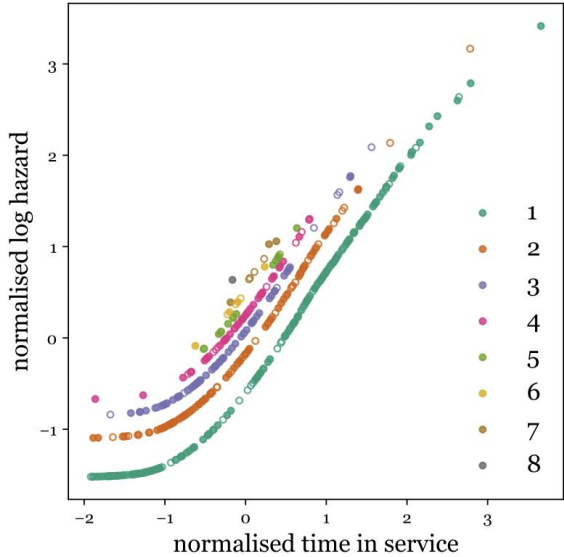
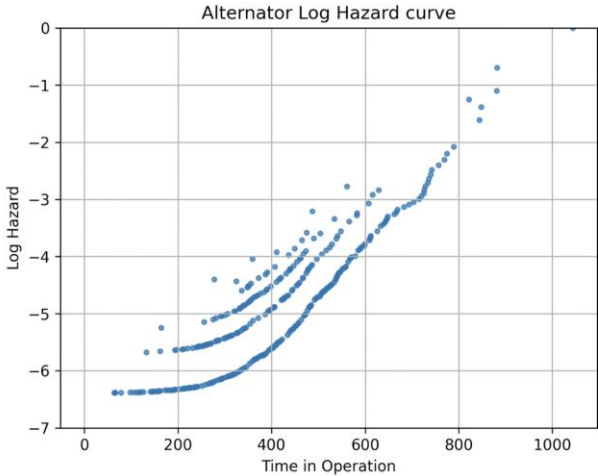
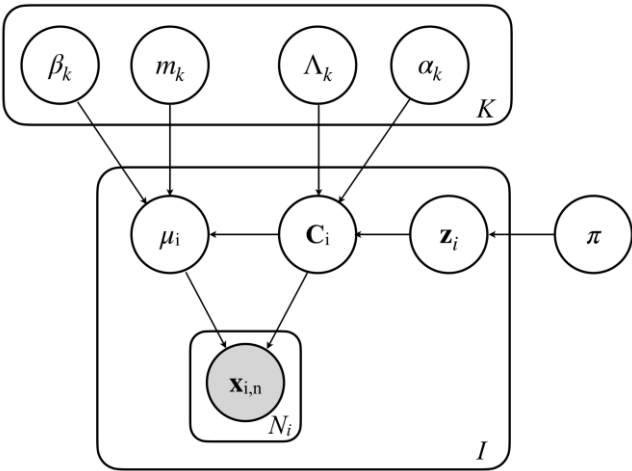
Act



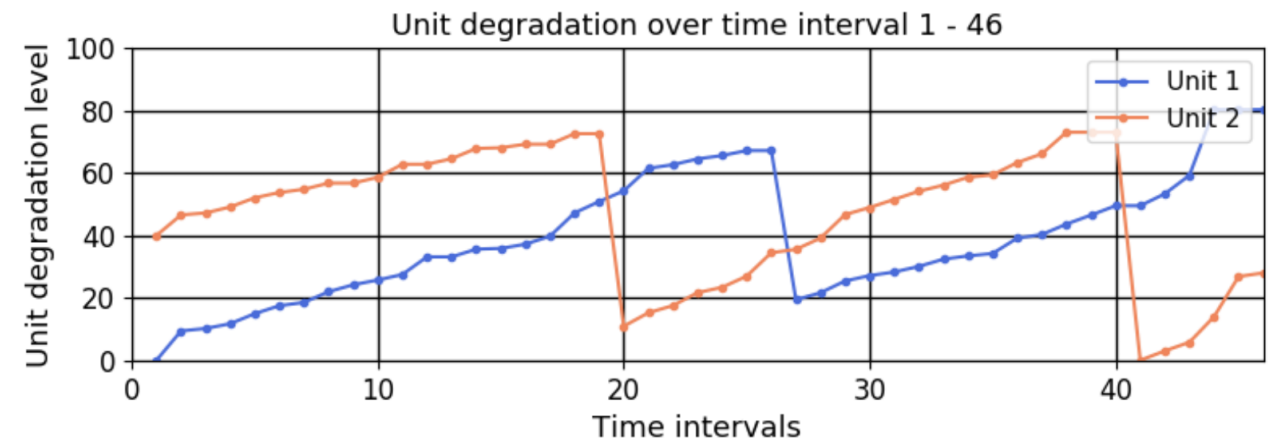
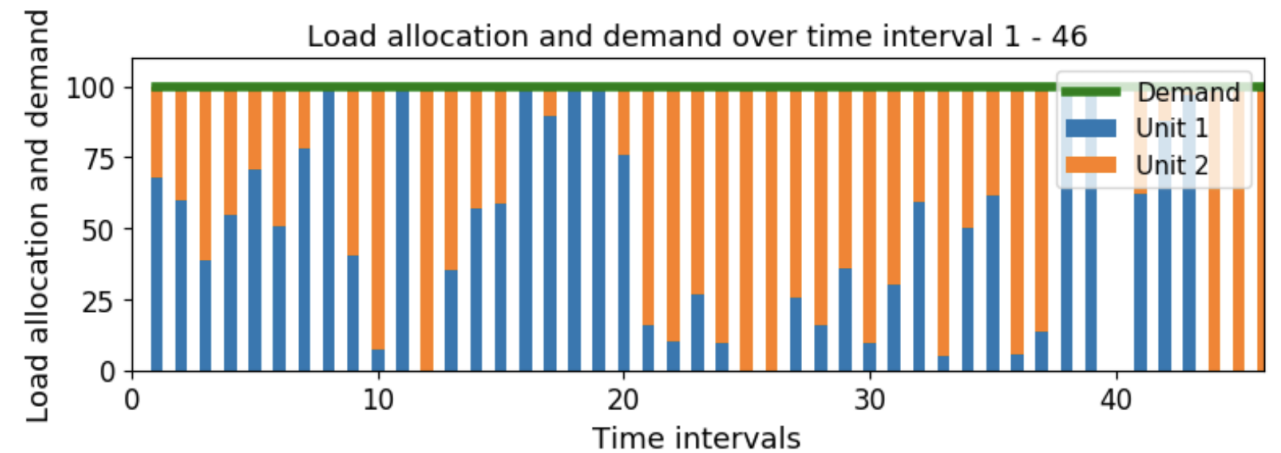
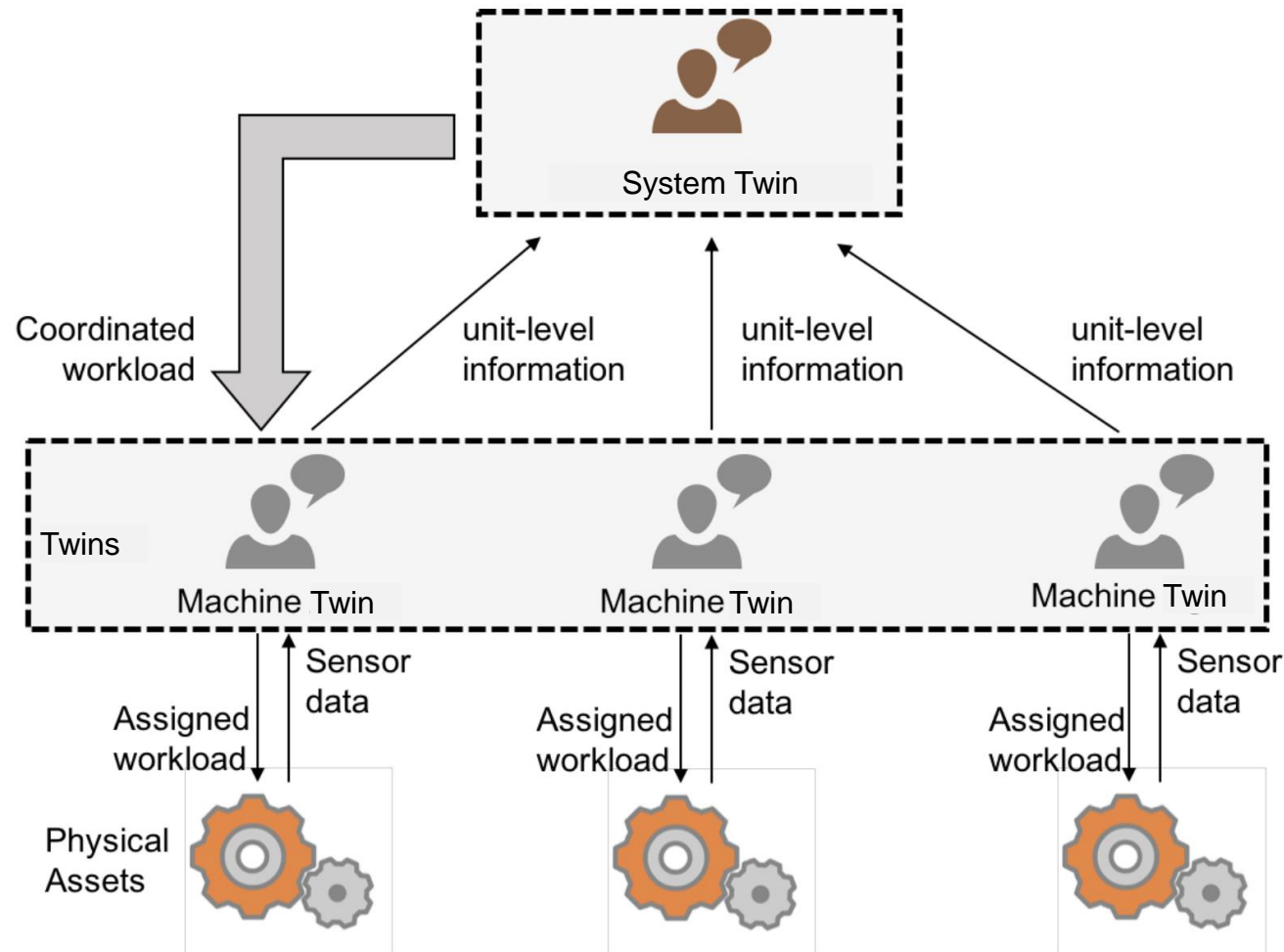
A 'social network' of digital twins can collaborate to learn failure patterns faster



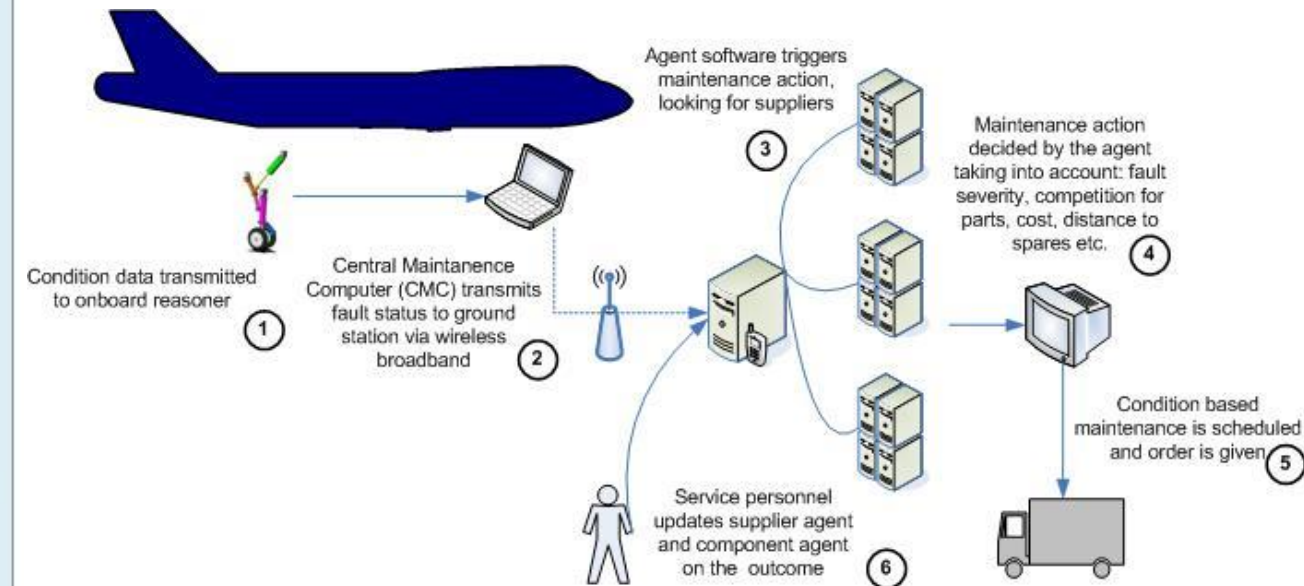
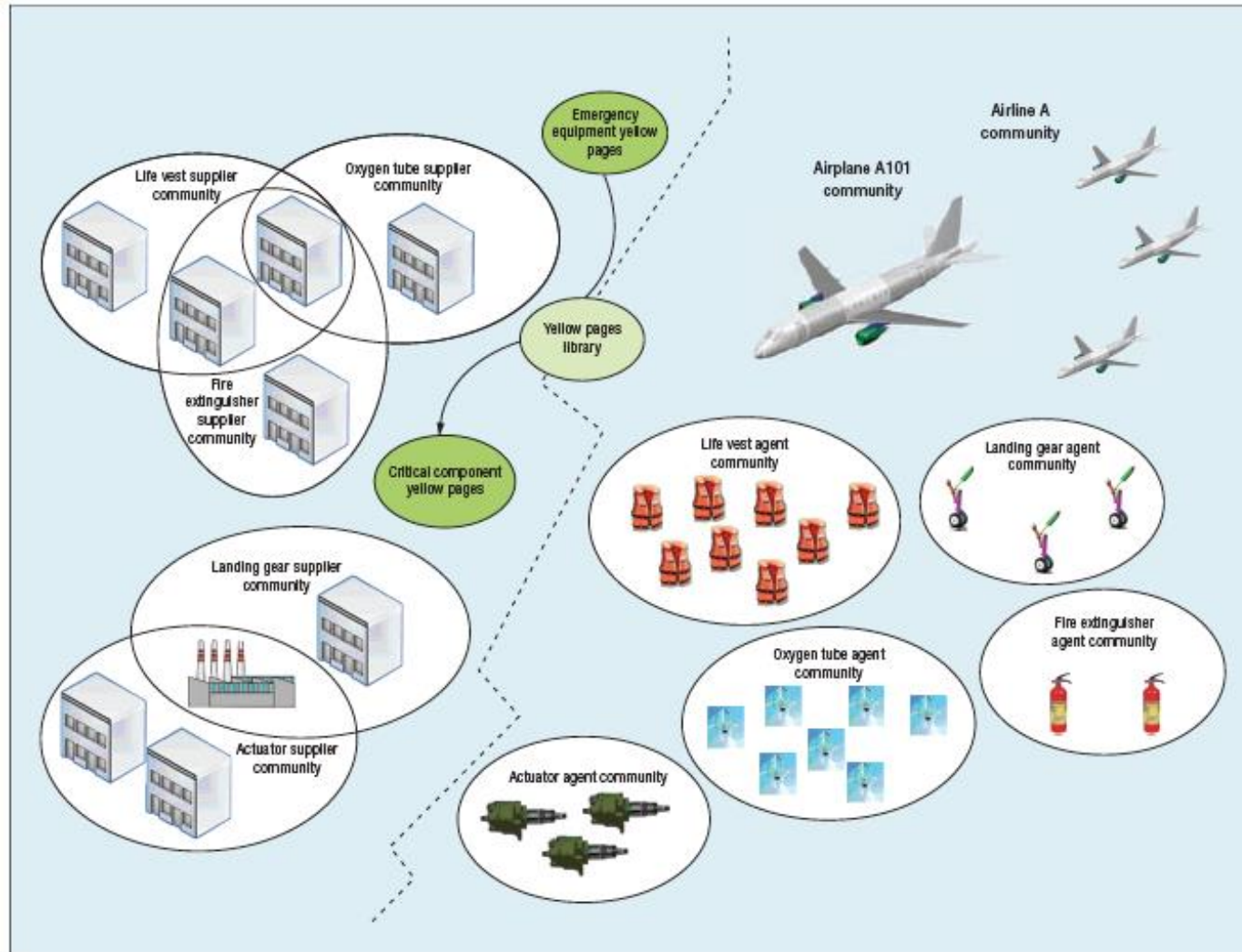
Collaborative assets can learn by sharing their ‘models’



Collaborative assets can help each other in times of trouble



Social assets enable dynamic management of spares



Where we need to get to...



This is the revised system PM plan!



I had an alternator failure now.



I am working as hard as you are. Hmm...I am likely to fail soon too!



Okay. Let me slow down a bit to help you out!



Unusual vibrations! Suspected bearing failure in 3 days!



Challenges and opportunities



Dealing with uncertainty



Learning system
relationships and
causalities



Adaptive Digital Twins



Holistic Digital Twins



Thank you



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