

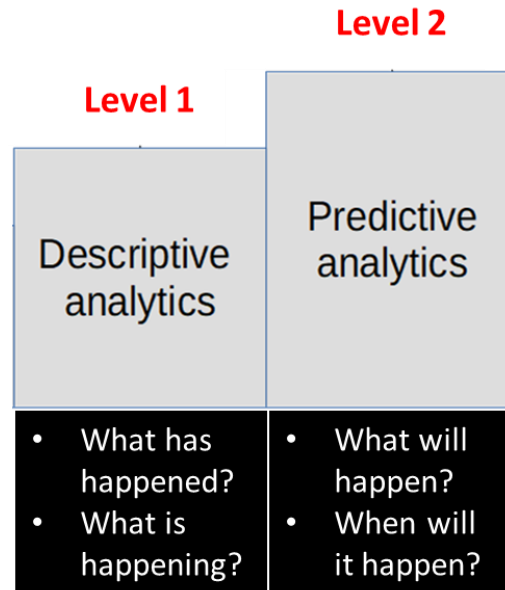
# Asset Analytics: Present and Future



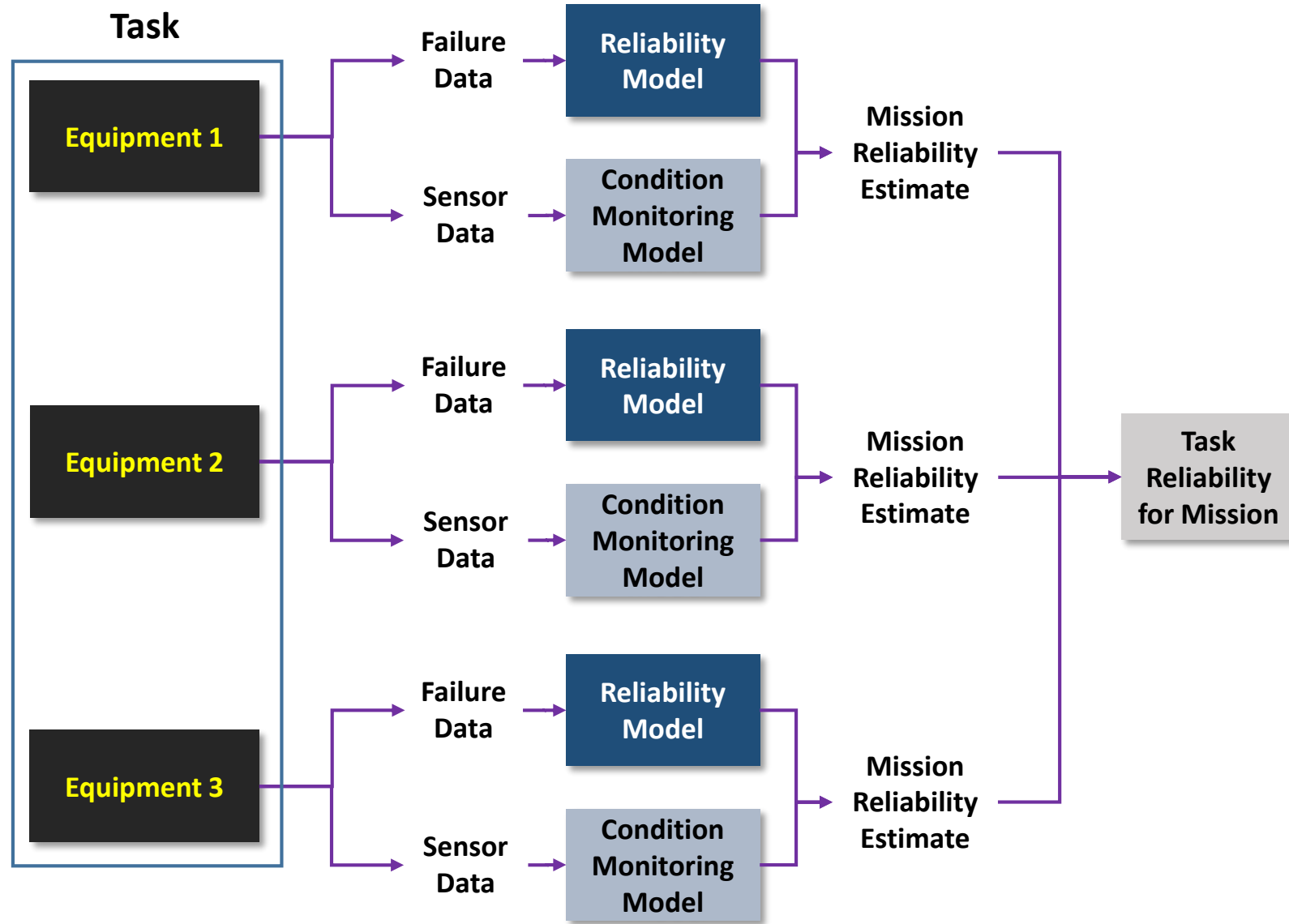
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# Asset Analytics

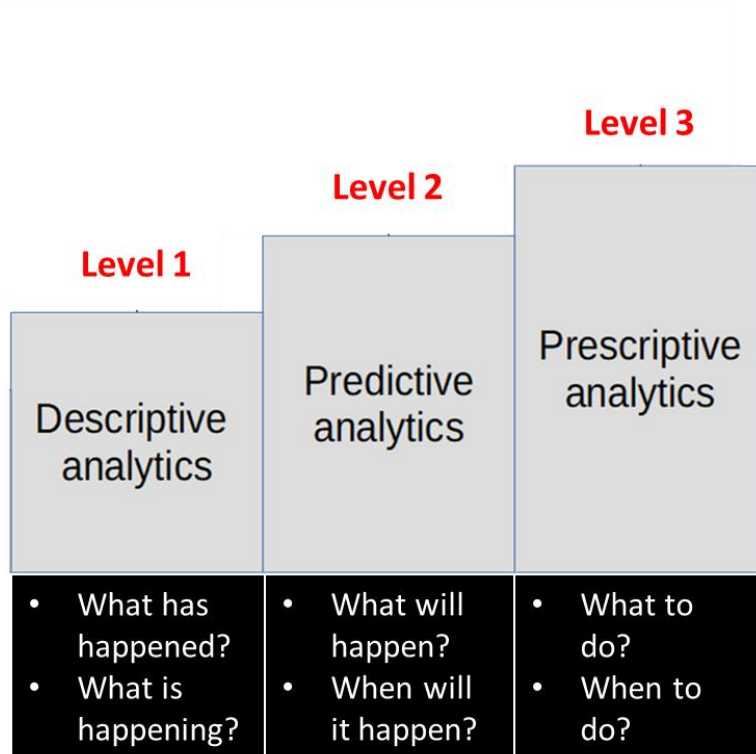


1. Calculate performance metrics.
2. Assess current state of an asset.
3. Predict future behavior of an asset.

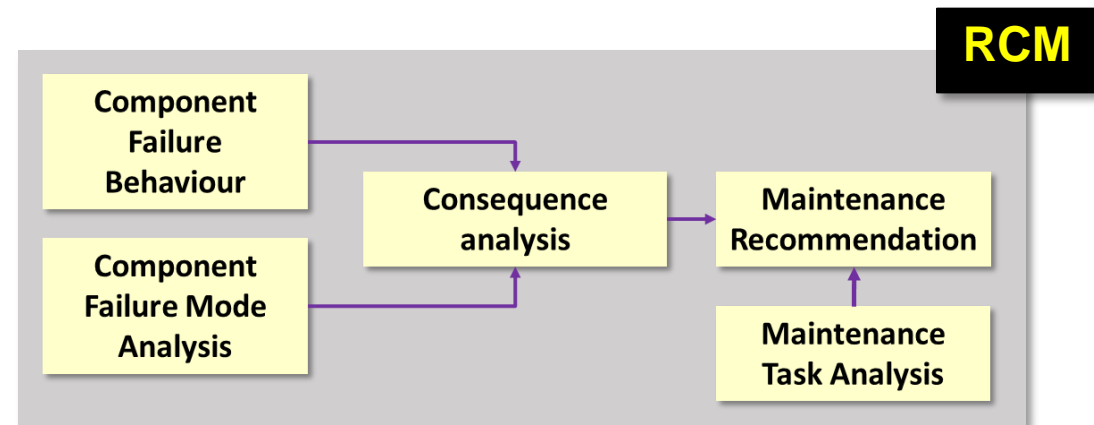




# Asset Analytics

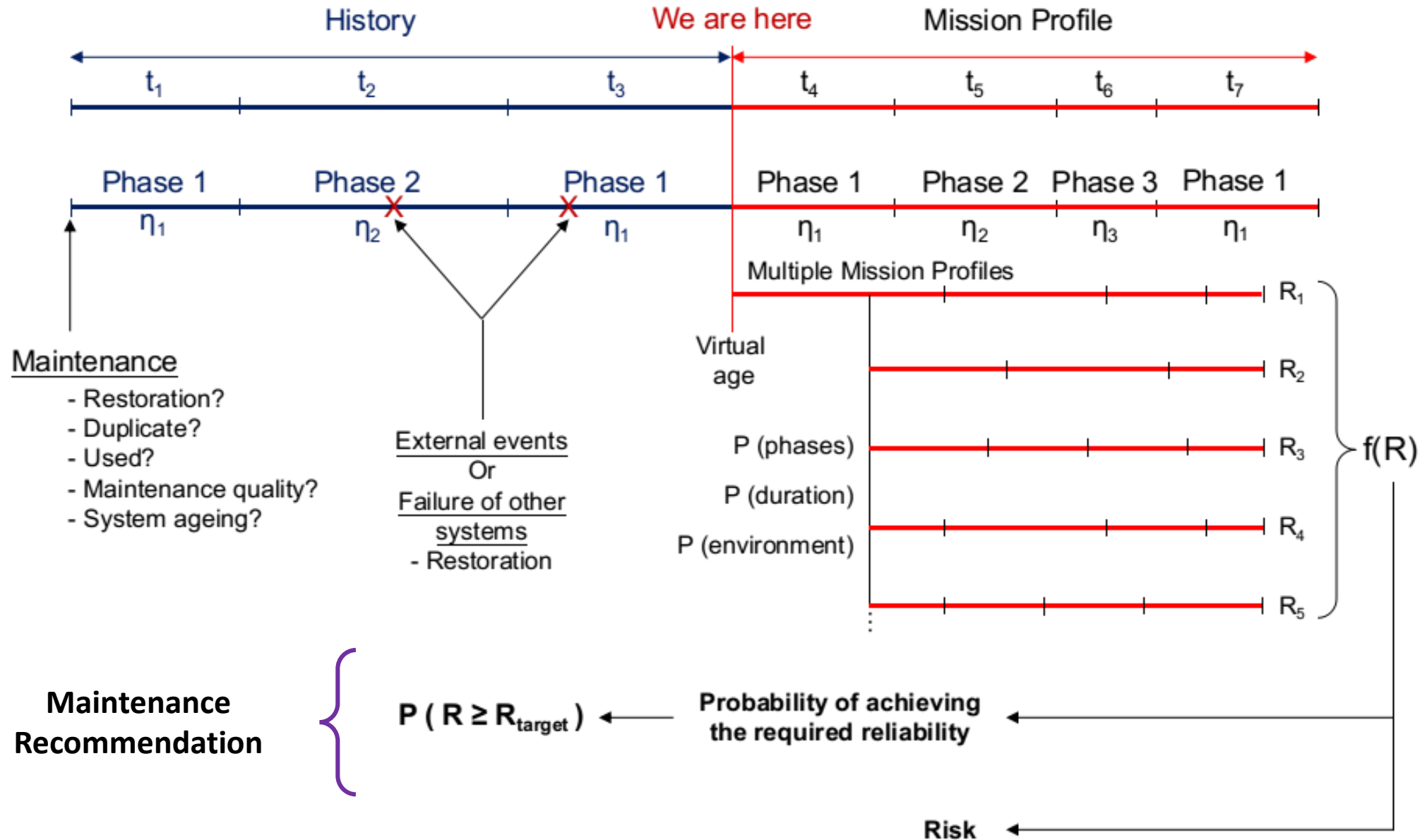


1. Calculate performance metrics.
2. Assess current state of an asset.
3. Future asset behavior.
4. Provide recommendations





# Asset Analytics





# Requirements

**Accuracy:** All failures to be recorded.

**Granularity:** Failure and maintenance data required till component level along with failure modes.

**Traceability:** Failure and maintenance data tagged to subsystems through out the product lifecycle.



A digital thread enables one to get product performance inputs from asset operations, maintenance, upgrades to engineering. closed-loop Insight to action pathways related to performance KPIs are established by digital thread, which is crucial for maximizing the operational efficacy of assets during their entire lifespan.

<https://blogs.sap.com/2022/05/09/design-to-decommission-digital-thread-to-augment-intelligent-asset-management/>



Digital Thread is key to achieving full product lifecycle traceability—allowing you to track a product and its digital assets all the way from concept through design, manufacturing, quality, and service. Learn how this unbroken flow of information will help your organization gain crucial insights that can inform decisions throughout every aspect of the product lifecycle.

<https://www.aras.com/en/why-aras/digital-thread>



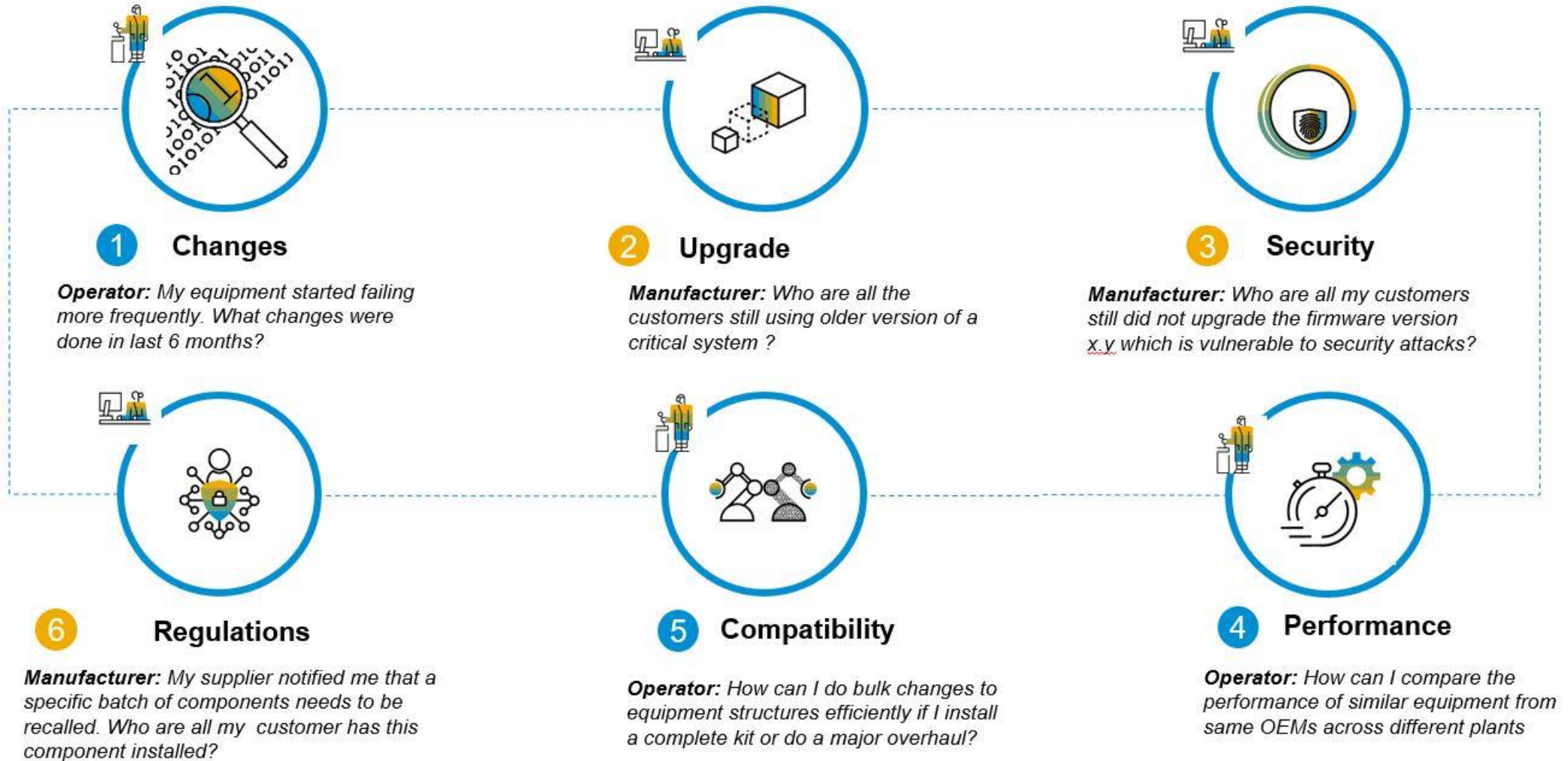
Digital thread enables traceability in either direction, upstream or downstream in the product's lifecycle. This is incredibly valuable as it enables decision-makers to analyze the impact of changes before they are made.

<https://www.ibm.com/blogs/internet-of-things/digital-threads-engineering-efficiency/>



A digital thread creates a closed loop between digital and physical worlds, transforming how products are engineered, manufactured, and serviced.

<https://www.ptc.com/en/blogs/corporate/what-is-a-digital-thread>



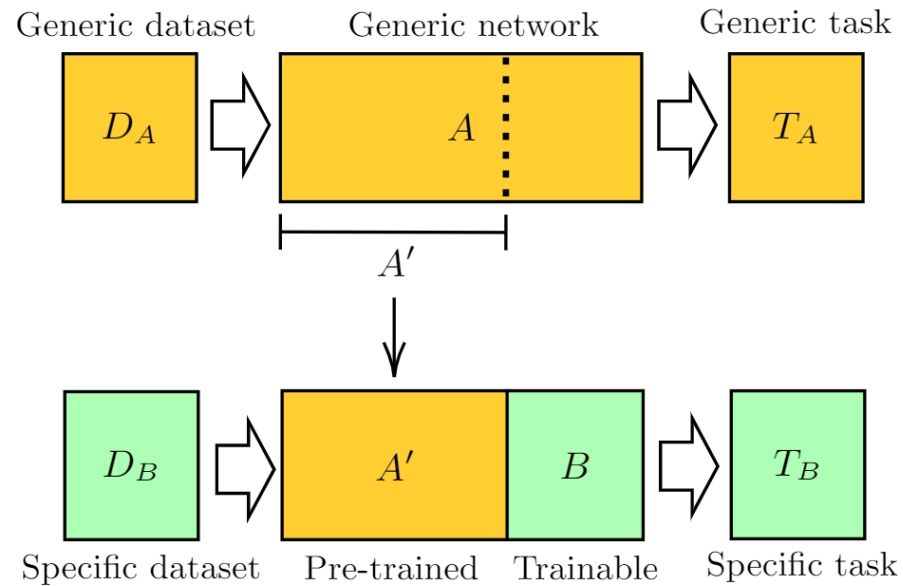




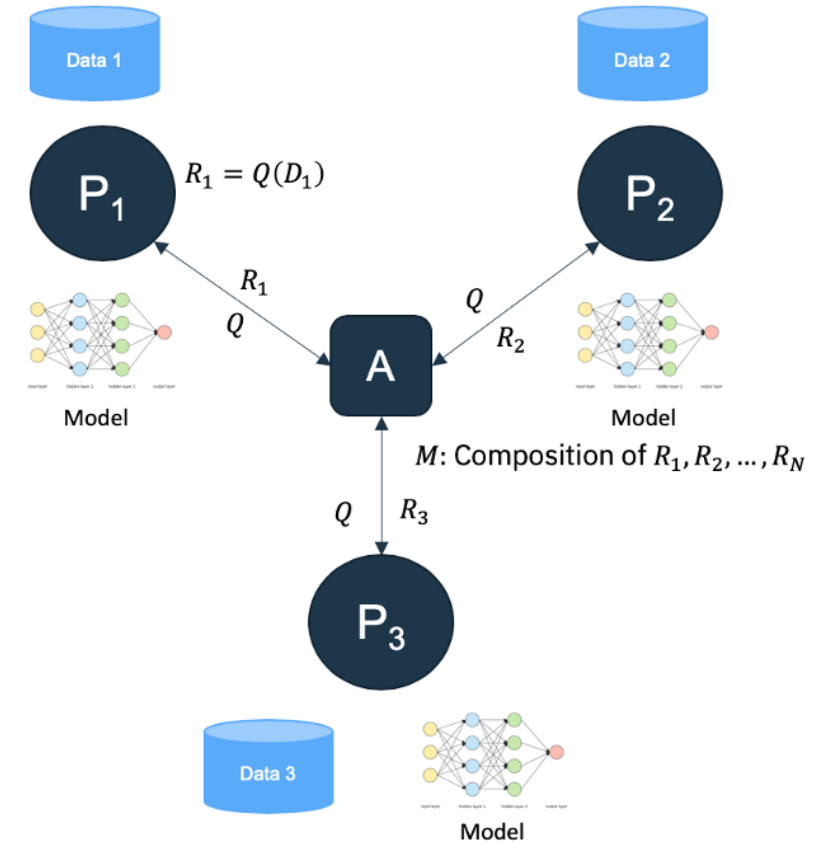
# Digital thread will also support

Traceability of model parameters at different time points becomes possible.

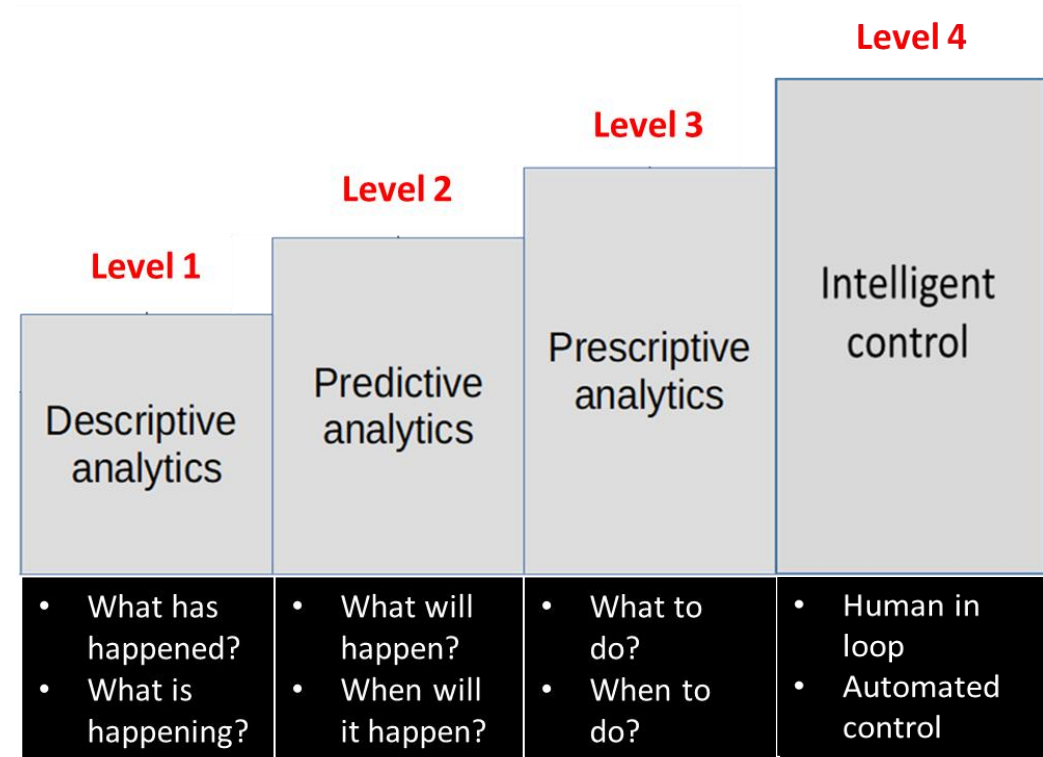
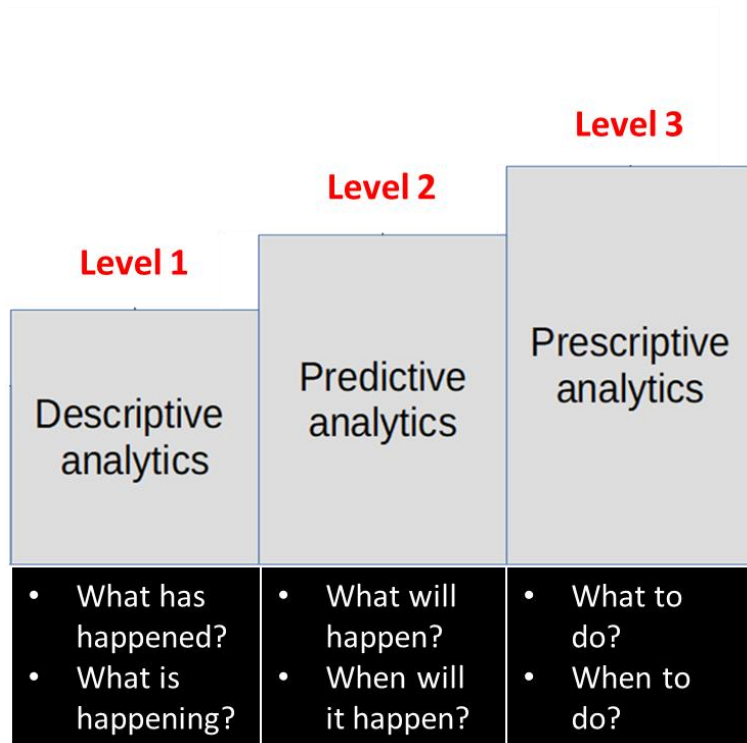
- Transfer learning



- Federated learning



# Asset Analytics





# Capabilities Required for Intelligent Control

A **self-aware** entity is one which can acquire knowledge about its internal states, history, social or physical environment and goals.

A **situational aware** entity is one which can perceive environmental elements and events with respect to time or space, comprehend their meaning, and

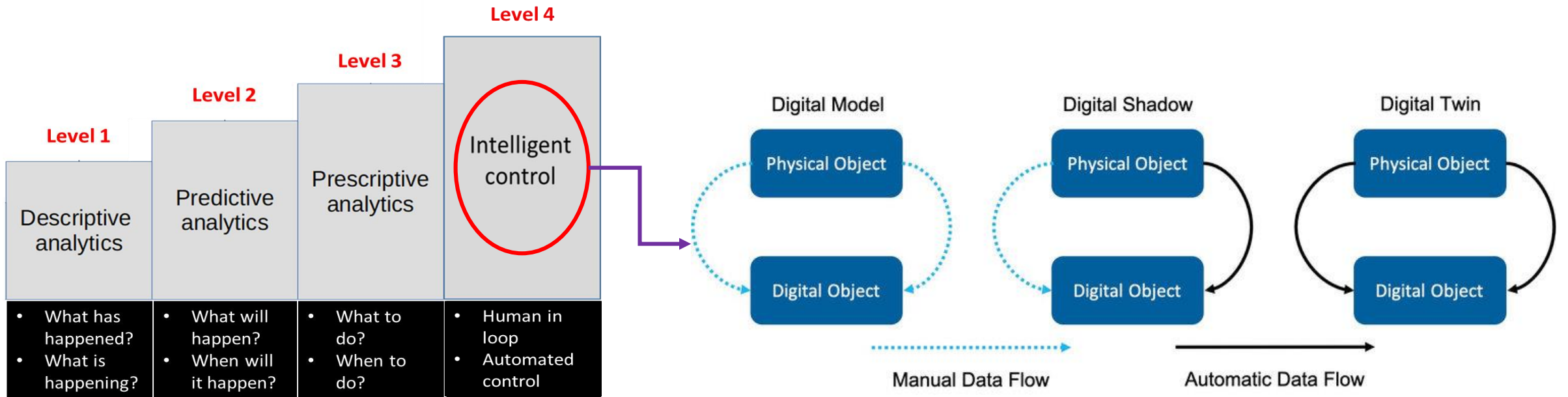
A **context aware** entity is one which has the ability to comprehend the meaning of a situation and categorize it appropriately.

**Look-ahead** capable entity is one which has the ability to anticipate a future situation based on its current situation.

**Responsive:** adapt its behaviour or generate recommendations in the specific context.



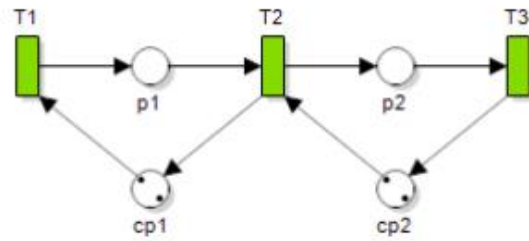
# Digital Twin Journey



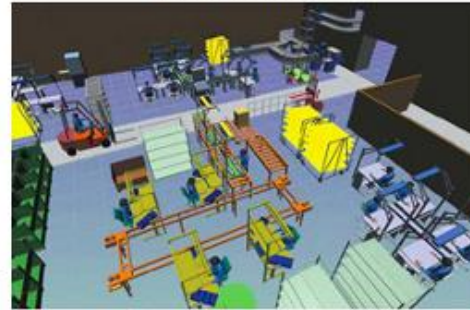
# Digital Models



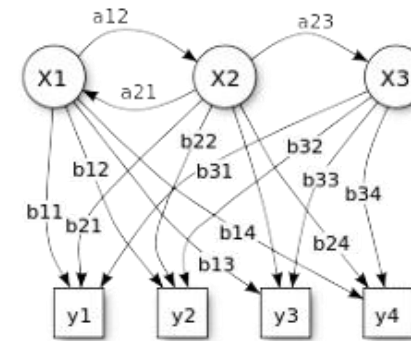
Petri Nets



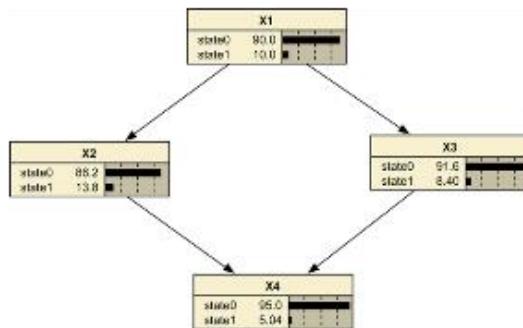
Discrete Event Simulation



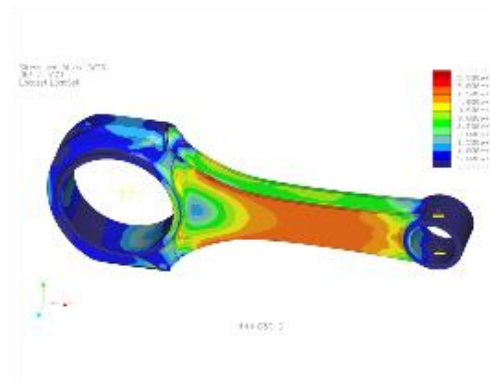
Markov/Semi Markov Models



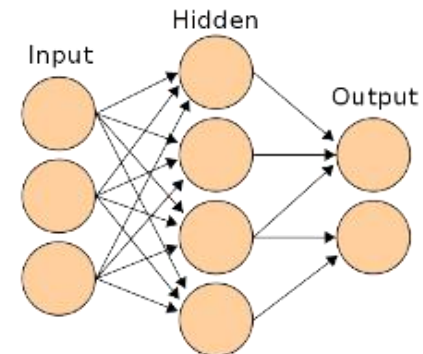
Bayesian Networks



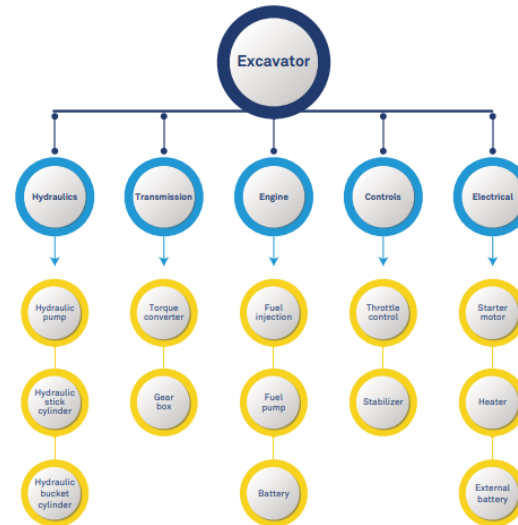
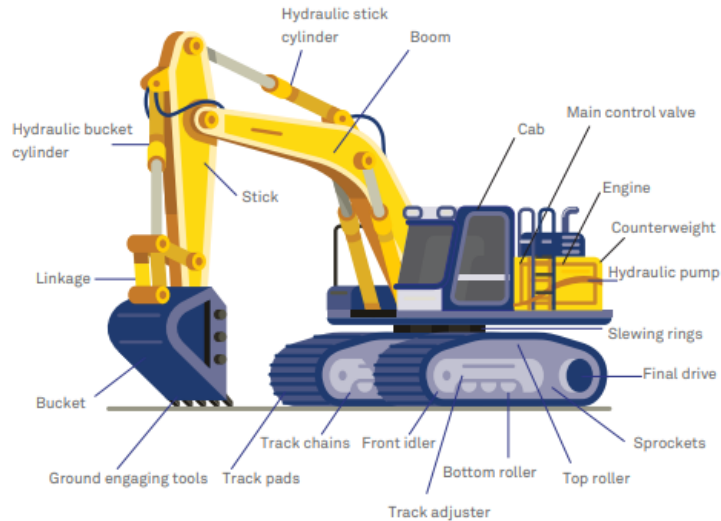
FE Models



Neural Networks



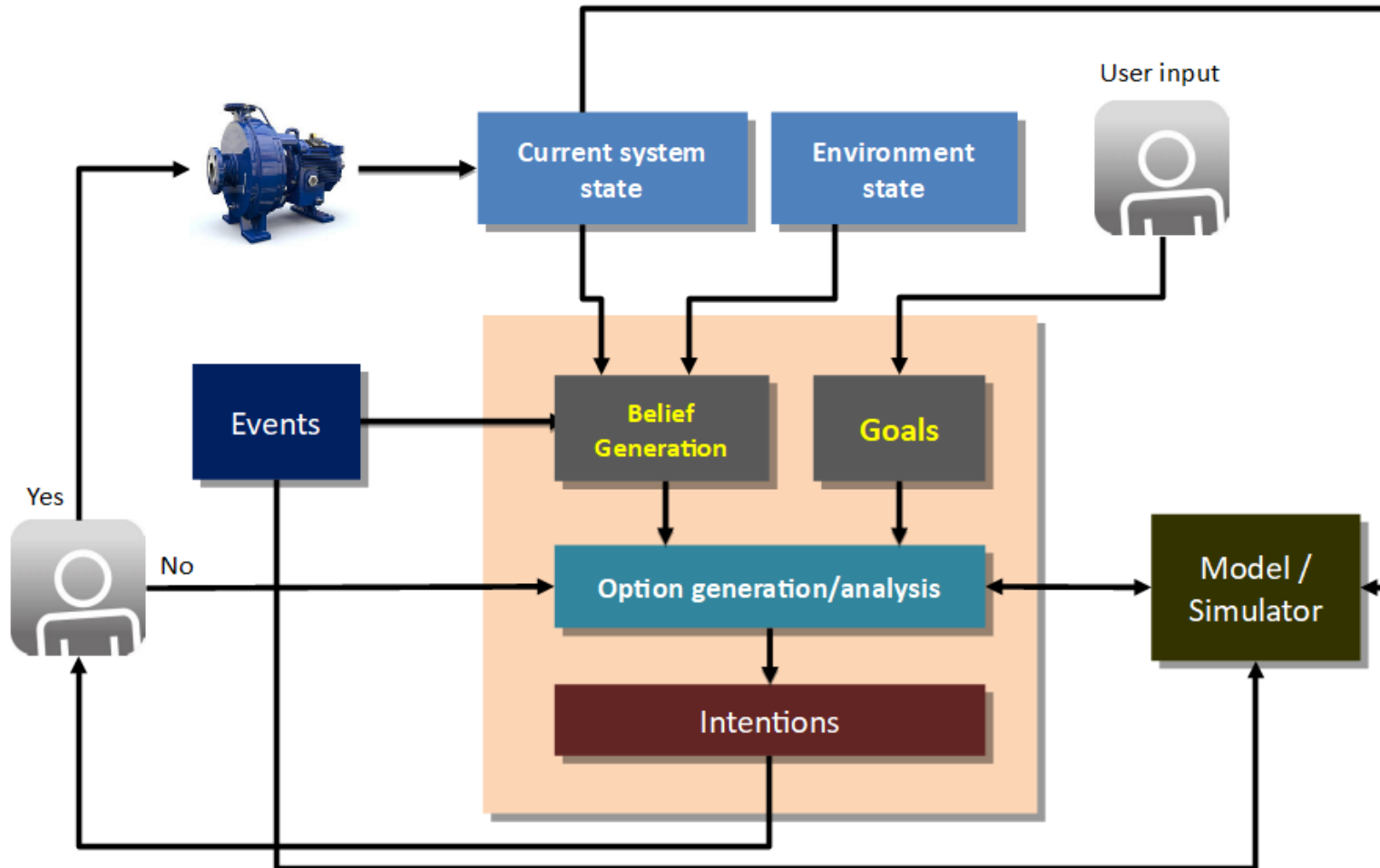
# Digital Shadow



Operational Parameters	
Data Item	Value
Altitude	4.2
EngineRunningBand1	2
EngineRunningBand2	18
EngineRunningBand3	4
EngineRunningBand4	551
EngineRunningBand5	0
EngineRunningBand6	0
EngineRunningBand7	0
EngineRunningHours_Current	1.200000
<input checked="" type="checkbox"/> EngineTemperature	35
<input checked="" type="checkbox"/> ExternalBatteryVoltage	13.3
<input checked="" type="checkbox"/> FuelLevel	110
FW_Version_Number	09.01.02
GPSFix	true
Hour	1344.8
InternalBatteryCharge	100

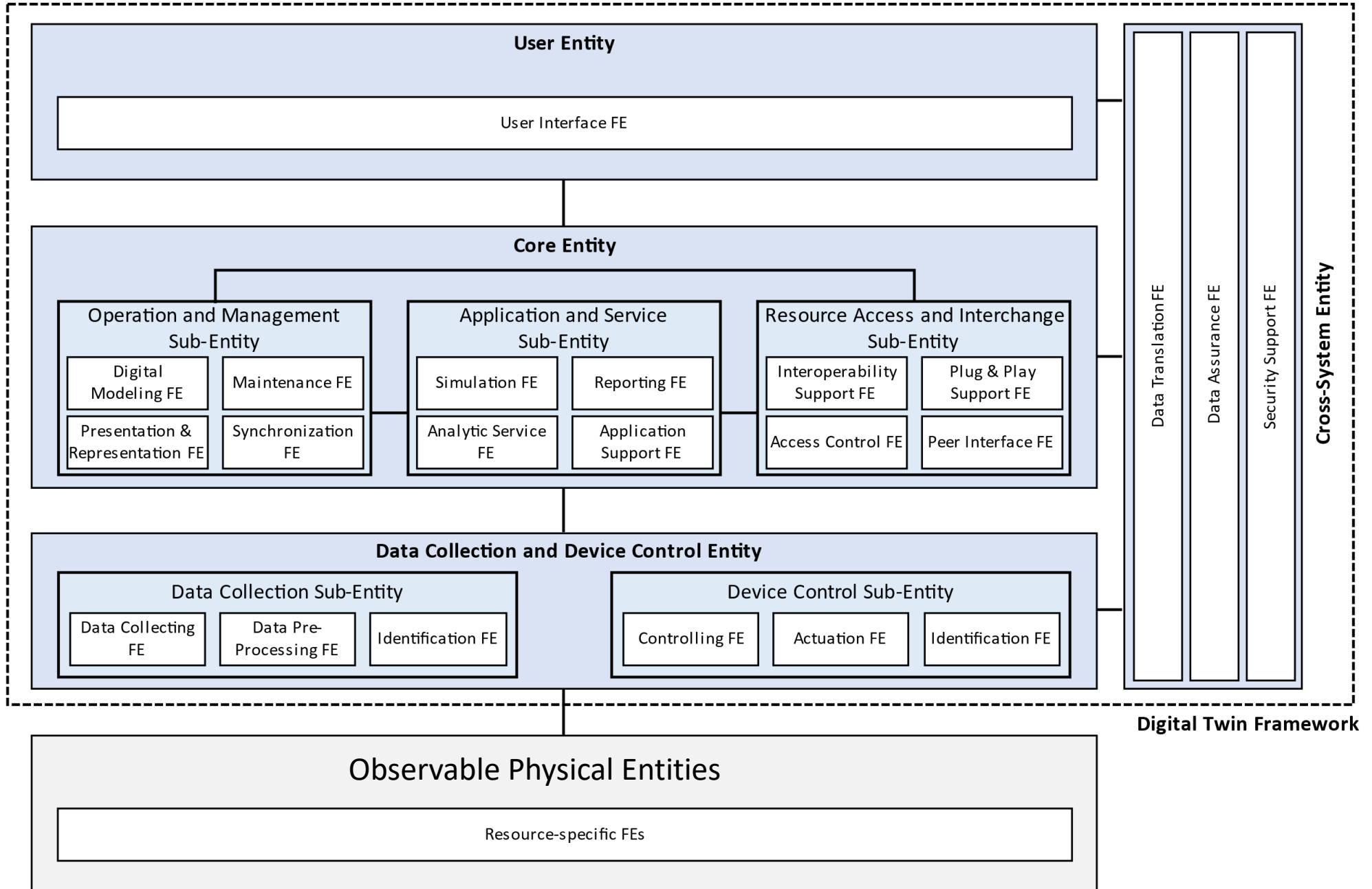
“As these values are stored against the respective variables as time series data, the state of the Logical excavator at any point in time is exactly the same as that of the physical excavator. “

# Digital Twin



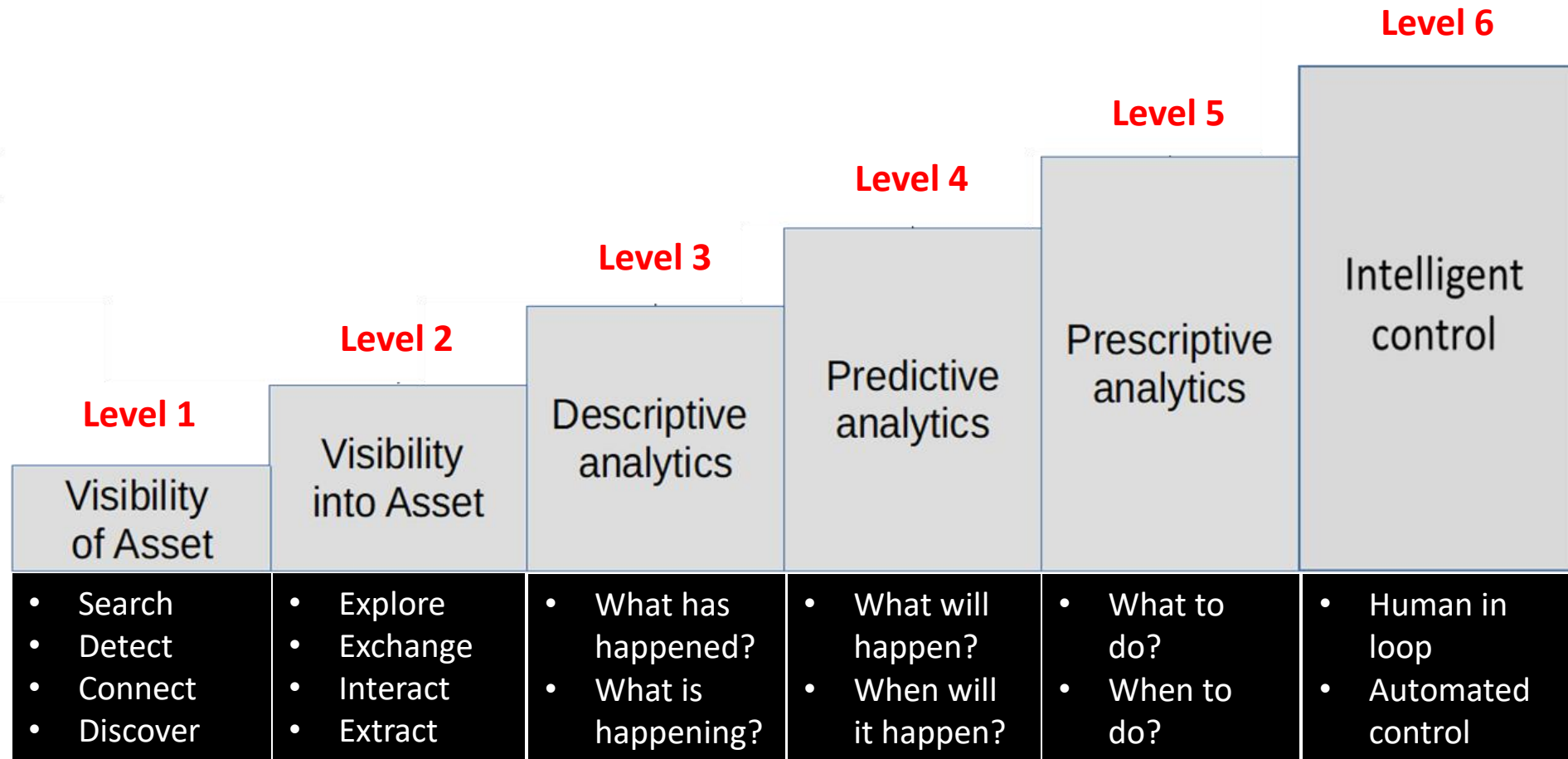
- Self Aware
- Situation Aware
- Context Aware
- Look ahead capability
- Responsive

# ISO 23247





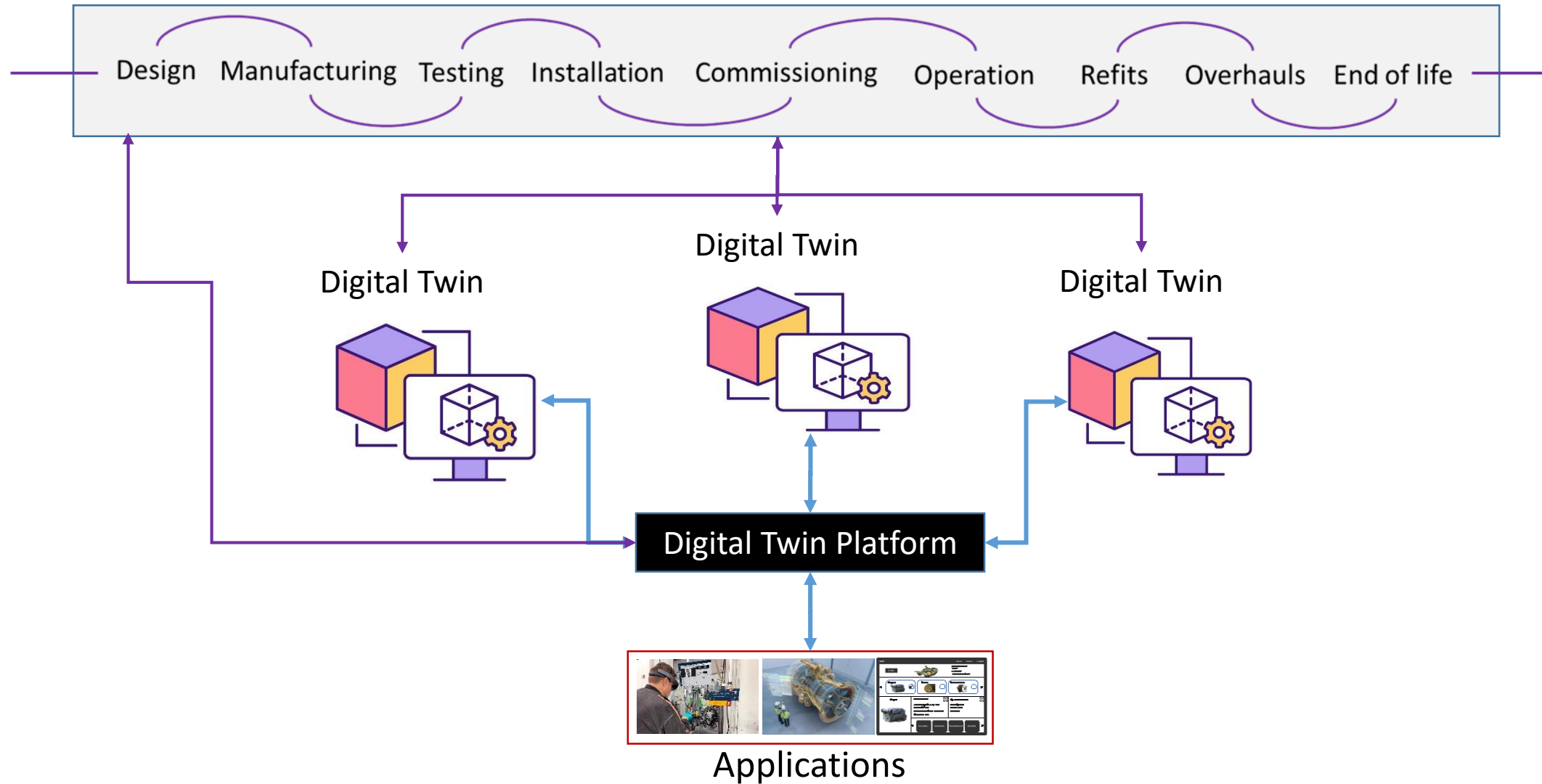
# Asset Analytics





- **Search** It should be possible to find if it exists in the digital space.
- **Detect** Given that it exists, it should be possible to find if it is accessible over network.
- **Connect** It should be possible to establish a connection with it.
- **Discover** It should be possible to get asset description through its meta-data.

- **Explore** It should be possible to determine if the asset meets user's requirement. ??
- **Communicate** It should have a mechanism to transmit data/information.
- **Interact** It should offer a HMI
- **Extract** It should be possible to query the asset.





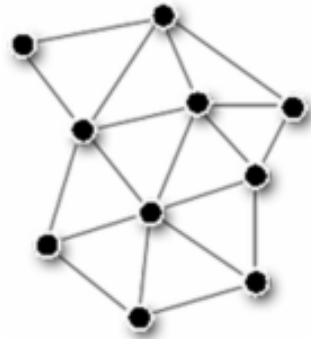
# Physical Assets coupled with their Digital Twins

1. Have a unique identification
2. Actively interact with the user and other products
3. Can store data about itself and learn
4. Has a communication language
5. Are capable of self assessment
6. Are capable of participating in or making decisions
7. Help in executing an action



# System of Systems

It is about bringing together IT, OT, IoT and machine intelligence to create System of Systems (SoS) that are not only interconnected, but communicate, analyze, and use information to generate insights to drive intelligent actions back into the physical world.



*Distributed SoS*



*Centralized SoS*



*Decentralized SoS*



**Thank you**