Digital Twins @ SLB

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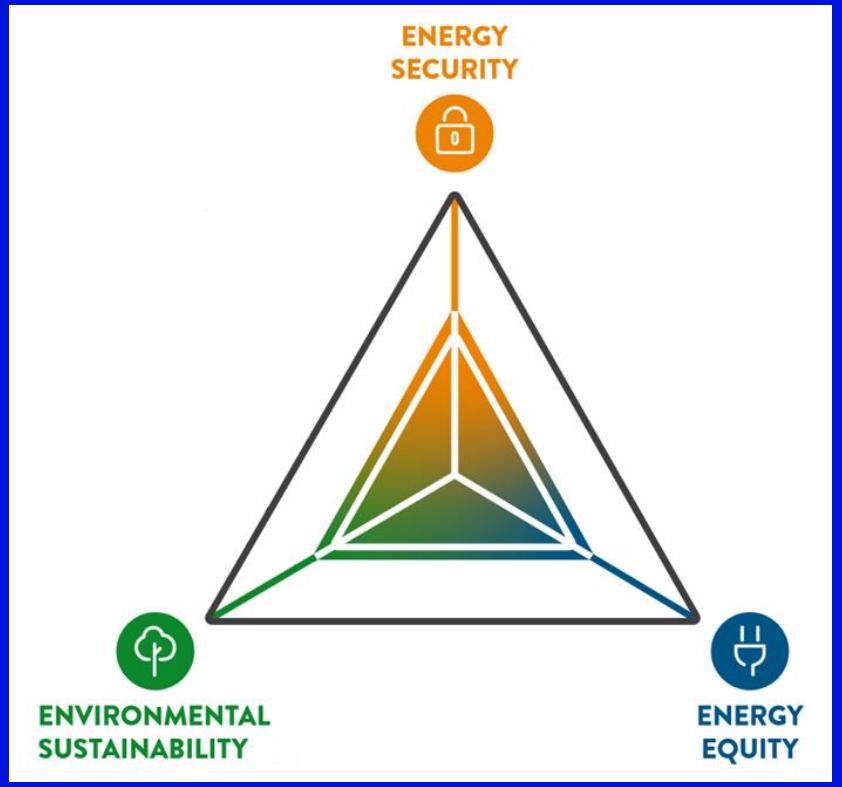
Energy Trilemma

Security, Sustainability & Equity



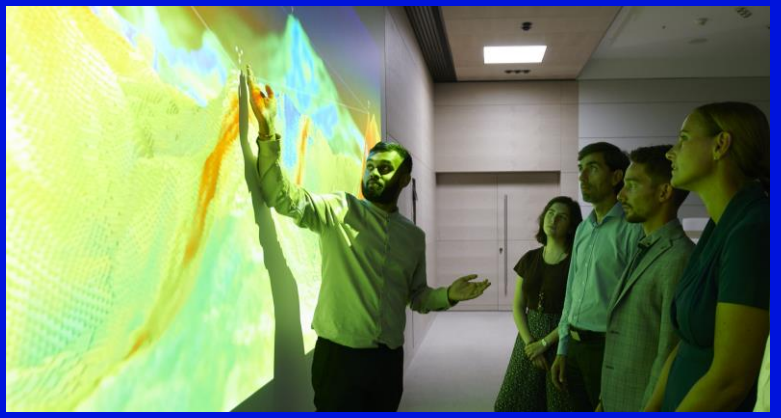
Source: World Energy Council

What we do

Decarbonizing industry
Working together to abate emissions

Innovating in oil and gas
Improving performance
in the oil and gas industry

Scaling new energy systems
Accelerating the transition
to clean energy



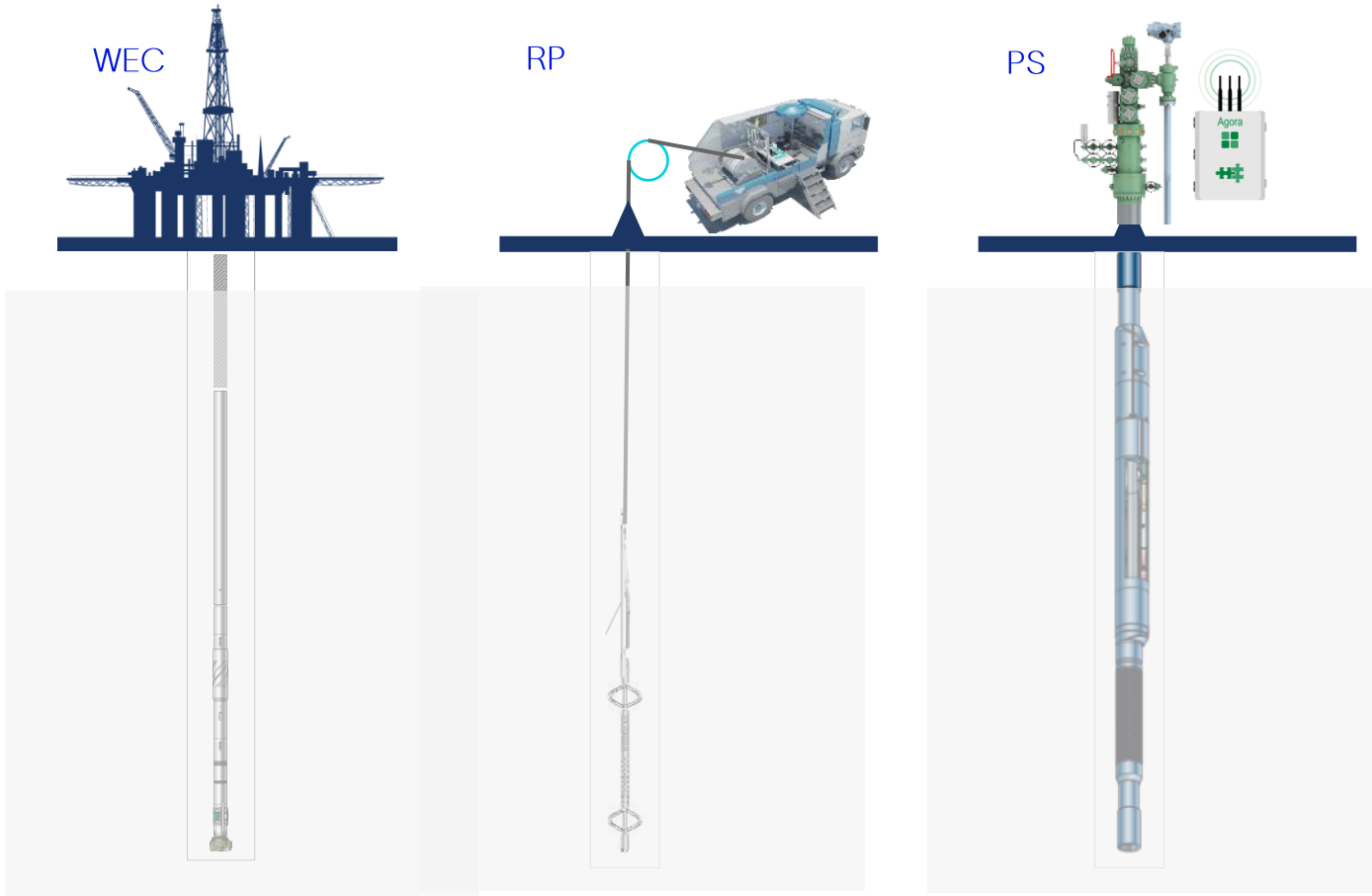
Delivering digital at scale
Accelerating time to value

Oilfield Equipment's are IOT

Challenge: finding and consuming matching records from multiple sources

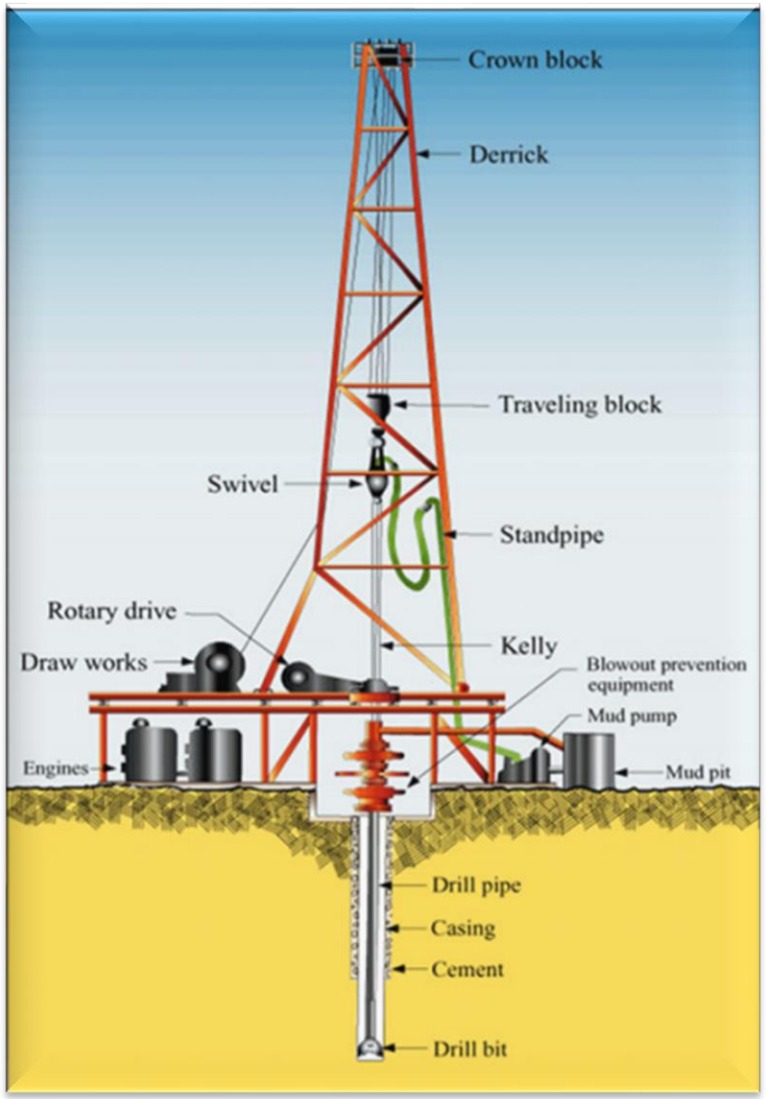
GEMS	QUEST	InTouch	SAP	OSDU	FDP	GCP	Azure	AWS	WODF	Cognite	Maximo

Influxdb	Maxwell	DrillOps	LiveOps	Helios Edge	CTOps	TalliX	CoilCAT	FracCAT	StimOps



- Data Richness
- Connectivity
- Interoperability
- Security
- Distributed Computing

Flexible Complexity



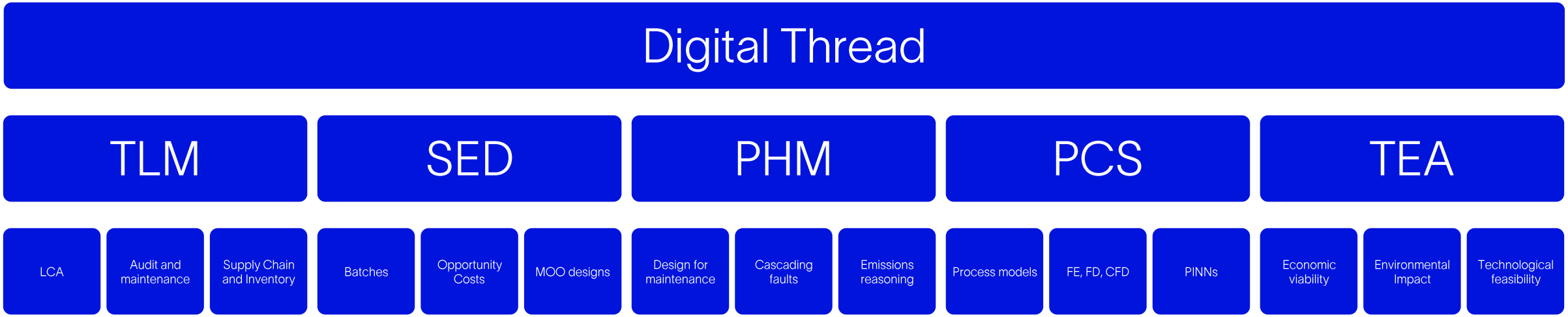
Typical SLB job requires:

A construction project
Custom equipment assembly
System-level coordination and control
Consumables inventory and logistics management

Engineering, manufacturing, sustaining:

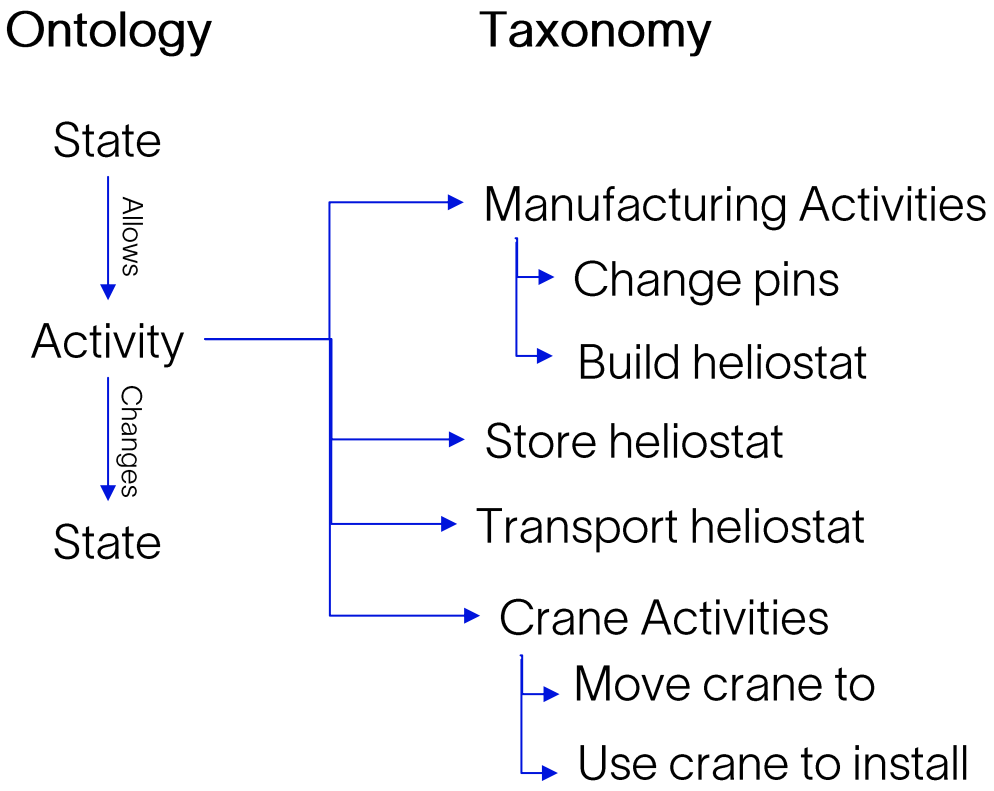
Scheduled maintenance
Troubleshooting maintenance
Lifecycle of materials
Logistics of raw materials
Logistics of complete tools
Supply chain

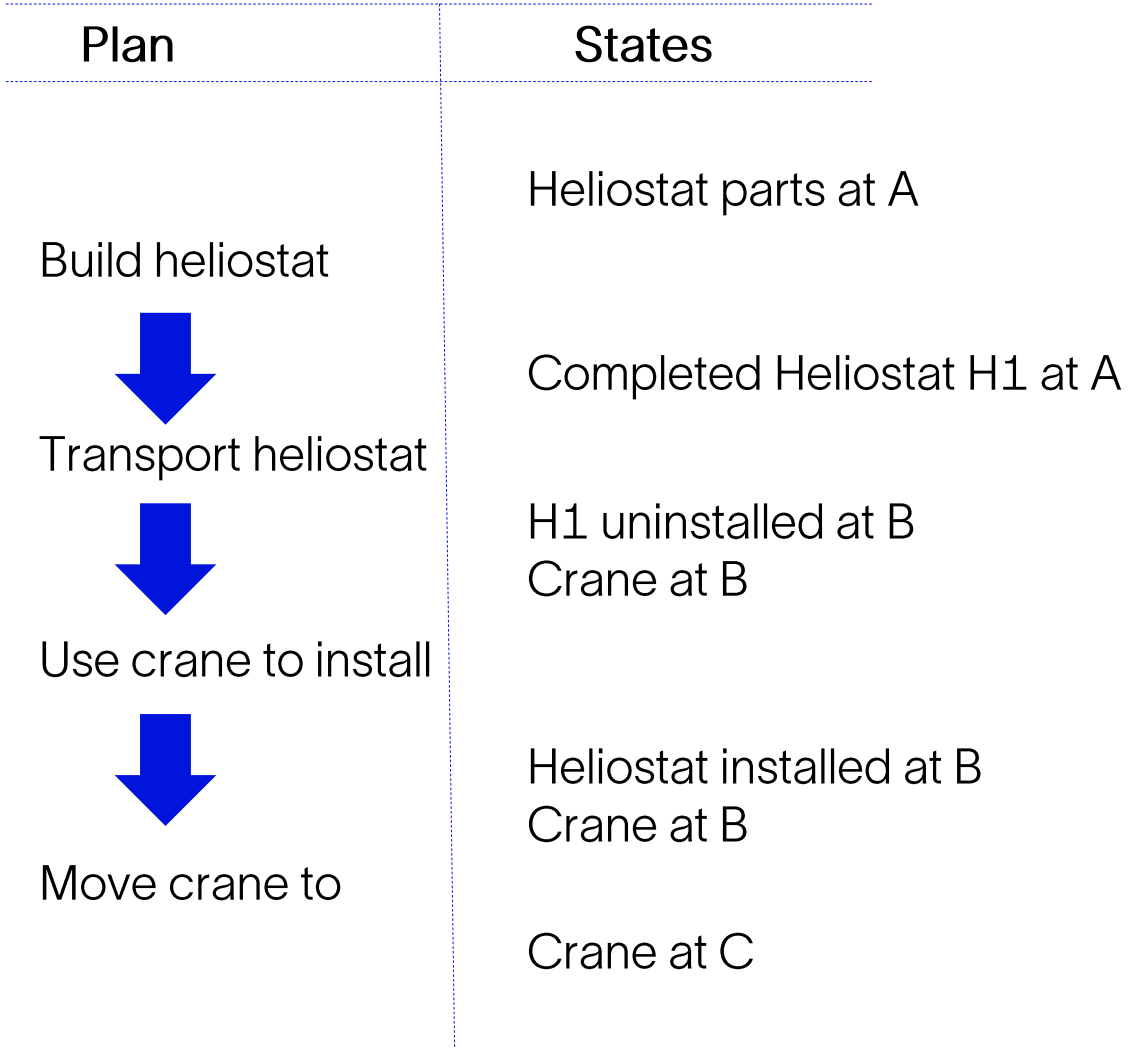
Digital Twins require digital thread



TLM: total lifecycle management
SED: sequential design of experiments
PHM: predictive health monitoring
PCS: physical-chemical simulations
TEA: technoeconomic analysis

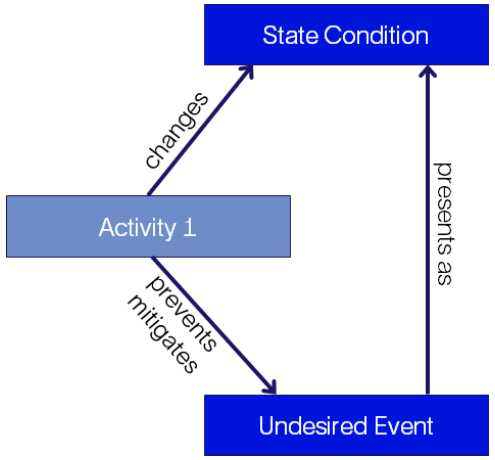
Planning Operations





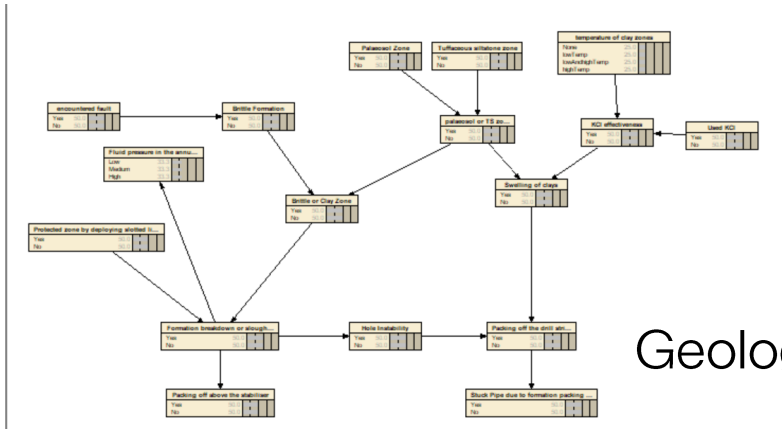
Risk and Root Cause

Ontology

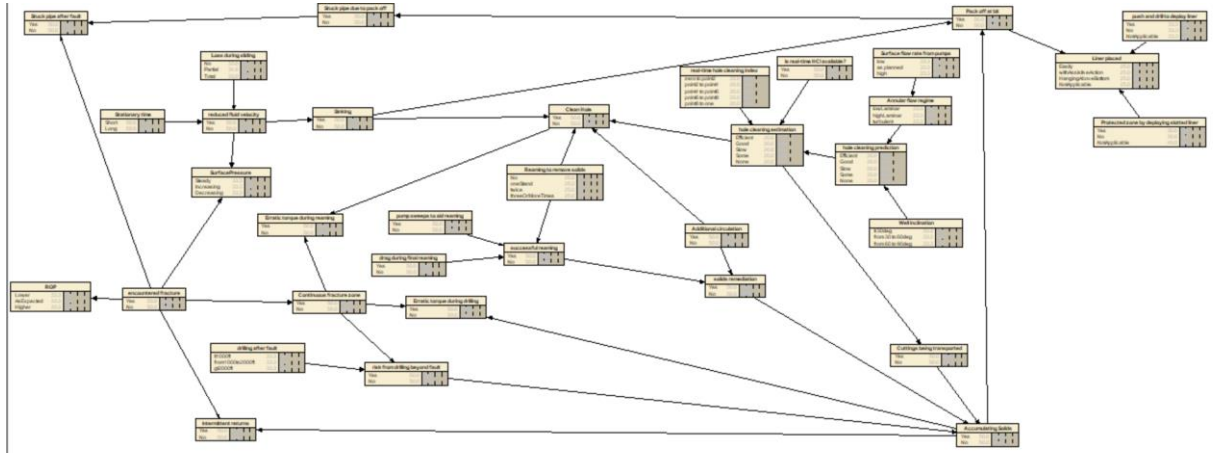


Taxonomy

- Activity
  - Drilling Operations
  - Intervention Operations
- StateEstimator
  - Circulation Monitoring
  - Differential Pressure Monitoring
  - Pipe Release Mechanism
  - Wireline Inspection
- Undesired Event
  - Differential Sticking
  - Loss of Circulation
  - Operational Disruption
  - Stuck Pipe Situation
  - Wireline Retrieval Failure
- World State
  - Circulation Loss
  - Differential Stuck
  - Operational Sticking
  - Pipe Stuck
  - Wireline Failure



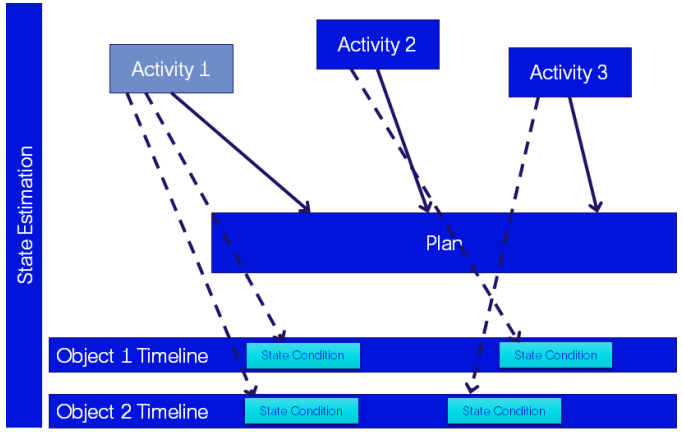
Geology



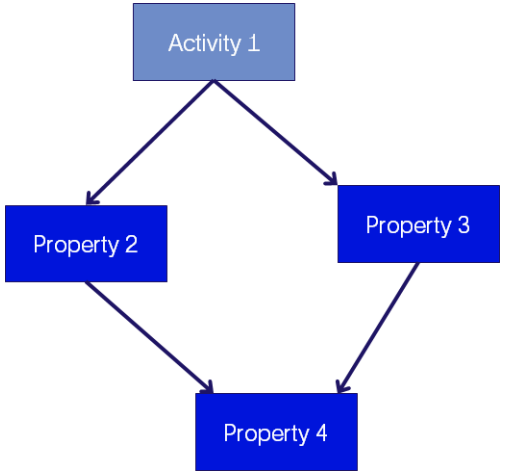
Well engineering

Activities across operations

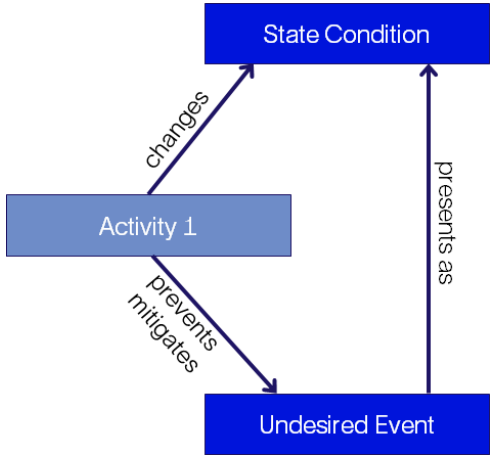
Activity



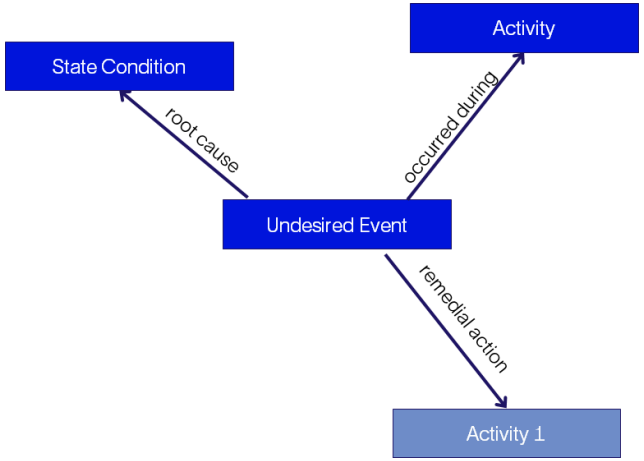
Causality



Risk



Lessons Learnt



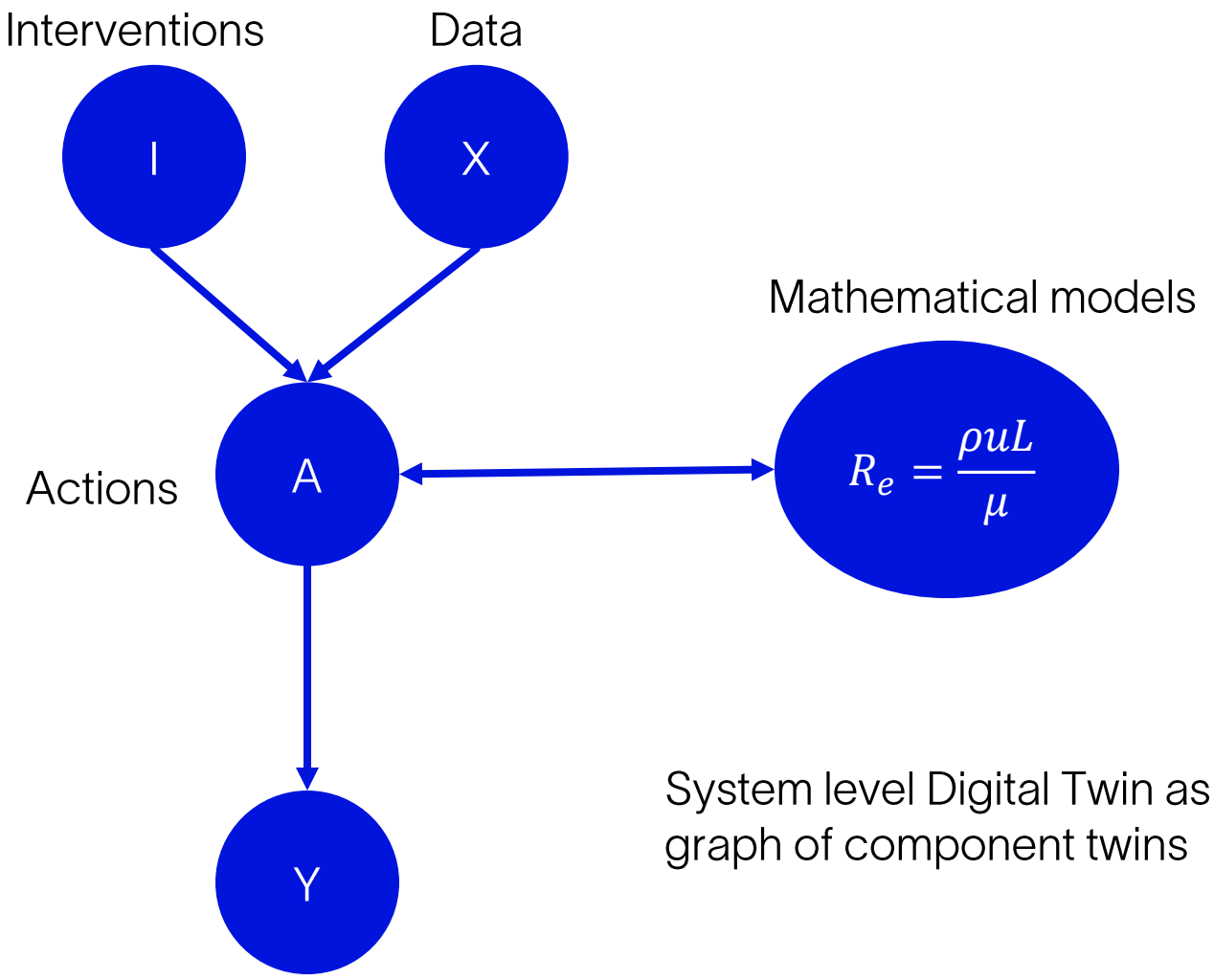
Digital Twins in Deployment

SLB technology in deployment is always treated as a custom system

DT1

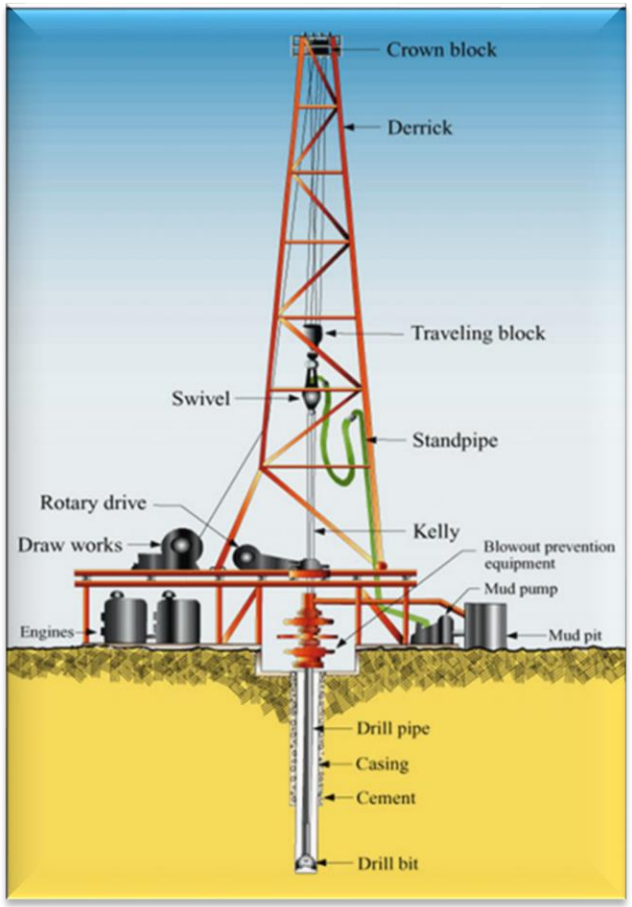
DT2

DT3



System level Digital Twin as a causal graph of component twins

Spotlight: Prognostics and Health Management (PHM)



Open Standard Architecture – Condition Based Maintenance (OSA-CBM)

- Data Acquisition
- Data Manipulation
- State of Health
- Diagnosis
- Prognosis
- Advisory Generation
- Maintenance Action

From Localized towards Holistic View and Process

Data Acquisition → Maintenance Action → Data Acquisition → Maintenance Action → Data Acquisition → Maintenance Action

LRU1 ↕ LRU2 → Subsystem 1 ↕ Subsystem 2 → System

LRU → Subsystem 2

LRU Level Digital Twin → Subsystem Level Digital Twin → System Level Digital Twin

Interactions → Cascading faults → *Digital Twins* Simulations → Mapped by *Knowledge Graph* → Data Availability enabled by Digital thread → Emissions Calculations and maintenance at higher level

Digital Thread

System level PHM/ Emissions Reasoner

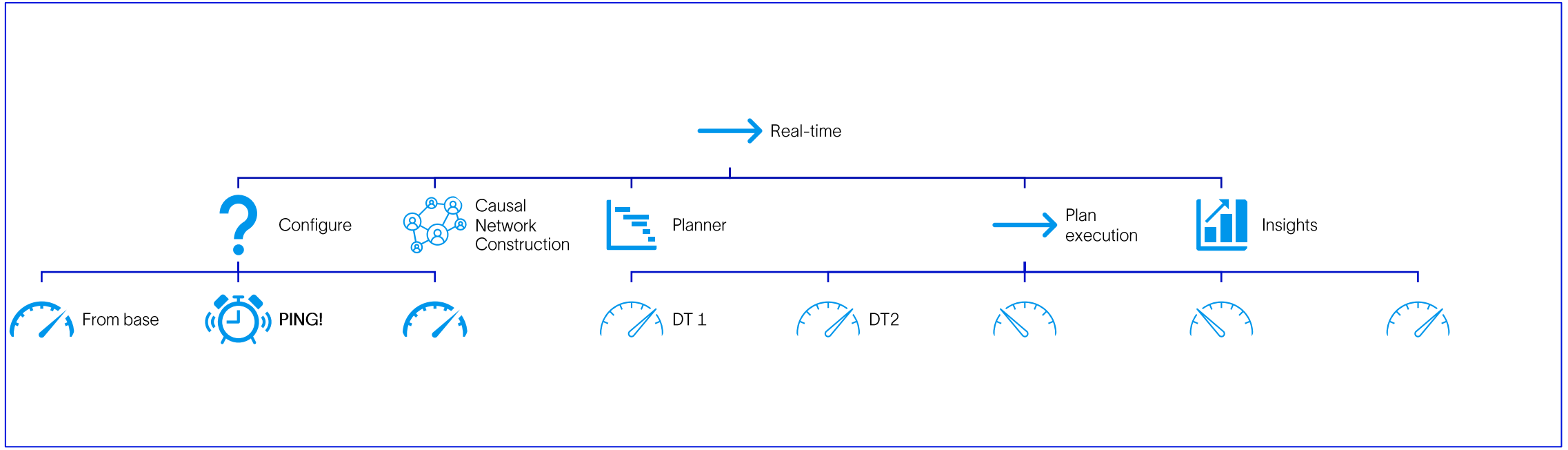
Digital Twins in Deployment

SLB technology in deployment is always a custom system

Increasingly reconfigurable in-use.

Digital Twin in deployment must be system-level reconfigurable

Operationally we use Behaviour Trees



Tips

Taxonomies

- The dictionary and definitions
- Develop for cataloguing and data management
- Owned by subject matter experts

Ontologies

- General, keep them concise
- Develop for application instantiation or “competency questions”
- Owned by digital applications teams

Application Graphs

- Specific
- Always instantiated by combining one or more ontologies with the relevant taxonomies and attaching to data
- Usually ephemeral

- Data is stored, application graphs are usually not
- Ownership, governance and responsibility is important at the level of each ontology or taxonomy
- Large-scale, top-down “define everything” governance committee approach is less successful