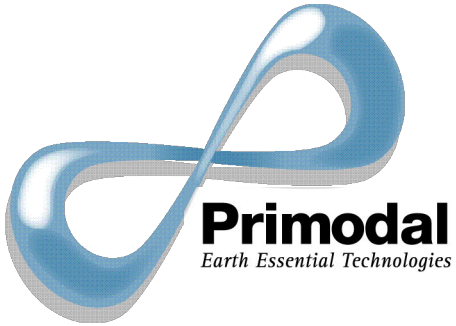
Wastewater Treatment Digital Twins Made Possible:

A New Tool for the Integration of Data Analysis with Near Real-Time Simulation



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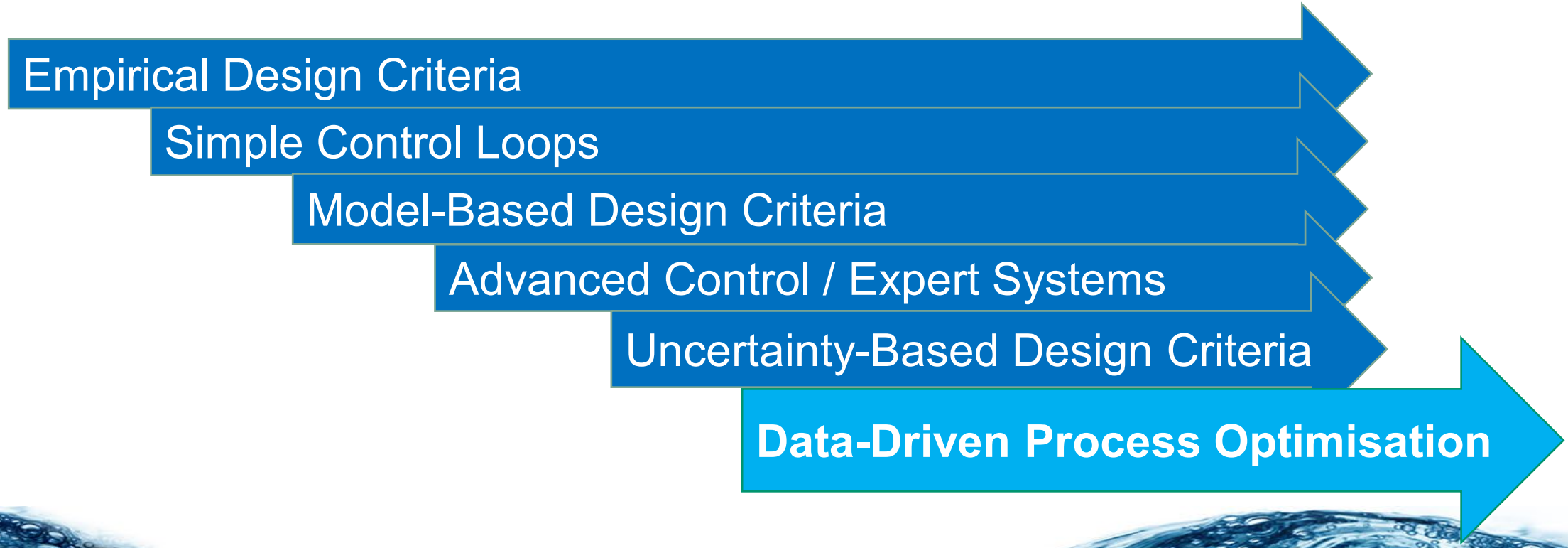
Primodal

- Based in Hamilton, ON. (est. 2005)
- Data-Driven Solutions
  - Mechanistic Process Modelling Specialists
  - Process Engineering & Modelling, Design, Control, Uncertainty Analysis, and Data Analytics
- COMMON THEME → <u>Data Evaluation</u>
  - the need for accurate and representative data
  - data analytics (quality, analysis, open data, …)
- *PrecisionNow*© software suite (data analysis, modelling)
  - dDesk, dDock & dDockDT

Precision***Now*** → *Why?*

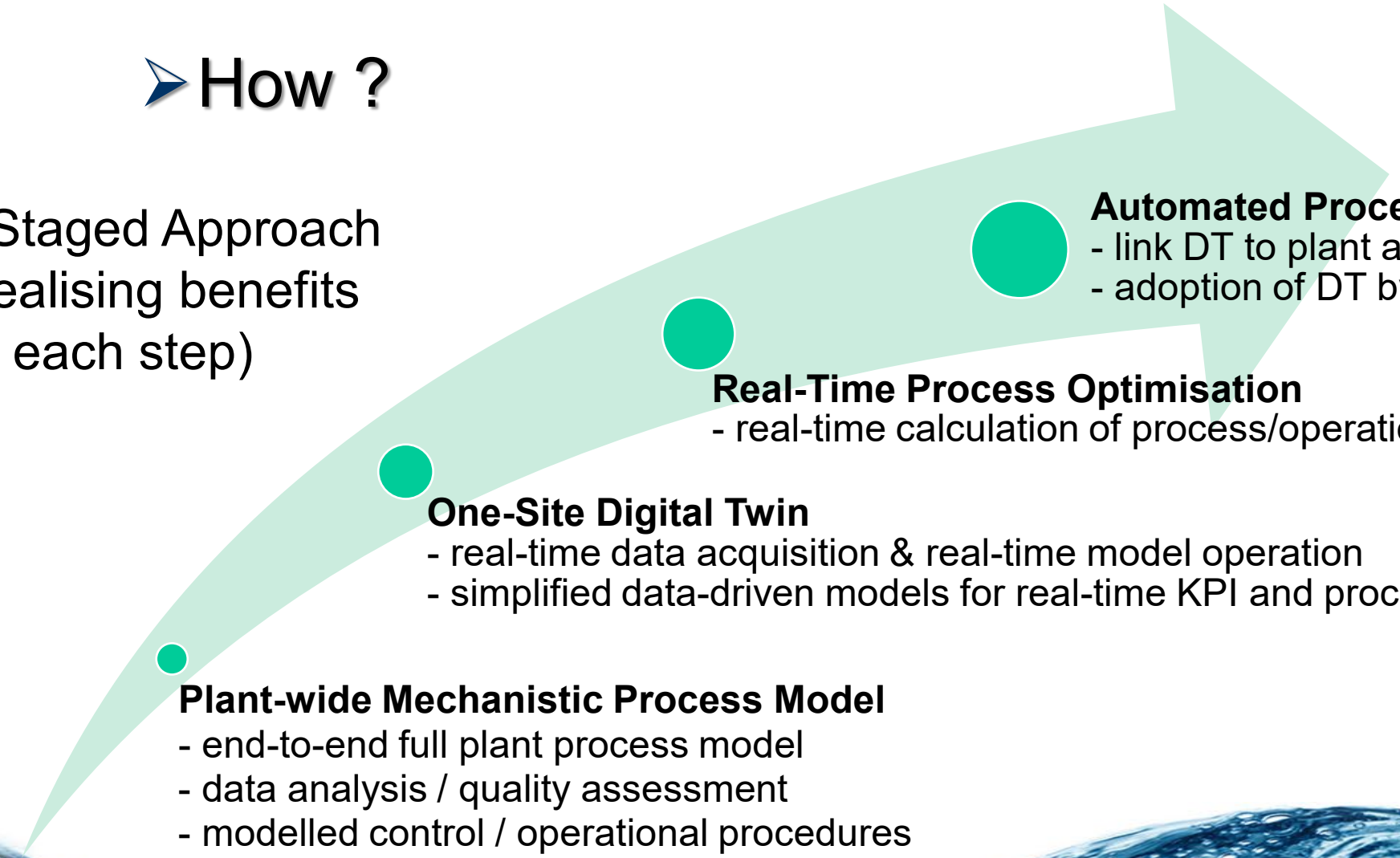
- Simply Put:
  - Practical Process Understanding / Better Operation, Decision-Making (in a user-configurable tool using data ***already*** being collected)



Towards A Digital Twin

How ?

- Staged Approach (realising benefits at each step)



Automated Process Control
- link DT to plant actuators
- adoption of DT by all disciplines

Real-Time Process Optimisation
- real-time calculation of process/operational variables

One-Site Digital Twin
- real-time data acquisition & real-time model operation
- simplified data-driven models for real-time KPI and process optimisation

Plant-wide Mechanistic Process Model
- end-to-end full plant process model
- data analysis / quality assessment
- modelled control / operational procedures
- detailed system understanding

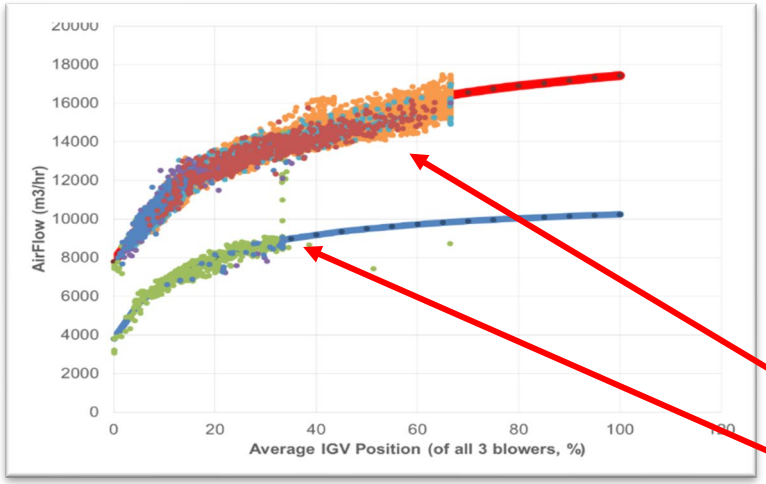
Barriers to Implementation

- Data Quality
- SILO issue
  - PROBLEM:
    - Communication within organisations
  - **EXAMPLE:**
    - Terrible DO control, erratic blower activity
    - Effluent ammonia spikes
  - INITIAL ANALYSIS
    - DO setpoint based on ammonia value (ABAC)
    - Setpoint algorithm reasonable
    - Valve / Pressure / Blower algorithms reasonable

Barriers to Implementation

SILO issue

- DATA ANALYSIS / MODEL-BASED RESULT
  - Aeration response too slow → response dampening
  - Ammonia sensor inappropriately deployed
    - Spatial issues
    - Maintenance issues



AirFlow Control:
- not correlated to actuators being controlled,
- impact of delays in aeration response??

Barriers to Implementation

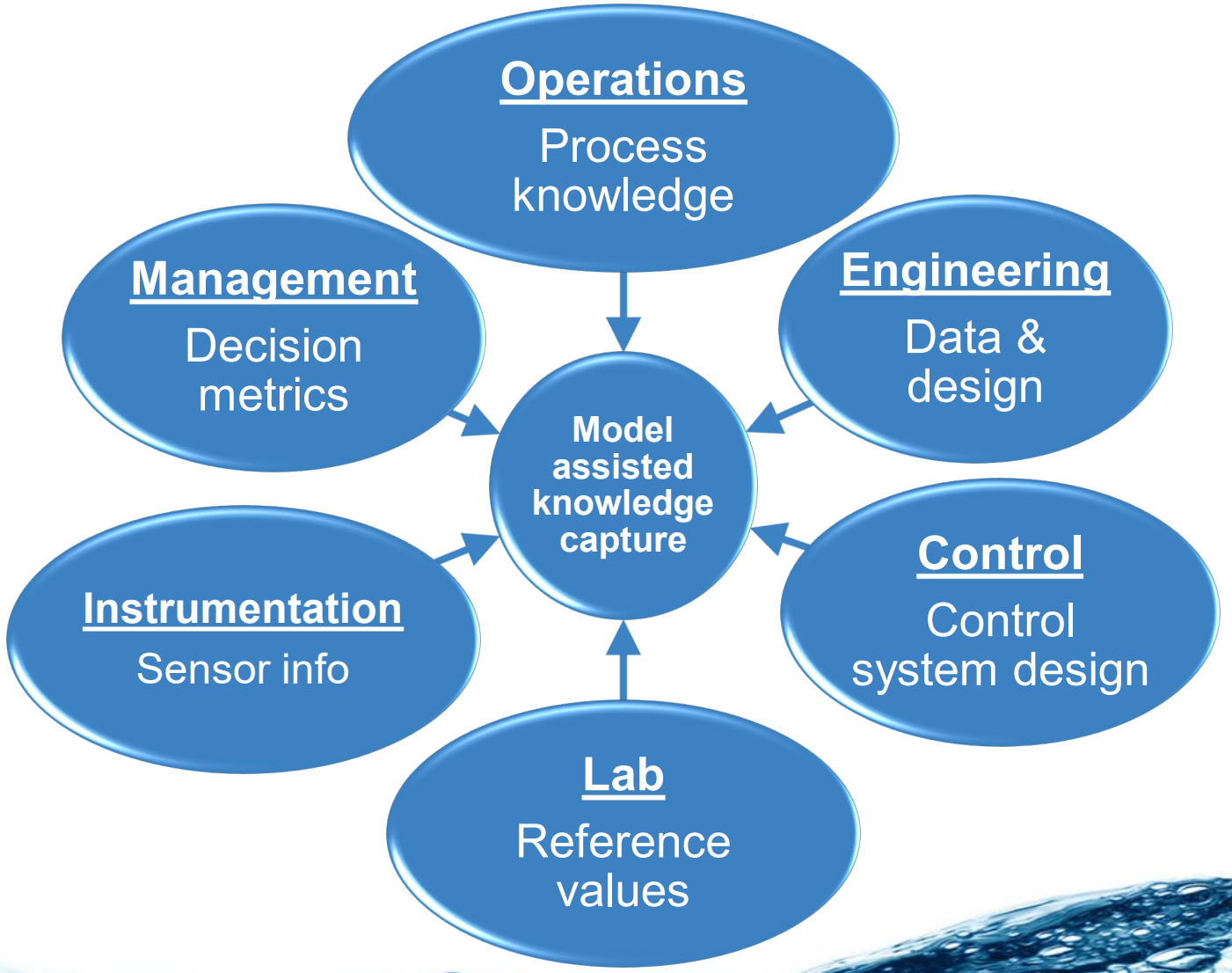
SILO issue

- PROBLEM:
  - Everyone doing their jobs correctly
  - Lack of understanding how each task impacts next step outcome
  - Lack of understanding how the pieces work together (i.e. SILOs)

- SOLUTION
  - Interdisciplinary process analysis
  - Model-based knowledge capture and decision intelligence

- VISION
  - Digital Twin implementation with *real-time data verification* & *automated model updating* for real-time plant status and operation

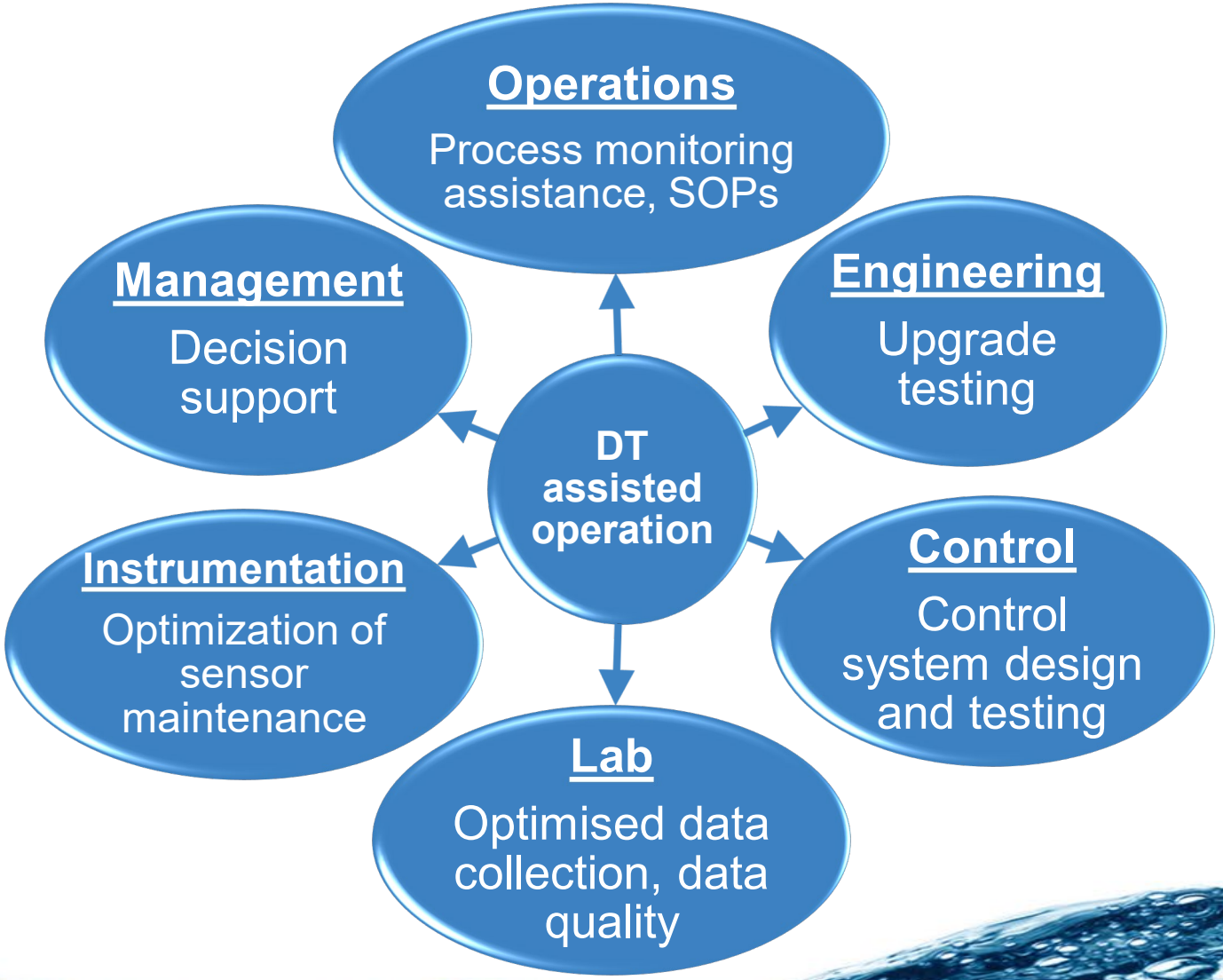
Interdisciplinary Approach



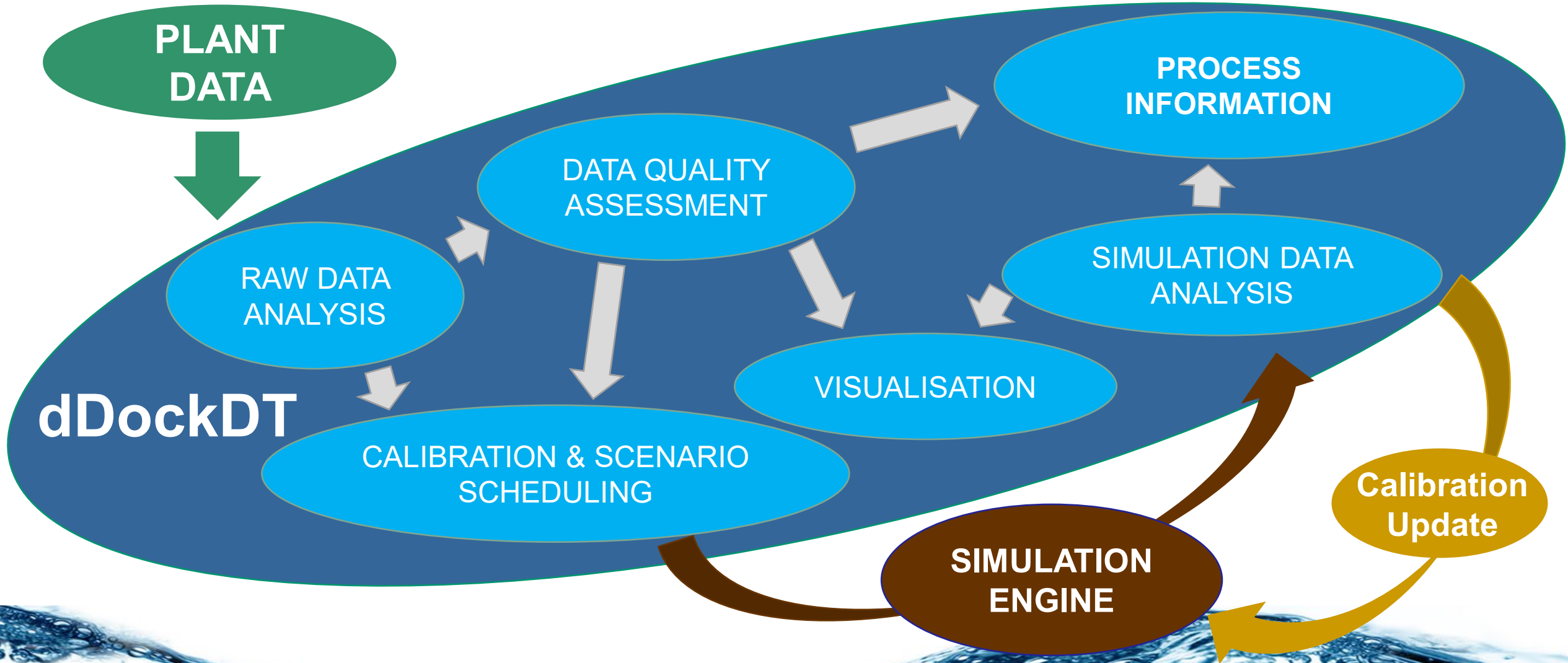
Successful DT Implementation

- Includes all disciplines
- Creates incentives for all disciplines
- Incorporates existing operations in DT
- Data quality control
- Optimises data usage
- Incorporates new data-driven operational outcomes into existing SOPs and operator work schedules

Successful DT Implementation



Precision***Now***: *dDockDT*



Precision*Now* Software Suite

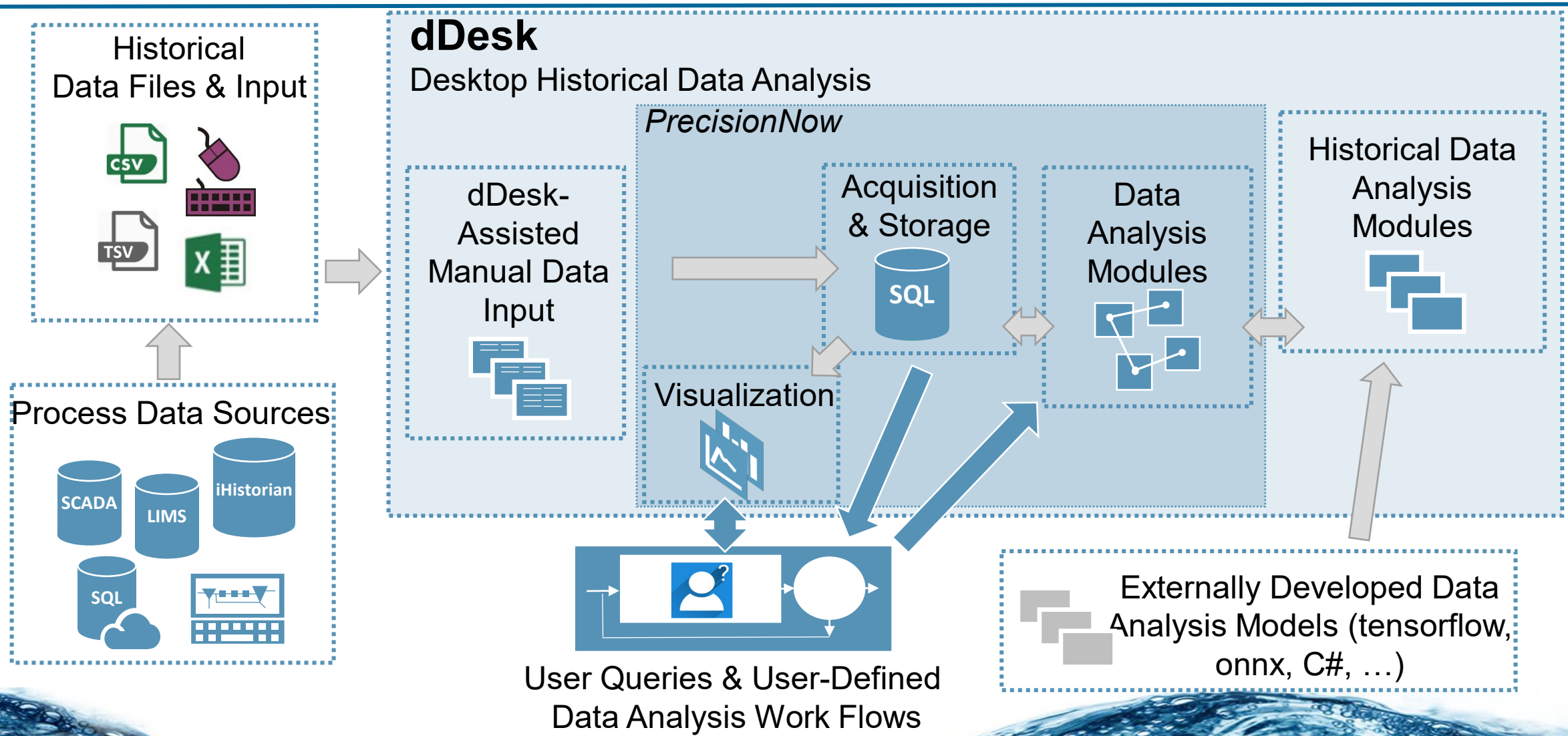
Historical Data
- Manual data import
- Single-run data analysis
- Standard / custom data module library
- Python / AI model linking

Real-Time Data
- dDesk functionality +
- Automated data import
- Continuous data analysis
- Real-time module library

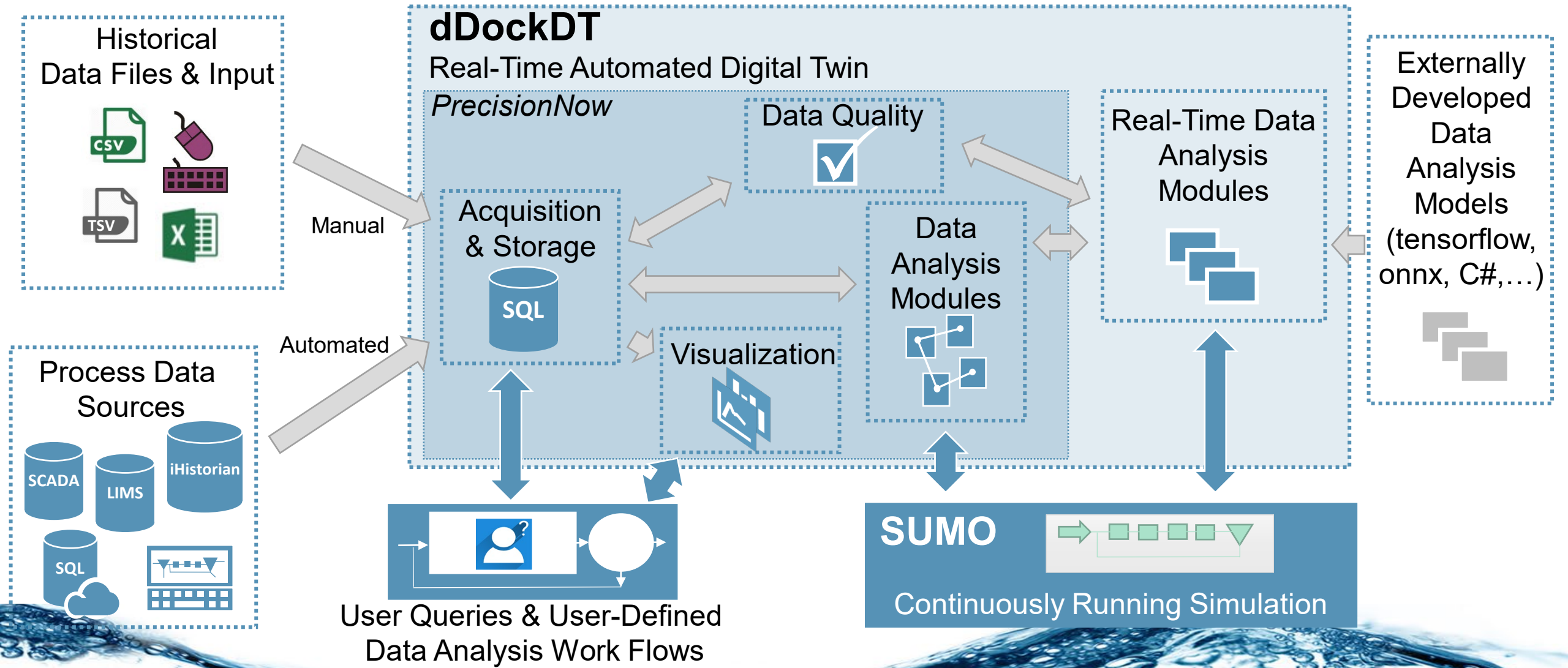
Platform
- Database
- Visualisation
- Data import / export
  - Manual, automatic
  - Excel, csv, OPC, python, …
- Data analysis engine
- External communication

Digital Twin
- dDock functionality +
- Task scheduling
- Real-time model linking / updating
- Operational feedback

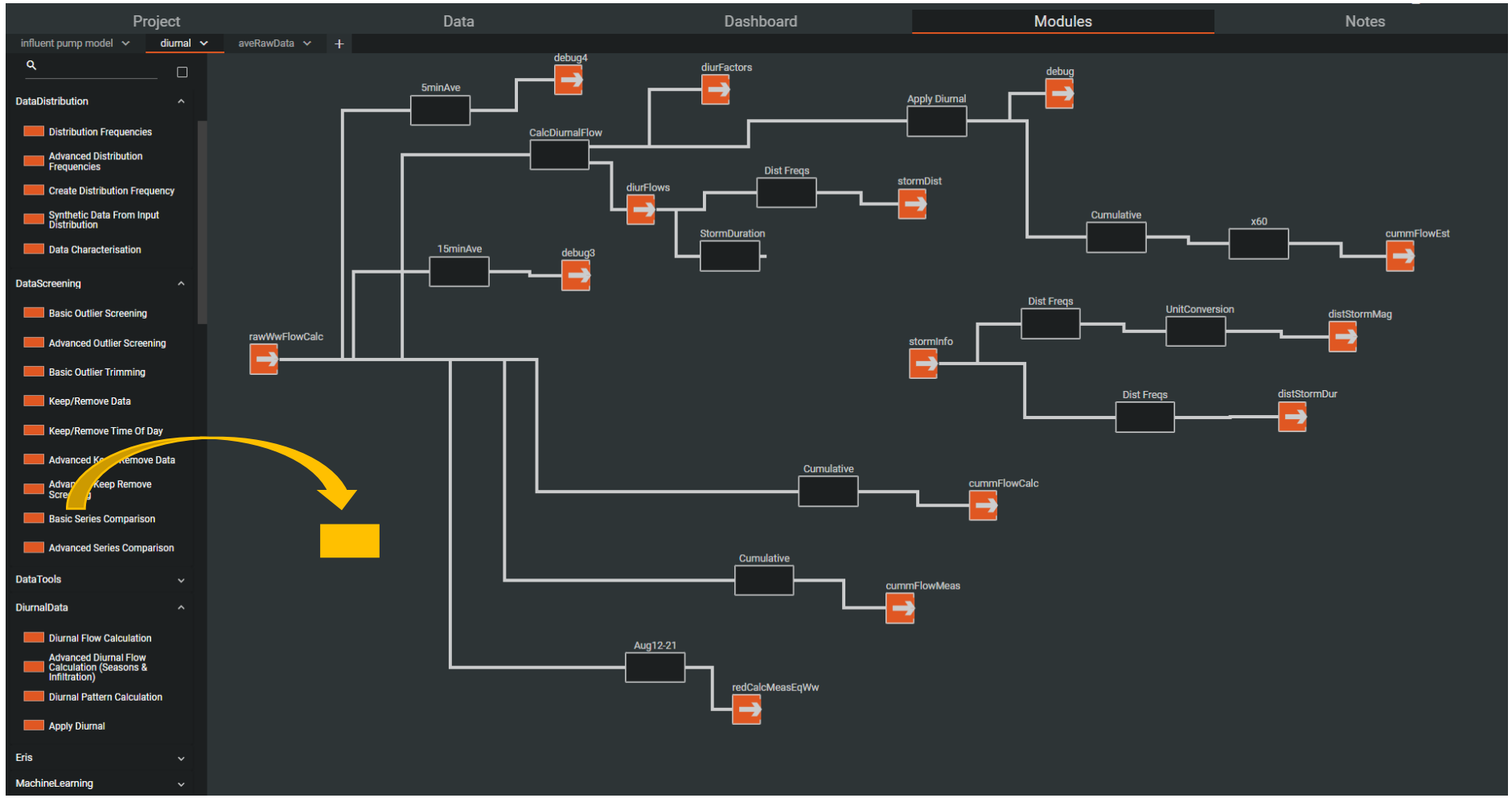
Precision*Now*: *dDesk*



Precision***Now***: *dDockDT*



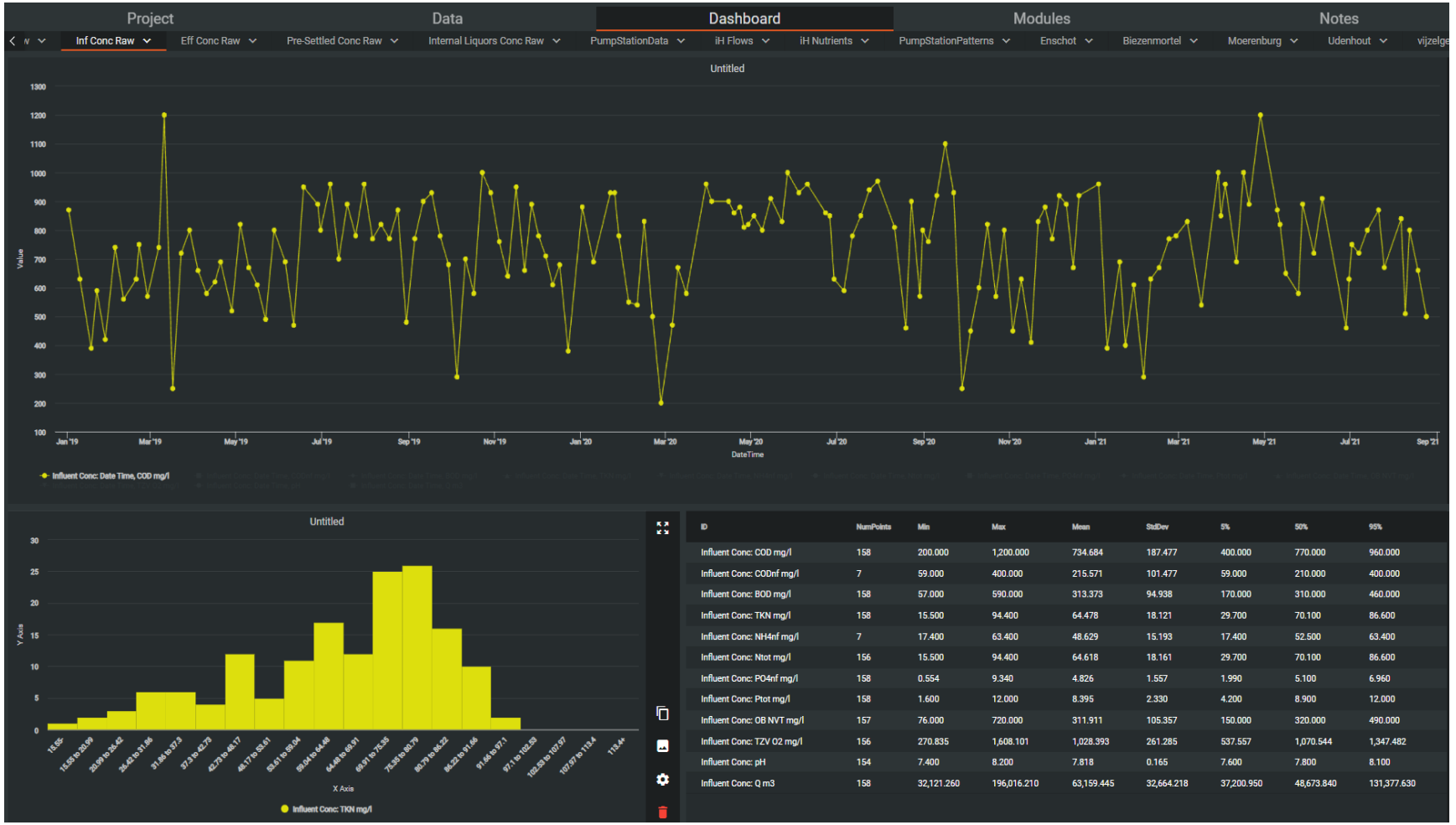
PrecisionNow → *User-Configurable Data Analysis*



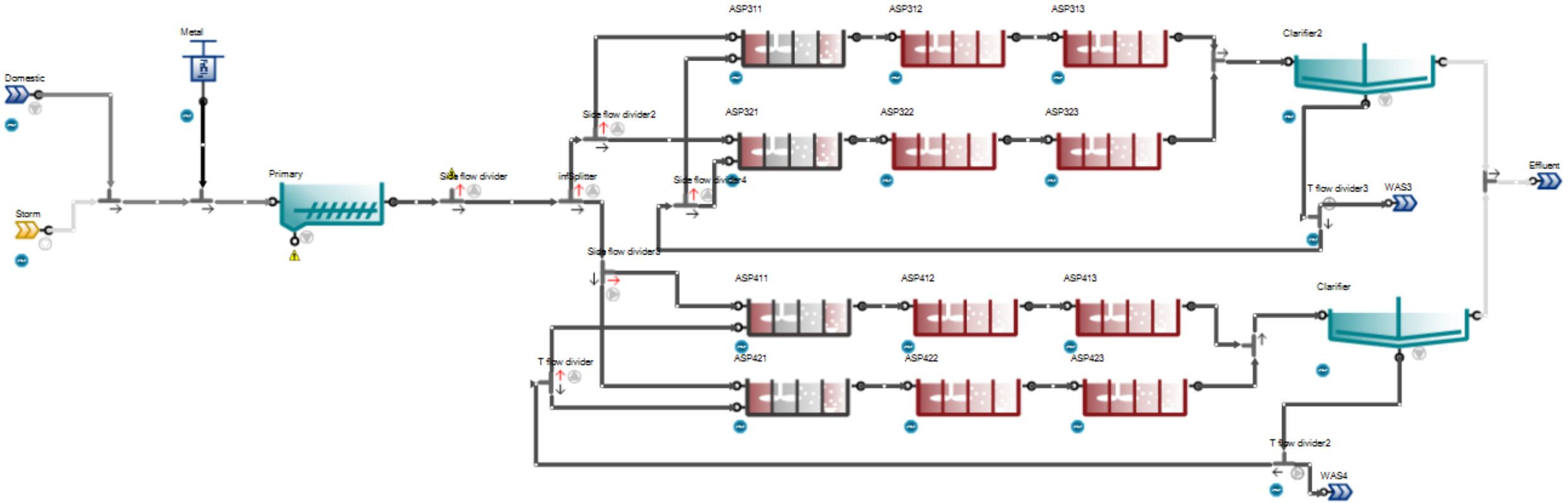
- Drag-n-drop 100s of user-configurable data analysis modules, then connect them up
- Visualise your data analysis flow

PrecisionNow → *User-Configurable Visualisation*

- Choose your own visualisation options
- Configure personalised dashboards



Demo


Domestic
Metal
Storm
Primary
Side flow divider
infSplitter
Side flow divider2
Side flow divider4
Side flow divider5
T flow divider
ASP311
ASP312
ASP313
ASP321
ASP322
ASP323
ASP411
ASP412
ASP413
ASP421
ASP422
ASP423
Clarifier2
Clarifier
T flow divider3
WAS3
T flow divider2
WAS4
Effluent

Demo

PrecisionNow

dDesk

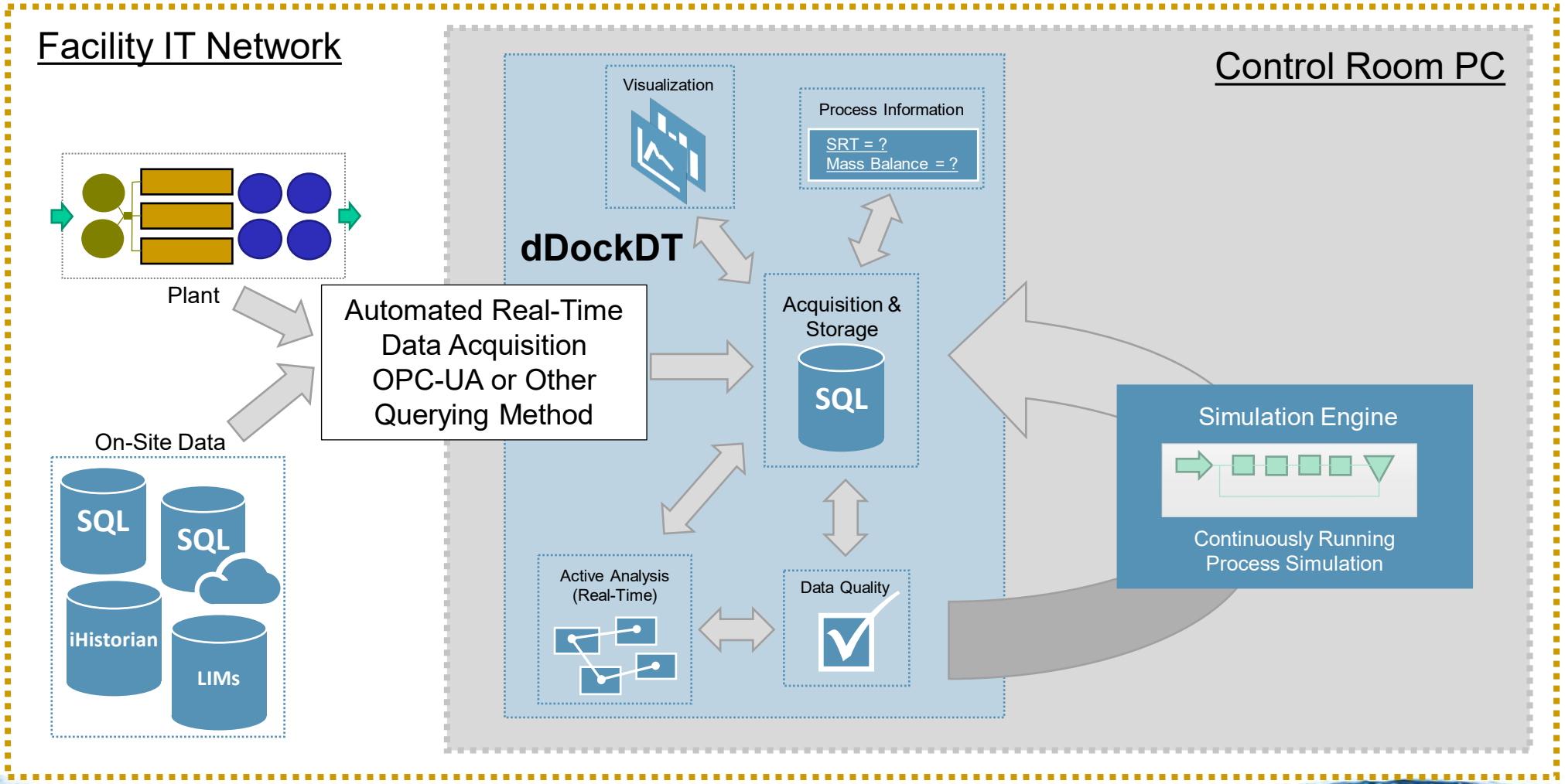
A PRIMODAL SYSTEMS DATA ANALYSIS PRODUCT

PrecisionNow

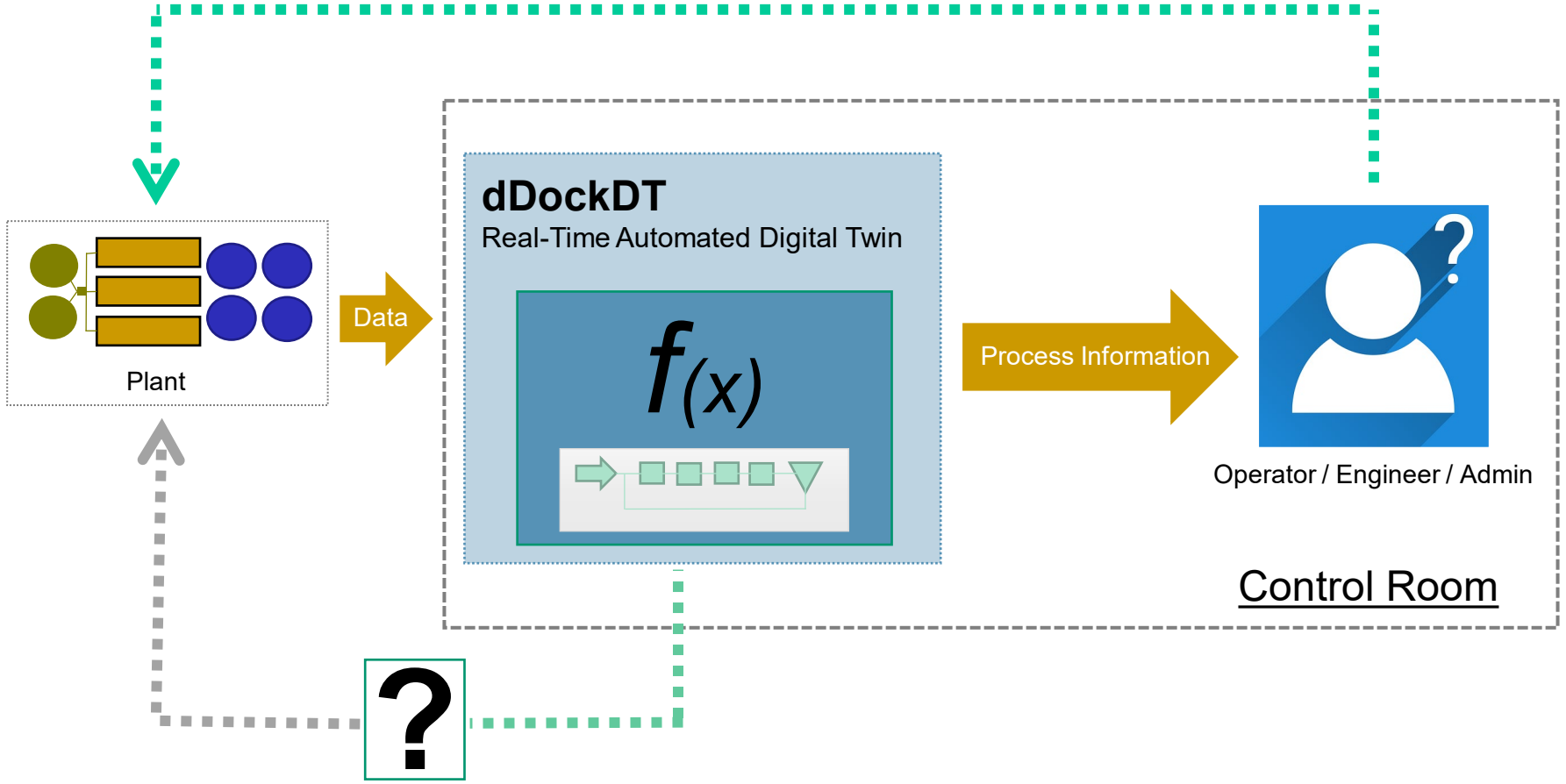
dDockDT

A PRIMODAL SYSTEMS DIGITAL TWIN TECHNOLOGY

Precision***Now***: *dDockDT*

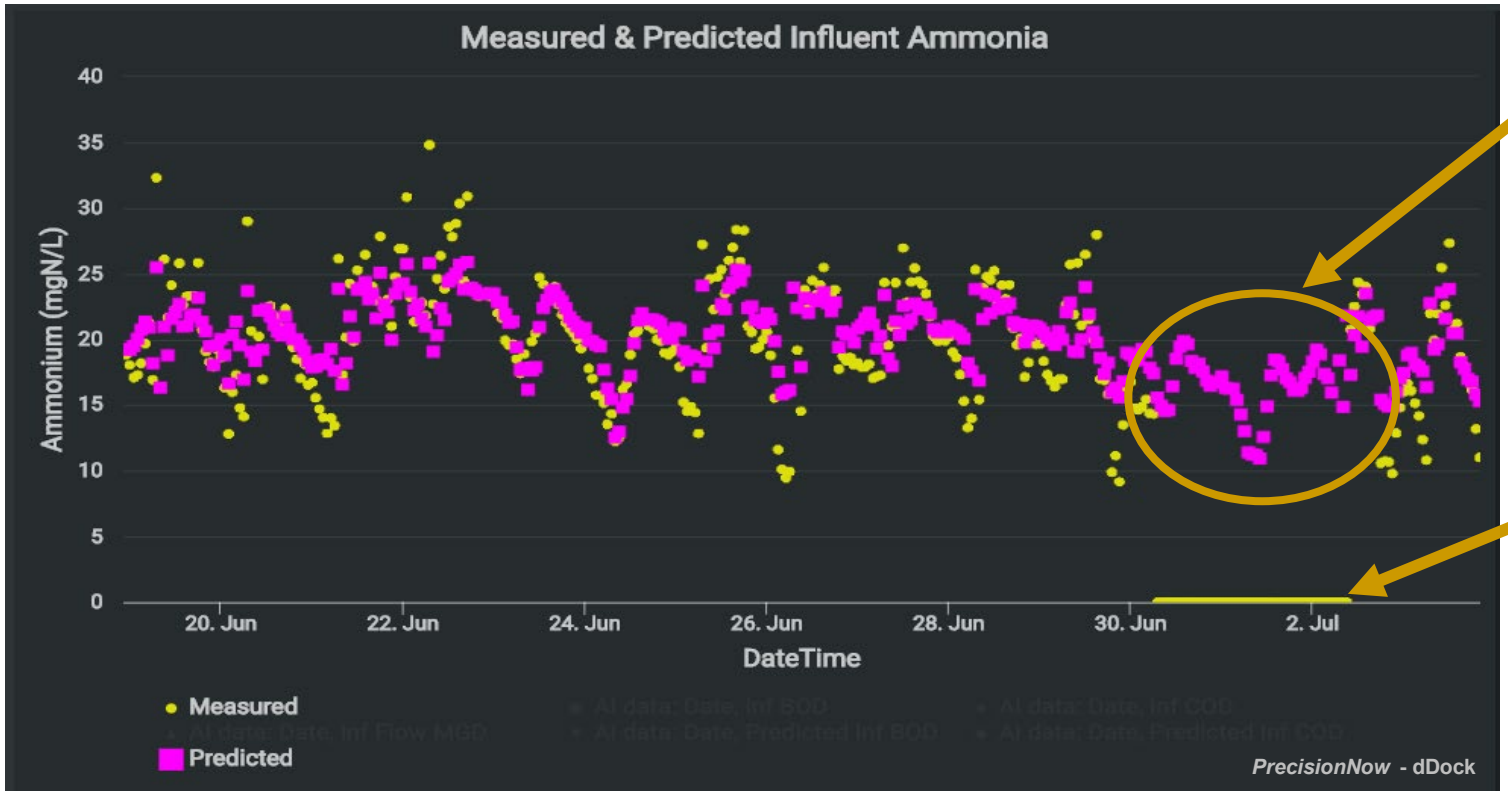


Precision***Now***: *dDockDT*



Failures, Process Oddities …

- Predictive Fault Detection & Soft Sensors



Real-time soft sensors running in parallel, or alone

Sensor failure & alarm

Failures, Process Oddities …

- Predictive Fault Detection & Soft Sensors
- Optimise and adaptive control structures
  - DO, SRT, MLSS, Chemical Dosing, …
- Flow & Mass Balances
  - Influent/Effluent, Flow splits
- Identify maintenance issues
  - Statistical comparison of parallel ASPs
  - DO probes, Airflows, Valves, Ammonia …

Conclusion

Data Quality

- Data Quality is essential
  - You've invested in the equipment, so spending the time and money ensuring data quality will help realise the benefits

- Maintenance
  - Understanding when and how often maintenance is required saves money (avoid *ad hoc* estimates)

Conclusion

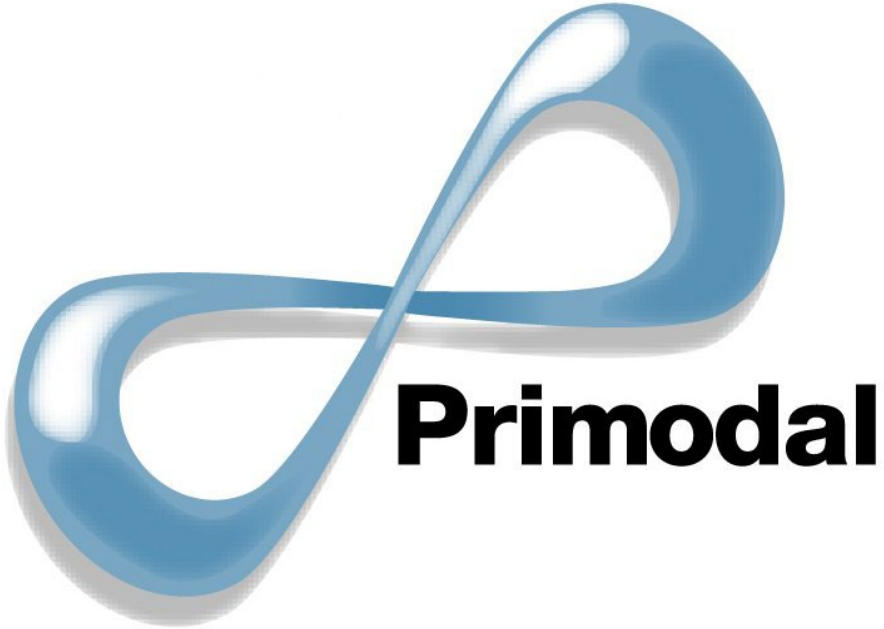
Digital Twins Need Prior and Post Model Data Analysis

- Raw data analysis for proper data to the model
- Model output analysis for real-time operational efficiency

Precision*Now*

- User-Configurable DT technology
  - data analysis & visualisation
  - data flow to/from the model
  - multiple model capabilities, scheduling, optimisation

Thank-you !



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