

# Smart Manufacturing Solutions

Build our Future with  
Digital Transformation



# A prosperous society realized through Digital Transformation

Today, companies and countries are striving to achieve a prosperous future and sustainable operations through initiatives such as autonomous operations, reductions in energy consumption and greenhouse gas emissions, resource conservation, and the safe production of quality products. Yokogawa helps customers realize their objectives by working together, with a focus on sustainable development, such as sustainable development goals (SDGs) and the goals of the Paris Agreement.



DESIGN

DISCOVER



DEVELOP



More than ever, market forces and new technologies are bringing unprecedented opportunities to the business. Digital Transformation makes it possible to transform one's operations and alignment of the people, process, and technology aspects of your business, which makes it possible to create significant economic value, resolve social issues, and meet SDGs.

While Digital Transformation (DX) means different things to different people, it has become a mantra for enterprises looking to become relevant and establish themselves as leaders in the digital economy.

By combining an understanding of our customers' businesses, automation, and operational technologies, cultivated over decades, with the latest digital technologies, Yokogawa supports your DX journey toward sustainable, smart, and autonomous operations and our prosperous society of the future.

C o n t e n t s

Supply Chain Management



Production Optimization



Operations Management



Smart Manufacturing



SDGs, Energy Management & Optimization



Plant Asset Management



Topics



# Your Digital Transformation Journey

Digital Transformation is about Enabling your business strategy through the judicious application of digital technologies, while digitization is the act of converting information into a digital format, digitalization and Digital Transformation involve business and workflow changes, enterprise operations, and business transformation. Yokogawa is ready to apply our method to help customers realize substantial benefits through a Digital Transformation journey.

## The Anatomy of a Digital Transformation

Digital Transformation can only occur when people, processes and technology are considered as an integrated group. This integrated group is then aligned to your corporate vision and dominant business strategy such as operational excellence, product leadership or customer intimacy.

### Digital enablement through:

- Leveraging cloud and the Industrial Internet of Things (IIoT) to integrate process, asset, and even raw control system data enables high-quality analysis and the prediction of future conditions.
- Optimizing decision making processes across the supply chain by integrating workplaces, sites, and companies.
- Empowering the next generation of digitally fluent workers with the experience and know-how of industry veterans to maximize the potential of your workforce.

Combining business and domain knowledge with new technologies not only enhances production efficiency, safety, and profitability but also encourages innovative changes in business culture.

## Partner up

Because every company is unique in how it operationalizes its' business strategy, so too will be the desired approach to Digital Transformation. Partnering with consultants, suppliers, and customers incorporates the entire supply chain and allows implementation teams to best manage complexity, project execution, risk, and the full scope of domain expertise that is required. Yokogawa offers a Discovery Workshop to introduce the Digital Transformation Framework, help align your Digital Transformation efforts, and create organizational awareness.

### DISCOVER



Discover digital opportunities for organization and establish Digital Transformation blueprint.

**Activities:**

- ▶ Value Discovery
- ▶ Digital Maturity Assessment
- ▶ Key Stakeholder Interviews
- ▶ DX Blueprinting

**Deliverables:**

- ▶ Digital Transformation Blueprint
- ▶ DX Maturity Assessment Report
- ▶ Interim Action Plan

### DESIGN



Design a Digital Transformation business plan which is ready for implementation.

**Activities:**

- ▶ Stakeholders Alignment Sessions
- ▶ Business Process Mapping
- ▶ Analyze and Design
- ▶ Business Case Challenge Sessions

**Deliverables:**

- ▶ Business Case
- ▶ DX Roadmap
- ▶ DX Governance Framework
- ▶ Digital Architecture Design
- ▶ Cybersecurity Philosophy
- ▶ Application Framework Design
- ▶ User Requirement Specifications (URS)
- ▶ Proof of Value

### DEVELOP



Develop outcome-based Digital Transformation experience according to plan

**Activities:**

- ▶ Programme Governance
- ▶ Project & Change Management
- ▶ Build, Test and Production Release
- ▶ Agile Sprints & DevOps

**Deliverables:**

- ▶ Digital Products and Services
- ▶ Training Programme
- ▶ Documentation
- ▶ Sustainability Plan

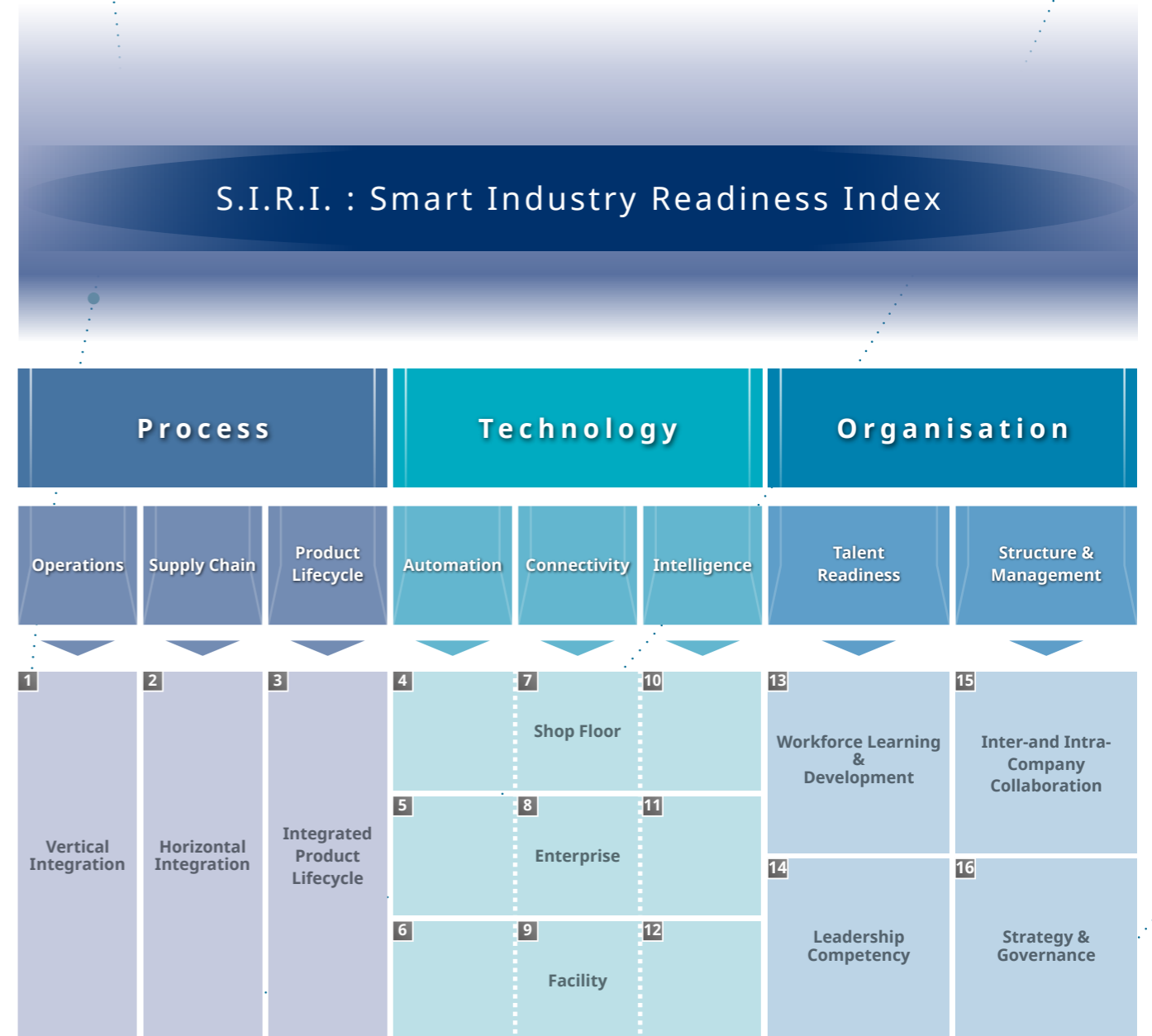
# Success Factors and Where to Start

While strategies and digital initiatives should be developed with a strong orientation toward external forces, the practical execution of a Digital Transformation begins internally, where your company can fully own its choice of actions and outcomes. We recommend the following practical steps when embarking on your journey:

- Align the Digital initiative with Corporate Goals and Strategy
- Assess Readiness
- Challenge Organizational Structures to Foster Collaboration
- Organize Processes around Customers
- Identify Quick Wins
- Build a Technology Foundation

Yokogawa brings a deep, broad experience in operations, process automation, technology consulting and support services. Our engagement model starts with understanding your goals, identifying challenges, quantifying financial impacts, and estimating complexity. This is followed by a design driven approach to comprehensively understand as-is and desired business processes, human factors, and enabling technologies. Quick wins are identified to accelerate acceptance and business value realization.

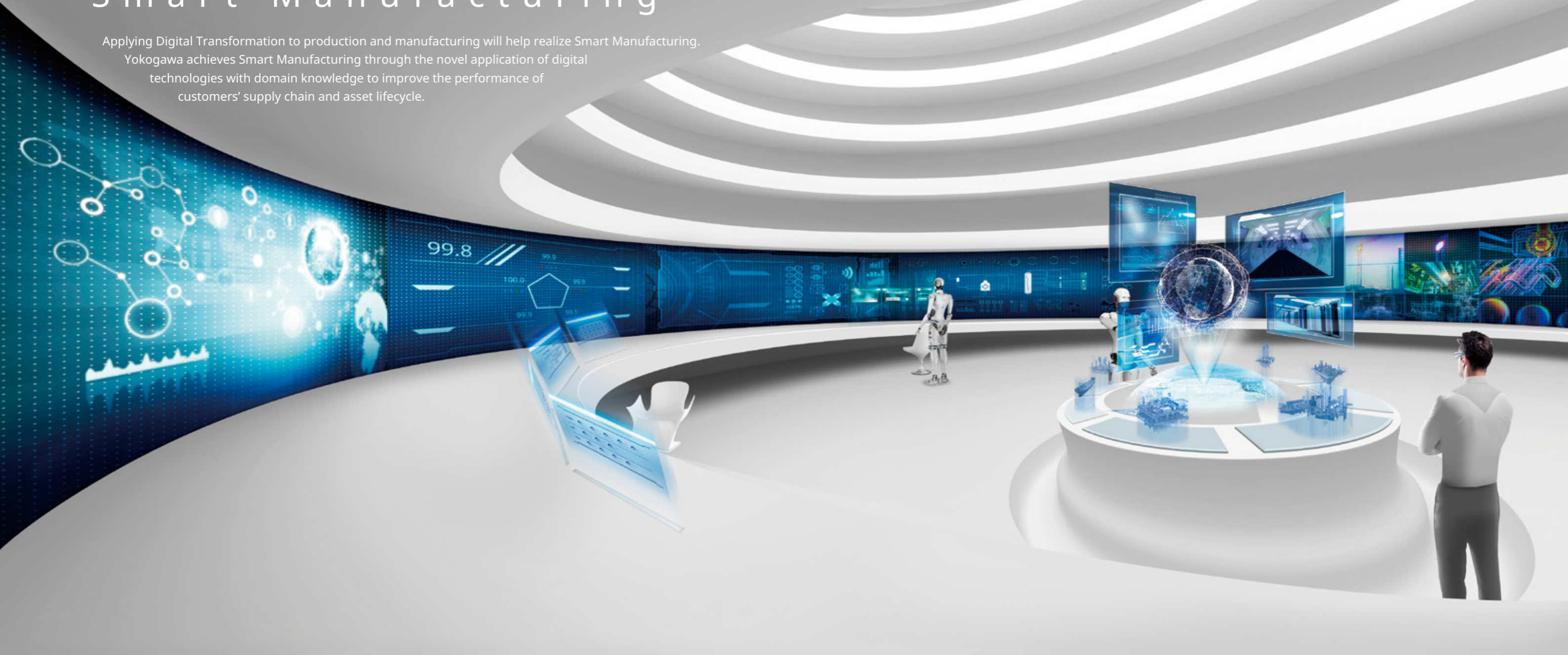
Yokogawa assists customers to assess their maturity levels by Smart Industry Readiness Index (S.I.R.I.) and makes appropriate strategy of DX, followed by thorough execution for it.



Source: International Centre for Industrial Transformation

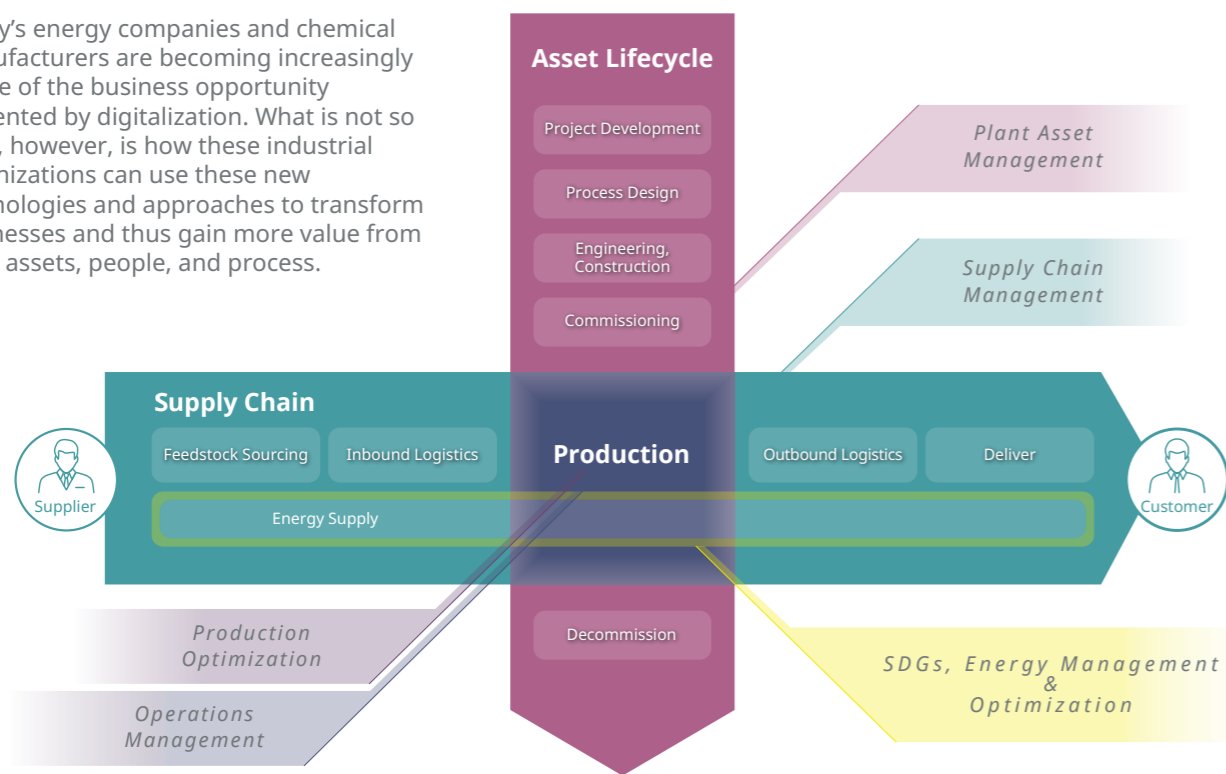
# Smart Manufacturing

Applying Digital Transformation to production and manufacturing will help realize Smart Manufacturing.  
Yokogawa achieves Smart Manufacturing through the novel application of digital technologies with domain knowledge to improve the performance of customers' supply chain and asset lifecycle.



# Smart Manufacturing

## Business scope



Today's energy companies and chemical manufacturers are becoming increasingly aware of the business opportunity presented by digitalization. What is not so clear, however, is how these industrial organizations can use these new technologies and approaches to transform businesses and thus gain more value from data, assets, people, and process.

Another achievement of Smart Manufacturing is the installation of digital technologies which can transform field operations, such as robots, drones, mobile devices, and wearables. Yokogawa **Field mobile solutions** will assist field operators in working in the right way at the right place. Also, a small number of experts in IOC can support them via real-time communication tools.



Dangerous area for Human

Sensitive operation with intelligence

## Secured network



The **Integrated Operation Center (IOC)** is one of achievements of Smart Manufacturing, which is a transformation demolishing a basic concept of manufacturing. A lack of experience and a skilled workforce is one of the recent critical issues in terms of plant management. The IOC can be a solution to maintain human reliability with following benefits;

The IOC actualizes remote plant operation and the innovation of enterprise team effectiveness, which is realized by connecting multiple plants to headquarters.

Operation and process data retrieved from each plant are assembled in real-time in the IOC for unified management, accumulating data and know-how. It enables operators to liaise easily with others who work on different shifts or have different responsibilities. In addition, comparative analysis and improvement are made possible by a minimum number of experts, creating knowledge, intelligence, and best practices, which are available to other plants horizontally. This corresponds to a lack of expertise.

It requires technology transformation enabling plant operation from the integrated control room remotely as well as revolution in organization and the mindset of operators.

**Robots** are beneficial in dangerous areas, while humans can focus on intervention and decision-making to help robots work individually. These technologies will be provided with strong **Cybersecurity** solutions.



**Integrated Performance Management**  
*featuring plant big data and Cloud computing  
for collaborative performance optimization in real time*

**Autonomous Business Intelligence**  
*featuring plant big data and AI machine learning for smart and  
agile decision-making*

**SOP Automation**  
*featuring plant big data and AI production system for  
future unattended operation*

**Profit-driven Operation Training**  
*featuring virtual reality and digital twin for safe  
and optimal operation*

# Operations Management



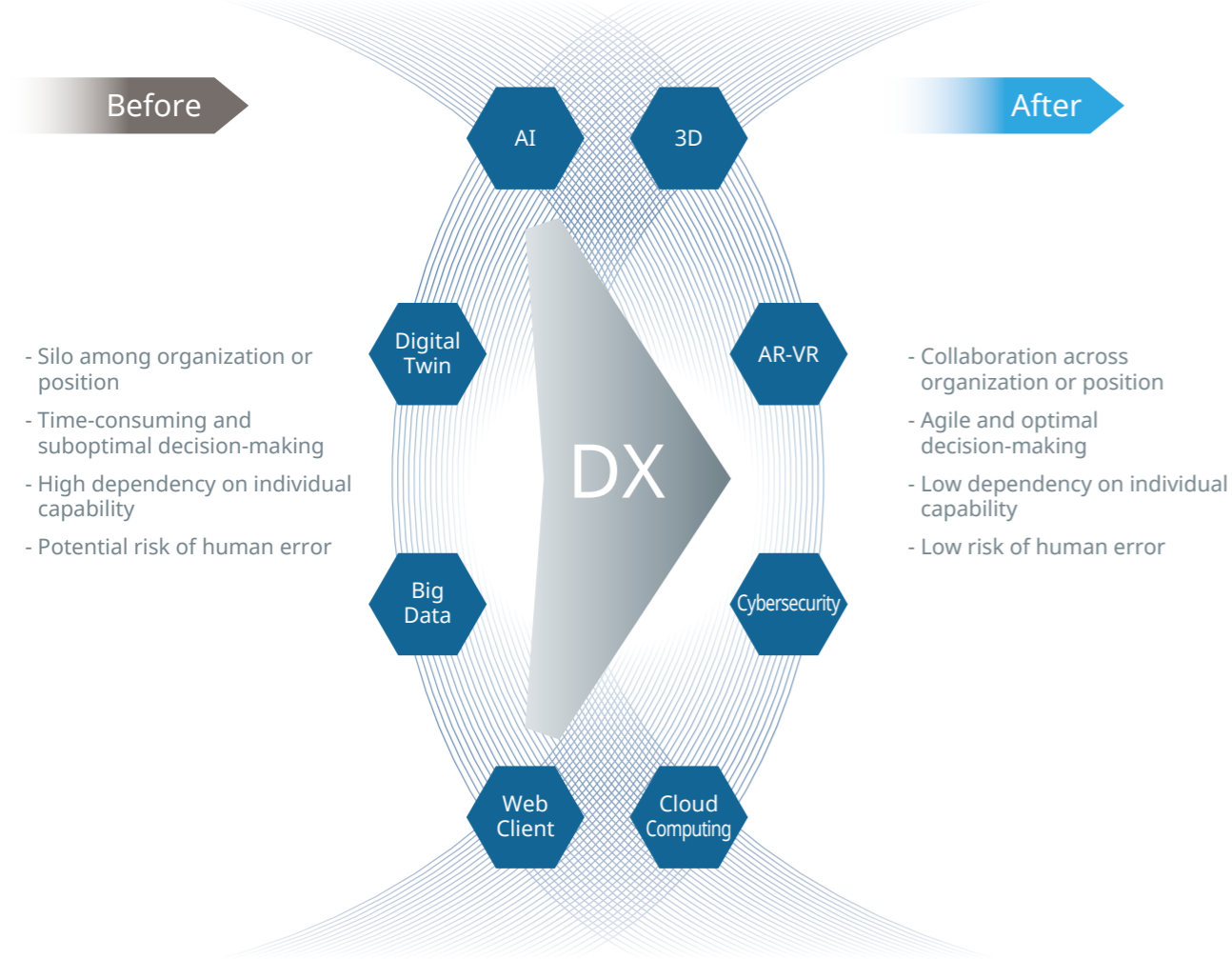
# Operations Management

- Integrated Performance Management featuring plant big data and Cloud computing for collaborative performance optimization in real time
- Autonomous Business Intelligence featuring plant big data and AI machine learning for smart and agile decision-making
- SOP Automation featuring plant big data and AI production system for future unattended operation
- Profit-driven Operation Training featuring virtual reality and digital twin for safe and optimal operation

## Operations Management Suite

YOKOGAWA has strengthened its expertise in operations management through understanding the business process, people, and corporate culture of our customers. We will help process manufacturers transform their business by integrating our industrial knowledge with the latest digital technologies.

### Digital Transformation in Operations Management



Operations management is a way for process manufacturers to achieve optimal, sustainable and flexible operations by connecting all plant personnel from C-level to plant operators and by maximizing their performance using the latest digital technologies. It makes business transformation (DX: Digital Transformation) in your plant operation.

Yokogawa's operations management is a comprehensive suite of customer-centric solutions that were developed based on longstanding experience and knowledge obtained through tens of thousands of automation projects. It is applicable in a phased manner to all manufacturing plants at various maturity levels.

#### Command Center and Production Center Design

Design consulting : Yokogawa's industrial designer creates design document, drawing it for integrated Command Center in headquarters office and integrated Production Center in manufacturing plant.

#### Integrated KPI Design

Design consulting : Yokogawa's process consultant facilitates the design of holistic KPIs from C-level to Operations, covering the latest management objectives such as productivity, profitability, availability and safety.

#### Real-time KPI Dashboard and Report

Engineering : Yokogawa's DX engineer incorporates the designed KPIs into the real-time dashboarding system, installing it in a site (Cloud or on-premises). It helps engineers and operators to solve their performance issues in real time before these reach the management level.

#### KPI and Data Analytics

Reporting : Yokogawa's data scientist analyzes the KPI historian using mathematical or AI algorithm, submitting a report on new findings.

#### Online Prediction

Engineering service: Yokogawa's DX engineer incorporates the created mathematical or AI model into an online prediction system, installing it in a site.

#### Procedural Automation

Consulting : Yokogawa's knowledge engineer helps to formalize and standardize various operational procedures

and incorporates them into the automation system so that even junior operators can achieve the same quality of plant operation without human error.

#### Profit Improvement Program

Consulting : KBC's process consultant helps to define the improvement area, discover improvement opportunities, develop solutions, deliver them, and sustain the achieved benefit continuously.

#### Operation assistance

Engineering : Yokogawa's DX engineer installs the automation system to achieve secure plant operations.

#### Performance and Process Alarm Management

Consulting: Yokogawa's process consultant helps to manage the alarm system so that it can deliver the necessary alarm to the right person at the right time.

#### Advanced Operating Graphic

Design and engineering : Yokogawa's industrial designer creates design policy and template documents for operation graphics, incorporating them into the dashboarding system.

#### Enterprise Team Effectiveness

Consulting : KBC's consultant helps guide to improve the effectiveness of the organizations, workflows and employees.

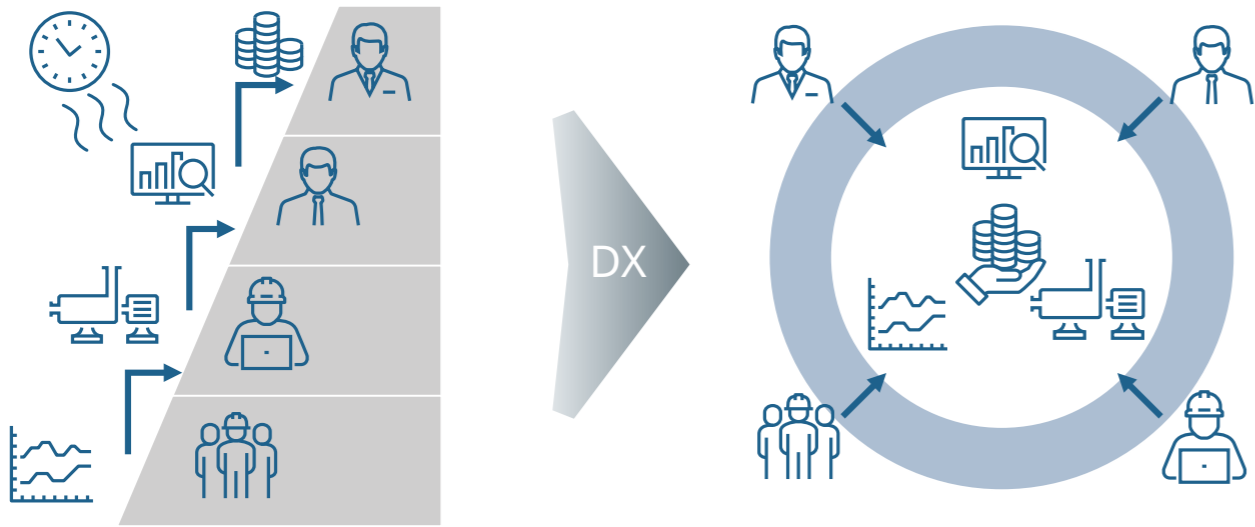
#### 3D Virtual Training

Engineering: Yokogawa's industrial designer develops a virtual training system for infrequent operations and maintenance work.

The operations management suite also becomes a toehold in future unattended operations, by formalizing, standardizing, and automating the operational knowledge of all plant personnel.

## Integrated Performance Management

featuring plant big data and Cloud computing  
for collaborative performance optimization in real time



- Siloed by organization position
- Time-consuming and suboptimal decision-making
- High dependency on individual capability
- Potential risk of human

- Collaboration across organization or position
- Agile and optimal decision-making
- Low dependency on individual capability
- Low risk of human error

### Challenges

- KPI disconnection -between C-level and operators causes silo
- Partial KPI management results in partial optimization
- Existing KPI system is designed for reporting after the fact
- Management needs something to motivate operators to achieve profitable operation
- Performance improvement is not sustainable due to the busyness of engineers

### Solutions

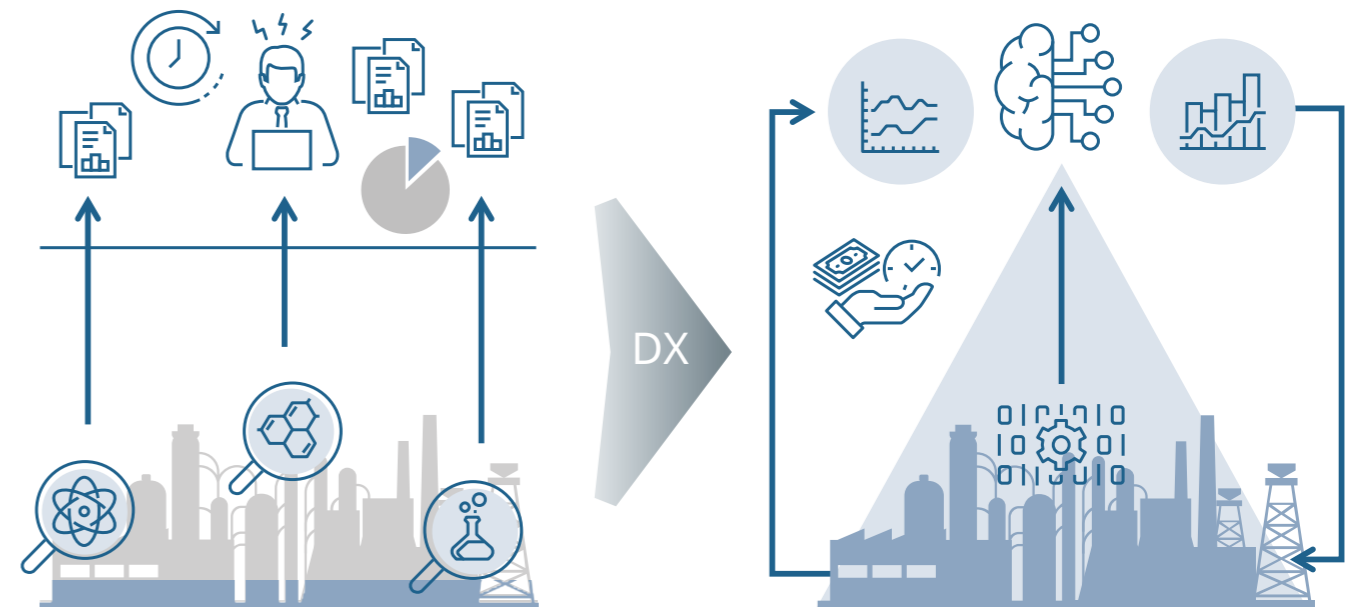
- Connected KPIs based on industrial knowledge provide collaborative operation
- Holistic KPI management covering all management objectives results in total optimization
- Real-time KPI system realizes agile performance improvement on the same day
- Connected KPIs visualizes operators' contribution to C-level KPIs
- Dispatch of external consultant supports sustainable performance improvement

### Benefits

- 5-10MUS\$/year benefit in 230,000bbl/day oil refinery
- 500K-2MUS\$/year benefit in 600MMSCFD gas separation plant

## Autonomous Business Intelligence

featuring plant big data and AI machine learning for  
smart and agile decision-making



Only a limited amount of raw data is available for analysis

New data analytics implemented autonomously at high speed; analysis scope expanded to entire plant

### Challenges

- Current data analytics takes long time to reach a result
- Base knowledge and experience required for an analyst to analyze data
- Only a limited amount of raw data is available for analysis
- Analysis result is not fully utilized to take immediate action

### Solutions

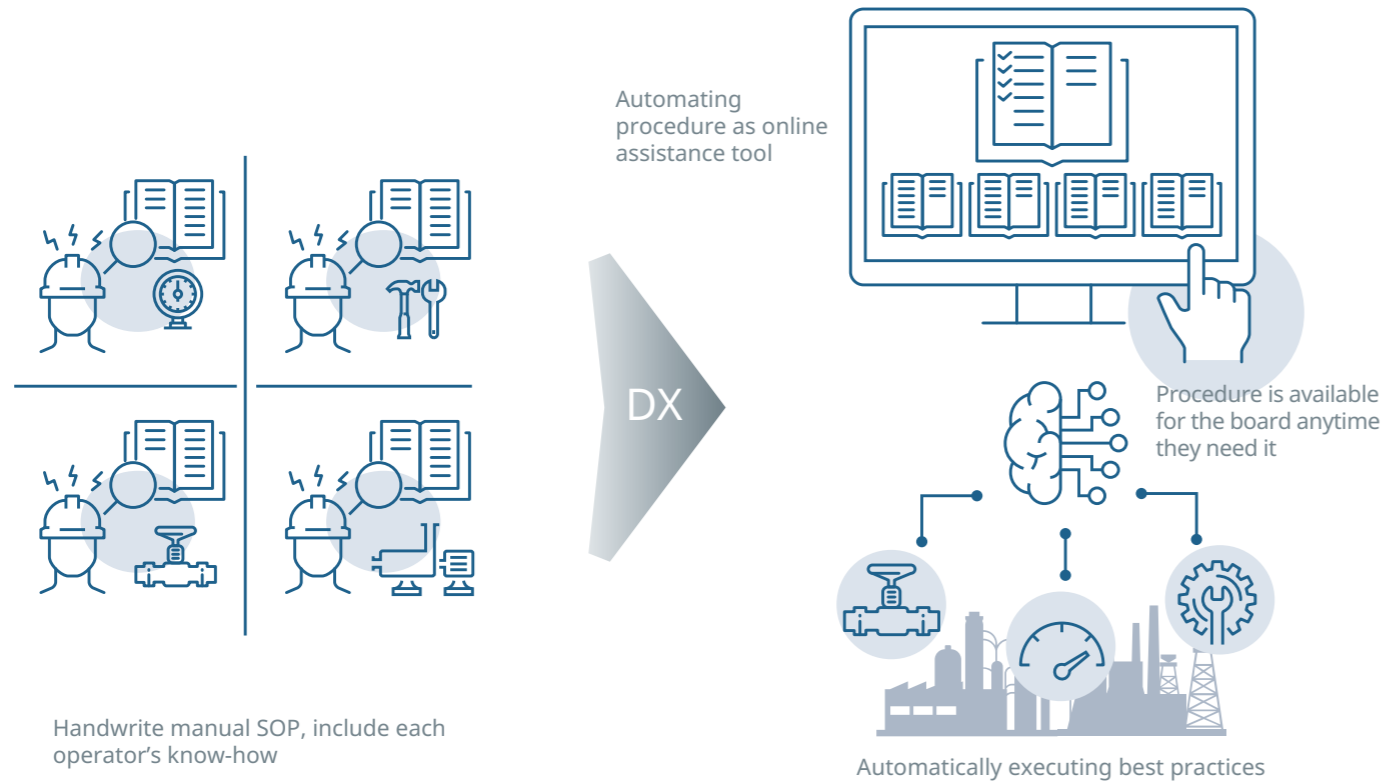
- AI machine learning assists data scientist/analyst in data analytics
- Plant big data is used to identify new findings
- Online prediction actualized on IA model is available

### Benefits

- New data analytics implemented autonomously at high speed; analysis scope expanded to entire plant
- An unskilled worker with high digital literacy can implement data analytics
- Necessary actions are shown at a glance to ensure actions are taken in a timely manner
- Prevent sudden plant shutdown and product quality issues predictively
- 10 to 100 KUS\$ estimated benefit

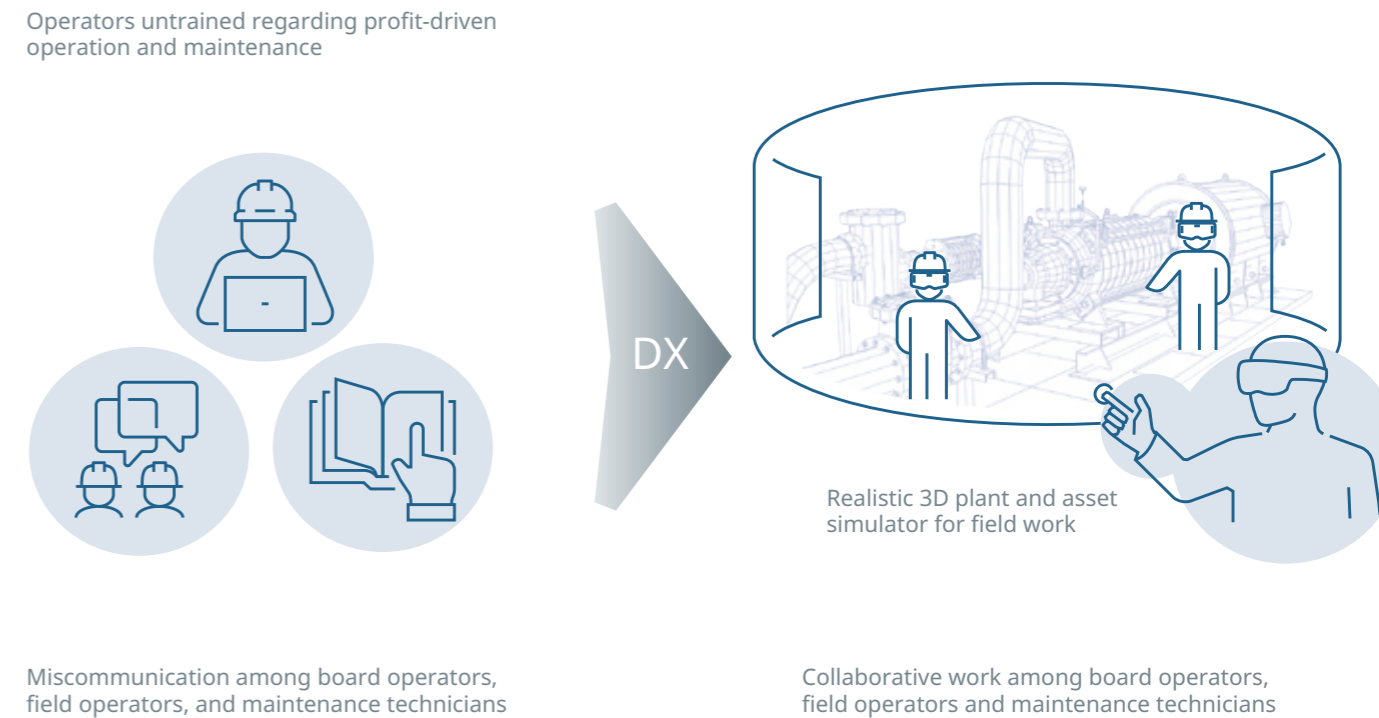
## SOP\* Automation

featuring Plant big data and AI production system for future unattended operation



## Profit-driven Operation Training

featuring virtual reality and digital twin for safe and optimal operation



### Challenges

- Time-consuming for operation supervisors to handwrite and maintain SOP
- SOP is not updated and does not include all operator know-how
- Operator seldom refers to paper-based SOP
- Advantage of manual SOP is limited in terms of preventing major human error

### Solutions

- Generating best practices by analyzing operation records and existing SOP
- Digitizing SOP as e-SOP (online) for an executable document for Board/Field operators
- Automating procedure as online assistance tool

### Benefits

- Improvement of efficiency by automatically executing best practices
- Not only a key procedure but more the details of the procedure are available for board/field operators anytime they need
- Reducing human errors caused by lack of skills, beliefs, and morals
- Streamlining manual procedures
- 500KUS\$/year by shortening grade changeover in a polymer plant

\*SOP: Standard Operating Procedure

### Challenges

Achieve continuous increase in profit and safety by resolving the followings:

- Operators untrained regarding profit-driven operation
- Technicians untrained regarding profit-driven maintenance
- Miscommunications among board operators, field operators, and maintenance technicians
- Redundant investment for training systems

### Solutions

- Consolidated training environment (operation and maintenance)
- High-fidelity dynamic process simulator using a real operator's console for board work
- Realistic 3D plant and asset simulator for field work
- Scenario builder for profit-driven operation and maintenance
- Integration of performance dashboards

### Benefits

- Achieve continuous increase in profit and safety by having
  - Operators trained regarding profit-driven operation
  - Technicians regarding profit-driven maintenance
  - Realistic training for hazardous situations
  - Collaborative work among board operators, field operators, and maintenance technicians
  - Consolidated investment for training systems
  - 1MUS\$~ by avoiding unplanned shutdowns



**Adaptive Advanced Process Control**  
*featuring digital twin and self tuning for sustainable performance operation*

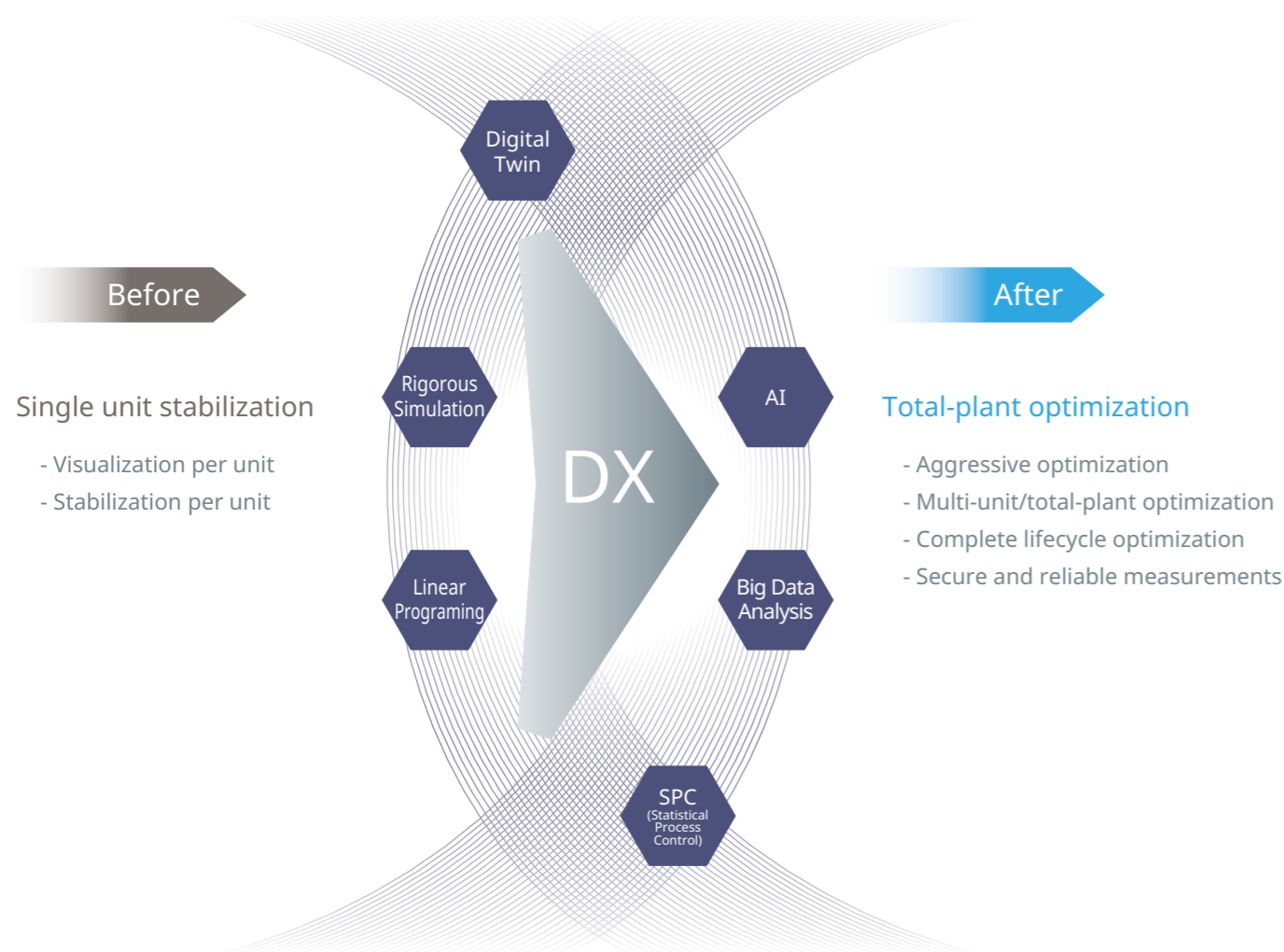
**Dynamic Real-time Optimizer**  
*featuring digital twin and real-time data integration for real-time total-plant optimization*

## Production Optimization

# Production Optimization

- Adaptive Advanced Process Control featuring digital twin and self tuning for sustainable performance operation
- Dynamic Real-time Optimizer featuring digital twin and real-time data integration for real-time total-plant optimization

Yokogawa will contribute to improving profitability by increasing productivity, which will be realized by combining OT and IT and utilizing Digital Transformation technology based on our abundant experience, knowledge, and expertise in production area.



Yokogawa has helped increase profit improvement via energy savings and operational efficiency improvements, which was achieved via visualization and stabilization per unit. Combining the best practice with the latest digital technology enables the optimization of the entire plant and lifecycle, increasing productivity even further.

# Yokogawa's efforts to improve Productivity

## Efficiency

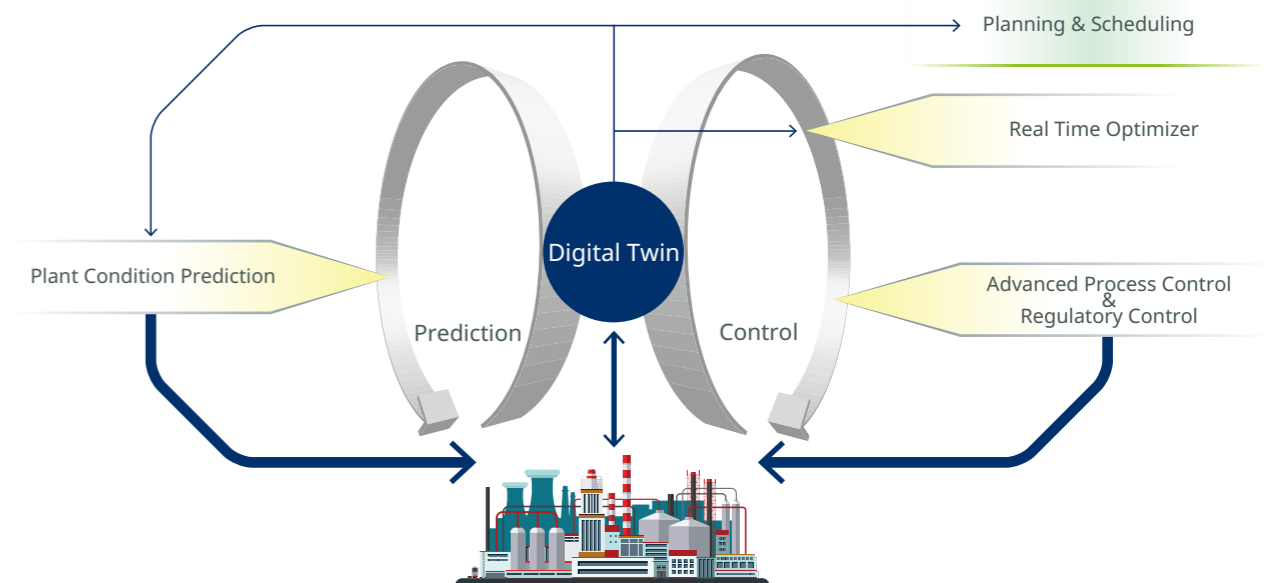
Utilizing our knowledge and experience in sensing technology and control and combining DX technologies, we propose optimization over the entire lifecycle, with multiple devices and multiple plants.

## Value added

Optimizing our services based on data accumulated by the abundantly installed base, we are ready to leverage the best practices cultivated by the global experience. We will help customers add value and create new value by actively combining the latest digital technology with outstanding simulation and control technologies.

Yokogawa aims to realize next-generation productivity improvements in both efficiency and value added and to continue on a growth journey together with our customers.

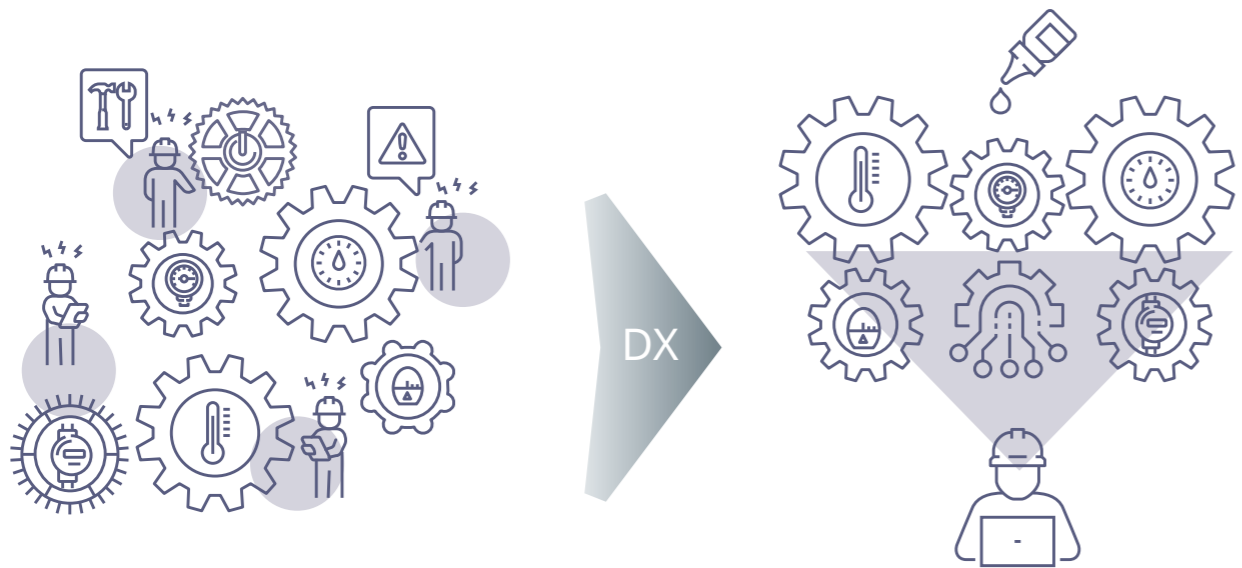
## Production Optimization



We perform seamless production through the connectivity of simulation technology and control technology by reflecting the plant model in the production plan. By repeating this cycle, the entire plant can be optimized with a high level of accuracy throughout its lifecycle.

## Adaptive Advanced Process Control

featuring digital twin and self tuning for sustainable performance operation



Difficult to stabilize process and maximize throughput because of manually controlling multiple variables; thus, quality control also becomes difficult

All-in-one application for advanced process control and integrated analyzer management

### Challenges

- Difficult to stabilize process and maximize throughput caused by manually because of manually controlling multiple variables; thus, quality control also becomes difficult
- Low accuracy of analyzer and the long time needed for analyzer results during product quality evaluation results in production loss

### Solutions

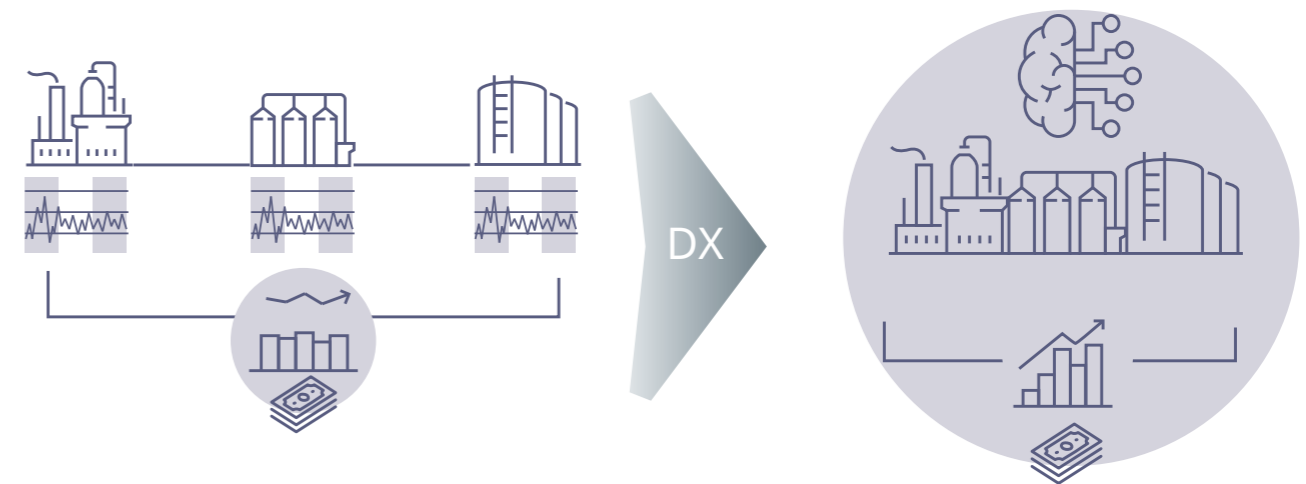
- Advanced process control for multi-variable control model
- Robust quality estimation for correcting analyzer accuracy and shortening long analysis time of analyzers
- Easy maintenance of APC model via automatic step response tests and enhanced online model tuning function
- All-in-one application for advanced process control and integrated analyzer management

### Benefits

- Reduction of operator's stress via Yokogawa's automation solution suites, focusing on high-value operations
- Improvement of productivity and stabilization of quality, integrated analyzer management
- Typical payback: less than 1 year
- Case study in an Indonesia refinery
- CO<sub>2</sub> emission reduction = 22,000 ton/Year
- Energy savings = 3,187,000 US\$/Year

## Dynamic Real-time Optimizer

featuring digital twin and real-time data integration for real-time total-plant optimization



High effectiveness of APC-controlled individual process unit does not mean the optimization of the entire plant

Total-plant optimization ensures operation closer to global optimum, maximized and sustainable plant performance, and an increased return on investment

### Challenges

- Profitability improvement for entire plant
- High effectiveness of APC-controlled individual process unit
- Disturbances from externalities prevent optimization
- Frequent changes in feed and product market price prevent total-plant optimization
- Performance maintenance across multiple units

### Solutions

- Proven technology : Multivariable model predictive control
- Multi-unit optimization
- Autonomous supervisor integrated with rigorous steady-state models

### Benefits

- Total-plant optimization ensures operation closer to global optimum
- Maximized and sustainable plant performance and increased return on investment
- Tight integration with APC ensures easier maintenance
- Closer alignment with planning and scheduling
- 1 -2 MUS\$/year estimated benefit from optimization of CDU (Crude Distillation Unit) and VDU (Vacuum Distillation Unit)



# Supply Chain Management

## **Supply Chain Optimization**

*featuring optimizer and real-time data integration for agile and flexible production*

## **Advanced Tank Operation Management**

*featuring optimizer and AI production system for stock/stockout minimization*

## **Blend Property and Ratio Control**

*featuring digital twin and real-time data integration for product quality optimization*

## **Inventory and Logistics Management**

*featuring Cloud computing and multi-plant data integration for inventory and logistics optimization*

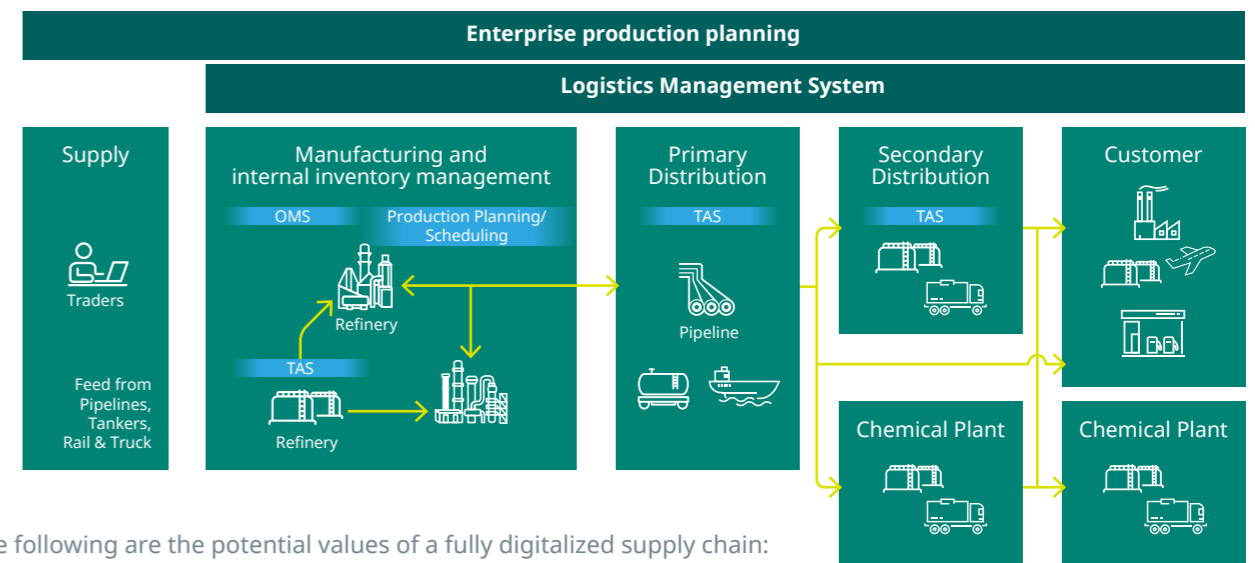
# Supply Chain Management

- Supply Chain Optimization featuring optimizer and real-time data integration for agile and flexible production
- Advanced Tank Operation Management featuring optimizer and AI production system for stock/stockout minimization
- Blend Property and Ratio Control featuring digital twin and real-time data integration for product quality optimization
- Inventory and Logistics Management featuring Cloud computing and multi-plant data integration for inventory and logistics optimization

Real-time visualization of the entire supply chain

The process manufacturing industry is either established close to the feedstock or close to the market. As such, it has a very long supply chain from raw materials to consumer, coupled with very fast market dynamics on both the supply and demand sides, making the supply chain management of the process industry extremely complex.

## Strategic Manufacturing and distribution over supply chain



The following are the potential values of a fully digitalized supply chain:

### Term Contract Planning

Commercial and economic evaluation of long-term contract obligations based on improved granularity of transaction information

### Production Scheduling

Improve granularity of plant information such as quantity and quality of remaining oil in tanks and long pipelines for baselining

### Inventory Management

Real-time visualization of entire supply chain inventory helps improve inventory management and thus reduce working capitals and losses in material movements

### Supply Chain Planning

Improve planning optimization with more precise measurements of feedstocks, process yields, inventory, and demand

### Commercial Contracting

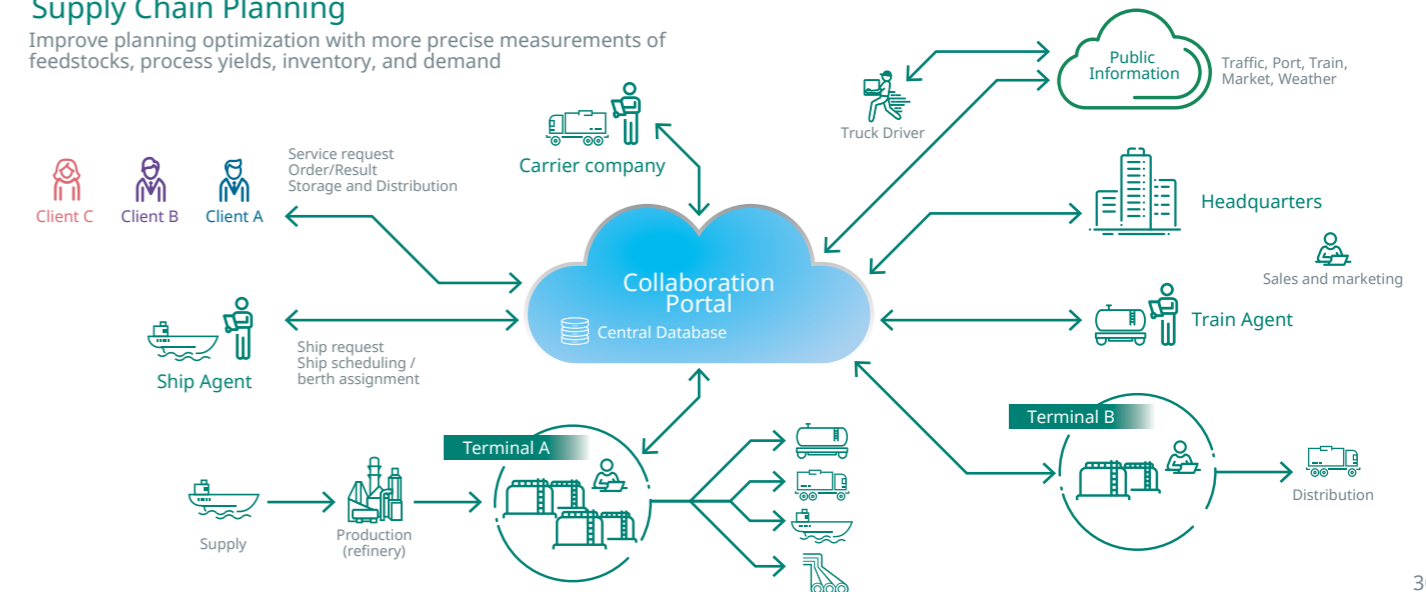
Improved precision management of feedstocks and yields helps develop better contract terms for feedstocks

### Collaboration Portal

Improved customer and partner engagement with on-line collaboration portal

### Dispatch Management

Complete sales-order-to-invoice-processes digitalization; fully automated to improve customer engagement

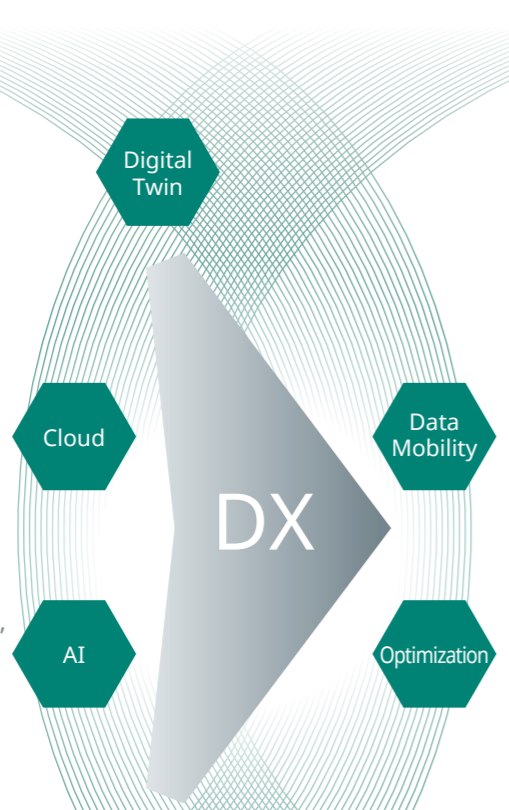


Before

After

Independent OT systems operated by organization in silos, stitched together by manual spreadsheets

- Legacy methods such as emails, spreadsheets, and phone calls for exchange of information across organization silos
- Snapshot information without work process tracking
- Planning and scheduling system fragmented



Automated business processes from sales order to invoice, and from planning to production

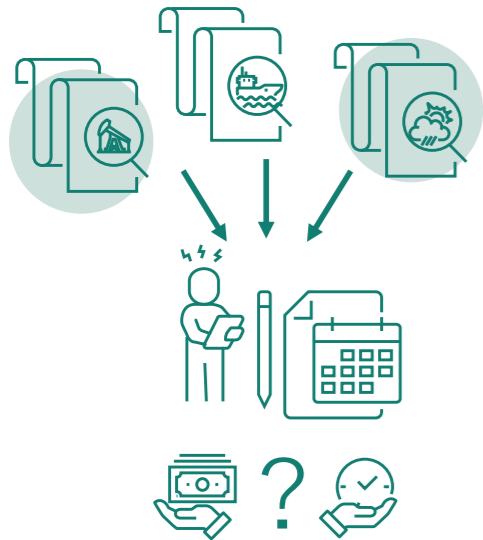
- Agile response to supply and demand shocks
- End-to-end visualization of inventory and movement of entire supply chain
- Reduced wastage with precision management
- Engaged customers and partners
- Supply chain optimization

Precision management is Yokogawa's approach to supply chain management, from feedstocks and material movements to product delivery. Precision management starts with precision measurements, combined with the real-time management of materials' movements and full digitization, from sales order to invoices processes.

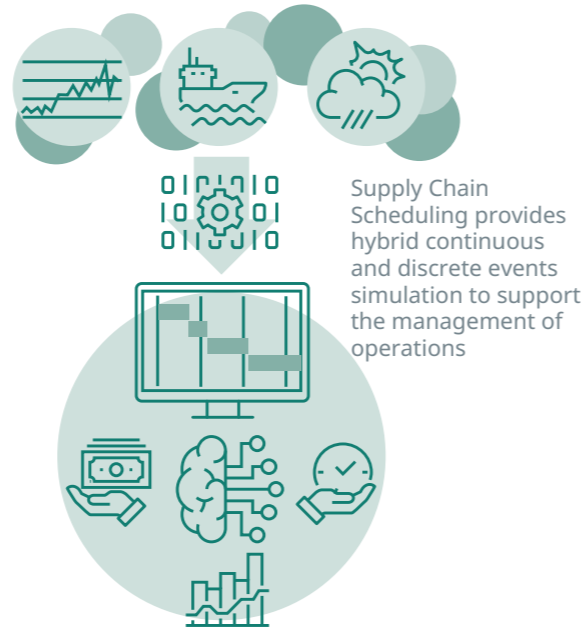


## Supply Chain Optimization

featuring optimizer and real-time data integration for agile and flexible production



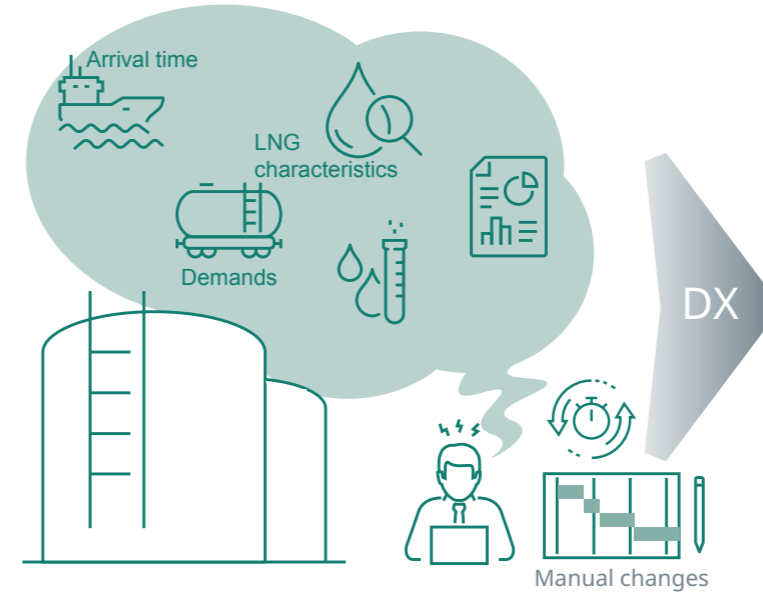
Maximizes enterprise value from integrated supply, refining, distribution, and marketing systems, is multi-faceted



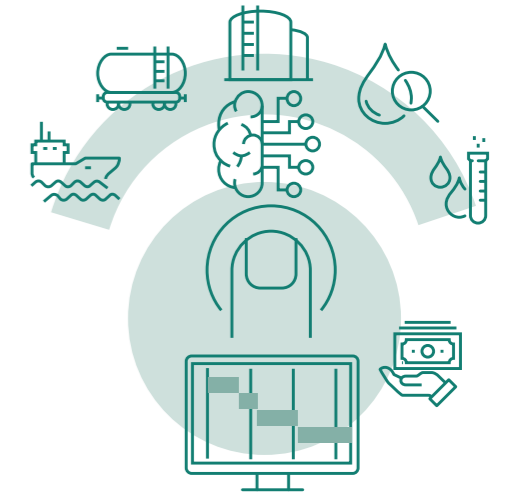
Production Accounting calculates site-wide daily mass/volume/ energy balances

## Advanced Tank Operation Management

featuring optimizer and AI production system for stock/stockout minimization



Only limited experts can make a plan appropriate to demand based on the various data collected, which is done manually



Anyone can make a schedule with a simple operation

### Challenges

- Difficulty of maximizing enterprise value from integrated supply, refining, distribution
- Insufficient digitalization in the context of the solutions and capabilities needed to achieve operational excellence

### Solutions

- Our approach to the application of digital technologies is to work backwards from the business goals, constraints, best practices, and users to define technologies and deliver on business outcomes
- Introduction of HQ-level planning solution and integration with refinery planning and scheduling
- Automation with real-time feedback on accounting, process, and supply/demand planning

### Benefits

- Provides proven customer value around digitalization to help customers decide on their unique set of applications and capabilities; assists with the implementation and accommodates legacy applications; innovates with new business models beyond the plant; and ensures the solution is always available and in use to deliver and sustain operational excellence
- Potential implemented benefits of 60-90 c/bbl expected

### Challenges

- Planning tank operation for the supply chain is quite a complex forecast, satisfying many constraints
- The workload is very high, and only a skilled scheduler can perform scheduling manually, relying on experience with trial and error
- Rescheduling occurs every time due to changes in constraints
- Difficult to produce optimal scheduling satisfying all the constraints

### Solutions

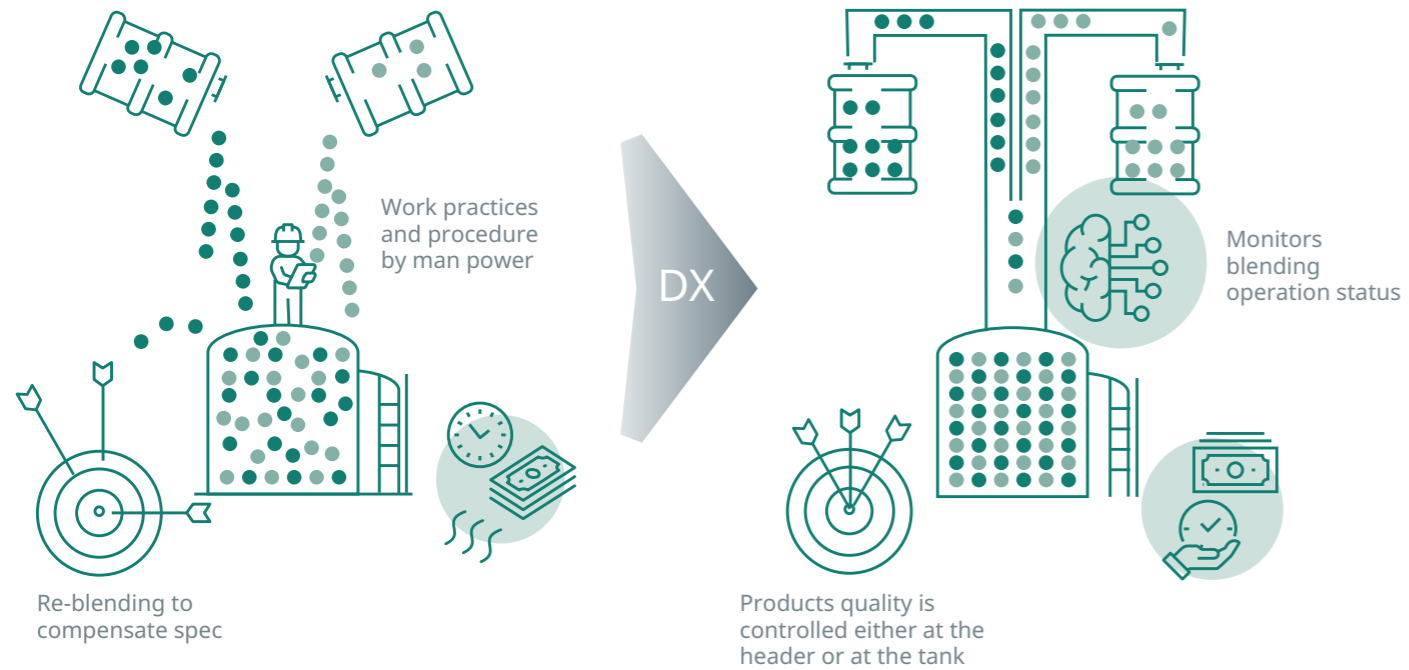
- Optimal scheduling that aims to improve efficiency and reduce the cost of the entire supply chain while satisfying the required constraints
- Simulate and monitor the feasibility of scheduling and the risks of operation

### Benefits

- Non-experts can obtain feasible and optimal scheduling consistently with a single button operation, minimizing operating costs
- Schedulers are able to make decision accounting for commercial and operational impacts
- Provide optimal scheduling rapidly

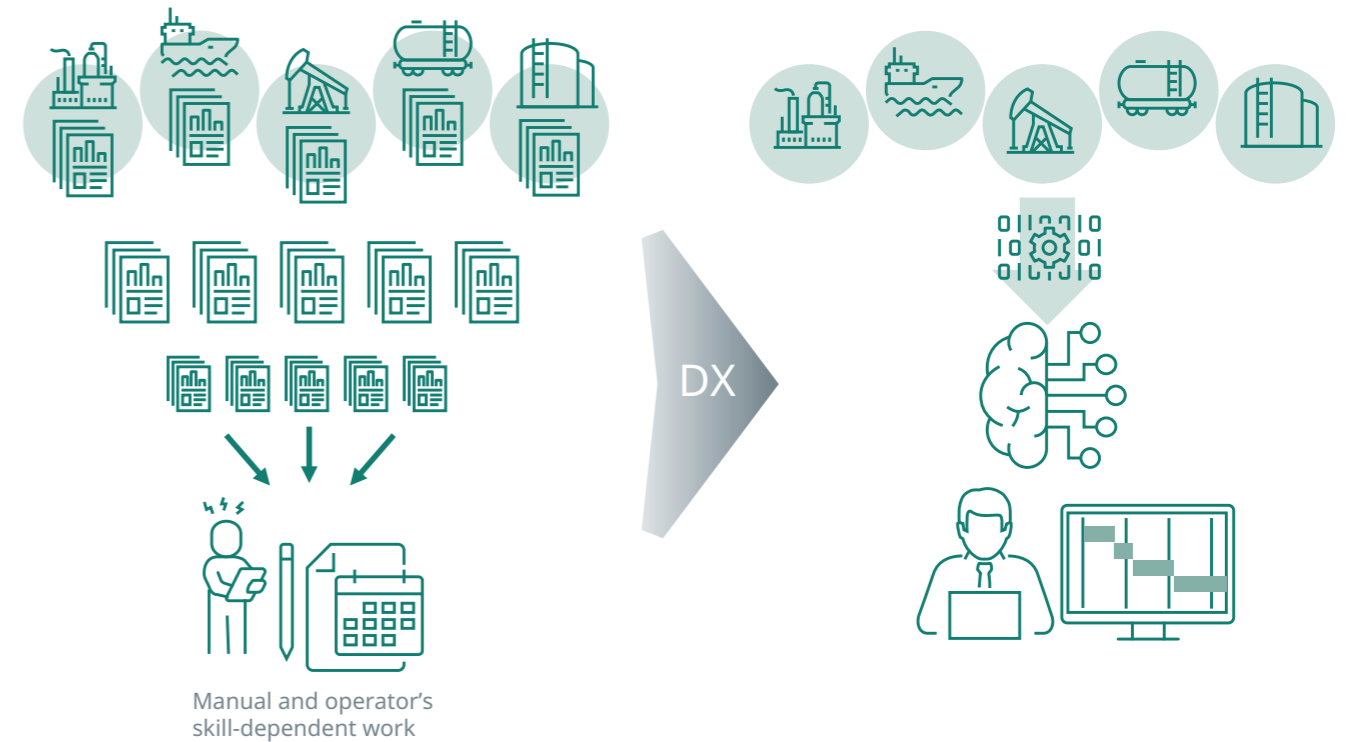
## Blend Property and Ratio Control

featuring digital twin and real-time data integration for product quality optimization



## Inventory and Logistics Management

featuring Cloud computing and multi-plant data integration for inventory and logistics optimization



### Challenges

- Work practices and procedures not integrated in blending
- A great deal man power required and time-consuming to take quality assurance for blend operation
- Occurrence of re-blending and quality giveaway
- Independent optimization of onsite control and blend process

### Solutions

- Complete total integration for blending execution in terms of technology, people, work processes and procedures, and organizational capability
- Provide the ratio set with the cheapest cost while satisfying the constraints
- Collect various blend data and provide KPI for blend operation
- Integration of onsite unit process and blend optimization

### Benefits

- Minimizing re-blending by improving quality, reducing the laboratory load of quality checks
- Guaranteeing shipping blend quality with an online analyzer, enabling the delivery of the of the product by quality certificate
- Analyzing trends in the historic blend data will drive the continuous improvement of KPIs
- Expanding optimization as a large controller
- Reducing giveaway of RON 9.3MUS\$/Year

### Challenges

- Enterprise pressure must change from "logistics is cost" to "logistics is value"
- Manual and operator's skill-dependent work
- Fragmented data in fragmented system
- Volatile market demand and external situation

### Solutions

- End-to-end visualization of inventory and movement of entire supply chain
- Vertically and horizontally integrated data management throughout enterprise
- Real-time order information helps predict necessary inventory
- Movement management enables precise data recording and tracking

### Benefits

- 1 MUSD return gained in 6 months after TAS (Terminal Automation System) implemented
- Demand forecasting allows storage terminal to ensure better availability of materials and products
- Digitalization makes operations/systems/plants/ent erprise integrated for visualization in real-time situations

# Plant Asset Management

## **Asset Failure Prediction**

*featuring field digital and AI machine learning for plant uptime maximization*

## **Plant-wide Asset Management**

*featuring Cloud computing and asset data integration for maintenance work optimization*

## **Digitalized Maintenance**

*featuring Cloud computing and asset data integration for safer, secure and on-schedule maintenance*

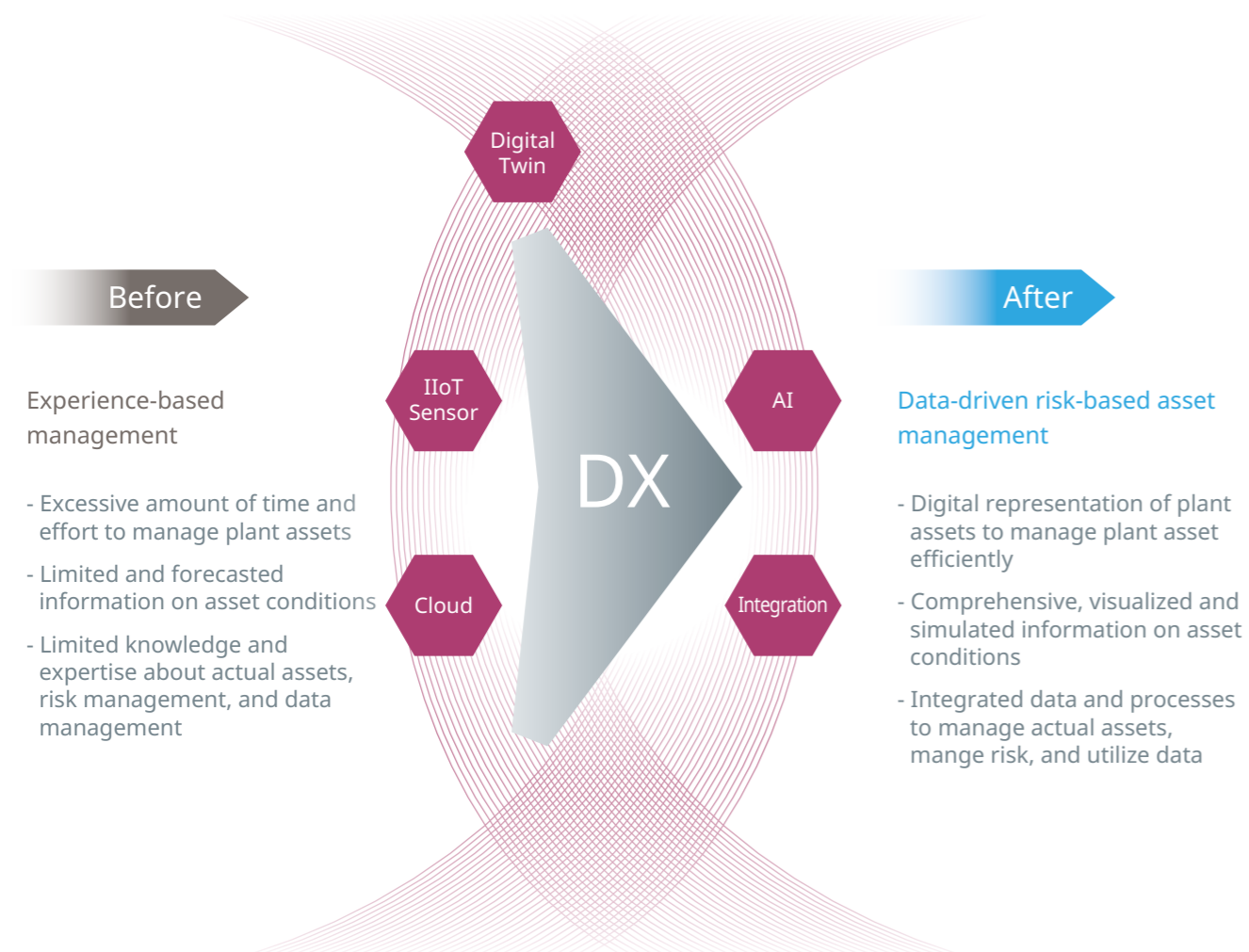
## **Asset Performance Management**

*featuring field digital and asset data integration for maintenance cost optimization*

# Plant Asset Management

- Asset Failure Prediction featuring field digital and AI machine learning for plant uptime maximization
- Plant-wide Asset Management featuring Cloud computing and asset data integration for maintenance work optimization
- Digitalized Maintenance featuring Cloud computing and asset data integration for safer, secure and on-schedule maintenance
- Asset Performance Management featuring field digital and asset data integration for maintenance cost optimization

Yokogawa's plant asset management combines domain and asset expertise with digital technologies to help the industry understand, predict, and optimize asset performance. With a data-driven and risk-based approach to the asset lifecycle, customers can increase production and operational efficiency while ensuring compliance and decreasing downtime.



Being the industry's trusted partner, Yokogawa has worked with customers in breaking down problems and opportunities into small steps to derive tangible value from their assets and asset management program. Starting with an understanding of the customer's goals and acceptable risks in view of their desired asset performance, we believe in investing only when and where it is needed most.

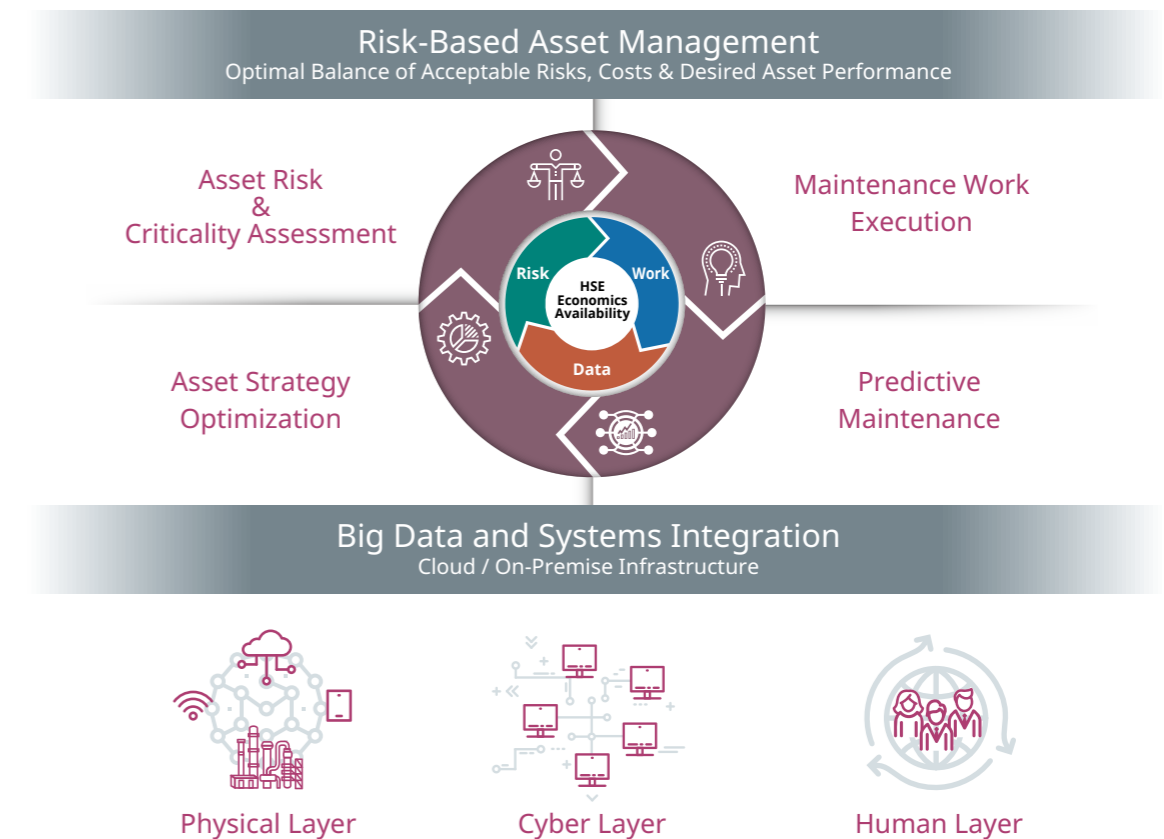
## Data-driven Risk-based Asset Management

### Asset Management across the entire asset lifecycle

Maximizing return on assets means considering them from a holistic perspective and managing them across their lifecycle. With data from IIoT and AI, industrial organizations can monitor current asset conditions and predict failures before they occur, enabling them to derive actionable insights to optimize activities from process design to decommissioning. With a holistic approach to asset management, the industry is empowered to achieve a sustainable transition from reactive to proactive maintenance, ultimately supporting its organizational goals.

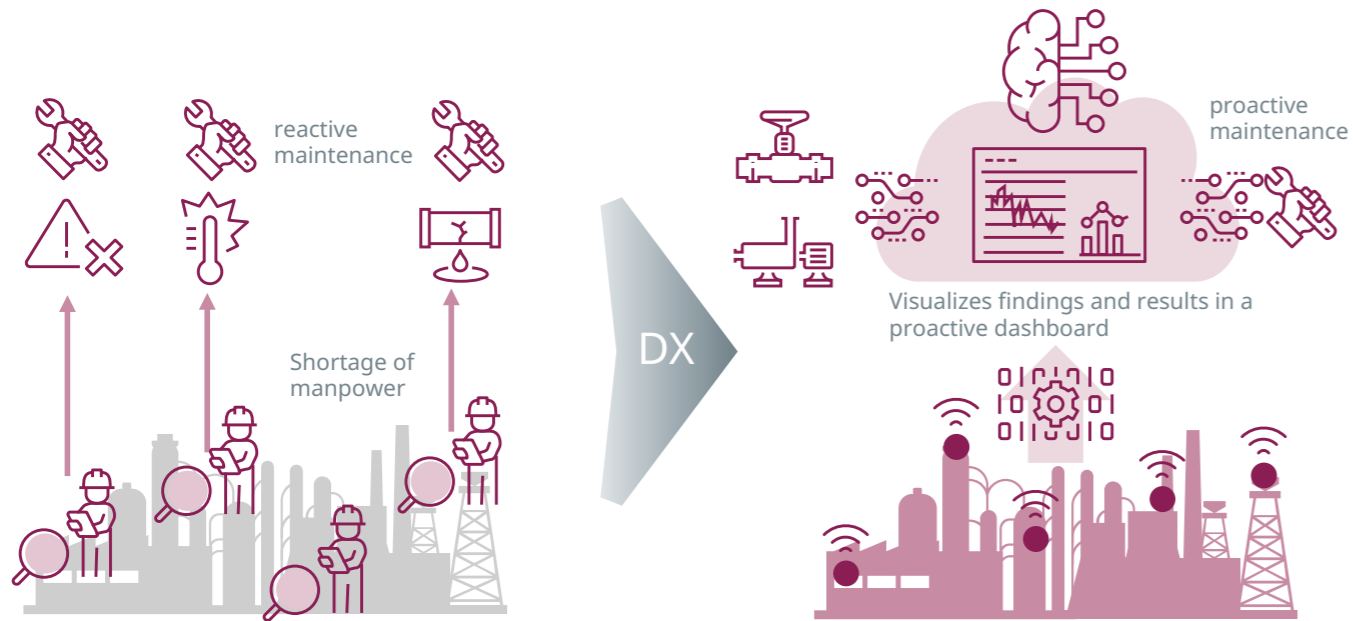
### Data-driven, Risk-based Asset Management

Integration is key to enabling data-driven, risk-based asset management. Relevant data across multiple sources are continuously collected, processed, and visualized to optimize risk mitigation, asset strategy development, work execution, and asset condition monitoring activities. This framework closes the data and process loop of asset management, ensuring all activities are aimed at contributing to the optimal balance of risks, costs, and desired asset performance.



## Asset Failure Prediction

featuring field digital and AI machine learning for plant uptime maximization

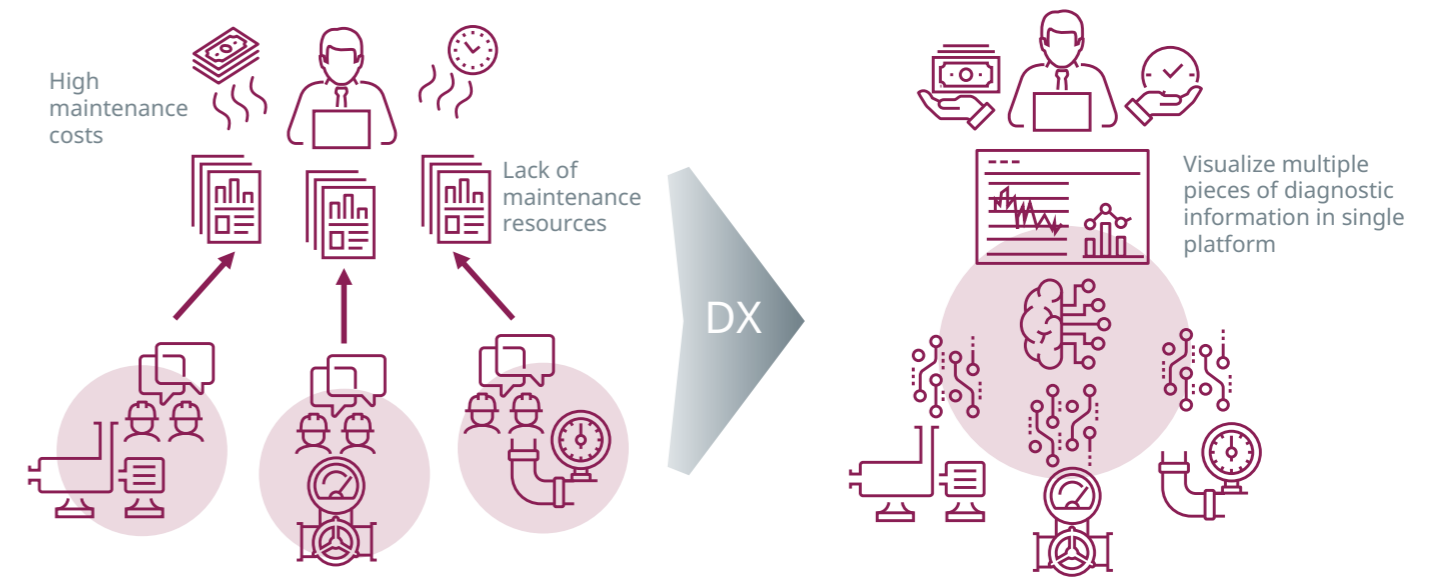


Difficulty in identifying potential failures

Connects and collects valuable asset data in real-time

## Plant-wide Asset Management

featuring Cloud computing and asset data integration for maintenance work optimization



Managing too many pieces of equipment, devices, and systems simultaneously

Collect historical and real-time information by integrating smart devices, control and monitoring systems, and manually entered data

### Challenges

- Ensuring an adequate number of sensors installed in the plant due to the high cost
- Sustainable transition from reactive to proactive maintenance by leveraging data
- Timely identification of potential failures
- Prevention of manpower shortages, particularly when facilities increase

### Solutions

- Connect and collect valuable asset data in real-time using wide-range, low-cost high-performance IIoT sensors
- Simulate potential failures with predictive analytics on data accumulated by the IIoT
- Visualize findings and results in a proactive dashboard to deliver actionable insights to operators

### Benefits

- High performance IIoT sensor with low cost installation
- Increase plant availability by 20%
- Decrease reactive maintenance costs by 40%
- Increase workforce safety as well as efficiency by 30% (reduce frequency of mandatory inspections)

### Challenges

- Manage multiple pieces of equipment, devices, and systems simultaneously
- Lack of skilled maintenance resources with enough capability to interpret process and asset data
- High maintenance costs of frequent, complex device adjustments

### Solutions

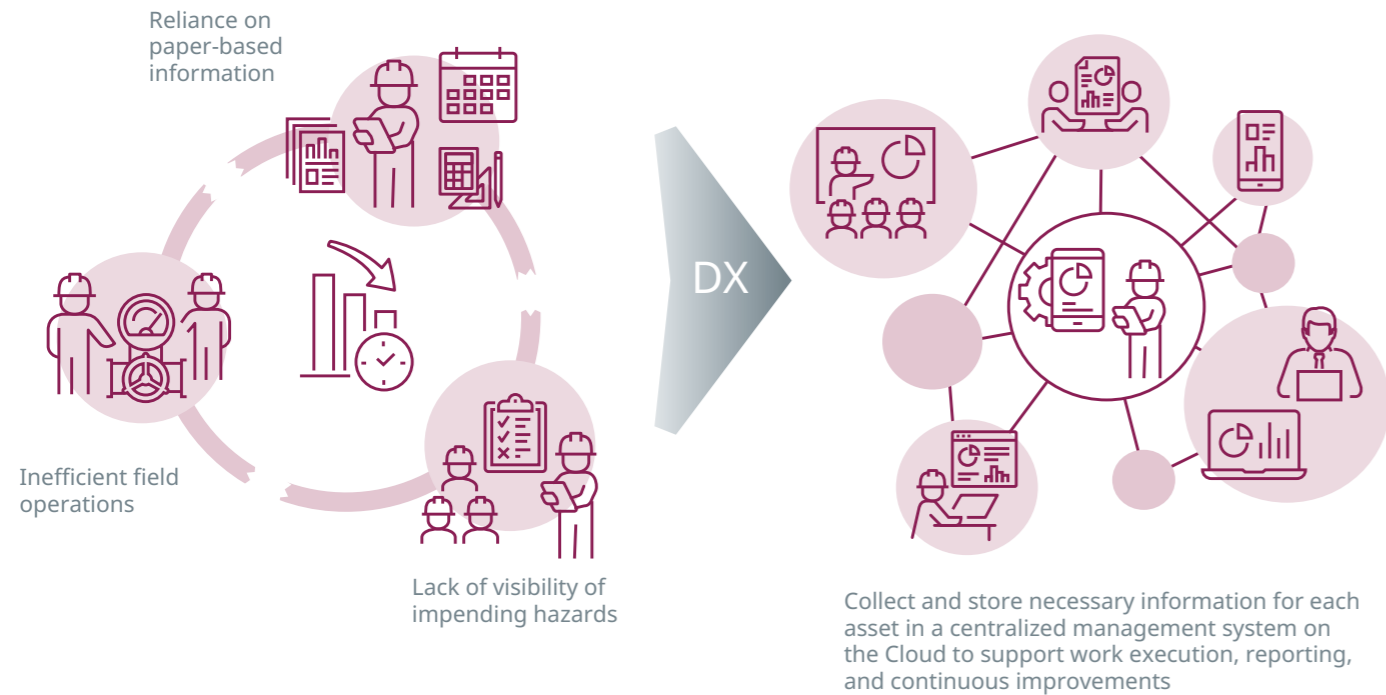
- Manage production and automation assets using a single integrated condition monitoring and advanced diagnostics platform
- Visualize asset health in a role-based dashboard and notify maintenance and operations teams automatically when failures are identified
- Visualize and remotely configure equipment status using templates

### Benefits

- Lower manpower costs to monitor plant assets
- Avoid unplanned downtime and unnecessary maintenance costs by up to 20%

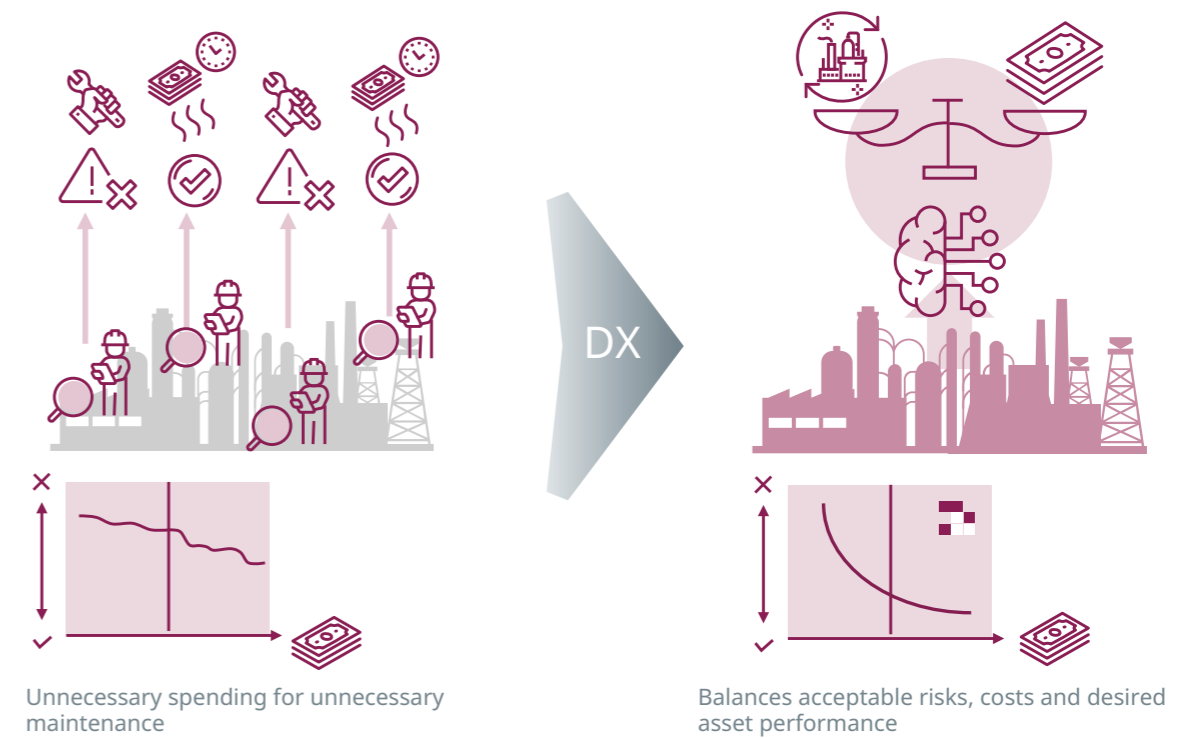
## Digitalized Maintenance

featuring Cloud computing and asset data integration for safer, secure and on-schedule maintenance



## Asset Performance Management

featuring field digital and asset data integration for maintenance cost optimization



### Challenges

- Reliance on paper-based information and workflows for asset information management, permit-to-work, and on-site operations
- Narrow visibility of impending hazards and requirements for on-site operations
- Inefficient on-site operations due to the lack of support technologies

### Solutions

- Centrally collect and store asset information on the cloud to support work execution, reporting and continuous improvements
- Ensure all safety and compliance rules via a user-friendly permit-to-work system and an extensive library for risk assessment
- Easily view asset information and record work results using wearables and handhelds

### Benefits

- Create and store a single version of asset information for >10,000 assets in the plant
- Optimize routine maintenance work by 50%
- Cut overall maintenance costs by 15%
- Gain a holistic view of the who-what-when-how of work, to mitigate on-site risks

### Challenges

- Excessive spending on maintenance based only on condition monitoring and AI
- Low-value improvement opportunities due to the lack of knowledge and visibility of risks and asset criticality
- Disconnection between organizational and plant KPIs, increasing departmental and information silos

### Solutions

- Manage overall risks to develop optimal asset strategies that balance acceptable risks, costs, and desired asset performance
- Holistically manage assets across their lifecycle with integrated work processes and big data
- Visualize and evaluate plant-wide performance against organization goals with reliability and performance KPIs

### Benefits

- Increase overall profitability, reliability, and safety
- Reduce routine maintenance and turnaround costs by 25%
- Reduce reactive maintenance by 40%
- Increase return on assets by 10%



**Plant-wide Energy Management**

*featuring digital twin and plant-wide data integration for total energy optimization*

**Community Energy Management**

*featuring digital twin and data integration for community energy optimization*

**Continuous Emission Monitoring  
Predictive Emission Monitoring**

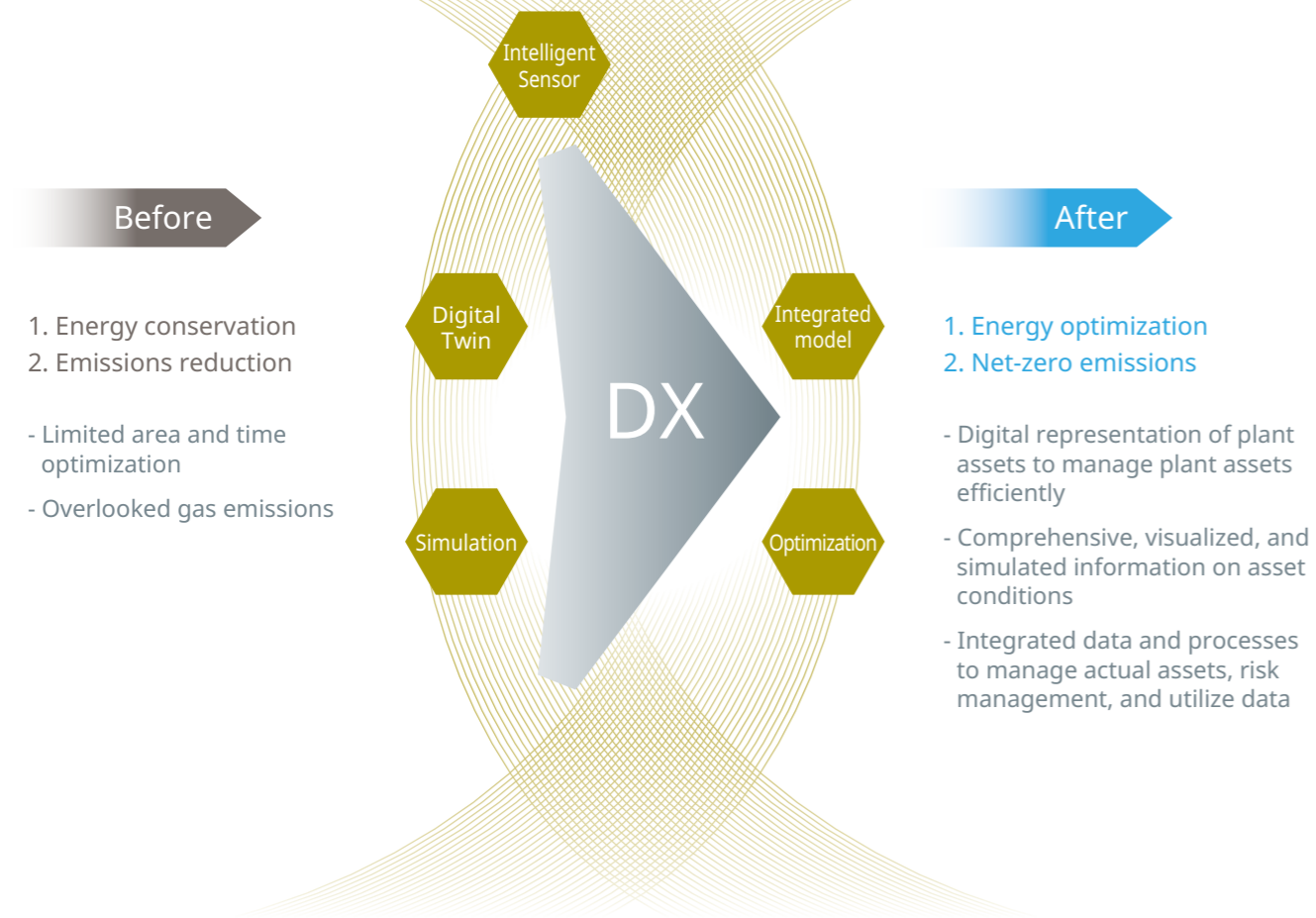
*featuring digital twin and data integration for the minimization of exhaust gas emission*

Sustainable Development Goals (SDGs)  
Energy Management & Optimization

# SDGs, Energy Management & Optimization

- Plant-wide Energy Management featuring digital twin and plant-wide data integration for total energy optimization
- Community Energy Management featuring digital twin and data integration for community energy optimization
- Continuous Emission Monitoring Predictive Emission Monitoring featuring digital twin and data integration for the minimization of exhaust gas emission

Energy conservation and gas emission reduction are key initiatives in realizing a sustainable society, but they are not enough. Data that are continuously collected by a wide variety of sensors are utilized for future forecasts regarding the total amount of renewable energy provided by nature and the absorption of greenhouse gas, as well as energy demand and gas emissions due to social activities. In addition, simulation and planning are implemented to determine what is best for the entire time period at the community level, for example, simulating impacts by leveling or shifting production operation, as well as building the operation planning of social infrastructure to save and share energy. These activities will enable not only community-wide net-zero emissions but also a society in which the process of energy production, storage, and use is optimized, allowing anybody access to energy in an easy way and at a reasonable price.

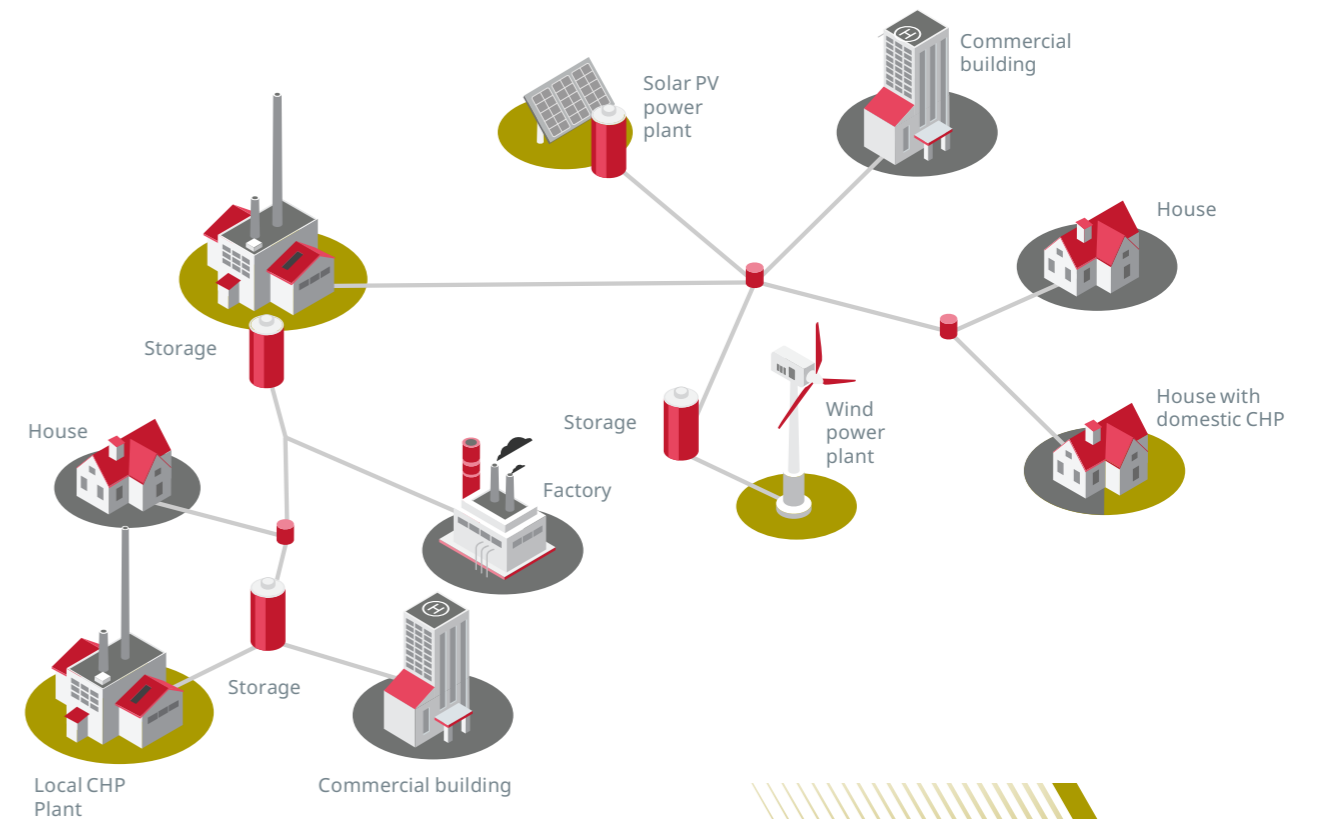


Yokogawa has contributed to improving the efficiency of energy use by identifying and eliminating wasteful energy use, which is made possible by utilizing its energy sensing technology to visualize the energy flow at sites. In addition, the emission monitoring system, which reduces gas emissions in production, is effective for environmental conservation.

The energy data from the sensors is input into an energy flow model that emulates the flow of energy in the field, and the flow of energy in the field can be simulated in real-time, in digital space (digital twin). Also, digitized energy information is shared among multiple sites (head office, factories, and facilities).

This digitization offers two major benefits.

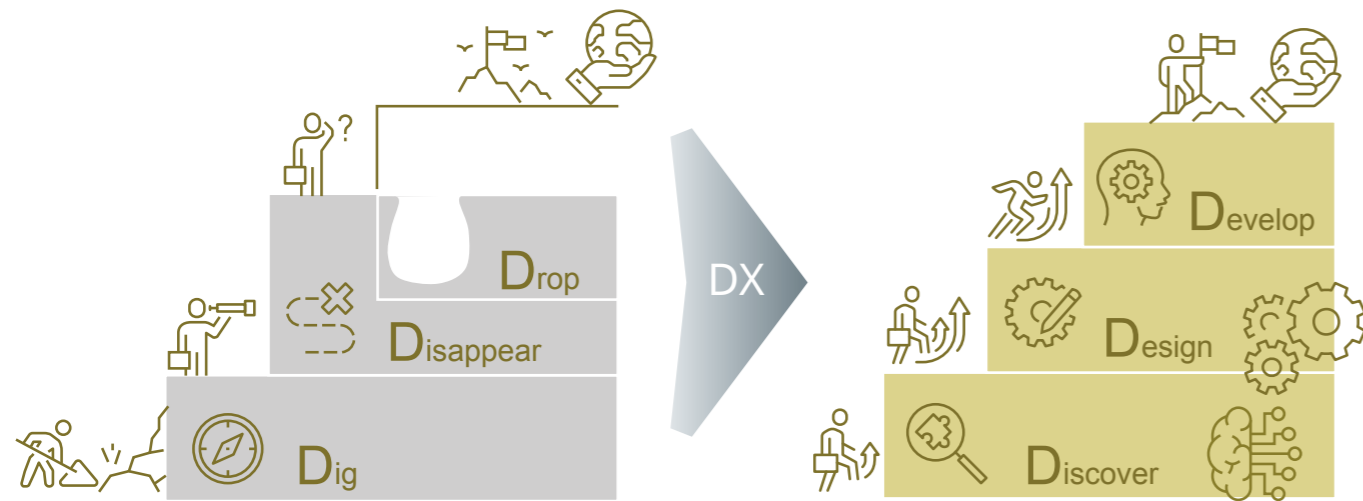
- It is possible to propose an energy generation method and an energy transport path that are totally optimal without changing the quality or quantity of the energy supply for the end user.
- It makes it easier to compare best practices in energy use and enables rapid problem discovery and countermeasures.





## Plant-wide Energy Management

featuring digital twin and plant-wide data integration for total energy optimization

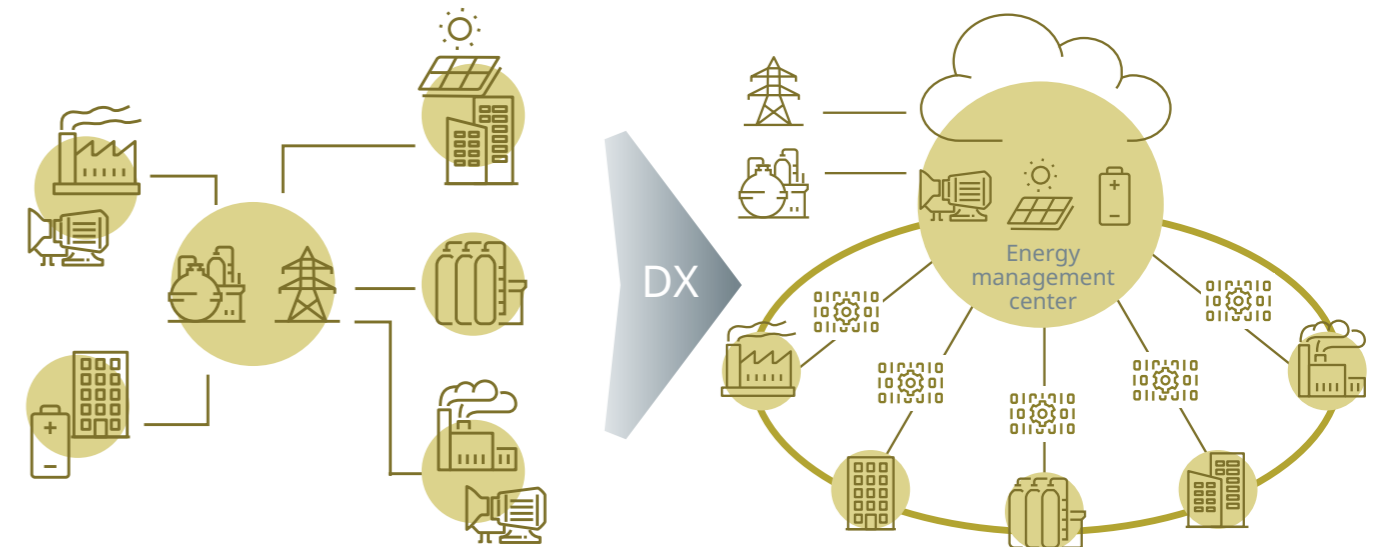


Rising pressure from governments and society, including investors, to reduce carbon emissions

Comprehensive solutions in energy supply, demand, and in re-use of energy through consulting services provided by Yokogawa, and our co-innovation partners

## Community Energy Management

featuring digital twin and data integration for community energy optimization



Smart community

### Challenges

- Unknown where and how to realize energy savings in plant
- Few people have the expertise needed for each energy solution
- Difficulty on realizing site-wide energy saving optimization
- Continuous maintenance of energy management system to maintain optimum conditions

### Solutions

- Comprehensive solutions in energy supply, demand, and re-use through consulting services provided with deep domain knowledge and the best-in-class digital technologies of Yokogawa, and our co-innovation partners
- Solve energy-savings challenges via a discover, design, and develop approach

### Benefits

- Enables the identification of energy-saving areas, and design/develop solutions for energy-saving issues
- Overall energy savings (e.g., 3.2M\$/year at utility area)
- Production increase, reduce maintenance, and improve availability

### Challenges

- Society's desire for CO2 reduction
- Contributing to the community
- Energy security during shutdown of the external grid

### Solutions

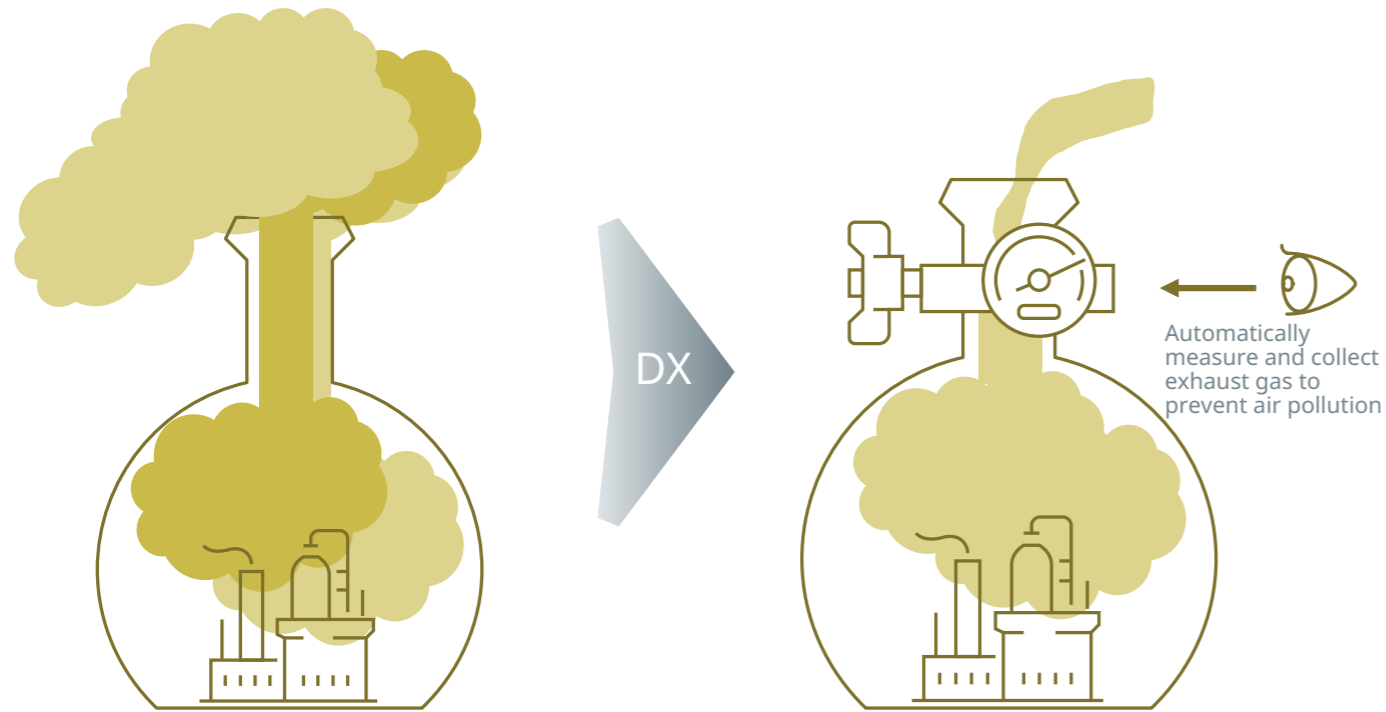
- Closed integration with FEMS (factory energy management system) at each factory and prediction of energy demand
- Optimization of supply plan from multiple energy resources
- Optimization of energy purchase and sales plan from and to the external grid

### Benefits

- Over 20% reduction in community energy cost
- Generated profit can be shared within the community
- Optimized use of energy resource in the community
- Reduction of carbon footprint in the community (in case renewable energy resource is available)

# Continuous Emission Monitoring Predictive Emission Monitoring

featuring digital twin and data integration for the  
minimization of exhaust gas emission



## Challenges

- Measure the concentration of exhaust gas to prevent air pollution
- Use the system that complies with national and local regulations
- Measure and collect these data automatically
- Reduce the cost of maintenance and operation

## Solutions

- Measure the exhaust gas automatically and continuously
- Create suitable sample handling system based on experience
- Prepare systems that meet local regulations
- Provide not only analyzers but also data collection systems and analyzer houses

## Benefits

- Contribute to environmental protection via control the exhaust gas
- Reduce maintenance costs by using our sampling system based on experience
- Ensure cost reduction for install and maintenance
- Provide DaaS (Data as a Service) solution to save on the initial investment cost



Topics

*Digital Twin*

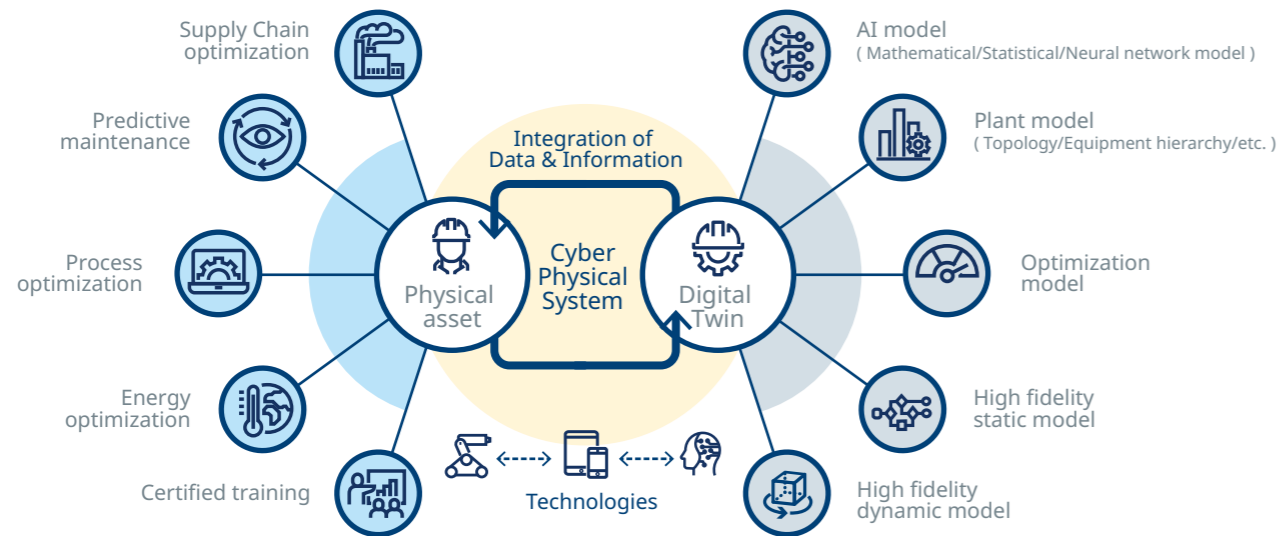
*Robotics*

*Cybersecurity*

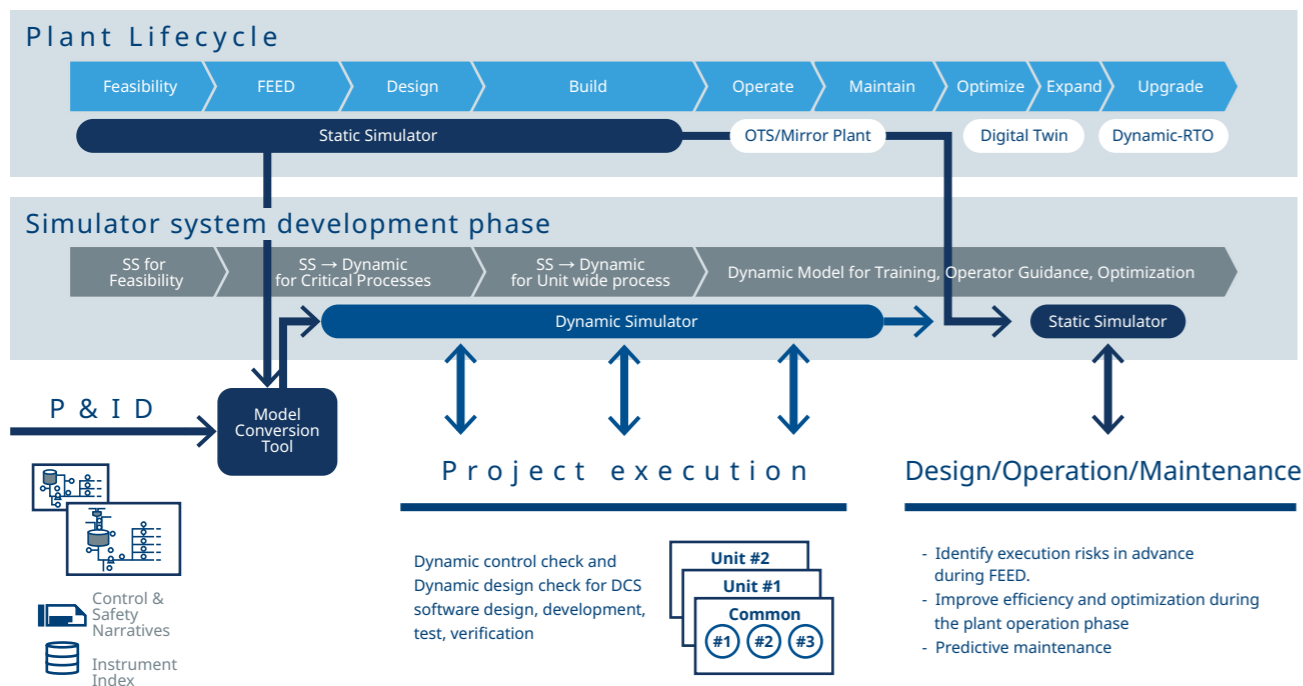
# Digital Twin

Eliminate operational hindrance caused by equipment deterioration

Digital twins are a key element in implementing Smart Manufacturing and industrial autonomy initiatives in process plants. Yokogawa has all the necessary components to support customers' expectation to develop a digital twin and assess operation optimization, failure prediction for assets, and the reduction of process development lead time.



Process simulators can be used to improve both automation project delivery performance and the operation and maintenance of process plants over the entire plant asset lifecycle. To implement and support the realization of the solution using process simulators, Yokogawa utilizes an innovative model conversion tool to increase efficiency.



## Digital Twin for Operation utilizing Big Data Analysis

Multiple plant data  
Actual plant data can be used in the Digital Virtual World.

Advisory Dashboard  
Based on the output from process simulator and Machine Learning result, the dashboard shows process KPI, health index, and recommended operations

AI Analytics  
The health index informs us the necessity for maintenance and indicates that it has recovered to a good condition after maintenance.

Process Simulator  
1. Machine Learning model detects process anomaly  
2. Machine Learning alarm triggers Process simulator  
3. Process simulator what/if analysis is used to decide best action before implementation

### Challenges

- Leakage leading to off-spec product
- An unexpected shutdown due to reactor degradation
- Product quality deterioration due to reactor degradation

### Solutions

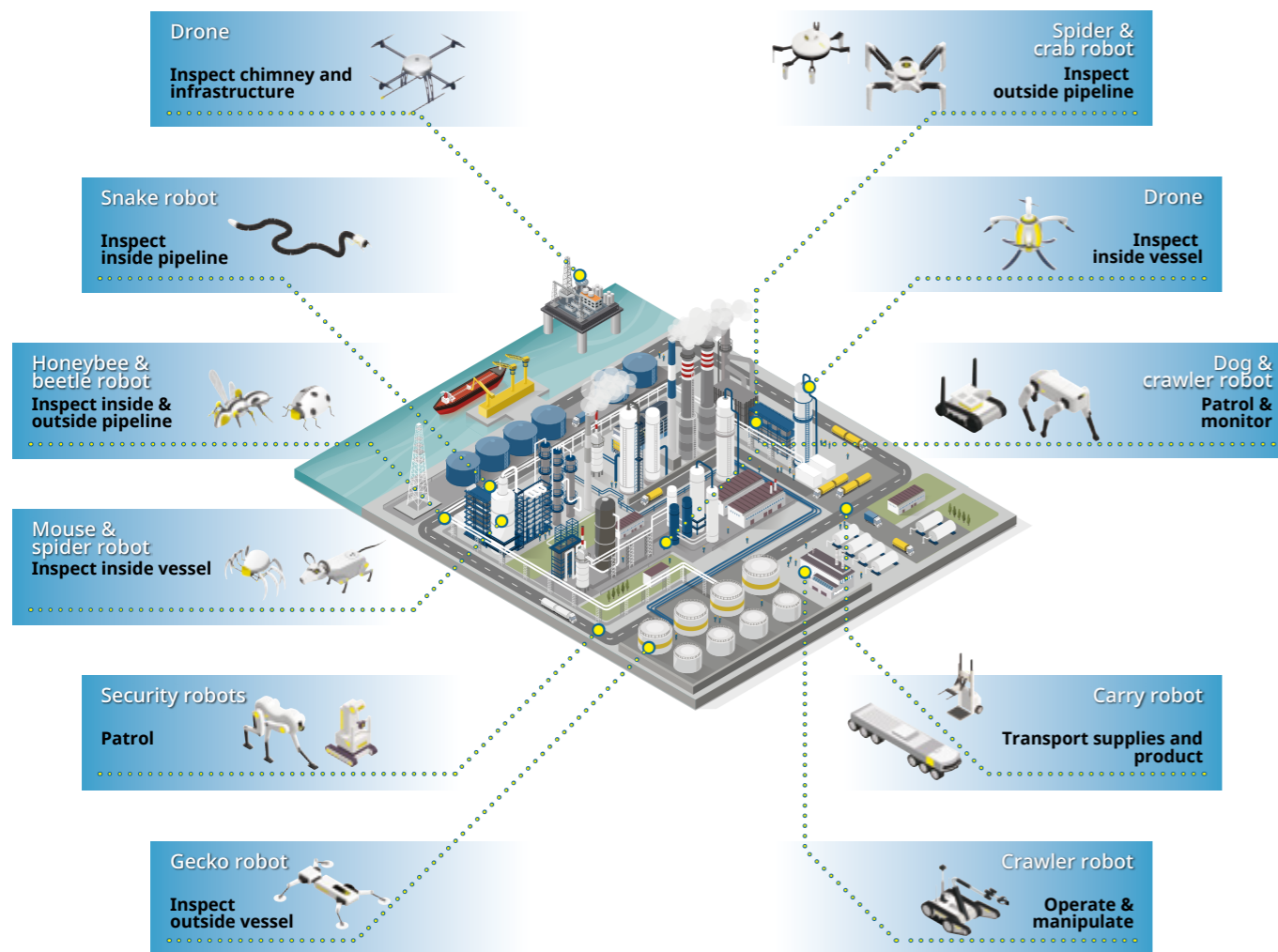
- Yokogawa AI that realize:
- Prediction of symptoms before causing low performance of reactor
  - Prediction of reactor health index for early detection of reactor degradation
  - Prediction of when the composition of ingredients that reduce product quality in the product will increase

### Benefits

- Optimal plant operation to minimize product quality degradation
- Customers can spend more time planning maintenance to restore reactor performance and ensure a faster reactor recovery

Process simulator suggests optimal action

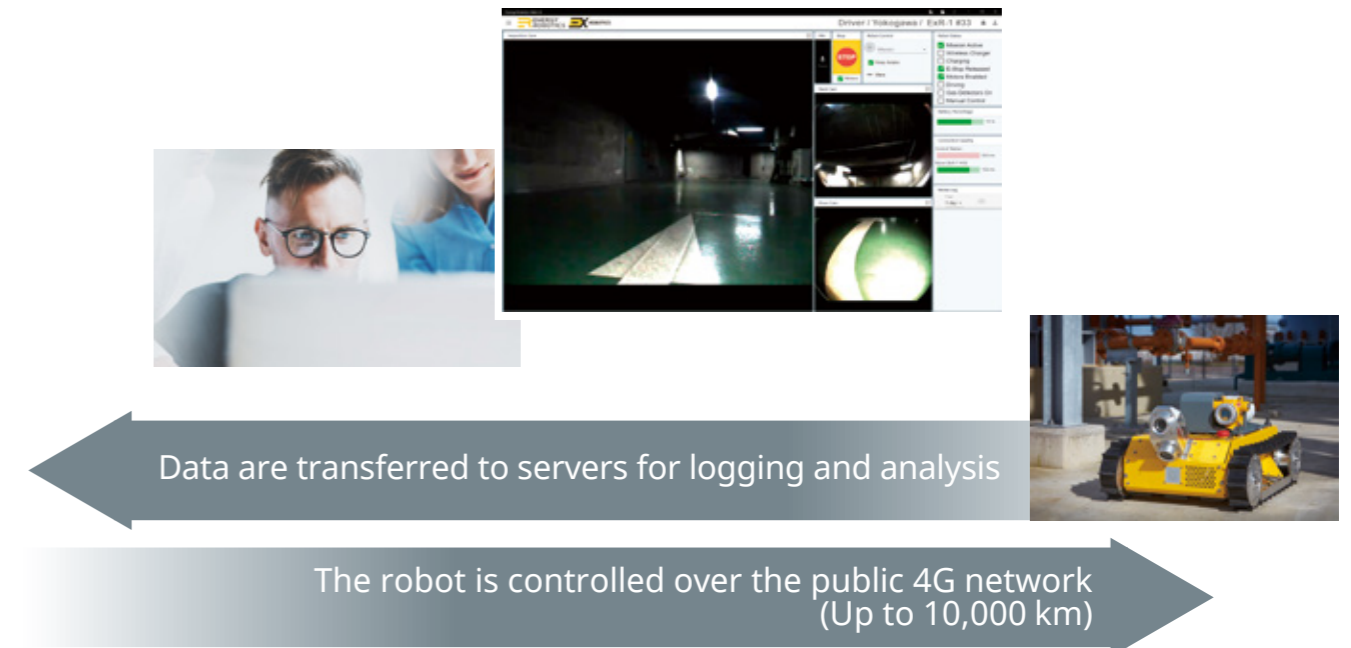
Robotics technology is a key enabler of industrial autonomy and is becoming easier to use and less costly. Yokogawa Robotics Service Platform (YRSP) has project reference and meets the requirements for unattended and/or remote facilities.



### Requirements for unattended and/or remote facilities:

- Robotics vendor that is type independent to support various types of robots for operations and maintenance
- Application that is independent and can support various operation and maintenance needs
- Able to integrate smart data analysis by using AI, machine learning, etc.
- Able to support applications beyond the industrial automation market

### Robots in normally unattended or remotely operated facilities



### Challenges

- Safety risks related to travel and operation in hazardous/remote locations
- Lack of experienced or available personnel
- Inconsistent/insufficient data gathering in production facilities
- More frequent inspections required for increasingly environmentally aware operations

### Solutions

- The world's first robot with IECEx\*1 Zone 1 certification for commercial use enables;
- Assessing an incident before taking action
- Preventative maintenance by regular inspection rounds gathering data more systematically and reasonably than a human operator
- Operator rounds for inspection instead of people

### Benefits

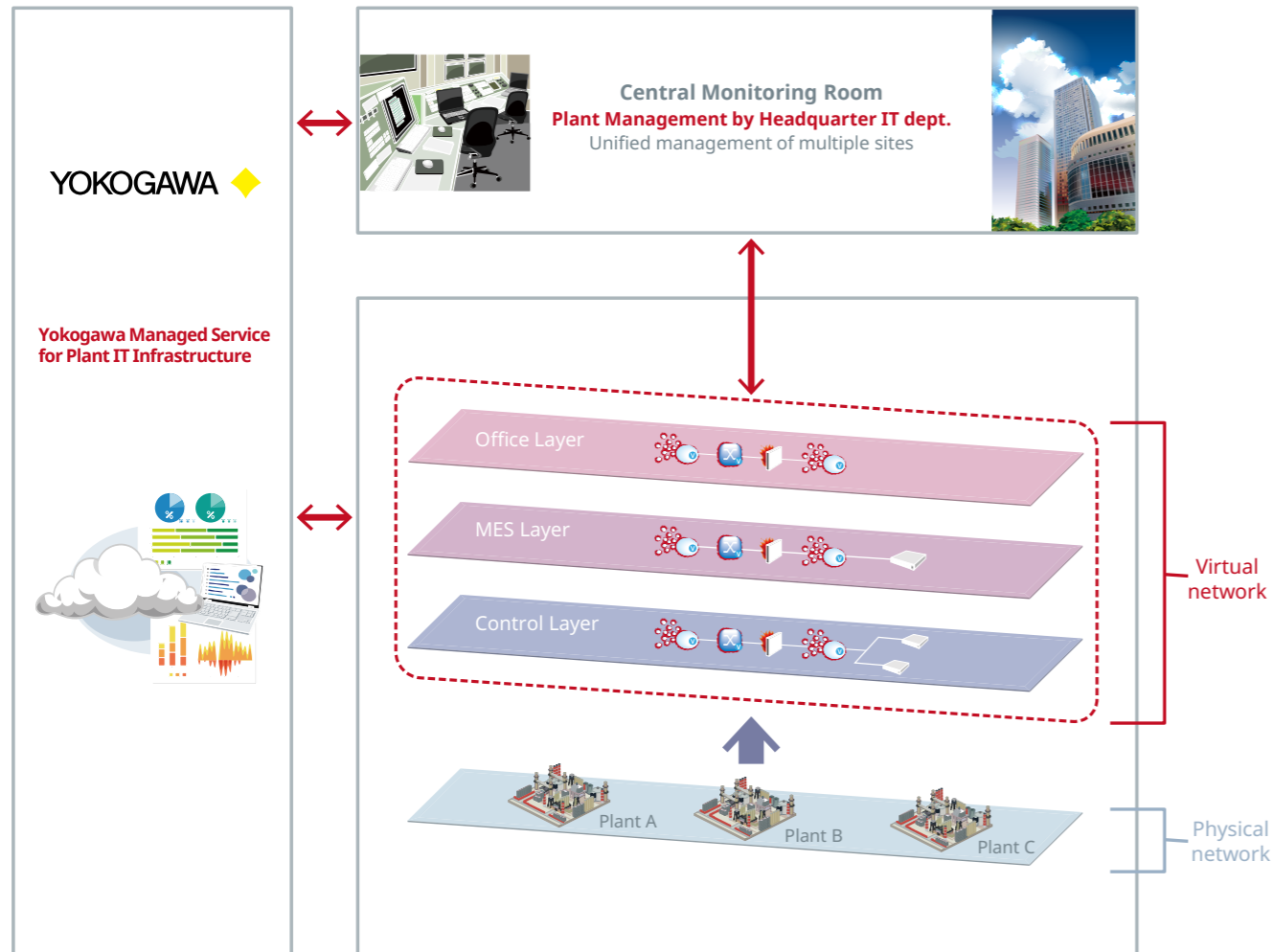
- Safety improvement, fewer people in hazardous locations
- More cost-effective, frequent and reliable inspections of facilities
- Reliable execution of repeatable work processes
- Minimized risks of leakage and explosions

# Cybersecurity

## Centralized and Standardized cybersecurity management with real-time monitoring

Utilizing our OT and IT knowledge, cultivated over more than 100 years of experience in providing industrial automation and services in green and brown field plants, Yokogawa will help with cybersecurity management with, at a maximum, brief interrupts in operations. Yokogawa has one overall objective: to minimize risk and maximize corporate values based on our self-commitment as a lifecycle value partner.

Enterprise-wide security management will be made possible by our managed service, which adopts a virtual network constructed for each system. This effectively protects your plants from cyber-intrusion. Yokogawa will help customers take appropriate steps to implement security management based on customers' systems environments and the skills and knowledge of employees.



## Cybersecurity management solution



### Challenges

- Security level variance at each plant around the world
- Need to manage plant network involving integration and complications, with operation risks and an opaque control network
- Reduce total cost of ownership (TCO) for security management

### Solutions

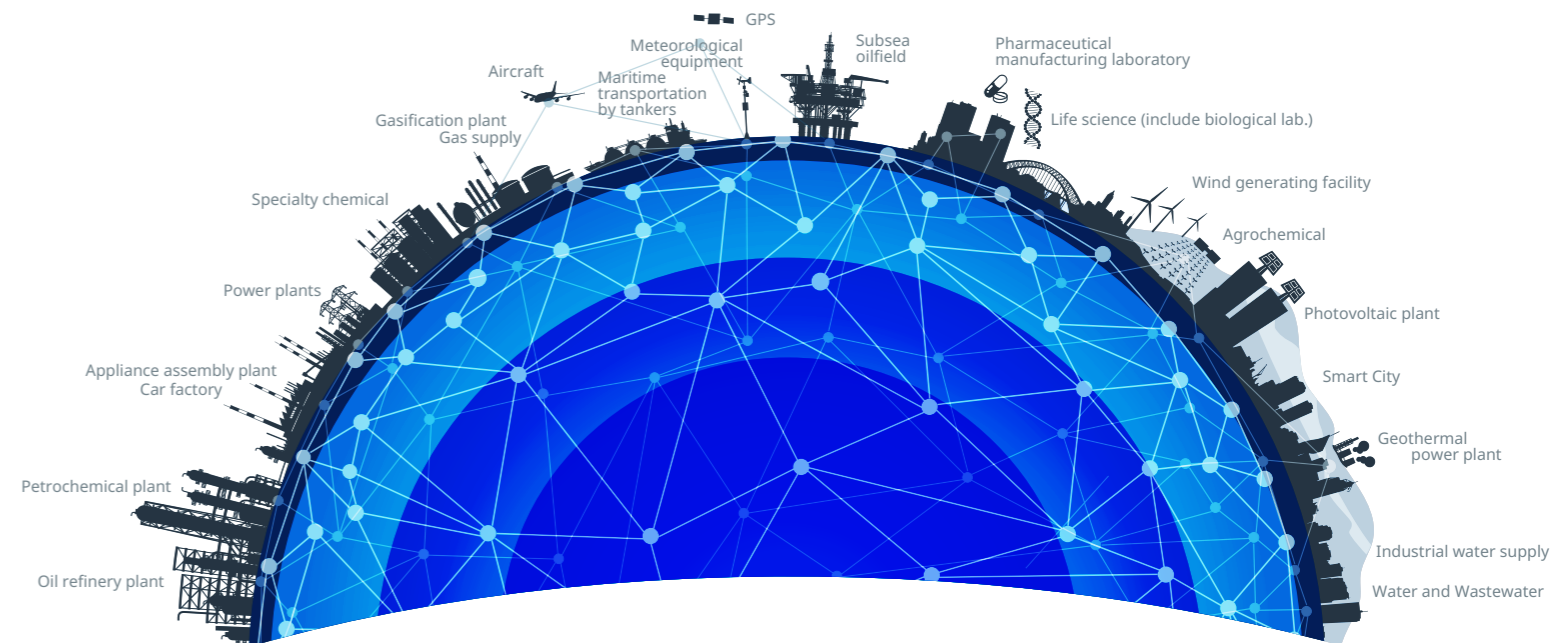
- Centralize and standardize cybersecurity management
- Distribution of OS security updates and antivirus signature files for control systems
- Centralized security management via real-time monitoring
- 24/7 help-desk operation to manage the solution globally

### Benefits

- Centralize IT asset inventory to manage risks and support decision making
- Reduce costs via simplified, standardized, and more integrated security management
- Improve security level by complying with industry standards, such as IEC62443 and company security standards

# Co-innovating tomorrow™

Yokogawa partners with customers and supports the development of the oil, gas, chemical, power, steel, pulp and paper, and food industries. We envision a Digital Transformation that optimizes your operations, grows your business, and contributes to society by connecting companies, regions, and society across industries and borders. Our brand slogan, "Co-innovating tomorrow," embodies this commitment and spirit. We look forward to partnering on a Digital Transformation journey with you.



**OpreX™** Through the comprehensive OpreX portfolio of products, services, and solutions,  
Yokogawa enables operational excellence across the enterprise.

**YOKOGAWA ELECTRIC CORPORATION**

**World Headquarters**

9-32, Nakacho 2-chome, Musashino-shi, Tokyo 180-8750, Japan  
<http://www.yokogawa.com/>

**YOKOGAWA CORPORATION OF AMERICA**

12530 West Airport Blvd, Sugar Land, Texas 77478, USA  
<http://www.yokogawa.com/us/>

**YOKOGAWA EUROPE B.V.**

Euroweg 2, 3825 HD Amersfoort, The Netherlands  
<http://www.yokogawa.com/eu/>

**YOKOGAWA ENGINEERING ASIA PTE. LTD.**

5 Bedok South Road, Singapore 469270, Singapore  
<http://www.yokogawa.com/sg/>

**YOKOGAWA CHINA CO., LTD.**

3F TowerD Cartelo Crocodile Building,  
No.568 West Tianshan Road, Shanghai 200335, China  
<http://www.yokogawa.com/cn/>

**YOKOGAWA MIDDLE EAST & AFRICA B.S.C.(c)**

P.O. Box 10070, Manama,  
Building 577, Road 2516, Busaiteen 225, Muharraq, Bahrain  
<http://www.yokogawa.com/bh/>

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