5. Digital Solutions

5.1 Enhancement of Design Tokens in TOSHIBA SPINEX Design System

Example of design tokens using base colors specified by TOSHIBA SPINEX Design System

TOSHIBA SPINEX Design System is used to design graphical user interfaces (GUIs) compliant with Toshiba IoT Reference Architecture (TIRA). Its purpose is to ensure consistency in the appearance and behavior of operating elements.

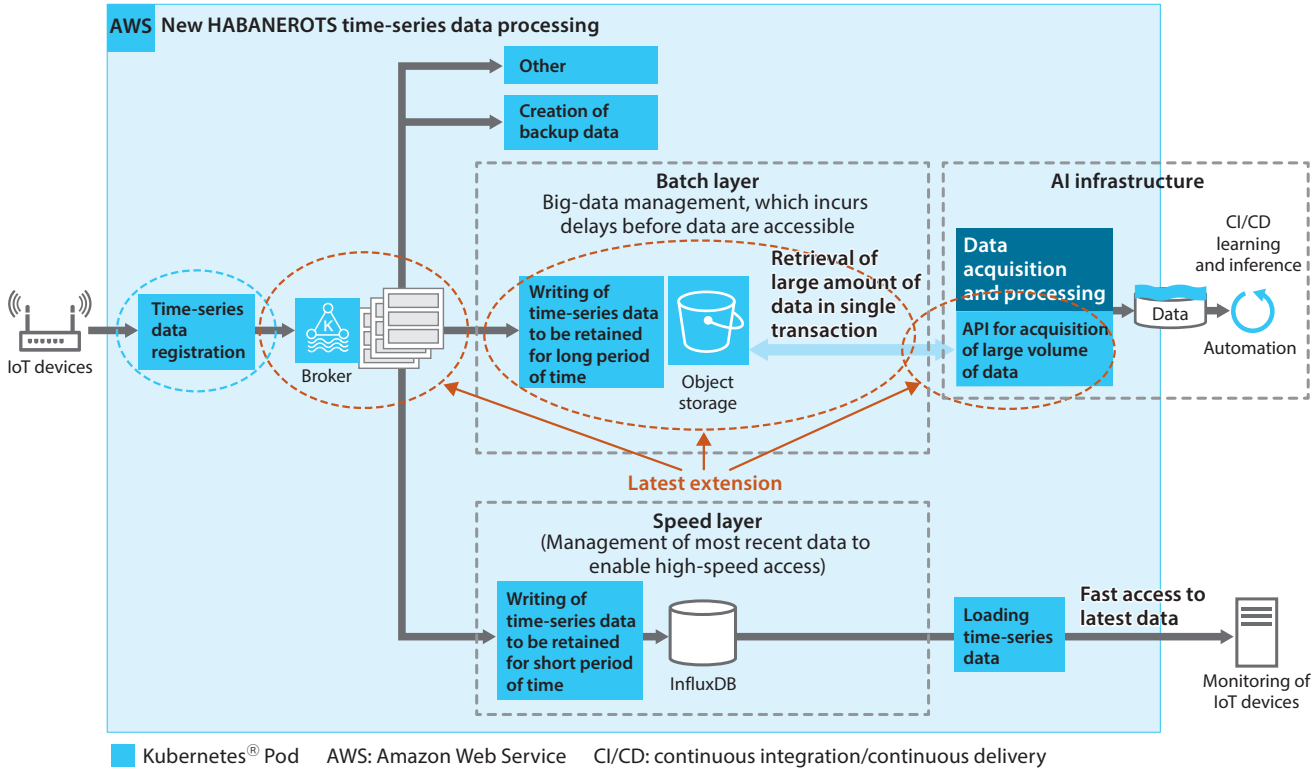
Toshiba Corporation has created sophisticated rules for design tokens, particularly those for assignment of component colors. Specifically, we have classified basic components into the following three categories and formulated rules for the background and foreground colors of each category:

(1) Base: Elements that occupy a large area such as screens and card backgrounds
(2) Input: Input elements such as text fields and checkboxes
(3) Blend: Elements that accompany Base or Input elements, such as labels and icon buttons

Design token sophistication will eliminate inconsistencies among operating elements created by different designers and enable developers to create a design for simple applications. In addition, because the color palette has been adjusted to match the new rules, user application accessibility is ensured by following the rules.

Moreover, it will be easier to create new color themes by replacing the design token color palette. For example, it is now possible to use the signature color of a client company as the primary color, which was previously difficult to accomplish at low cost.

5.2 Time-Series Data Processing System for AI Infrastructure



Architecture of HABANEROTS time-series data processing system in conjunction with AI platform systems

Toshiba IoT Platform Service HABANEROTS from Toshiba Corporation provides a common application programming interface (API) independent of the cyber-physical systems (CPS) of each business unit. The primary function of HABANEROTS is to acquire time-series data at high speed from a dedicated database.

Artificial intelligence (AI) applications that require a large amount of data for learning generally acquire data from many devices over a long period of time. However, the time-series data infrastructure based on InfluxDB(*) had the following issues:

(1) Backup and other operations of a massive amount of data are complicated, and long-term data storage is costly.

(2) The existing system lacks the flexibility to add new pipelines, for example, for secondary data processing.

(3) There are constraints for splitting the acquisition of a large amount of data into multiple API calls to fit within the system timeout period.

To resolve these issues, we have improved the data processing architecture as follows:

(1) The new architecture is dual-layered consisting of a speed layer for high-speed data acquisition and a batch layer for efficient mass data acquisition. It uses object storage for long-term data storage, making it possible to achieve a low-cost data processing system that handles large volumes of data.

(2) The new architecture uses brokers to improve the flexibility of data pipelines and reduce the transaction time required by the user.

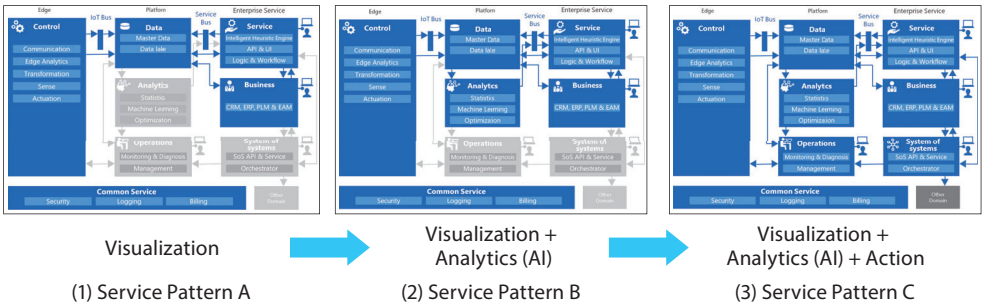
(3) The new architecture provides a dedicated API that returns a Uniform Resource Locator (URL) for data acquisition and generates search results asynchronously for bulk data.

As a result, the new time-series data processing system can utilize data from many devices over a long period while maintaining the advantages of a short registration-to-availability delay and a fast response time.

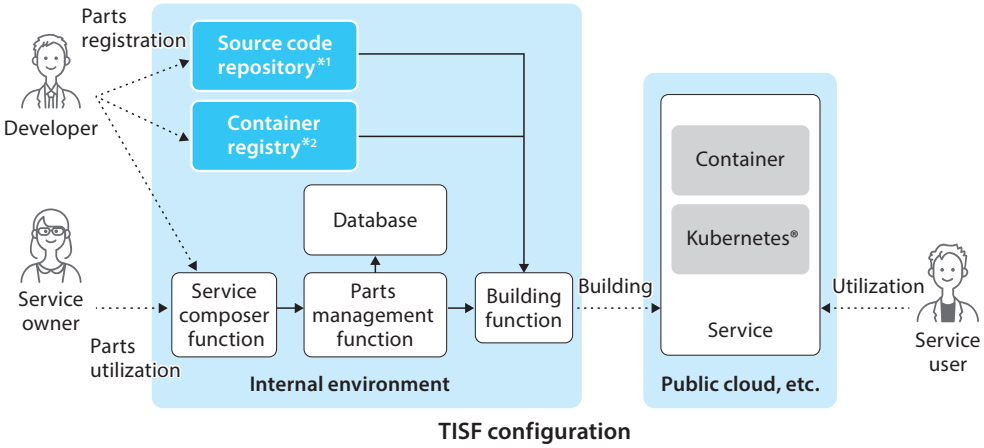
We will continue to enhance the data infrastructure to accommodate various workloads and expand application areas, thereby reducing development costs and improving the competitiveness of big-data systems.

(*) Open-source time-series database developed by InfluxData Inc.

5.3 Toshiba IoT Service Factory for Agile Development of Services Eliminating Need for System Integration



Patterns of CPS services classified according to maturity model



TISF configuration

*1: Server for version management and distribution of source code
*2: Server for version management and distribution of containers

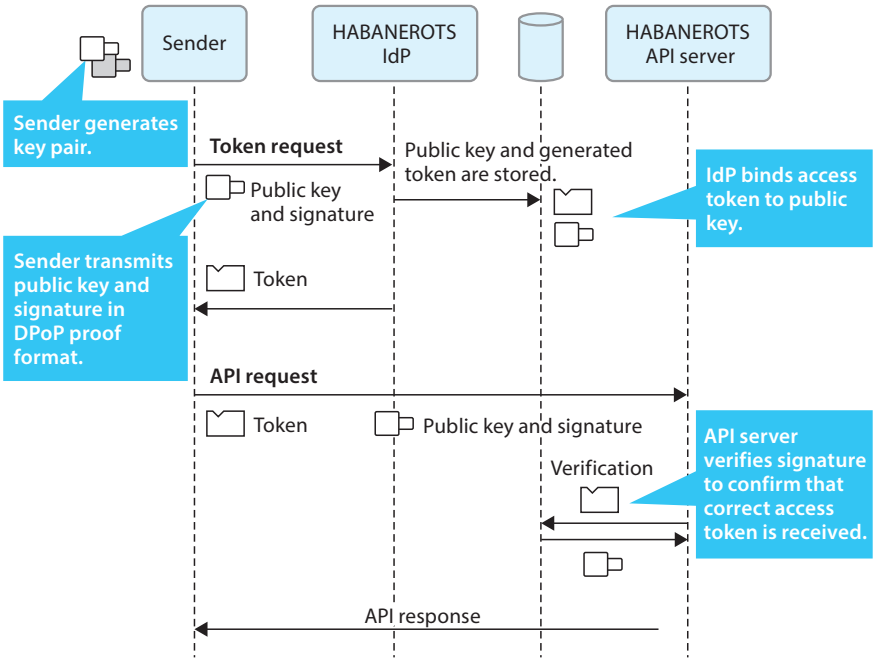
Toshiba IoT Service Factory (TISF) architecture for building CPS services without need for system integration

Toshiba Corporation has developed Toshiba IoT Service Factory (TISF) to facilitate the provision of services based on TIRA, a common framework to support the development and operation of CPS. By leveraging TISF to facilitate asset reuse, CPS services can be created without the need for traditional system integration (SI).

TISF allows developers to evolve CPS services from Pattern A to Pattern C with successive levels of services, starting with visualization and adding AI-based data analysis and then coordination and control of other systems. These patterns make it relatively easy to determine the required functions and configurations, security options to be programmed, and non-functional requirements, depending on the scale of the service to be implemented. In addition, the TISF allows patterns to be converted into common components, which help shorten service development time.

Kubernetes is a registered trademark of the Linux Foundation in the United States and other countries.

5.4 Implementation of OAuth DPoP in HABANEROTS IdP

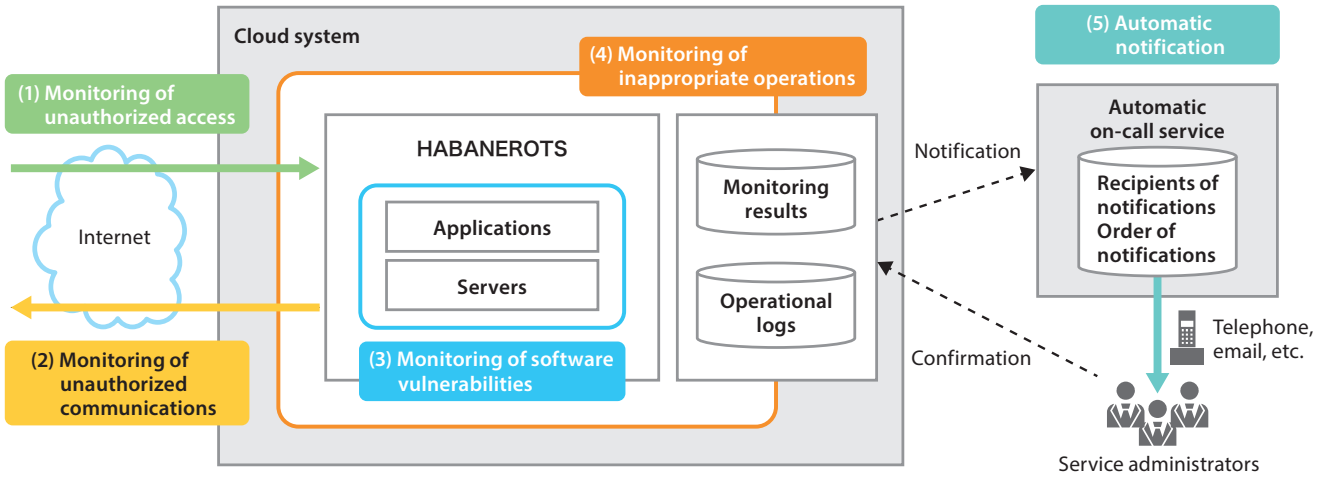


Outline of OAuth Demonstration for Proof of Possession at the Application Layer (DPoP) implemented in HABANEROTS identity provider (IdP)

Toshiba Corporation has implemented OAuth Demonstration Proof of Possession at the Application Layer (DPoP) in the identity provider (IdP) of HABANEROTS, our industrial Internet of Things (IoT) platform service. As an important specification for authentication and authorization, the OAuth DPoP is currently undergoing standardization at the Internet Engineering Task Force (IETF).

The OAuth DPoP is an application layer protocol for a sender-constrained access token mechanism. Under this protocol, the sender generates a key pair and a DPoP proof for a server multiple times. Signed using a private key, the DPoP proof contains request information and a public key. Using the OAuth DPoP with HABANEROTS makes it possible to prevent malicious access using stolen access tokens.

5.5 Security Monitoring Platform for Cloud-Based IoT Systems



Numbers (1) to (5) in above figure correspond to numbered phrases in following text.

Overview of security monitoring system for HABANEROTS IoT platform service

In recent years, cloud platforms have been widely used to provide services for analyzing data from IoT devices. When using a cloud platform, the cloud service provider is responsible for the quality of its hardware and other infrastructure components whereas IoT system developers are responsible for the quality of cloud-based IoT systems. This underscores why security is an important consideration when building and operating cloud systems.

HABANEROTS, an IoT platform service that provides functions such as data collection and remote control of IoT devices, is a cloud-based IoT system from Toshiba Corporation. We have implemented a security monitoring platform for HABANEROTS to ensure continuous and secure service operations. It includes the following functions: (1) monitoring of unauthorized access from outside the cloud system, (2) monitoring of unauthorized communications from inside the cloud system, (3) monitoring of vulnerabilities for software running on the cloud system, and (4) monitoring of inappropriate operations on the cloud system such as incorrect firewall settings.

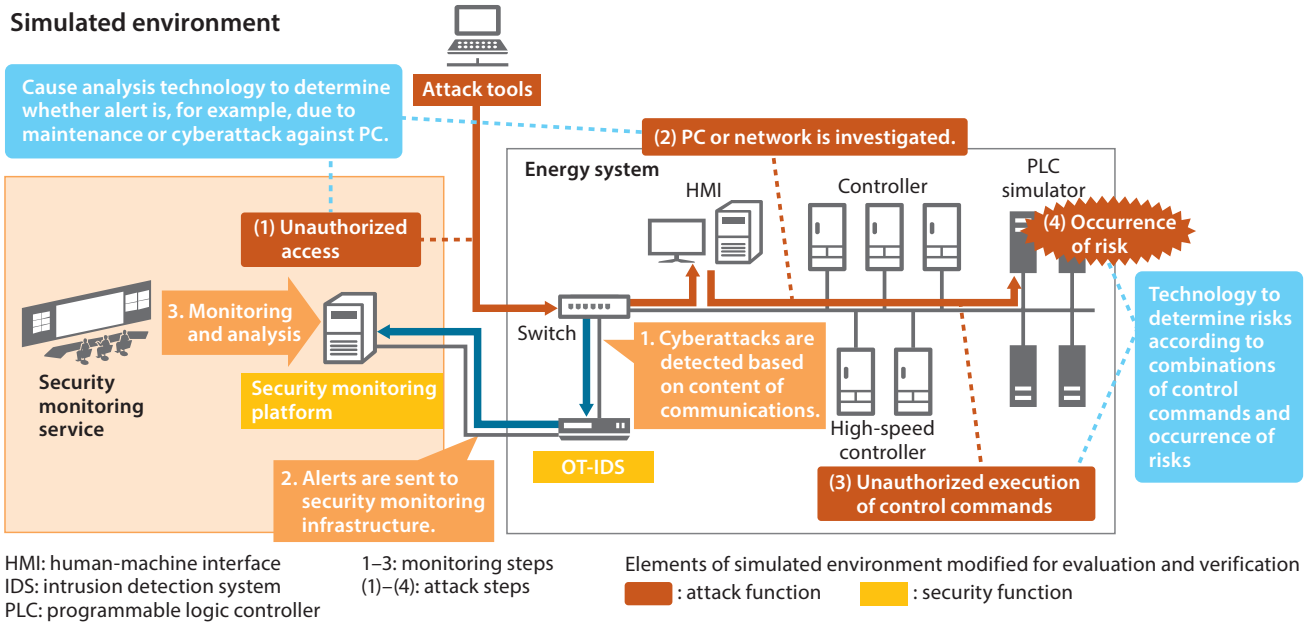
Cloud systems change constantly as service providers add new servers, change server configurations, discover software vulnerabilities, and so on. It is therefore insufficient to perform security checks prior to the release of a service and then conduct periodic security checks. The new security monitoring platform constantly monitors for changes to cloud systems and detects security violations immediately.

When a serious security violation is detected, the system automatically notifies the service administrator by telephone or email via the automatic on-call service (5). The service administrator can use the monitoring results and operational logs to determine the root cause of security violations.

This security monitoring platform was implemented using only standard security monitoring services provided by cloud service providers and software-as-a-service (SaaS). Because the infrastructure as code (IaC) that automatically builds the platform is available in-house as open-source code, it can easily be applied within the Toshiba Group.

We will continue to contribute to security improvements and standardization of cloud systems.

5.6 Advanced Security Monitoring Technologies for Operational Technology Systems



Sophistication of security monitoring technologies for operational technology (OT) systems via utilization of simulated environments

Modern social infrastructure and industrial control systems are driven by general-purpose OS, applications, and communication protocols that are commonly used for information systems. In addition, connectivity with production management and other information systems and Internet connectivity for accessing manufacturing data in cloud systems is growing at an accelerating rate. As a result, cyber threats against both control and information systems is on the rise.

To provide solutions and services that reduce cyber risks throughout the entire lifecycle of control systems, the Toshiba Group has developed two security monitoring technologies, combining our control system knowledge and operational security experience: one to analyze the cause of a security alert and the other to determine the risk of an attack.

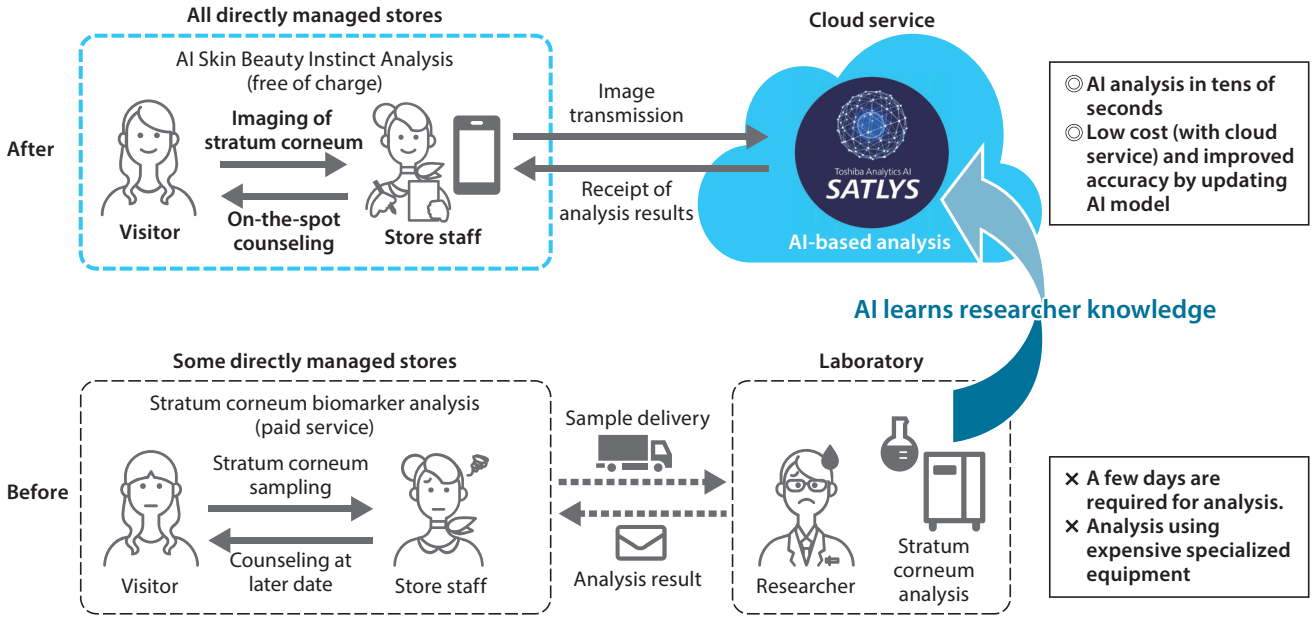
Upon detection of a security alert, the cause is analyzed to determine whether it is due to a cyberattack and to evaluate its impact on safety. Control systems frequently require non-routine maintenance, so when an abnormal communication alert is raised, it must be determined whether it is due to maintenance or a cyberattack. The cause of the alert is analyzed accurately by comparing the information on maintenance work with the alert from the security monitoring platform.

Because the top priority of control systems is to prevent the loss of human life, personal injury, and environmental damage, it is of the utmost importance to determine whether a cyberattack can affect safety. The new risk determination technology improves risk assessment accuracy by evaluating control commands that may affect the safety of control systems in advance.

5. Digital Solutions

We have confirmed the effectiveness of the new technologies by conducting actual cyberattacks against in-house mock environments such as energy systems. We will leverage the new technologies to provide advanced security monitoring and operation services.

5.7 SATLYS Toshiba Analytics AI Service for Skin Stratum Corneum Analysis



Reductions in time and cost required for stratum corneum analysis using SATLYS Toshiba Analytics AI image-processing

FANCL Corporation offered a stratum corneum biomarker analysis service that visualizes damage inside skin and possible future skin issues by measuring the proteins related to skin conditions contained in stratum corneum cells, a task that was impossible with previous skin measuring methods. However, this service was costly and time-consuming because specialized analysis equipment and expert knowledge were required to analyze biomarker levels in the stratum corneum.

With this in mind, FANCL and Toshiba Digital Solutions Corporation have collaborated to develop a technology to estimate biomarker levels and cell shapes from stratum corneum images. FANCL provided knowledge and data obtained through its research and service related to stratum corneum biomarkers while we offered our expertise in the field of AI for image analysis applications.

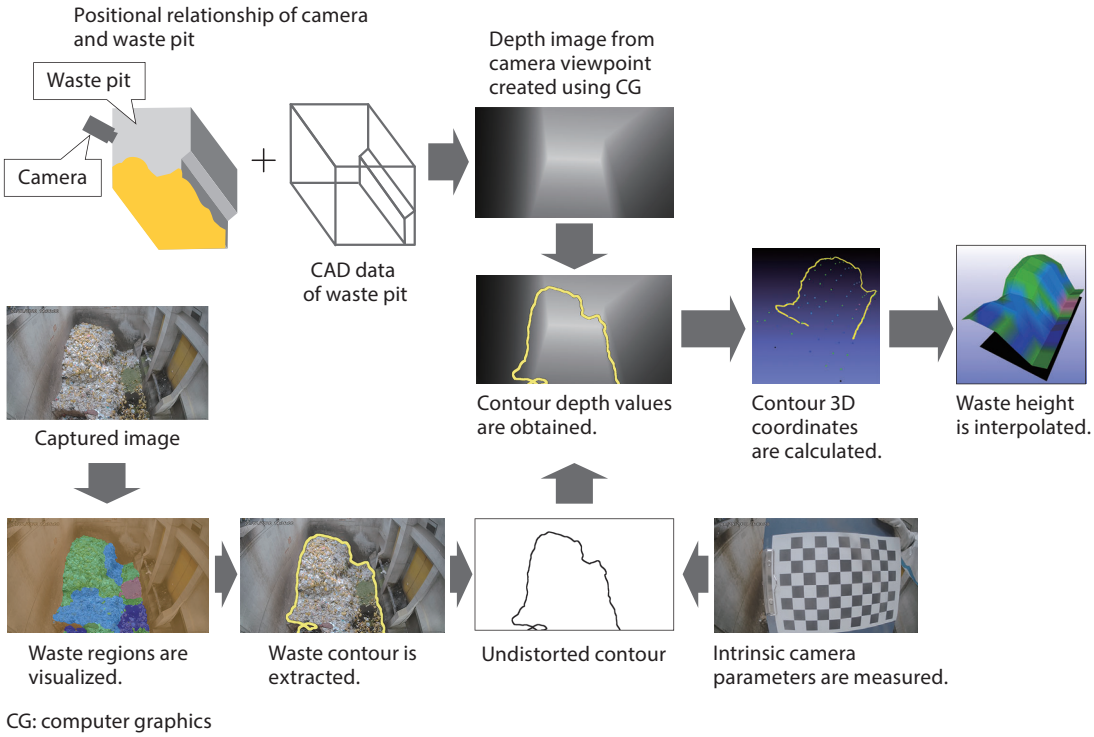
In this co-creation project, we provided SATLYS Toshiba Analytics AI professional service, ranging from consultation on AI applications to building an AI model, including deep-learning techniques. Having implemented the new AI model in the "SATLYS AI platform" on the cloud, we now offer it as a managed service. FANCL combined this AI model and an application for their stores and launched the "AI Skin Beauty Instinct Analysis®" in September 2022.

This service solves issues of time and cost because it requires neither specialized equipment nor expert knowledge. FANCL can now provide free personal counseling in about 30 minutes based on the results of an AI analysis, enhancing service quality. Furthermore, we have implemented a function for building and updating an AI model on the "SATLYS AI platform" for FANCL, enabling it to maintain and improve AI model accuracy on its own as necessary.

5. Digital Solutions

We will continue to co-create AI systems with customers in various industries, support them in solving problems and creating business value, and offer services and systems that enable them to develop and operate AI models smoothly without the need for AI expertise.

5.8 SATLYS Toshiba Analytics AI Service for Improved Waste Treatment Facility Operational Efficiency



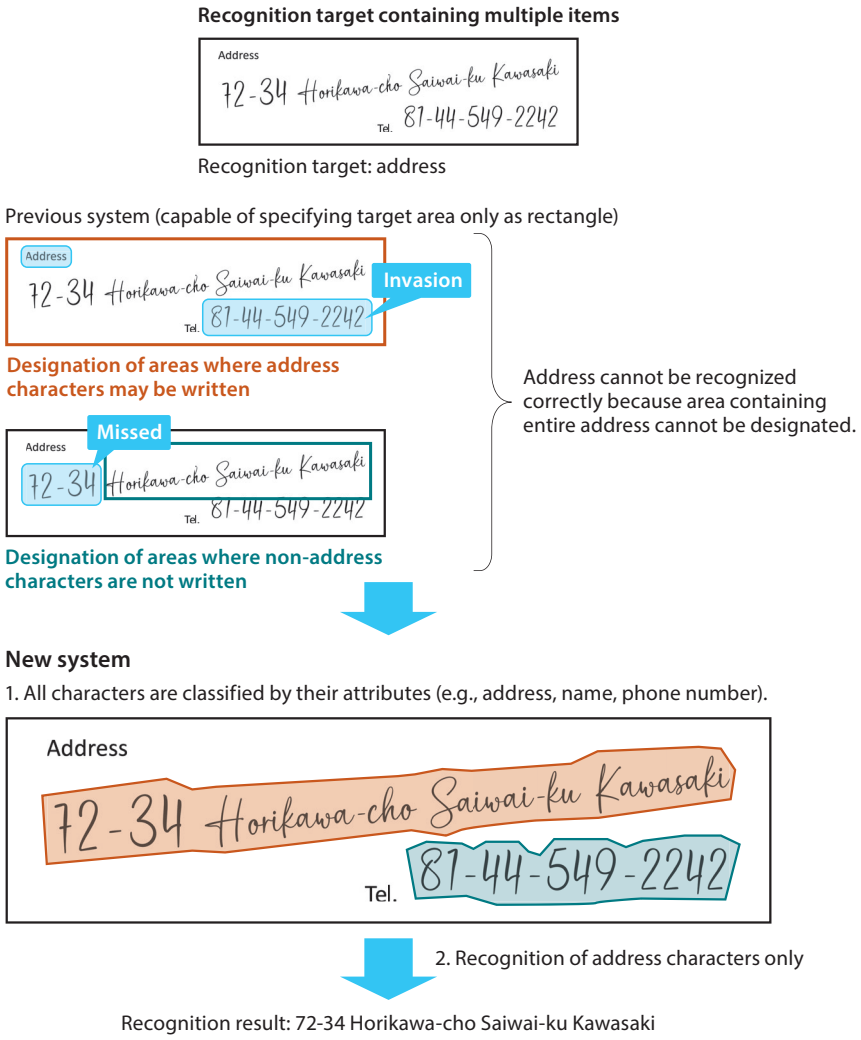
Processes for waste segmentation and estimation of waste height using images and CAD data of waste pit

There is a growing need for waste treatment facilities in Japan to improve waste treatment operational efficiency accompanying a growing awareness of environmental issues, tight finances faced by local governments, and aging workers in recent years. In this context, application of automatically controlled cranes using AI technologies at waste pits in order to efficiently stir and transship wastes is garnering attention.

As an addition to its professional service lineup of SATLYS Toshiba Analytics AI services, the Toshiba Group has developed an AI technique to recognize and visualize conditions in waste pits including the type of waste and waste stirring conditions using images captured by a monocular camera. In addition, this AI technique estimates the waste height from visualization results and waste pit computer-aided design (CAD) data.

Incorporated into a fully automatic AI waste crane system developed by Kawasaki Giken Co., Ltd., this AI technique has demonstrated its ability to improve crane control operational efficiency even at small waste pits where difficult crane control operations are required.

5.9 New AI-Based OCR Service Supporting Irregularly Formatted Text



Overview of technique for improvement in OCR accuracy to read specific information from multiple items written in single field

Toshiba Digital Solutions Corporation provides an AI-based optical character recognition (OCR) service for text documents, including handwritten forms and semi-structured documents such as invoices. It is available as a cloud or on-premises service.

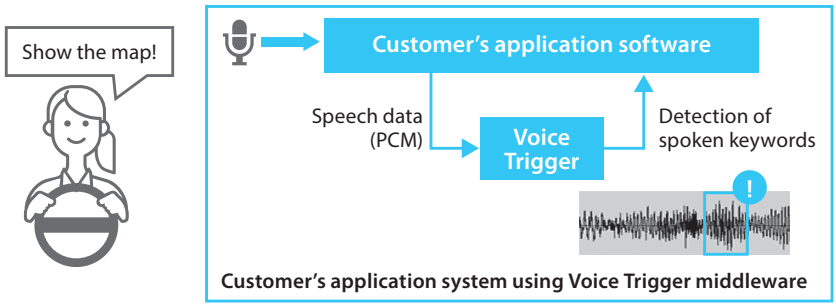
We use the DevOps approach to continually update our OCR service and adopt agile development practices to accelerate software release cycles.

Our latest OCR release supports recognition of complex fields. For example, some forms have fields in which multiple items must be written. However, it is quite difficult to set recognition areas for such fields as characters in one item may be written in an area where another item should be written. To solve this problem, we have developed an item extraction technique using semantic segmentation, successfully improving the recognition rate for such fields.

The latest release incorporates many other updates for the entire recognition process. One is the adoption of deep-learning technology for the form identification process, eliminating the need for keyword designation in order to identify the type of form. Deep learning also improves form identification accuracy.

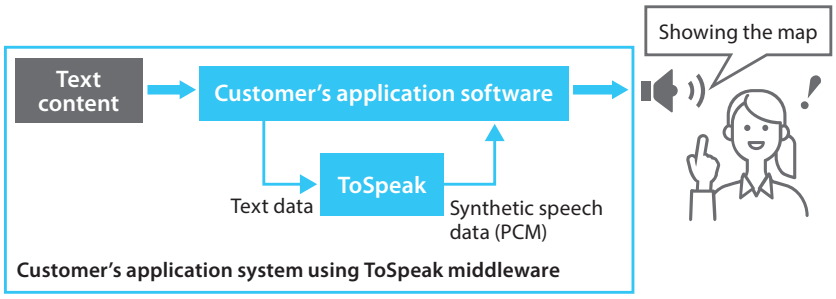
We will continue to update our OCR service to support the digital transformation (DX) and digital evolution (DE) efforts of our customers.

5.10 ToSpeak RECAIUS Text-To-Speech Middleware and Voice Trigger RECAIUS Speech Recognition Middleware Supporting 30 Languages



PCM: Pulse Code Modulation

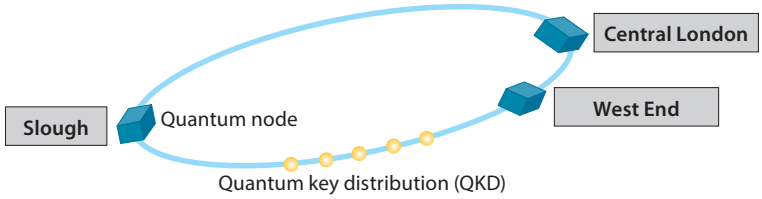
Voice Trigger speech recognition middleware



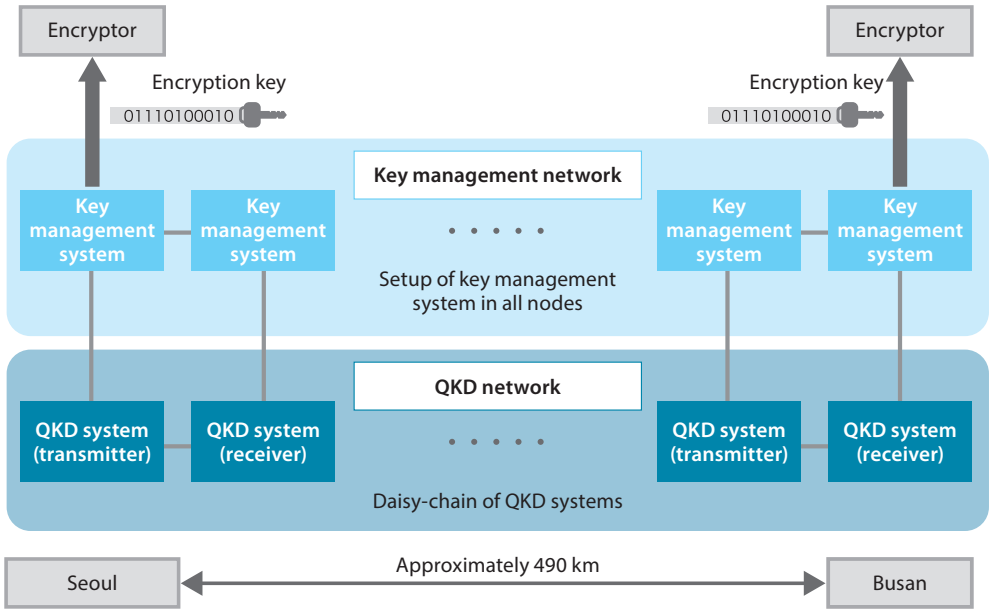
ToSpeak text-to-speech middleware

ToSpeak RECAIUS Text-To-Speech (TTS) middleware and Voice Trigger RECAIUS speech recognition middleware from Toshiba Digital Solutions Corporation convert text data into synthetic speech data and detect spoken keywords in audio data respectively. We have added supported languages to the middleware components to include Western, Northern, and Central European and Asian languages in addition to Japanese, US English, and Mandarin. ToSpeak and Voice Trigger now support 30 and 29 languages respectively, including Spanish, Brazilian Portuguese, Vietnamese, Arabic, Russian, Greek, and Thai, which have their own unique characters as well as rules on the use or lack of use of spaces for word separation. Both ToSpeak and Voice Trigger are offered as a library of API functions and run quickly and smoothly on edge devices with a small memory footprint and low computational cost. They are licensed to manufacturers planning to develop products with text reading and voice operation functions.

5.11 Global Expansion of Quantum Key Distribution Network Business



QKD core ring for quantum-secured metro network in London



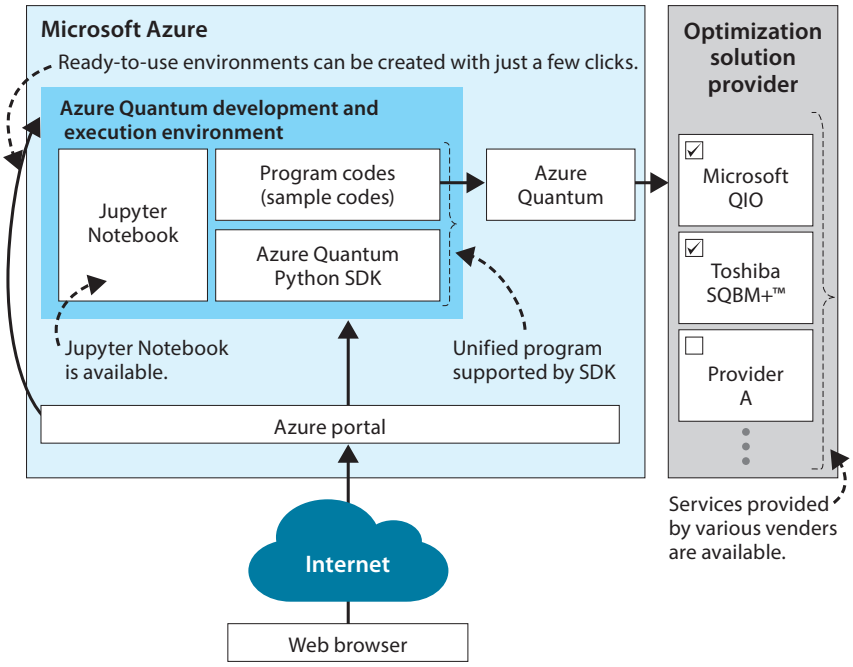
QKD network demonstration system in South Korea

With the aim of launching quantum key distribution (QKD) services in the global market, the Toshiba Group is collaborating with partners in many countries and regions. In 2022, we achieved implementation and operation of QKD networks in collaboration with telecommunication companies and commenced commercial trials with user companies.

In the United Kingdom, we collaborated with BT Group plc to construct a quantum-secured commercial metro network in London. Ernst & Young Global Limited, the first user, began using the quantum-secured network service to share confidential information between two of its major London sites.

In South Korea, we collaborated with KT Corporation to construct a hybrid QKD network of inhomogeneous QKD systems over approximately 490 km from Seoul to Busan and evaluated the service quality. We achieved a key relay scheme that shares a key between the source and destination nodes by daisy-chaining QKD transmitters and receivers as well as key management systems through all nodes using optical fiber. Even though a segment of the optical fiber connection is more than 100 km long, a demonstration has confirmed stable key delivery.

5.12 SQBM+™ Cloud on Azure Quantum, Easy-to-Use Quantum-Inspired Optimization Solution



SDK: software development kit

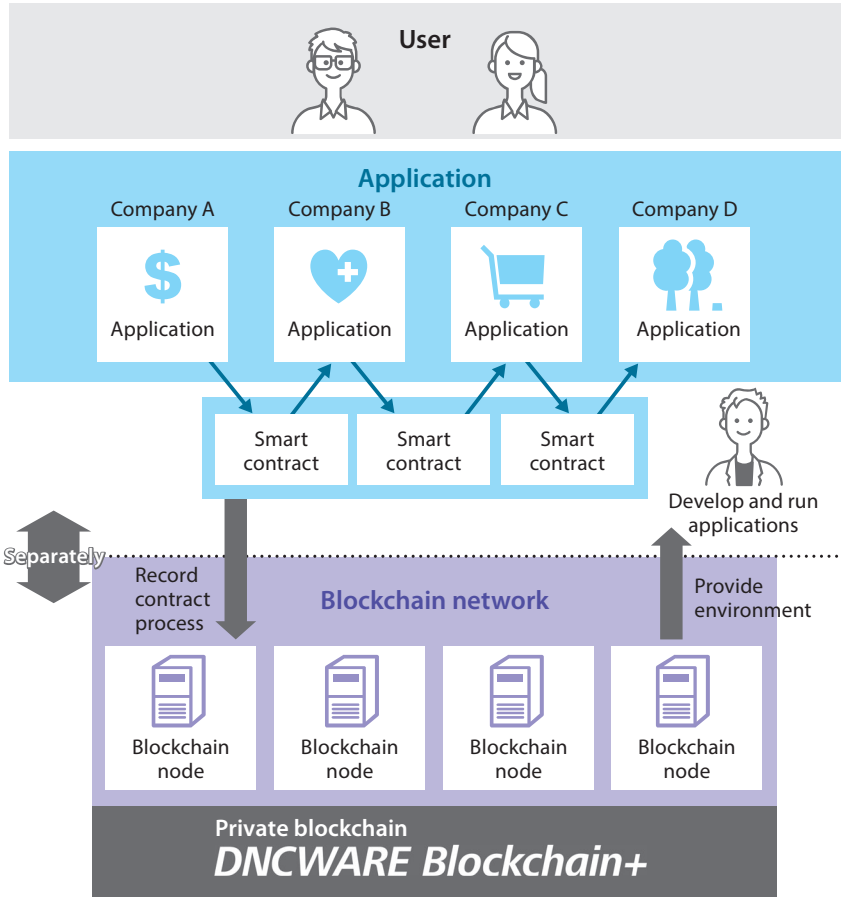
Features of SQBM+™ Cloud on Azure Quantum allowing customers to easily use quantum-inspired optimization solution

SQBM+™ is a quantum-inspired optimization solution from Toshiba Digital Solutions Corporation that can solve large-scale combinatorial optimization problems at high speed and with high accuracy. It is based on the simulated bifurcation algorithm that we invented during research on quantum computers. SQBM+™ has been provided as cloud software, but it has been difficult to build a running environment and create programming and benchmarking environments. In addition, considerable time was required to adjust the parameters for solving optimization problems.

To resolve these issues, we have developed SQBM+™ Cloud on Azure Quantum as a SaaS cloud service on Microsoft Azure Quantum. Being a SaaS cloud service, SQBM+™ Cloud on Azure Quantum eliminates the need to build an execution environment. In addition, the development tools and sample programs available with Azure Quantum make it easy to start using SQBM+™ Cloud on Azure Quantum. Furthermore, SQBM+™ Cloud on Azure Quantum automates parameter adjustment, thereby reducing user workload. As a result, high-speed and highly accurate SQBM+™ can now be easily evaluated and used.

We will continue to improve its performance and functions to allow handling of a wider range of combinatorial optimization problems.

5.13 DNCWARE Blockchain+, a Managed Service Providing Blockchain for Enterprises



Overview of DNCWARE Blockchain+ managed service providing enterprise blockchains

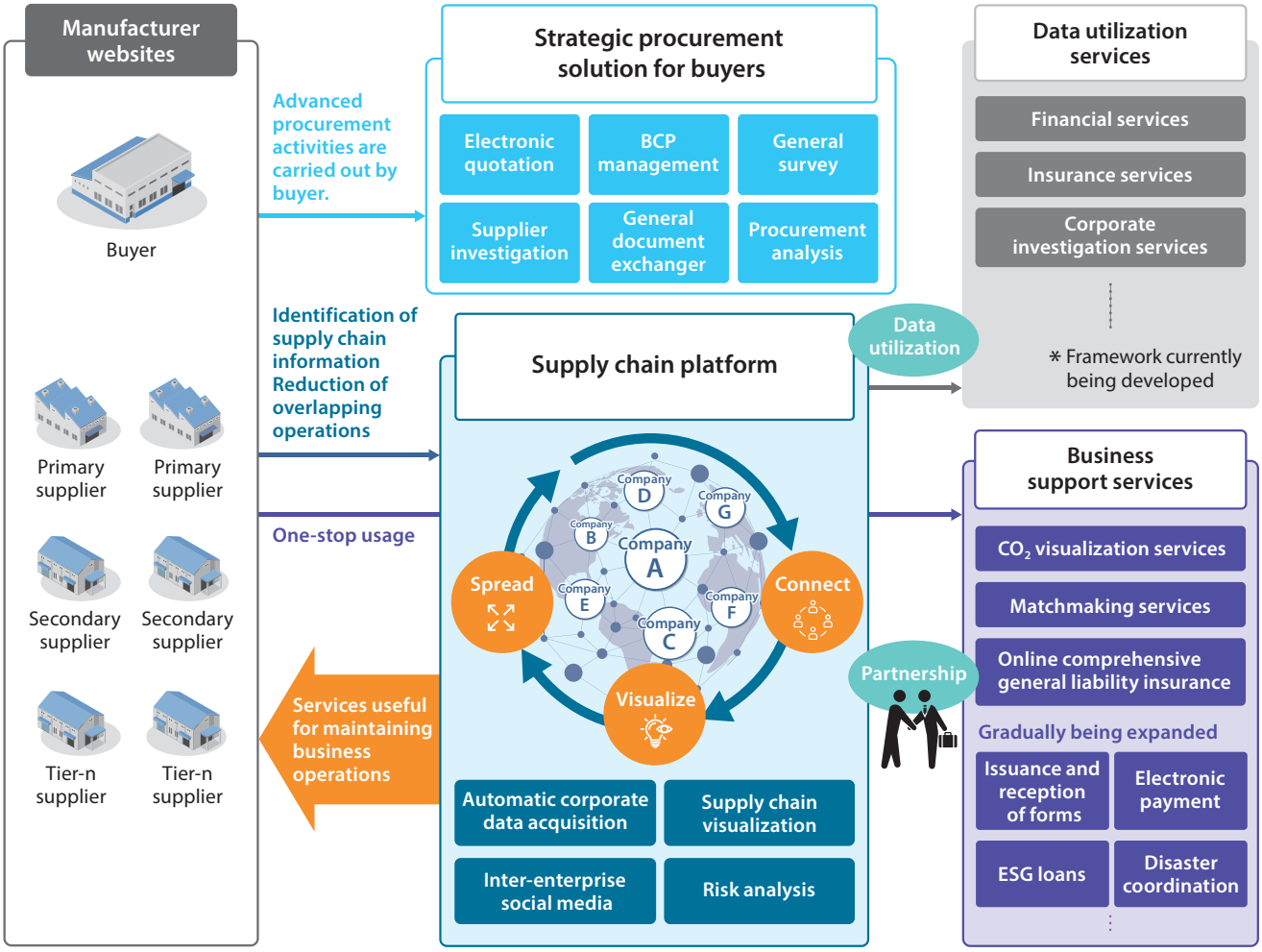
Toshiba Digital Solutions Corporation launched DNCWARE Blockchain+ in May 2022 as a managed service that provides a private blockchain environment.

By providing DNCWARE Blockchain+ as a managed service instead of software, users can develop and run applications immediately without being aware of blockchain network management and operations.

The blockchain is highly reliable and tamper resistant due to the new consensus building logic developed based on our proven cluster technology. In addition, users can easily develop applications that run on the DNCWARE Blockchain+ because they can write smart contracts that define the contract execution process on the blockchain as a program in JavaScript.

We are going to apply DNCWARE Blockchain+ to an electronic contract system for local governments, and are working with multiple companies to launch new services in the fields of insurance, inheritance, and logistics.

5.14 Open Platform to Achieve Supply Chain Networking



BCP: business continuity planning SNS: social networking service ESG: environment, social, governance

Overview of supply chain platform

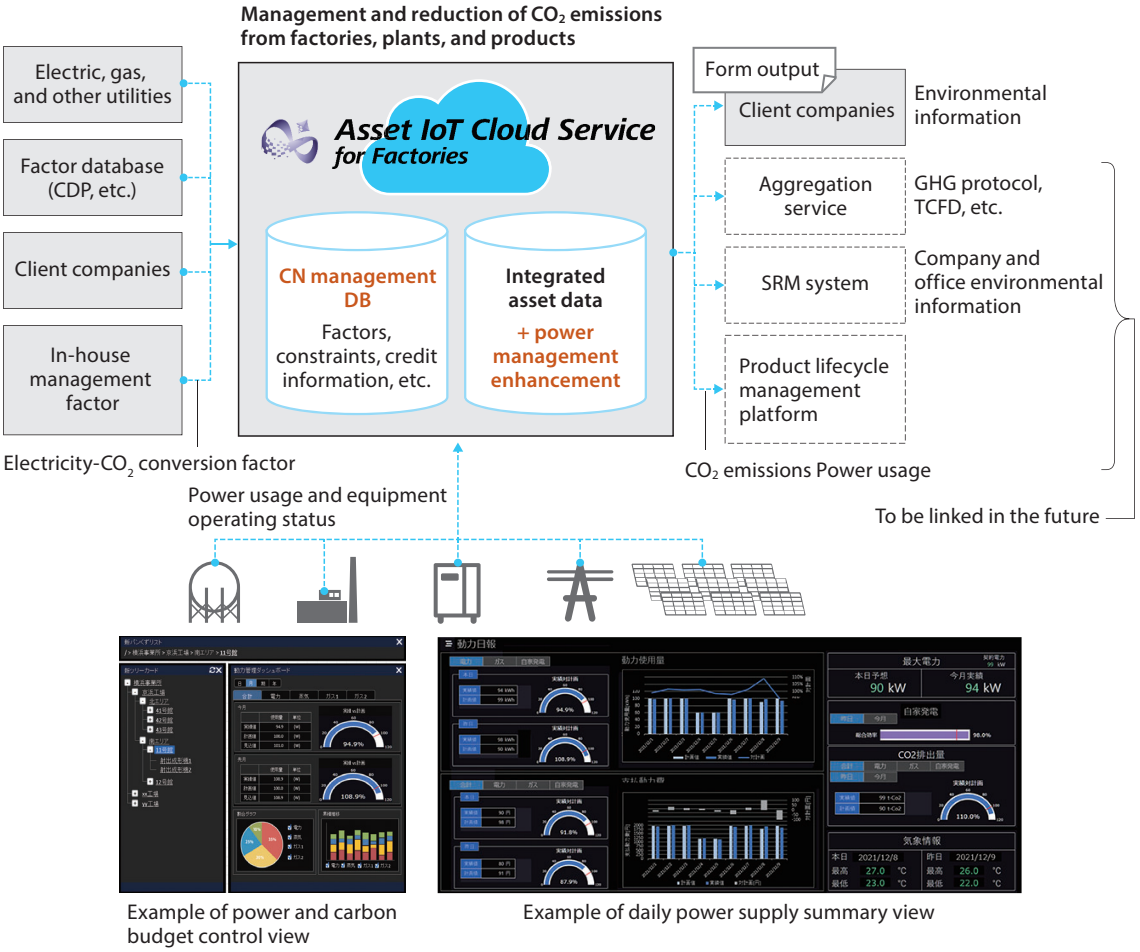
There is a pressing need for many manufacturers to ensure supply chain resilience so that they can adapt to unexpected events or changes in business environments such as the COVID-19 pandemic and trade friction. To do so, manufacturers need to communicate and coordinate not only with their primary suppliers with whom they do business directly, but also with secondary, tertiary, and lower-tier suppliers.

With this in mind, Toshiba Digital Solutions Corporation has launched the supply chain platform, a cloud service that supports business activities in the manufacturing industry to enhance supply chain resilience and agility. It allows subscribers to connect with one another via a network to share and relay information of their own accord. This helps facilitate communication among subscribers. The information collected on the platform makes it possible to visualize supply chain conditions, identify procurement risks, and improve the efficiency of various surveys.

5. Digital Solutions

Furthermore, we are working with a number of partners to provide various services that support subscriber business activities such as carbon dioxide (CO_2) visualization, matchmaking, and comprehensive general liability insurance services. The data accumulated in the supply chain platform will be used to create new value such as analysis services for improving business efficiency and financial services.

5.15 Asset IoT Cloud Service for Factory CO_2 Emission Management



Example of power and carbon budget control view

Example of daily power supply summary view

CDP: Carbon Disclosure Project
CN: carbon neutrality
DB: database
GHG: greenhouse gas
TCFD: Task Force on Climate-related Financial Disclosures
SRM: supplier relationship management

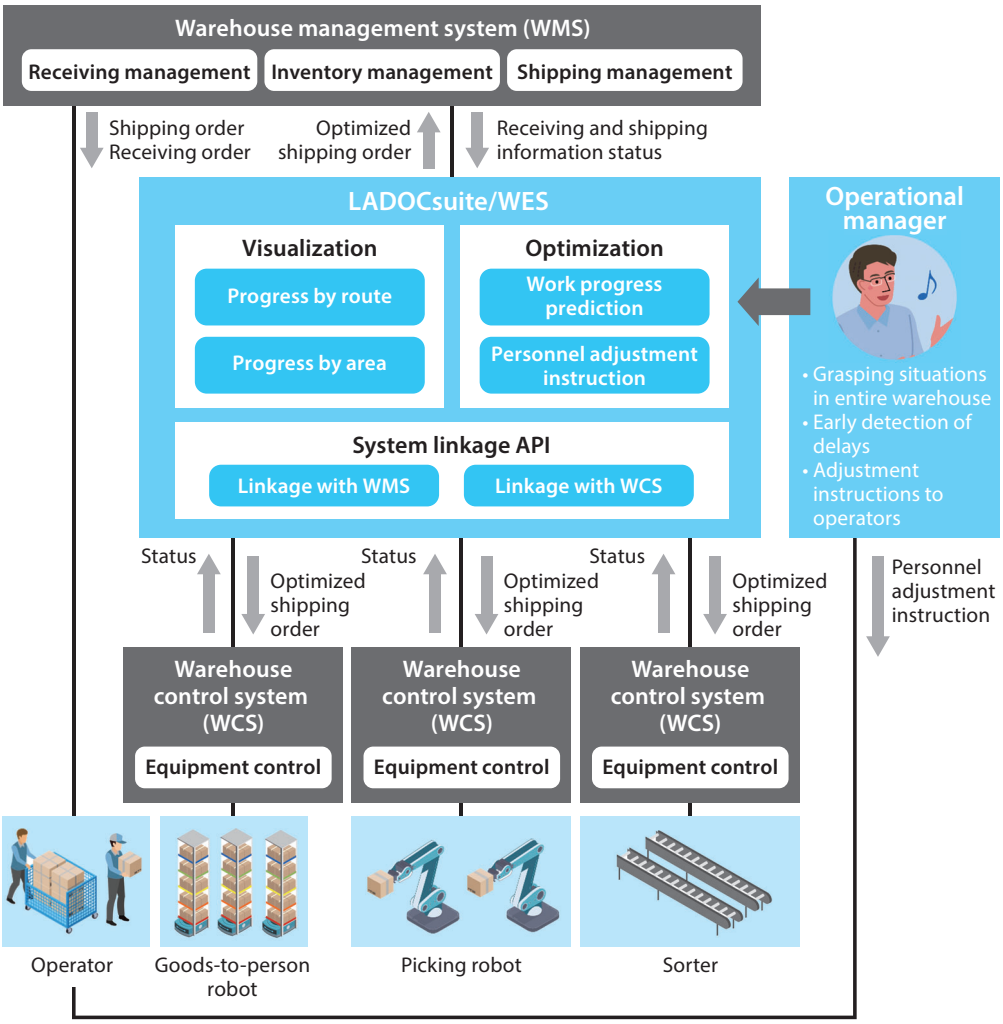
Examples of CO_2 emissions management dashboards in Asset IoT Cloud Service for Factories

Factories and plants have actively pursued carbon neutrality in recent years. To support such efforts, Toshiba Digital Solutions Corporation has added a new function for CO_2 emission visualization and optimal equipment operations to its Asset IoT Cloud Service for Factories. This function visualizes the equipment operating status and CO_2 emissions in real time, thereby contributing to energy saving and carbon neutrality through optimal data-driven equipment operations.

In addition to enhancing calculation, contract management, and conversion factor management database functions, we have developed user interface (UI) component templates suitable for managing CO_2 emissions from factories and plants and enabled carbon budget control.

In the future, we will develop functions that will contribute to the advancement of factory and plant operations, including those for flowchart representations of actual power usage and CO_2 emissions, cause-and-effect analysis, prediction, simulation, and linkage with various report services.

5.16 LADOCsuite/WES to Optimize Personnel and Machine Work Sharing at Distribution Warehouses



Overview of LADOCsuite/WES service to improve business efficiency by optimizing work sharing of personnel and machines in warehouses

In the face of the declining birthrate, aging population, and expanding e-commerce, labor shortages are becoming increasingly apparent in the field of logistics. It is therefore necessary to improve efficiency in this domain.

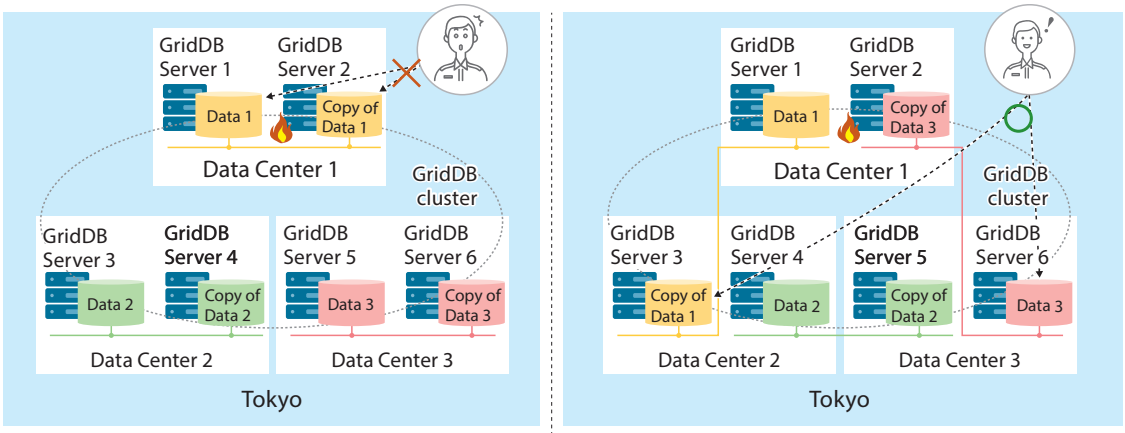
With this in mind, Toshiba Digital Solutions Corporation has collaborated with Toshiba Infrastructure Systems & Solutions Corporation to develop LADOCsuite/WES, a service that visualizes, optimizes, and controls distribution warehouse operations to achieve the best outcome from humans and machines working together. LADOCsuite/WES creates a link between a warehouse management system (WMS) that organizes the operations of a warehouse and warehouse control systems (WCS) that control the real-time activities of automated machines within the warehouse.

5. Digital Solutions

LADOCsuite/WES predicts when human workers and machines will finish each task to estimate work delays, making it possible to promptly implement countermeasures. This was not possible with a conventional WMS. When delays are anticipated, LADOCsuite/WES provides guidance about personnel coordination between different work areas, considering the progress in each, thereby reducing the burden on site managers and improving warehouse throughput.

In the future, LADOCsuite/WES will be linked with various automated machines, transportation, and delivery management systems. This link will further improve efficiency not only in the warehouse operations but also for the entire distribution process.

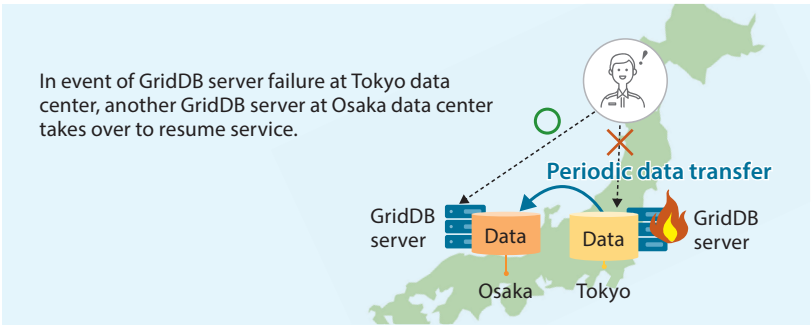
5.17 GridDB 5.1 EE Database Featuring Disaster Recovery Function to Mitigate Data Center Failures



Prior to GridDB 5.1 EE
Copies of data can be duplicated to same data center. Data become inaccessible if data center fails.

From GridDB 5.1 EE onward
Copies of original data are duplicated to different data centers so that data remain accessible even if one of data centers fails.

Rack-zone awareness function of GridDB 5.1 EE database for big data and IoT data



Cross-region disaster recovery function

In recent years, an increasing number of on-premises systems have been migrated to the public cloud. As a result, more customers are considering subscribing to a disaster recovery plan.

The GridDB 5.1 EE database from Toshiba Digital Solutions Corporation incorporates the following enhancements to allow for uninterrupted database service by distributing data among multiple data centers within the same or different regions:

(1) Rack-zone awareness function

The enhanced data copy function allows data to be copied to different data centers. In the event of a server failure or a natural disaster affecting a given data center, a server at another data center takes over to allow uninterrupted database operations.

(2) Cross-region disaster recovery function

To mitigate the adverse impact of data center failures or disasters affecting all data centers within a region, transaction logs can be sent periodically to data centers in other regions. The GridDB database can then be restored at data centers in unaffected regions.