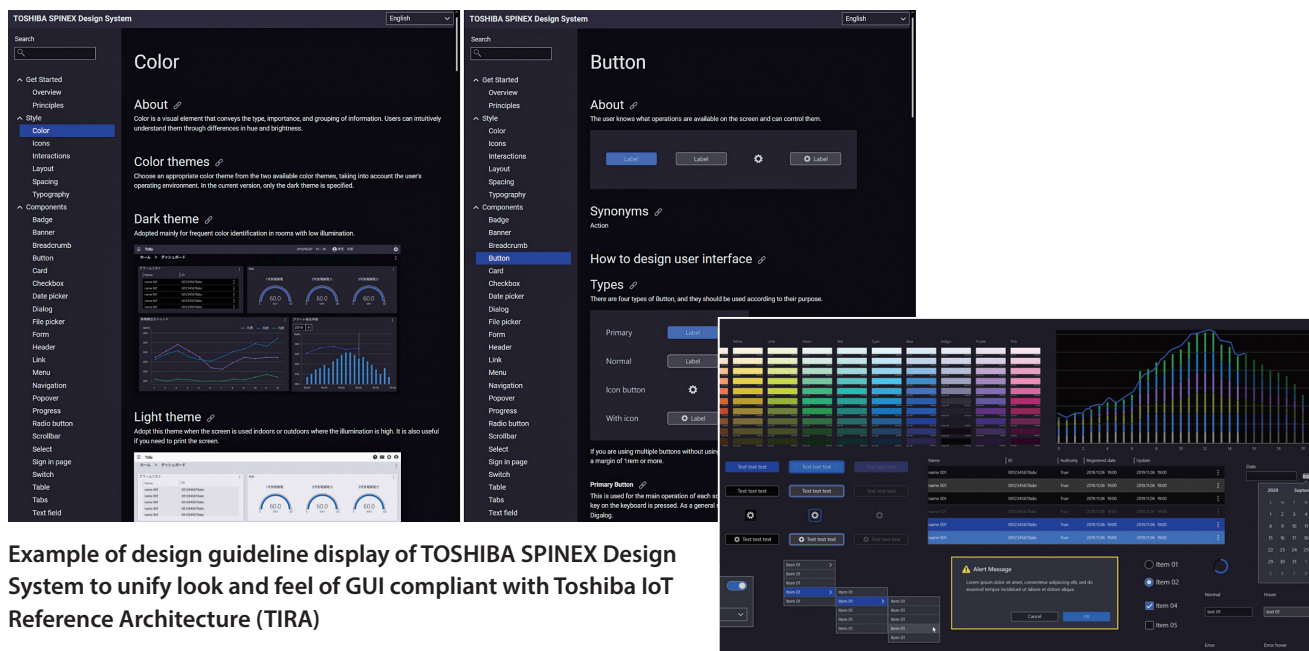


5. Digital Solutions

5.1 TOSHIBA SPINEX Design System to Improve UX and Web Application Development Efficiency



Example of design guideline display of TOSHIBA SPINEX Design System to unify look and feel of GUI compliant with Toshiba IoT Reference Architecture (TIRA)

Examples of component list displays

The TOSHIBA SPINEX Design System is a design system for graphical user interfaces (GUIs) compliant with the Toshiba IoT Reference Architecture (TIRA). The purpose of this design system is to unify the appearance and behavior of operating elements.

This design system incorporates web design guidelines. Following these guidelines ensures consistent user experience (UX) and compliance with international web content accessibility standards. The main features of these guidelines include support for large dashboard monitors and other applications unique to industrial Internet-of-Things (IoT) services and considerations for web content accessibility compliant with WCAG 2.0(*1).

The TOSHIBA SPINEX Design System provides design patterns in addition to user interface (UI) components, colors, and typography. Design patterns include issues that web developers tend to face and their solutions, such as how to use different components.

In addition, the TOSHIBA SPINEX Design System provides developer resources such as UI components (Tailwind UI, React UI) using Tailwind Cascading Style Sheets (CSS)(*2) and React(*3) as well as icon components using React (React Icons). These developer resources can be used according to the needs of a specific organization. They make it easier to follow the guidelines for web application development than in cases where only guidelines are available, leading to a reduction in development costs.

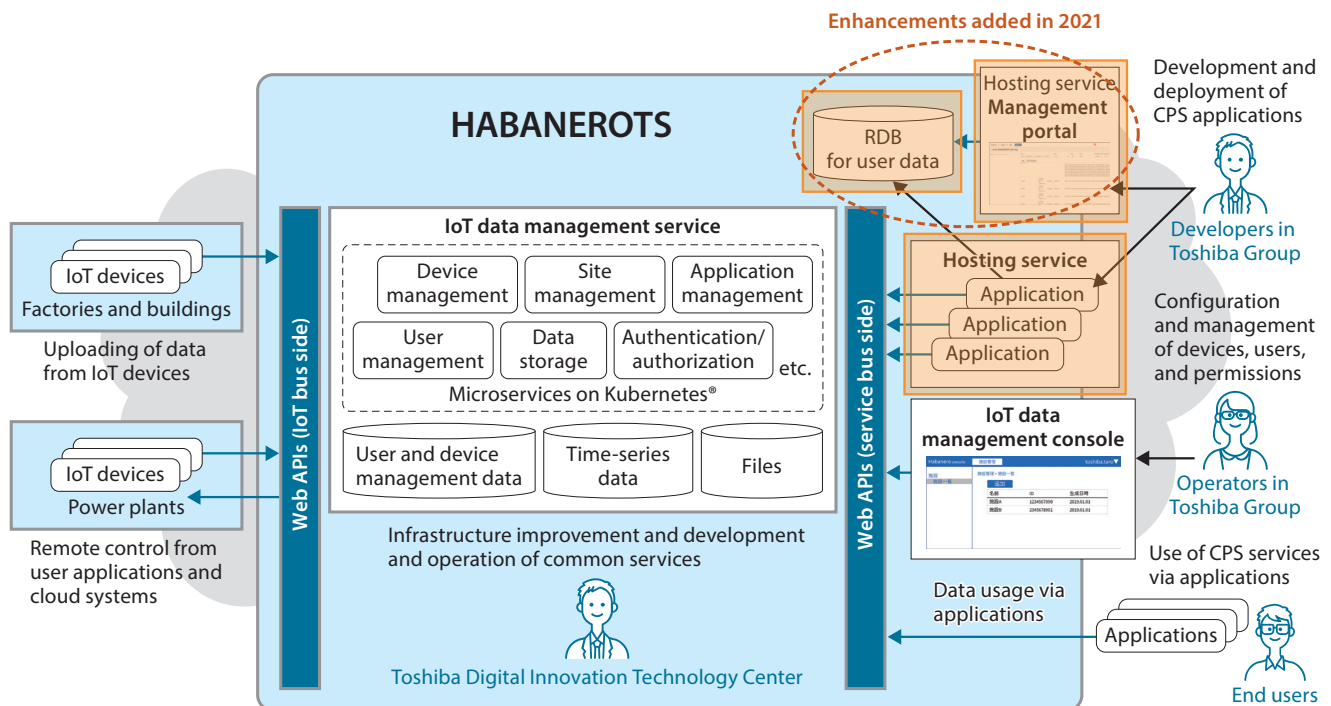
(*1) A World Wide Web Consortium (W3C) Recommendation published on December 11, 2008

(*2) A collection of web design elements using utility classes

(*3) A JavaScript library developed by Meta Platforms, Inc. for building user interfaces on websites

5. Digital Solutions

5.2 Updating of HABANEROTS Hosting Service Functions



Overview of IoT system using common components of HABANEROTS industrial IoT platform service

HABANEROTS, an industrial IoT platform service from Toshiba Corporation, provides standard functions independent of specific cyber-physical systems (CPS) as a set of convenient application programming interfaces (APIs) available on cloud systems. It also provides a hosting service to run containerized applications.

HABANEROTS ensures high availability for each CPS by using the Kubernetes® container orchestration platform. In addition, it offers standard functions required for user services such as load balancing, network encryption, and domain management.

The latest version of the HABANEROTS hosting service provides the following enhancements requested by many users:

- (1) enabling of the persistence of user data used by applications
- (2) provision of a management portal for referencing application logs based on open-source software (OSS) dashboard tools.

An infrastructure-as-a-service (IaaS) database from a cloud service provider enables data persistence with high availability and automatic data storage scalability.

The management portal provides a graphical user interface (GUI) that allows users to manage application logs and a relational database (RDB) for user data persistence.

These enhancements will increase the range of systems that HABANEROTS can service, facilitate users' management of applications, and lower the threshold for adopting HABANEROTS.

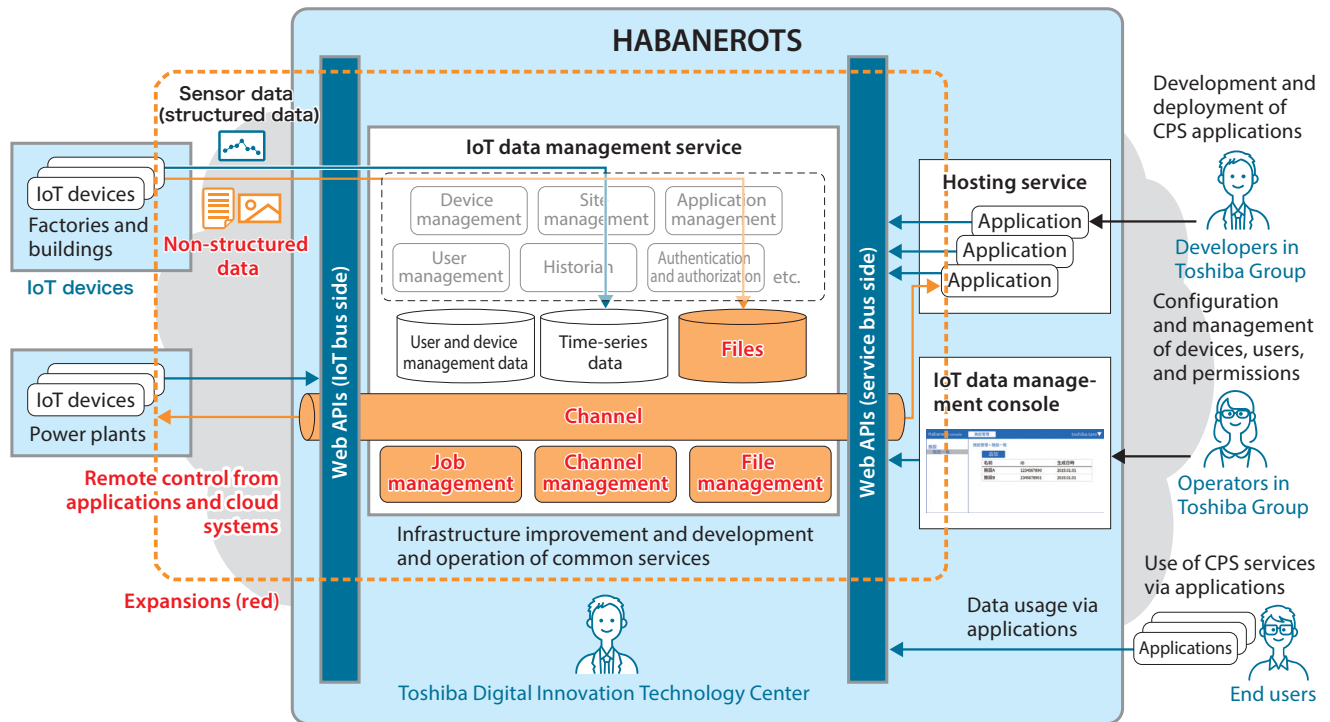
5. Digital Solutions

The next version of HABANEROTS will support in-memory databases to realize an additional improvement of system performance. It will provide an enhanced infrastructure to support the migration of applications to the cloud and expand its application areas even more widely. The new version will further reduce the infrastructure operating costs and improve the competitiveness of business units.

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

5. Digital Solutions

5.3 Extended Remote Monitoring and Control Capabilities of HABANEROTS



Overview of HABANEROTS with expanded remote monitoring and control functions

HABANEROTS is an Internet-of-Things (IoT) infrastructure service for the Toshiba Group compliant with the Toshiba IoT Reference Architecture (TIRA) that provides common functionalities necessary for business units to launch IoT services. HABANEROTS is updated continuously to meet various requests from users.

While HABANEROTS supports the continuous collection of routine data from IoT devices, we have now added three application programming interfaces (APIs) for remote monitoring and control of IoT devices: (1) JobAPI for issuing commands to IoT devices to acquire their status, (2) ChannelAPI for bidirectional communication between IoT devices and applications via push notifications, and (3) FileAPI for managing non-routine data.

JobAPI allows an application to request an IoT device to perform batch processing. Since its progress can be managed by HABANEROTS, developers can concentrate on the logical implementation of batch processing.

ChannelAPI establishes a bidirectional communication channel between an application and an IoT device. Since WebSocket^(*) provides high affinity with existing firewalls, it is unlikely to compromise flexibility in the installation of IoT devices.

FileAPI allows new non-routine data to be sent, received, and stored as files. For example, it allows images and unstructured log files from IoT devices to be handled.

5. Digital Solutions

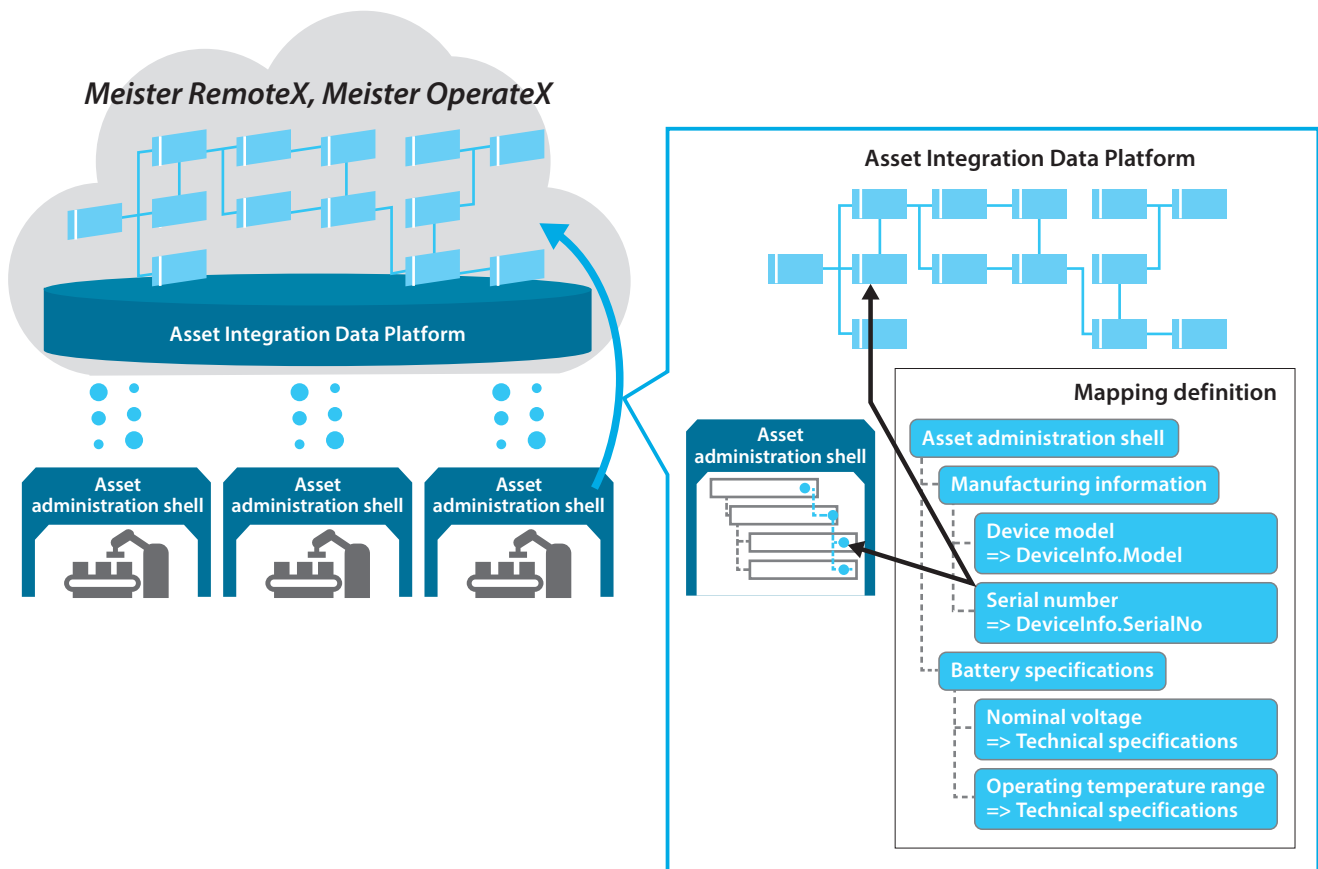
These APIs will allow business units not only to use IoT devices as sensors to receive information but also to operate them remotely as a part of a system, thereby enhancing system flexibility and reducing system costs.

We will continue to expand and organize the functions of HABANEROTS to contribute to further enhancement of the value of IoT services.

- (*) A bidirectional communication protocol compatible with the Hypertext Transfer Protocol (HTTP) that is capable of using a proxy for HTTP

5. Digital Solutions

5.4 Meister Cloud Series Services Compliant with Asset Administration Shells



Overview of Meister RemoteX and Meister OperateX asset IoT cloud services with data acquisition function using asset administration shells (AAS)

To increase equipment availability and optimize productivity and energy efficiency, there is a growing need to make factories and plants smarter by using IoT and artificial intelligence (AI) technologies. To improve the “smartness” of factories and plants, data must be collected from various facilities, equipment, and sensors. However, this requires significant expenditures of time and costs because a variety of data formats and procedures are used by different manufacturers and models.

To solve this problem, Toshiba Digital Solutions Corporation has developed a new function for our asset IoT cloud services—Meister OperateX for factories and Meister RemoteX for equipment manufacturers—to automatically map and import various asset data into our Asset Integration Data Platform via asset administration shells (AAS).

A concept being promoted as an international standard in Germany’s Plattform Industrie 4.0, AAS allow assets such as facilities, equipment, and systems to be represented in a unified data model using submodels and properties. This makes it easy to interconnect various facilities, equipment, and systems.

5. Digital Solutions

In order to describe various properties of assets, the submodels and properties that comprise AAS are defined according to the Common Data Dictionary (CDD), a metadata registry based on the International Electrotechnical Commission (IEC) 61360 standard. We have defined a mapping between the definitions of the CDD and the data models of our services so that the facility and equipment data in AAS can be automatically imported into the Asset Integration Data Platform.

This development enables our services to easily collect data from facilities and equipment of different manufacturers, making it possible to visualize the operating status of the entire process, factory, or plant and optimize operation and maintenance.

5. Digital Solutions

5.5 Enterprise Asset Management Solution Template for Electric Power and Machinery Industries

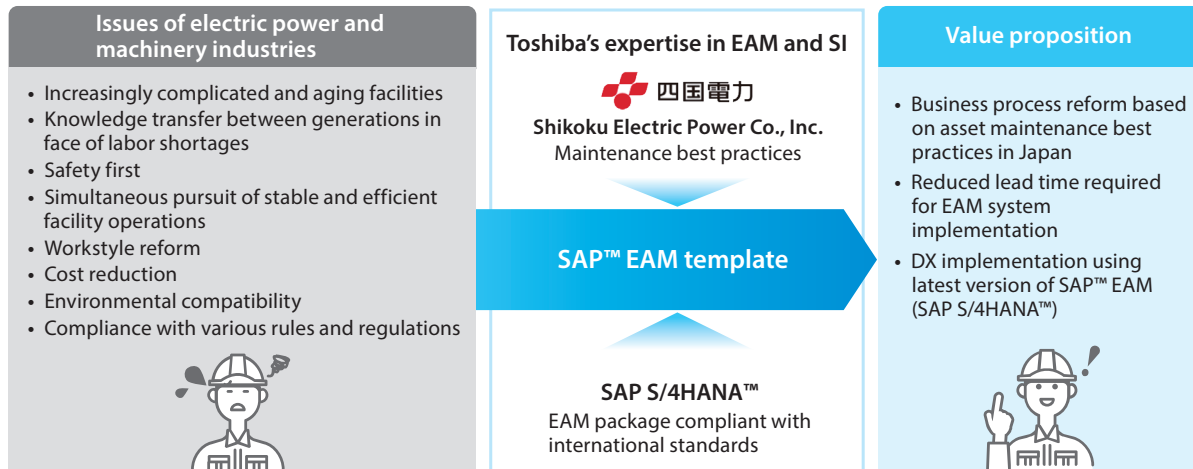
Toshiba Digital Solutions Corporation has developed an enterprise asset management (EAM) solution template for the electric power and machinery industries based on SAP S/4HANA™ from SAP Japan Co., Ltd. This EAM solution template is designed to standardize and optimize asset maintenance work. The template is based on the Shikoku Electric Power Co., Inc. (Yonden) model (see (1) in figure), which incorporates the accumulated asset maintenance knowledge and experience of Shikoku Instrumentation Co., Ltd. By presetting parameters based on the Yonden model, and leveraging our software standardization technology and system integration (SI) expertise acquired throughout our asset maintenance services, we were able to realize a specialized EAM template (see (2) in figure) that can be extended to different industries, which was previously considered difficult to create.

A typical EAM system implementation begins with several consultations to review business practices (based on the opinions of field workers), followed by the defining of business requirements and processes. The system design and development cycle takes place thereafter. With this procedure, however, much time and effort are often expended on the initial phases. The newly developed EAM solution template can be used to re-engineer the asset maintenance implementation processes in order to reduce the time and cost required for the development of an EAM system.

The new EAM solution template has various functions including maintenance planning, trouble and failure reporting, maintenance activities, corrective action, and performance evaluation. The template also supports continuous improvement of management processes through the plan-do-check-act (PDCA) cycle. In addition, it is expected to facilitate compliance with various regulations and systems, and contribute to the optimization of asset maintenance work through standardization. As a result, the new template will help to promote workstyle reform and alleviate labor shortages due to the declining birthrate and the aging population currently being experienced by Japan.

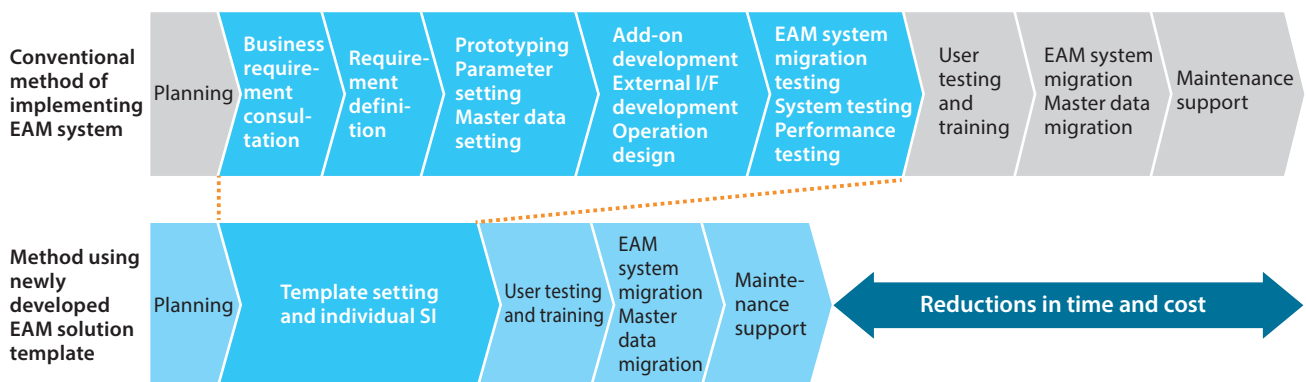
Our next step will be to develop additional optional features for various industries and integrate the template (see (3) in figure) with existing EAM systems using our EAM and SI expertise in order to address and solve issues faced by customers.

5. Digital Solutions



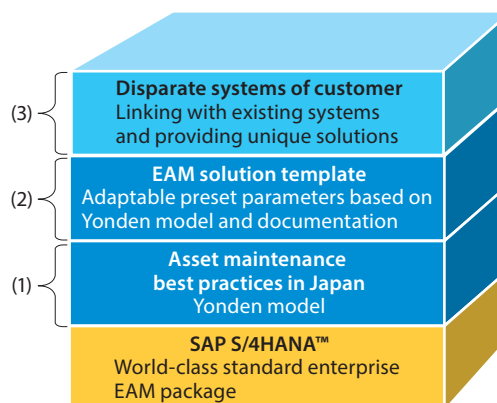
DX: digital transformation

Overview of template for enterprise asset management (EAM) solutions for electric power and machinery industries



I/F: interface

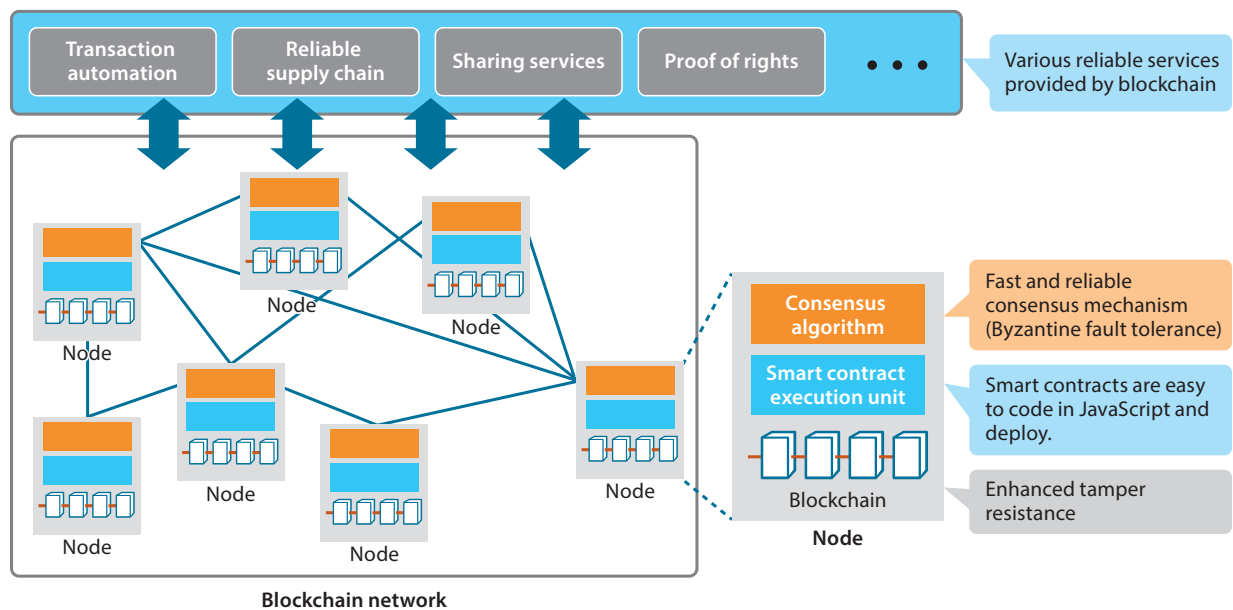
Comparison of conventional method of implementing EAM system and method using newly developed EAM solution template



Concept of template implementation

5. Digital Solutions

5.6 Technology to Realize Fast and Reliable Private and Consortium Blockchains



Overview of fast and reliable private or consortium blockchain using cluster control technology

Blockchains have been attracting much attention in recent years. They are expected to be utilized for diverse corporate and municipal operations and services because of their tamper resistance, reliability, and traceability.

Private and consortium blockchains are intended for use by private companies and local governments. Being permissioned blockchains, they must be operated via a private server under the control of human operators and require high performance and reliability. To realize private and consortium blockchains, a new technology is required that is different from that employed in public blockchains used for cryptocurrency. However, none of the existing blockchain technologies, including open-source software (OSS), provides practical performance, reliability, or usability levels.

Under these circumstances, Toshiba Digital Solutions Corporation has developed a unique technology to realize private and consortium blockchains that satisfy all of these requirements at a practical level.

The new blockchain technology features a fast and reliable consensus algorithm that we have developed using cluster control technology cultivated through our experience in the development of DNCWARE ClusterPerfect integrated cluster software. This blockchain technology makes it possible to withstand the failures of some nodes. Even if some nodes in a blockchain behave abnormally due to a malfunction, intentional act, or cyberattack, the entire blockchain system can still make correct decisions. In other words, the blockchain system has Byzantine fault tolerance. Furthermore, it provides enhanced tamper resistance because of the unique data structure used.

5. Digital Solutions

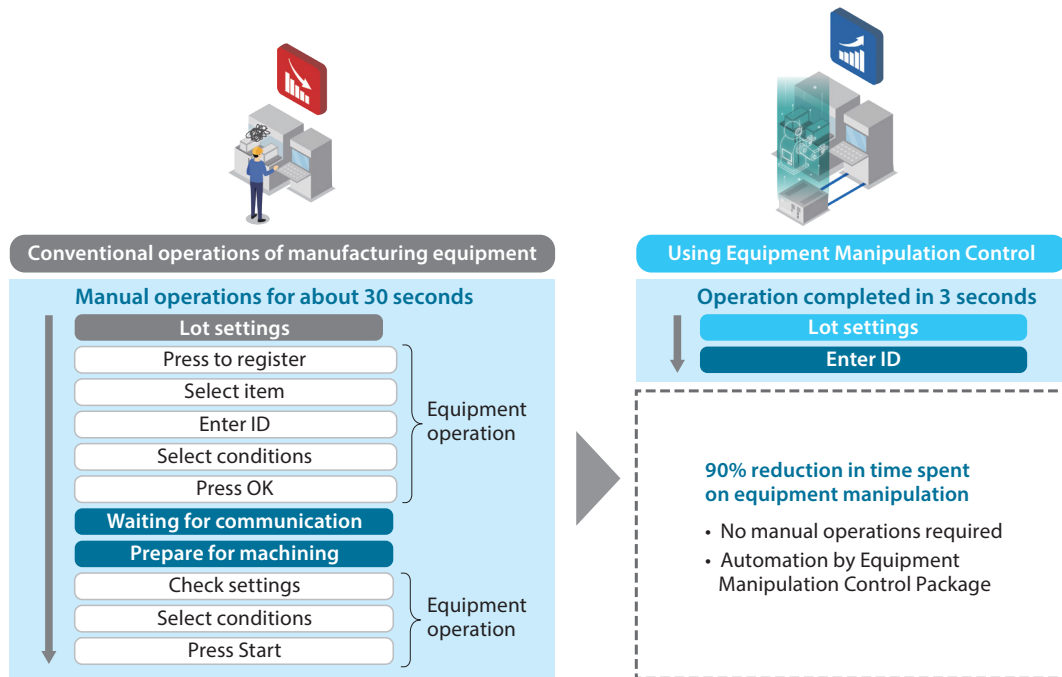
In typical blockchains, the contract execution process can be programmed as a smart contract. In contrast, a blockchain based on the newly developed technology allows a smart contract to be described in JavaScript, a general programming language, and deployed with a simple operation. This allows users to easily create and add fast, reliable smart contracts to a blockchain.

Applications of this blockchain include various types of registration required by private companies and local governments, and transactions requiring trust between transacting parties such as loyalty point services, sharing services, supply chains, and electric power services. The new technology is expected to provide execution, authenticity, and traceability for these applications.

We will use this technology to realize a platform that supports cooperation between different organizations and users as well as various services.

5. Digital Solutions

5.7 Digitalization Technology to Automate Operations of Existing Legacy Manufacturing Equipment



Overview of Equipment Manipulation Control Package to improve productivity by automation of routine tasks

Toshiba Digital Solutions Corporation has released the Equipment Manipulation Control Package, which automates routine operations of legacy manufacturing and inspection machines.

Automatic machines are being increasingly used to compensate for serious labor shortages. However, many manually operated machines remain in use due to the difficulty of replacing them because of cost and technical problems.

The Equipment Manipulation Control Package has the following features:

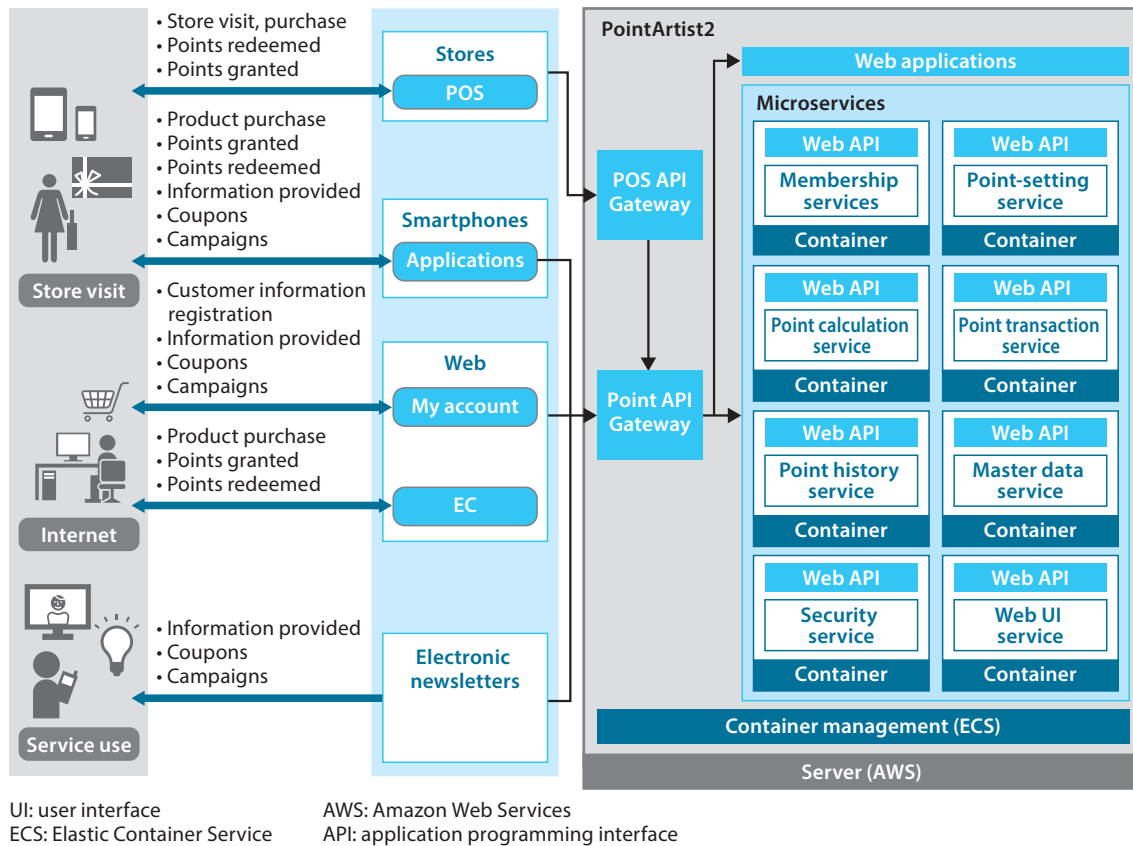
- A retrofit device automates the operations of an existing machine with little risk and in a short period of time. This device reads screen signals from the machine and sends operating signals back to it according to a predefined control scenario.
- Productivity is improved as the Equipment Manipulation Control Package automates routine operations and helps to reduce human error.
- The Equipment Manipulation Control Package makes it possible to attach IoT and remote monitoring devices to legacy equipment to obtain operating data from a screen.

The Equipment Manipulation Control Package is based on proven manipulation control technology that the Toshiba Group has developed in cooperation with its manufacturing sites and installed on more than 250 machines. We will continue to contribute to the acceleration of brownfield transformation(*).

(*) Digital transformation of legacy factories and equipment

5. Digital Solutions

5.8 PointArtist2 Loyalty Point Management System Applying Modern Application Architecture



Overview of PointArtist2 loyalty point management system applying modern application architecture

Toshiba Digital Solutions Corporation has developed PointArtist2, a retail business system to manage customer and loyalty point information in real time via linkages with point-of-sale (POS) and electronic commerce (EC) systems. The modern application architecture makes it possible to add new functions and expand information technology (IT) infrastructure into the future.

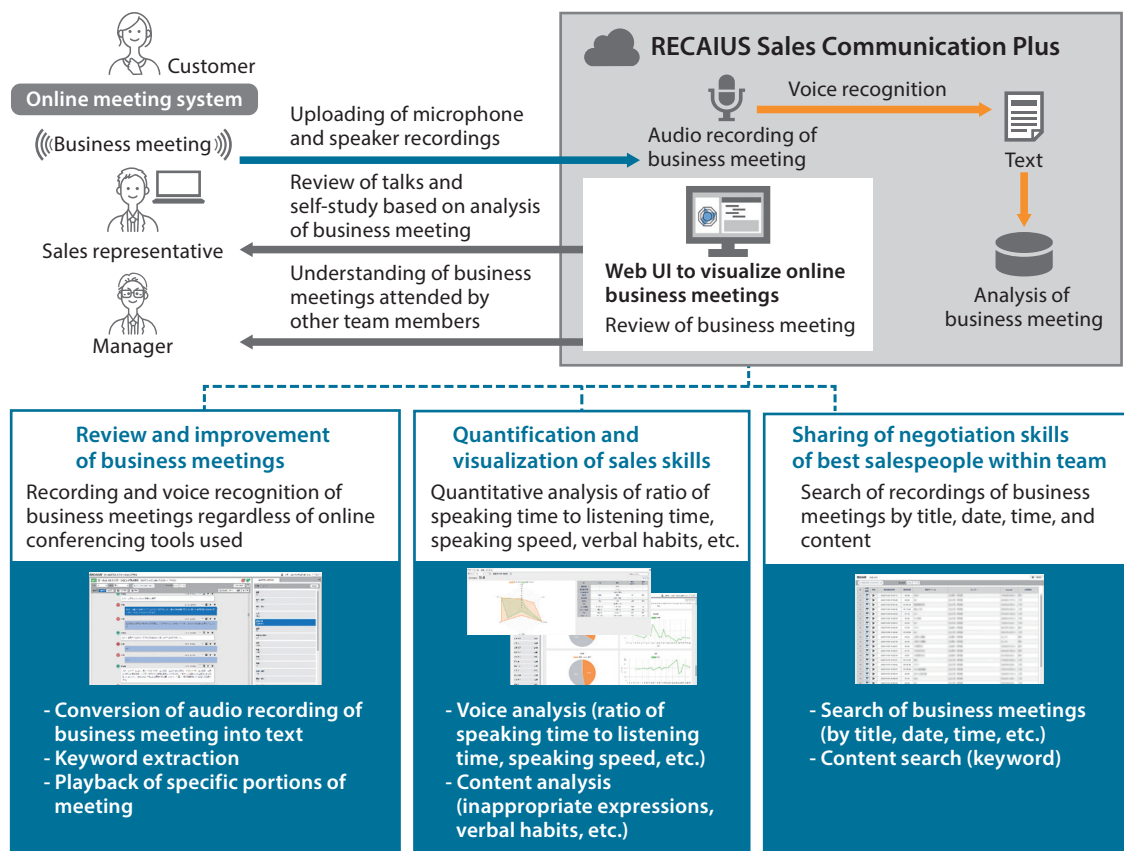
PointArtist2 supports a wide range of retailers from small and medium-sized operators to large-scale retailers with memberships of more than 10 million. PointArtist2 facilitates the flexible implementation of loyalty programs in a manner that satisfies the requirements of individual retailers. It can also be connected with diverse services such as smartphone apps and social networking services (SNS).

To achieve these features, PointArtist2 adopts a microservices architecture and containers with autoscaling to create a standard functional configuration for the point management structure.

Our next step is to provide a data service platform connected with AI services and marketing automation tools in order to connect consumers, retailers, and manufacturers.

5. Digital Solutions

5.9 New RECAIUS Service for Visualizing and Analyzing Online Meetings



Web UI: web-based user interface

Overview of RECAIUS Sales Communication Plus service to visualize and analyze web-based meetings

Toshiba Digital Solutions Corporation has released RECAIUS Sales Communication Plus, a new service for a “new normal” where teleworking is the norm.

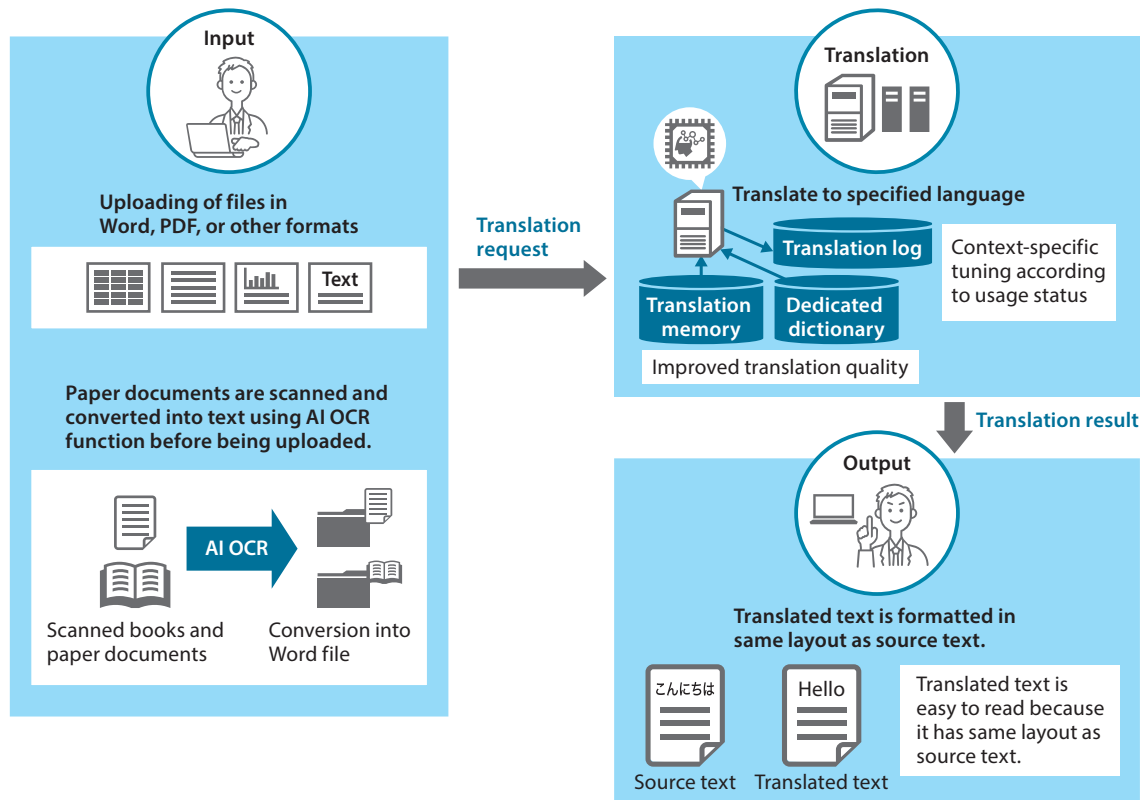
In teleworking, communication becomes a black box, which can easily lead to problems such as young workers feeling insecure about their skills and managers having difficulty perceiving the growth and challenges of their subordinates.

RECAIUS Sales Communication Plus captures audio recordings of online meetings such as business negotiations and converts them into text through voice recognition. It also automatically measures the frequency of inappropriate expressions and verbal habits, whether the speaker is interrupting others, and whether he or she is giving appropriate responses. It supports the improvement of communication skills by quantifying speaking habits that are difficult to notice by oneself and visualizing daily changes.

Following joint research on voice sentiment analysis with the Japan Advanced Institute of Science and Technology, we are currently developing a platform that facilitates the acquisition of insights from voice communication in various situations, including conferences, call centers, and fieldwork.

5. Digital Solutions

5.10 High-Precision Automatic Document Translation Solution



Overview of high-precision automatic document translation solution using deep learning

Toshiba Digital Solutions Corporation has launched an automatic document translation service using deep learning. It incorporates a translation engine developed by the National Institute of Information and Communications Technology (NICT) of Japan.

This translation service provides the following features for business translation:

(1) High usability for efficient translation

- The translated text is formatted in the same layout as the source file (e.g., Word, PDF^(*), etc.).
- Paper documents can be scanned and translated using the AI OCR^(*) function.

(2) Security features for the translation of confidential documents

- The translation service is available as an on-premises edition to prevent information leakage.
- Translation logging can be disabled so as not to leave any logs related to information access.

(3) Translation tailored to specific business needs

- Appropriate term dictionaries and translation memories (i.e., databases that store the source text and its corresponding translation) specific to a given organization or department can be used.
- Eleven languages are supported.

5. Digital Solutions

(4) Translation performance according to the workload and required priority

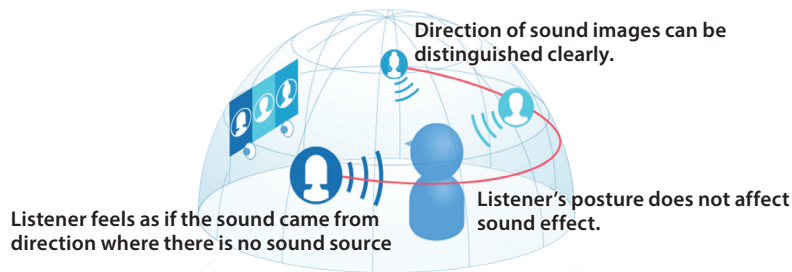
- Translation resources are customizable to meet the needs of a specific organization or department.

(*1) PDF: Portable Document Format

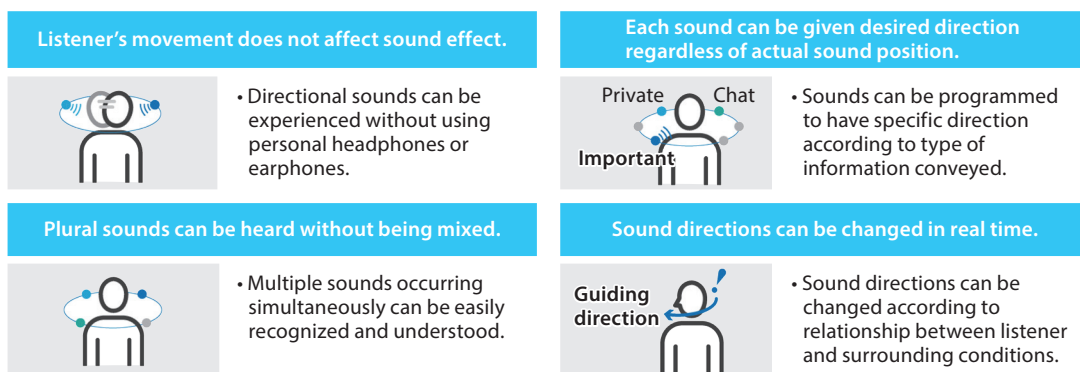
(*2) OCR: optical character recognition

5. Digital Solutions

5.11 Soundimension Software for Creation of Sound Images with Controlled Stereophony to Give Specific Sense of Directionality



Overview of method to create sound images with controlled stereophony



Applicability of sound images with controlled stereophony

To expand the applications of sound information, Toshiba Digital Solutions Corporation has released a software product called Soundimension for the creation of sound images with controlled stereophony to give a specific sense of directionality.

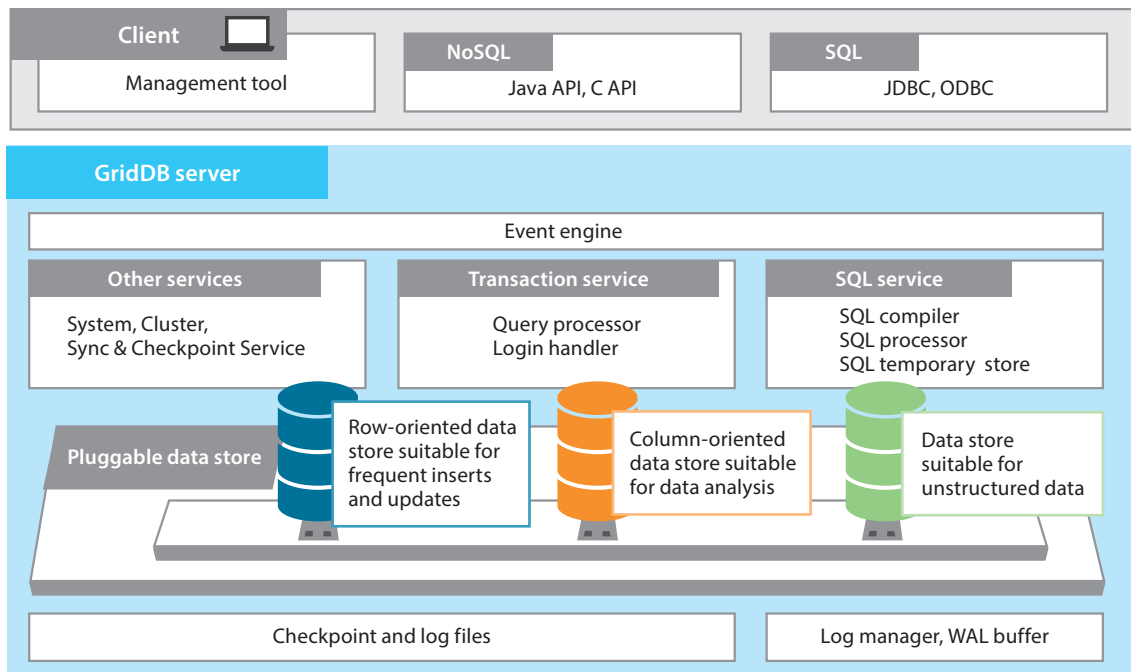
The listener does not need to adopt a specified hearing position or wear earphones or headphones to experience directional sounds. Soundimension provides a more robust sense of directionality than the conventional method that simply produces a timed stereo delay for the left and right ears. In contrast, Soundimension represents the aural differences between both ears by means of the complex sound pressure ratio between them. Soundimension thus offers more flexible applicability due to its robustness with respect to the listening position.

The ability of Soundimension to create directional sounds realizes listener-friendly audio assists, sound effects that allow people to share a common feeling in remote communication, and so on.

We will continue exploring more applications of Soundimension to offer new sound experiences.

5. Digital Solutions

5.12 GridDB V5.0 Database for IoT and Big Data Featuring Revamped Architecture



NoSQL: Not Only SQL

JDBC: Java Database Connectivity

ODBC: Open Database Connectivity

WAL: write-ahead logging

API: application programming interface

Architecture of GridDB V5.0 database

IoT and big-data systems require a fast, scalable, and reliable database. To meet these requirements, the GridDB database is equipped with an event-driven engine and an autonomous data distribution algorithm.

In response to the increasingly diverse areas of application of GridDB, Toshiba Digital Solutions Corporation has released GridDB V5.0, which features a revamped data store functionality vital for data management. A data store is the underlying software component used by a database management system (DBMS) to create, read, update, and delete data from a database.

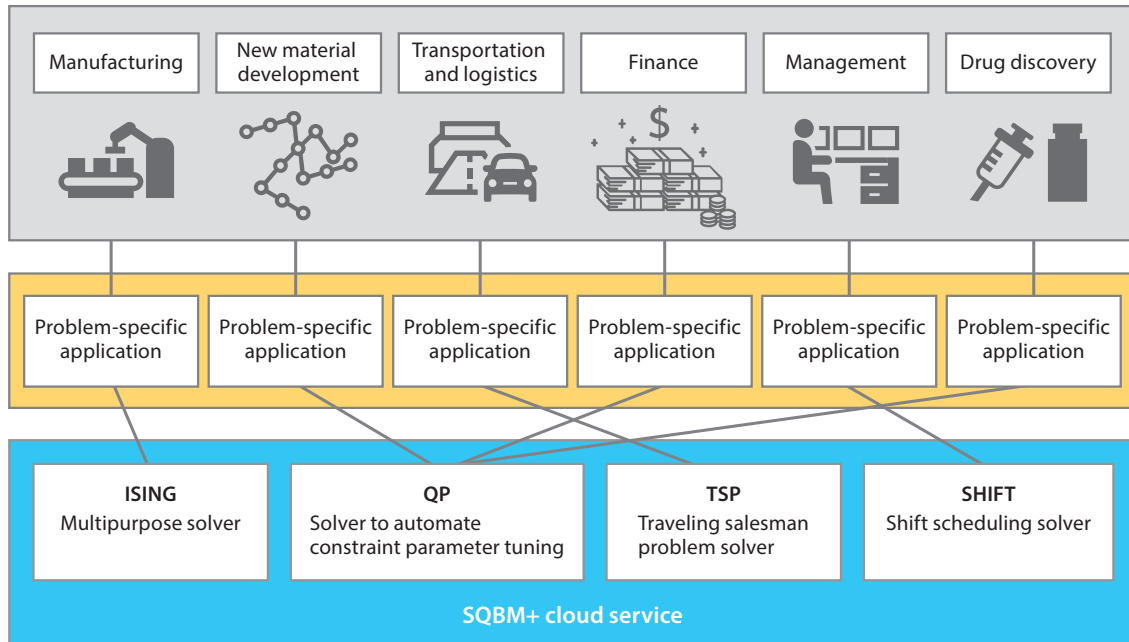
GridDB V5.0 incorporates a pluggable multi-store mechanism. In addition to the existing data store suitable for frequent data ingestion and update, the new architecture allows for the utilization of multiple data stores optimized for different applications. Furthermore, Structured Query Language (SQL) benchmarking has shown that GridDB V5.0 provides a considerable improvement in scan performance, including a reduction in the size of the memory managed, faster checkpoint operations, and faster record scanning.

In the future, we will provide a column-oriented data store suitable for data analysis and a data store for unstructured data.

5. Digital Solutions

5.13 New Features of SQBM+ Simulated Bifurcation Machine to Solve Large-Scale Combinatorial Optimization Problems at High Speed

SQBM+ for fast solution of large-scale combinatorial optimization problems in various social and industrial fields



SQBM+ cloud service providing four types of solvers according to specific applications

The SQBM+ Simulated Bifurcation Machine is a cloud service that incorporates algorithms based on quantum technology to deliver near-optimal solutions to large-scale combinatorial optimization problems at high speed.

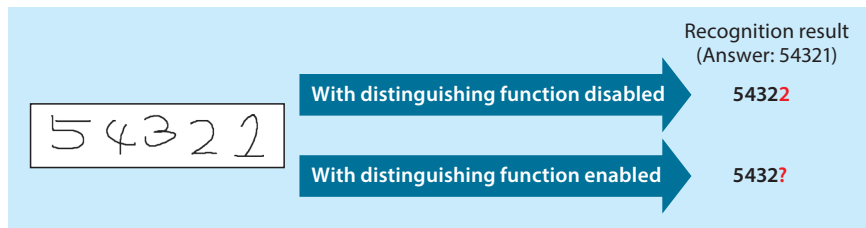
Toshiba Digital Solutions Corporation has now launched its first commercial SQBM+ service for practical use. SQBM+ provides four solvers: QP, TSP, and SHIFT, which make it easy to solve real-world combinatorial optimization problems, and ISING for general Ising problems.

It is sometimes difficult to adjust the parameters of an Ising problem in order to balance objective function optimization and constraint satisfaction. QP automates this parameter adjustment and delivers stable results for practical problems. TSP and SHIFT can directly solve traveling salesman and shift scheduling problems, respectively.

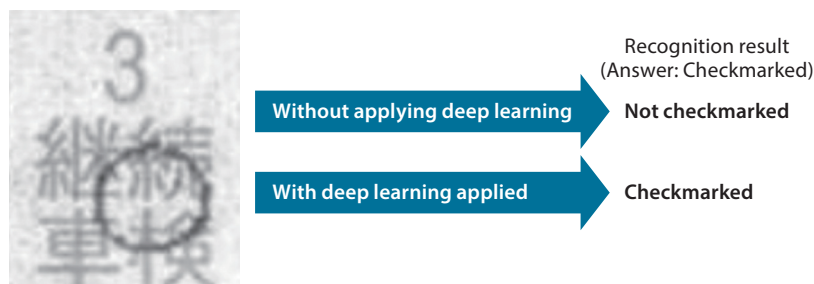
We are promoting the practical application of these solvers, starting with their adoption in the financial sector for a quantum application platform to accelerate AI processing. Our next step is to develop value-added solvers capable of solving real-world combinatorial optimization problems more efficiently while scaling up and improving the speed and accuracy of each solver.

5. Digital Solutions

5.14 OCR Service Using AI and Deep Learning Technology



(a) Use of function to distinguish unrecognizable characters in non-framed text



(b) Checkmark recognition

Examples of functions of OCR service using AI

Toshiba Digital Solutions Corporation has developed an optical character recognition (OCR) service that uses deep learning technology to convert handwritten and typed text into electronic data using AI. It is currently available as a cloud service and as on-premises software.

We released the latest version (V2.6) in October 2021, which features half the recognition errors for framed text in comparison with the previous version. This reduction in recognition errors has been achieved by improving the learning method and training data for deep learning. Another enhancement in V2.6 is the extensive use of deep learning for the identification of strike-through lines, correction seals (special seals used in Japan to indicate a correction in an official document), and the checkmark symbol (✓), including the corresponding symbol commonly used in Japan (○), in order to accommodate mistakes in writing and overflowing text. Another enhancement in V2.6 is a function to suppress possible misreadings by distinguishing unrecognizable characters^(*), returning question marks (?) instead. This includes unrecognizable numbers and katakana characters in non-framed text. These functions further improve the efficiency of data entry.

In addition to OCR, we will continue to enhance our products with document management and AI functions, contributing to customers' digital transformation (DX) and problem-solving capabilities.

(*) The results of our tests have shown that V2.6 achieves a recognition accuracy of 99.7% or higher, excluding items denoted by question marks.