# Technology Innovation
Finance, Social, Healthcare

1 PBI/Blockchain Combination Provides Secure Transactions on Blockchain

As a means of conducting transactions without requiring an intermediary, blockchains have many potential applications such as in peer-to-peer electricity trading. In current blockchains, an electronic signature is affixed to transaction data to guarantee its trust-worthiness. If the private key by which a user generates electronic signatures is compromised or lost, however, they may lose the assets they have traded on the blockchain or may be a victim of fraudulent transactions made by someone using their identity.

In response, Hitachi has developed a technique for reducing blockchain risks that uses its proprietary public biometrics infrastructure (PBI) for generating private keys from biometric information. Because the technique allows users to generate their private key from biometric information whenever they need it, they no longer need to store the key on an authentication device and are at much lower risk of having their key lost or stolen.

Hitachi intends to proceed with the practical implementation of this technique, including by engaging in demonstration projects with corporate customers.


PBI: public biometrics infrastructure
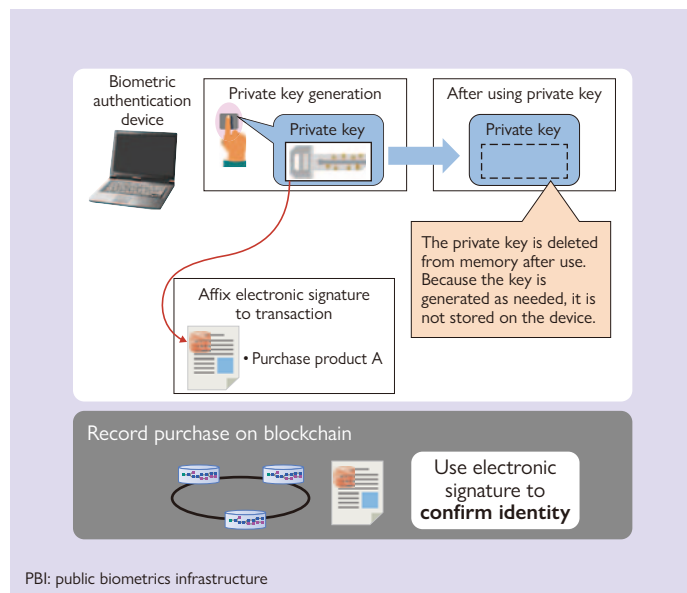
1 Overview of technique combining PBI and blockchain

2 Digital ID Management Platform Using PBI and Blockchain

The growing use of financial transactions in digital services, such as payments and the use of vouchers, has created a demand for a reliable means of personal identification (ID) similar to that used with bank tellers in the past.

In response, Hitachi has developed a technique for generating digital IDs that utilizes its proprietary PBI technology and can reliably identify a person using biometric information acquired from a conventional mobile device such as a smartphone. Accompanying this, Hitachi has also developed a digital ID platform that enables the digital ID to be shared and reused not only by institutions with which the user has registered but also

ID: identification
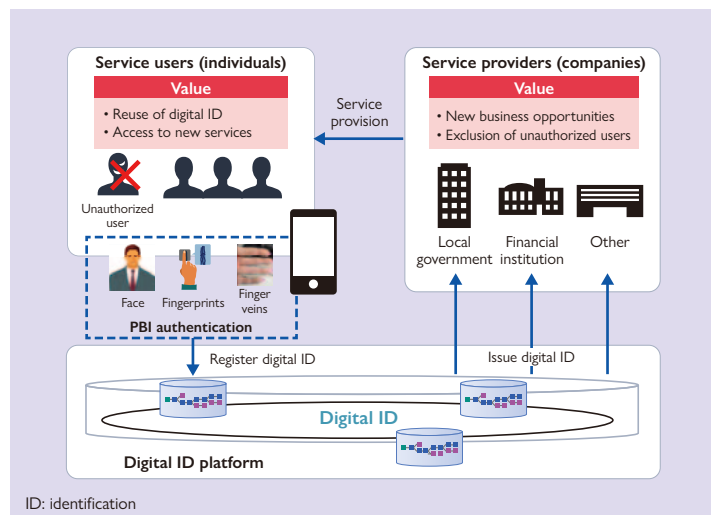
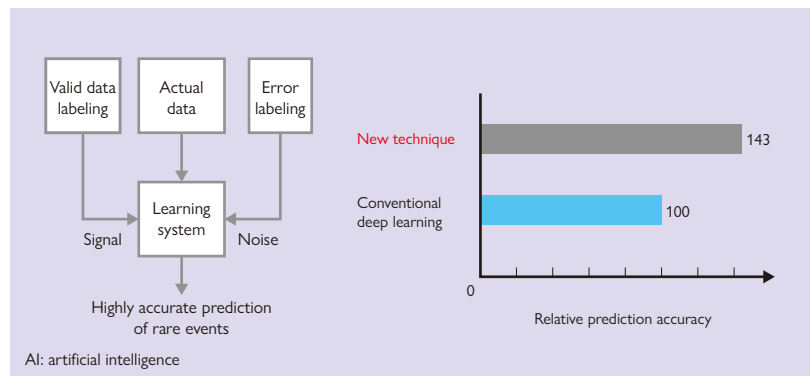**2** How digital ID platform is used

by local government, financial institutions, retailers, and various other participating organizations. The risk of identity theft or data tampering is reduced by using a blockchain, a technology that is very resistant to data falsification, meaning the platform can be used to offer new services on which organizations can work together with confidence.

Hitachi intends to expedite the commercialization of the platform by engaging in collaborative creation with corporate customers.

3 Improvements to Accuracy of Bad Debt Prediction from Loan Data Using AI that Predicts Rare Events

The prediction of rarely occurring events is an important part of tasks such as credit decisions regarding bad debt or assessing the validity of transactions, for example. While the conventional practice with deep learning is to utilize learning from actual data to reduce the error of prediction formulae, the lack of such data for rarely occurring events makes this difficult. Another issue is that attempting to improve the accuracy of predictive models tends to make the formulae more complex, making it more difficult to explain the reasoning behind their predictions.

3 Signal noise learning (an AI technique for predicts rare events) and its performance

Now, Hitachi has developed an artificial intelligence (AI) that can predict rarely occurring events with a high level of accuracy and describe the basis for its predictions. This involved the development of signal noise learning, a technique that is trained not only on data acquired under normal conditions, but also on how not to be influenced by biased or outlier data. Testing in which this was applied to loan data and used to make bad debt predictions found a 43% higher accuracy than when using conventional deep learning.

4 Data Modeling for Railways

Advances in the Internet of Things (IoT) are providing railway operators with the ability to collect a variety of data from both onboard and off-board equipment, bringing with it rising expectations for using this data in applications like condition-based maintenance (CBM) and predictive maintenance (PdM) that can boost maintenance efficiency without compromising safety. While modeling the behavior of machinery and other equipment to identify potential faults and consider countermeasures plays an important part in implementing CBM and PdM, a problem with using conventional machine learning for modeling is that its operation is difficult for humans to interpret, making it hard to deploy in practice.
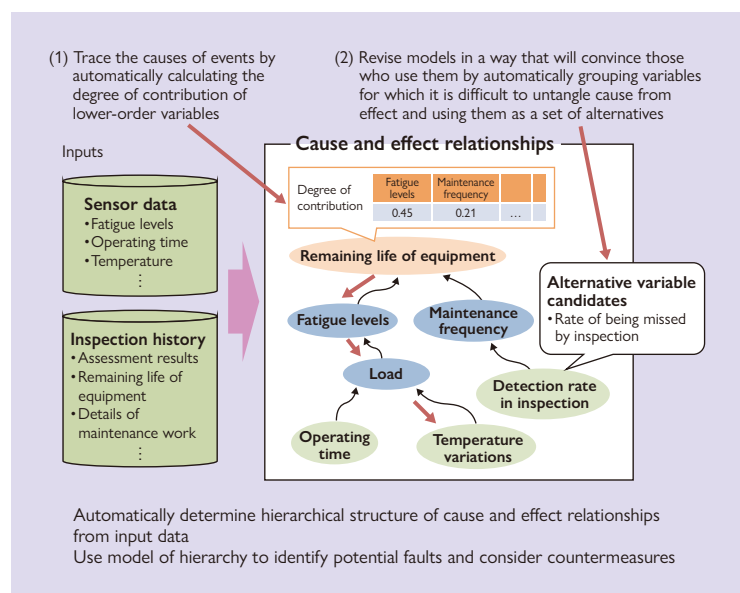
4 Algorithm for determining cause and effect relationships

In response, Hitachi has developed a cause-finding technique that can automatically identify cause and effect relationships in data. The technique involves creating a hierarchical model of the relationships between data and automatically calculating the degree of contribution of lower-order variables (1), thereby making it easy to trace the causes of events. Moreover, in the case of sets of variables for which it is difficult to untangle cause from effect, the technique can be used to revise models in a way that can convince those who will use them in practice by using automatic grouping to create alternative variable candidates (2).

Hitachi intends to deploy the technique in railway maintenance by implementing it as a support system for boosting maintenance efficiency without compromising safety.

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5 Passenger Flow Analysis for More Comfortable Use of Public Transportation

Transportation operators and local governments need to be able to assess the degree of congestion in urban railway networks as quickly as possible during major events or when disruptions occur in the network, and to get travelers safely to their destinations. To this end, Hitachi has developed a technique for using real-world data to analyze the flow of passengers through public transportation networks and is working on ways of providing appropriate information to transportation operators and users.

The following are two examples of this work.

(1) Hitachi has worked with East Japan Railway Company to develop a system that presents a real-time map showing current train locations in the commuter railway network for the Tokyo region, also indicating the extent to which each train is crowded or delayed. This allows the traffic control staff who manage train operations to take account of crowding in their deployment of train services.

(2) Hitachi has also developed a simulation that can predict railway usage during major events. A trial was conducted for the 2018 Sumida River Fireworks Festival in which congestion predictions and advice on how to avoid it were provided, including by predicting the outcomes of various methods of avoiding crowded trains such as traveling at different times or not using busy lines[*].

In the future, Hitachi aims to use this technology to create an urban environment with greater freedom of movement, helping to optimize urban transportation by coordinating the services of different operators.

* Some of this work was conducted as part of a Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving System / Large Scale Field Operation Test / Next Generation Transportation / ART Operational Data Aggregation and Storage of Operation, Construction of Mechanism for Providing Information to ART Users, and Implementation and Management of Large Scale Field Operation Test projects commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

ATOS: autonomous decentralized transport operation control system
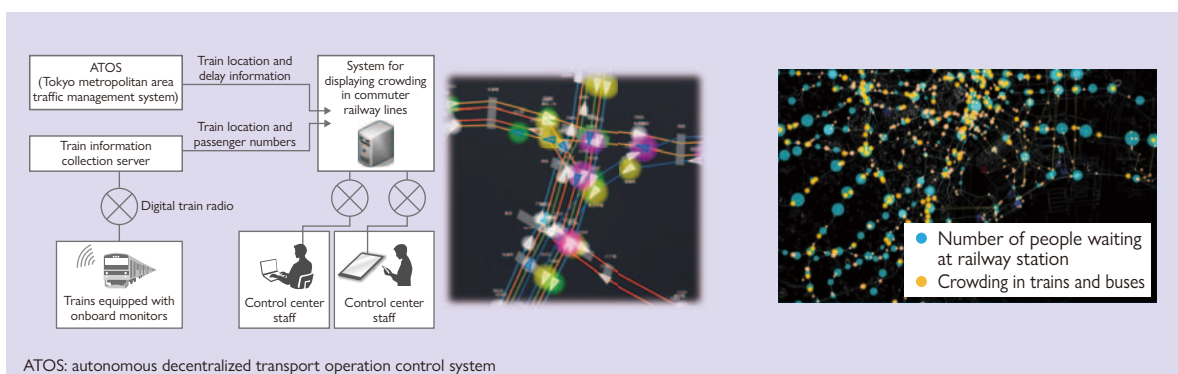
5 System for displaying crowding in commuter railway lines in the Tokyo region (East Japan Railway Company) and the results of predicting crowding during a major event

6 Highly Accurate Risk Prediction of Heart Failure Patient Readmissions (Collaboration with Partners HealthCare)

Hitachi, in collaboration with Partners HealthCare, developed AI technology that accurately predicts heart failure patient readmissions.

In the USA, the Hospital Readmission Reduction Program has been in action since 2012. To reduce readmissions, Partners HealthCare implemented a remote monitoring program for monitoring daily symptoms, blood pressure, and weight, plus just-in-time feedback about measurements from the clinical team for patients with heart failure. Even though the program has been largely successful, there is still a need to better stratify patients based on risk to achieve greater reductions in readmissions.

To address this challenge, Hitachi developed a new deep learning algorithm (recently known as explainable AI), that sorts about 3,500 risk factors in order of weighted importance and leveraged this information successfully to achieve an accuracy of area under the curve of 0.71. By using this AI tool, Hitachi and Partners HealthCare are now exploring new opportunities to achieve better post-discharge care coordination support by making actionable information available to multidisciplinary care teams.
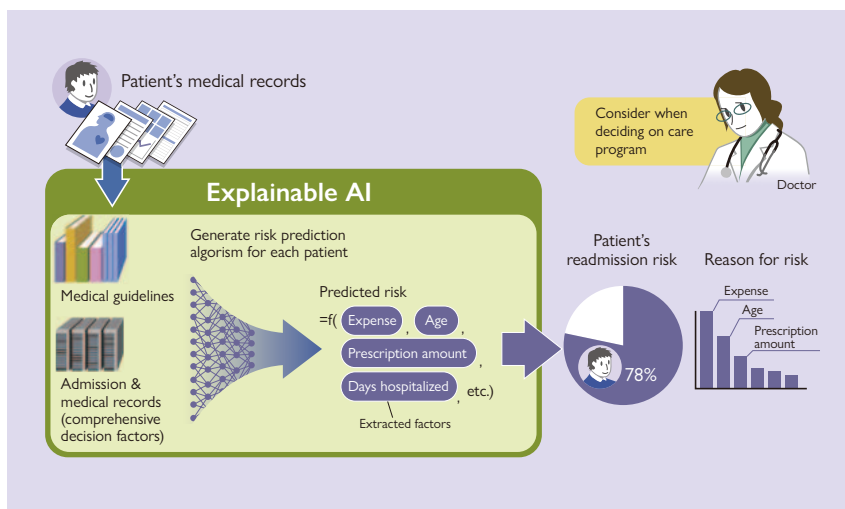
6 Overview of AI that Can Explain Risk Factors

7 Precise 3D Matrix Probe for Shortening Time Required for Ultrasound Scans

To shorten the time taken for ultrasound scans looking for disorders of the cardiovascular system, Hitachi has launched a three-dimensional (3D) matrix probe[1] and the LISENDO 880[2], its high-end scanner model.
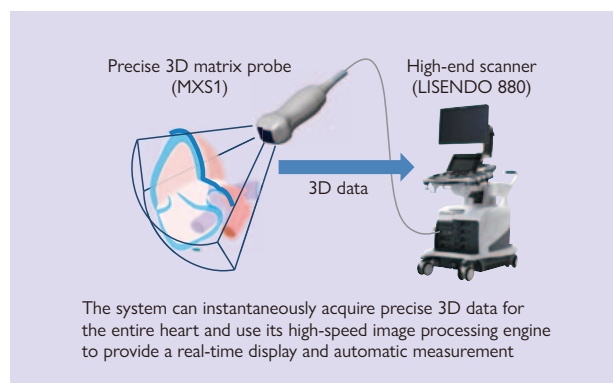
The newly developed matrix probe contains a large number of tiny ultrasonic transducers arranged in a matrix (grid) as well as a small integrated circuit that processes the ultrasound signals at high speed. It can instantaneously acquire precise 3D data for the entire heart simply by placing it on the subject's body.

The LISENDO 880, meanwhile, uses a high-speed image processing engine to generate high-quality 3D volume images from the data acquired by the matrix probe. It is also equipped with an application that utilizes machine learning to automate the various measurement and analysis tasks that are needed for cardiovascular diagnosis. These help to significantly shorten the time required to perform an ultrasound scan.

7 Precise 3D matrix probe and high-end LISENDO 880 scanner

By expanding the scope of application of 3D imaging and making greater use of AI, Hitachi intends to help deliver customer value in ways that impose less stress on patients, improve diagnostic quality, and increase hospital scanning throughput.

*1 Product name: MXS1 probe (Medical device certification number: 228ABBZX00097000)
*2 Product name: ALOKA LISENDO 880 (Medical device certification number: 228ABBZX00092000)

8 World-smallest Accelerator for Carbon Ion Beam Cancer Therapy Systems

Hitachi's first carbon ion beam cancer therapy system commenced operation and use at the Osaka Heavy Ion Therapy Center in October 2018. A major feature of the system is that it uses a synchrotron accelerator that, with a perimeter of 56.8 m, is the smallest in the world ever used for carbon ion beam cancer therapy (as of October 2018). This has enabled it to be installed at a small site in central Osaka that is easy for patients to access.

The smaller size was achieved by using particle path simulation to reduce the number of electromagnets to two thirds that of previous systems. The accelerator accelerates particles around a circular path to build up the required energy, temporarily destabilizing the path to emit the beam. The number of electromagnets required for emission was successfully reduced by turning around the property whereby fewer electromagnets makes emission easier, thereby reducing the total number of magnets.

In the future, Hitachi intends to work on further reducing the size and improving the performance of particle beam therapy systems based on the accelerator characteristics obtained from this installation.
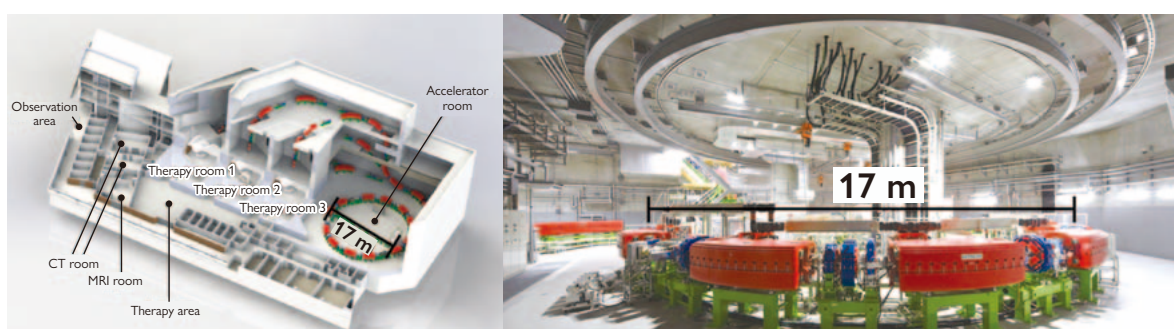
CT: computed tomography   MRI: magnetic resonance imaging

8 Osaka Heavy Ion Therapy Center (left) and accelerator room (right)

9 Measurement Technique for 3500 Automatic Multi-function Analyzer

Automatic analyzers are powerful instruments for blood testing at hospitals and, when capable of measuring a wider range of concentrations, can help improve operational efficiency by allowing a wide variety of tests to be done using the same analyzer. Hitachi automatic analyzer 3500 launched by Hitachi High-Technologies Corporation in 2017 was the first in the world to incorporate a scattered light photometer, achieving its multi-function capabilities by utilizing this enhanced sensitivity to measure a wide variety of tests.

When an automatic analyzer is used for immunoassay testing, latex beads sensitized with antibodies are used as a reagent and mixed with the blood sample, with the concentration of the different components being measured from the change in turbidity due to agglutination (clumping) in the reaction liquid. The conventional method is to perform this measurement by using an absorption photometer to detect transmitted light.

For the new technique, Hitachi has developed a scattered light photometer that can measure lower concentrations than previously possible by selecting a light source wavelength and an angle for scattered light measurement that is appropriate for the latex beads. This technique allows a wide variety of tests by using the scattered light photometer to measure low concentrations and the conventional absorption photometer for high concentrations.
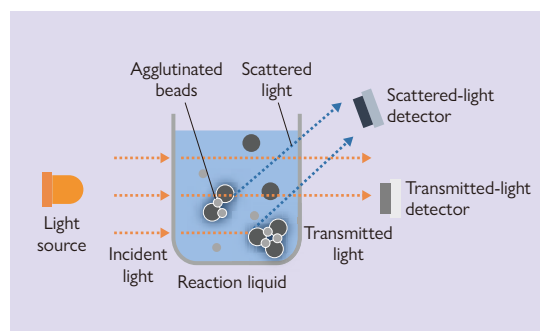
9 Principle of measurement of scattered light photometer