Realizing Advanced IoT Society with AI Edge Computers

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AI technology typified by deep learning has been rapidly evolving supported by high-speed processor technology and advanced memory/storage technology. Amid the situation, dedicated AI accelerator chips have appeared enabling AI computing on small terminals installed at the edge. This AI edge computing is effective for real-time processing, load distribution and ensuring reliability. Moreover, working in conjunction with the cloud, it is possible to analyze business data and update trained models. AI edge computing is expected to be a driving force for further promoting social implementation of AI technology.

Launching its AI edge computer with high real-time performance, reliability and security, and working with its co-creation partners, OKI aims to accelerate the resolution of social issues.

This article describes the advanced IoT society realized with the launch of OKI's AI edge computer "AE2100[1)]," the directionality of the ecosystem with co-creation partners to concretely realize the advanced IoT society, and showcases examples of AE2100 utilization.

OKI's Vision

OKI's advanced technologies in sensing, network and data processing/operations is characterized by its expertise in acoustic, optical, radio and image signal processing. Based on these technologies and the vast achievements in the market, OKI provides various solutions, products, and services that support social infrastructure to solve emerging social issues.

The advancement of IoT and AI connects ICT to the real world with data, and digital transformation is said to create new value. In order to facilitate utilization of the explosively increasing data, fast and efficient processing at the edge as well as in the cloud is gaining attention. This stems from the fact that the edge is precisely where data is acquired from the real world and feeds back obtained knowledge.

As shown in **Figure 1**, OKI has leveraged the expertise gained from IoT/AI technologies and its customer base to contribute to the creation of a safe and convenient society through the use of ICT with various information terminals in the edge domain. New AI functions will be implemented upon these technologies and accumulated experience to bring real-time data processing to the edge domain. Addition of an AI edge computer capable of collaborating with AI in the cloud will accelerate the implementation of IoT leading to an advanced IoT society. This "real-time intelligence" is OKI's vision. "Real-time" means "faster feedback" and "intelligence" means "providing more optimal and valuable solutions," and together it will drive the advancement of ICT environment in the edge domain.

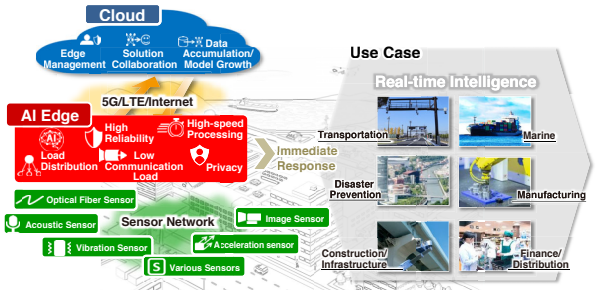

Figure 1. Concept of AI Edge Computing

Three "Ready" Concepts

As shown in **Table 1**, the AI edge computer AE2100 features three "Ready" concepts: IoT-Ready, AI-Ready, and Security-Ready.

The IoT-Ready concept supports a variety of interfaces including USB, Ethernet and serial line as well as the 920MHz multi-hop wireless SmartHop®[*1)] to easily accommodate various sensors the solutions may require. An outdoor casing is also available for housing the power supply, hub switch and other peripheral devices in addition to the main AE2100 unit for installation in harsh outdoor environment.

*1) SmartHop is a registered trademark of Oki Electric Industry Co., Ltd.
*2) Intel, Movidius, Myriad, and OpenVINO are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and/or other countries.

The AI-Ready concept ensures compatibility with Intel's OpenVINO™*2) toolkit for a general-purpose and open AI execution environment, and developed AI modules can be remotely downloaded to the AE2100 in a container format. Additionally, OKI's proprietary libraries that utilizes AI technology are provided for solution development including "Waveform Analysis ForeWave™*3) for AE2100."

In the Security-Ready concept, security features such as secure boot, Trusted Platform Module (TPM) support, and remote access control are provided to withstand malicious attacks coming through the networks. The goal is to make the user feel at ease when using an AI/IoT system.

Table 1. "Ready" Concept

Feature		Overview	Support
IoT Ready	Full line of physical interfaces	Equipped with physical interfaces to accommodate various sensor devices that are indispensable in IoT. Equipped with WebUI for easy configuration and maintenance.	• Ethernet, USB, serial (RS232C, RS485), contact I/Fs • WebUI for configuration/maintenance
	Various wireless protocol support	920MHz wireless support (with SmartHop). Enables construction of self-administered NW connecting various sensors, and also supports LTE and Wi-Fi of upper layer NWs.	• SmartHop • LTE/Wi-Fi
	Environmental resistance/ High reliability	Environmental performance that can withstand harsh outdoor environment. Ideal for use in the social infrastructure market.	• Dustproof and waterproof (IP55 / 66) • -30 to 45 °C temperatures (under direct sunlight)
	Affinity with the cloud	Provides connection and collaboration functions with cloud services from other providers.	• Microsoft Azure*4) IoT Edge certified
AI Ready	Open AI execution environment	Supports OpenVINO toolkit, an open deep learning execution environment.	• Intel's OpenVINO toolkit
	High AI processing performance	Equipped with an AI accelerator (VPU) for processing large volumes of data from cameras and sensors at high speeds.	• Intel's® Movidius™*2) Myriad™ X*2) VPU
	OKI value-added AI functions	OKI's own AI processing functions (software libraries) provided to match the used sensor.	• Video, waveform, acceleration analysis libraries
Security Ready	High security	Security measures that take into account IoT system characteristics for safe use of AI/IoT systems.	• Secure boot • TPM (Trusted Platform Module) • Access control

Building an Ecosystem with Partner Companies

In addition to the SmartHop ecosystem, which has been fostered together with adoption vendors and sales partners in the field of IoT sensor networks, and initiatives with co-creation partners to create value-added services, OKI is building a new ecosystem in the AI edge domain as shown in **Figure 2**.

This new "AI Edge Partnership" ecosystem will be propelled with partner companies related to AI business, such as SIer providing AI solutions, AI vendors, sensor device vendors, and sales companies handling AI/IoT products, to solve customer issues with AI and meet their digital transformation needs. Through this ecosystem, OKI plans to expand the market in the AI edge domain, create various solutions using AI edge computers, and promote activities to capture business opportunities.

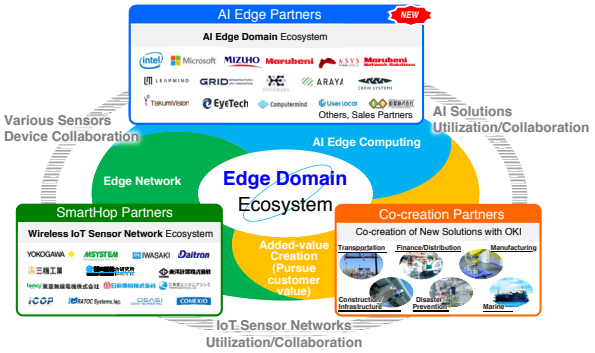

Figure 2. OKI Ecosystem

Use Cases

OKI has expertise in the areas of "transportation," "construction/infrastructure," "disaster prevention," "finance/distribution," "manufacturing" and "marine," and provides optimal solutions to each area.

(1) Transportation

The AI function in the edge computer instantly recognizes road conditions from images of outdoor cameras installed at intersections, and quickly grasps the traffic conditions by measuring the position and speed of vehicles, pedestrians, etc. Collaborating with the cloud, it will be possible to monitor traffic conditions and manage safety for an entire region as shown in **Figure 3**.

Traffic Monitoring System for an Entire Region

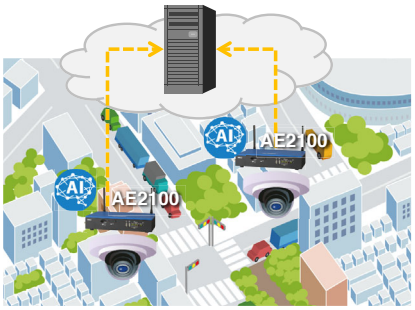

Figure 3. Transportation Example

(2) Construction/Infrastructure

At construction sites, poor visibility due to bad weather and blind spots created by large vehicles or large facilities can hinder human visual inspection. This leaves a risk of accidents and compromises the safety of workers. Using information from camera images and laser distance sensors, situation at construction sites can be monitored to support the improvement of safety, security and

*3) ForeWave is a trademark of Oki Electric Industry Co., Ltd.
*4) Microsoft and Azure are trademarks or registered trademarks of Microsoft Corporation in the United States and other countries.

productivity. As shown in **Figure 4**, integrating camera images with laser distance sensors and utilizing AI, the movements of people, vehicles, and equipment can be visualized with high precision. Based on this visualized information, the safety of field workers is ensured by monitoring with both human and machine eyes.

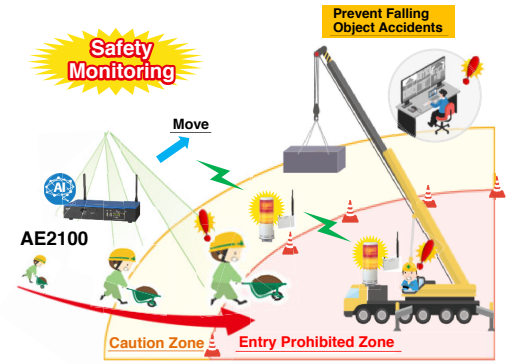

Figure 4. Construction/Infrastructure Example

(3) Disaster Prevention

Solar-powered cameras and sensors can be combined with low-power wireless communication technology to enable on-site AE2100 to make situational decisions at a location where sudden natural phenomenon is likely to occur, as shown in **Figure 5**. In addition to reducing the communication cost to the location of the administrative organization, the results of the system's determinations are collected as the phenomenon occurs, so that evacuation advisories and road closures can be quantitatively assessed and executed. It is also possible to obtain sensor data and camera images as needed for a more thorough confirmation and decision making.

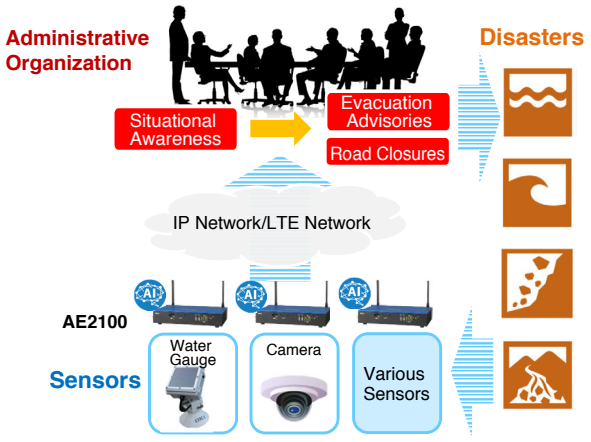

Figure 5. Disaster Prevention Example

(4) Finance/Distribution

At retail stores, the number of customers and their attributes (gender/age), buying time by attribute, and number of customers lining up at the cash register are monitored with image sensors, and the appropriate number of cash registers to open is predicted using AI. By positioning cashiers at the registers before congestion occurs, it will be possible to prevent customer dissatisfaction, which is an issue for stores. The AI can also reference past trends and support the creation of an optimal shift plan for cashiers. This will reduce the load on the manager and optimize the shift of store staff. Even more, tracking the flow of customers from entrance to exit using image and other sensors, the obtained data can be analyzed for marketing purposes such as creating attractive store layouts.

In another example, the number of people waiting at an entrance gate, ticket counter, ATM, etc. and other accumulated data is utilized by AI to predict waiting time. The information can then be sent to customers via smartphone, signage and other forms of notification to prevent customer dissatisfaction and loss of sales opportunities (**Figure 6**).

Figure 6. Finance/Distribution Example

(5) Manufacturing

Analysis of vibration and acoustic data obtained from sensors placed with production equipment and delivery products at manufacturing sites helps improve productivity and efficiency of maintenance. Currently, during the drilling process of products and parts that require high-precision machining, workers visually inspect the process to prevent defective products due to tool wear (drill fractures or lack of accuracy requirement) or damage. However, many oversights occur, and maintaining accuracy requires lots of resource and time. As shown in **Figure 7**, the AE2100 is used to generate a differentiation model for the "new/nicked/damaged" state of the drill, and using a waveform analysis algorithm, the state of the tool can be determined with high accuracy.

When an abnormality is detected, a stop instruction is issued to the NC control system, thus stopping the machine and enabling drill bit replacement in real-time. This reduces the cost of visual inspection and drilled-hole repair leading to quality improvement.

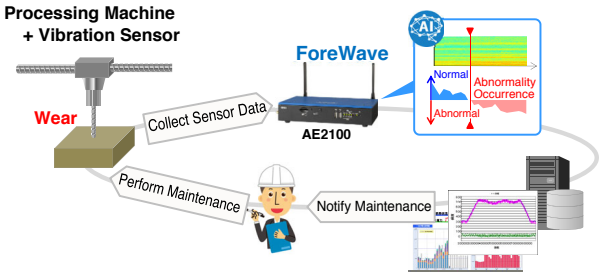

Figure 7. Manufacturing Example (1 of 2)

Signs of failure in equipment with a long service life, such as escalators and belt conveyors, are detected through regular inspections using the eyes and ears of maintenance personnel. However, securing and training skilled personnel is a problem. Furthermore, if a failure is not detected early, it may lead to suspension of operation and an increase in repair costs.

Acoustic sensing, which is one of OKI's core technologies, and a proprietary AI algorithm will solve these issues and support the operation and maintenance of the equipment. As shown in **Figure 8**, detecting signs of failure in a timely manner will enable maintenance personnel to catch a failure at an early stage and also alleviate the problem of personnel shortage

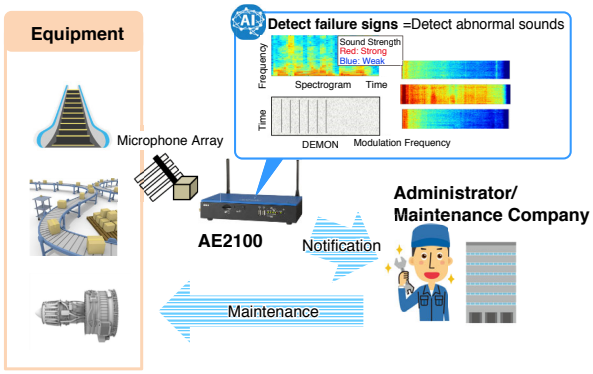

Figure 8. Manufacturing Example (2 of 2)

(6) Marine

Using various sensing technologies, OKI is actively working in the ship IoT field for safe and efficient ship operation and future autonomous ships.

Reducing the communication load for exchanging the large volumes of shipboard sensor data with the land is a major issue, and there is high demand for shipboard ICT equipment to perform processing at the edge side. As shown in **Figure 9**, the use of AI edge computing technology is being promoted in various ship IoT areas, including hull distortion monitoring using optical fiber sensing, vibration monitoring of shipboard equipment such as engines and pumps, and the bird's-eye view monitoring using FlyingView®*5).

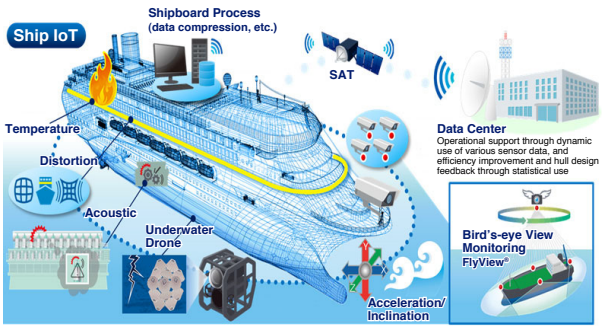

Figure 9. Marine Example

Conclusion

Taking advantage of the AI edge computer AE2100's strength with various sensors including optical fiber, acoustic and vibration, proven AI library, high environmental characteristics for use in social infrastructures, and highly IoT-compatible SmartHop, OKI will provide solutions to its focus areas of "transportation," "construction/infrastructure," "disaster prevention," "finance/distribution," "manufacturing" and "marine."

Additionally, OKI plans promote co-creation with various partners through the ecosystem providing a wide range of solutions to solve issues facing society and work toward its goal of realizing an advanced IoT society. ◆◆

References

1) Takamitsu Shimada: Realizing High-Speed Deep Learning Inference with AI Edge Computer "AE2100," OKI Technical Review, Issue 234, Vol.87, No.2, pp16-19, December 2019

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TIPS【Glossary】

Ecosystem
A common revenue environment for products and services built by multiple companies.

*5) FlyingView is a registered trademark of Oki Electric Industry Co., Ltd.