Edge Computing Will Merge Human Abilities and Intelligent Objects

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Information and Communications Technology (ICT) is witnessing a movement to push computing applications, data, and services from centralized nodes to embedded networks. Behind this movement is edge computing, which enables process control and the generation of analytics to occur at the source of the data. By combining ICT with Operational Technology (OT), we are accelerating the merging interaction of human abilities with machines and objects.

Edge computing is a hot topic, but because it covers such a wide range of devices many questions about the direction for further research, applicable scope of use, and the relationship to the Internet of Things (IoT) and to the Internet itself are raised.

Interplay Between Edge Computing and the IoT

Shenyang Institute of Automation (SIA), focused on robotics and smart manufacturing, recognizes that ICT is important for accelerating the transformation of traditional industries. For example, 'Industry 4.0' — Germany's 21st century manufacturing strategy — aims to employ Information Technology (IT) to consolidate its leading position in the global market. Also for the 'Industrial Internet' in the U.S., the goal is to maximize the country's competitive edge in manufacturing using IT. In turn, China has introduced the 'Made in China 2025' initiative for the purpose of extending China's influence as a global manufacturing giant. These three initiatives represent the development directions of the leading industrialized countries of the world, with each emphasizing an increasing convergence of ICT and OT.

In manufacturing, China faces enormous challenges, including resource waste, high energy consumption, and deteriorating environmental conditions. Although not overshadowed by developed countries in terms of industrial infrastructure, China lags in operational efficiency. One contributing factor is that China has many low-grade mines where the set value of raw material components fluctuates considerably, with big differences between offline optimization and actual production. In this case, ICT-based interconnections are an effective way to boost efficiency by

The Internet of Things must share the computational load between processors located in data centers and at the network edge to provide the optimization necessary to meet the functional objectives for specific applications. Achieving this result will require a robust ecosystem of technical standards and industry solutions. >>

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enabling automation and monitoring of all processes throughout the industry chain.

Proposed by China's Premier Li Keqiang in his *Government Work Report* in March 2015, the 'Internet Plus' program is essential to meeting the goals stated for 'Made in China 2025.' Internet Plus refers to the application of the Internet and other IT advances to conventional industries. It is an incomplete equation where various Internet platforms (mobile, cloud, Big Data, and the IoT) can be added to other fields and foster new industries and business developments. In the virtual world, Internet Plus brings people closer together; however, in the physical world, Internet Plus has yet to play any significant role.

The IoT refers to the ever-growing network of physical objects that feature Internet connectivity and communication links between these objects and other similarly enabled devices and systems. A majority of IoT functions face fragmentation challenges in a variety of scenarios due to the sheer volume of different device types, communications technologies, and software used to manage, configure, and develop nodes and links. The unification of these different technology fragments is both mandatory and the biggest game changer, since it will level the playing field for small and large vendors competing for the best solutions.

Issues to be resolved by IT will be modular in nature and focused on the unification of computing models. In terms of OT, the intended outcome will require that IoT systems be dominated by edge computing resources that locate processing workloads in near proximity to the IoT sensors and endpoints themselves — in other words, at the edge.

Challenges Facing Edge Computing

Whether Industry 4.0 in Germany or the Industrial Internet in the U.S., technological innovations are successful because each new product generation and infrastructure uplift is relatively more efficient and effective (optimal) than its predecessor. Today, China urgently needs to converge the IoT and OT. Such convergence is beset with difficulties because OT and IT are two completely different technologies with separate models, concepts, and platforms. In the face of increasing fragmentation on the edge, traditional IT terminals are not able to meet modern IoT requirements. New solutions and future-ready scenarios must be based on the convergence of chipsets and networks with edge computing.

In traditional industrial automation, OT is primarily tasked with the breakdown of procedural objectives and the generation of real-time feedback. The next step for industrial automation will be the ability to adjust the production objectives dynamically if and when commanded changes fail to achieve the intended outcome. This requires massive amounts of converged information, from design to development to production and then to management. IT offers many opportunities for convergence, the first of which is connectivity. The maturing Internet, for example, has established a platform of connections between humans and machines that permits users and businesses to store, share, and analyze tremendous amounts of historical and predictive data on which to base any secondary changes that need to be made in production.

At this point, the IoT is still in its early stages and has not matured enough to match existing industry standards. It is still fragmented due to all of its different technologies, hardware, and non-uniform development languages. It contains a large number of elements and is accommodating new content with the development of the IoT.

The public will also be a part of the IoT. The relationship between people and machines will change radically over the next 20 years. Human intentions, behaviors, knowledge, and expressions will present new challenges, and people will be increasingly engaged with edge computing on a regular basis.

In a traditional model, the IoT transmits collected data to a data center for processing and analysis. In the future, it will be impossible to manage and house billions of IoT connections using today's cloud technology. This issue will be resolved because of edge processing of data collection, storage, and presentation of results. By today's standards, it will be difficult to allocate tasks and perform automatic adjustments because the IoT data types have physical features (such as multi-dimensional heterogeneity and temporal-spatial correlations) that are totally different from

current technology. These issues will be best resolved by edge computing rather than by edge networks with little or no local processing. The Huawei LiteOS kernel is an example of the type of lightweight, memory-resident operating system that will become a central foundation for severely restricted resource operations for enabling computing power at the edge, before transmitting the results to the cloud data centers.

Edge computing will be primarily used in OT for distributed sensing, decision making, and control, thus meeting real-time service requirements. The advantage of edge computing is sensor-processor response times within hundreds of milliseconds, which is a data interaction frequency that is much higher than is possible between sensors and cloud data centers.

Driving the Convergence

At SIA, we propose an open platform based on edge computing to address the fragmentation, data heterogeneity, and interconnection issues found in the open source environment.

An edge computing platform makes converged IT and OT a reality. Whether on the edge or the cloud, computerized processing must be modular, either digitally or semantically. Take the application of robots in the automotive industry as an example. Starting in the 1980s, people were replaced by automated robots in many situations, with little collaboration from outside sources. If a change needed to be made to the system controlling the robots, the robots needed to be stopped, reprogrammed, and then restarted. This resulted in long wait times and, during the startup phase, led to many mistakes. By 2020, a great number of co-existent and collaborative methods will emerge, enabling robots to better understand people, and vice versa, by eliminating long reconfiguration periods and other manual tasks needed to interact with robots. Therefore, the convergence of human abilities, machines, and objects will become a major trend.

To overcome the difficulties arising from this convergence, we have established the 'Edge Computing Industry Alliance.' The alliance will start with the definition of an open platform specification to engage more industry vendors, drive ICT and OT convergence, and accelerate the development of edge computing in the form of Internet-like, rapid iteration. The alliance will capitalize on its technologies, standards, and test beds to achieve edge computing breakthroughs in manufacturing and the creation of new business models for ICT vendors.

Orchestrating a robust ecosystem to attract more players is a vision shared by the members of the alliance and the SIA. Members of the alliance will provide edge computing technology to combine industries, manufacturing, sensing, control, computing, storage, and networks. Their complementary advantages will fully meet edge computing requirements for technologies, standards, and industry solutions. Today, the entire ICT industry is attaching increasing importance to developments by ecosystems; edge computing cannot depend on just one or two enterprises for its success. ▲

Edge computing needs to interact and grow with networks because the data to be processed is heterogeneous and real time. Edge computing will be primarily used in OT for distributed sensing, decision making, and control, thus meeting real-time service requirements. >>

Link: Shenyang Institute of Automation (SIA)

A research arm of the Chinese Academy of Sciences, SIA has more than 1,100 employees, two members of the Chinese Academy of Engineering, and more than 500 enrolled master's and Ph.D. students. In the robotics field, SIA studies key technologies and has a presence in institutions, sensing, and control in a variety of domains, including land, sea, air, aerospace, and medicine. With industrial robots, SIA has made remarkable achievements, including the founding of SIASUN, a leading robotics company in China. In the automation field, SIA is involved in industrial chipsets, smart devices, control systems, and holistic industry solutions. SIA's automation technologies have been widely used in oil exploration and the smelting and rolling of nonferrous metal, aerospace, and electrical equipment, as well as intelligent automobile manufacturing.