

Edge Computing Technical Research Brief

Lab 58 Technology Research Brief

July 2022

Three technology trends are creating use cases that require organizations to consider moving to edge computing: Internet of Things (IoT), artificial intelligence (AI), and the 5th generation mobile network (5G).¹ Businesses and individuals use IoT devices that generate large amounts of data. In 2021, there were approximately 40 billion IoT devices installed worldwide, and it is projected that there will be 75.44 billion by 2025.² Every household has an average of 50 internet-connected IoT devices. The increasing amount of data that needs to be processed, transferred, and stored is driving the shift from cloud computing to edge computing for reduced costs required to handle the same data.

Edge Computing and AI

As NVIDIA's Scott Martin explained, "Edge computing is the concept of capturing and processing data as close to the source of the data as possible via processors equipped with AI software. Frequently, the processors are in the form of intelligent sensors embedded in Internet of Things devices."³ Edge Intelligence or Edge AI is the use of AI algorithms (instructions) running directly on edge devices.⁴ Edge and cloud platforms are not required to be used exclusively of each other, and these technologies work together to build stronger frameworks to support today's increasing demands from IoT devices (Figure 1).

Figure 1: Making smart devices to track trucks.



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KEY TAKEAWAYS

1. The growing array of devices connecting to the internet, as well as the volume of data they produce and users' desire for real-time response, is burdening traditional data center infrastructures.⁵
2. Edge computing brings computation and data storage closer to the sources of data, improves response times, and saves bandwidth.
3. Edge and cloud technologies are not exclusive of each other, as they combine to support today's technology trends. These two platforms complement each other, and each plays a role in building a modern data framework.⁶

¹ Yeung, T. (2019, October 22). What is edge computing?

² Steward, J. (2022, February 15). *The ultimate list of Internet of Things statistics for 2022*. Findstack.

³ Martin, S. (n.d.). What is edge computing?

⁴ SCC. (2021). What is edge computing and why does it matter? *SCC Industry News*.

⁵ 41.6 billion IoT devices will be generating 79.4 zettabytes of data in 2025.

⁶ Analytics Insight. (n.d.). *How edge computing leverages automation*.

Mechanics of Edge AI

Edge computing was originated in the 1990s when Akamai Technologies, Inc., a global content delivery network company, provided customers with private networks that bypassed the public internet, which created more efficient data paths and resulted in reduced latency. As noted by Sarah Lewis in her article, "Gateway," "All networks have a boundary that limits communication to devices that are directly connected to it." This means that a gateway (entry/exit station) is positioned at the edge of a network and manages the flow of data into and out of the network.⁷

IoT devices such as smartphones, smart refrigerators, smartwatches, smart fire alarms, smart door locks, and so on share the sensor data they collect by connecting to an edge computing device.⁸ At the edge device, relevant data are instantly processed within the network, and the remaining data are bundled and sent to the cloud or data center. One of the most common edge devices or gateways is an edge router. Edge routers are usually positioned at the boundary of a local area network (LAN) to connect it to the internet or a wide area network (WAN)⁹ located outside of the business network. Machine learning is bringing the processing power of the cloud to the edge (Figure 2). Edge devices are now able to make decisions, make predictions, process complex data, and administer solutions.

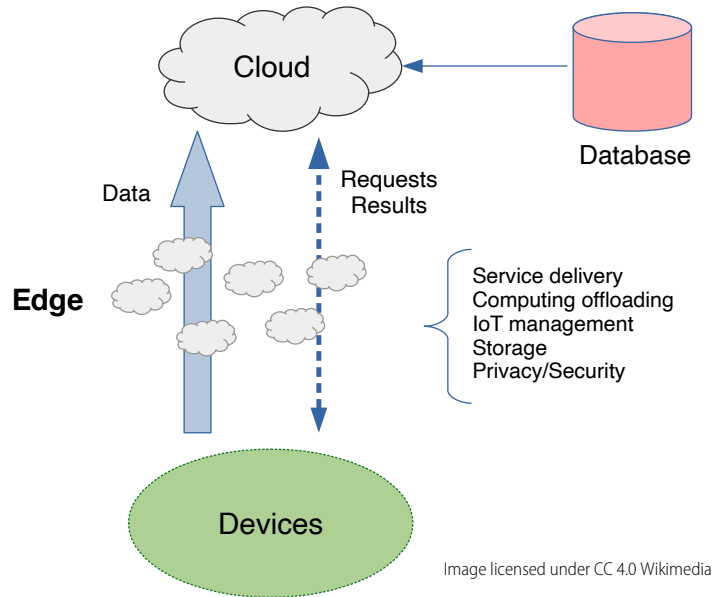


Figure 2: Edge computing paradigm.

AI brings cloud computing to the edge of IoT devices and closer to the point of data generation.

Types of Edge AI Devices

Edge devices range from simple sensors embedded in IoT devices to complex graphics processing units (GPUs). Two factors to consider when choosing a platform capable of edge processing include the following:

- How much processing power is needed?
- Does the device need to support common interface technologies such as ethernet, Universal Serial Bus (USB), cameras, and keyboards (Figure 3)?

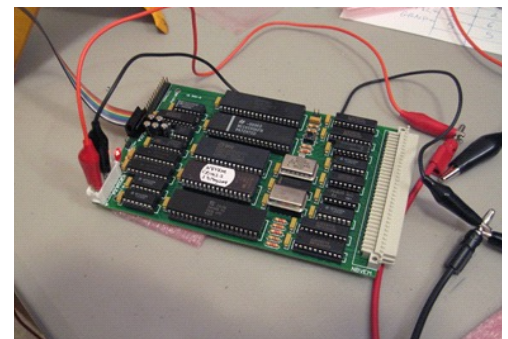
Edge AI devices come in a variety of configurations. One type is the single board computer (SBC) pictured in Figure 4. Currently, SBCs are being designed with sensors, or with input/out needed to connect to other sensors. Factors to consider when selecting an SBC edge device include processing power, ability to run applications, and complexity/user-friendliness.

Figure 3: Picture of a generic Edge PC for IoT and Cloud Use Cases



Photo by IPhoto by Veit Hammer on Unsplash

Figure 4: Z80 Single Board Computer



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⁷ Lewis, S., & Burke, J. (2019, June). Gateway. *TechTarget*.

⁸ Gillis, A. S. (2021, August). What is the internet of things (IoT)? *TechTarget*.

⁹ Posey, B., & Scarpati, J. Edge device. *TechTarget*.



Figure 5: Edge AI is used to produce innovative edge technologies that bring real-time AI across industries.

Image by Gerd Altmann, Pixabay

Use Cases of Edge AI

Edge computing uses can be mobile (i.e., a vehicle or smartphone) or they can be stationary (i.e., a building management solution or manufacturing plant). They can also be a mixture of both. According to information technology solutions company SCC, “The edge computing market landscape consists of players from the public cloud (Microsoft, IBM, Google, and Amazon), as well as networking companies, independent software vendors (KPMG) and industrial automation companies (Siemens).”⁴ Technology companies such as Intel, NVIDIA, Dell Technologies, AMD, Samsung, and Qualcomm are producing innovative edge technologies that bring real-time AI across industries (Figure 5).

Health Care

Intel Technologies uses edge computing combined with AI to improve medical devices including wearables, health monitors, and AI-powered imaging systems. In the past, healthcare systems used the cloud to store, analyze, and process data, but advancements in technology have provided edge computing as an option or as a partnering platform. According to Intel’s article *How Edge Computing is Driving Advancement in Healthcare Analytics*, “Combining edge AI with cloud computing results in quality clinical decision support (CDS), faster diagnosis, and improved patient monitoring and recovery.”¹⁰

Manufacturing

Edge AI brings AI processing closer to the data source or manufacturing area. Advantages to manufacturers include reduced latency or processing delay; enhanced security of data remaining within the device; reduced bandwidth of data transmission and related costs; increased IT domain knowledge; and enhanced workflow efficiency. Technology company NVIDIA identifies the following Edge AI use cases for promoting manufacturing efficiency and productivity: predictive maintenance to avoid machine downtime; quality control to detect defects and reduce waste; and use of AI-enabled cameras and sensors to identify worker conditions and ensure worker safety.¹

Agriculture

The agricultural industry has been slower to advance and adopt modern technologies than some of the other industries. However, advances in Edge AI technology are being applied to precision agriculture to result in “smart farming” or processing and analyzing data to maximize crop production. Edge AI agricultural opportunities include incorporation of Ag Robots or autonomous tractors and robotic machinery, as well as farm automation using IoT edge computing and disaster protection, which uses remote sensors to acquire and process data regarding weather changes to forecast disasters. Edge AI devices can communicate with nearby sensors to acquire data regarding feeding livestock, watering plants, controlling temperature, humidity, or light.¹¹ IBM has combined Edge AI with agricultural IoT data and the expertise of veteran food and agribusiness industry leaders to create Regenerative Agriculture within the Environmental Intelligence Suite. The goal of this technology suite is to help agricultural stakeholders make faster and more informed agricultural decisions.¹²

¹⁰ *How edge computing is driving advancements in healthcare analytics.* (n.d.) Intel Corporation.

¹¹ Dutta, A. (2021, August 27). Edge computing: Reshaping the agricultural sector with smart farming.

¹² *IBM environmental intelligence suite: Regenerative agriculture.* (n.d.) IBM Environmental Intelligence Suite.

Benefits and Considerations of Edge AI

Edge AI represents the first wave of truly integrating AI into daily living.³ In the past, development costs limited AI to research institutions and wealthy corporations. The relative affordability of edge devices has made the use and development of AI more accessible than ever before for individuals to obtain it and develop it for their own uses. Other benefits of Edge AI include reduced latency or lag time and increased data security as the data never leave the premises.¹³ Additionally, Edge AI has (1) reduced bandwidth requirements and cost because fewer data are transmitted between devices and (2) improved reliability because computing processes are performed at the source of the data and independent from the cloud.³

Considerations before deciding to use an Edge AI system include the availability of skilled information technology professionals who can launch and manage a local edge network in the geographic area and the greater difficulty of preventing and monitoring security breaches, which is required at each localized point of the edge network. Also, loss of data with potential usefulness is a possibility if the edge device incorrectly assesses the usefulness of data and discards the data instead of storing or forwarding them to the cloud for future use. Cost and storage capacity needs are also considerations, as Edge AI devices may require more hardware and software for optimal performance.¹⁴

Ethical Considerations for Edge AI

Because AI is a complex technology, and its systems are not always transparent, ethical concerns arise surrounding the use of Edge AI or any other technology in combination with AI. Video surveillance data and individual privacy are major areas of concern. Achieving a balance between security, personalization, efficiency, and individual rights to privacy must be resolved.

Bias and discrimination are also of ethical concern when using AI technology. Algorithmic decision-making appears to offer objectivity, overcoming human bias and prejudice; however, machine learning is based on data sets that are fed by humans. The probability is high that these data sets replicate historical events and past failings that resulted in systemic bias and discrimination.¹⁵

Currently, companies that develop or use AI systems largely police themselves. Tight regulation of the use of AI is being considered; however, there is no clear agreement about how it will be enforced or who will make the rules. Regulatory bodies and government agencies do not have the expertise in AI to conduct oversight without considerable investments of time and resources.

Future of Edge Computing

The growing array of devices connecting to the internet, as well as the volume of data they produce and users' desire for real-time response, is burdening traditional data center infrastructures.⁵ Gartner predicted that by 2025, 75% of enterprise-generated data will be created outside of centralized data centers.¹⁶ Edge computing is expected to reach \$17.8 billion by 2026.¹⁷ Moreover, according to IDC's Global DataSphere Forecast, "The amount of data created over the next 3 years will be more than the data created over the past 30 years, and the world will create more than three times the data over the next 5 years than it did in the previous 5."¹⁸ As long as businesses and individuals continue to create larger and larger amounts of data, the need for real-time processing and management of that data at the edge or closer will be needed.

Work With Lab 58

Thanks for your interest in our work! Our researchers and developers are actively exploring use cases for the combination of Edge AI, and we want to help you explore opportunities to work with the technology.

Please email us at Lab58@rti.org. We will set up a 30-minute, one-on-one chat to discuss opportunities and answer any questions. We are interested in partnering with you to find a solution that meets your needs.

For more information, contact
Lab58@rti.org.

¹³ Hilliard, G. (2020, September 29). Using SBCs to 'sense' at the edge. *Embedded Computing Design*.

¹⁴ Hiter, S. (2021, April 1). The pros and cons of edge computing. *Datamation*.

¹⁵ Pazzanese, C. (2020, October 26). Great promise but potential for peril - Ethical concerns mount as AI takes bigger decision-making role in more industries. *The Harvard Gazette*.

¹⁶ Van der Meulen, R. (2018, October 3). What edge computing means for infrastructure and operations leaders.

¹⁷ *Global Edge Computing Market Report 2021*. (2021).

¹⁸ IDC's Global DataSphere forecast shows continued steady growth in the creation and consumption of data. (2020, May 8). *Business Wire*.

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RTI 14490 R2 0722