



Edge Computing Implementation by Education Industry

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Abstract

Edge computing entails distributed and decentralized processing, localization, where the technology stack would remain the same but the operating system, the data storage unit, the network components and tools, the security mechanisms would reside and execute with efficiency on the restricted hardware.

Edge Intelligence on the other hand evolves from the intersection of Edge Computing and Artificial intelligence methodologies and associated technologies, concerning the perception of distributed data and IoT devices.

Until recently 90 percent of the enterprise data was on the cloud, but in recent years the number has significantly dropped according to Gartner Research. Cloud and Edge are anticipated to supplement each other by optimizing cloud network traffic, reduce delays and enhance responses using the edge, and improvise on data processing and ensure scalability. This paper would address the usage of edge computing technologies in the segment of education with a focus on accessibility and availability of edu-resources and relevant learning management systems using edge nodes, that would ascertain uninterrupted and optimal utilization by the learners. Scenarios would also be presented that would highlight management and control of the software, the platforms, and related ed-infrastructures, to ensure continuous availability and also seamless delivery with restricted resource availability.

Keywords: Edge Nodes; Technology in Education; Analytics of Learning Technology; Case Studies

Introduction

Edge computing is keeping data closer to where it is generated to enable rapid, near real-time analysis and response. Industries and corporates have combined operations by having a unifying data storage and computing environment in the cloud. There has been a rise in new kind of user demands that are enabled by an enormous number of distributed devices - such as the new age warehouse and inventory management solutions to AI enabled manufacturing units to advanced smart cities —have made this model unsustainable.

The increased use of edge devices—that are Internet of Things (IoT) enabled, has driving multi-fold growth in the amount of data generated and collected [2].

An assessment says that by the coming years, more than 70% of data will be brought in from outside of central data centers, where most processing takes place today [5]. It is also estimated that only 10% of all data collected by organizations today will be used. Edge computing offers the benefits of data collected from devices through better performance processing, quicker connectivity, and safe platforms.

The cloud has There is a shift and cloud is involved towards helping edu-techs to deliver on more calculated goals towards teaching-learning process and student interaction.

The benefits of cloud computing are immense but, its positioning requires strong connectivity, high bandwidth and lesser delays

– conditions that may typically not be available on educational campuses. Thus we see that, edge computing is coming up as a corresponding enabler in the classroom. A good base in cloud computing forming a solid foundation for edge networks. Let’s look at its application in the classroom and benefits in teaching-learning.

The advantages of edge computing for educational institutes

A unified cloud platform processes data by collecting it from a varied number of sources and away from them, edge computing on the other hand collects and analysis data at or close to the source. Instead of sending the data to major servers, edge computing brings intellect to devices at the network edge like routers, routing switches, or even computers and hand held devices [1].

As data has a shorter distance to travel from the source to the edge, users experience a better network performance. This gives way to augmented-reality (AR) and virtual-reality (VR) applications. In the classroom, for example a virtual lab which will require higher connectivity to work seamlessly [3]. An edge computing enabled environment will mean that students and teachers can access the information and applications they need to learn, teach and conduct research.

In a unified cloud, a service down at the edge will not disrupt the complete network, ensuring continuity during crises. Today educational organizations continue to depend on the distributed cloud for research and major events, the safety factors of edge computing will benefit the institutes a lot.

A common benefit of both edge and cloud is its scalability. A study by an IT giant says edge computing can offer a cheaper way for organizations to grow their computing capability [4].

How edge computing differs from cloud is important to be understood. As it will be a very close call for the decision makers when choosing a technology that are both growing and competent. Let’s take a look at a border difference, between them.

Edge computing for the classroom

Better connected devices

As more interconnected and independent IoT devices continues to grow, where nearly half of the students say they use a desktop

| Edge Computing | Cloud Computing |
|-----------------------------------|---|
| Decentralised Design | Centralised Design |
| Latency is Low | Latency is High |
| Located Close to Source | Remote from source |
| Data loads are small and sporadic | Data load Large and continuous |
| Implementation cost is less | Implementation cost is comparatively high |
| Infrastructure is limited | Infrastructure is Scalable |
| Mobility is supported | Mobility is Limited |

Table 1

computer in the classroom the other half uses a smartphones. 30 percent of students use interactive whiteboards and 20 percent use tablets for education and co-curricular needs. Such devices, that lack bandwidth to send data and information back to the central cloud could find processing data on the edge faster and more efficient [6].

For students, this means access to enhanced learning and collaborative experience. For toddlers and their teachers, sensors based toys in hand can provide real-time information about student behaviours and changing aspects, giving insights for more focused actions.

More immersive and interactive learning

Edge computing supports smoother and more realistic AR and VR applications in schools. Equipped with industrial motherboards and intelligent edge computers, schools will be able to support local data processing and reduced delays [14,15]. This means that students will experience virtually no distance compared to applications that rely solely on the central cloud. Enhanced immersion only enriches and animates the learning experience and opens the door for the future of learning.

It is the future of learning that can enable edge computing: AR flashcards and worksheets combine interactions and audio-visual interests into comparatively-black-white notes and lesson plans. Meanwhile, VR Lab and experiment opened space for problem-solving and innovation, even support deeper understanding and remembrance [15].

Enhanced real-time feedback

In the future, supported edge devices with machine-learning capabilities can take input from learners and respond quickly with the help of edge computing. Imagine smart feedback and tools that can track and monitor students in academic, curriculum, and extracurricular activities - logging areas where they are best or where they struggle. These intelligent edge hardware and software solutions already exist, allowing organizations and institutions to prototype Edge AI solutions and manage and secure them easily [7].

Due to the high network speed that is affordable through Edge Computing, these tools and systems can quickly adapt to students' learning styles, increase online classes to close distances, distribute instructions and questions to promote learning, or suggest appropriate curricula according to their needs. Although such use cases have not yet been resolved, edge computing allows these endless possibilities.

Lets' get familiar with some terms

- **Edge computing:** Edge computing is a physical calculation infrastructure located on the spectrum between equipment and hyperscale cloud, supporting various applications. The edge computing process brings capabilities closer to the end user/device/data source that eliminates the journey of the cloud data center and reduces delays.
- **On-premise edge computing:** Computing resources on premises that are managed by a third-party operators for any organization. On-premise edge computing holds sensitive data on-premises while still taking advantage of the pliability offered by the edge cloud.
- **Edge Cloud:** Edge cloud has the aids of both cloud and on-premise servers, as it has the capacity to handle unprecedented rise in data load.
- **Private Cloud:** Cloud services are provided to fixed or specific users over a private network. They have the benefits of scalability and agility along with that of higher security and privacy.
- **Network edge:** Here the organization owned networks are connected to the internet or other networks.

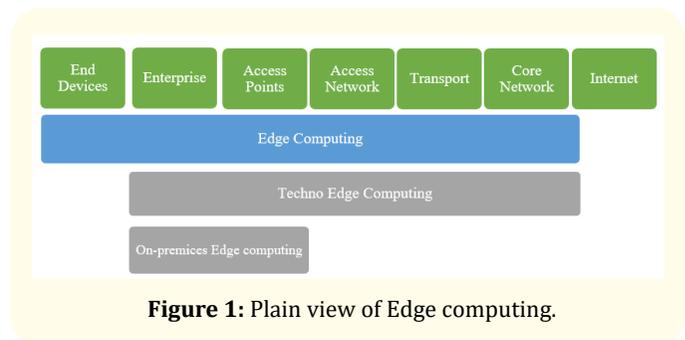


Figure 1: Plain view of Edge computing.

Implementing this technological advancement in education sector

Modern technology is needed by students at every level of education, this helps them in staying relevant in the competitive job market. As more of the classroom gets online and interactions between student and teacher become virtual, schools have to implement a host of services through applications. Replacing the traditional teaching-learning methodology is inevitable. Providing the current age technology for learning has put our schools and educational institute under strain to maintain the cost of implementing the IT setup [9].

Some ways edge computing is impacting the classroom.

Adjusting network traffic

Within edge computing, micro data centres have technology that can increase and decrease the resources a per the school's requirements. As data is brought on campus, latencies can be reduced considerably for a enhanced user experience. Since edge computing tasks can be managed remotely the cost of travelling to these sites reduces response time [11].

Improving user experience

As schools start to use edge computing, they give importance to connectivity and networking across several campuses to eliminate slow speeds, which makes the experience of students and teachers better and efficient [12].

Enhance student performance, confidence and mental wellbeing

An edge computing enabled AI would monitor pointers of students' understanding and ease with the subject matter being

taught. If the students seems to lag in understanding, the system provides a re-run of the topic by offering help and repeating the critical parts of lessons [14].

Evolving methodologies

The manner in which classes are planned, conducted and evaluated, has a lot of influence of IoT devices. Use of e-books, smart boards, natural language based note-taking systems, GPS tracked school buses, disaster alarms, etc. has changed the methods of teaching and learning.

Automated attendance recording

IoT can solve the hefty task of recording and consolidating attendance. Biometric attendance or barcode-based with the identity card number of the student can be used in automatically recording the attendance as they enter the classroom.

Distance learning

Attending online class was the normal for the last 2 years for all students. Attending online classes, viewing pre-recorded classes, online time-based quizzes, were some point that are now a regular activity amt most institutes.

A summarization of the points discussed can be seen in figure 2. IoT devices give students dependable access to the entire student learning process and progress.

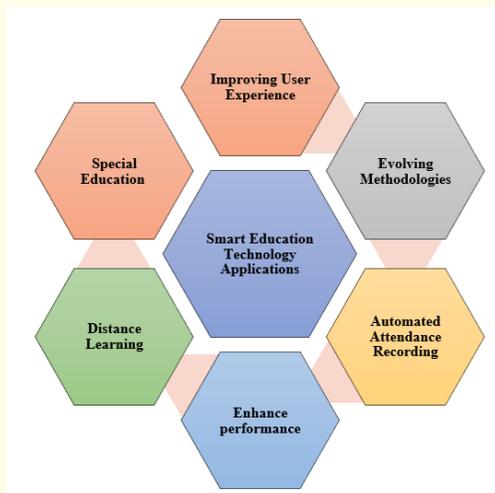


Figure 2: Application of edge computing based IoT devices.

Now let’s look at some statistics on implementation and plans of different sectors with respect to edge computing. The figure 3 represents the view of global agile decision makers on inclusion of edge computing. As we see eleven percent of education and healthcare leaders plan to implement edge technology in 2022 and nearly twenty four percent in the upcoming years. Though we that implementation and planning in other sectors are at least six percent higher than the education and health care combined, it is a positive outlook. The manufacturing shows the most promising implementation and planning growth.

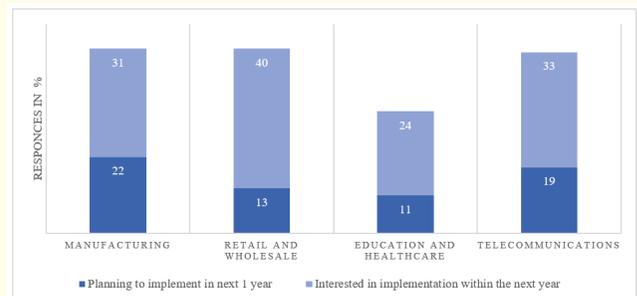


Figure 3: Planning, Implementation and acceptance of Edge Computing in different sectors across the world.

Let us get familiar with some actual implementation of the technology, in the form of case studies from across the world.

Case 1

Here we take a case of a computer science teacher, from Alabama. She has shared her experiences using IoT platform in her classroom and throughout the school. Using IoT-enabled electric settings helped her redirect students’ attention.

She also used the application feature where a virtual assistant alerts the administration of an emergency. The IoT based app would generate different alerts depending on the type of emergency [16].

Case 2

An Elementary school in Virginia has created a choice of reading print books or on a hand-held device in the library, teachers can take social media based development workshops, alongside regular offline programs. The teachers of this school, for example, might use popular applications for finding and sharing innovative ideas with their class and the world at large [17].

Case 3

A teacher from the South of India uses AR in the classroom. He uses 3d viewing applications to take students on virtual trips. The students explore historical places, zoos and sanctuaries, underwater expeditions. With this experience at hand, he encourages them to write on it. He points that once started using technology in class there was more visual media for them to learn from. Students were able to grasp new vocabulary. Student participation has also increased; they ask more questions about how things work [18].

Conclusion

A substantial change is already underway at educational institutions due to the pandemic of 2020, and inclusion of IoT in teaching-learning is supported by edge computing. Many educational institutes prefer students to attend online classes rather than miss any school [18]. Online teaching and learning is now a very obvious and active part of the entire education instruction medium. Edge computing is playing a significant role in collaboration of edutech applications and devised based support. Research and decisions makers believe that edge combined with other aspects will bring convenience, improved experience and better teaching learning in this sector. Edge-adjacent technologies are here to stay and will continue to develop and deploy across the education sector.

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