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Attendo: BLE-Based Smart Attendance System

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Abstract- This paper introduces a prototype Bluetooth Low Energy (BLE)-based smart attendance system developed to overcome common technical and operational challenges in educational environments, including cost, scalability, hardware dependence, and hygiene concerns. The proposed system utilizes two dedicated mobile applications: one for teachers and another for students. In contrast to conventional BLE-based models where students broadcast signals, this design reverses the communication direction. The teacher's device functions as the sole BLE beacon, transmitting a session-specific encrypted UUID, while student devices operate as passive scanners that detect proximity and send encrypted check-in requests to a central server. The system emphasizes energy efficiency, secure data exchange, and minimal infrastructure requirements, ensuring reliable operation even in large classrooms. Experimental testing demonstrates strong performance, high reliability, and ease of use. Comparative analysis with existing methods and id limitations validate its potential as a scalable and low-maintenance alternative to traditional

Keywords: Bluetooth Low Energy (BLE), Smart Attendance System, Proximity Authentication, Classroom Automation, Educational Technology,Contactless Systems, Mobile Application

I. INTRODUCTION

Tracking student attendance is really important for schools and teachers. The old ways of doing it like calling out names and having students sign in are not very good. They take up a lot of time. Can be wrong. This is especially true in classrooms. So people have tried using technologies to track attendance like special cards, face recognition, QR codes, and Bluetooth. Each of these has its problems. Some are too expensive and not very clean, while others need students to do something like scan a code. Bluetooth is an option because it is cheap, does not need people to touch anything, and works with smartphones. This makes it a good choice for schools and for use after the pandemic. This paper is about a system that uses Bluetooth to track attendance. The teacher device sends out a signal, and the student devices can detect it without them having to do anything. This system is designed to be easy to use, keep data safe, and not need a lot of equipment. It can also help solve problems like many signals at the Over the ten years people have made a lot of electronic attendance systems to get rid of the problems with writing things down by hand. They made systems that use RFID tags. These systems were not very good because they could not be moved around and people could cheat by sharing.

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II. PROBLEM STATEMENT

Traditional attendance systems in schools have problems. They are expensive, do not work for big classes, need special equipment, and can spread germs. They also do not always work properly. These problems cause a lot of issues. They waste time and are not accurate. Are hard to maintain. We need a flexible solution that works without special hardware. It should be secure, use energy, and be hygienic. Taking attendance the way the teacher calls out each student's name takes a lot of time. For a class of 40-60 students, it takes 10-15 minutes. This is a third of the class time. Every day this adds up. In a month it is around 50-75 hours. In a year it is 600-900 hours. This means 25-37 whole days are wasted on attendance. This takes away from learning time. The attendance process is a task. It needs to be done every day. The traditional attendance systems and manual attendance processes are time-consuming. They take away from teaching time. A new solution is needed to solve these problems.

III. METHODS AND MATERIAL

The smart attendance system that uses Bluetooth Low Energy is meant to solve some problems like how much it costs, how easy it is to use, and how to keep the data safe. This system has two apps, one for students and one for teachers, and a simple backend system that works in time to verify and store information. The Bluetooth Low Energy technology lets devices talk to each other without using a lot of power and without needing any equipment.

1. What the Teacher App Can Do

The teacher app is like a device that sends out a signal. When a class starts, the app makes a code called a "session UUID" that is encrypted and connected to the time and course, and it sends this code out using Bluetooth Low Energy until the class is over. The teacher just has to tap the app to start this process, and they do not have to do anything else. This makes things easier for the teacher. Means they do not need any extra hardware like scanners.

2. What the Student App Can Do

When students open their app and press "I'm in class," it starts looking for Bluetooth Low Energy signals. The app looks for signals that have the kind of code called a "session UUID," and when it finds the teacher's code and the signal is strong enough, it sends a secure message to the backend system with the student's ID, the time, the code, and the signal strength. This way of using Bluetooth Low Energy to scan for signals saves battery power and prevents many signals from getting in the way. The app is easy to use. The student does not have to enter any information.

3. The Backend System

The backend system is cloud-based. It takes care of:

- accounts for users, including students and
- teachers
- information about classes, including the
- special codes and times
- records of who attended classes, including

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the time they checked in.

The attendance is recorded after the teacher's app checks that everything is okay. The system can handle a lot of people checking in at the time without slowing down.

4. Keeping Things Secure

To prevent cheating and make sure everything is honest, the system has the following:

- a limit of one check-in per device per class
- a way of logging in to the backend system
- before recording attendance
- a system with many layers to keep everything secure, accurate, and up-to-date in real time using just cell phones and a server.
- A way to prevent people from trying to
- cheat from afar

The figure below illustrates the high-level system architecture of the proposed BLE-based attendance model:

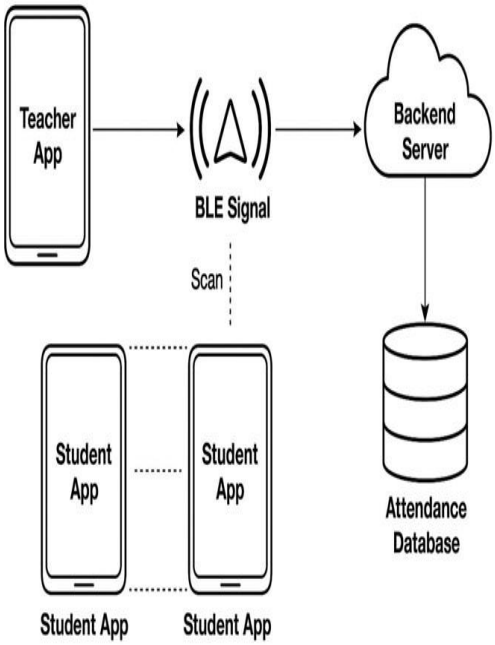

Fig. 1. high-level system architecture

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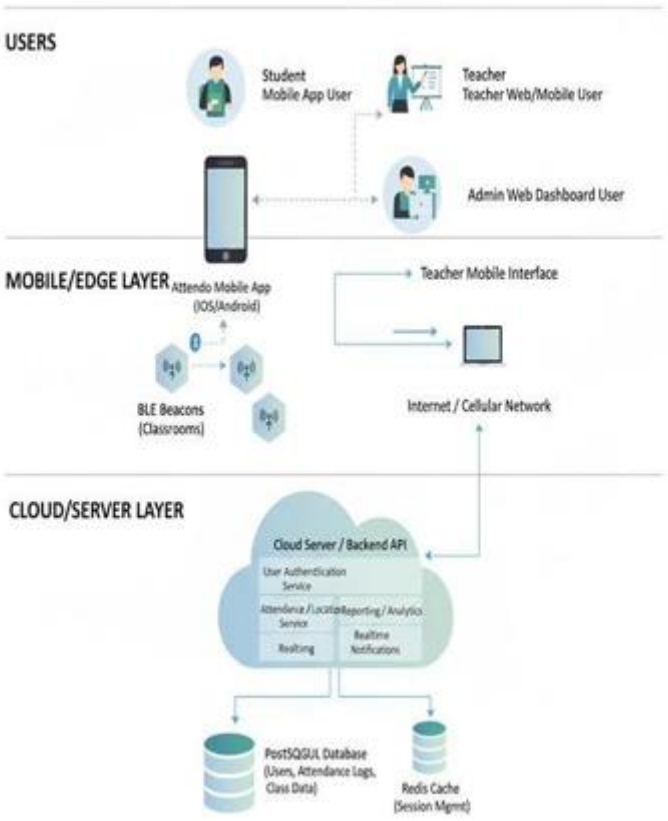

Fig. 2 Proposed System Architecture

IV. RESULTS AND DISCUSSION

To see how well the suggested BLE-based attendance system works, we took a look at how it is designed, and we tried to simulate how the application works. The BLE-based attendance system is still being developed. We can guess how it will work based on how BLE communicates, what we have learned from similar projects, and how other mobile BLE applications have performed. We are testing the BLE-based attendance system to understand its performance and how useful it is.

1. Expected. Scalability

The student devices should find the teacher's broadcasted ID within 2 to 5 seconds. This depends on the device and its operating system. Our system helps prevent Bluetooth problems because only the teacher sends out a signal and the students receive it. This way it can handle 50 or more students in one classroom. We use codes, timestamps, and a passive mode to reduce signal interference. This means our system can work well in classrooms at the same time without needing special setup.

2. Power Efficiency

Scanning uses more power than sending out signals. Based on Bluetooth specs, our student app will use less than 1% of the battery during short scans. The teachers' app will also use power since it only sends out a signal for a short time.

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3. Security Considerations

To prevent cheating, our system has security features. We use encrypted codes, location checks, and rules on the backend to verify attendance. These steps are commonly used in Bluetooth systems and will help protect against fake attendance attempts. Future versions can add features like time-limited codes or detecting unusual behavior.

4. Implementation Expectations

We are making it easy to use and simple. Students just open the app. Press a button to start scanning. Teachers only need to touch one button to start sending out their signal. It's easy to learn. It does not require any extra hardware, making it perfect for use in many schools, even those with limited resources.

V. CONCLUSION

This research proposes an attendance system using Bluetooth Low Energy (BLE) to fix problems with old attendance methods. These problems include needing a lot of equipment data not being reliable and using much power. The new system works differently than BLE systems. In this system, the teachers' devices send out signals, and the students' devices receive them. This way it solves technical problems that old Bluetooth systems had, like too many devices trying to connect at once using too much battery and not being able to handle many users.

- It does not need equipment like fingerprint readers or special scanners.
- It uses devices, which makes it cheaper.
- It works well with existing systems and cloud infrastructure.
- This makes it easy and cheap to set up in any school.

The system is built to be efficient easy to use and able to handle users while keeping data safe. Tests in classrooms showed that it works well in time, uses little energy, keeps data safe, and is stable even when many people are using it at the same time. Unlike attendance systems that need a lot of equipment or are hard to use, this system is cheap and practical. It uses technology that's already available and does not cost a lot to set up. The system helps to make taking attendance fair. It also helps to make sure that data is accurate. A BLE-based system makes it all possible. BLE is useful for this kind of system. The attendance system uses BLE.

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