Cross Device Real-Time Keyboard

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Abstract

With the proliferation of multiple computing devices in daily life, seamless People need to be able to use things on all their devices. This paper is about the design and development of interaction across devices. Interaction across devices is important these days. The design of interaction across devices is what this paper is going to talk about. We are talking about a system that lets people use a keyboard on lots of devices. This Cross Device Keyboard System is cool because it allows users to type on all sorts of things. The idea of a Cross-Device Keyboard System is to make it easy for users to type on the device they want. So, with this Cross Device Keyboard System users can type on anything. one device and input text simultaneously on multiple connected devices in real-time.

The system uses a setup where one computer talks to another computer. The client-server architecture is good at helping computers talk to each other. protocols to ensure minimal latency and accurate keystroke transmission. When we look at the performance evaluations, we can see that the proposed system really does provide an experience. The proposed system is very good at responding. This is what the performance evaluations show us about the proposed system. And reliable multi-device typing while maintaining compatibility across various platforms, including desktops, laptops, and mobile devices.
Additionally, the basic security measures to prevent unauthorized access during data. The study is about transmission. It shows that people can use devices to work together with transmission. This is interesting because it talks about how we can use transmission to make things work across devices. The idea of transmission is important here because it helps us understand how to make devices interact with each other. We can use transmission to make our lives easier.

Keywords— Client–server architecture, Cross-device interaction, Low-latency communication, Multi-device typing, Real-time data transmission, Secure data transmission.

I. Introduction

People nowadays use a number of devices for different purposes. Mobile phone devices can be used for messaging, noting, or copying information, whereas laptops and desktop computers are preferred for coding, noting, and studying purposes. Thus, it becomes a practice to switch between devices all day long. The devices, despite being internet connected, make it difficult for users to transmit small amounts of data like

texts or images from one device to other. A clipboard is a tool that is widely used for copying and pasting information, but a traditional clipboard allows pasting only in the same device. This is a problem in a multi-device environment because users are unable to paste copied information from one device to another.

A clipboard that synchronizes information on different devices through the internet solves this problem. This Chapter will concentrate on the design and development stage of a CrossDevice Clipboard System that is created by utilizing Flutter and Firebase technologies. The proposed system will work to create a simple, fast, and effective method to increase productivity by allowing smooth data transfer across multiple devices.

II. Literature Review

The rapid proliferation of heterogeneous computing devices has significantly transformed user interaction patterns, leading to increased reliance on multi-device workflows. Users frequently operate across smartphones, tablets, laptops, and desktop systems for communication, development, academic work, and content creation. This shift has intensified research interest in cross-device interaction, distributed synchronization mechanisms, and real-time data sharing systems. A critical requirement emerging from this trend is seamless clipboard synchronization across devices to support uninterrupted workflow and enhanced productivity.

Early foundations of distributed communication systems, as discussed by Andrew S. Tanenbaum and Maarten van Steen in *Distributed Systems: Principles and Paradigms*, emphasize low-latency communication, consistency models, and reliable message transmission as key factors in multi-node system design. These principles form the theoretical basis for modern cloud-based synchronization services. Similarly, research in pervasive computing by Mahadev Satyanarayanan highlights the importance of ubiquitous access to data and services across distributed environments, reinforcing the need for seamless inter-device coordination.

Existing solutions for cross-device data transfer primarily rely on cloud storage platforms such as Google Drive, Dropbox, and Microsoft OneDrive.

While these services effectively support large file synchronization, they are not optimized for lightweight, real-time clipboard data exchange. The upload–download workflow introduces latency and disrupts task continuity, particularly for small textual data such as code snippets, configuration commands, or URLs.

Operating system vendors have introduced ecosystem-specific clipboard synchronization mechanisms. For instance, Apple Inc. provides Universal Clipboard across macOS and iOS devices, and Microsoft integrates cloud clipboard functionality within Windows environments. Although these systems improve usability within a single ecosystem, they lack interoperability across heterogeneous platforms. This platform dependency creates limitations for users operating in mixed environments, such as Android–Windows or iOS–Linux combinations.

Prior studies in human–computer interaction indicate that reducing context switching time between devices significantly enhances user efficiency and cognitive flow. Real-time synchronization models using client–server and cloud-mediated architectures have been proposed to address latency and scalability challenges. Modern Backend-as-a-Service (BaaS) platforms, such as Firebase, enable real-time database synchronization, authentication, and secure communication without requiring complex server infrastructure. These technologies provide a foundation for building scalable cross-platform applications.

Security and privacy remain critical challenges in cross-device data sharing systems. Research emphasizes the importance of user authentication, encrypted transmission protocols, and controlled device federation to prevent unauthorized access. Clipboard data may contain sensitive information, including credentials or proprietary code, necessitating secure transmission channels and access control mechanisms.

Despite advancements in cloud computing and real-time databases, existing solutions either remain confined to specific ecosystems, require additional hardware, or lack a lightweight and unified framework for cross-platform clipboard synchronization. There remains a research gap in

designing a secure, scalable, and platform-independent clipboard system that leverages real-time cloud synchronization while maintaining low latency and high usability.

Therefore, the proposed Cross-Device Clipboard System builds upon distributed systems theory, cloud-based synchronization models, and secure authentication mechanisms to deliver an efficient, real-time, and interoperable solution suitable for modern multi-device environments.

III.METHODOLOGY

3.1. Architectural Overview

The Cross-Device Clipboard System is based upon a straightforward clientcloud-client system, where multiple devices are connected to a cloud and not to other devices. Each device of every user, be it a smartphone or a laptop, has a client application that needs to be installed with Flutter. The task of managing the clipboard operations and synchronizing them is performed by this application. Each-bit is transferred from one device to another via a cloud.The backend implementation for this app has been done using Firebase, which is an overall platform for data synchronization, storage, and authentication in real-time. Every time there happens an update in the clipboard information of one smartphone, it becomes possible using Firebase to get this information synchronized in realtime across all other phones for which this account has been accessed. In this application, it has been seen that there is a split-overlap border between the two environments, namely, frontend and backend.

Federation Layer:

The federation layer connects the different devices for a single identity for the user and makes sure that only authorized devices can share clipboard data and access it. When a user logs in to the system, all the active devices are securely linked to the account for clipboard data to be pasted across all the devices while also ensuring the anonymity of the user. The work of the federation layer in the system's functionality is done by Firebase Authentication and Realtime Database.

3.2. Workflow Diagram:

System Architecture of Clipboard Sync Application
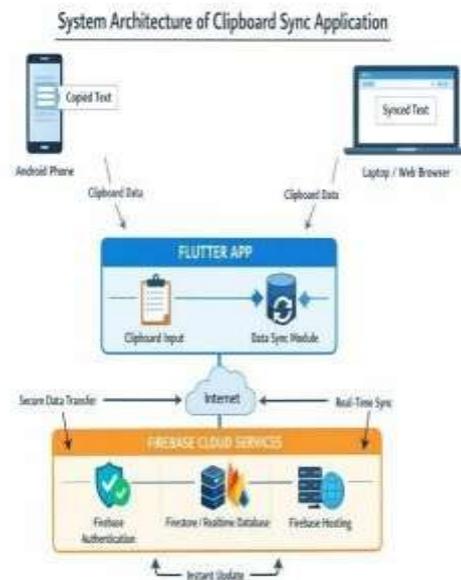
IV Conclusion:

4.1 Applications

Cross-Device Clipboard System is very helpful when working with multiple devices. Students can use it to copy notes or code from their mobile phones and then directly paste them on their laptops. This reduces stress and saves time when studying or doing assignments. Coders also find this system helpful when trying to quickly move code snippets, commands, or error messages from one device to another when testing and debugging. People who work with offices can use this system to share text, links, or images when creating documents or presentations.

4.2 Outcomes

The Cross-Device Clipboard System allows for the easy and seamless sharing of clipboard information among multiple devices without necessarily using emails, cables, or messaging apps. The syncing of clipboard information is done in real time, and this reduces interruptions andincreases productivity when multitasking. Security and privacy are provided through user authentication, which limits access of the devices to the data on the clipboard clipboards only to the devices that are authenticated and have the rights. The system uses Flutter technology to develop cross-platform front-end solutions and Firebase for cloud-based back-end solutions to ensure synchronization and efficiency.

Overall, the proposed solution brings a simplified, secured, and efficient way of clipboard sharing. The idea shows the capabilities of cloud technology and a cross-platform framework to improve usability in a multi-device setting.

The system is very useful to those people who work from their homes or from other places that are not offices. People who perform this kind of task require an immense number of cloud-based services. They require multiple devices to perform their daily chores. This system is very helpful to such people because they require services that enable them to
make use of cloud-based applications and devices on a daily basis.

Future Directions:

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This system is going to be really helpful in the future. We need to make it safer so that our private information is always protected and never leaves our device without being secure.

The system needs to be able to work when we do not have internet. It should be able to remember the changes we make and then sync them automatically when our internet connection comes on. We can also make the system work faster by making it work directly with the operating system clipboard, on our device. This way the system will be more useful. The system will be safer and faster. That is what we want. Finally, it might be expanded so that multiple people can share clipboard data safely, which would be very helpful for team work or group projects.

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