In the last week, I interacted with my friends on a laptop through an application called Discord whilst playing a video game together. By using the Discord application's voice call function, I was able to communicate with my friends during the video game without any delays. This interaction required the use of digital audio data as well as the peripherals to collect the data, the hardware such as the Central Processing Unit within the laptop and the software such as Discord installed on the laptops. Alongside the Internet, these computing technologies were needed to allow for this interaction to be possible.

COMPUTER ARCHITECTURE

The laptop we used to play video games and interact with each other had a Central Processing Units(CPUs), Random-Access Memory(RAM) sticks and a Graphics Processing Units(GPUs) built into them. With peripherals such as a microphone and a mouse, these hardware allowed for a seamless experience for me and my friends to play a video game together whilst communicating with each other on a Discord voice call. The CPU which functions as the brain of the computer handled the processing of the digital audio data that was being taken in using the microphone as the input device. The CPU handled the encoding and decoding of the digital audio files being transferred and received to allow for seamless communication between me and my friends. The RAM provided quick access to the digital audio data and temporary storage of essential information, aiding in establishing a smooth and uninterrupted exchange of audio data between me and my friends. The GPU allowed for smooth rendering of the graphics on the laptop screen, allowing for a smooth gaming experience, in turn improving the user experience by allowing for a smoother overall visual experience such as seeing graphics in higher definition or the smoother visuals when using the laptop. The peripherals such as microphone and mouse helps in improving the user experience with the microphone helping to capture the audio data clearer while the mouse helps in the user experience by allowing an easier movement of the pointer on the laptop monitor. The speakers built into the laptop allowed for the audio from the game to be able to be heard as well as to hear what my friends were saying.

DATA REPRESENTATION

Data such as digital audio files are used to allow for real-time conversations between my friends on Discord. Discord uses the microphone to collect audio data of our voices. This audio data that was collected by the microphone is then converted into the Opus audio format via the built-in Opus codec within Discord. The codec can convert the analogue audio signals into digital forms as well as optimizing the digital audio files for the bandwidth of the network connection through constant or variable bitrate encoding. The converted audio files are then sent to the Discord server and members within the voice call can have the files decoded by the Opus codec to be played through their headphones or speakers for them to hear in real-time. The Opus audio format codes speech and general audio into a single format that is low-latency, enabling real-time communication and being low-complexity enough for low-end processors.

AUDIO COMPRESSION

The Opus audio format is a lossy audio coding format, which means that while the audio will be degraded as information is lost during the compression, it results in a smaller file size. This is important for Discord voice calls as by using a lossy audio coding format, the file size being sent to Discord servers is much smaller as compared to using a lossless audio coding format and the data being lost is not substantial enough to affect the voice call. Coupling with

the fact that everyone's bandwidth is different means that by making use of a lossy audio coding format, everyone is able to receive the audio data without any problems, allowing for seamless real-time conversation on the Discord voice call. If Discord was using a lossless audio coding format, Discord will not be able to handle the Discord voice calls at the scale that it does as with such an audio coding format, as the amount of data storage required by Discord would be so high that it would not be financially viable. With the fact that some devices might have poor bandwidth which results in slower transmissions of the audio data means that the real-time conversations that Discord currently has would not be possible.

OPERATING SYSTEMS

The main functions of an operating system is to manage the computer's resources such as the CPU, to establish a Graphical User Interface(GUI) and execute and provide services for application software. Without the operating system, applications like Discord would not have access to the network framework that operating systems have to function as intended or be able to display the application as intended on the display. The Windows Operating System installed on our laptops as such provided a GUI for us to select applications like Discord easily and display them whilst it handles the resources required to launch the applications. The operating system handles the requests given and sends the appropriate requests and/or information to the different parts of the laptop such as the CPU, GPU or RAM. The Windows Operating System also provided Application Programming Interfaces(APIs) for Discord to be able to communicate with the hardware on the laptops to be given the resources the application needs to run efficiently. These APIs provided by the operating systems allows Discord to be able to maintain compatibility across different devices whilst optimizing performance. The operating system provided the necessary framework for Discord to manage the data inputs from peripherals such as our voices and to send it to the relevant servers on the Internet by connecting the laptop to the Internet.

CONCLUSION

Thus, this interaction required a multitude of computational technologies such as the Opus codec within the Discord application to be able to convert the analogue signals collected by the microphone into a digital file format that can be sent to a Discord server via the Internet such that it can be shared across a multitude of devices that can then decode the audio file and play it through a speaker or a headphone such that the user can hear it in real-time without any delay. The Windows Operating System made it easy for me and my friends to select the applications that we wanted to open as well as provide the necessary frameworks and APIs for the applications that we use to function. The hardware within our laptops allowed the operating system and the application to be able to run as the CPU handled the tasks it was given and allocated them effectively, providing us with a pleasant user experience during the interaction.

REFERENCES:

Ars Staff - Sep 12, 2012 6:59 pm UTC. "Newly Standardized Opus Audio Codec Fills Every Role from Online Chat to Music." *Ars Technica*, 12 Sept. 2012, arstechnica.com/gadgets/2012/09/newly-standardized-opus-audio-codec-fills-every-role-from-online-chat-to-music/.

Meilinaeka. “The Definition of Windows Operating System: History, Functions, and Features.” *Direktorat Pusat Teknologi Informasi*, 28 Apr. 2023, it.telkomuniversity.ac.id/en/windows-operating-system/#:~:text=Managing%20Computer%20Resources%3A%20The%20primary,printing%20documents%20using%20these%20resources.

“Opus (Audio Format).” *Wikipedia*, Wikimedia Foundation, 5 Jan. 2024, en.wikipedia.org/wiki/Opus_(audio_format).

“Opus Codec.” *Opus Interactive Audio Codec*, opus-codec.org/. Accessed 5 Jan. 2024.