

9-01 **Lynx**

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Introduction

Lynx is a purpose-built solution for integration between Android phones and Windows PCs.

The Problem

Android and PC devices are not tightly integrated with each other out-of-the-box. In addition, current Android-PC integration solutions are slow, have poor feature-sets, and threaten user privacy.

Our Solution

Lynx comprises an Android app and Windows app. Together, these provide several features to deepen Android-PC integration, including:

- Bidirectional file transfer between PC and phone
- Ability to view phone screen & remotely control phone from PC
- Access to all files & media on phone through drive mapping

We respect user privacy by doing almost all data transfer over the user's local area network. User data never enters the public internet without their explicit consent.

Target Audience + Project Scope

Our project is targeted at Android and Windows users, along with anyone who wants to integrate their phone and PC experience. Our project focuses mainly on allowing users to access their Android phone's functionality through the Lynx PC client and letting users access files on the phone from the PC and vice versa.

Literature Review

There are several existing solutions for Android-PC integration, but each has its own issues.

Solution 1 – Sending files to oneself via email / WhatsApp

WhatsApp and email can be accessed from both phones and PCs, leading to some using them to transfer files between devices.

Issues:

- Internet connection required
- Lack of privacy – data resides on 3rd party servers
- WhatsApp compresses media drastically
- Email is slow
- Both impose file size limits

Solution 2 – Microsoft Your Phone

Microsoft has recently created a solution known as “Your Phone”, which comes pre-installed with Windows, but offers a limited feature-set.

Issues:

- Internet connection required
- Slow transfer speed
- Full feature-set only on Samsung phones
- No direct access to files on user’s phone

Solution 3 – Zapya

Zapya is a file transfer app developed by Dewmobile, Inc.

Issues:

- Unreliable
- Allegedly used to spy on users

Solution 4 – USB file transfer

Users can physically connect their phone to their PC using a USB cable, and transfer files via the Media Transfer Protocol (MTP).

Issues:

- Physical wired connection – inconvenient
- Slow – MTP fails to saturate USB connection speed even on slower USB 2.0 connections; unusably slow when transferring multiple small files

Methodology

Research was done to determine if there is indeed demand for a better Windows-Android integration solution.

Needs Analysis

We did research on user reception to existing solutions we identified, to determine if demand for better solutions existed. Below are examples of existing solutions which users feel can be improved.

Microsoft's "Your Phone" app has ~250,000 downloads and largely positive reviews. However, users have complained that it:

- requires an Internet connection
- is unreliable
- has a complicated setup process, at times requiring troubleshooting steps
- has subpar transfer speeds and responsiveness

Zapya by Dewmobile, Inc. is rather popular, with ~600,000 downloads on Google Play. However, users have complained that it:

- is extremely slow
- contains several advertisements
- has unreliable connectivity
- requests for unreasonable permissions (e.g. access to location data and contacts)

As such, there is indeed demand for better Windows-Android integration solutions. Lynx has almost no dependency on an Internet connection, just requiring a local network, and also has a simpler setup process than its competitors, requiring the user to simply scan a QR code and nothing else. Lynx also requires no permissions except for storage (for file transfer functionality) and camera (to scan QR code), hence respecting user privacy.

Protocols

- **Application level: WebSocket**
 - o Low-latency, persistent connection
 - o Faster than standard HTTP request-response model
 - o Saves bandwidth by eliminating the need to poll application state
- **Lynx internal protocol**
 - o Messages exchanged to perform actions (e.g. request approval to send files)
 - o Binary data transferred for large data transfers (e.g. file transfers)
 - o Initial authentication protects users from unauthorised connections

App Platforms

- **Windows**
 - o Acts as a server
 - o Integrates with File Explorer and network drive capabilities of Windows
- **Android**
 - o Acts as a client
 - o Connects to Windows app over local network (able to connect over Internet with user's consent)
 - o Integrates with Android's "Share" menu

Languages & Frameworks

- **Node.js** for Windows app internals
- **Electron (HTML, CSS, JavaScript)** for Windows app UI
- **Java** for Android app

Member Roles

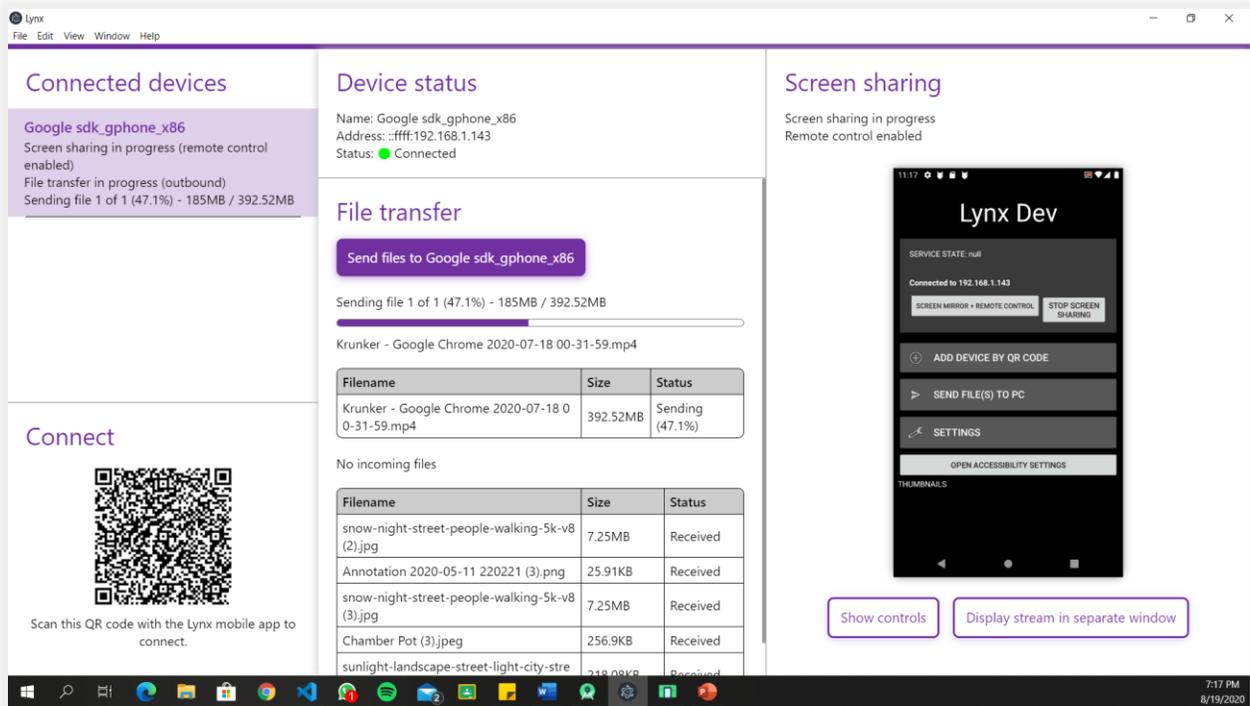
- Ho Wing Yip: **Windows app programmer, UI designer**
- Theodore Lee: **Android and Windows apps programmer**
- Tan Yu Bin: **Windows app programmer**
- Wong Zenwei: **Logo**

Timeline

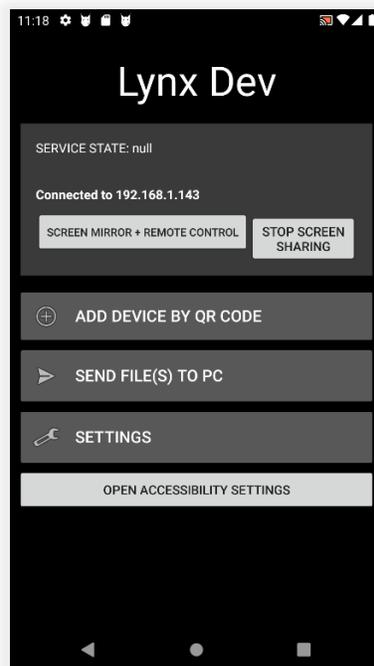
Dec 2019	Android app development started Screen sharing implemented on Android
Jan 2020	Desktop app development started Screen sharing implemented on desktop
Feb 2020	Remote control implementation started
May 2020	Support for multiple connected devices added
Jun 2020	Remote control completed File transfer implementation started
August 2020	File transfer, drive mapping, desktop app UI completed

Outcomes, Analysis & Discussion

Finished Products

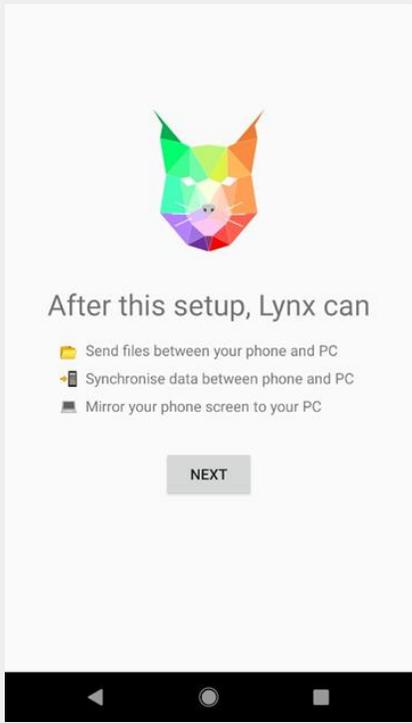
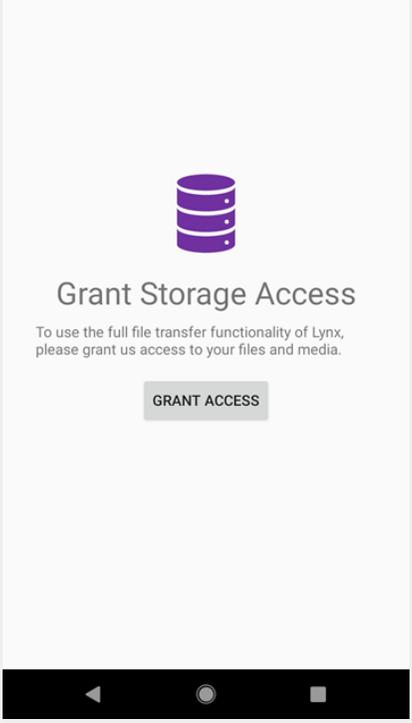
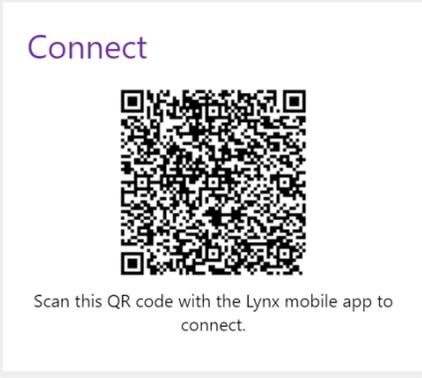
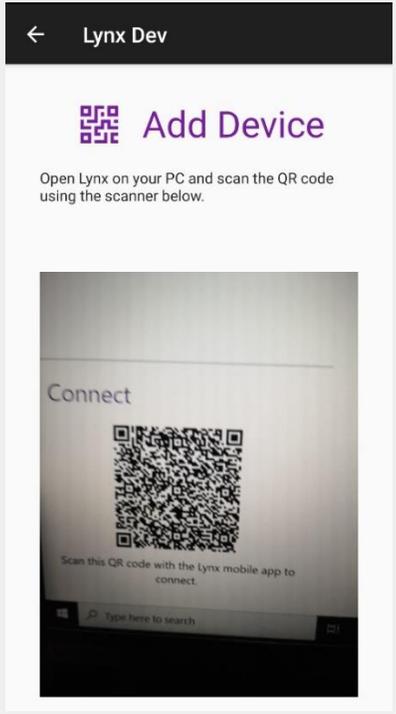
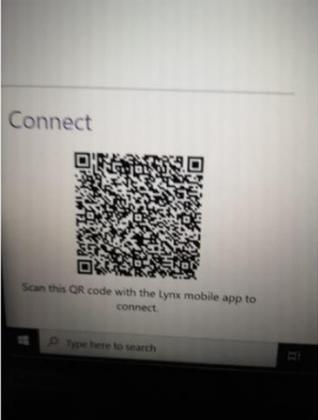


Desktop app



Mobile app

Features

<p style="text-align: center;">Mobile</p>  <p>After this setup, Lynx can</p> <ul style="list-style-type: none">Send files between your phone and PCSynchronise data between phone and PCMirror your phone screen to your PC <p style="text-align: center;">NEXT</p>	 <p style="text-align: center;">Grant Storage Access</p> <p>To use the full file transfer functionality of Lynx, please grant us access to your files and media.</p> <p style="text-align: center;">GRANT ACCESS</p>	<p>Users setup the Lynx Android app to choose a save location and grant permissions</p>
<p style="text-align: center;">Desktop</p>  <p>Connect</p>  <p>Scan this QR code with the Lynx mobile app to connect.</p>	<p style="text-align: center;">Mobile</p>  <p>Lynx Dev</p> <p>Add Device</p> <p>Open Lynx on your PC and scan the QR code using the scanner below.</p> 	<p>Users connect by using Lynx Android app to scan QR code displayed in Lynx desktop app</p>

<p style="text-align: center;">Desktop</p> <div style="border: 1px solid #ccc; padding: 10px; margin: 10px auto; width: 80%;"> <h3 style="color: #6a3d9a;">Connected devices</h3> <div style="background-color: #e6e6fa; padding: 5px; margin-bottom: 5px;"> <p>Google sdk_gphone_x86 File transfer in progress (outbound) Sending file 0 of 1 (0.0%) - 0B / 1.35MB</p> </div> <hr/> <p>HUAWEI EML-L29 Screen sharing in progress (remote control enabled)</p> <hr/> </div>	<p>User can view currently connected devices using desktop app's connected devices pane</p>
<p style="text-align: center;">Desktop</p> <div style="border: 1px solid #ccc; padding: 10px; margin: 10px auto; width: 80%;"> <h3 style="color: #6a3d9a;">Device status</h3> <p>Name: Google sdk_gphone_x86 Address: ::ffff:192.168.189.71 Status: ● Connected</p> </div>	<p>Desktop app's device status pane shows basic device information</p>

Desktop

File transfer

[Send files to Google sdk_gphone_x86](#)

Sending file 1 of 1 (7.6%) - 30MB / 392.52MB

Krunker - Google Chrome 2020-07-18 00-31-59.mp4

Filename	Size	Status
Krunker - Google Chrome 2020-07-18 00-31-59.mp4	392.52MB	Sending (7.6%)
Lock Screen 3.jpg	1.35MB	Sent

No incoming files

Filename	Size	Status
No incoming or received files		

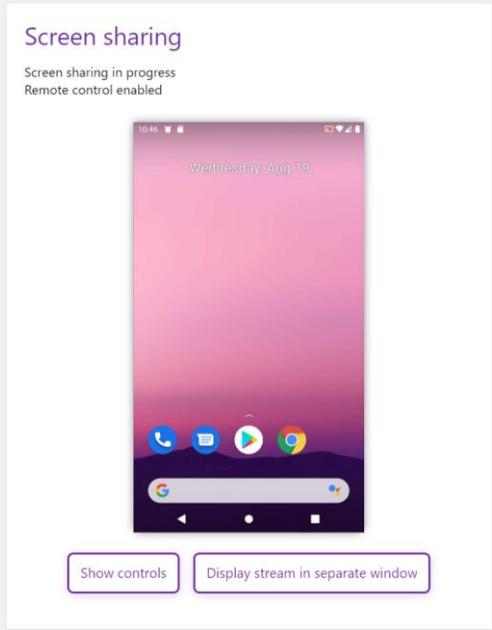
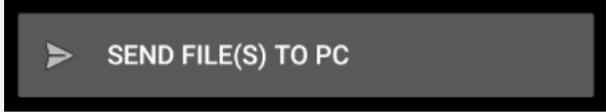
Desktop app's file transfer pane lets user **send files to phone** and **monitor file transfer**

Desktop (Windows File Explorer) – phone has an assigned drive letter

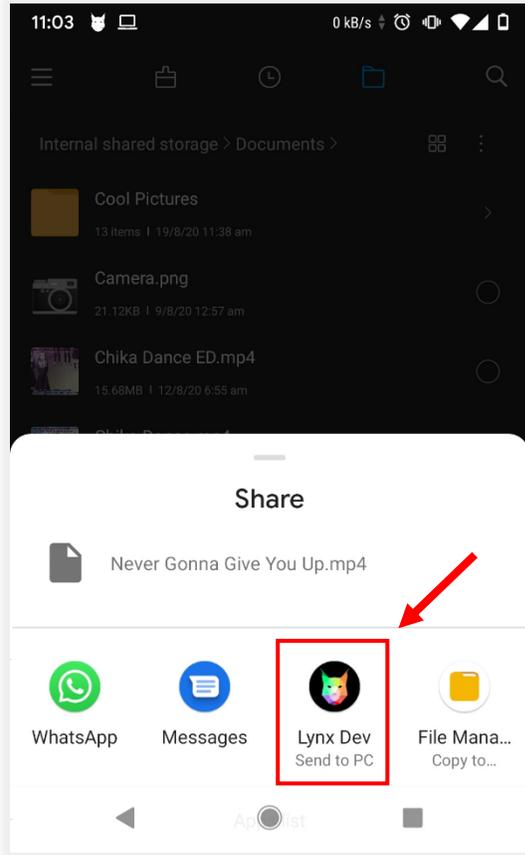
This PC > Google sdk_gphone_x86 - Lynx (Y:)

Name	Date modified	Type
Alarms	8/19/2020 6:40 PM	File folder
Android	8/19/2020 6:40 PM	File folder
Audiobooks	8/19/2020 6:40 PM	File folder
DCIM	8/19/2020 6:40 PM	File folder
Documents	8/19/2020 6:40 PM	File folder
Download	8/19/2020 6:40 PM	File folder
Movies	8/19/2020 6:40 PM	File folder
Music	8/19/2020 6:40 PM	File folder
Notifications	8/19/2020 6:40 PM	File folder
Pictures	8/19/2020 6:40 PM	File folder
Podcasts	8/19/2020 6:40 PM	File folder
Ringtones	8/19/2020 6:40 PM	File folder

Users can **access files on their phone** through File Explorer

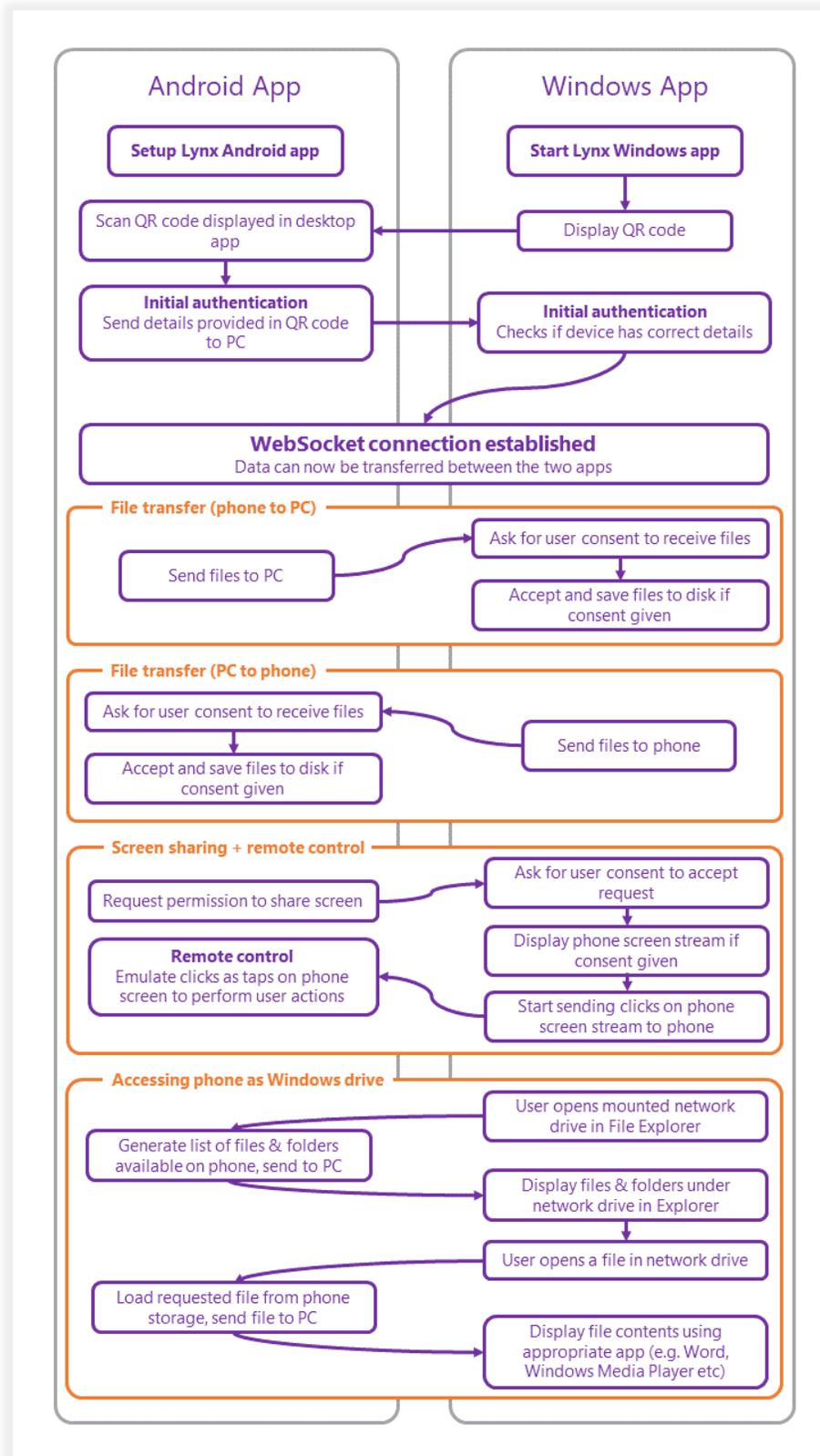
<p style="text-align: center;">Desktop</p> 	<p style="text-align: center;">Mobile</p> 	<p>Desktop app's screen-sharing pane lets users view their phone screen and remotely control their phone if accessibility features enabled</p> <p>"Screen mirroring + remote control" button in mobile app starts screen-sharing</p>
<p style="text-align: center;">Mobile</p> 		<p>"Send files" button in mobile app opens file-picker for user to transfer files to PC</p>

Mobile



Users can **send files** from phone to PC **outside mobile app** by using "Share" menu

Feature Flowchart



Implications & Recommendations

Limitations

- Devices must be connected to a local network
- Mobile app is Android-only
- Desktop app is Windows-only

Areas for Improvement

- Android app UI could use improvement
- Windows drive integration could use faster protocol (e.g. USB emulation)

Possible Extensions

- Backup feature to backup files on phone to PC – build on existing file transfer functionality
- Previously connected devices could automatically connect when in range – no need to reconnect multiple times
- Enable users to launch Android apps on phone as Windows apps on PC without launching Lynx

Conclusion

Learning Points

- **Key design decisions** made early in the project are important (e.g. decision to use WebSocket protocol)
- **No obstacle is impassable** – despite many issues with Android OS itself, development of the Lynx Android app could proceed, after careful discussion and planning

Reflections

Theodore

Lynx stemmed partially from my desire for a better Windows-Android integration solution, motivating me to help produce a stellar product, which we certainly delivered. This is my first time developing an Android app of such great complexity; Android's many idiosyncrasies (storage-access framework, screen-casting, undocumented APIs, etc) challenged me to think of workarounds and research ways to still deliver a great user-experience. I am grateful to Wing Yip for showing me, through our work on the Electron app, the benefits of higher-quality code – better extensibility and collaboration. Going forward, I plan to develop Lynx further and possibly release it.

Wing Yip

Building Lynx was, for the most part, enjoyable. This was my first time developing a desktop application (outside of incomplete pet projects), and it was a refreshing experience. Building Lynx on the Electron platform allowed me to utilise my previous knowledge in web development and Node.js, while also introducing new Electron APIs to learn. I also had to learn the fundamentals of WebSocket, the underlying realtime message-exchange protocol that Lynx is built on. I was also able to pull weight on the frontend side of things – to this day, I am still proud that I managed to prototype and implement Lynx's desktop app UI in two days. This valuable learning experience, coupled with the fact that we were able to fulfil the need for Android-PC integration, makes Lynx one of my software projects that I am the most proud of, and indeed, one that I will not forget anytime soon.

Yu Bin

Through this year's project work, I have certainly learned a lot not just from developing the application itself, but also from my fellow group members. This was my first time working on a project that involved an Android phone. It was difficult to test the application as I did not have one and had to rely on an emulator that at times, was quite honestly unusable. Nonetheless being involved in this project was very interesting as it is something entirely different from what I used to do.

Zenwei

Having joined the group later into development of Lynx, I found it difficult to understand and help with development. Though I managed to create the Lynx logo, I wish I had contributed more than that, perhaps in terms of front-end which I am more familiar with. Despite this, it is still heartening to witness the development of Lynx, even from though I was less involved in its development.

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(1500 words, excluding references, charts and labels)