

Background Research

I will be focusing on 2 topics, Academic Network and Public Wifi for the History of Internet in Singapore from 2005-2025.

Academic Network

2005 – Establishment of SingAREN Gigabit Internet Exchange (GIX)

SingAREN set up the GIX at Global Switch, enabling Singapore's Research & Education (R&E) community to connect internationally at gigabit speeds.

2005 – Joining the TEIN2 Network

Singapore became part of the high-capacity TEIN2 network linking Asia-Pacific and Europe, with Singapore as a Point of Presence (PoP).

2012 – Launch of eduroam

SingAREN introduced eduroam, providing global seamless and secure wireless connectivity for researchers and students across participating institutions.

2013 – Campus-wide WiFi at NUS

In collaboration with Cisco and NCS, NUS deployed over 3,200 access points across campuses and shuttle buses. This flexible high-speed network supported eduroam and became Southeast Asia's largest wireless education environment.



Pic 1: Launch of SLIX (Our Journey-SingAren)

2014 – Launch of SingAREN Lightwave Internet Exchange (SLIX)

Southeast Asia's first 100Gbps R&E network gave researchers 100× more bandwidth, enabling seamless access to high-speed research data globally.

2016 – Multiple Service Launches

1. Database Mirroring Service (with A*STAR): Hosted replicas of major overseas scientific databases in Singapore for faster research access.
 2. Singapore Access Federation (SGAF): Federated Identity Management System enabling trusted collaborations.
 3. SingAREN Open Exchange (SOE): A resilient, open exchange co-funded by the National Supercomputing Centre.
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2019 – SLIX 2.0 Upgrade

Enhanced to meet higher demands for secure, advanced, and reliable connectivity for the research and education community.



Pic 2: High-Capacity International Links (Our Journey-SingAren)

2021 – High-Capacity International Links via KAUST

Launched $2 \times 100\text{Gbps}$ links from KAUST to SingAREN and to Amsterdam, boosting global research data transfer capability.



Pic 3 (TECHGOONDU, 2022)

2022 – 5G-Powered Outdoor WiFi Trial at NUS

Solar-powered outdoor WiFi integrated with StarHub's 5G extended seamless indoor-outdoor campus coverage, enhancing digital campus experiences.



Pic 4 (Our Journey-SingAren)

2023 – First Remote Robot Telesurgery

NUS Medicine and NUH remotely performed robotic surgery on a simulated organ in Japan, demonstrating ultra-low latency networking via SingAREN.

2024 – Expansion of SingAREN’s Membership

Nanyang Polytechnic (NYP), Singapore Institute of Technology (SIT), and Singapore University of Technology and Design (SUTD) joined SingAREN, extending the SLIX fiber footprint beyond NUS, NTU, and SMU.



Pic 5: NUS Integrated Operations Centre (NUS news, 2025)

2025 – Launch of NUS Integrated Operations Centre

Singapore’s first university-based IOC consolidates real-time campus data on security, emergency services, and building management, reflecting advanced smart campus capabilities.

2016–2023: NIE’s Transformation into a Digitally Connected Education Hub



Pic 6: Students participating in a digital learning session (Straits Times, 2020)
2020–2025: MOE's Push for Digital Classrooms and Cloud-Based Learning Tools

Public WiFi



Pic 7: Wireless@SG in MRT Stations (Straits Times, 2018)

2006 – Launch of Wireless@SG

To provide free, high-speed wireless broadband access in public spaces. It is aimed to promote internet access "on the go" and bridge the digital divide.

2013 – Expansion and Improvement of Wireless@SG

Evolved with faster internet speeds and more seamless user experience, including easier login via SIM card credentials or the newly launched Wireless@SGx app. By this time, the program had been enhanced to cover a wider range of locations and provide improved reliability.



Pic 8: Outdoor WiFi at NUS (TECHGOONDU, 2022)

2013 – Campus-wide WiFi integration

Public WiFi developments aligned with university campus wireless rollouts, such as NUS deploying extensive campus-wide WiFi, supporting both students and public visitors.

2013 – Nationwide Fibre Broadband Enables Better Public WiFi

The completion of fibre broadband deployment across Singapore in 2013 set the foundation for more reliable and higher-capacity public WiFi services.

2017-2020: Wireless@SG Hotspot Growth to 6,500+ Locations

Wireless@SG hotspots increased to over 6,500 across Singapore, embedding public WiFi coverage deeply into daily urban life including popular commercial and community spaces.

2022 – 5G-Powered Outdoor WiFi Trials

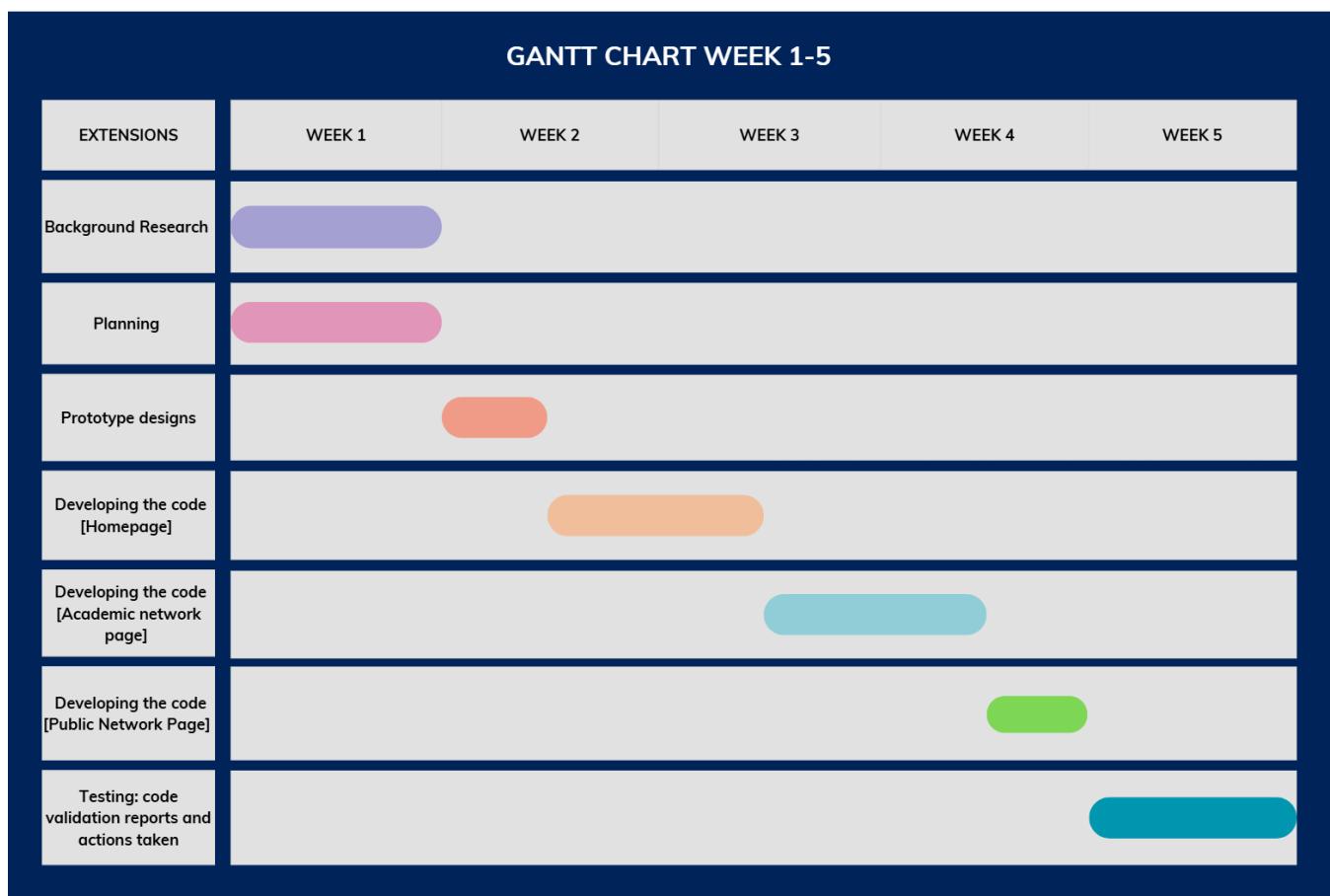
A solar-powered outdoor WiFi network trial, leveraging StarHub's 5G infrastructure, was launched at NUS campuses, enhancing seamless indoor and outdoor coverage. This initiative demonstrated emerging technologies for resource-efficient, extensive public WiFi.

2025 - Present: Integration with Smart Nation Initiatives

Public WiFi is increasingly integrated with Singapore's Smart Nation projects, providing connectivity that supports IoT applications and environmental monitoring.

Planning

I chose the Waterfall project management strategy, thus I used a Gantt Chart to plan for my project.



Wireframes:

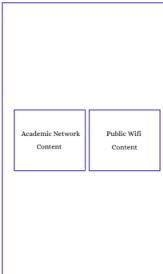
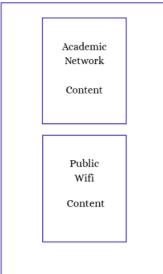
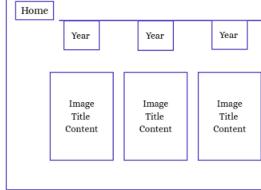
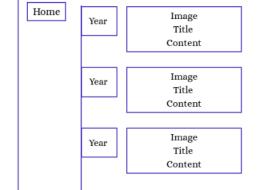
- 1) Desktop design layouts for each page
- 2) Responsive layout of interface

Developing the code:

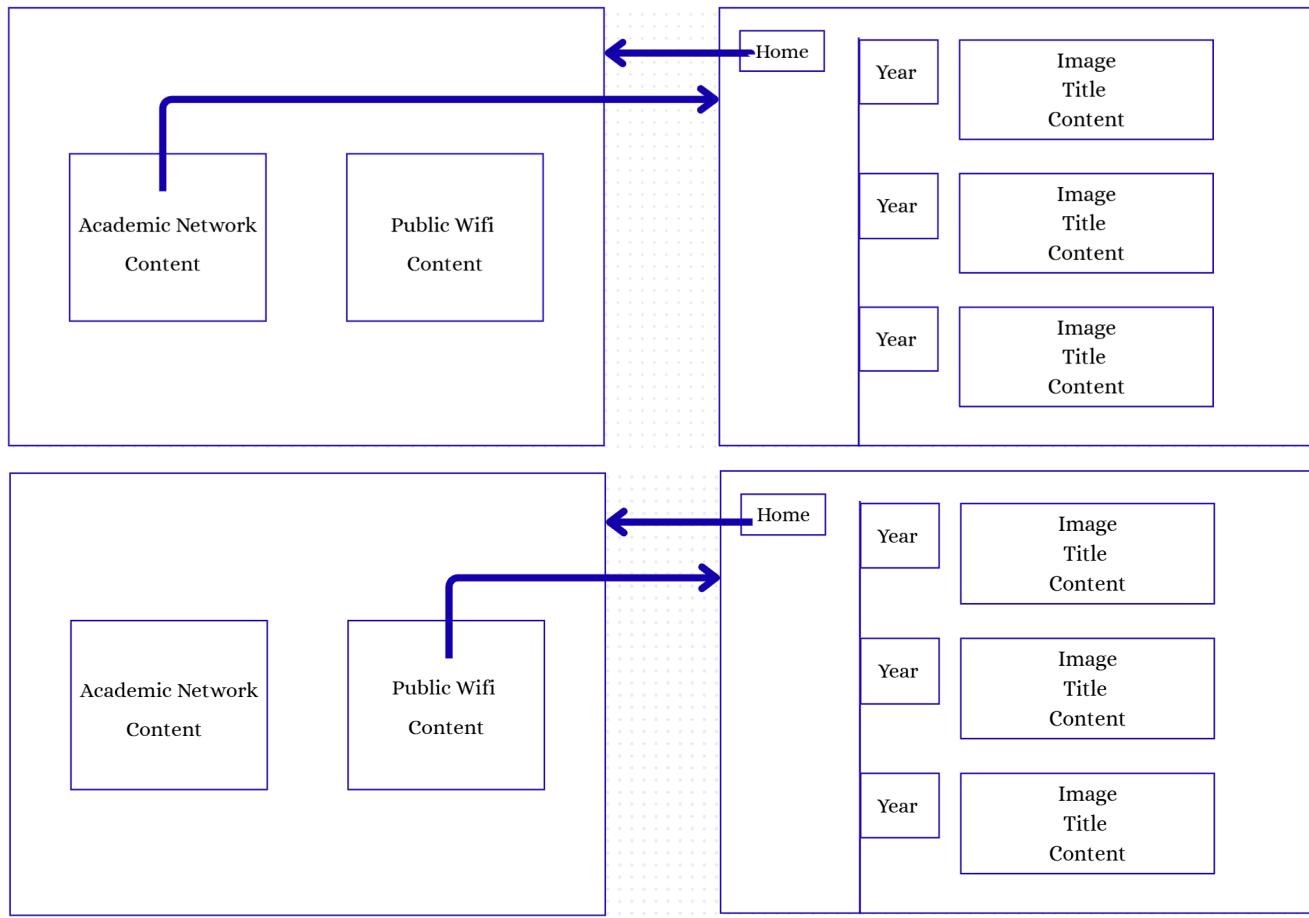
- 1) Create JSON data files
- 2) Create a REST API server and access JSON data via it.
- 3) Create html home page, academic network page, public wifi page.
- 4) Work on user interface with CSS.

Development process: Prototype designs

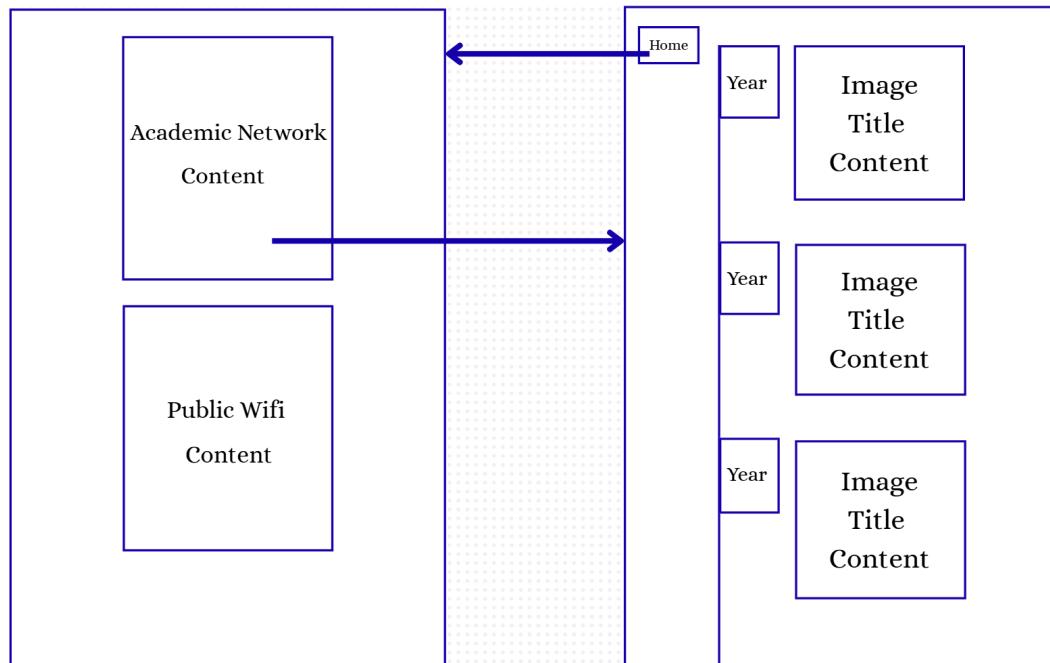
Feedbacks

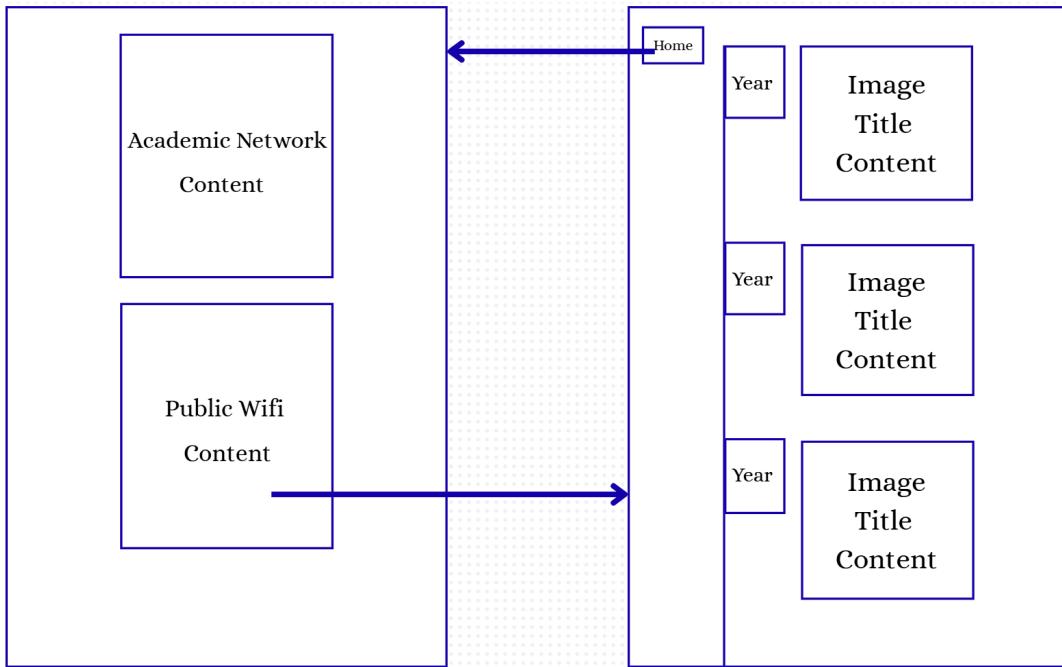
Before Feedback	Feedbacks	After Feedback	Improved effect
*Mobile device size 	When the page is in mobile device size, the interface is too small, making it difficult to see.	*Mobile device size 	Content becomes more visible
*Desktop size 	*Desktop size Scrolling horizontally to view the timeline content is not comfortable/convenient.		Vertical scrolling offers a more comfortable experience on both mouse and touchpad .

Final Desktop layout



Final Mobile Device layout

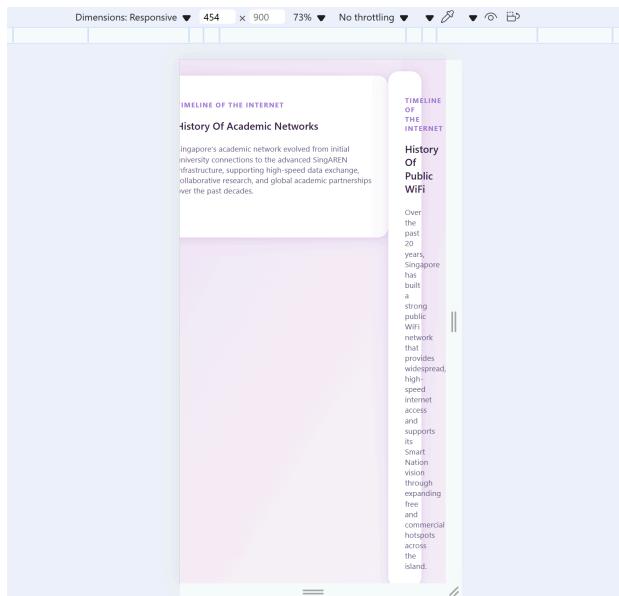




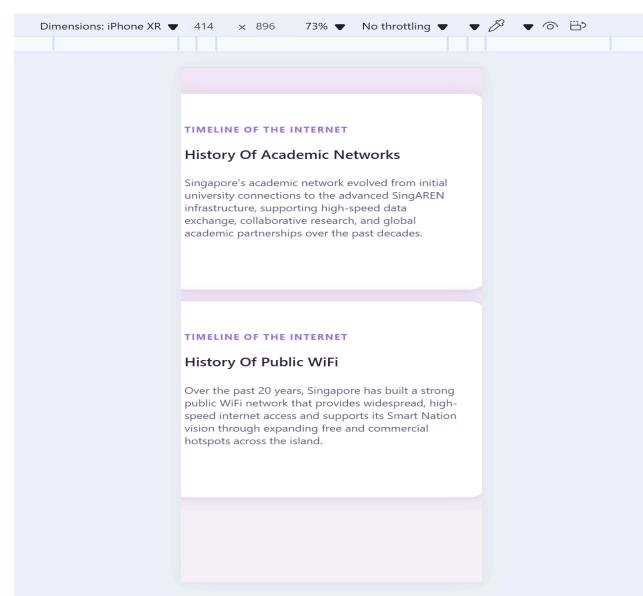
Development process: Developing the code

Problems and Solution

1. Responsive layout of the interface is not implemented well.



Pic 9: Cards not stacking vertically



Pic 10: Cards are being cut off

```

/*Responsive css */
@media (max-width: 600px) {
    .page-wrapper {
        height: auto;
        flex-direction: column;
        align-items: center;
        padding: 24px 2vw;
        justify-content: flex-start;
    }

    .card-container {
        flex-direction: column;
        align-items: center;
        overflow-x: visible;
        height: auto;
        gap: 2rem;
        /*gap between cards*/
        padding: 0;
        width: 100%;
        max-width: 400px;
        box-sizing: border-box;
    }

    .card {
        width: 70vw;
        max-width: 400px;
        min-width: 0;
        transform: none;
        margin-top: 25px;
        height: auto;
    }
}

```

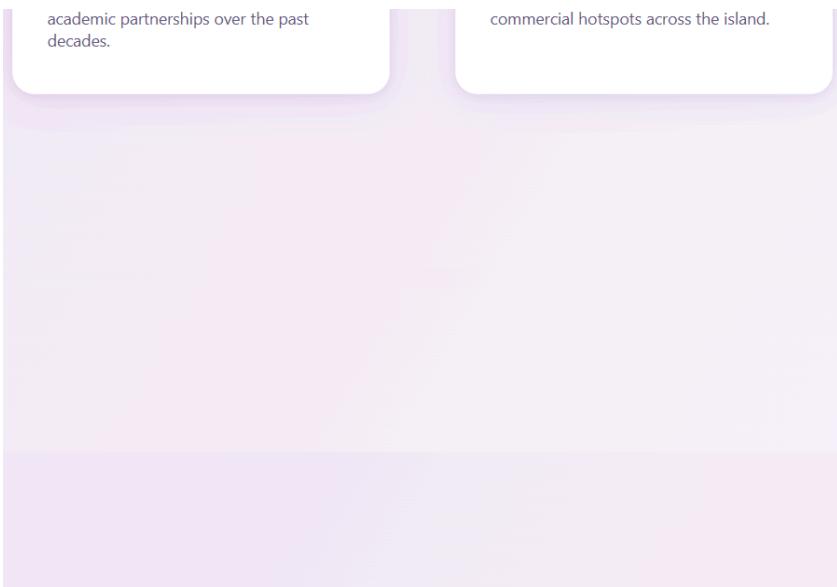
Pic 11: Updated Code



Pic 12: Fixed interface

Solution: I used `flex-direction: column;` to make the cards stack vertically, and `width: 70vw;` to specify the width such that it will not be cut off, when in mobile device size.

2. The background gradient does not cover the full screen.



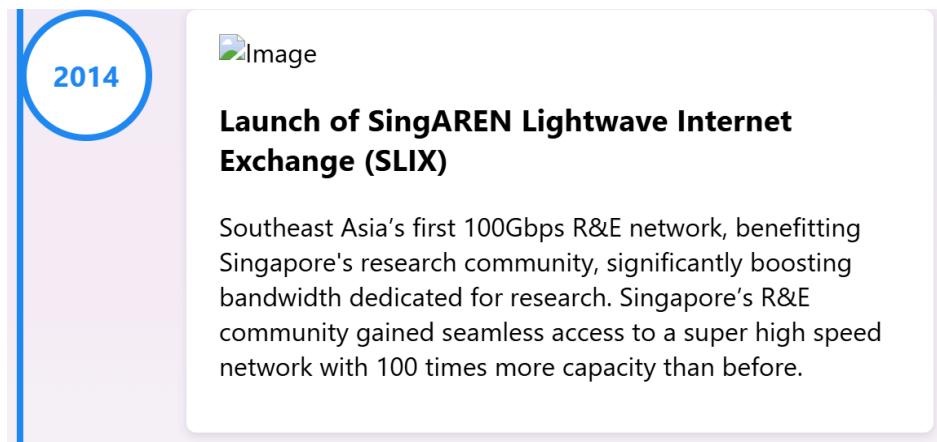
Pic 13: Background gradient not covering the full screen



Pic 14: Background gradient covers the full screen

Solution: I added a .page-wrapper container to ensure that the background gradient covers the full viewport height independently of the cards' height. This prevents the background color from being constrained/affected by the varying height of the cards, maintaining a consistent full-screen background effect

3. Images not displayed



Pic 15: Image not displayed

2014



Launch of SingAREN Lightwave Internet Exchange (SLIX)

Southeast Asia's first 100Gbps R&E network, benefitting Singapore's research community, significantly boosting bandwidth dedicated for research. Singapore's R&E community gained seamless access to a super high speed network with 100 times more capacity than before.

Pic 16: Image displayed successfully

Solution: I realized the issue was with the image path. Initially, it was just "... .jpg," but it should have been "data/... .jpg" since the images are located in a folder named "data."

Testing: Code validation reports

I performed automated accessibility and HTML validation tests using ACheker, Validator.W3 and WAVE, following WCAG 2.0 Level AA standards.

Homepage

The screenshot shows the ACheker homepage. At the top, there are 'Login' and 'Register' links, and the ACHECKER® logo. Below the logo is a banner for 'Subscribe for automatic accessibility monitoring with ACHECKS!'. The main area has a heading 'Check Accessibility By:' with three tabs: 'URL' (selected), 'Upload', and 'Markup'. Under 'URL', there is a file input field with 'Choose File' and 'No file chosen' placeholder text, and a 'Check It' button. A link to 'Options' is also present. Below this is a section titled 'Accessibility Review' with the sub-section 'Accessibility Review (Guidelines: WCAG 2.0 (Level AA))'. It displays statistics: 'Known Problems(0)', 'Likely Problems (0)', 'Potential Problems (10)', 'HTML Validation (0)', and 'CSS Validation (0)'. A green message at the bottom of this section says 'Congratulations! No known problems.'

Nu Html Checker

This tool is an ongoing experiment in better HTML checking, and its behavior remains subject to change

Showing results for uploaded file homepage.html

The screenshot shows the Nu Html Checker interface. It has a 'Checker Input' section with a 'Show' dropdown menu ('source', 'outline', 'image report') and an 'Options...' button. Below it is a 'Check by' section with a 'file upload' dropdown ('Choose File') and a 'No file chosen' message. A note states 'Uploaded files with .xhtml or .xht extensions are parsed using the XML parser.' There is a 'Check' button. At the bottom, a green bar indicates 'Document checking completed. No errors or warnings to show.'

Used the HTML parser.

Total execution time 2 milliseconds.

The following apply to the entire page:

Contrast

Styles: OFF ON

Summary Details Reference Order Structure Contrast

Click a Contrast icon below or within the web page to view details.

Foreground Hex Value #0000FF Color Picker Alpha 1.00 Lightness

Background Hex Value #FFFFFF Color Picker Lightness

Contrast Ratio: 8.59:1

Text Size: Normal

[Sample](#)

WCAG AA: Pass WCAG AAA: Pass

Desaturate page

WAVE does not detect contrast errors when gradients, filters, or background transparency are present. WCAG requires a conformant fallback background color when background images are present. Use the Color Picker eye dropper to measure image contrasts.

TIMELINE OF THE INTERNET

History Of Academic Networks

Singapore's academic network evolved from initial university connections to the advanced SingAREN infrastructure, supporting high-speed data exchange, collaborative research, and global academic partnerships over the past decades.

Click for more >>

TIMELINE OF THE INTERNET

History Of Public WiFi

Over the past 20 years, Singapore has built a strong public WiFi network that provides widespread, high-speed internet access and supports its Smart Nation vision through expanding free and commercial hotspots across the island.

Click for more >>

</> Code

★ No problems/errors detected from all tests

Academic Network Page

Accessibility Review

Accessibility Review (Guidelines: WCAG 2.0 (Level AA))

[Known Problems\(0\)](#) [Likely Problems \(0\)](#) [Potential Problems \(22\)](#) [HTML Validation \(0\)](#) [CSS Validation](#)

✔ Congratulations! No known problems.

Document checking completed. No errors or warnings to show.

Used the HTML parser.

Total execution time 2 milliseconds.

The following apply to the entire page:

Styles: OFF ON

Contrast

Summary Details Reference Order Structure Contrast

Click a Contrast icon below or within the web page to view details.

Foreground Hex Value #0000FF Color Picker Alpha 1.00 Lightness

Background Hex Value #FFFFFF Color Picker Lightness

Contrast Ratio: 8.59:1 Text Size: Normal Sample

WCAG AA: Pass WCAG AAA: Pass Desaturate page

WAVE does not detect contrast errors when

2005 h3 Establishment of SingAREN Gigabit Internet Exchange (GIX)

SingAREN set up the GIX at Global Switch, enabling Singapore's Research & Education (R&E) community to connect internationally at gigabit speeds.

2005 h3 Joining the TEIN2 Network

Singapore became part of the high-capacity TEIN2 network linking research and education communities in Asia-Pacific and Europe, with Singapore as a Point of Presence (PoP).

2012 h3 Code

★ No problems/errors detected from all tests

Public WiFi Page

Accessibility Review

Accessibility Review (Guidelines: WCAG 2.0 (Level AA))

[Known Problems\(0\)](#) [Likely Problems \(0\)](#) [Potential Problems \(22\)](#) [HTML Validation \(0\)](#) [CSS Validation](#)

Congratulations! No known problems.

Document checking completed. No errors or warnings to show.

Used the HTML parser.

Total execution time 2 milliseconds.

The following apply to the entire page:

Styles: OFF ON

powered by WebAIM

Contrast

Summary Details Reference Order Structure Contrast

Click a Contrast icon below or within the web page to view details.

Foreground Hex Value #0000FF Color Picker Alpha 1.00 Lightness

Background Hex Value #FFFFFF Color Picker Lightness

Contrast Ratio: 8.59:1

Text Size: Normal Sample

WCAG AA: Pass WCAG AAA: Pass

Desaturate page

WAVE does not detect contrast errors when gradients, filters, or background transparency are present. WCAG requires a conformant fallback background color when background images are

The following apply to the entire page:

2001

FREE WiFi@MRT

FREE CONNECTED MOBILE@SG

Launch of Wireless@SG

To provide free, high-speed wireless broadband access in public spaces. Initially targeting areas like shopping malls, schools, hospitals, MRT stations, and community centers, it aimed to promote internet access 'on the go' and bridge the digital divide.

</>

Code

★ No problems/errors detected from all tests

As shown above, no known issues were detected, indicating compliance with required standards.

Reflections

This project has been a comprehensive learning experience, deepening my understanding of both frontend and backend web development, including layout design, dynamic content loading, API creation, and web accessibility standards.

First, managing multiple HTML pages with their corresponding JavaScript files highlighted the importance of clear project structure and modularity. Ensuring that each page was associated with specific scripts helped me maintain organised code, avoid cross-page interference, and streamline debugging.

On the backend, creating the REST API endpoint with Express reinforced my knowledge of RESTful API design and asynchronous JavaScript. Fetching data from the backend and dynamically rendering cards on the frontend by asynchronously loading JSON data showcased the seamless integration possible between server and client. Through this, I learned how crucial error handling is when dealing with asynchronous operations to provide a good user experience.

Styling the web pages using CSS, particularly with flexbox layouts and media queries, also taught me about responsive design principles. Applying a background gradient that covered the entire viewport regardless of content height required innovative use of containers like .page-wrapper. This experience enhanced my skills in ensuring design consistency across various screen sizes.

Importantly, conducting HTML validation and accessibility testing with WCAG 2.0 Level AA standards introduced me to the discipline of inclusive design. Using automated tools to detect issues, then addressing them, made me appreciate how accessibility is fundamental for reaching a wider audience, including users with disabilities. Even when no known problems are found, the process highlighted the value of proactive testing and adherence to standards for high-quality web applications.

At last, I realised the significance of documentation and reporting. Presenting automated accessibility reports and reflections not only validated the technical work but also improved my communication skills.

Overall, this project has strengthened my practical web development capabilities, problem-solving skills, and awareness of accessibility considerations that are essential for creating user-friendly, high-quality websites.

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