

# Design

## Design Context

### Broader Context

Area	Description	Examples
Public health, safety, and welfare	The increased knowledge that we are looking to provide about 5G technologies should serve to better educate a portion of the public and, as such, will better increase the general knowledge of safety and utilization of 5G technologies.	The increased knowledge we look to provide should clear up the confusion that some people may have about the safety of 5G technologies.
Global, cultural, and social	Our website is being created with the purpose of being used for education by the university, and as a result, the site will work effectively in the community it is intended for.	Students that use our website in an educational setting should be able to increase their knowledge of 5G technologies, effectively increasing the potential that the university has to teach new material.
Environmental	While our website and educational materials may not take up or affect the environment significantly, the eventual development of 5G technologies in the area will take up space and require power to function.	The eventual inclusion of 5G technologies will include increased energy usage in the deployment areas. Deploying underground fiber optic cables would also be required.
Economic	As we will be building our website ourselves, the only cost associated should be the hosting of the site and the purchase of a domain name. This makes the project extremely financially viable as the benefit far outweighs the cost.	Since the hosting of our site would be paid for by our client/university, the product would always remain affordable for users, increasing its effectiveness and viability.

### Prior Work/Solutions

Similar product: 5G RuralFirst: <https://www.5gruralfirst.org/>

This product is grounded with some of the same basic elements as the ARAWireless project - one of which is supplying 5G solutions to rural areas. This project concluded in 2020 and as

such they have provided a project-conclusion report. This report contains data on what the project discovered, as well as listing topics such as specific-use cases, the potential of 5G, and what hardware was implemented in their project.

The following list provides some pros and cons which describe the effectiveness of the 5G RuralFirst website as an education source.

Pros	Cons
<ul style="list-style-type: none"> <li>● The 5G RuralFirst project is complete and contains information describing the project.</li> <li>● The website is designed gracefully and is user-friendly.</li> <li>● The 5G RuralFirst project has in-depth test cases describing the deployment of 5G technologies.</li> </ul>	<ul style="list-style-type: none"> <li>● The 5G RuralFirst website does not seek education as its primary goal.</li> <li>● The 5G RuralFirst website does not include instructional videos/lessons.</li> <li>● Website does not include resources for users to test their knowledge.</li> </ul>

Like our project, this website acts as an extremely helpful tool for us to determine what kinds of information we should be publishing and talking about. While this website mainly focuses on the work that the 5G RuralFirst team was doing, and as such talks more about what they hope to accomplish, it still provides a good example of effective ways to portray the kinds of work that we will hope to teach.

Below are some additional sources which include literature on the topic.

Sources:

- *5G RuralFirst*, 29 Sept. 2020, <https://www.5gruralfirst.org/>.
- "Ara Wireless Living Lab." *ARA*, <https://arawireless.org/>.
- Peterson, Larry, and Oguz Sunay. "5G Mobile Networks: A Systems Approach." *5G Mobile Networks: A Systems Approach - 5G Mobile Networks: A Systems Approach Version 1.1-Dev Documentation*, 2022, <https://5g.systemsapproach.org/>.
- "Open Air Interface." *OpenAirInterface*, <https://openairinterface.org/>.

## Technical Complexity

1. The design of our project not only includes countless hours of research on the topic, but we must understand the content well enough to demonstrate things such as performing complex network tests and teach individuals how to do so.

2. This design contains many systems and subsystems. First, we must host, test and design the website itself using web programming languages such as HTML, CSS, and JavaScript. We then

must ensure that we understand the complex teachings, testing, and applications of it well enough to instruct users who may have never used important aspects such as linux.

3. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

4. There have been many clear examples of students who have been placed onto this project before and were experiencing difficulties with onboarding as mentioned by the advisor and client.

## Design Exploration

### Design Decisions

#### Quantity of Educational Material VS Quality of Educational Material:

Documentation portion of the website will not be purely text based, but will include graphics, embedded videos, and small tests along each core topics of 5G networks. This is crucial to ensure an engaging learning experience and not a regurgitated textbook.

#### Hands On Experiments to learn 5G VS More Digital Experiments. such as Quizlet learning games and Digital Experiments with Cisco Packet Tracer and Wireshark

For now our mind is on both, if it is within our time constraints. In terms of priority, there is a little more emphasis on digital experiments but there should be implementation of both if the opportunity arises.

#### Public Server hosted by Amazon Web Services VS ISU based Web Server hosted by the ETG and only available while on ISU Network

There are pros and cons to both. ISU based Web Server hosting has the benefit of having the security provided by the ISU network administrator teams, and ensures a reasonable number of website hits. Public Servers are a little out of our experience but our public IPv4 address will not change and should be accessible to anybody with an internet connection.

Prioritizing ARA Members VS Prioritizing Juniors and Seniors

We are going to try and make this website a fantastic starting point for college students and as a supplementary or refresher site for members of ARA. It should also be mentioned that the ARA members currently have a form of documentation regarding the ARA network, but this documentation is on a more advanced level.

**Ideation**

For at least one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). Describe at least five options that you considered.

Hosting website using ISU servers	Build off of existing ARA website	Content Management System
Hosting website using hosting service	Documentation and educational website design	Website builder
—	—	HTML/CSS/JavaScript

In order to identify our potential options, we used a Lotus Blossom Technique. We first started by putting our main task in the center, and then thinking of different aspects and ideas within our project that are connected to the main task. By doing this, we were able to come up with all of the different options that we will have to face.

**Decision-Making and Trade-Off**

We chose to use the weighted decision matrix that we did so that we could factor in several different aspects of the project that determine whether an option should be used or not be used.

0-10 Trade-off Ranking 10 = GOOD, 0 = BAD	Cost-Efficiency	Feasibility	Man Hours	Expected Performance	Total
Build off of existing ARA website	10	3	4	8	25

Content Management System	1	5	5	7	18
Website builder	1	5	5	7	18
HTML/CSS/JavaScript	9	7	6	10	32
Hosting website using hosting service	5	4	5	6	20
Hosting website using ISU servers	10	7	4	5	22

**Agreed Upon Option:**

Based on the weighted decision matrix, HTML/CSS/JavaScript using ISU servers will be the main method of approaching Documentation and educational website design. While website building may be cheaper in time and resources, It was ranked lower due to low technical complexity and the ability to design and be creative is not as good. Our client, who is also a professional in this field, recommended coding our own website.

It should also be noted that while building off of the existing ARA website may be the best choice in the long run, due to the difficulty of implementing within the existing website database, it was ranked lower in the decision matrix. The matrix only takes into account options that will most likely have the best performance based on the limited time the group has.

## Proposed Design

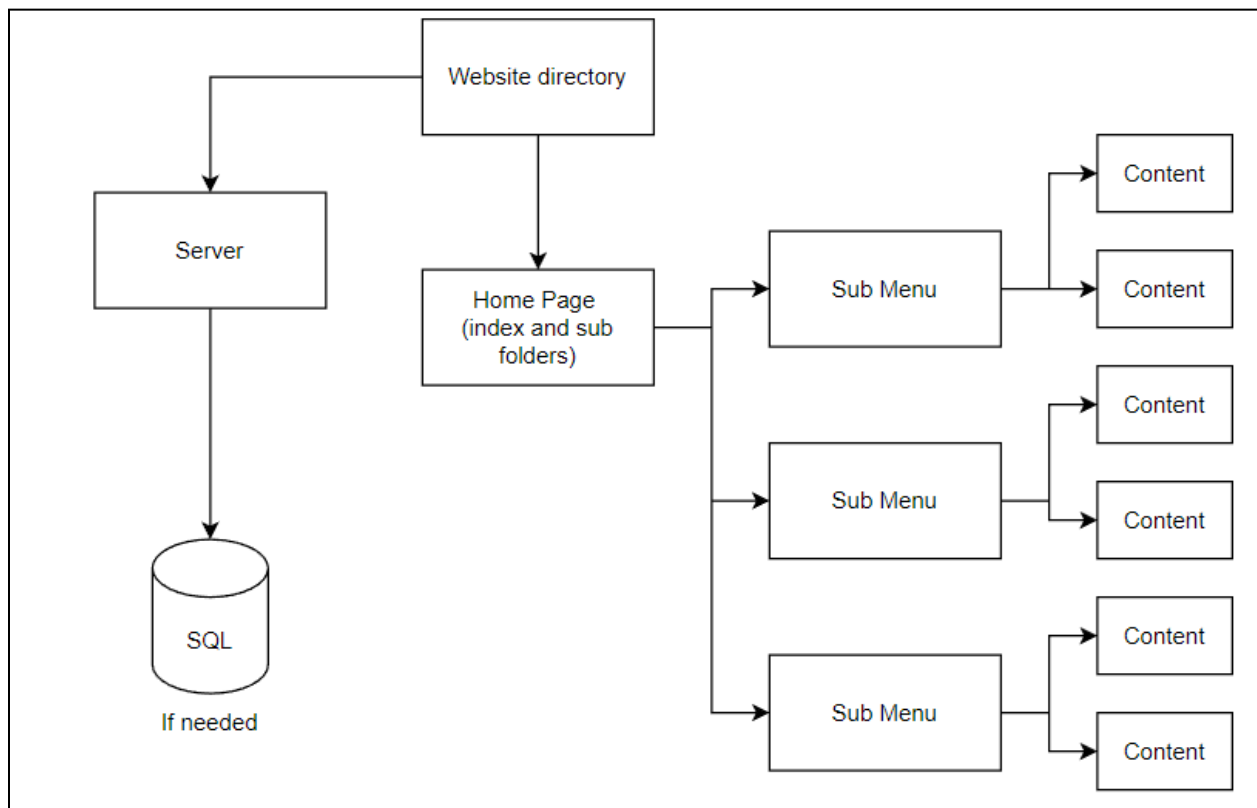
**Overview**

We are first establishing our goals and determining research relevant to 5G, ARA, and networking and routing. We then have to analyze what we researched and whether it is suitable for relevant academic consumption. After this, we will perform testing on the educational content to gauge how useful it is for 5G applications. Once testing is complete, we begin designing and compiling a website containing our research and findings

**Detailed Design and Visual(s)**

The website that will be hosted will be able to store the educational content designed in an organized way so that users can easily know what they are learning. The structure of the

website is going to be organized using HTML, this is the most baseline level of the website. Once we have the structure of the website implemented, we are going to implement sub folders and categories placed in an easy to access way to the user using CSS (cascading style sheets). Depending on feedback and our testing from users, we will alter the website accordingly, as well as the actual content of the website itself. Creative implementations of the website will be fueled by the JavaScript programming language. If user feedback is just and we need to implement a database for user data, we are prepared to do so. The domain of our website is TBA, and is yet to be purchased until we are confident that our website will function properly, and is ready to be released to the public. Once the website is finished, and all testing has been done, we will then connect it to the ISU servers, by pointing the domain (i.e. [www.ARAdocumentation.org](http://www.ARAdocumentation.org)) to the designated static IP address so that users can access the website. Much of the design of the website and content is dependent on our testing, and how each and every element and aspect of the website is organized and implemented. We will carefully cater to our users and this will result in the release of our final product.



Code website layout using mark-up language HTML, design web pages individuals using CSS, add onClickEvents and creative functionalities using JavaScript, and organize the overall design -> Determine which content is to be put on the website -> Organize tested content into the designed website -> Establish a connection to server and database.

### Subsystems:

- SQL - If needed a database, we will be able to send data from our website to be validated to our database.
- Sub Menus- A way to organize our data so that users can navigate with ease
- Content- the actual research content for users.

### Components:

- Server System - We need available hosting and network access from ISU to enable our website to be accessible to those in ISU campus.
- Domain - We must have a public domain address so that users can access our url.
- Usage of markup language HTML to design the layout of the website.
- Usage of Cascading Style Sheets to alter visuals and tailor the overall design to our users.
- Usage of JavaScript so that users can have a more delightful experience navigating our webpages.

## **Functionality**

Our design intends to operate as a functional website where users can learn about the deployment and science of 5G technology. We would expect that the user would be able to use our site to access well sourced information from documents and textbooks.

We would also expect that our site provides resources to test and perform experiments which include wireless network experiments using resources such as POWDER and Linux, as well as virtual experimentation. We expect to test the responsiveness and effectiveness of our system by testing some of the users on our site.

## **Areas of Concern and Development**

We expect that our design should fully encompass the needs that our project has. Everything that we plan on implementing on our site is within reason, and by using design matrices to decide on how to do our project we feel that we have developed an efficient plan for completing our assignment.

One of the primary concerns for our project is effectively testing our site on real students here at the university. It's easy for our team to work on the site as we can organize times to meet, but testing with students not only means that we need to adjust to the schedules of said students, but we have to make sure that we have a product that fits our different requirements and will produce good test data.

One of our immediate plans for addressing these concerns is to work with our advisor in order to arrange times with these students. Since our advisor is a professor at the university, we should be able to work with him and his resources in order to organize that part of the project.

## Technology Considerations

Since our design is going to be a website used for hosting information and educating the public, our main technology is the way that we create/host our website.

We decided, using a decision matrix, that creating the website ourselves using HTML/CSS would be the most effective option. One strength that comes from using this technology is that we are able to effectively do whatever we would like with our website as long as we possess the knowledge to actually create it. As a result, one of the weaknesses of this method also includes the possibility of not knowing how to code a feature into our website.

One alternative method to writing the website ourselves would be using a website building service. We would not have to worry about creating the features that our website would have as we could use the given tools to do it, but this comes with an additional weakness - if the service we are using does not have a feature we want there isn't much we can do as a work around.

As a result, we believe that the HTML/CSS method should be the most effective.

## Design Analysis

As our project mainly stems from applying the information about 5G network systems in a learning format on an interactive website, we have yet to build the website. However, there have been several instances of the team experimenting with setting up open source 5G networks and completing successful connectivity tests which will be applied to the project.

Regardless, there is a major emphasis on having to collect relevant information that is both factually correct and the website will hopefully present all of this information effectively with the web development phase as mentioned in the timeline. The main implication for the overall feasibility of our design will be the web development portion as we must be able to implement modern web features as our team consists of mainly three members who are experienced with the web development tools.

There may also be some build issues when implementing experimental practices on the website as the software required to do so operates on a waitlist timer for holding experiments. We



unfortunately have not found an alternative to countering this issue and time will have to be spent in order to address this issue.