Tribe D Documentation

ELP305

Design and System Laboratory
Project 2

Requirements and Specifications Submission

Submitted to:
Prof. Subrat Kar

Submitted by:
Tribe D (Demantors)

Document type: Private Release
Document Authorised by: Vansh Jain
Contact Details: `mt1210234@maths.iitd.ac.in`
Publication Date: 23/03/2024
Document ID: v1.2.0
The most recent version of this document can be found at
https://github.com/niteshsiingh/ELP305-Tribe-D-P2

Abstract

The objective of our project is to employ smart technology to improve the effectiveness and user experience of campus bus services. Our main goal is to provide a complete system with connection, power management, bus-mounted components, and intelligent bus stop displays. The bus stop gives the information about the time of arrival of the bus.

Beyond enhancing passenger experience, our solution equips transportation authorities with invaluable operational insights. By leveraging data analytics, we empower authorities to optimize scheduling and maintenance strategies, ensuring smooth operations and enhanced service reliability.

The survey team surveyed how the buses run in real-time on the IIT Campus and also identified the spots for putting up the Display units and interacted with the operators of the bus system. To enable passengers to make well-informed travel decisions, the system gives them up-to-date information about the next bus arrival time. Along with that electrical team has worked on what will be the specifications of software and hardware in this project and how will be implemented in real real-life scenario

Motivation

This project is driven by the desire to increase passenger pleasure and streamline campus transportation. Recognizing the pivotal role that efficient transportation plays in the daily lives of students, faculty, and staff, we want to use smart technology to address existing challenges and elevate the standard of campus transit.

By harnessing the guidance provided to us in this course, we aim to alleviate common pain points such as uncertainty surrounding bus arrival times and inefficient scheduling practices. We envision a future where passengers feel empowered with real-time information, enabling them to make well-informed travel decisions with ease.

By optimizing transit operations and reducing unnecessary waiting times, we seek to create a more effective campus transportation system not only for the students but also for the authorities involved in the transportation system through our analysis and surveys.

Ultimately, our motivation lies in creating a more connected, efficient, and user-centric campus transportation system that enhances the overall quality of life for the entire IIT Delhi community.

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Mind Map

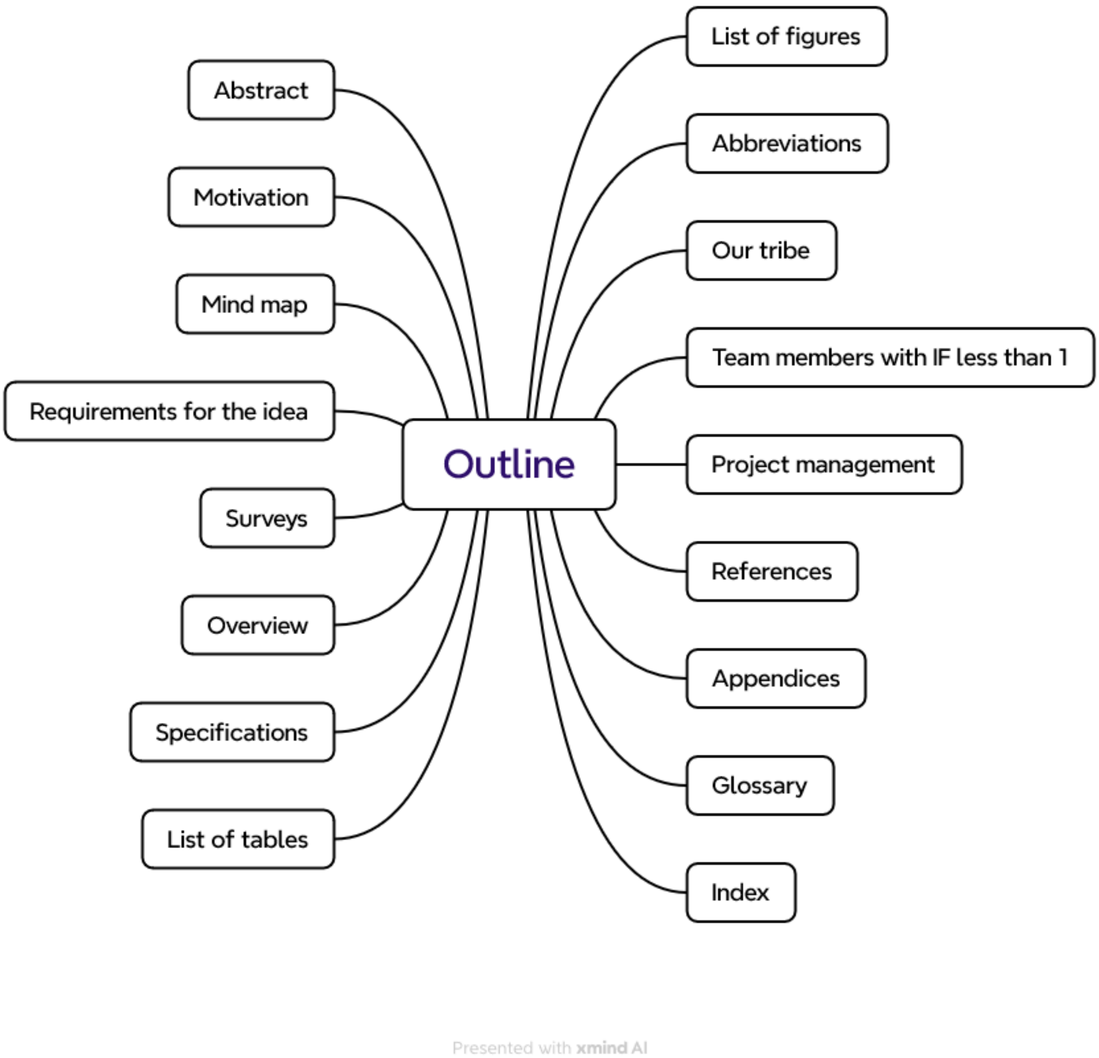


Figure 1: Outline Mind Map

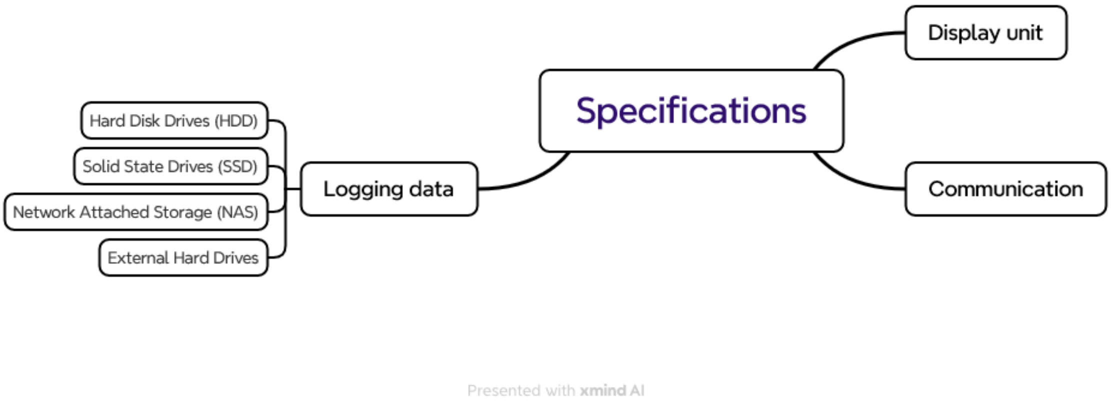


Figure 2: Specifications Mind Map

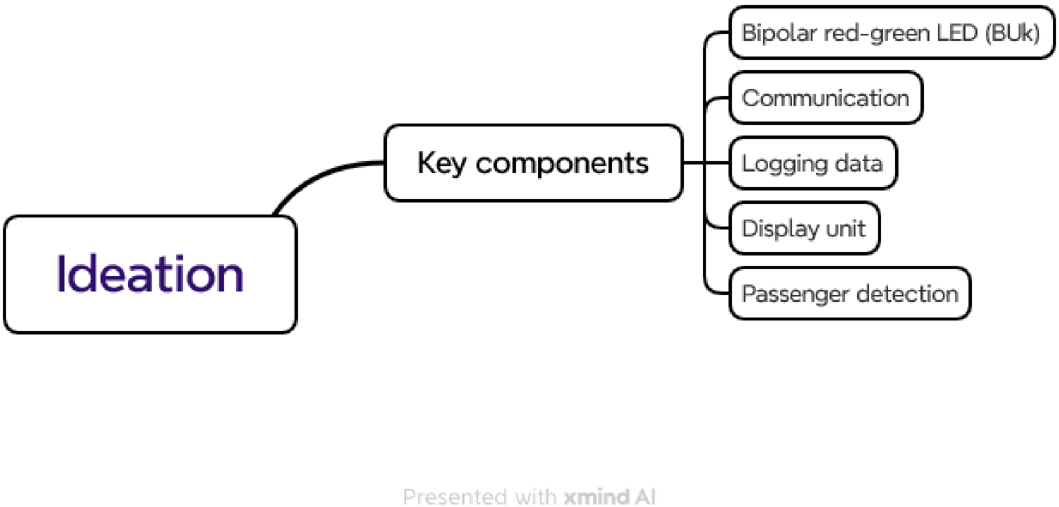


Figure 3: ideation Mind Map

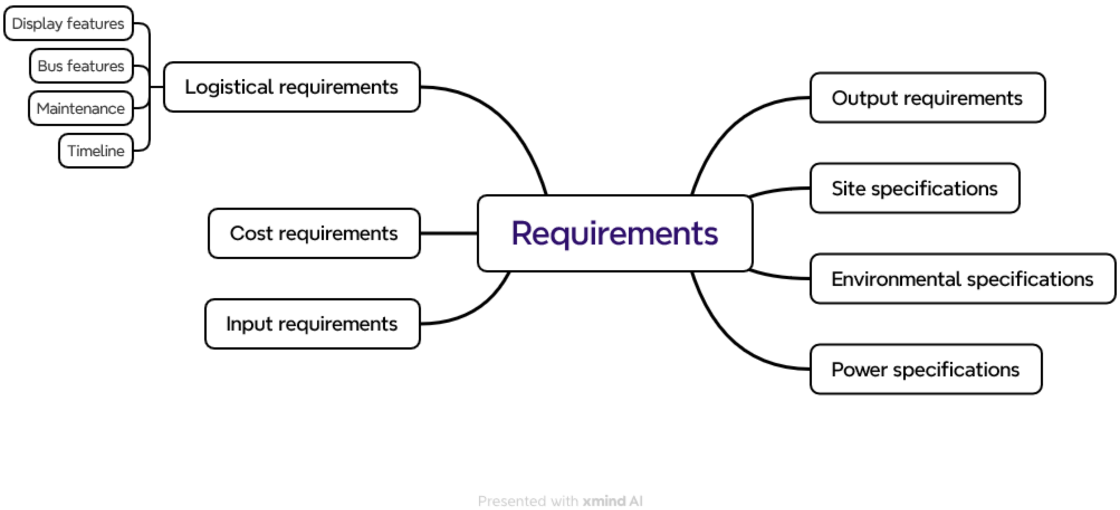


Figure 4: Requirements Mind Map

1 Requirements for the idea

1.1 Logistical Requirements

1.1.1 Display Features

- A 7-segment LED display is used, with consideration to the angular resolution and distance for far and short-sighted people.
- The display unit is placed in such a way that it is too difficult to steal and has low resale value. This is ensured with mechanical fixation and placing it at an unreachable height.
- A QR Code is displayed to provide feedback.

1.1.2 Bus Features

- Bus stops at every stop, even if the bus is full, as the driver does not know if passengers will deboard the bus.
- Initially, there are only 2 buses, but scalability aspects are to be considered
- The speed of the bus is unknown. It can be constant or variable
- The bus is not expected to stop at an empty bus stop.
- Connectivity is considered only between buses and stops.
- The bus is expected to stop in emergencies (such as if someone is about to throw up) but not anywhere else apart from bus stops unnecessarily.

1.1.3 Maintenance

- Daily maintenance of the bus stops is available.
- Location and Travel activity logs are to be stored for around a month. Start times, when the bus reaches each stop, and the duration of out-of-service times should be logged to calculate other metrics.
- No real-time maintenance for the system, but the logs can be checked.

1.1.4 Timeline

- The desired timeline for the system's development, testing, and deployment is April 25th, 2024.
- Technical support is available in case of any discrepancy.

1.2 Cost Requirements

- The tribe needs to consider budget constraints on installing the signboard.

1.3 Input Requirements

- Burst transmission rather than sporadic WiFi use is preferred (For example – 2
- No human intervention should be required for the operation for the system. BUk is not turned on by anyone.
- User feedback can be recorded through a digital interface.
- Buses do not need to be informed about the location of other buses.
- The arrival of buses is detected automatically.
- The driver sees the passengers waiting at the stop that is he visually confirms and stops the bus.
- The distance between bus stops needs to be surveyed.

1.4 Output Requirements

- The expected time of arrival (ETA) should not be approximated.
- A flash should be blinking if a passenger is waiting at the bus stop.
- There should be language support, disability support, or other specific software functionalities for disabled people or people having visibility disorders.
- The buses will be labeled as OOS or Out of Service in case of refueling, washing, and other maintenance issues.
- The display should read 999 to indicate emergency or unforeseen delays.
- PWM output of the Microcontroller/speech IC could be used to cater to visually impaired travelers.
- An interface can allow passengers to find out the bus wait time.

1.5 Site Requirements

- The stop display unit should not move around and should not be loose, it should not create unnecessary sounds.
- During heavy traffic and construction, the shortest route will not be changed.
- Two buses should not be at the same stop.
- There is no need to create additional bus stops other than the ones provided.
- The most basic bus stop is the pole with an embossed inverted triangle. The next more evolved bus stop is a stainless-steel pole with a stylized photograph of the IITD bus and a timetable.
- The solar panel might have to be mounted in the nearest continuously sunny spot with a concealed wire leading back to the display unit.
- Total Space available - 6 x 5 x 2 inches (about the size of a 250-gram food packet).
- The bus will leave as soon as the passengers at the stop are boarded.
- To avoid the display getting stolen and being readable, it is placed at an optimal height.
- The BUk and the red toggle button must be placed on the display board.
- The BUk may have a Red LED that turns on when the Out-Of-Service button is on.
- Standing for 0.5 minutes would qualify someone as a potential passenger. Wrong identification (false positives) is okay.

1.6 Environmental Requirements

- In peak Delhi winter, the availability of sunlight and, therefore, solar energy is questionable. Otherwise, a bigger battery or a bigger solar panel is enough.
- Normal weather conditions in New Delhi are assumed and the display is ordered accordingly to account for visibility of timings.

1.7 Power Requirements

- There is no need for solar panels for charging the display in the bus.
- The display is powered by the bus's battery.
- The BUk is powered by the bus battery since it needs to be running even when ignition is turned off.

1.8 Miscellaneous

- Logging and maintenance will be done by individuals.
- OOS or 999 will be displayed on board when the buses are out of service.
- Two buses can be run simultaneously if there are more than one bus capacity passengers waiting.
- It is not needed for the driver to know about the waiting time of passengers.
- If the bus is full, the bus driver doesn't need to stop the bus if it is already full.
- There will be no change in the route of the bus even if the bus is empty.

2 Surveys

2.1 Group 1 Survey

S. No.	Initial Destination	Next Destination	Travel Time
1.	LHC	Sahyadri	1 min 40 s
2.	Kailash / Himadri	The bus didn't stop	Unknown
3.	Sahyadri	LHC	2 min

Table 1: Surveyed Route Information

Information obtained at bus stops:

- Display units at bus stoppages contain incorrect time information.
- Bus stops with fixed timings are IITD market, DMS, and LHC, where the bus waits longer. For example, at LHC, in this case, it was observed 27-30 people were boarding, and the bus stayed for nearly a minute.
- Other bus stops are only considered as per the crowd at them.
- The onboarding times from Sahyadri are 8:00 am, 9:05 am, 9:15 am, 1:00 pm (fixed) in-between the bus stops intermittently.
- Buses stop as per passenger convenience in an ad-hoc manner.

Other survey tasks:

1. Collected transportation information from the security controller's office
2. Contacted transportation office near IITD hospital
3. Detailed talk with bus conductor knowing about timings and route of the bus
4. One of the shuttle buses was out of service, which was used to carry passengers to the IITD market, and was no information about out of service to any of the passengers causing inconvenience to them
   Conclusion: Something must be there on the labels at bus stops to notify the passengers waiting there about the out-of-service bus so they can manage their time accordingly.
5. The buses don't run according to the timings mentioned in the stoppages. Sometimes the bus can stop wherever the passenger needs to get down in the way.
   Conclusions: The display units, if small in width, can be installed directly below the labels without extra construction and spacing in the Kailash stop. But the bus hardly stops at this stand and is nearly empty most of the time.

(a) Interaction with Bus conductor

(b) Group photo

(c) Bus display units at Kailash

(d) Boarding at LHC bus stop

Figure 5: Group 1 Survey

2.2 Group 2 Survey

Route surveyed (forward journey): [Start time: 12:35 pm for Survey Group 2]

S. No.	Destinations	Travel Time	Passengers Onboarded	Passengers Deboarded
1	Transport Office	5 min	–	–
2	DMS	1 min	6 (usually 10-15)	0
3	Aravali (ad-hoc)	1 min	2	4
4	Kumaon	1 min	1	0
5	Shivalik	1 min	1	0
6	Bharti (ad-hoc)	1 min	1	1
7	LHC	2 min	23	0

Table 2: Surveyed Route Information (Forward Journey)

2.3 Group 3 Survey

Route surveyed (return journey): [Start time: 1:58 pm]

S. No.	Destinations	Travel Time	Passengers Onboarded	Passengers Deboarded
1	IITD Market	1 min		
2	Kalyana Mandapam (ad-hoc)	1 min	3	0
3	B-15	1 min	0	0
4	B-12	1 min	1	0
5	Sahyadri	1 min		
6	Kailash / Himadri (ad-hoc)	2 min	1	0
7	IDDC/IRD/LHC	2 min	4	5
8	Bharti / Mittal (ad-hoc)	1 min	1	0
9	Hospital	1 min	0	3
10	SAC / Nalanda	1 min	0	0
11	Karakoram	1 min	0	0
12	Gupta Market / Nilgiri	1 min	5	1
13	DMS	2 min (bus empty)	0	6

Table 3: Surveyed Route Information (Return Journey)

The time at which they returned to the transportation office: 1:14 pm

Information obtained at bus stops:

1. At DMS: A room is there near the starting point of the bridge. The wall of the room facing the road is the best location for the display.
2. It should also be noted that the total number of seats on the bus is 36.
3. For the DMS bus stop we feel that this wall is a good option for where the bus display could be placed:
4. About the BUk units, this is the photo of the dashboard:
5. The bus driver specified that if no person is waiting at a particular stop he doesn't wait, he keeps driving the bus. Also while there are no stops at places like Bharti and Kumaon, they do act like Ad Hoc stops and should be considered. The Ad hoc stops we were able to identify were: Aravalli, Karakoram, Kumaon, and Bharti. Also, certain stops like Taxila have little usage.
6. The main rush hours of the bus are from 8:00 AM to 1:00 PM. After that, there are no more passengers to travel.
7. If there are more passengers, the bus usually slows down and takes more time to cover the route.

Figure 6: Possible board location for time display at SAC Circle

(a) Bus waiting at DMS bus stop

(b) Dashboard for installation of BUk unit

Figure 7: Group 3 Survey

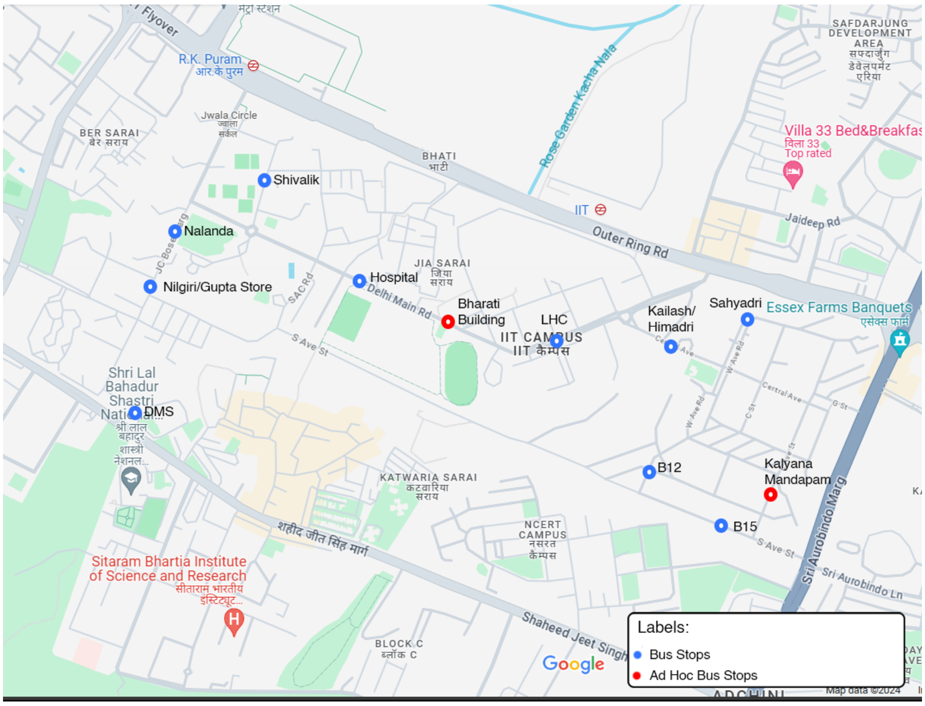
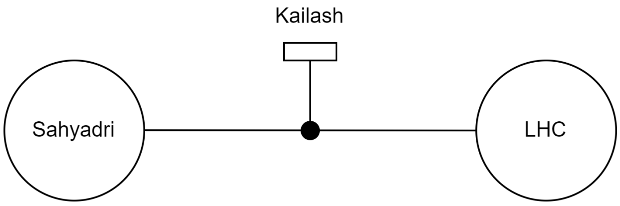
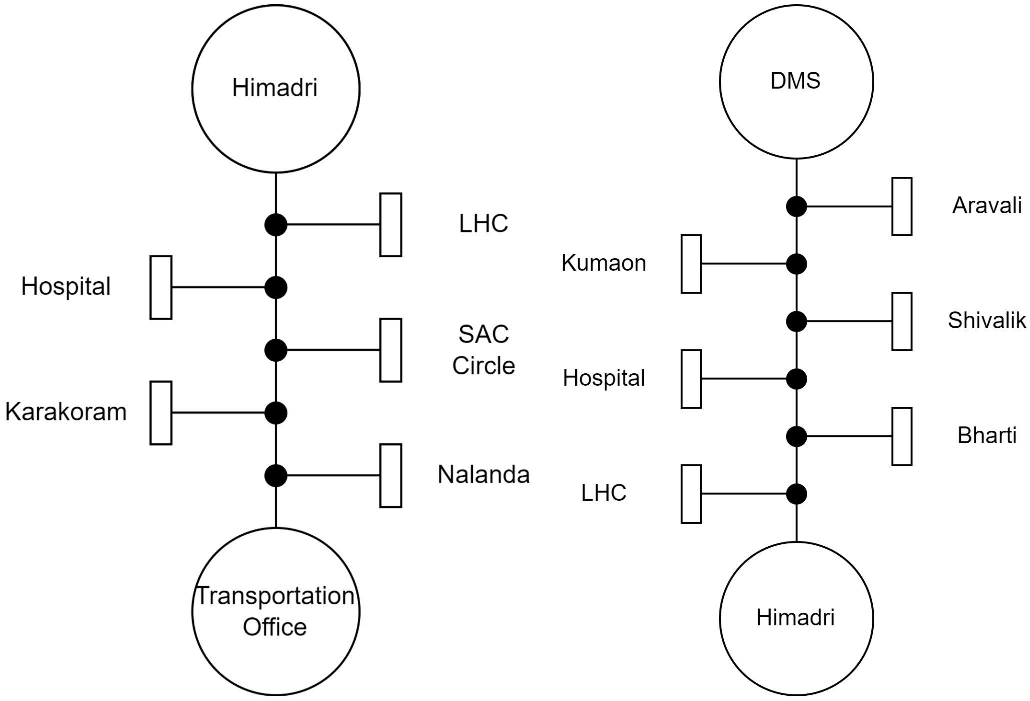


Figure 8: Bus Stops on Campus



(a) Route from Sahyadri to LHC



(b) Route of Round Trip

Figure 9: Bus Routes

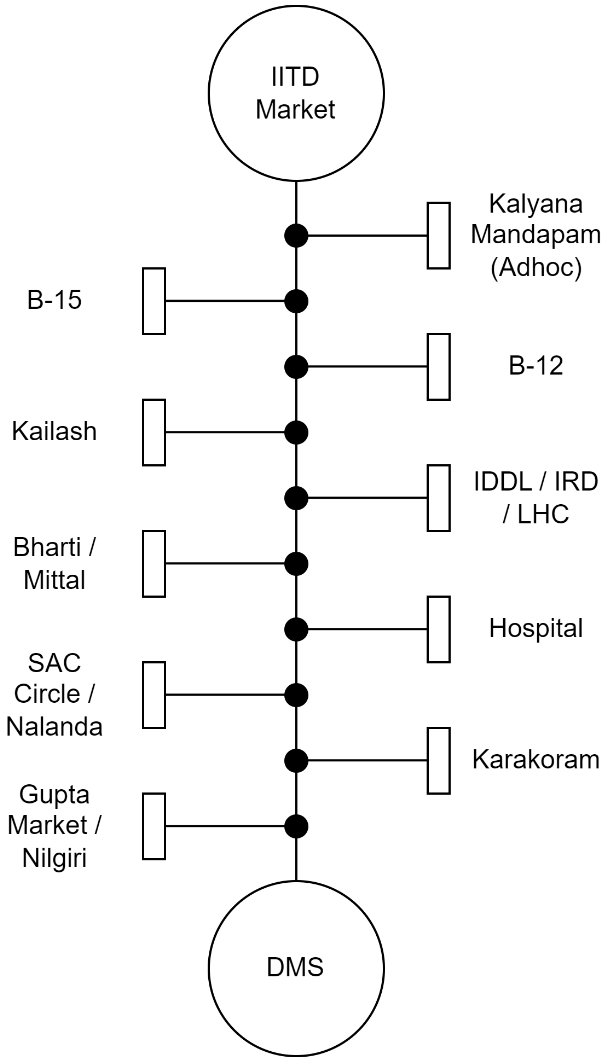


Figure 10: Route from IITD market to DMS

3 Ideation

We are using a straightforward system to implement the solution to the given problem statement. We would have systems in place that would enable signal transfer and communications between signboard (k) and signboard (k-1) as well as signboard (k+1). We would also have sampled and analysed data to determine the average time between two stops. Then, for starters, each signboard would be programmed to display the waiting time as the waiting time of the previous signboard plus the average time between two stops. As and when a bus arrives at a particular bus stop, the timer for that specific bus stop will reset to zero. When the bus leaves that stop, it will be set to the value determined by the previous algorithm. However, the problem to be tackled here is the time shown at the next station. In order to address that, we will send a signal to the next station, communicating to it to show the calculated average time between the two stations instead of following the algorithm. This way, in a simple recursive way, we can form an elementary solution system to the problem statement.

3.1 Key Components

3.1.1 Bipolar (red-green) LED (BUk)

A bipolar (red-green) LED is a type of light-emitting diode that can emit both red and green light from the same component. This LED typically has three leads or pins: one for the common cathode (negative terminal) and two for the anodes (positive terminals) of the red and green LEDs. By applying different voltages to the anode pins, you can control which color (red or green) the LED emits. This type of LED is commonly used in applications where you need to display multiple colors or signals with a single component, such as in traffic lights, indicators, and displays.

3.1.2 Communication

ESP32 inbuilt Bluetooth and Wi-Fi will be used for communication.As searched on the internet, we can get a range of around 100m range in an open field with about 30 percent packet loss.Now if we want to communicate between devices that are far from 100m(say) then we can add some devices and hop the packets over these devices to get the required data at the end device.These values need to be backtested and appropriate time is needed to conclude the geographical features of IITD.

Reason for using Bluetooth and not WiFi :

- WiFi might not be available at all the locations in IITD. So, the system will not be reliable if WiFi is being used.

Note : While logging the data from the bus to the server WiFi will be used to connect and upload the data either on a Google sheet or on some other cloud hosting websites.

How will the communication take place :

- Each DU will communicate with the DU at the previous bus stop to fetch data like the expected waiting time and expected arrival time of the bus.
- DU will communicate with BUk to get the current location of the bus. Although this communication will not happen all the time. This will only be done when the bus has left the previous stop and approaching the stop of our interest.

3.1.3 Logging Data

Different methods of Data Storage are as follows:

1. Hard Disk Drives (HDD): A hard disk drive (HDD) is an electro-mechanical data storage device that stores and retrieves digital data using magnetic storage with one or more rigid, rapidly rotating platters coated with magnetic material.
   - Advantages
     - High storage capacity (up to several terabytes or more).
     - Relatively low cost per gigabyte compared to other methods.
     - Longer lifespan.
   - Limitations
     - Mechanical parts can lead to failure over time.
     - Slower read/write speeds compared to SSDs.
     - HDDs are noisier than other storage drives,
     - HDDs use more power than other storage drives, which can shorten laptop battery life.
2. Solid State Drives (SSD): A solid-state drive (SSD) is a solid-state storage device. It provides persistent data storage using no moving parts, only electronic circuits, to provide its function.
   - Advantages
     - Faster read/write speeds compared to HDDs.
     - No mechanical parts, leading to better durability.
     - More energy efficient. SSDs consume less power than HDDs.
     - SSDs produce less noise because they use computer chips and not moving parts.
   - Limitations
     - Generally, it is more expensive per gigabyte compared to HDDs.
     - SSDs have limited write cycles, which means that frequent, heavy use can degrade their performance over time
     - Recovering data from SSDs is more complex than from HDDs.
     - SSDs can fail, leading to data loss
3. Cloud Storage: Cloud storage is a model of computer data storage in which data, said to be on "the cloud", is stored remotely in logical pools and is accessible to users over a network, typically the Internet.
   - Advantages

- Accessible from anywhere with an internet connection.
- Scalable storage options.
- Cloud service providers employ encryption and backup mechanisms to enhance data security. Encryption safeguards data, while regular backups ensure accessibility even during server maintenance.
- Cloud storage facilitates collaboration among users by allowing them to share and edit documents in real time.

- Limitations
  - Dependence on internet connectivity.
  - Potential security and privacy concerns.
  - Upload and download speeds may be slow.
  - Users have limited control over data management.

4. Network Attached Storage (NAS): Network-attached storage (NAS) is a file-level (as opposed to block-level storage) computer data storage server connected to a computer network providing data access to a heterogeneous group of clients.

   - Advantages
     - Centralised storage is accessible by multiple devices.
     - It can provide redundancy and backup options.
     - NAS systems can protect data from hard drive failure.
     - NAS devices can provide a centralised backup model.
   - Limitations
     - NAS performance is limited by the network it's connected to. Highly congested networks can cause performance to degrade.
     - If there are no backups, NAS devices can be a single point of failure if they fail, resulting in the loss of all data.
     - NAS capacity is limited by the type and number of drives it supports.
     - Large-scale storage may require the purchase of several NAS systems. Power outages can affect file access.

5. External Hard Drives: External storage refers to non-volatile (secondary) data storage outside a computer's own internal hardware and thus can be readily disconnected and accessed elsewhere.

   - Advantages
     - It is portable and can be easily moved between devices.
     - Offers additional storage capacity to existing systems.
   - Limitations

  - Vulnerable to physical damage if mishandled.
  - Limited capacity compared to internal drives or NAS.

6. Tape Storage: A tape drive is a data storage device that reads and writes data on a magnetic tape. Magnetic-tape data storage is typically used for offline, archival data storage.

   - Advantages
     - High storage density, suitable for long-term archival storage.
     - Relatively low cost per gigabyte for long-term storage.
     - Tape storage can be physically disconnected from the network and archived. It also offers encryption, password protection, and physical locks and can withstand harsh environmental conditions.
     - Tape storage allows for better data management, storing all data within a single namespace or server.
   - Limitations
     - Slower access times compared to disk-based storage.
     - Limited suitability for frequent access or random access workloads.
     - Difficult to Recover Specific/Individual Files.
     - Susceptible to Physical and Environmental Damage

3.1.4 Display Unit

In the operation of a 7-segment LED display powered by solar energy, the display unit is controlled by an FPGA (Field-Programmable Gate Array) board. Solar panels convert sunlight into electricity, which is then regulated and transformed to the required voltage level for the display via a DC/DC converter. The regulated power is directed to the LED segments of the display. The FPGA board acts as the control center, receiving input data or instructions and coordinating the activation of specific segments to form numbers or characters on the display. By programming the FPGA, users can define the behavior and functionality of the display, making it adaptable to various applications. This setup allows for the continuous operation of the display unit using solar energy, with the FPGA board managing its functionality efficiently.

We use 7 segment display and increase the size of it using FRESNEL LENS (To make sure visible distance is 8 feet) to magnify the size of display.

1. FPGA

   Field Programmable Gate Array (FPGA) is a kit which is made up of several Programmable Logic Arrays. The FPGA enables the implementation of any logic functions with reduced cost, high performance, space and reduced power dissipation. In our project the seven segment display unit is performed using the FPGA kit which effectively utilizes low power for the implementation and with minimumm latency.

2. Solar Panel

   Solar panel converts sunlight to electrical energy.

3. DC-DC Converter

   DC-DC converter converts DC electricity at one voltage level to another voltage level(higher, lower or equal). Use a mini screwdriver to increase or decrease output voltage by adjusting the screw on the blue potentiometer and monitor voltage with multimeter to get the needed voltage, clockwise to step up voltage and counterclockwise to step down voltage.

4. PWM Converter

   PWM is used to adjust the output pulse width in order to regulate the average output voltage.

5. USB

   USB is used for storage, backup data, and transferring files between devices.

3.1.5 Passenger Detection

1. Video People Counting:

    - Advantages
        - One of the most accurate methods at 98
        - Easy to verify remotely that the counting system is working correctly.
        - System can be scaled up to include other areas
        - Privacy – people are not identified
        - Counts can be integrated with POS systems in real-time
        - Can measure dwell time and occupancy
        - Can generate heat maps of popular areas
        - Handles wide entrances and outdoor counting
        - Data can be made available via WiFi and the Internet-of-Things
        - Can be adjusted via software for individual situations – crowds, poor light, etc.
    - Drawbacks
        - Installation takes longer than for simpler systems like beam counters .

2. Thermal Sensors :
   Positioned above an entrance, thermal sensors identify people by measuring their body heat.

    - Advantages
        - Quoted accuracies are between 96 and 98
        - Privacy – people are not identified .
        - Network together for wide areas.
    - Drawbacks
        - Accuracy can be affected by the ambient temperature within the counting area being above or below a certain value. Low ceilings can also reduce accuracy.
        - Have difficulty measuring the dwell time of people.
        - Needs a camera or other method to verify counts.

3. Infra-Red Beam Systems:
   Thermal uses body heat and computer vision to determine objects. These were popular twenty years ago – now higher accuracy and more information is generally needed for most applications.

- Advantages
  - Privacy – people are not identified.
  - Low cost.
  - Easy to install.
  - Can communicate with server in real-time.
- Drawbacks
  - Accuracy tends to decrease with wide or busy entrances. Direct sunlight onto the beam will also affect the system. Difficult conditions can bring accuracy down to 80
  - Don't measure dwell time or provide heat map data.
  - Needs a camera or other method to verify counts.

Ideation:
There can be 'passive' detection and 'active' detection. A photoelectric motion sensor sends a beam of light across a monitored space to a photoelectric sensor. The sensor alerts when the light beam is broken. Ultrasonic, microwave, and infrared motion sensors are active sensors, which means they actively send energy. A passive sensor can be thought of as a "read-only" device. An example is a passive infrared(PIR) sensor, which detects infrared energy created by body heat. We here are preferring the use of passive infrared sensors as the bus stop model available on campus are all open bus stops. There are no gates/ boundaries from where people enter and wait for the bus. Thus if we want to set up active sensors, we must first build real boundaries for bus stops and install these units at the gate. But for a passive IR sensor, we just need to install 1 device at a height, and it would cover the distance around it like an umbrella. As of now we have gone with like as of now we were able to think about infrared because infrared senses heat and it can easily detect humans in day or night. So you will have a top down infrared camera. Any resolution is fine but it has to be a camera. It can't be a single sensor. It has to be an infrared camera. So it will also have its own lens.
Using that camera we will be taking a video or we will be sampling photos at frequency fs. Where fs is L/Vh where L is the length of the bus stop parallel to the sidewalk and Vh is the speed of humans walking average speed.
In the problem statement it's written that if a subject stands for 30 seconds then he or she is a passenger, so we will be taking samples every 1/fs seconds till 30 seconds. A total of 30*fs samples will be taken. Out of those frames we will find out the percentage of red in each frame. Red is the human and everything else is surrounding. No of passengers stood from time equal to 0 to 30 seconds would be calculated as the minima of red percentage across all these 30*FS frames divided by R. R is the percentage of red when a single human stands in the frame. And we will be updating this number at FS frequency (means 1 frame every (1/FS) second) . We update the number of passengers and we take a window size of 30 seconds.

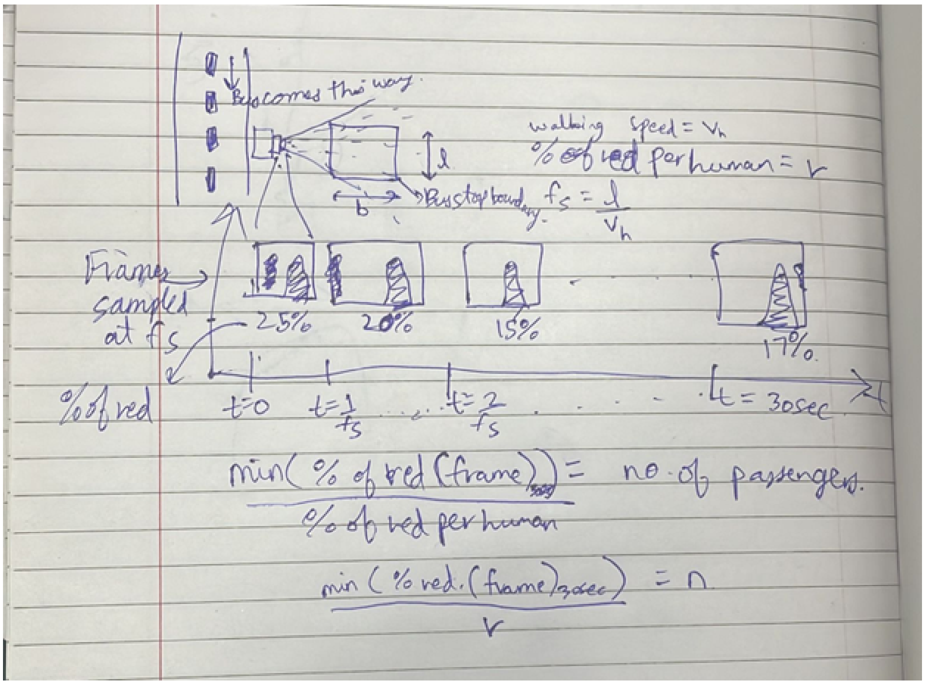


Figure 11: Ideation on passenger detection

4 Specifications

4.1 BUk LED

Bipolar(red/green) LED BUk

Energy	Forward Voltage	1.8V-3.6V
	Forward Current	25mA
Power	Minimum	60 mW
	Maximum	100 mW
Cost	Maximum	Rs. 100
Space	Diameter	3 mm
	Length	28 mm
	Height	5 mm

Table 4: BUk LED Specifications

4.2 Logging Data

4.2.1 Hard Disk Drives (HDD)

Power	Idle	5.5 W - 9.4 W
	Read	6.4 W - 14.5 W
	Write	5.7 W - 9.4 W
Cost	1 TB	4000 - 5600 INR
Space	Platter's Diameter	2.5in - 3.5in
Performa -nce	Data Processing Speed	500 MB/s
Spindle latencies	4,200 RPM	7.14 ms
	5,400 RPM	5.56 ms
	7,200 RPM	4.17 ms
	10,000 RPM	3.00 ms
	15,000 RPM	2.00 ms

Table 5: HDD Specifications

4.2.2 Solid State Drives (SSD)

Power	Idle	0.02 W - 2 W
	Read	0.5 W - 3 W
	Write	0.7 W - 8 W
Cost	1 TB	8000 INR
Space	Form factor	2.5in
Performa -nce	Data Processing Speed	2000-3500 MB/s

Table 6: SSD Specifications

4.2.3 Cloud Storage

Power	Variable energy consumption depending on the provider and usage
Cost	Cost can vary widely depending on the amount of data and the provider
Space	There is no physical space requirement
Performance	GCP quotes a capacity of 5,000 object reads per second for its storage buckets, with a per-region limit of 50Gbps per project per region when accessing data from a given multi-region

Table 7: Cloud Storage Specifications

4.2.4 Network Attached Storage (NAS)

Power	Power	36 W
	Voltage	100-240 V AC
	Frequency	50/60 Hz
Cost	Two-bay 4TB NAS unit without swappable drives	40000-48000 INR
	Two-bay 4TB NAS unit with swappable drives	80000 INR

Table 8: NAS Specifications

4.2.5 External Hard Drives

Power	Idle	2.5 W - 6 W
	Read	3 W -8 W
	Write	2.5 W - 7 W
Cost	2 TB	6000-7000 INR
Space	Desktop computers	3.5in
	Laptops	2.5in

Table 9: External Hard Drives Specifications

4.2.6 Tape Storage

Power	**For minimum library configuration:**	
	Total idle power	44 W (150 Btu/hr)
	Steady state maximum	67.5 W (230 Btu/hr)
	A ten-module library with 20 tape drives and 20 power supplies	
	Total idle power	338 W (1154 Btu/hr)
	Steady state maximum	751 W (2564 Btu/hr)
Cost	LTO 9 tape	8000 INR
Space	Space to fit 14 drives	15 sq. feet
Performa -nce	Native capacity per cartridge	20 TB
	Data Processing Speed	400 MB/s

Table 10: Tape Storage Specifications

4.3 IR Sensor

Power	5-15 W
Cost	25000 INR
Height	6.5-10 ft
Angular Range	60-120°

Table 11: IR Sensor Specifications

4.4 Display Unit

7-segment display	Size	14.2 mm
	Energy/power (required supply voltage)	3-5V
	Energy/power approximate	12 Watts
	Cost	Rs 100
Fresnel lens	Minimum	60 mW
	Cost	2700 INR
	Focal Length	50 mm
	Diameter	100 mm
FPGA	FPGA Chip	Altera Cyclone II, EP2C5T144C8N
	Input Voltage	5V
	Input Ouput Pins	89
	EEPROM Chip	4Mbit EPCS4
	Oscillator Frequency	50 MHz
	Cost	2560 INR
	FPGA IO Voltage:	3.3V
Solar Panel	Power	10 W
	Voltage Output	12V
	Open Circuit Voltage	21.7V
	Cost	890 INR
	Space	30L X 34W X 1.7H Cm
	Connector	USB
	SC current	630 mA
DC-DC Converter	Input Voltage	DC 4V to 35V
	Output Voltage	DC 1.25V to 30V
	Current Rating	3A
	Frequency Range	50 Hz to 150 Hz
	Space	21 mm X 42 mm
	Cost	129 INR
PWM Converter	Space	13.9 cm x 9 cm x 4 cm
	Voltage Rating	12/24V
	Current Rating	6A
	Power Rating	100 W
	Cost	241 INR
USB	Space	8 cm X 5 cm X 3 cm
	Memory Storage Capacity	32 GB
	Performance Read(Max.)	15MB/s
	Performance Write(Max.)	8MB/s
	Cost	352 INR

Table 12: Display Unit specifications

4.5 Communication

Power	**If solar pannel is procured:**	
	Solar Pannel output voltage range	10W/12V
	ESP32 input voltage range	2.6-3.6V
	Buck converter rated for	12V/3.3V
	If power banks are procured:	
	Power Bank voltage rating	3.3V
Cost	ESP32	400 (for each ESP32)
	Solar Panel	900 (for each solar panel)
	Buck Converter	200 (each)
	Power Bank	900 each (rated at 5V, 10000mAh)
No. of Devices	ESP32	3
	Solar Panel	2
	Buck Converter	3
	Power Bank	1

Table 13: Communication specifications for the Model

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Abbreviations

Abbreviation	Stands For
IF	Involvement Factor
SSD	Solid-State Drive
HDD	Hard Disk Drives
DMS	Department of Management Studies
LED	Light Emitting Diode
QR Code	Quick Reference Code
BUk	Bus Unit k
ETA	Expected Time of Arrival
OOS	Out of Service
IC	Integrated Circuit
LHC	Lecture Hall Complex
IDDC	Instrument Design Development Centre
IRD	Industrial Research and Development unit
SAC	Student Activity Centre
DU	Display Unit
NAS	Network-Attached Storage
FPGA	Field-Programmable Gate Array
PWM	Pulse Width Modulation
USB	Universal Serial Bus
POS	Point of Sales
EF Team	Electrical and Fabrication team
Wifi	Wireless Fidelity

Table 14: Abbreviations

Our Tribe

SNo	Name	Roll No.	Position	Email	IF
1	Ayush Dudawat	2021EE10694	Tribe Coordinator	ee1210694@ee.iitd.ac.in	1
2	Vansh Jain	2021MT10234	Tribe Coordinator	mt1210234@maths.iitd.ac.in	1
3	Naunidh Singh	2021MT60956	Documentation Coordinator	mt6210956@maths.iitd.ac.in	1
4	Nancy Kansal	2021MT10905	Research Coordinator	mt1210905@maths.iitd.ac.in	1
5	Sharesth Thakan	2021EE30730	Electrical and Fabrication Coordinator	ee3210730@ee.iitd.ac.in	1
6	Pavan Bharadwaj	2021EE10630	Electrical and Fabrication Coordinator	ee1210630@ee.iitd.ac.in	1
7	Ayush Sharma	2021MT10244	Research	mt1210244@maths.iitd.ac.in	1
8	Rishika Arya	2021MT10926	Research	mt1210926@maths.iitd.ac.in	1
9	Sarmistha	2021MT10261	Research	mt1210261@maths.iitd.ac.in	1
10	Anshika Prajapati	2021MT60961	Research	mt6210961@maths.iitd.ac.in	1
11	Rupam Kumawat	2021MT60267	Research	mt6210267@maths.iitd.ac.in	1
12	Sakshi Magarkar	2021MT60965	Research	mt6210965@maths.iitd.ac.in	1
13	Aniket Pandey	2021MT60266	Research	mt6210266@maths.iitd.ac.in	1
14	Mukund Aggarwal	2021MT60939	Research	mt6210939@maths.iitd.ac.in	1
15	Keshvi Tomar	2021EE10682	Research	ee1210682@ee.iitd.ac.in	1
16	Aravind Udupa	2021MT60940	Research	mt6210940@maths.iitd.ac.in	1
17	Arpit Rathore	2021MT10920	Research	mt1210920@maths.iitd.ac.in	1
18	Abhas Porov	2021EE10781	EF Team	ee1210781@ee.iitd.ac.in	0.9
19	Vandit Srivastava	2021EE10640	EF Team	ee1210640@ee.iitd.ac.in	1
20	Ankita Meena	2021EE10173	EF Team	ee1210173@ee.iitd.ac.in	1
21	Aditya Gupta	2021EE30713	EF Team	ee3210713@ee.iitd.ac.in	1
22	Aditya Bhalotia	2021EE30698	EF Team	ee3210698@ee.iitd.ac.in	1
23	Ayush Shrivastava	2021EE10632	EF Team	ee1210632@ee.iitd.ac.in	1
24	Harshit Nagar	2021EE10155	EF Team	ee1210155@ee.iitd.ac.in	1

25	Shreyansh Jaiswal	2021EE10154	EF Team	ee1210154@ee.iitd.ac.in	0.9
26	Akshar Tripathi	2021EE10980	EF Team	ee1210980@ee.iitd.ac.in	1
27	Muskan Yadav	2021EE10686	EF Team	ee1210686@ee.iitd.ac.in	1
28	Aluka Mokshavi	2021MT10909	EF Team	mt1210909@maths.iitd.ac.in	1
29	Palle Sathvika	2021MT10928	EF Team	mt1210928@maths.iitd.ac.in	1
30	Shubham Anand	2021EE10674	EF Team	ee1210674@ee.iitd.ac.in	1
31	Kumar Sanu Singh	2021EE31213	EF Team	ee3211213@ee.iitd.ac.in	0.9
32	Diyvansh Agarwal	2021EE10035	EF Team	ee1210035@ee.iitd.ac.in	1
33	Rahul Kumar	2021MT10893	EF Team	mt1210893@maths.iitd.ac.in	1
34	Manav Garg	2021EE30017	EF Team	ee3210017@ee.iitd.ac.in	0.9
35	Kushagr Goyal	2021EE10634	EF Team	ee1210634@ee.iitd.ac.in	1
36	Champak Swargiary	2021MT10263	EF Team	mt1210263@maths.iitd.ac.in	1
37	Ajay Naik	2020MT60888	EF Team	mt6200888@maths.iitd.ac.in	0.9
38	Aryan Sharma	2021EE10141	EF Team	ee1210141@ee.iitd.ac.in	0.9
39	Tanisha	2021MT10927	EF Team	mt1210927@maths.iitd.ac.in	1
40	Shreyansh Jain	2021MT10930	EF Team	mt1210930@maths.iitd.ac.in	0.9
41	Ishu	2021EE30735	EF Team	ee3210735@ee.iitd.ac.in	1
42	Ayush Madhur	2021EE10161	EF Team	ee1210161@ee.iitd.ac.in	0.9
43	Tanishk Singh	2021EE10167	EF Team	ee1210167@ee.iitd.ac.in	1
44	Kanak Kumar Singh	2021EE10163	EF Team	ee1210163@ee.iitd.ac.in	0.9
45	Vadlapudi Manoj	2021MT10245	Documentation	mt1210245@maths.iitd.ac.in	1
46	Alvakonda Sashidhar	2021EE30744	Documentation	ee3210744@ee.iitd.ac.in	1
47	Harshdeep Shakya	2021EE30745	Documentation	ee3210745@ee.iitd.ac.in	1
48	Bhavik Garg	2021EE10657	Documentation	ee1210657@ee.iitd.ac.in	1
49	Abhinava Anwesha Mohanty	2021EE10136	Documentation	ee1210136@ee.iitd.ac.in	1
50	Atishay Aggarwal	2021MT60941	Documentation	mt6210941@maths.iitd.ac.in	1
51	Srinath K S	2021MT10912	Documentation	mt1210912@maths.iitd.ac.in	1
52	Kshitij K Gautam	2021MT60269	Documentation	mt6210269@maths.iitd.ac.in	1

53	Chandan Kumar	2021MT60268	Documentation	mt6210268@maths.iitd.ac.in	1
54	Nitesh Singh	2021MT10250	Documentation	mt1210250@maths.iitd.ac.in	1
55	Vipul	2021EE30731	Documentation	ee3210731@ee.iitd.ac.in	1
56	Amit Singh	2021MT10921	Documentation	mt1210921@maths.iitd.ac.in	1
57	Sumanth Mandala	2021EE10153	Documentation	ee1210153@ee.iitd.ac.in	1
58	Prabhat Babu	2021MT10255	Documentation	mt1210255@maths.iitd.ac.in	1

Table 15: Team Members list

Tribe Members with IF less than 1

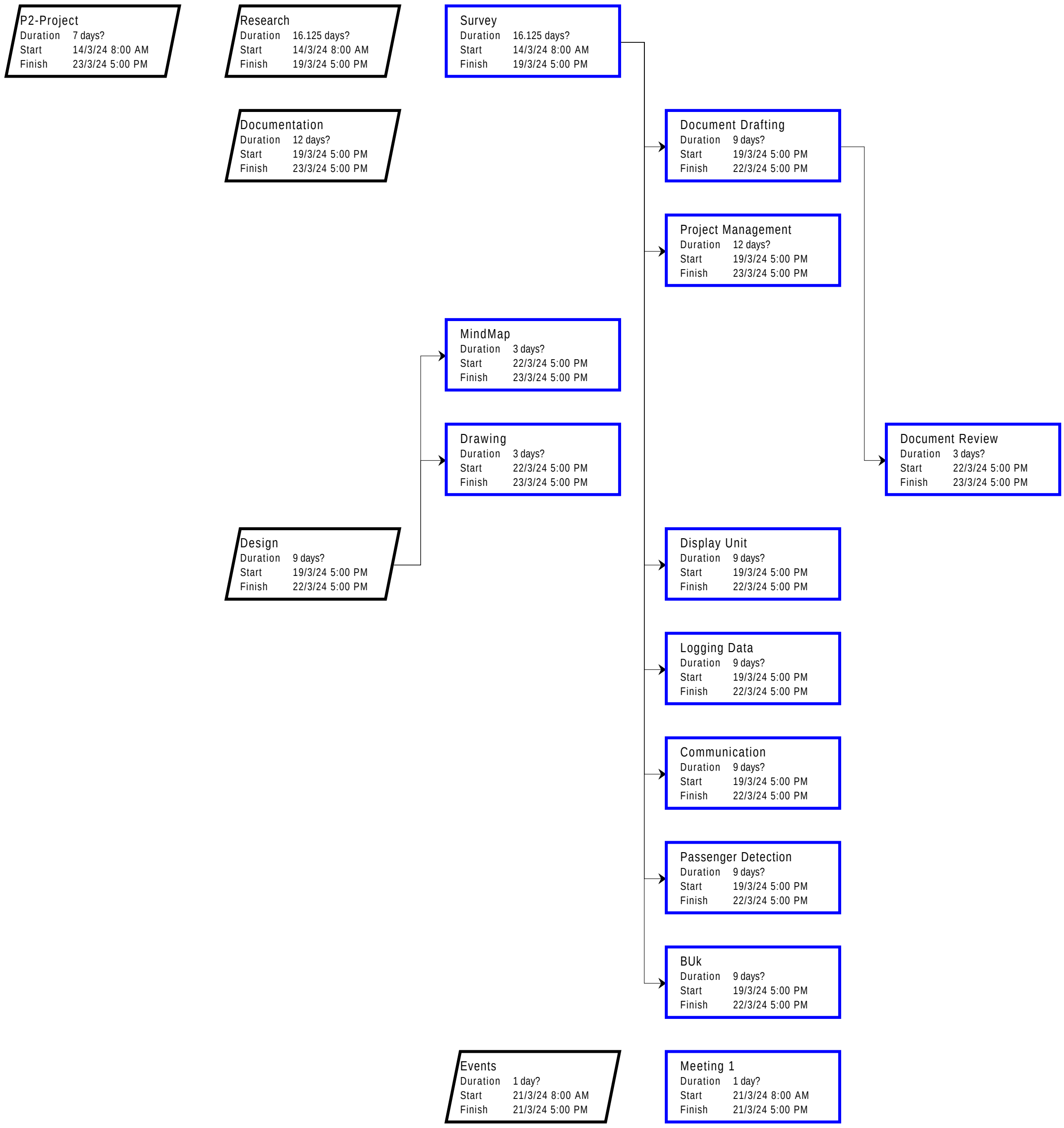
1	Abhas Porov	2021EE10781	EF Team	ee1210781@ee.iitd.ac.in	0.9
2	Shreyansh Jaiswal	2021EE10154	EF Team	ee1210154@ee.iitd.ac.in	0.9
3	Kumar Sanu Singh	2021EE31213	EF Team	ee3211213@ee.iitd.ac.in	0.9
4	Manav Garg	2021EE30017	EF Team	ee3210017@ee.iitd.ac.in	0.9
5	Ajay Naik	2020MT60888	EF Team	mt6200888@maths.iitd.ac.in	0.9
6	Aryan Sharma	2021EE10141	EF Team	ee1210141@ee.iitd.ac.in	0.9
7	Shreyansh Jain	2021MT10930	EF Team	mt1210930@maths.iitd.ac.in	0.9
8	Ayush Madhur	2021EE10161	EF Team	ee1210161@ee.iitd.ac.in	0.9
9	Kanak Kumar Singh	2021EE10163	EF Team	ee1210163@ee.iitd.ac.in	0.9

Table 16: Team Members with IF <1

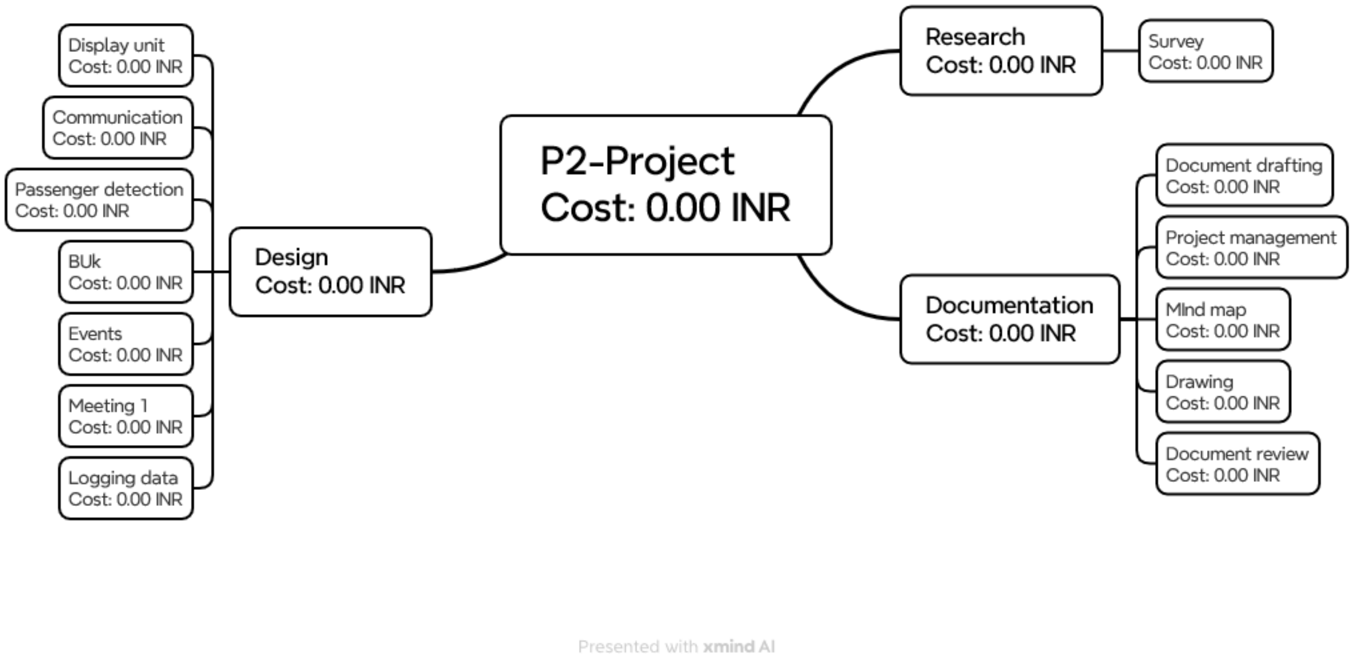
Reason: Assigned tasks were not completed, Low participation in most of the meetings even after multiple reminders on the group. No inputs were given for the research stage.

Project Management

Network Chart



WBS

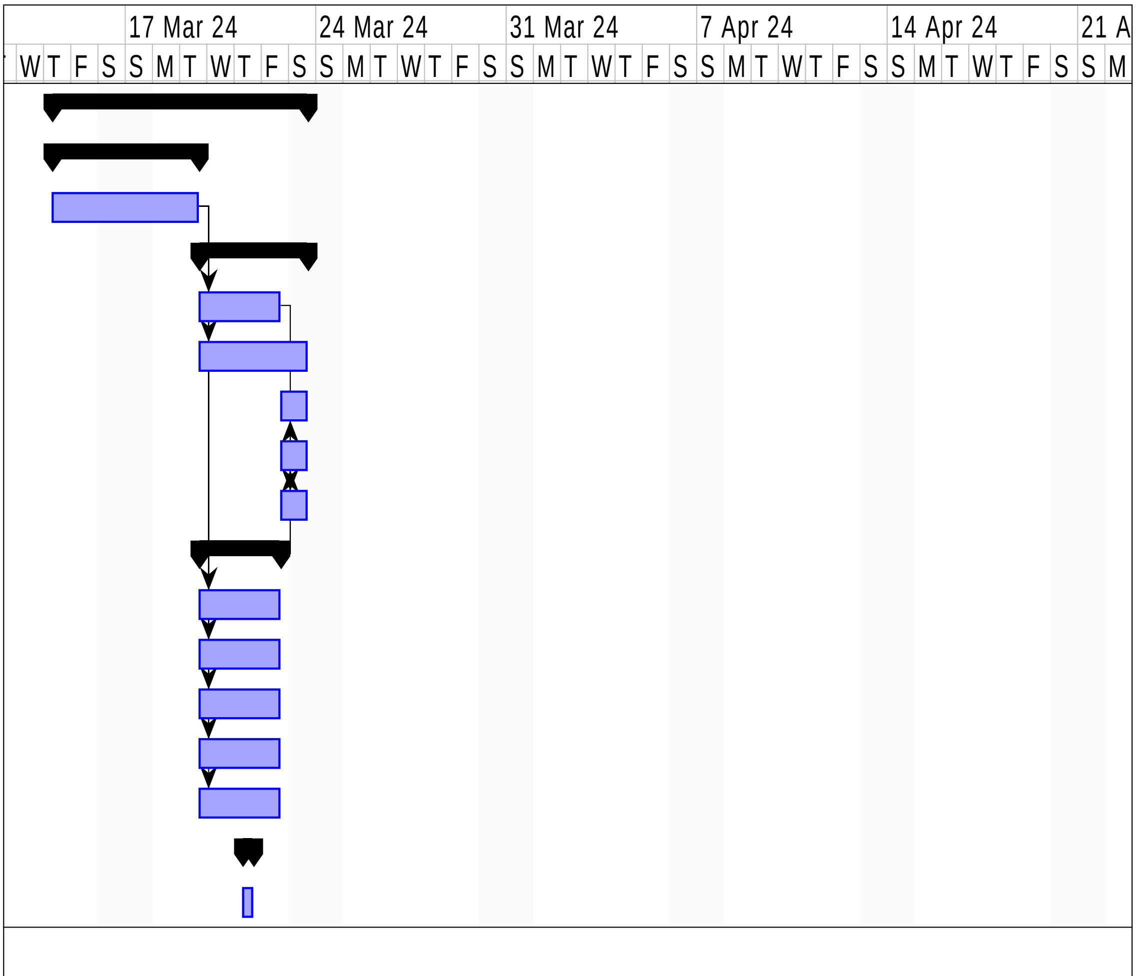


P2-Project
Cost: 0.00 INR
Research
Cost: 0.00 INR
Survey
Cost: 0.00 INR
Documentation
Cost: 0.00 INR
Document drafting
Cost: 0.00 INR
Project management
Cost: 0.00 INR
MInd map
Cost: 0.00 INR
Drawing
Cost: 0.00 INR
Document review
Cost: 0.00 INR
Design
Cost: 0.00 INR
Display unit
Cost: 0.00 INR
Communication
Cost: 0.00 INR
Passenger detection
Cost: 0.00 INR
BUk
Cost: 0.00 INR
Events
Cost: 0.00 INR
Meeting 1
Cost: 0.00 INR
Logging data
Cost: 0.00 INR
Presented with xmind AI

Gantt Chart

		Name	Duration	Start	Finish	Predecessors	M T
1		**P2-Project**	**7 days?**	**14/3/24 8:00 AM**	**23/3/24 5:00 PM**		
2		**Research**	**16.125 da...**	**14/3/24 8:00 AM**	**19/3/24 5:00 PM**		
3		Survey	16.125 d...	14/3/24 8:00 AM	19/3/24 5:00 PM		
4		**Documentation**	**12 days?**	**19/3/24 5:00 PM**	**23/3/24 5:00 PM**		
5		Document Drafting	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
6		Project Management	12 days?	19/3/24 5:00 PM	23/3/24 5:00 PM	3	
7		MindMap	3 days?	22/3/24 5:00 PM	23/3/24 5:00 PM	10	
8		Drawing	3 days?	22/3/24 5:00 PM	23/3/24 5:00 PM	10	
9		Document Review	3 days?	22/3/24 5:00 PM	23/3/24 5:00 PM	5	
10		**Design**	**9 days?**	**19/3/24 5:00 PM**	**22/3/24 5:00 PM**		
11		Display Unit	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
12		Logging Data	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
13		Communication	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
14		Passenger Detection	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
15		BUk	9 days?	19/3/24 5:00 PM	22/3/24 5:00 PM	3	
16		**Events**	**1 day?**	**21/3/24 8:00 AM**	**21/3/24 5:00 PM**		
17		Meeting 1	1 day?	21/3/24 8:00 AM	21/3/24 5:00 PM		

Gantt Chart - 2



Resource Breakdown

		Name	RBS	E-mail Address
1		Vadlapudi Manoj	Grammarly	mt1210245@iitd.ac.in
2		Nitesh Singh	Github	mt1210250@iitd.ac.in
3		Bhavik Garg	Overleaf	ee1210657@iitd.ac.in
4		Alvakonda Sashidhar	Grammarly	ee3210744@iitd.ac.in
5		Harshdeep Shakya	Grammarly	ee3210745@iitd.ac.in
6		Abhinava Anwesha M...	Overleaf	ee1210136@iitd.ac.in
7		Atishay Aggarwal	Overleaf	mt6210941@iitd.ac.in
8		Srinath K S	Overleaf	mt1210912@iitd.ac.in
9		Kshitij K Gautam	Overleaf	mt6210269@iitd.ac.in
10		Chandan kumar	Overleaf	mt6210268@iitd.ac.in
11		Vipul	Draw.io	ee3210731@iitd.ac.in
12		Amit Singh	Overleaf	mt1210921@iitd.ac.in
13		Sumanth Mandala	Grammarly	ee1210153@iitd.ac.in
14		Prabhat Babu	Xmind	mt1210255@iitd.ac.in
15		Ishu	Google Doc	ee3210735@iitd.ac.in
16		Rishika Arya	Google Doc	mt1210926@iitd.ac.in
17		Sarmistha Subhadarsh...	Google Doc	mt1210261@iitd.ac.in
18		Anshika Prajapati	Google Doc	mt6210961@iitd.ac.in
19		Rupam Kumawat	Google Doc	mt6210267@iitd.ac.in
20		Mukund Aggarwal	Google Doc	mt6210939@iitd.ac.in
21		Sakshi Magarkar	Google Doc	mt6210965@iitd.ac.in
22		Aniket Pandey	Google Doc	mt6210266@iitd.ac.in
23		Aravind Udupa	Photoshop	mt6210940@iitd.ac.in
24		Arpit Rathore	Google Doc	mt1210920@iitd.ac.in
25		Ayush Sharma	Google Doc	mt1210244@iitd.ac.in
26		Vandit Srivastava		ee1210640@iitd.ac.in
27		Aditya Gupta		ee3210713@iitd.ac.in
28		Aditya Bhalotia		ee3210698@iitd.ac.in
29		Ayush Shrivastava		ee1210632@iitd.ac.in
30		Harshit Nagar		ee1210155@iitd.ac.in
31		Shreyansh Jaiswal		ee1210154@iitd.ac.in
32		Akshar Tripathi		ee1210980@iitd.ac.in
33		Muskan Yadav		ee1210686@iitd.ac.in
34		Aluka Mokshavi		mt1210909@iitd.ac.in
35		Palle sathvika		mt1210928@iitd.ac.in
36		Shubham Anand		ee1210674@iitd.ac.in
37		Kumar Sanu Singh		ee3211213@iitd.ac.in
38		Ankita Meena		ee1210173@iitd.ac.in
39		Abhas Porov		ee1210781@iitd.ac.in
40		Divyansh Agarwal		ee1210035@iitd.ac.in
41		Rahul Kumar		mt1210893@iitd.ac.in
42		Kushagr Goyal		ee1210634@iitd.ac.in
43		Tanishk Singh		ee1210167@iitd.ac.in
44		Tanisha		mt1210927@iitd.ac.in
45		Keshvi	Zotero	ee1210682@iitd.ac.in

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[11] *Teams QnA*. en-GB. (Accessed 03/22/2024).

Index

Glossary

ambient temperature the average temperature of an environment, including the temperature of the air surrounding an object or equipment storage.. 20

beam counter a sensor that sends a beam to a reflector on the other side of a doorway, and when someone passes through the beam, the beam breaks and a person is counted.. 20

Burst transmission a telecommunication technique that involves broadcasting a high-bandwidth transmission over a short period of time.. 4

Destination the place to which someone or something is going or being sent.. 7

discrepancy The state of being different or in disagreement, or an instance of difference or inconsistency.. 3

durability the ability of a material to last a long time without significant deterioration.. 16

dwell time the amount of time users spend on a page from the search results before returning to the search engine results page.. 20

Focal Length The distance between the pole of the mirror (or the optical centre of the lens) and the focal point of a mirror (or lens).. 26

Fresnel lens a thin lens with a short focal length and large diameter.. 26

ideation he process of generating, developing, and communicating ideas, which can be visual, concrete, or abstract.. 1, b

ignition the process of starting something, usually an engine, to fire it up.. 5

infrared use infrared light to detect gases that absorb IR light at certain wavelengths.. 21

Maintenance The act of keeping something or someone in good condition by making repairs or correcting problems.. iii, 3

Microcontroller A small computer on a single integrated circuit. 4

occupancy the act of owning, renting, or taking possession of a building.. 20

Privacy the ability of an individual or group to keep themselves or their information private, allowing them to express themselves in selective ways.. 20

refueling the process of adding fuel to an aircraft or ship so it can continue its journey.. 4

scalability The ability of a system to increase or decrease in performance and cost in response to changes in application and system processing demands.. 3

sporadic something happens occasionally, singly, or in irregular or random instances.. 4

stoppage the act of stopping, the state of being stopped, or an obstruction in a pipe or tube.. 7

terabyte a unit of digital data storage that is equal to 1,000 gigabytes (GB) or 1,000,000 megabytes (MB).. 16

thermal sensors detect changes in temperature by measuring the electrical properties of sensor materials.. 20

toggle button a control that allows a user to switch between two or more states or options.. 5

transportation the action of transporting someone or something or the process of being transported.. 7

WiFi a networking technology that uses radio waves to allow high-speed data transfer over short distances.. 4

Appendix

Word Count	5515
Number of Sentences	442
Number of Characters (Without Spaces)	29098

Table 17: Document Statistics

Readability (0-100)[1]	71.3
Gunning Fog Index (0-20)[2]	8.5
Flesch Reading Ease (0-100)[3]	61.7
Coleman Liau Index (0-17+)[4]	9.5

Table 18: Readability Indices

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1. Readibility
Score Range: 0-100
Explanation: The Readability (0-100) score measures how easy or difficult a piece of text is to read. The higher the score, the easier the text is to understand. The score is calculated based on the average sentence length and the average number of syllables per word in the text.
2. Gunning Fog Readability
Score Range: 0-20
Explanation: The Gunning Fog Index estimates the years of formal education needed to understand a piece of text. The higher the index, the more difficult the text is to comprehend. It considers the average sentence length and the percentage of complex words (words with three or more syllables).
3. Flesch Reading Ease
Score Range: 0-100
Explanation: The Flesch Reading Ease score is a measure of how easy or difficult a piece of text is to read. The higher the score, the easier the text is to understand. The formula considers the average sentence length and the average number of syllables per word.
4. Coleman Liau Readability Index
Score Range: 0-17+
Explanation: The Coleman Liau Index determines the readability of a text by using characters per word and words per sentence. It provides an estimate of the U.S. school grade level required to comprehend the text. Higher scores indicate more difficult readability.