

GP106 Project Specification and Marking Rubric

The Pentagon

Course	GP106: Computing
Target Batch	E/19
Project Mode	3 Groups of 4 students as 1 main group
Time Duration	14 weeks
Milestones	Two regular and one bonus
Marks	15% (regular milestones) + 5% (bonus milestone)
Preamble	<p>This group project is designed to give students hands-on experience in building a system that involves both hardware and software. The project, in addition to the regular benefits of a project (such as soft skills development), is expected to benefit the students in applying the theory learned and the labs practiced.</p> <p>In brief, the project is to build a scaled down version of the security system of The Pentagon of the USA. Students will work with programming the hardware, gathering digital, analog inputs, communicating with a central server which makes decisions based on the provided data and finally a dashboard where the system is monitored.</p> <p>The project consists of 3 subprojects. 3 groups of 4 students each will work together completing each subproject. Subprojects are namely the Classified Document Room (CDR), President's Office (PO), Central Control Centre (CCC). Ultimately, these subprojects will work together as one system which will be evaluated. Students will be provided with necessary infrastructure and resources in order to complete the project.</p> <p>The project is expected to be completed within 14 weeks and you need to work according to the groups that are provided from the department.</p> <p>The first milestone of the project is to design the system and program basic hardware functionality. Here you should create flowcharts to show how the system is working, how you plan to use the inputs/outs and</p>

	<p>how each subproject is contributing to the main system. Moreover, students are required to implement the hardware for the first milestone. For example, using the knowledge gained in your labs and from the introductory session for the project that will be conducted, you will be able to communicate with the hardware using a serial connection from your laptop/pc, read digital/analog inputs, and handle outputs accordingly.</p> <p>The second milestone of the project involves communicating with the central server, data processing and real-time data visualization. Here the inputs are provided to the central server and once the server processes the data, outputs will be communicated to the relevant node. For example, CDR has a secret sequence entry system. Once the sequence is entered by a person, if that sequence is recognized and authorized, access to the room must be provided. Students can visualize giving access and denying access using color LEDs.</p> <p>The project also has a bonus milestone. This is for those who consider Milestones 1 and 2 are not challenging enough. For this milestone, you can enhance the project in any way you consider useful. This can be either using appropriate data structures where it's required, additional feature/insight or building the dashboard in a creative and attractive, user friendly design.</p>
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Milestone #	Deliverable	Deadline	Marks
1	Flow charts and Hardware	21-Feb-2022	7
2	Server communication and Dashboard	4-Apr-2022	8
Bonus	Additional feature/ enhancement / appropriate use of data structures / creative, attractive, user friendly Dashboard	4-Apr-2022	5

Description

In this project, you have to build a system which resembles a scaled down version of the security system for The Pentagon of the USA. As you all may have seen in spy movies such as James Bond's movies, Mission Impossible, imagine you are the company who won the contract to build the security system for one of the most secure buildings in the world, **The Pentagon**.

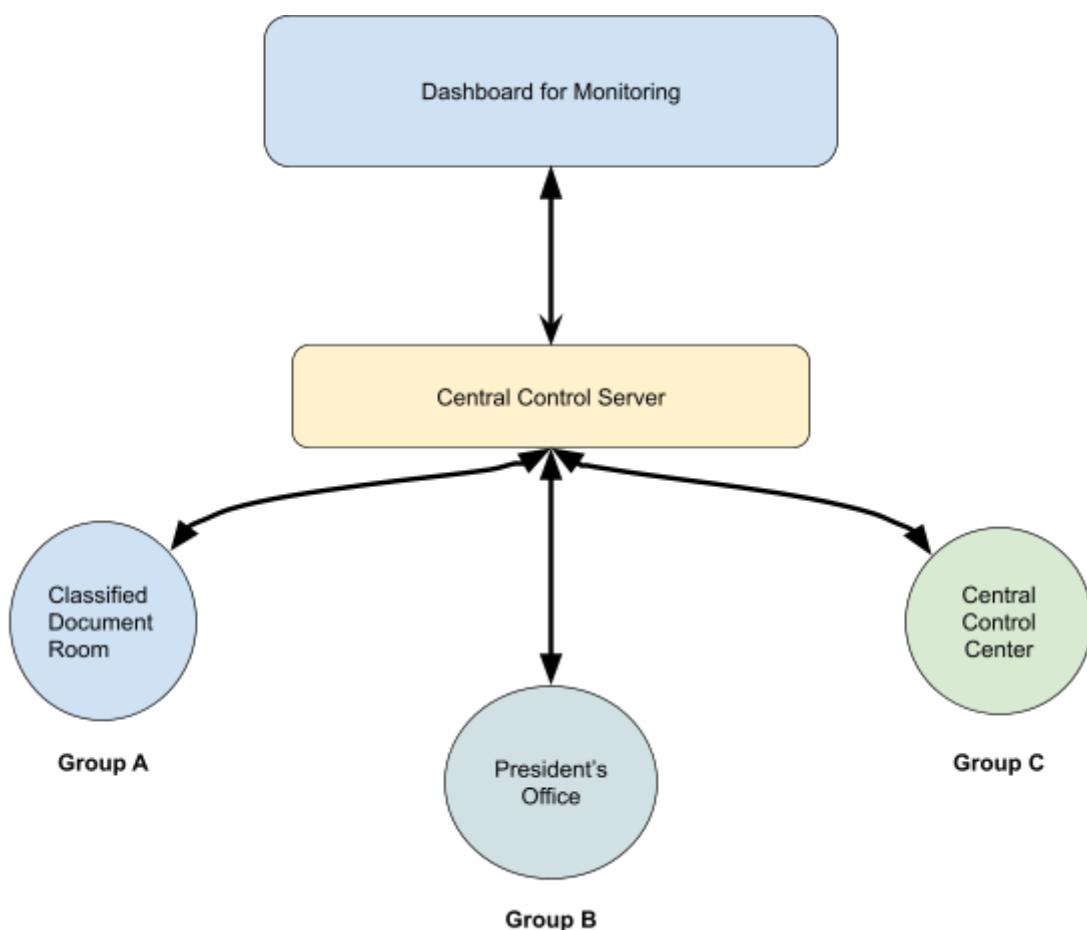
You were given this opportunity purely because of your creativity and unbeatable skill in problem solving. As a starting point, you are supposed to build 3 systems for the most important sections of The Pentagon. Namely, the Classified Document Room (**CDR**), President's Office (**PO**) and the Central Control Centre (**CCC**).



The Pentagon - USA : https://en.wikipedia.org/wiki/The_Pentagon

Given above is a picture of The Pentagon. Please feel free to read about it and have a brief picture of what it is so that you can passionately build the system. 4 students will work in one group and 3 such groups will combine together to build the final security system.

Overall system can be visualized using the following diagram.



Each group will be given a project kit, which contains the necessary components to build the system. and groups together will build the central control server and the dashboard.

Following sections will give you more information and what is expected from each group in detail. It is not required for each group to read each section, however, it is advisable to do so since you will get a better understanding about the overall system.

Use the following links to read more about subsystems for each group.

- Group A : [Classified Document Room](#)
- Group B : [President's Office / Situation Room](#)
- Group C : [Central Control Center](#)

Group A: Classified Document Room

Group A needs to build the security system for the **CDR**. The Classified Document Room is one of the most secure sections of the pentagon. The requirements for the system are as follows.

CDR requires the system to handle the following cases.

- Temperature is monitored for fire detection
- Light intensity is monitored for unusual activities
- Floor Pressure sensors are implemented for security breaches
- Secret entry sequence by 2 guards simultaneously. (2 push buttons, pressed in a sequence)
- Emergency Lockdown Indicator

The Pentagon requires secured access to the room using a secret entry sequence entered simultaneously by 2 members of the staff. There are several access levels for the staff within the pentagon. As you might have heard, the US government has 3 security clearance categories. Namely, confidential, secret, and top secret. For each of these categories, a certain set of sequences are available.

Using your imagination, creativity and knowledge gained from your course and labs, you will use a pair of buttons and by using the digital input signals of these 2 buttons, you will provide the captured sequence to the central server, which will validate the sequence against the above clearance categories. Here is a place where you can achieve that bonus marks by using an appropriate data structure and clever thinking.

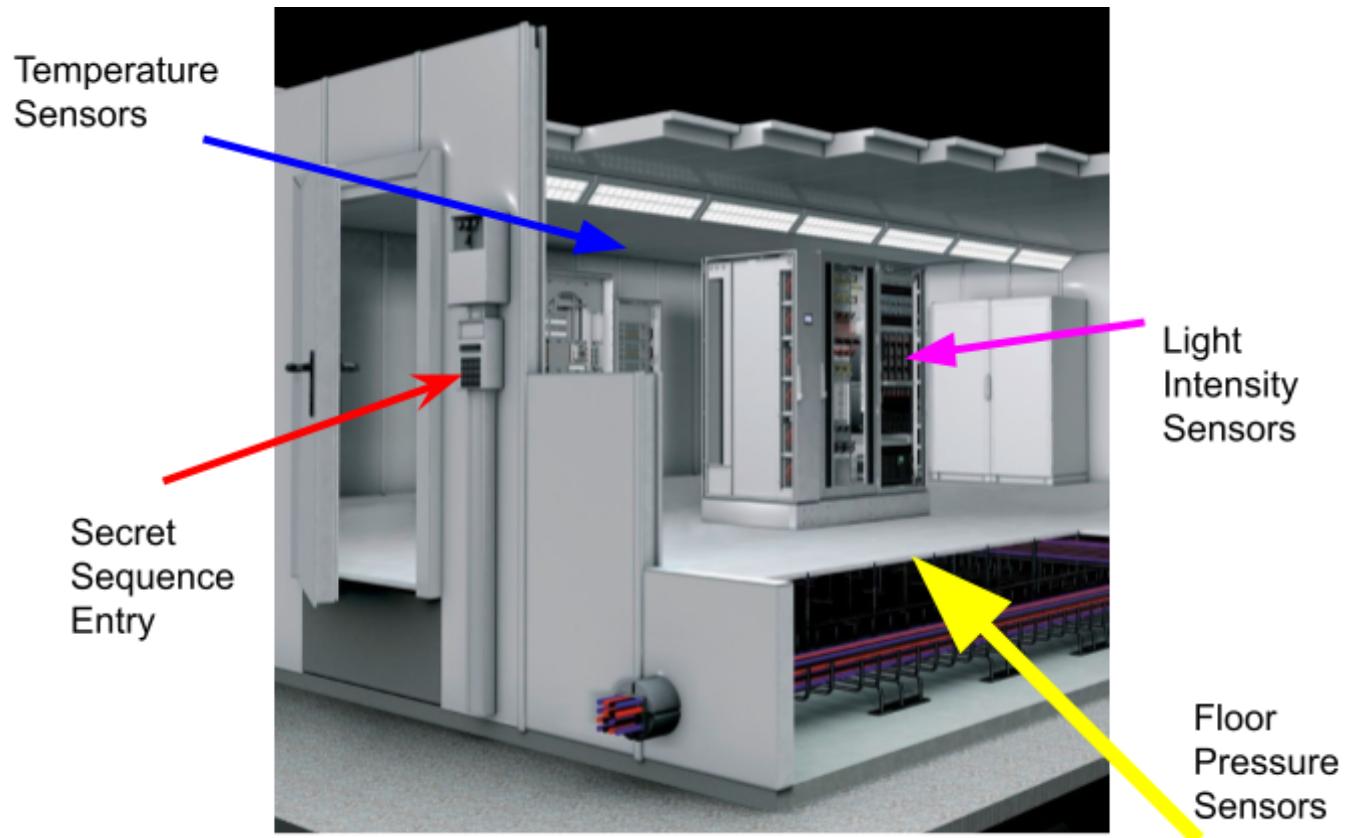
Moreover, Temperature is monitored for fire detection since the room has many important documents. Light intensity is monitored for unusual activities. For instance, the lighting condition of the room must be maintained at a certain intensity for security purposes. Your system should be capable of monitoring the intensity, and providing alarms/alerts if it's at unusual levels.

Floor pressure sensors are placed in the room floor in undisclosed locations to the public, which are activated at all times except when an authorized person enters the room.



Remember this scene? (<https://www.youtube.com/watch?v=ar0xLps7WSY>) Imagine the floor pressures sensors are push buttons and if they are triggered by an unauthorized person, immediately your system should go into lockdown (You may use an LED to indicate the lockdown and a buzzer - be creative and feel free to use your imagination). Moreover, it must be alerted to the central server so that CCC can see it in the dashboard and take security measures accordingly.

Ideally you can visualize the **CDR** using the below picture.



High level visualization of the CDR

If you are interested in reading the other subsystems, feel free to continue reading the document.

You may skip to the [System Architecture and Technical Stack](#) if you are not interested in other subsystems.

Group B: President's Office / Situation Room

Group B needs to build the security system for the **PO**. The President's office, also known as the **Situation Room** is one of the crucial and important sections of the pentagon. Therefore, the requirements for the system are as follows.

- Temperature is monitored for fire detection
- Secret Knock to enter the room
- Panic button for president
- Emergency Lockdown Indicator



Situation Room / President's Office

Your system should monitor the temperature of the room for fire detection, a panic button for the president under his table for him to alert the security in case he notices anything suspicious. Panic button should immediately start the lockdown procedure (You may use a LED/Buzzer to replicate it) and as mentioned above for CDR, it must be alerted as well.

In order to enter the room, imagine there's a secret door knock which an intelligent system understands. You will be using a push button to detect this secret knock, validate the knock through the central server and grant access. Here is another chance for you to gain that bonus mark. There is no right or wrong way to implement this. Feel free to use your imagination.



Secret Knock in action

If you are interested in reading the other subsystems, feel free to continue reading the document.

You may skip to the [System Architecture and Technical Stack](#) if you are not interested in other subsystems.

Group C: Central Control Center

The final group can build the system for the CCC. Central Control Center will have access to the Dashboard through which they can monitor the different sections of the building. The Pentagon requires the following to be implemented in the system.

- Temperature of the control center is monitored for fire detection
- MorseCode to enter secret passphrase to the server room using LDR and Light (Phone Torch)
- Central Control Dashboard for monitoring
- Central Control Server (Handles logic for authentication, alarm control, emergency protocols, etc)

For example, current status/readings of the CDR can be monitored from the dashboard. Moreover, the dashboard must have an Emergency Lockdown initiator button where CCC can immediately enter the pentagon into a building-wide lockdown. Once this lockdown is initiated, CDR, PO must go into lockdown as well.

Moreover, Central Control Server must be implemented by this group as well. However, the other groups must contribute to build the central control server logic and the dashboard.

For example, when CDR sends the captured secret sequence, the central control server must validate the sequence and communicate back to CDR whether the access is denied or not. Another role of the server is to monitor the temperatures, and security measures of the other sections of the building. For instance, if a pressure sensor is triggered from the CDR, it must be immediately alerted in the dashboard and it should initiate the lockdown protocol.

In order to enter the CCC, you will need to implement a system which can decode [Morse Code](#). For those of you who do not have an idea about what it is, please feel free to search the internet, watch some videos and get an understanding of how it works. In order to implement this, you will use an LDR and a Torch (Phone torch) to simulate a signal. Refer to this [video](#) to get an overview of what your system should accomplish.



Morse Code Signaling

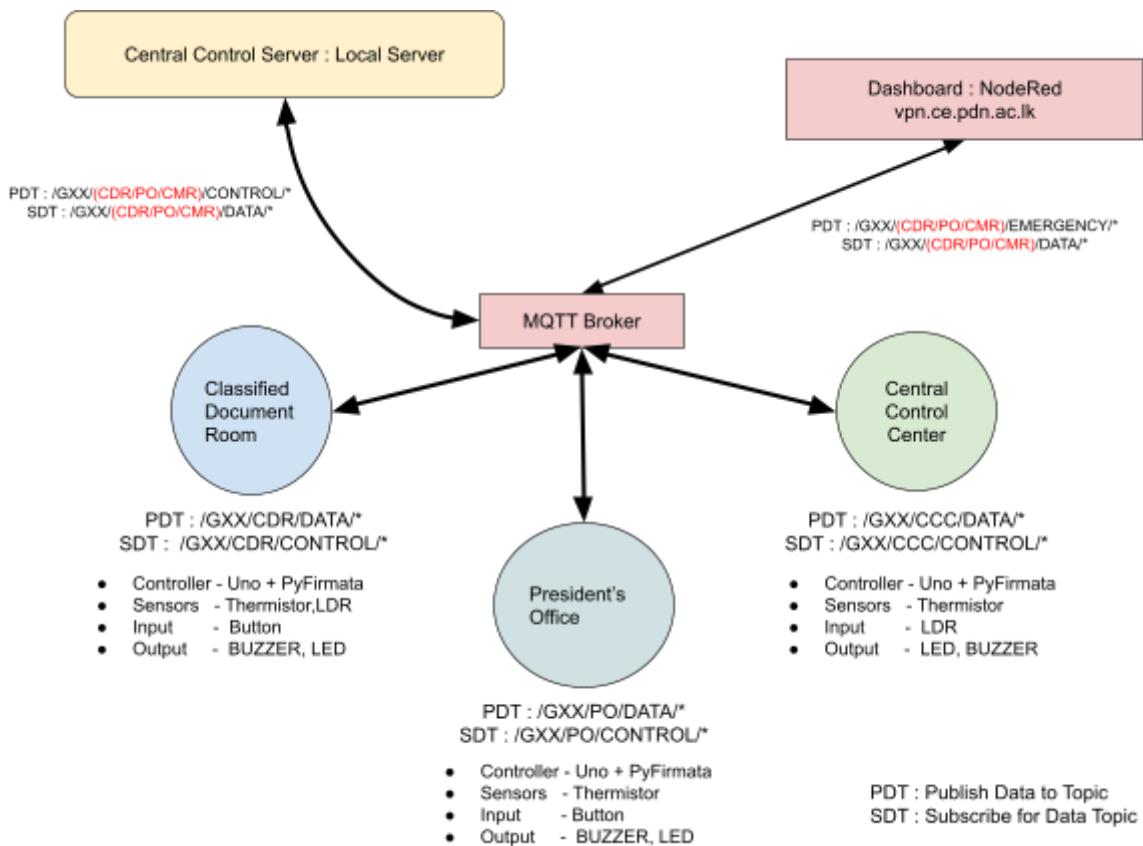
This is yet another opportunity to score some bonus points. Implementing morse code is not very intuitive and easy. However, with your thinking ability and knowledge, you do not have to worry about it too much. There are plenty of resources available on the internet for you to learn and tackle this.

Next section will have details about system architecture and the technological stack **all groups** will be using to build the entire system. Please make sure that you go through it and try your best to understand the overall architecture.

System Architecture and Technical Stack

All groups will be using [MQTT protocol](#) for communication. You will be provided with the necessary infrastructure for such communication, guides and resources for you to comfortably start using these protocols. You do not need to worry about how these protocols work for now. You will learn all these in depth if you do computer engineering.

However, it is advised that you do some background research on these protocols so that you have an understanding of what you are doing. In order to build the dashboard, you will be using a platform called [NodeRed](#). All 3 groups will be building a single dashboard. Again, we will be providing you with necessary infrastructure and guidance to start using these technologies. To get a brief overview of how the entire system works together, you may try to understand the following diagram.



Internet Resources

- <https://pyfirmata.readthedocs.io/en/latest/index.html>
- <https://pypi.org/project/paho-mqtt/>
- <https://www.youtube.com/watch?v=Ho1vMuA43ks&t=390s>

Skeleton Codes and Guides

- https://drive.google.com/drive/folders/1KC2Rp3rrHWq4JL-8LUc_sWzxzQPpBk5Z?usp=sharing

Milestones

The **first milestone** of the project is to design the system and program the hardware (Arduino) using the given sensors/components to acquire the following data and indicate following outputs.

- Temperature readings using the thermistor
- Light intensity reading using the ldr
- Push button input signals
- Controlling LEDs and Buzzers

Flowcharts for algorithmic components such as morse code decoding, secret sequence verification, secret knock verification is also expected from the students at this stage.

You'll have to refer to the Internet and find the necessary knowledge to build the required algorithms with given inputs. Before coding the solution you should create flowcharts to show how the system process is happening. Both design documents, hardware implementation and flowcharts for algorithmic components will be evaluated for this milestone.

The **second milestone** involves communicating with the central server, data processing and real-time data visualization. Initially, the data should be communicated from the Arduino to the central server using the given guidance and infrastructure. These data must be processed accordingly and the outputs should be communicated back to the Arduino. Moreover, these data must be visualized in real-time using the dashboard they will build.

Following are the main components of the dashboard

- Visualization of monitored values such as Temperature, Light Intensity of CDR,PO,CCC.
- Security breach indications
- Emergency lockdown button for CDR, PO, CCC.

Layout of the dashboard is not restricted. Students can use their creativity and imagination to build the dashboard.

Following are the main components of the central server

- Handle incoming data from CDR,PO,CCC and process them. (Temperature values, thresholds, alert/alarming accordingly etc).
- Validate security measures (Sequence verification, Morse code decoding etc)
- Lockdown protocol initiation (Alerting CDR,PO,CCC to start lockdown protocol)

For the **bonus milestone**, you can improve the work you have done by adding something creative/innovative to that. This can be either additional feature/insight or designing and building a creative/attractive/user-friendly dashboard or any other enhancement that might be useful with the implemented system. Bonus milestones will **only** be marked if you have completed the regular milestones.

Milestone 1: Marking Rubric

System Design and hardware implementation

Criteria	Marks	Description	Marks
System Design	3	The 3 sub projects must be planned based on flowcharts of how they will work together as one main system. Flowcharts for algorithmic components also must be provided. Should be submitted as a small report with a necessary explanation of the system workflow.	<p>3.0 - Have necessary flowcharts with proper explanations</p> <p>xx - Have a partial design or no proper description</p> <p>0.0 - Not attempted</p>
Basic Hardware implementation	4	Hardware must be setup to read digital inputs using push buttons, analog inputs using thermistors, ldr and convert the analog readings to appropriate units (Temperature C*, Light intensity 0-100%) and provide outputs using LED and Buzzers. (Temperature < XX -> LED/Buzzer should produce an output)	<p>4.0 - Completely working code with all the functions implemented, nicely written and proper explanations</p> <p>2.5 - Complete working code with all functions. Not properly written and no proper explanation.</p> <p>xx - Partial implementations with proper explanations. (Marks will depend on the number of functions completed)</p> <p>xx - Partial implementations without proper explanations. (Marks will depend on the number of functions completed)</p> <p>0.0 – Not attempted</p>
Milestone completion	1	Satisfactorily completed the milestone 1 as expected.	<p>1.0 - Completed</p> <p>0.5 - Partially completed</p> <p>0.0 - Unsatisfactory</p>

Milestone 2 + Bonus: Marking Rubric

System implementation and Dashboard

Criteria	Marks	Full Marks Criteria	Marks to be Awarded
Working System with the dashboard (Code)	4	The final security system should work as intended. Each subproject must provide the requirements mentioned .	<p>4.0 - Completely working subprojects interacting as one system, working dashboard and proper explanation</p> <p>xx - Partial implementations of the system (Marks will depend on the implemented work)</p> <p>0.0 – Not attempted</p>
Overall implementation	1	Depends on how overall system works together, user-friendly dashboard design, the quality of the code you have written, good coding practices etc	<p>1.0 - Very good.</p> <p>0.5 - Acceptable</p> <p>0.0 - Not Acceptable</p>
Project presentation and Video	3	Satisfactorily completed the presentation and video includes all subsystems working together	Marks are given individually considering the work is done and presented.
Bonus Milestone	5	Bonus marks will be given to any extra feature that has been implemented considering innovation, effort and completion. Maximum 5 marks.	