Product Requirements And Specifications Document (PRSD) GSM Remote Monitoring System

Approvals

Title	Print	Signature	Date

Revision History

Revision	Summary of Change	Originator
X0	New Document	UTSA-ECE

For: UTSA Senior Design
Project: GSM Remote Monitoring System
Date: 04/20/2021
Prepared by: Adam Whitman, Andre Crathers, Ngoc Nguyen, Ahmed Almoola

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1. Introduction

This document contains the system requirements for GSM Remote Monitoring System. These requirements have been derived from several sources, including brief listing of most important sources.

1.1 Purpose of This Document

This document is intended to guide development of **GSM Remote Monitoring System**. It will go through several stages during the course of the project:

1. **Draft:** The first version, or draft version, is compiled after requirements have been discovered, recorded, classified, and prioritized.
2. **Proposed:** The draft document is then proposed as a potential requirements specification for the project. The proposed document should be reviewed by several parties, who may comment on any requirements and any priorities, either to agree, to disagree, or to identify missing requirements. Readers include end-users, developers, university faculty, course instructor, and any other stakeholders.
3. **Validated:** Once the various stakeholders have agreed to the requirements in the document, it is considered validated.
4. **Approved:** The validated document is accepted as an appropriate statement of requirements for the project. The developers then use the requirements document as a guide to implementation and to check the progress of the project as it develops.

1.3 Scope of the Product

Our current design will use a GSM monitoring system that detects valid alarms such as the motion of vehicles and humans. The system will use YOLO which is implemented in a raspberry pi to analyze the video that is captured by a camera to detect the type of object. The system sends only valid alarms to the end user's cellphone.

1.4 Case for the Product (Need)

Currently, construction site managers utilize live/on-site security and/or fences and gates to prevent intrusion onto construction sites. The GSM Remote Monitor reduces the need for live personnel while still providing a high level of security. The system installation and setup is easy, it's a stand-alone product, and will have a DC-battery and solar panel to power it 24/7.

2. General Description

The Global System for Mobile (GSM) is a security system that alerts the user of potential illicit activity at sites that do not have any power or internet connectivity.

2.1 Product Perspective

The GSM Remote Monitoring System allows users to monitor an area without having to have personnel present on location. Stakeholders include the project manager (project manager is the client who is running a project in the given

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location), the project manager's customer (project manager is creating a product for a customer) and subcontractors from whom the GSM monitoring system are sourced. The project manager's customer benefits from using the GSM Remote Monitoring System because not having security personnel drives down labor costs of the project manager, ultimately driving down cost to the downstream customer.

2.2 Product Functions

The GSM Remote Monitoring System monitors an area and sends messages to the product owner relaying the status of the area being monitored. Product functions include monitoring and communication.

2.3 User Characteristics

Prospective product users include construction project managers, loss prevention organizations and high security/access site managers. The general profile of prospective product users includes high school education with basic understanding of how to use cell phones. No other specialized skills are needed.

2.4 General Constraints

Product constraints include using an existing microcontroller (Raspberry Pi), camera, battery and solar panel. The only constraint that negatively impacts the performance of the product is the battery – ideal situation would be for the new battery to be custom designed and built to sustain long periods of stand-alone charge (without needing charge from solar panel)

2.5 Assumptions and Dependencies

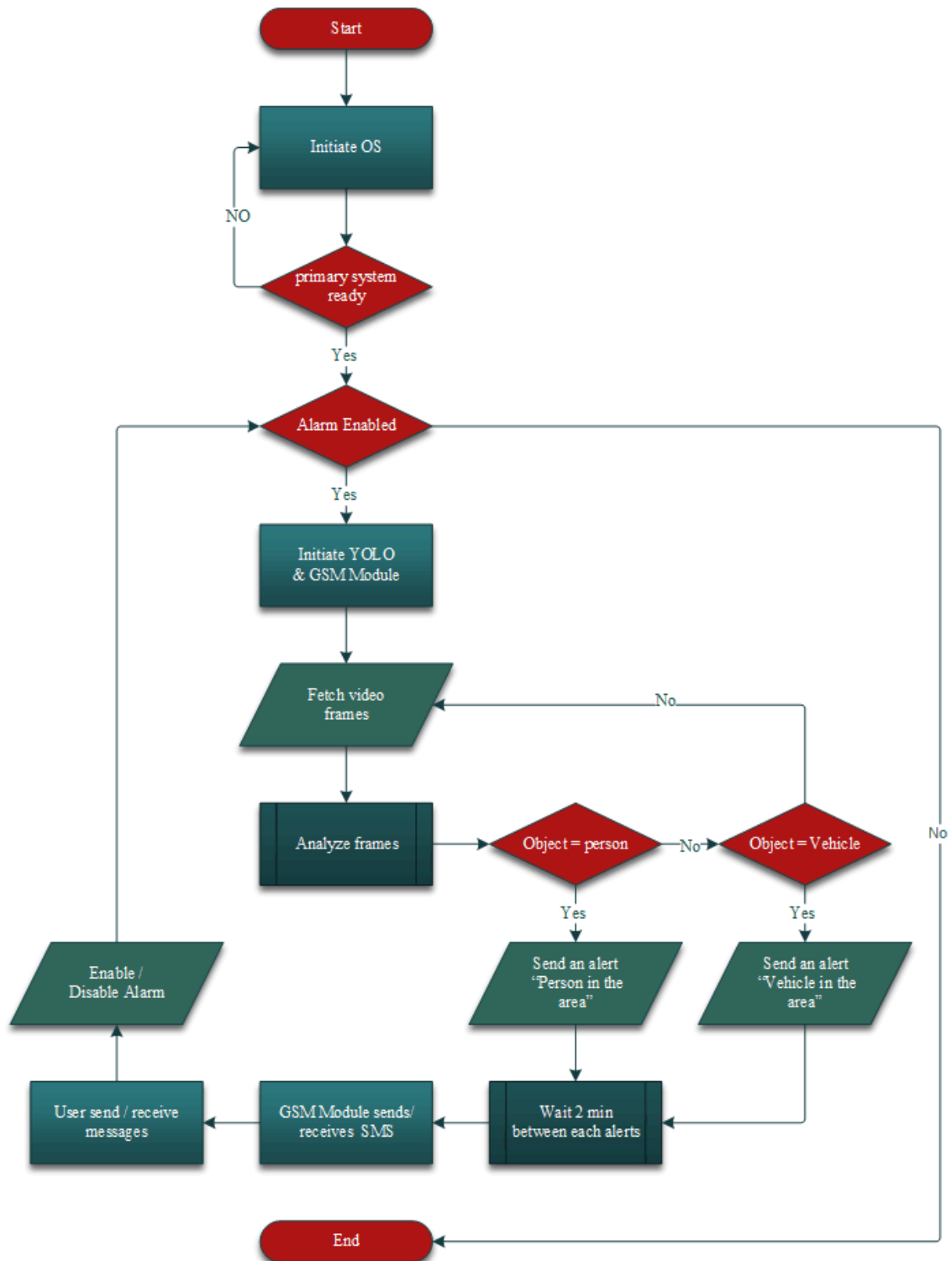Product dependencies include access to satellite communications network (existing satellites which are in use for general data transfer), continued production of cameras and microcontrollers (for future GSM Remote Monitoring production)

2.6 Objectives

Technical objectives include

- Monitor area (video feed)

- Detect significant changes in the observed area (motion detection)

- Communicate changes in observed are to end user

Software Flow Diagram

```
                          ┌──────────┐
                          │  Start   │
                          └────┬─────┘
                               │
                          ┌────▼─────┐
               ┌─────────▶│ Initiate OS│
               │          └────┬─────┘
         NO    │               │
               │          ◇ primary system ◇
               └──────────  ready
                               │ Yes
                               │
                    ◇ Alarm Enabled ◇ ───────────────┐ No
                               │ Yes                 │
                    ┌──────────▼──────────┐          │
                    │ Initiate YOLO       │          │
                    │ & GSM Module        │          │
                    └──────────┬──────────┘          │
                               │                     │
                    ╱ Fetch video ╱ ◀──── No ───────┐│
                    ╱ frames     ╱                  ││
                               │                    ││
                    ┌──────────▼──┐  ◇Object=person◇ No ◇Object=Vehicle◇
                    │Analyze frames│                  │            │
                    └──────────────┘                  │Yes         │Yes
                                                      │            │
   ╱ Enable /    ╱      ╱ Send an alert ╱  ╱ Send an alert ╱
   ╱ Disable Alarm ╱    ╱ "Person in the ╱ ╱ "Vehicle in the ╱
                        ╱ area"          ╱ ╱ area"          ╱
         ▲                    │                   │
   ┌─────┴────┐  ┌──────────┐ ┌──────────────────┐
   │User send/ │◀│GSM Module│◀│ Wait 2 min       │
   │receive    │ │sends/    │ │ between each alerts│
   │messages   │ │receives SMS│└──────────────────┘
   └───────────┘ └──────────┘
                               ┌──────────┐
                               │   End    │
                               └──────────┘
```

2.7 Plan

- Resource fund

- Decide all potential hardware components and source parts

- Get familiar with Raspbian OS and Raspberry Pi

- Learn Python, OpenCV, and YOLO

- Learn how to connect GSM module to Raspberry Pi

- Research on how to connect IP Camera to Raspberry Pi

- Research on designing and build the power supply circuit

- Design the waterproof container to store all parts together efficiently

- Assemble all components

- Test and Modify (Iterative Process)

- Deliver final product

2.8 Schedule Requirements
Schedule is laid out in the Gantt chart below
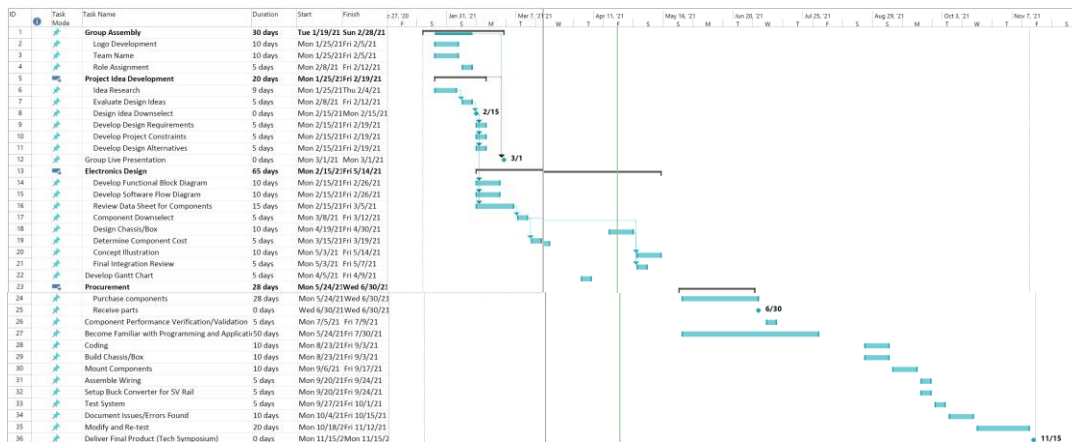
3. Specific Requirements and Specifications

This section of the document lists specific requirements and specifications for GSM Remote Monitoring System Requirements and specifications are divided into the following sections:

- User requirements and specifications. These are requirements and specifications written from the point of view of end users, usually expressed in narrative form.
- System requirements and specifications. These are detailed requirements and specifications describing the functions the system must be capable of doing.
- Interface requirements and specifications. These are requirements and specifications about the user interface, which may be expressed as a list, as a narrative, or as images of screen mock-ups.

3.1 User Requirements and Specifications

1.1.1   User interface

The user interface is the user's cellular phone. The user can disable and enable the system by sending a text to the phone number that is associated with the SIM card that is used in the GSM module.

1.1.2   Ergonomics

The system will be assembled inside a plastic dustproof and waterproof junction enclosure with lock and size (8.6"x6.7"x4.3"). In addition to that, the solar panel will be mounted outside with an articulated arm to give the flexibility of adjustment for direct solar light.

1.1.3   Training or skills required

Technical understanding or experience working with the GSM Remote security system are necessary for the most efficient use of this system. Technical understanding of the components, lifetime of the battery, location that have visibility to direct solar light, within the area of coverage of the cellular provider are highly recommended to further increase the efficient use of this system in the field.

3.2 System Requirements and Specifications

3.2.1 Physical Characteristics
- Weight: less than 30 lbs.
- Dimensions: 3' x 3' x 0.5'

3.2.2 Material Requirements
- Enclosure   ABS
- Articulate bracket   6061 aluminum alloy

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3.2.3 Electrical Requirements

- Battery   12v 20Ah
- Raspberry pi   5VDC, 1.2A
- IP Camera   12VDC, 0.5A

3.2.4 Abilities

- Camera
    - 4K
    - Has night-vision
    - Ethernet connection
    - 12VDC
- YOLO
    - Analyze image
    - Accurate object type detection
- GSM Module
    - Compatible with 4G LTE networks in the United States
    - Compatible with Raspberry pi
- Solar Panels
    - Provide enough power to all components and charge the battery
    - Battery
    - Enough to keep the components to be powered for at least 15 hours

3.2.5 Limitations

- No GSM signal in the area
- No direct solar light

3.2.6 Equipment or materials required to use the product

- Raspberry pi
- 30 Watts 12V Solar Panel
- 20AH rechargeable battery
- GSM sim card with phone service plane

3.2.7 Equipment interface requirements

- Any phone that can receive and display text message

3.2.8 Handling and storage requirements

- Operating temperature 0°C to 40°C
- Storage temperature -25°C to 55°C
- Operating and storage humidity 5-85% non-condensing
- Battery is recommended to be disconnected

3.2.9 Cleaning and Sterilization
- The lens of the camera needs to be cleaned once every three months with a wet towel and then wiped with dried microfiber.
- Clean the solar panel with a wet towel and dry it up with a clean dried towel once every three months.

3.2.10 Product maintenance and serviceability
- An overall annual service is recommended to ensure all the wires are remain intact and all the components are in good shape
- Replace the battery once a year.

3.2.11 Operating Parameters
- Raspberry Pi 4
    - Power: 4.63VDC – 5.10VDC, 0.6A – 3.0A
    - Operating Temperature: -25°C to 70°C
- IP Camera
    - Power: 12VDC, PoE(802.3af) Class 0
    - Operating Temperature: -30°C to 60°C

3.2.12 Repeatability and reproducibility
- The system is reusable with repeatable proper cleaning and maintenance of the components.

3.2.13 Reliability
- Depending on the GSM Signal and regular cleaning of the camera lens, and battery life cycle the system can function properly.
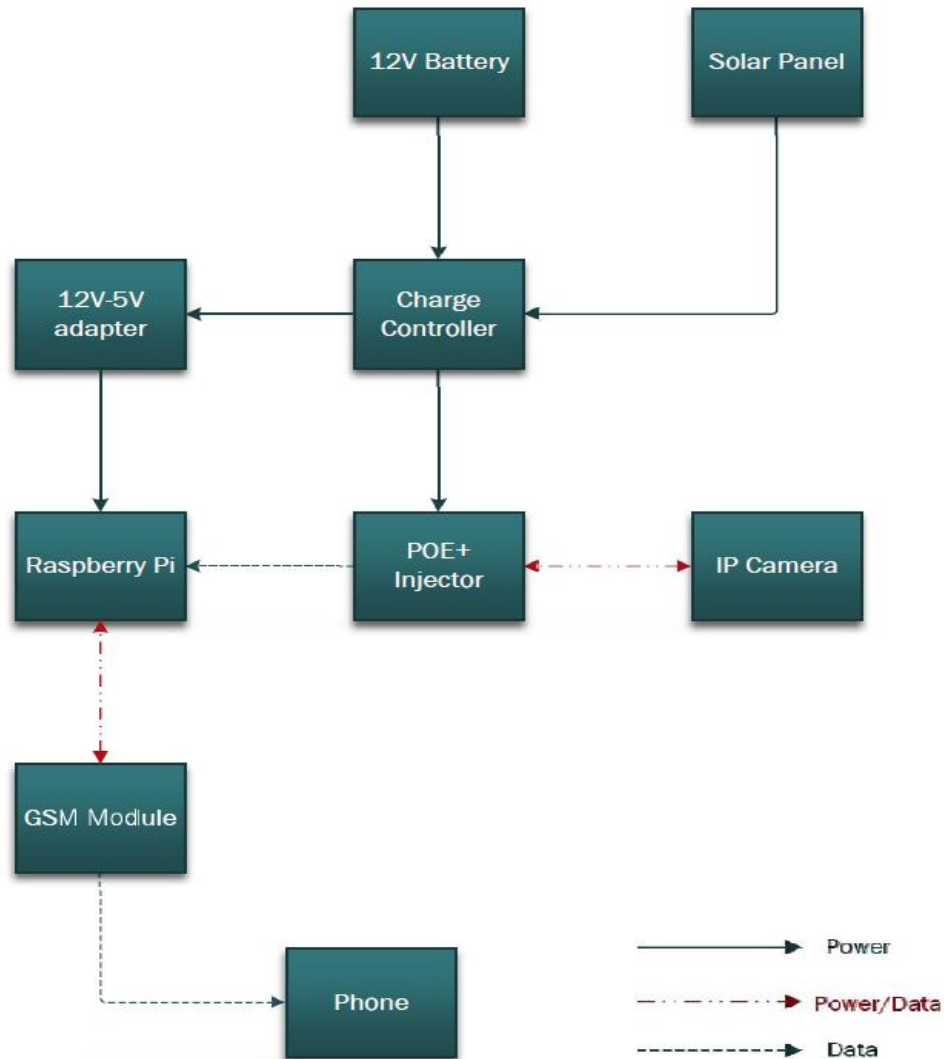
3.2.14 Mechanical safety features
- Components will be secured and properly mounted inside the enclosure
- Solar panel will be secured with a mounting bracket attached to the enclosure
- Camera will be fastened to the bottom of the enclosure

3.2.15 Electrical safety features
- 14/4 wire will be used from batter to the charge controller
- 18/2 wire will be used for power connection
- Cat6 cable will be used for the connection between the camera and processor

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3.3 Interface Requirements and Specifications

The solar panel will be connected to the charge controller to avoid overcharging of the battery power and will be provided to the processor via 12VDC to 5VDC adapter. The camera will receive connected to a PoE injector that can use 12VDC power. The camera is connected via cat6 cable to the processor. The processor sends text messages via the GSM module to the end user cellphone.

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3.4 Environmental Conditions

    3.4.1 Temperature

        3.4.1.1 Operating: -25°C to 60°C

        3.4.1.2 Storage: -25°C to 70°C

    3.4.2 Humidity

        3.4.2.1 Operating: 5-85% non-condensing

        3.4.2.2 Storage: 5-85% non-condensing

    3.4.3 Shipping, transportation vibration

        - Foam-in-place systems will be used to provide all the protection of foam during shipping, warehousing, and general handling

    3.4.4 Pressure and Altitude

        -Maximum External Pressure: 1 atm.

        -Maximum Altitude: 30km

    3.4.5 Electromagnetic Interference

        -less than 3 mT

    3.4.6 Electrostatic Discharge

        NA

    3.4.7 Impact Resistance

        NA

3.5 Manufacturing

    3.5.1 Cost

Item	Cost
- Raspberry Pi 4 8GB Extreme Kit - 128GB Edition (8GB RAM)	149.99
- Amcrest UltraHD Outdoor POE Camera Bullet IP Security Camera	49.99
- 25 Watt 12 Volt Polycrystalline Solar Panel	32.99
- 20A Solar Charge Controller Solar Panel Battery Intelligent Regulator	14.39
- Solar Panel Pole Mount Brackets Set Aluminum Mounting Brackets	49.99
- MMG SLA Rechargeable Battery 12V 20Ah	36.90
- Ogrmar ABS Plastic Dustproof Waterproof IP65 Junction Box	19.99
- 12V to 5V DC USB Type-C Right Angle Step-Down Power Converter	12.50
- PoE Texas | Gigabit Passive PoE Injector	7.49
- GSM/GPRS Module SIM800L	8.99
- SIM CARD and annual service plane	66
- Misc wires and hardware	30
	479.22

3.5.2 Environmental requirements for production
- Source, containment, and disposal of lithium-ion batteries.

3.5.3 Raw materials and suppliers
NA

3.5.4 Test methods, standards
- Install a prototype at a location with heavy traffic during the day and light traffic at night
- Testing the maximum system uptime on battery without connecting solar panel
- Testing the sending alert messages delay interval

3.6 Packaging

3.6.1 Packaging configurations
- About (3' x 3' x 0.5') is the assembled system

3.6.2 Packaging materials
- Foam-in-place systems will be used to provide all the protection of foam during shipping, warehousing, and general handling.

3.6.3 Special shipment requirements
- Contains batteries and must be marked appropriately
- Contain fragile components and must be marked with handle with care

3.7 Labeling

3.7.1 Detail intended use, warning, directions for use, cleaning, expiration date
- Intention - on the enclosure "GSM Remote Monitoring System"
- Warning - on the package "Fragile, handle with care"
- Warning - on the package "Contain batteries"
- Warning - on the enclosure "Connect battery before use"
- Direction - inside the enclosure "Insert SIM Card here"
- Direction - inside the enclosure "Press to Turn ON"
- Cleaning - by the camera "Clean every three months"
- Cleaning - on the solar panel "Clean every three months"
- Expiration date – on the battery

3.7.2 Identify target audience for labeling
- End user, installer, service technicians

3.7.3 Language requirements
- English

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3.8 Regulatory

3.8.1 Clinical trials
- NA

3.8.2 Submission type
- NA

3.8.3 CE mark
- NA

3.8.4 US and international standards
- The system assembly will abide by the guidelines of the following standards
- ISO
- IEEE-SA
- OSHA

3.8.5 Patent issues
- Non-exact system have been found in the United States Patent and Trademark Office database

3.8.6 Existing technology to avoid
- None

4. Appendices
N/A

5. Glossary
Yolo - You only look once – is a neural net that is pre trained to identify objects/people
Raspberry Pi 4 - A micro controller/computer that will be the brains of the project
IP camera – A digital camera that sends its data over an RJ-45 cable.
POE – Power over Ethernet
Switch – Device used to transfer data between IP camera and Raspberry Pi
Python – Computer programming language
Open CV – Program that is coded in Python that allows the program to see using cameras

6. References

List references and source documents, if any, in this section.

https://www.raspberrypi.org/documentation/hardware/raspberrypi/power/README.md

https://support.amcrest.com/hc/en-us/articles/360024404972-Power-Issues-When-Directly-Connecting-to-an-NVR-#:~:text=The%20power%20consumption%20of%20a%20single%20POE%2B%20camera%20is%20around,using%20the%20included%20power%20supply   .

https://www.raspberrypi.org/documentation/faqs/

https://drive.google.com/file/d/11bIYRP3R8b6kjzDgDsoyYgeQuTRdtei-/view

https://www.amazon.com/gp/product/B07KW2JBJ3/ref=crt_ewc_title_dp_3?ie=UTF8&psc=1&smid=A2LQJPXNVYS9OI

https://www.amazon.com/WS-GPOE-1-WM-Gigabit-Passive-Ethernet-Injector/dp/B00ENNUWO4/ref=sr_1_25?dchild=1&keywords=12v+to+48V+POE&qid=1619067002&sr=8-25

https://www.amazon.com/MMG-SLA-Rechargeable-Battery-20Ah/dp/B08GQGH4NS/ref=sr_1_27_sspa?dchild=1&keywords=12V+25AH+Battery&qid=1619067361&sr=8-27-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExTzdIWlNGSDUzNFhJJmVuY3J5cHRlZElkPUEwNjQ4Njc5MVc1V0hQSEZGWEo1RCZlbmNyeXB0ZWRBZElkPUEwNDU5OTY1MksxMzBUN0tKSEJGSCZaWRnZXROYW1lPXNwX210ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

https://www.ultramobile.com/product/250mb-prepaid-plan/?attribute_months=12-month-plan&gclid=CjwKCAjwmv-DBhAMEiwA7xYrd_USTDDskOkRPyfA1C9wh7x4KAfWGfugLfSuH0ioP8MHTiVjY1vA4BoCW4sQAvD_BwE&utm_campaign=Ultra-Shopping&utm_medium=shopping&utm_source=google&utm_term=ULTRA-XSMALL-01

https://www.amazon.com/Universal-Solar-Mounts-Brackets-Panels/dp/B01J2UO88I/ref=sr_1_32_sspa?crid=8D5GB0KZY6QC&dchild=1&keywords=solar+panel+mounting+brackets+adjustable&qid=1619067978&sprefix=solar+panel+mounting+brackets+a%2Clawngarden%2C191&sr=8-32-spons&psc=1&smid=A7YCV1LK1NBR2&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyTUYxUURRRT0xKS0hRJmVuY3J5cHRlZElkPUEwNzg0ODE5SlJUOVllDSUlJVk81JmVuY3J5cHRlZEFkSWQ9QTA0NDg3NTNEQk1SSENEUlQgmd2lkZ2V0TmFtZT1zcF9idGYmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG9Ob3RMb2dDbGljaz10cnVl

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