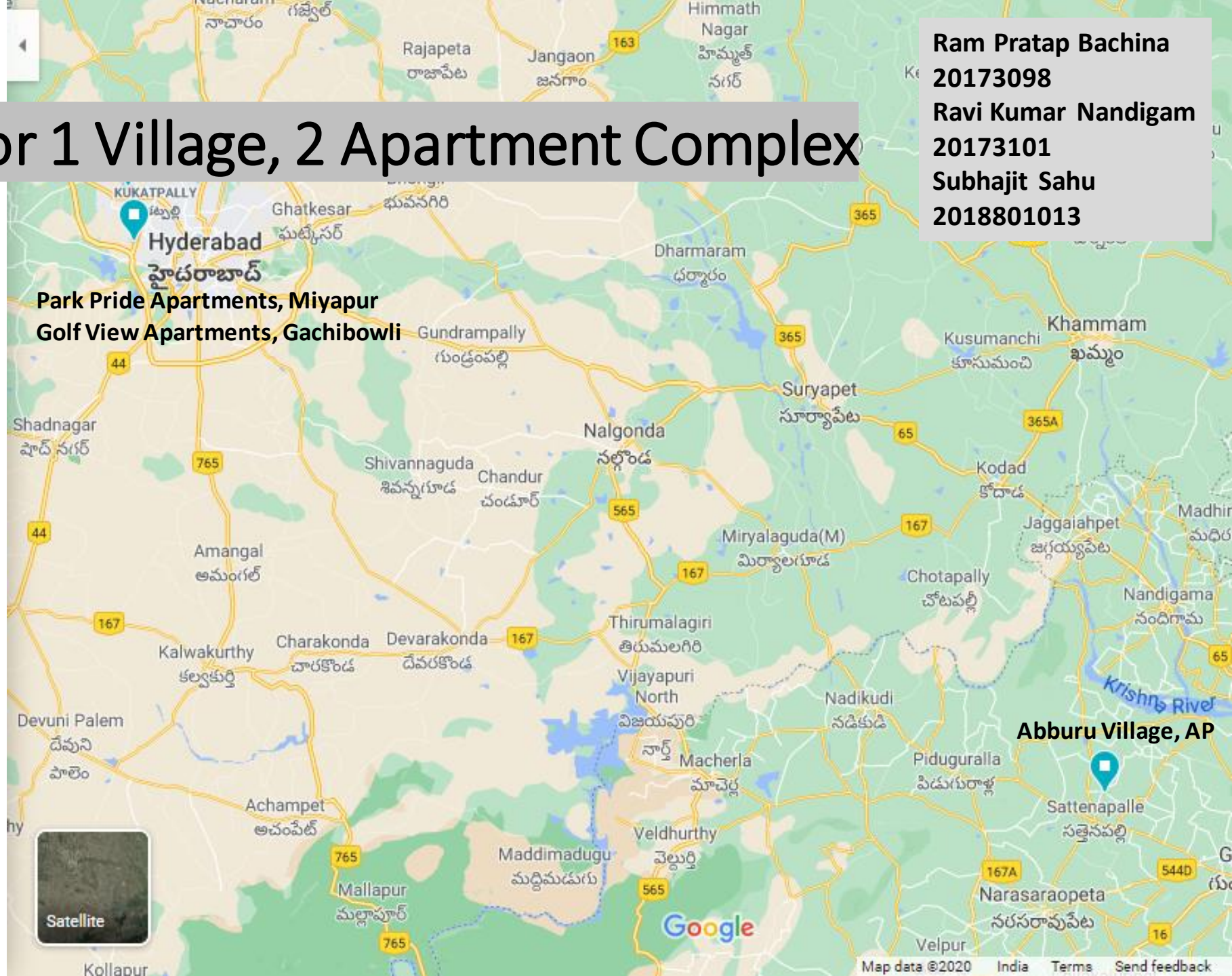
WAN Design for 1 Village, 2 Apartment Complex

Ram Pratap Bachina
20173098
Ravi Kumar Nandigam
20173101
Subhajit Sahu
2018801013

- **Abburu Village**:
- Ram Pratap Bachina
- LAN Design
- 1000 houses

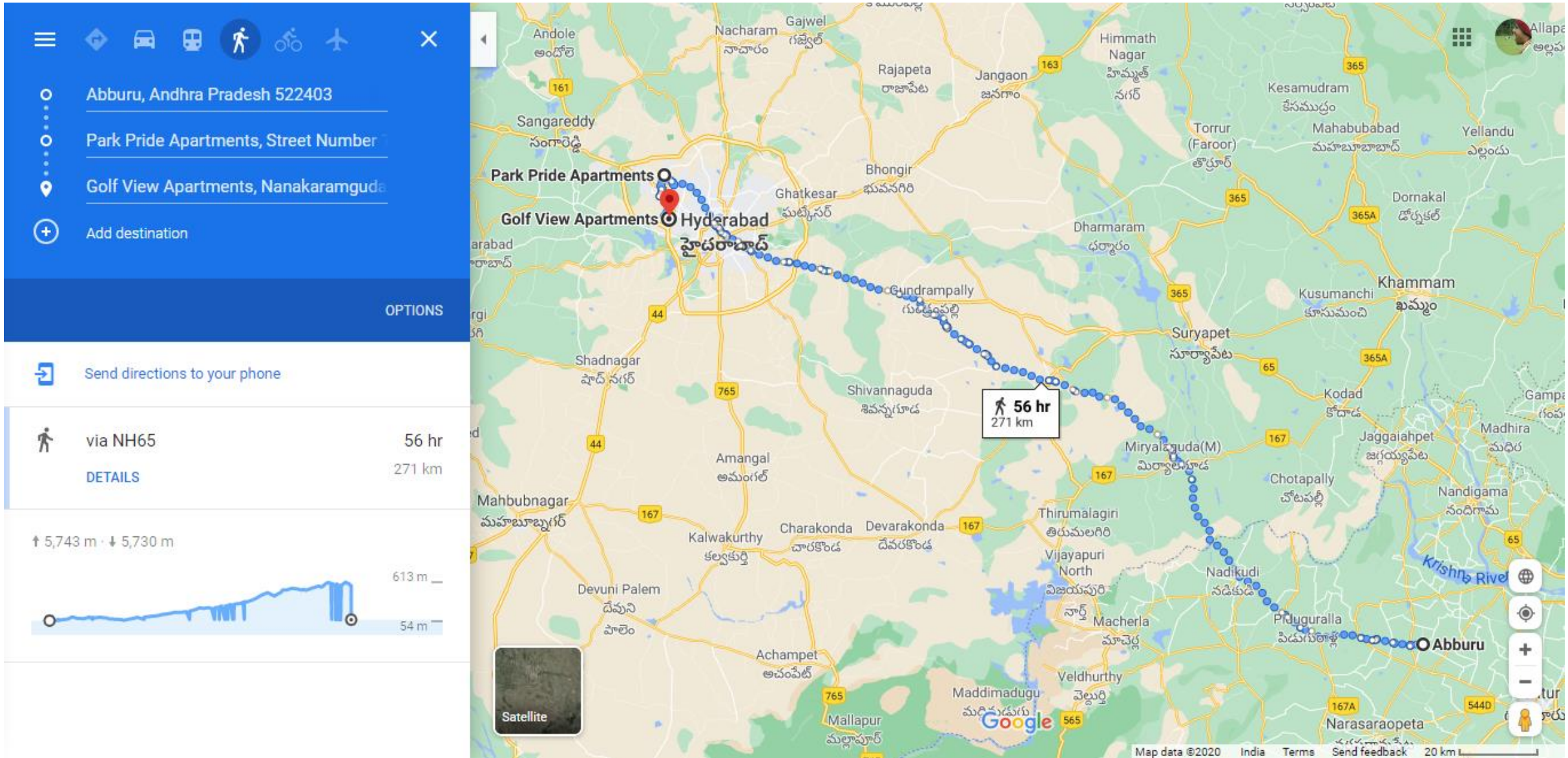
- **Park Pride Apartments**:
- Ravi Kumar Nandigam
- LAN Design
- 15 flats

- **Golf View Apartments**:
- Subhajit Sahu
- LAN Design
- 384 flats

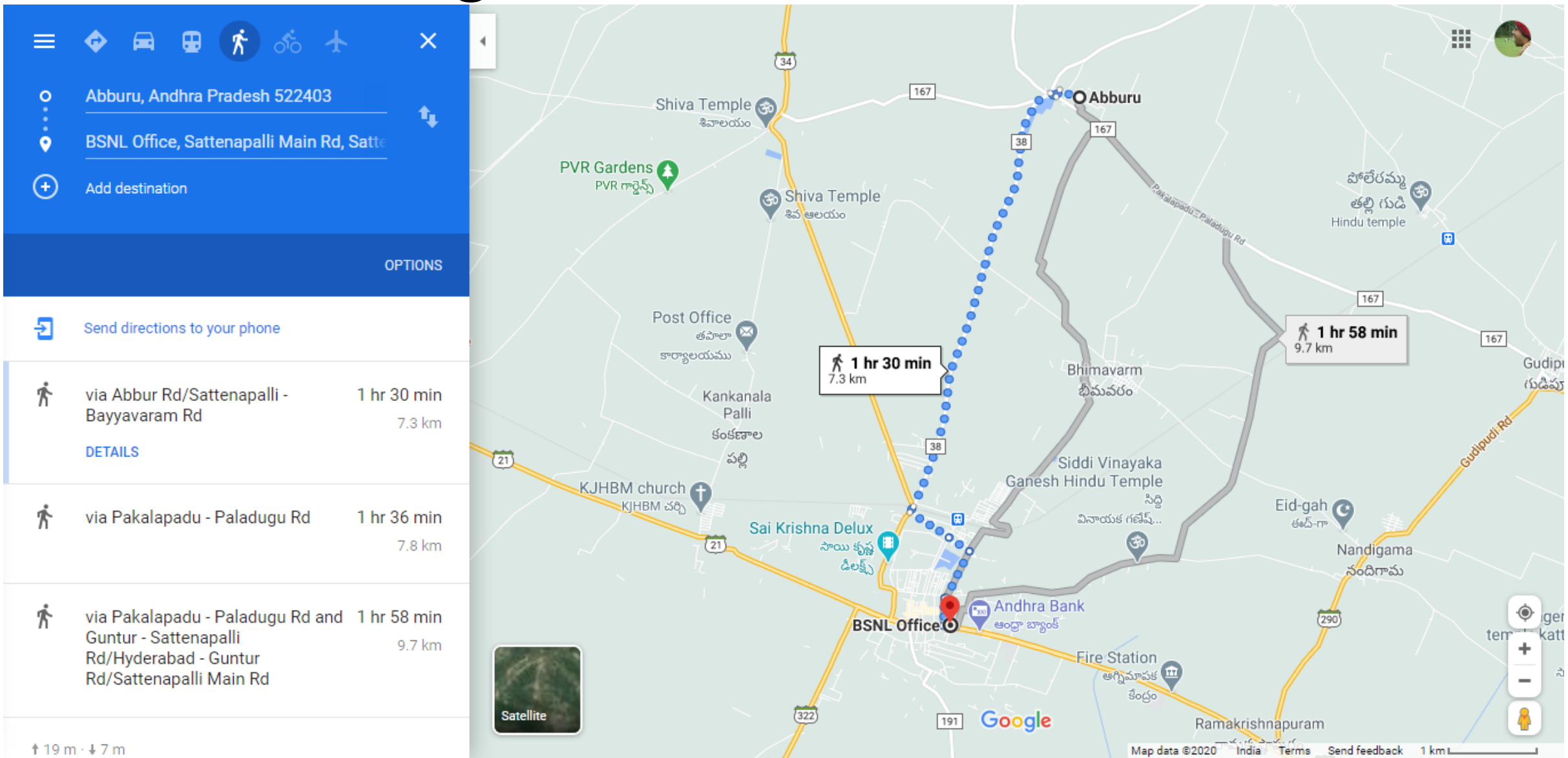


Network Requirements

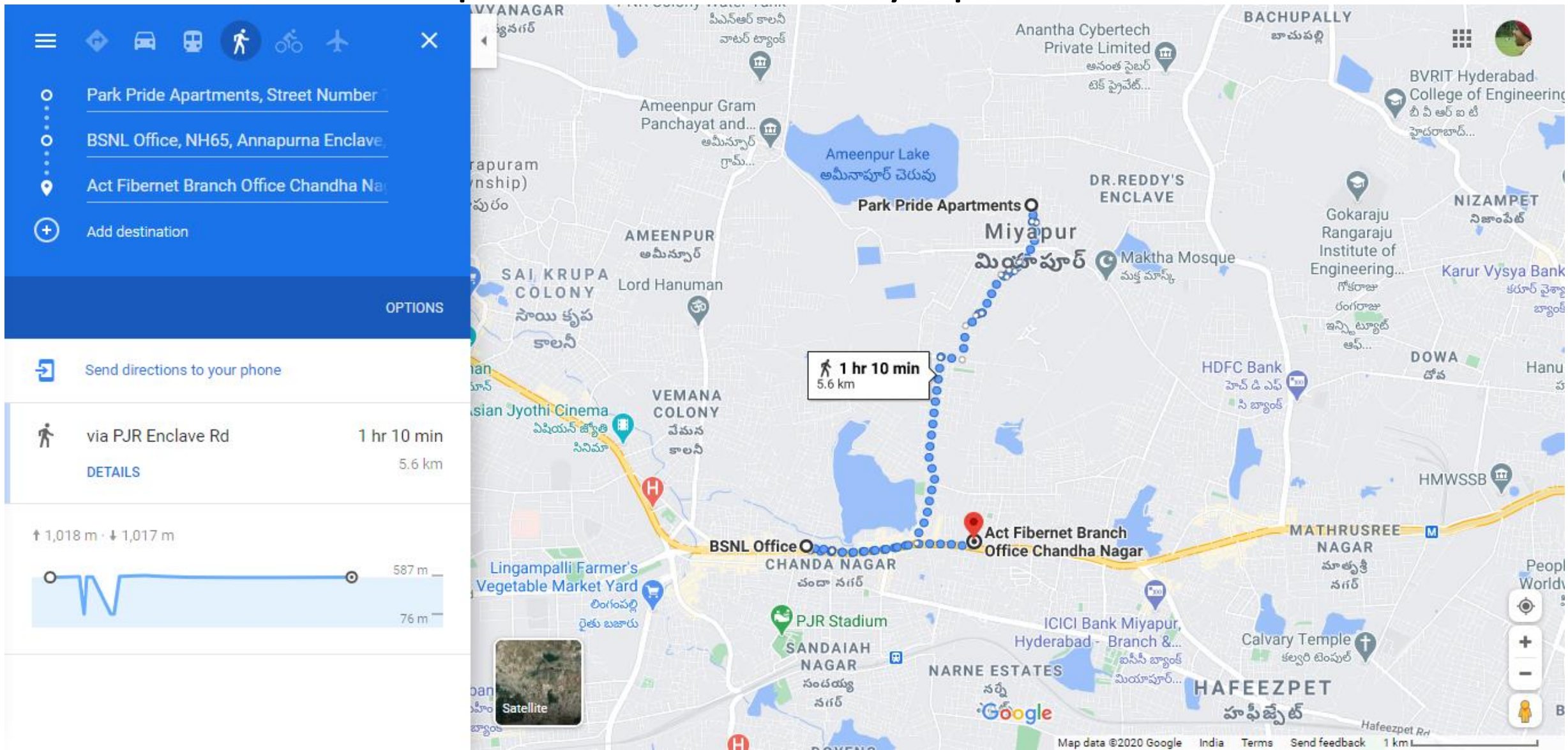
- As part of **National Village Growth Programme**, the Government on India is encouraging people located in cities to directly contribute to one of the selected **villages for upgradation** in various respects (providing tax exemption). Residents at Park Pride Apartments & Golf View Apartments have chosen to contribute to **Abburu Village**.
- Abburu Village Panchayat is to be connected with a **file sharing** network with both the apartment complexes in Hyderabad, which would be used for sharing various sensitive documents. Accordingly, encrypted **WAN** must be setup such that share folders can be accessed by all parties, without it being accessible in the public internet.
- Both the Hyderabadis and village people already have a broadband connection, and desire a number of automation upgrades.
- Setup Automated Metering Infrastructure (AMI) of each location for utilities such as **electricity** and **piped gas** (where available), using existing RF-DCU, GSM/GPRS, or WiFi based smart meters.
- Install **fire detection and alarm systems** for alerting local people through loud sirens and contacting nearest fire department for extinguishing, with a 5-10 min window to prevent false alarms.
- Provide a silent **intrusion (burglar) detection system** for alerting local security / gram panchayat, as well as contacting nearest police department, with again a 5-10 min window for false alarms.
- Since Abburu village lies in **seismic zone 3**, a seismometer can be installed at village center in order to **detect earthquakes** and alert local people. Hyderabad lies in seismic zone 2.


Abburu, Andhra Pradesh 522403
Park Pride Apartments, Street Number
Golf View Apartments, Nanakaramguda
Add destination
OPTIONS
Send directions to your phone
via NH65
56 hr
271 km
DETAILS
↑ 5,743 m · ↓ 5,730 m
613 m
54 m
Park Pride Apartments
Golf View Apartments
Hyderabad
హైదరాబాద్
56 hr
271 km
Abburu
Satellite
Andole
Nacharam
Gajwel
Rajapeta
Jangaon
Himmath Nagar
Sangareddy
Bhongir
Ghatkesar
Dharmaram
Torrur (Faroor)
Kesamudram
Mahabubabad
Yellandu
Dornakal
Khammam
Kusumanchi
Suryapet
Gundrampally
Shadnagar
Shivannaguda
Kodad
Jaggaiahpet
Madhira
Nandigama
Chotapally
Miryalaguda(M)
Amangal
Mahbubnagar
Kalwakurthy
Charakonda
Devarakonda
Thirumalagiri
Vijayapuri North
Nadikudi
Pidugu ralla
Macherla
Devuni Palem
Achampet
Veldhurthy
Maddimadugu
Mallapur
Narasaraopeta
Krishna River
Google
Map data ©2020
India
Terms
Send feedback
20 km

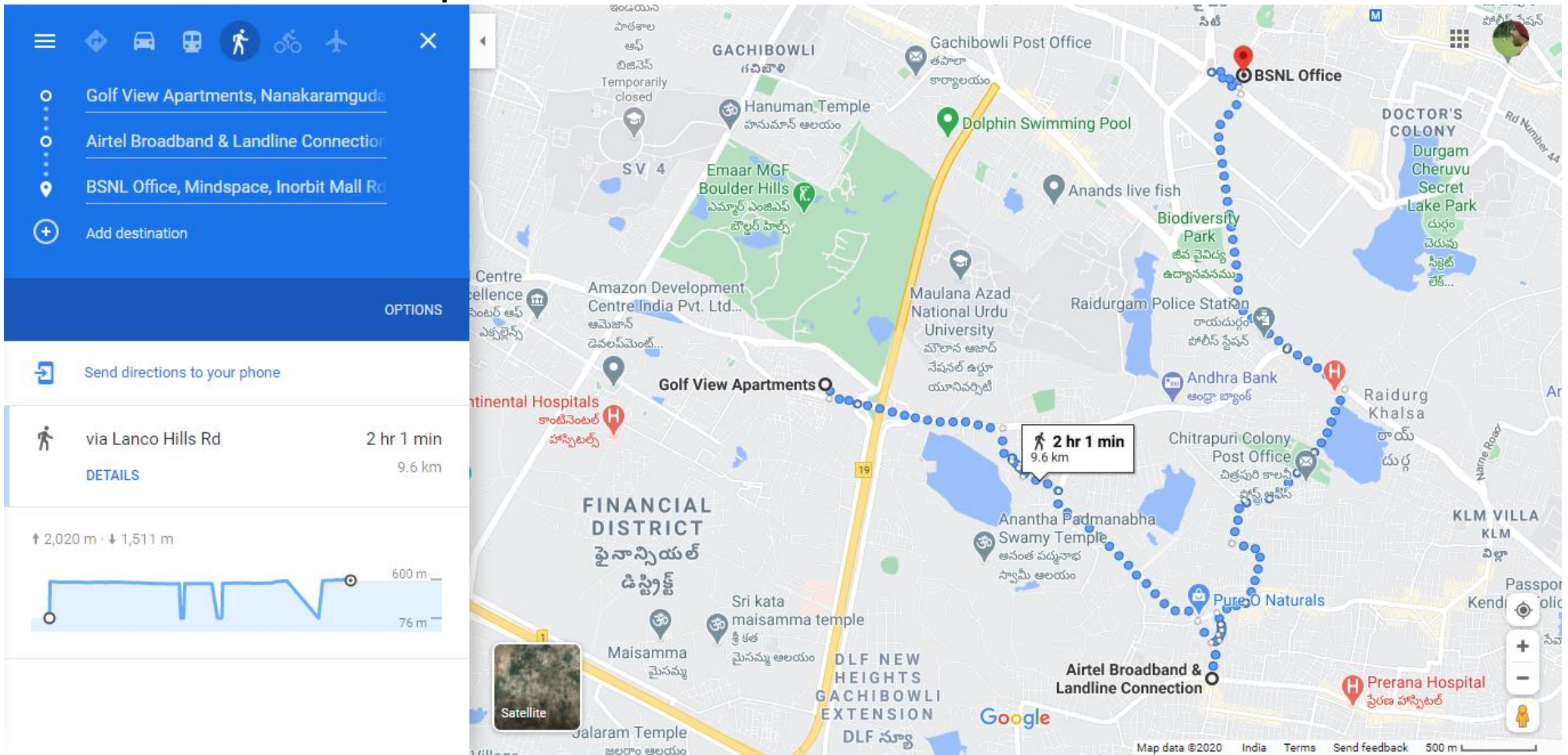
Abburu Village, Guntur district



Park Pride Apartments, Miyapur



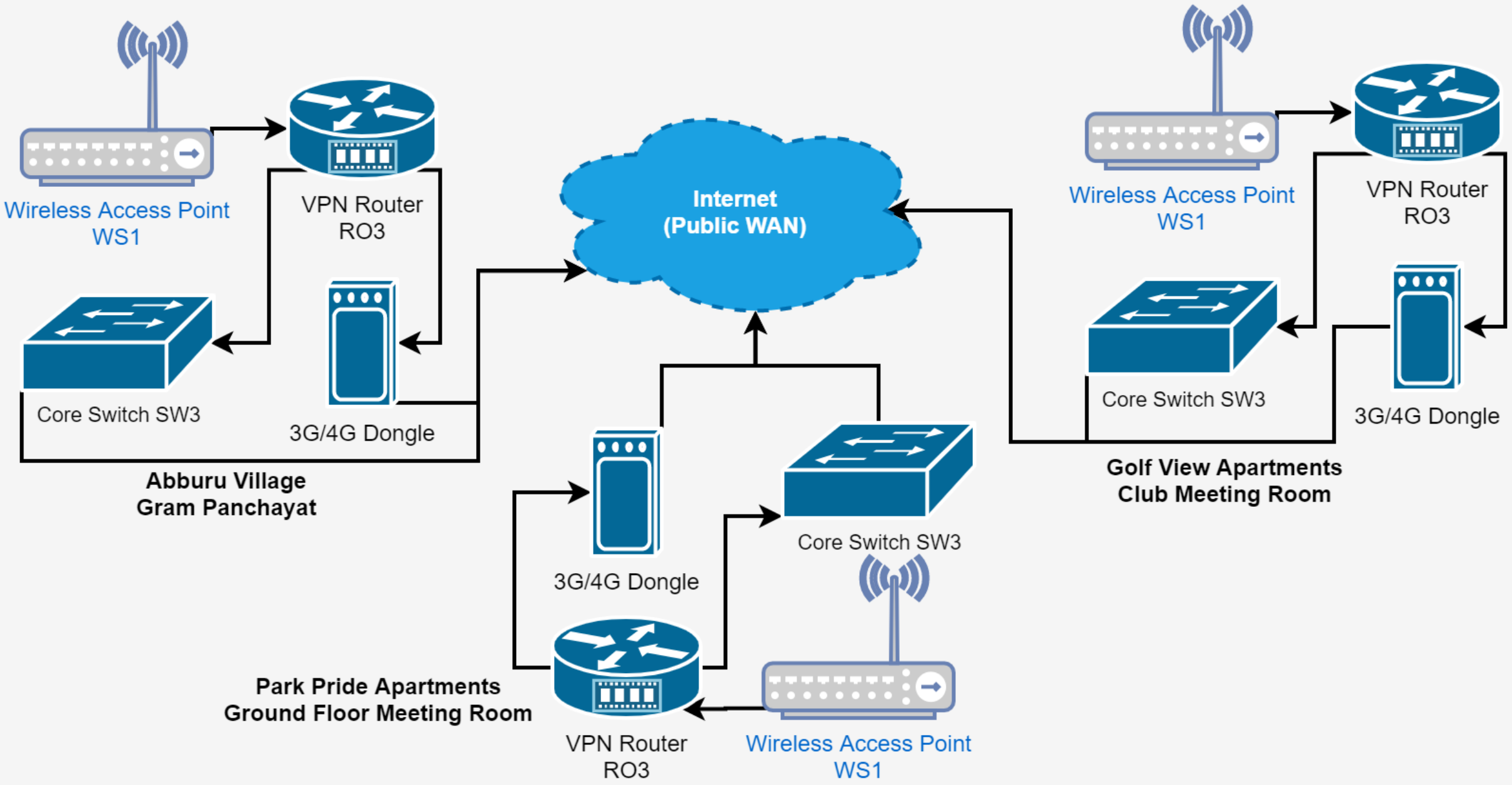
Golf View Apartments, Gachibowli



File Share WAN between locations

- At **Gram Panchayat, Abburu Village**, a small WiFi network has been created through a Wireless Access Point WS1. This AP is connected to a VPN Router RO3.
- Then VPN Router RO3 is then connected to the Central Core Switch SW3 which is connected to the ISP through optic fibre on its SFP ports.
- This VPN Router acts as a **VPN server** and allows other VPN clients to join through the Internet, thus forming a **Virtual WAN**.
- Devices connected through the VPN clients and well as devices connected through the Wireless AP here, can now share files among thesselves as if they belong to the same LAN.
- At **Ground floor Meeting room, Park Pride Apartments** there is a very similar arrangement to that of Aburru village, except that the VPN Router RO3 is configured to act as a **VPN client**, and connect to the VPN server at Aburru village.
- At **Club house Meeting room, Golf View Apartments**, the arrangement is exactly same as Park Pride Apartments.
- In order to ensure good QoS, the port on which VPN Router RO3 is connected to Central Core Switch SW3 is **assigned higher priority**, than other data connections.
- Highest priority is assigned to **automated electricity metering** network.
- Sensitive documents can now be easily shared among the people, without having to resort to encrypted zip files in email.

Abburu Village + Park Pride Apartments + Golf View Apartments: File Share WAN (Central)



RO3 VPN Router

₹ 19000 x 6

- **Cisco RV320 VPN Router with Web Filter**:
- 2 x GbE WAN for load balancing
- 2 x USB for 2G / 3G modem (if WAN fails)
- SSL & site-site VPN
- Stateful Packet Inspection (SPI) & HW Firewall

WS1 Wireless Access Point

₹ 1700 x 3

- **TP-Link TL-WA901N 450 Mbps Wireless N Access Point**:
- 450 Mbps wireless N @ 2.4 GHz
- Access Point, Range Extender, Multi SSID
- Supports passive PoE (PoE injector included)
- Upto 30 m (100 ft) range

SW3 Central Core Switch

₹ 30000 x 7

- **TP-Link JetStream T1700G-28TQ Smart Switch**:
- 24 x GbE, 4 x 10GbE SFP+ slots
- Stacking upto 6 units, 40 Gbps bidirectional BW
- ACL, Port security, DoS defend, DHCP snooping
- Web/CLI managed modes, SNMP, RMON

3G/4G Dongle

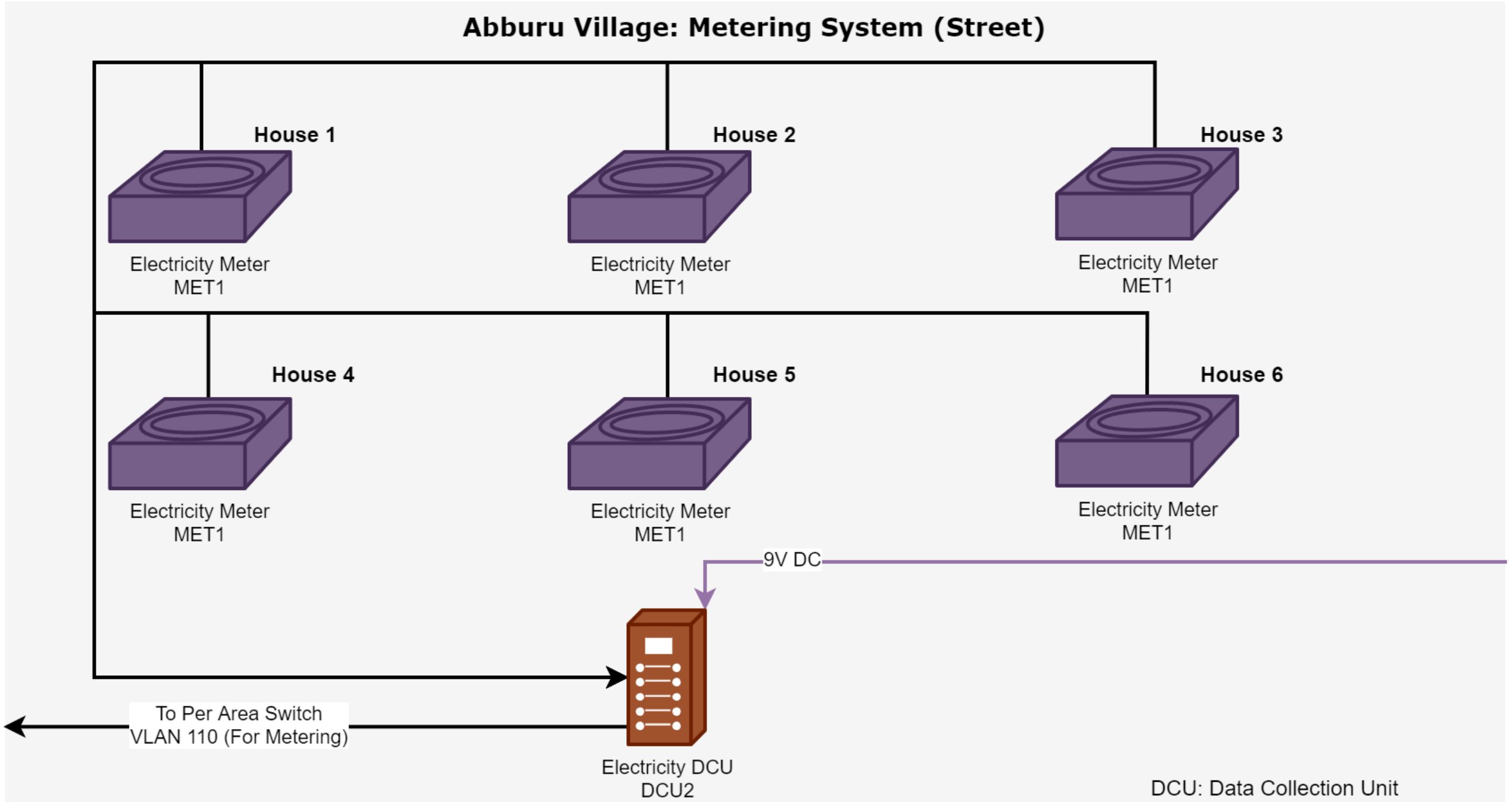
₹ 2000 x 3

- **JioFi JDR740 Dongle 150 Mbps wireless 4G router**:
- 4G speed: upto 150 Mbps download, 50 Mbps upload
- Expandable memory capacity: 32 GB

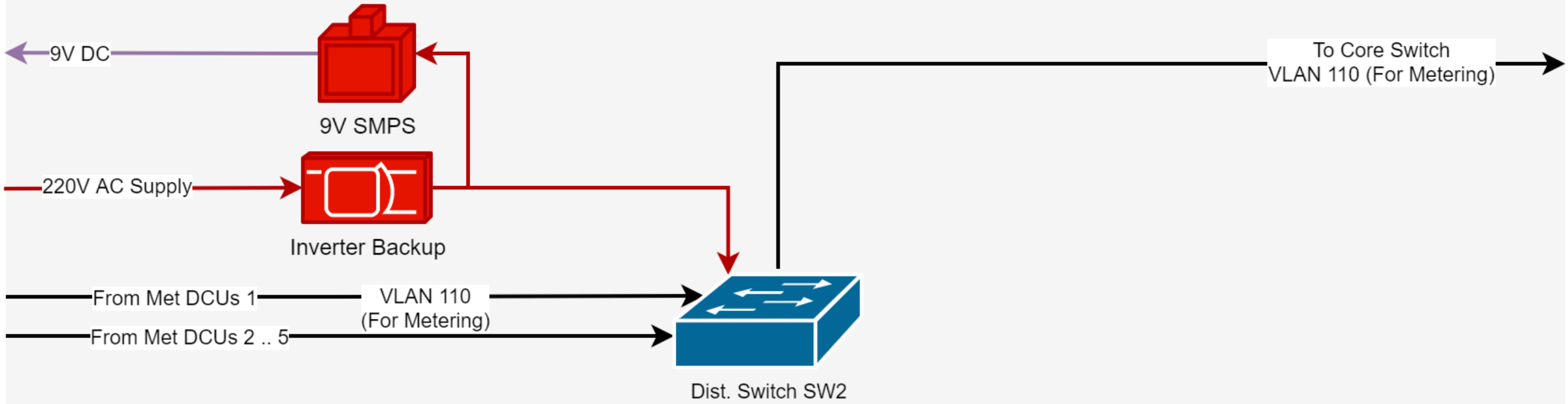
Abburu Village: Metering System

- Each house has a **gas cylinder** connection and thus has only an **electricity meter**.
- The electricity meters communicate with either wired **RS-485** or **wireless RF** mechanism with a **Data Collection Unit** (DCU) which is installed every street.
- The **DCU** is connected to **per-street** managed **switch** on **VLAN 110**, which is reserved for **metering** purpose.
- The per-street switch is connected to per-area **Distribution switch**, which is then connected to the central **Core switch**.
- An **Metering-cum-DHCP server** is present in Gram Panchayat connected to the Core switch on **VLAN 110**. The DHCP server is used to assign IP address to all DCUs.
- **VPN Router** RO3 can act as a **VPN client** and thus form a **Virtual WAN** with electricity board's network. A **server** on their network can now **query all our metering devices**.
- The smart meters report to the power distribution company every **15 mins** through the Metering server.
- The metering server sends data to the power distribution company over HTTPS secure channel through **GSM/GPRS modem**.
- This is done so because GSM/GPRS modems are cheaply available, are reliable, and are **commonly used** in most smart meters used in India (e.g. Genus).
- There is also a **backup** GSM/GPRS modem that uses SIM from a different service provider in case the primary fails.
- If the **power distribution company** provides a VPN server in order to connect all metering devices in a **Virtual WAN**, this can be achived through the VPN Router RO3.
- The VPN Router connects with all **metering devices** on **VLAN 110** and then connects to internet either through the **Central Core Switch SW3** or a **3G/4G dongle** connected to it USB port as backup.

Abburu Village: Metering System (Street)

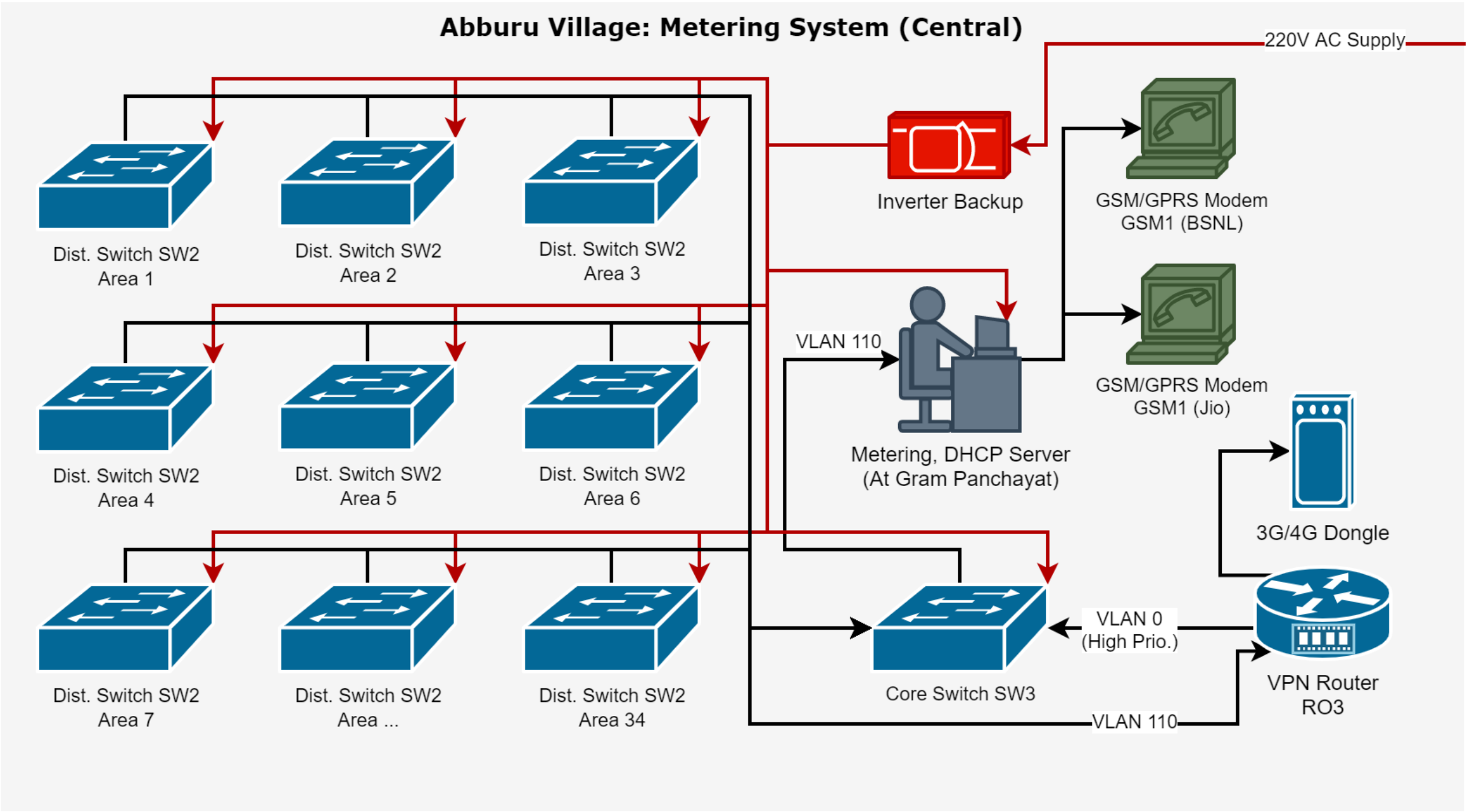


Abburu Village: Metering System (Area)



DCU: Data Collection Unit

Abburu Village: Metering System (Central)



MET1 Electricity Meter

₹ ? x ?

- **Saksham-125 Smart Residential Meter**:
- Single-phase AMI system
- Load management, Multi Rate, Time of use, Anti-theft
- Communicates w/ Head end sys. on req. or schedule
- Integrated GSM/GPRS modem

DCU2 Data Collector Unit

₹ ? x ?

- **Data Collector Unit (DCU)**:
- Integrated LPRF & GSM/GPRS communication
- LPRF communication on demand or schedule
- GSM/GPRS communicates with Head End System (HES)

SW2 Dist. Switch

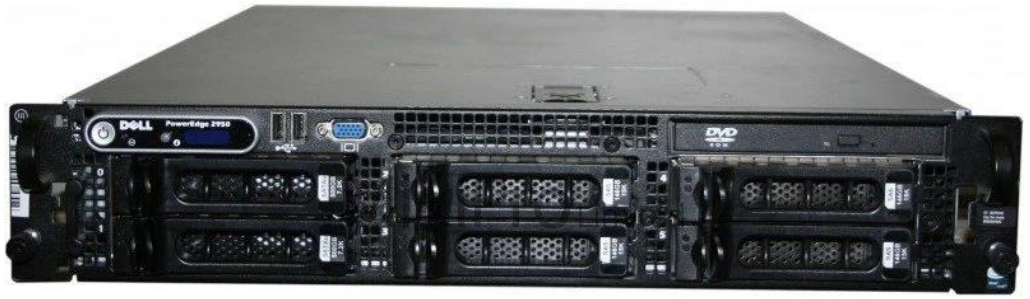
₹ 26000 x 50

- **Netgear GS748T-500INS Smart Managed Pro Switch**:
- 48 x GbE, 4 x GbE SFP slots
- VLAN, QoS, IGMP snooping, Link aggregation, ACL

X, DHCP Server

₹ 28000 x 6

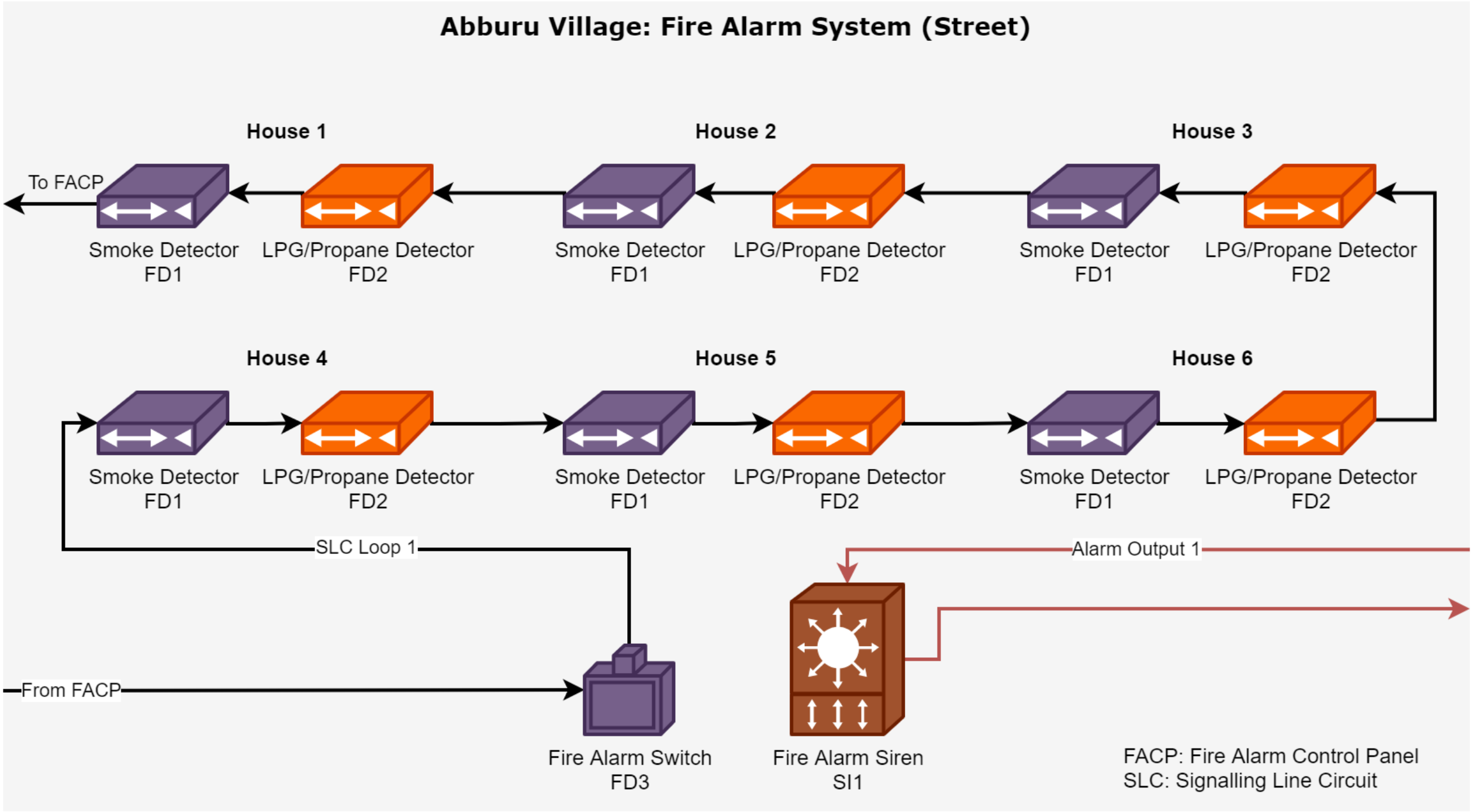
- **Dell Power Edge 2950 III**:
- 2U Rack mount
- 8 Core server
- 32 GB RAM
- 1 TB storage



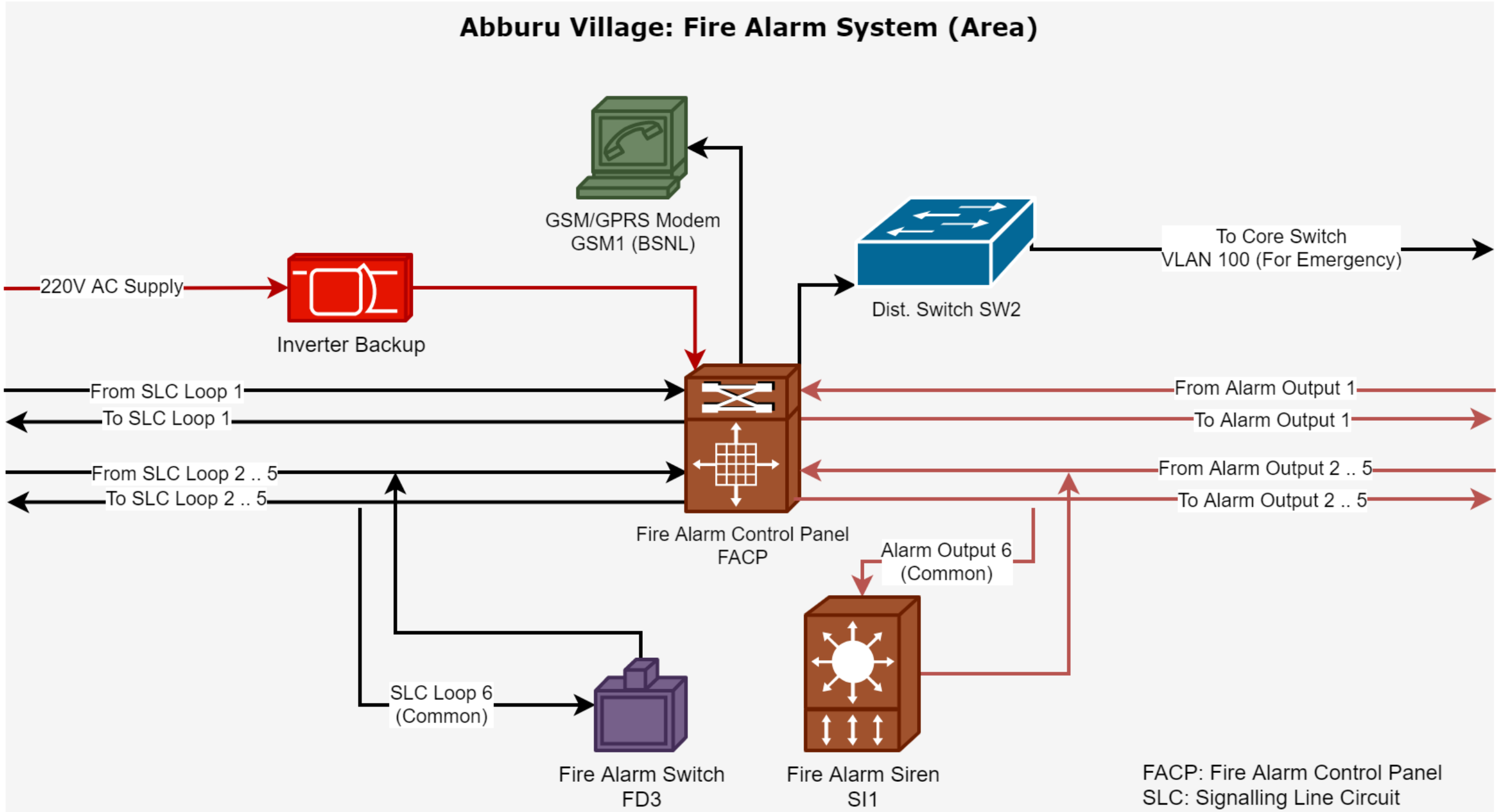
Abburu Village: Fire Alarm + Earthquake System

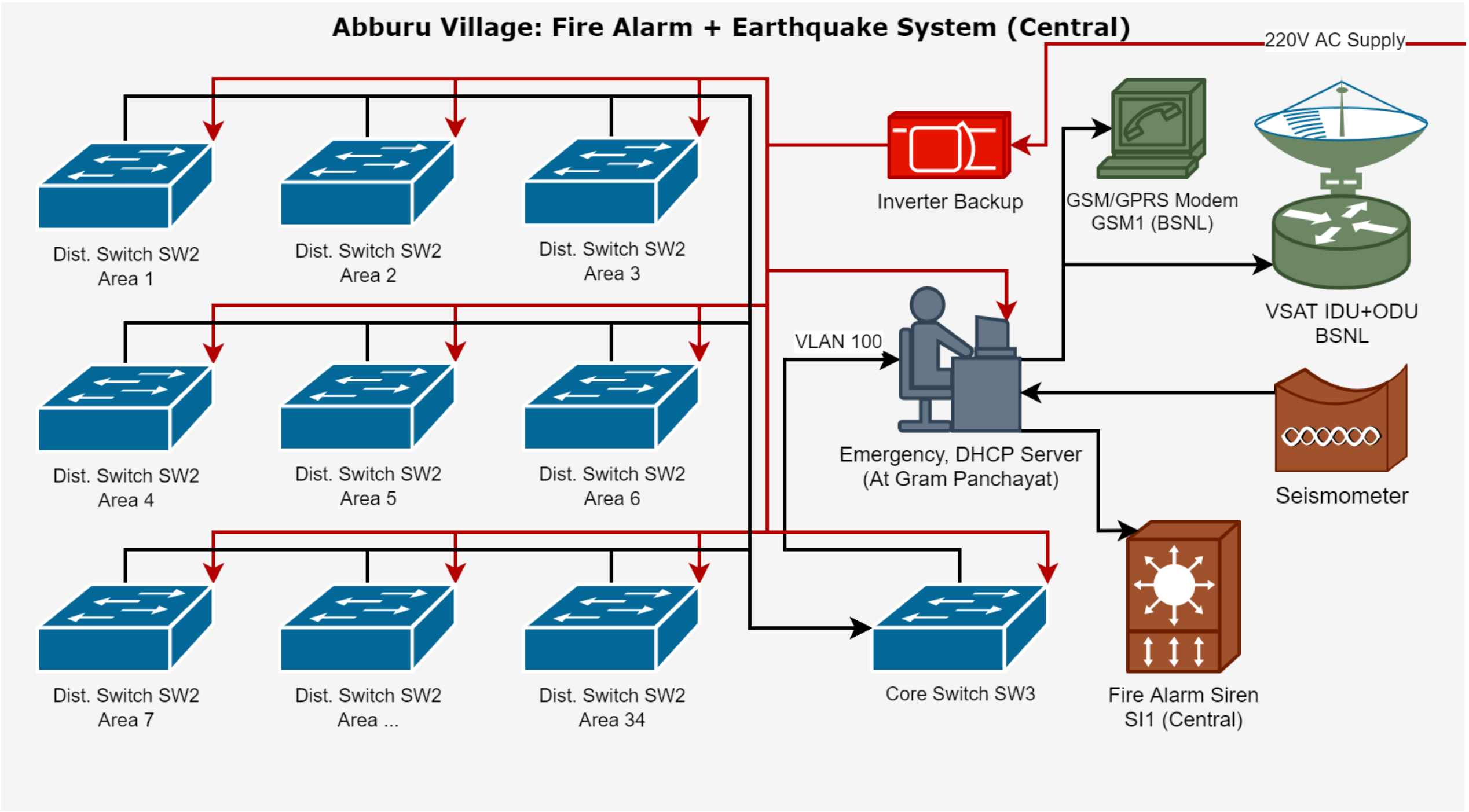
- We are using **Signaling Line Circuit** (SLC) based addressable **smoke detectors** and **LPG/Propane Gas sensors**. Each house is thus provided with a total of 2 sensors, and all 6 houses in a street are connected in a loop. Each street also has a **Fire Alarm switch** (manual) which can be used to manually trigger the fire alarm.
- Each street's loop (total 5 streets/area) is then connected to a **Fire Alarm Control Panel** (FACP) system which is also connected to a central **Fire Alarm Siren**. Each street is also connected to its respective Siren from the FACP.
- The FACP has a **GSM/GPRS interface** built-in through which it can be configured to send fire emergency events directly to nearby fire department at a certain **delay** (**5-10 min** to avoid false alarm).
- In case there is a false alarm, the FACP's alarm can be shutdown with the delay time.
- The FACP is also connected through ethernet port to the per-area Distribution switch.
- All per-area Distribution switches are connected to the central **Core switch** (managed).
- An **Emergency-cum-DHCP server** is present in Gram Panchayat connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case a Fire alarm is triggered, the Emergency server **alerts the Panchayat**, rings the central siren, and indicates the house number of the source.
- There is also a backup GSM/GPRS module connected so that in case the one directly connected to FACP fails, the Emergency server can send the message on its behalf.
- Since Abbru lies in seismic zone 3, a seismometer is installed at Gram Panchayat, and NDRF can be contacted in case a **earthquake** is detected (unless marked false-positive in 5-10 min).

Abburu Village: Fire Alarm System (Street)



Abburu Village: Fire Alarm System (Area)




Abburu Village: Fire Alarm + Earthquake System (Central)
220V AC Supply
Inverter Backup
GSM/GPRS Modem
GSM1 (BSNL)
VSAT IDU+ODU
BSNL
Dist. Switch SW2
Area 1
Dist. Switch SW2
Area 2
Dist. Switch SW2
Area 3
VLAN 100
Emergency, DHCP Server
(At Gram Panchayat)
Seismometer
Dist. Switch SW2
Area 4
Dist. Switch SW2
Area 5
Dist. Switch SW2
Area 6
Dist. Switch SW2
Area 7
Dist. Switch SW2
Area ...
Dist. Switch SW2
Area 34
Core Switch SW3
Fire Alarm Siren
SI1 (Central)

FD1 Smoke Detector

₹ ? x ?

- **4098-9754EA TrueAlarm Photoelectric & Heat Multi-Sensor Detector**:
- Analog photoelectric smoke & heat sensing
- Digital transmission of analog data
- Addressing dipswitch in permanently mounted base
- Automatic environmental compensation
- Fixed & Rate-of-rise heat detection

FACP Fire Alarm Ctrl. Panel

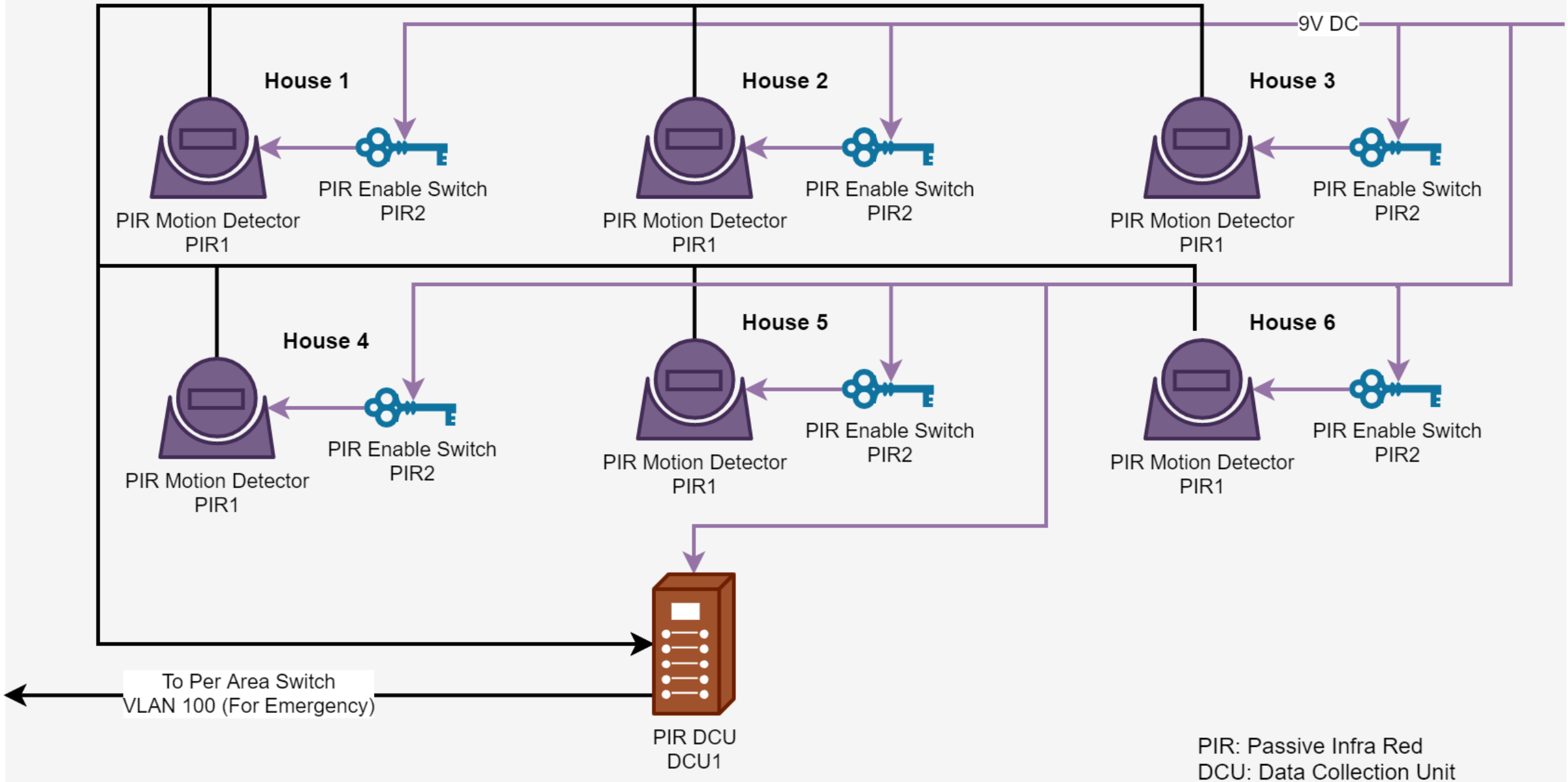
₹ ? x ?

- **Simplex 4007ES Fire Control Panel**:
- Provides built-in short circuit isolation for monitoring and control of TrueAlarm analog sensors and IDNet communications monitoring and control devices
- Standard panel SLC provides up to 100 addressable points
- Battery backup charging of up to 33 Ah

Abburu Village: Security System

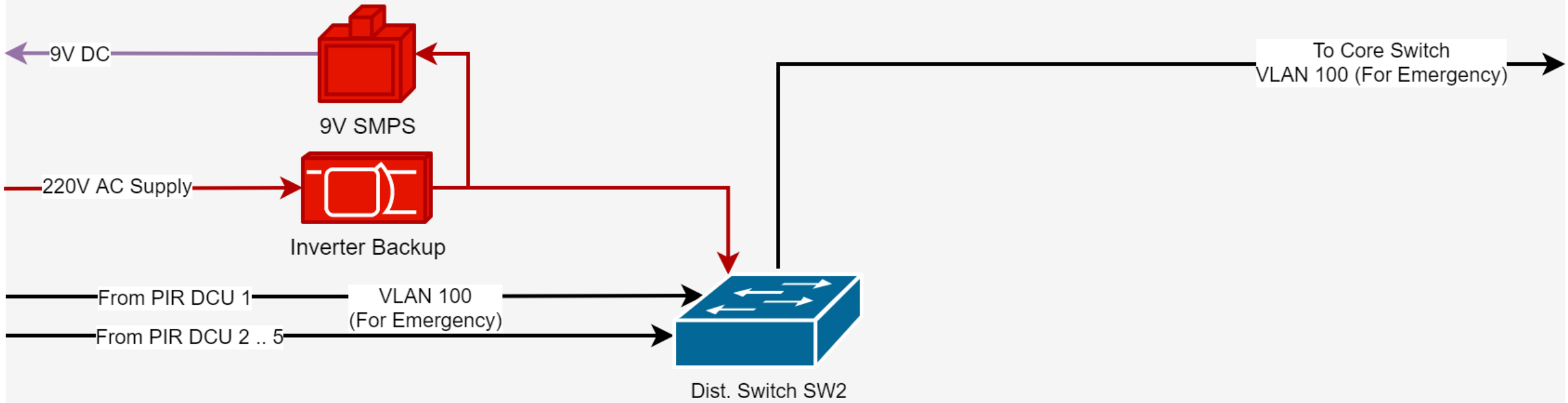
- We are using simple **PIR sensors**, that are able to detect motion as our security element. The sensor triggers an event when it **detects motion**, and this is sent to a **Data Collection Unit** (DCU).
- The sensors have a trigger **enable switch** which can be turned on and off. Normally, when people are staying in the house, the switch is turned off.
- When the members are about to **leave their house** empty, they **turn on** the switch, which enables the PIR sensor. From now on, if any burglar enters the apartment, it can be detected by the PIR sensor. When residents come back, they remotely turn off the sensor.
- The **DCU** is connected with ethernet cable to a hierarchy of **managed routers**. Any motion detect **events** are sent over IP packets to an Emergency server located with the Security.
- The DCU connected port is configured as **VLAN 100**, which is reserved for all **emergency devices** of the network.
- An **Emergency-cum-DHCP server** is present in Gram Panchayat connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case an PIR sensor trigger event is detected, the Emergency server **alerts the Panchayat**, indicating the house number of the source.
- If it is not marked as **false alarm within 5-10 mins**, a message is sent to **nearest police department** through **GSM/GPRS modem** (with a backup in case).

Abburu Village: Security System (Street)



PIR: Passive Infra Red
DCU: Data Collection Unit

Abburu Village: Security System (Area)



PIR: Passive Infra Red
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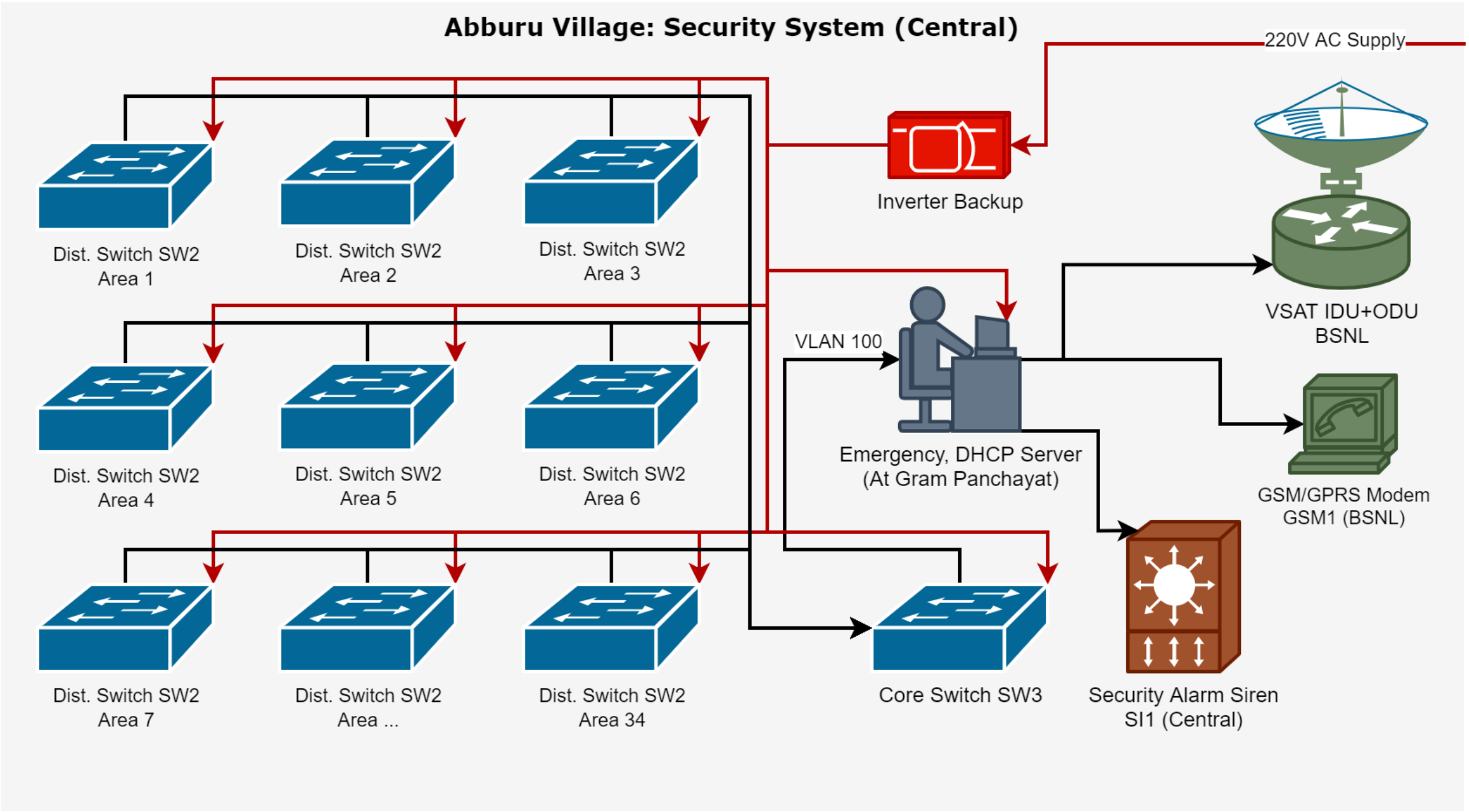
Abburu Village: Security System (Central)



Park Pride Apartments: Metering System

- Each apartment has a **piped gas** connection and thus has a **gas meter** as well as an **electricity meter**. The gas meter operates with 9V DC power provided by an SMPS installed in first floor.
- The electricity and gas meters communicate with either wired **RS-485** or **wireless RF** mechanism with a **Data Collection Unit** (DCU) which is installed every floor.
- The **DCU** is connected to **per-floor** managed **switch** on **VLAN 110**, which is reserved for **metering** purpose. The per-floor switch is connected to the central **Core switch**.
- An **Metering-cum-DHCP server** is present in 1st floor connected to the Core switch on **VLAN 110**. The DHCP server is used to assign IP address to all DCUs.
- **VPN Router** RO3 can act as a **VPN client** and thus form a **Virtual WAN** with electricity board's network. A **server** on their network can now **query all our metering devices**.
- The smart meters report to the power distribution company every **15 mins** through the Metering server.
- The metering server sends data to the power distribution company over HTTPS secure channel through **GSM/GPRS modem**.
- This is done so because GSM/GPRS modems are cheaply available, are reliable, and are **commonly used** in most smart meters used in India (e.g. Genus).
- There is also a **backup** GSM/GPRS modem that uses SIM from a different service provider in case the primary fails.
- If the **power distribution company** provides a VPN server in order to connect all metering devices in a **Virtual WAN**, this can be achived through the VPN Router RO3.
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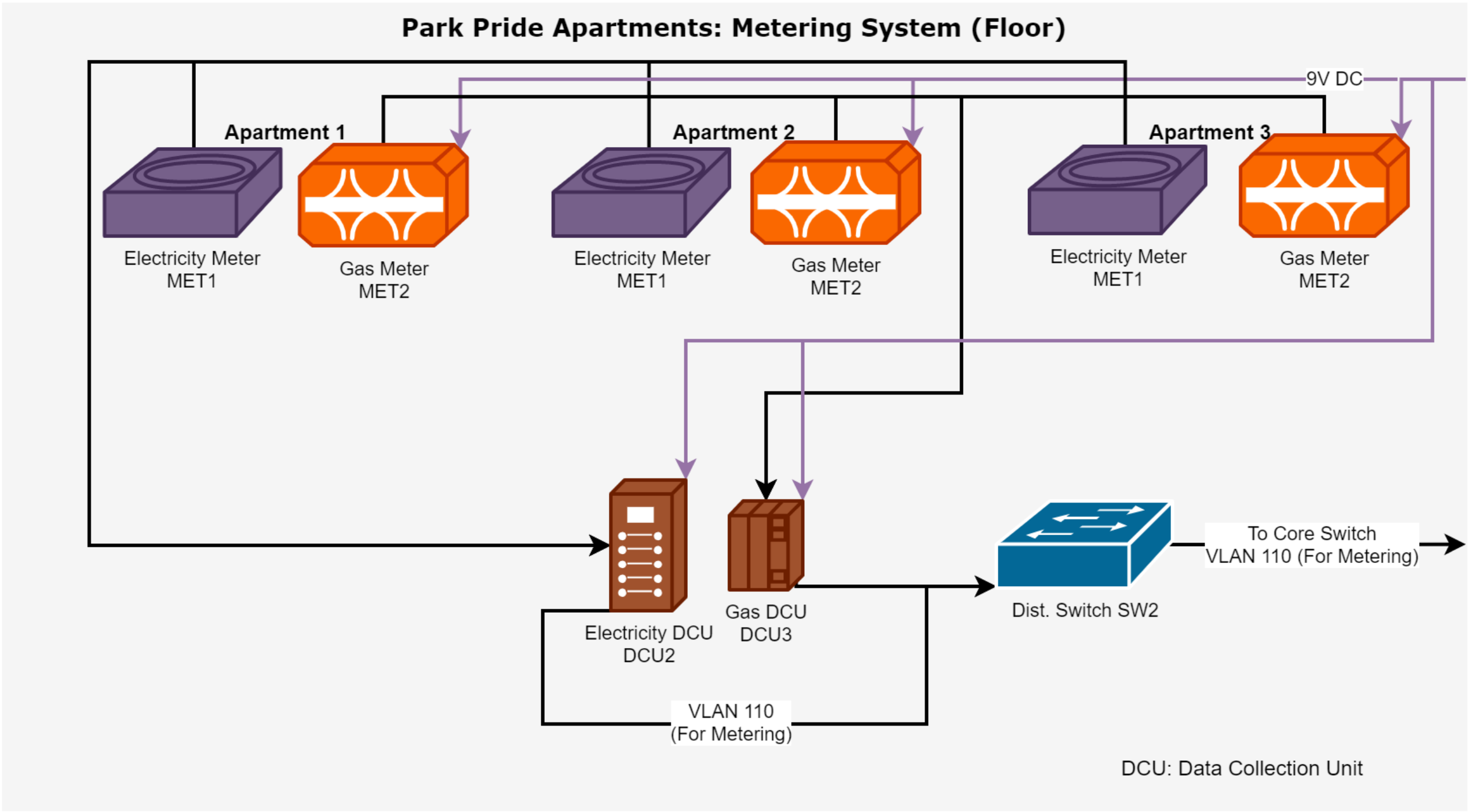
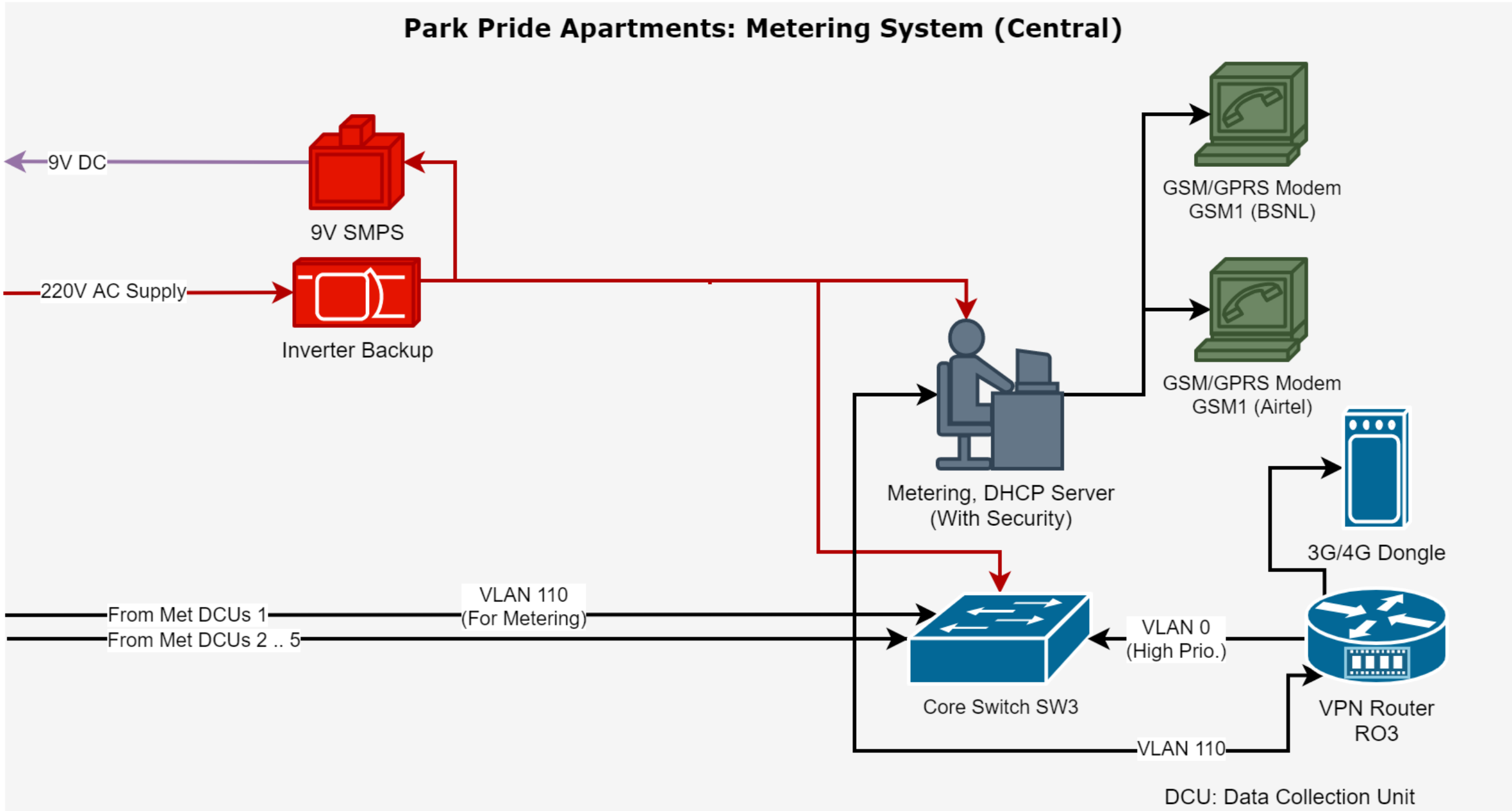

Park Pride Apartments: Metering System (Floor)
9V DC
Apartment 1
Apartment 2
Apartment 3
Electricity Meter
MET1
Gas Meter
MET2
Electricity Meter
MET1
Gas Meter
MET2
Electricity Meter
MET1
Gas Meter
MET2
Electricity DCU
DCU2
Gas DCU
DCU3
Dist. Switch SW2
To Core Switch
VLAN 110 (For Metering)
VLAN 110
(For Metering)
DCU: Data Collection Unit

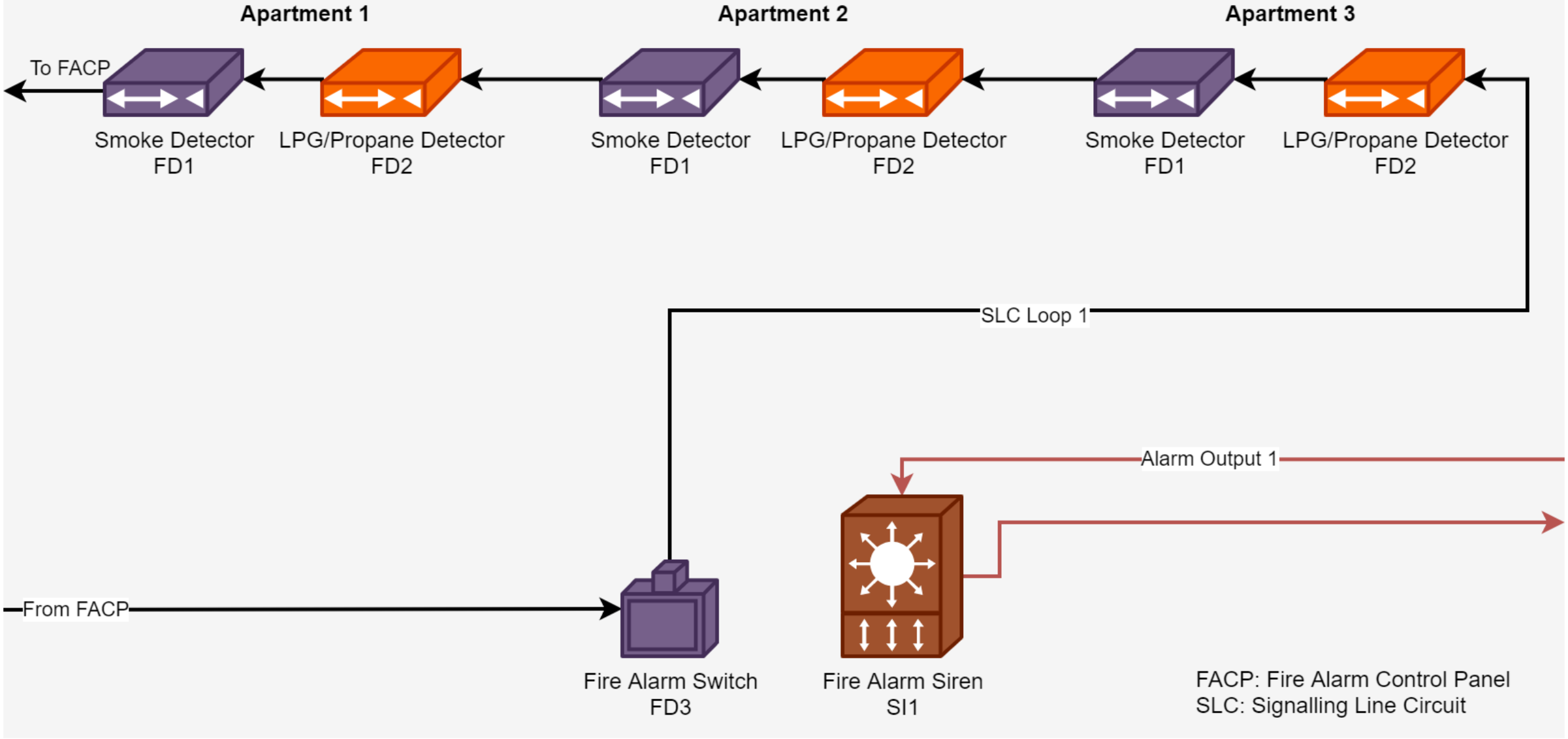
Park Pride Apartments: Metering System (Central)



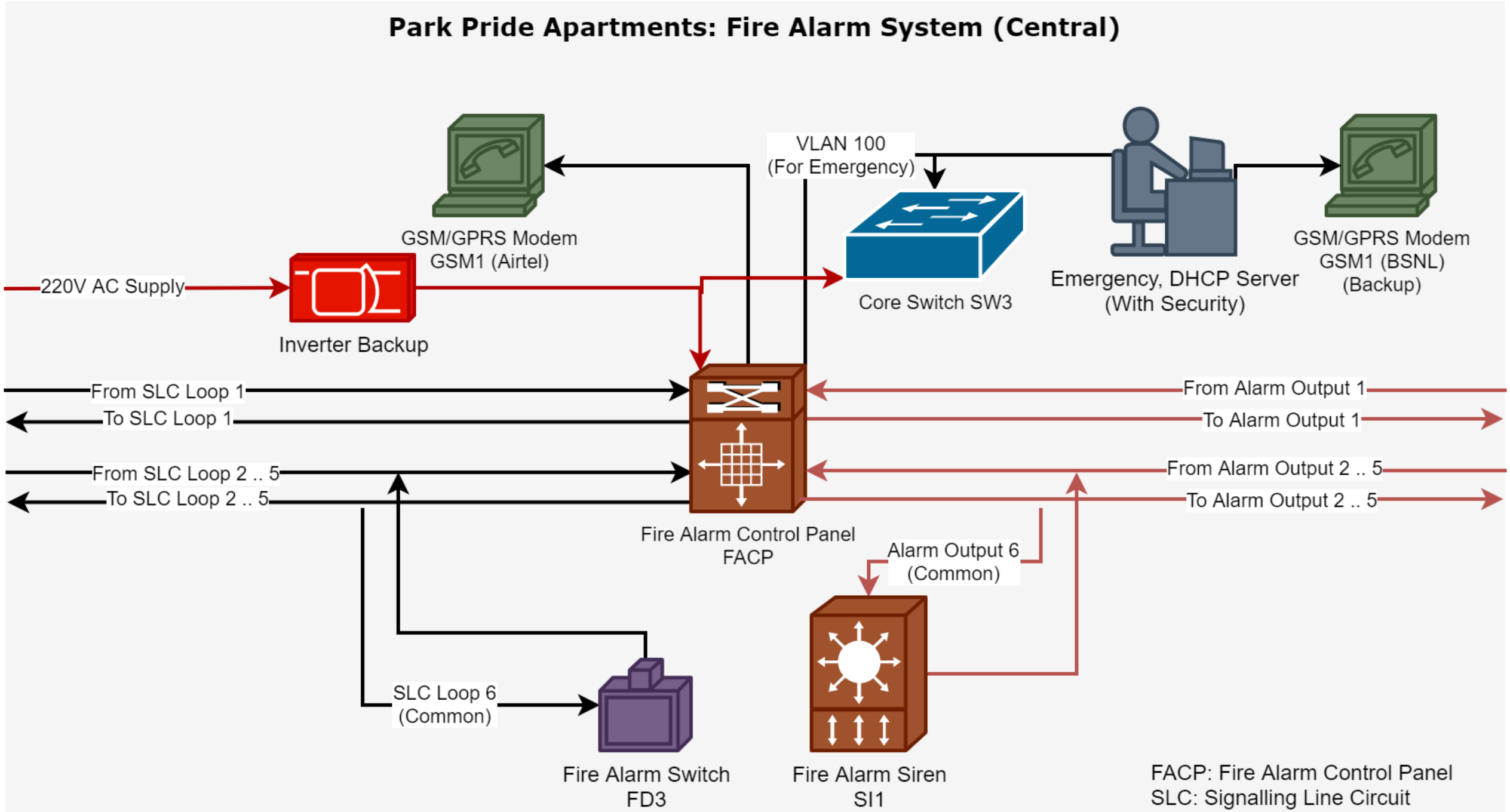
Park Pride Apartments: Fire Alarm System

- We are using **Signaling Line Circuit** (SLC) based addressable **smoke detectors** and **LPG/Propane Gas sensors**. Each apartment is thus provided with a total of 2 sensors, and all 3 apartments in a floor are connected in a loop. Each floor also has a **Fire Alarm switch** (manual) which can be used to manually trigger the fire alarm.
- Each floor's loop (total 5 floors) is then connected to a **Fire Alarm Control Panel** (FACP) system which is also connected to a central **Fire Alarm Siren**. Each floor is also connected to its respective Siren from the FACP.
- The FACP has a **GSM/GPRS interface** built-in through which it can be configured to send fire emergency events directly to nearby fire department at a certain **delay** (**5-10 min** to avoid false alarm).
- In case there is a false alarm, the FACP's alarm can be shutdown with the delay time.
- The FACP is also connected through ethernet port to the central **Core switch** (managed).
- An **Emergency-cum-DHCP server** is present in 1st floor connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case a Fire alarm is triggered, the Emergency server **alerts the security**, rings the central siren, and indicates the apartment number of the source.
- There is also a backup GSM/GPRS module connected so that in case the one directly connected to FACP fails, the Emergency server can send the message on its behalf.

Park Pride Apartments: Fire Alarm System (Floor)



Park Pride Apartments: Fire Alarm System (Central)



Park Pride Apartments: Security System

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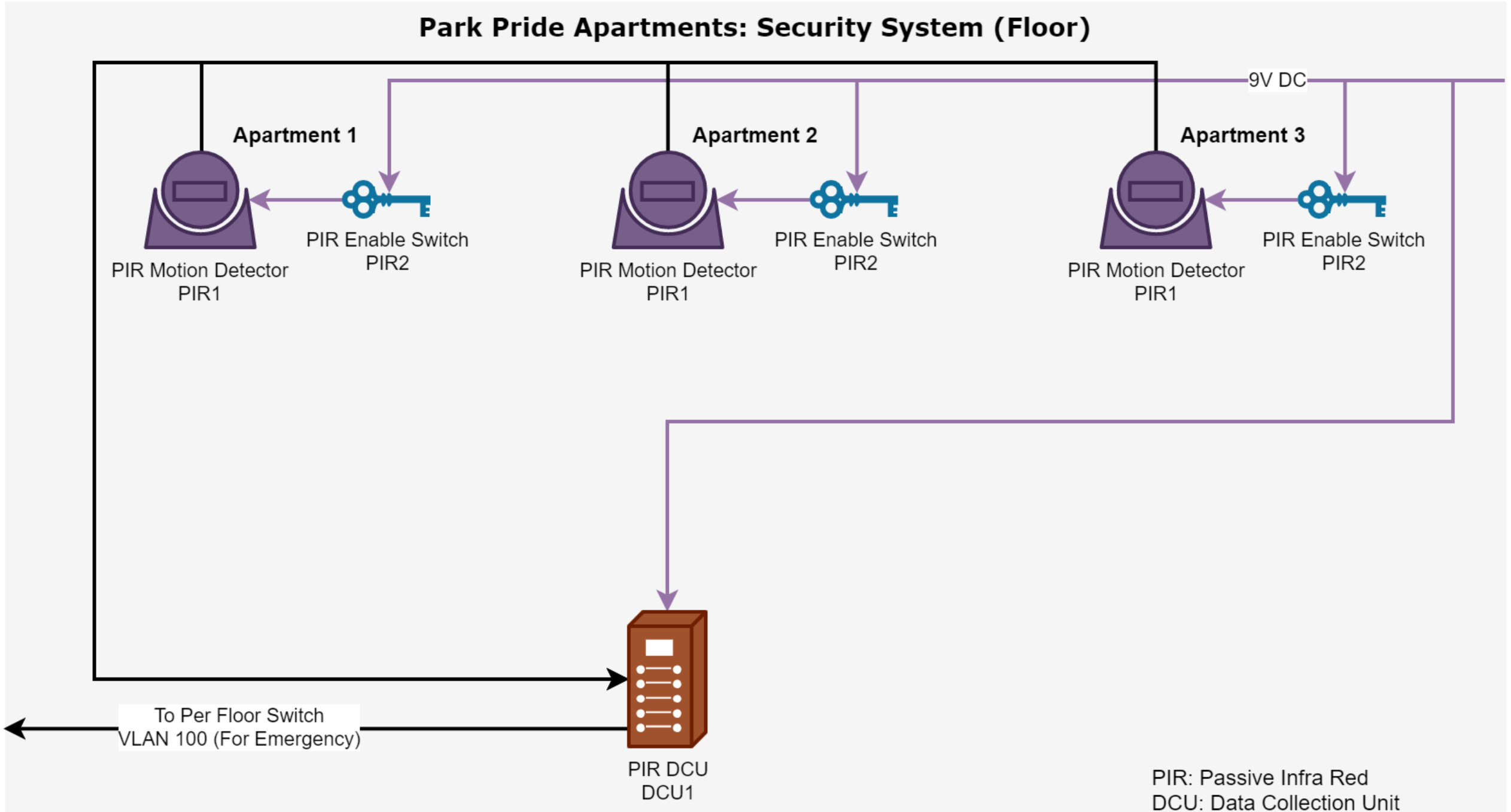
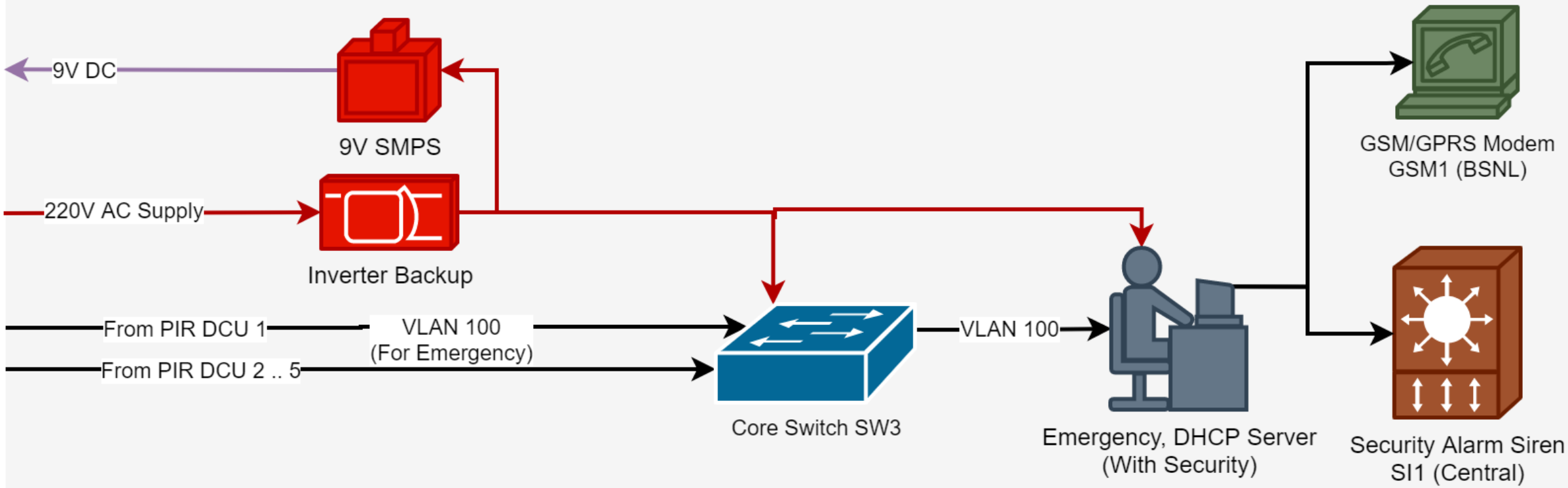
- The sensors have a trigger **enable switch** which can be turned on and off. Normally, when people are staying in the flat, the switch is turned off.
- When the members are about to **leave their apartment** empty, they **turn on** the switch, which enables the PIR sensor. From now on, if any burglar enters the apartment, it can be detected by the PIR sensor. When residents come back, they remotely turn off the sensor.
- The **DCU** is connected with ethernet cable to a **managed router** on the floor. Any motion detect **events** are sent over IP packets to an Emergency server located with the Security.
- The DCU connected port is configured as **VLAN 100**, which is reserved for all **emergency devices** of the network.
- The managed switch is then connected with **Cat 6** cable to the central Core switch at 1st floor.
- An **Emergency-cum-DHCP server** is present in 1st floor connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case an PIR sensor trigger event is detected, the Emergency server **alerts the security**, indicating the apartment number of the source.
- If it is not marked as **false alarm within 5-10 mins**, a message is sent to **nearest police department** through **GSM/GPRS modem** (with a backup in case).

Park Pride Apartments: Security System (Floor)



PIR: Passive Infra Red
DCU: Data Collection Unit

Park Pride Apartments: Security System (Central)

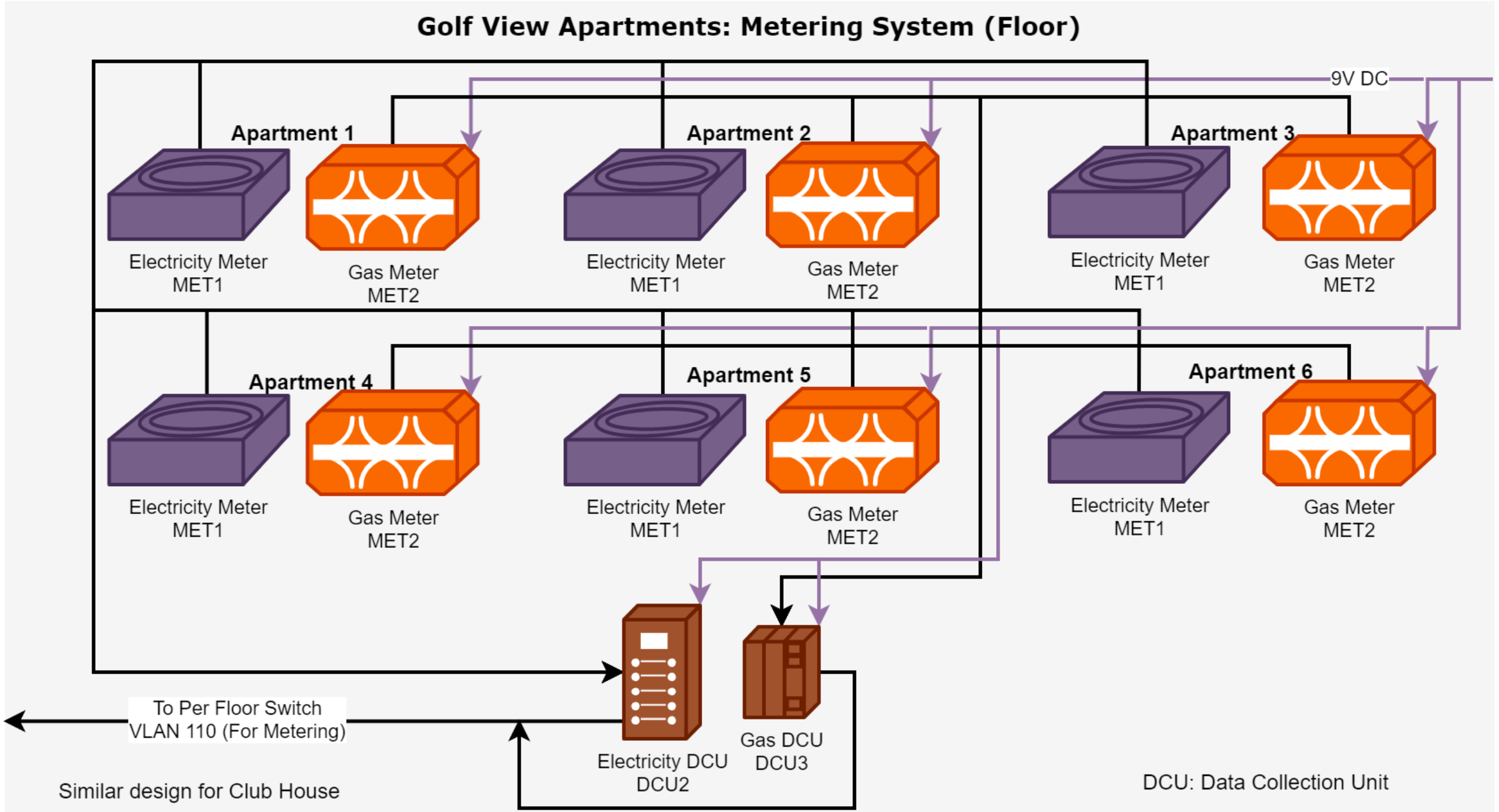


PIR: Passive Infra Red
DCU: Data Collection Unit

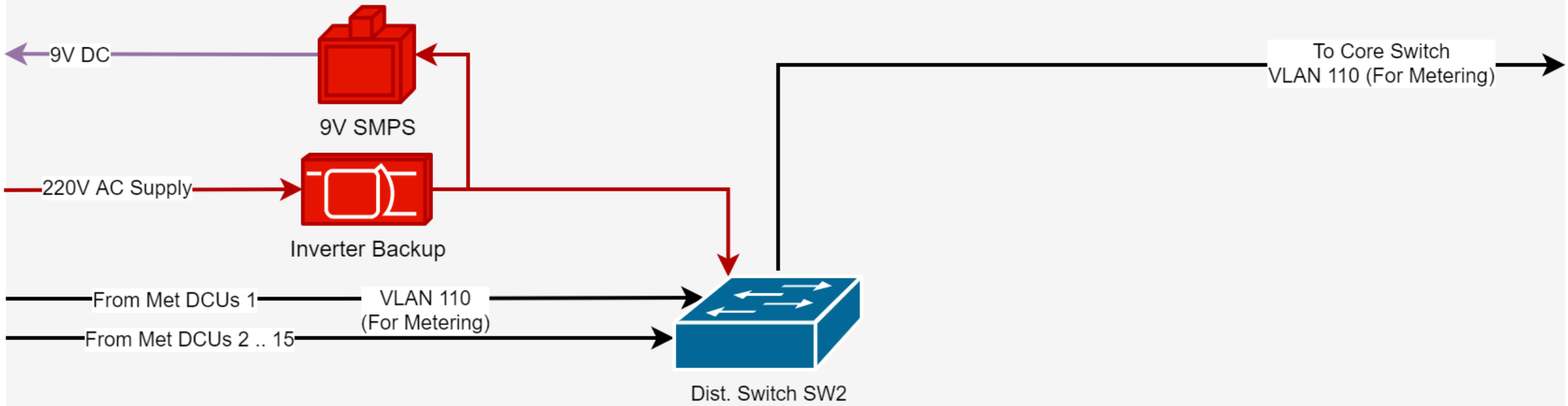
Golf View Apartments: Metering System

- Each apartment has a **piped gas** connection and thus has a **gas meter** as well as an **electricity meter**. The gas meter operates with 9V DC power provided by an SMPS installed in first floor.
- The electricity and gas meters communicate with either wired **RS-485** or **wireless RF** mechanism with a **Data Collection Unit** (DCU) which is installed every floor.
- The **DCU** is connected to **per-floor** managed **switch** on **VLAN 110**, which is reserved for **metering** purpose. The per-floor switch is connected to per-Block **Distribution switch**, which is then connected to the central **Core switch**.
- An **Metering-cum-DHCP server** is present in A-Block connected to the Core switch on **VLAN 110**. The DHCP server is used to assign IP address to all DCUs.
- **VPN Router** RO3 can act as a **VPN client** and thus form a **Virtual WAN** with electricity board's network. A **server** on their network can now **query all our metering devices**.
- The smart meters report to the power distribution company every **15 mins** through the Metering server.
- The metering server sends data to the power distribution company over HTTPS secure channel through **GSM/GPRS modem**.
- This is done so because GSM/GPRS modems are cheaply available, are reliable, and are **commonly used** in most smart meters used in India (e.g. Genus).
- There is also a **backup** GSM/GPRS modem that uses SIM from a different service provider in case the primary fails.
- If the **power distribution company** provides a VPN server in order to connect all metering devices in a **Virtual WAN**, this can be achived through the VPN Router RO3.
- The VPN Router connects with all **metering devices** on **VLAN 110** and then connects to internet either through the **Central Core Switch SW3** or a **3G/4G dongle** connected to it USB port as backup.

Golf View Apartments: Metering System (Floor)



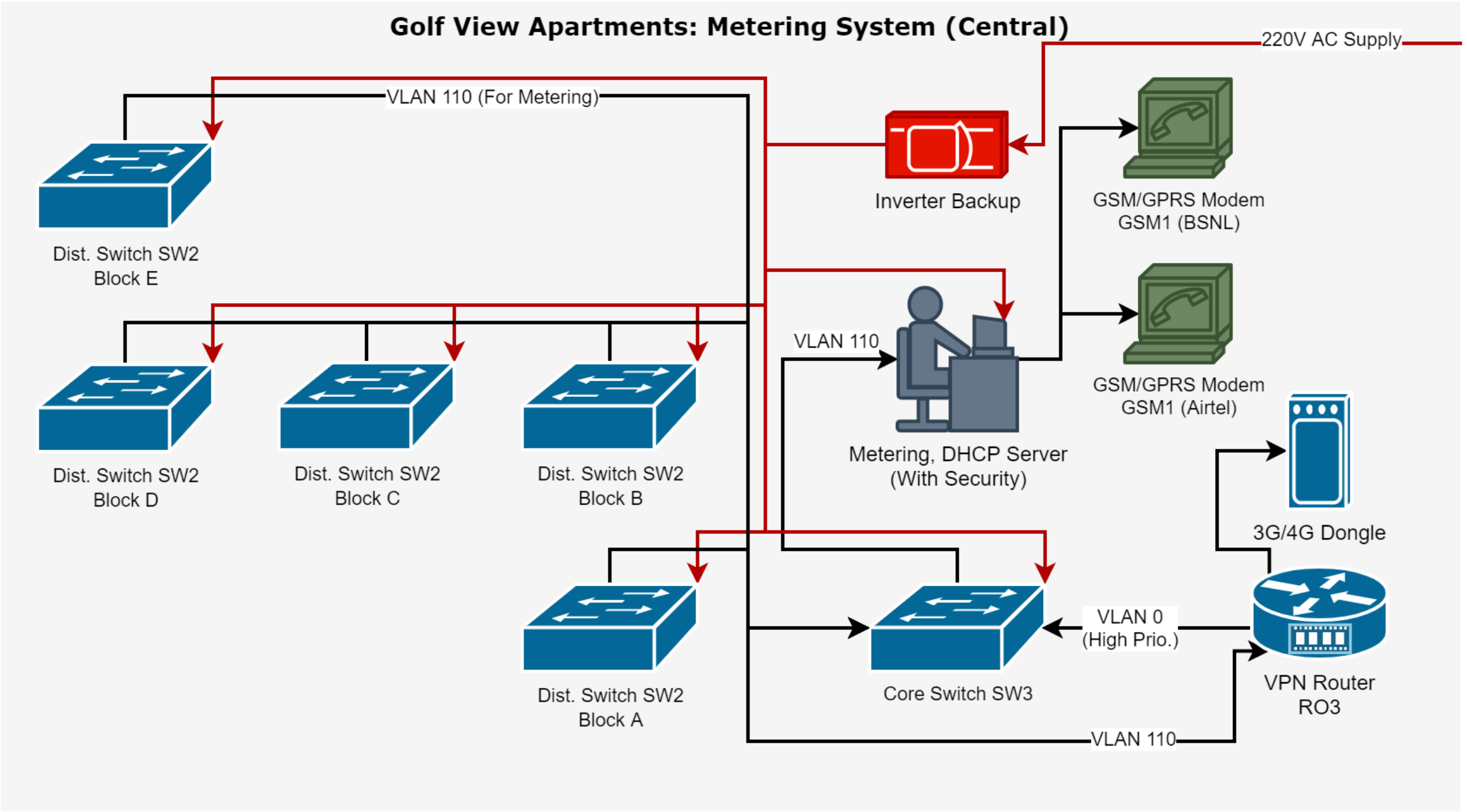
Golf View Apartments: Metering System (Block)



Similar design for Club House

DCU: Data Collection Unit

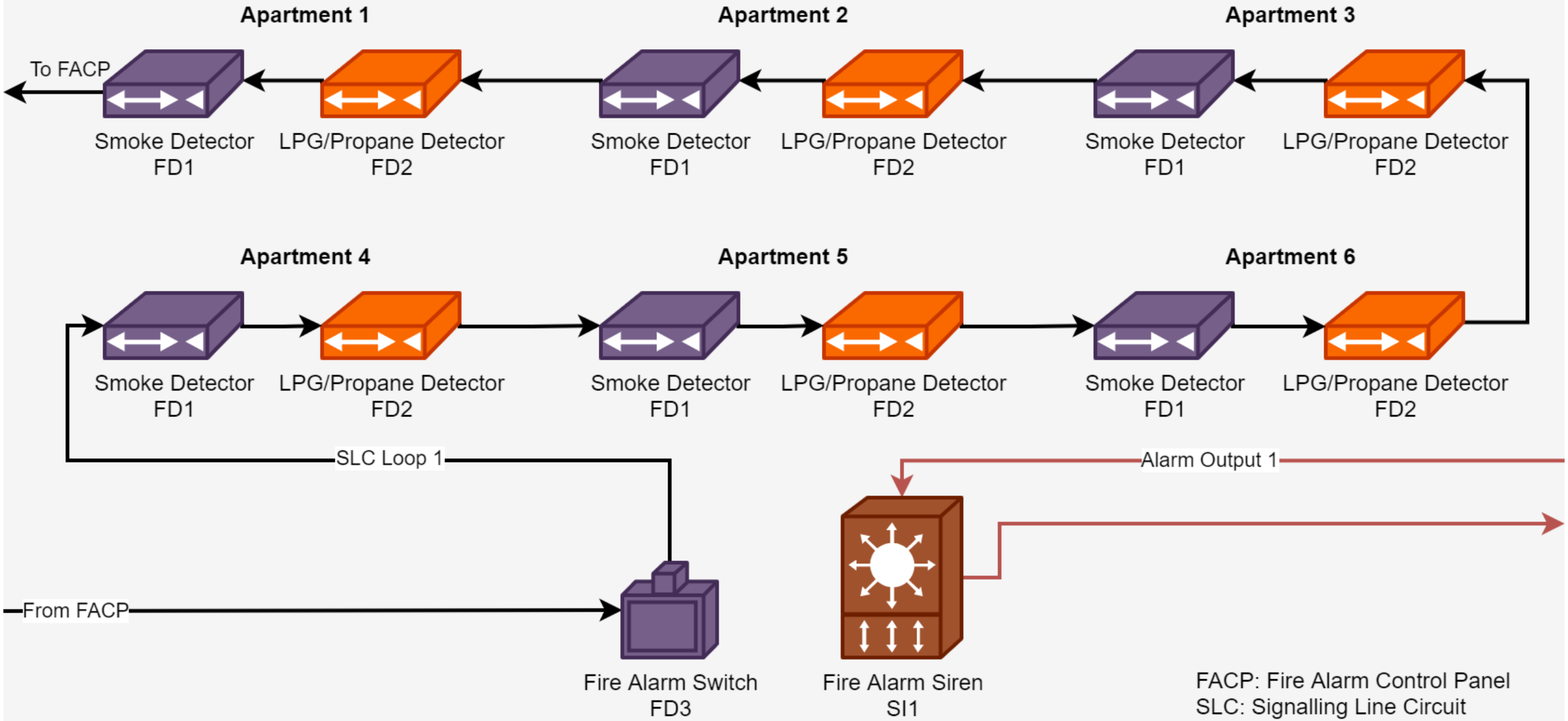
Golf View Apartments: Metering System (Central)



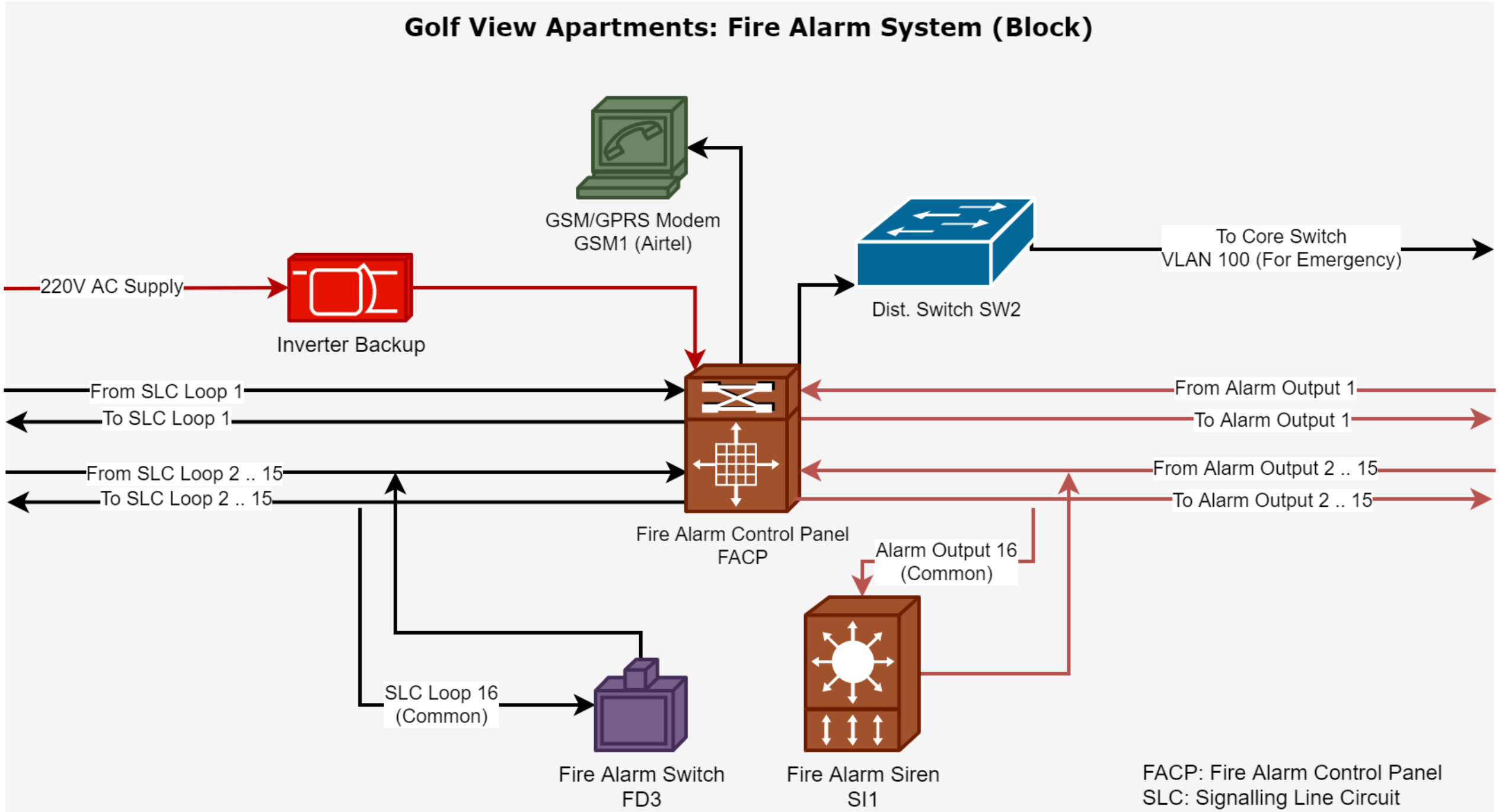
Golf View Apartments: Fire Alarm System

- We are using **Signaling Line Circuit** (SLC) based addressable **smoke detectors** and **LPG/Propane Gas sensors**. Each apartment is thus provided with a total of 2 sensors, and all 6 apartments in a floor are connected in a loop. Each floor also has a **Fire Alarm switch** (manual) which can be used to manually trigger the fire alarm.
- Each floor's loop (total 15 floors/block) is then connected to a **Fire Alarm Control Panel** (FACP) system which is also connected to a central **Fire Alarm Siren**. Each floor is also connected to its respective Siren from the FACP.
- The FACP has a **GSM/GPRS interface** built-in through which it can be configured to send fire emergency events directly to nearby fire department at a certain **delay** (**5-10 min** to avoid false alarm).
- In case there is a false alarm, the FACP's alarm can be shutdown with the delay time.
- The FACP is also connected through ethernet port to the per-Block Distribution switch.
- All per-Block Distribution switches are connected to the central **Core switch** (managed).
- An **Emergency-cum-DHCP server** is present in A-Block connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case a Fire alarm is triggered, the Emergency server **alerts the security**, rings the central siren, and indicates the apartment number of the source.
- There is also a backup GSM/GPRS module connected so that in case the one directly connected to FACP fails, the Emergency server can send the message on its behalf.

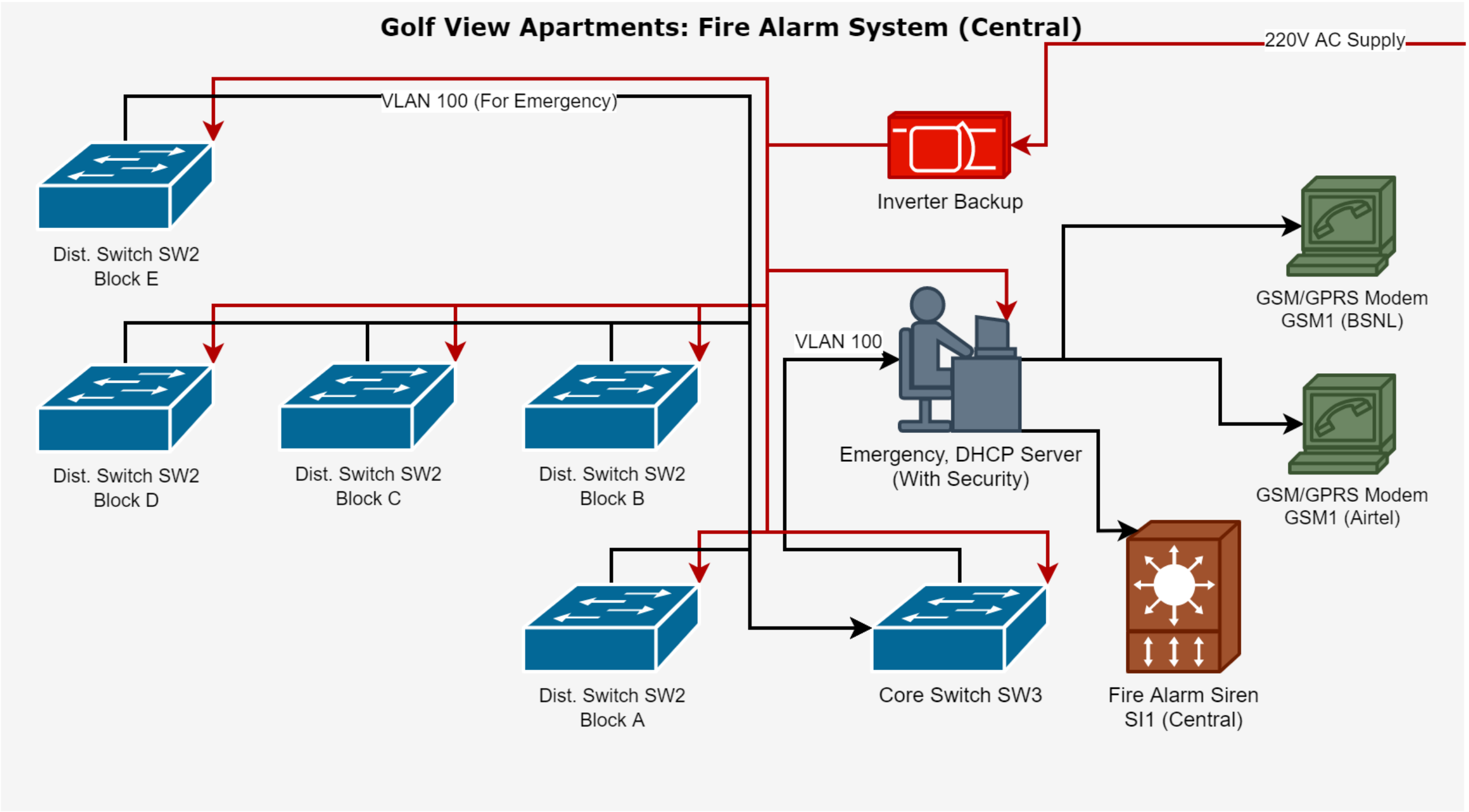
Golf View Apartments: Fire Alarm System (Floor)



Golf View Apartments: Fire Alarm System (Block)



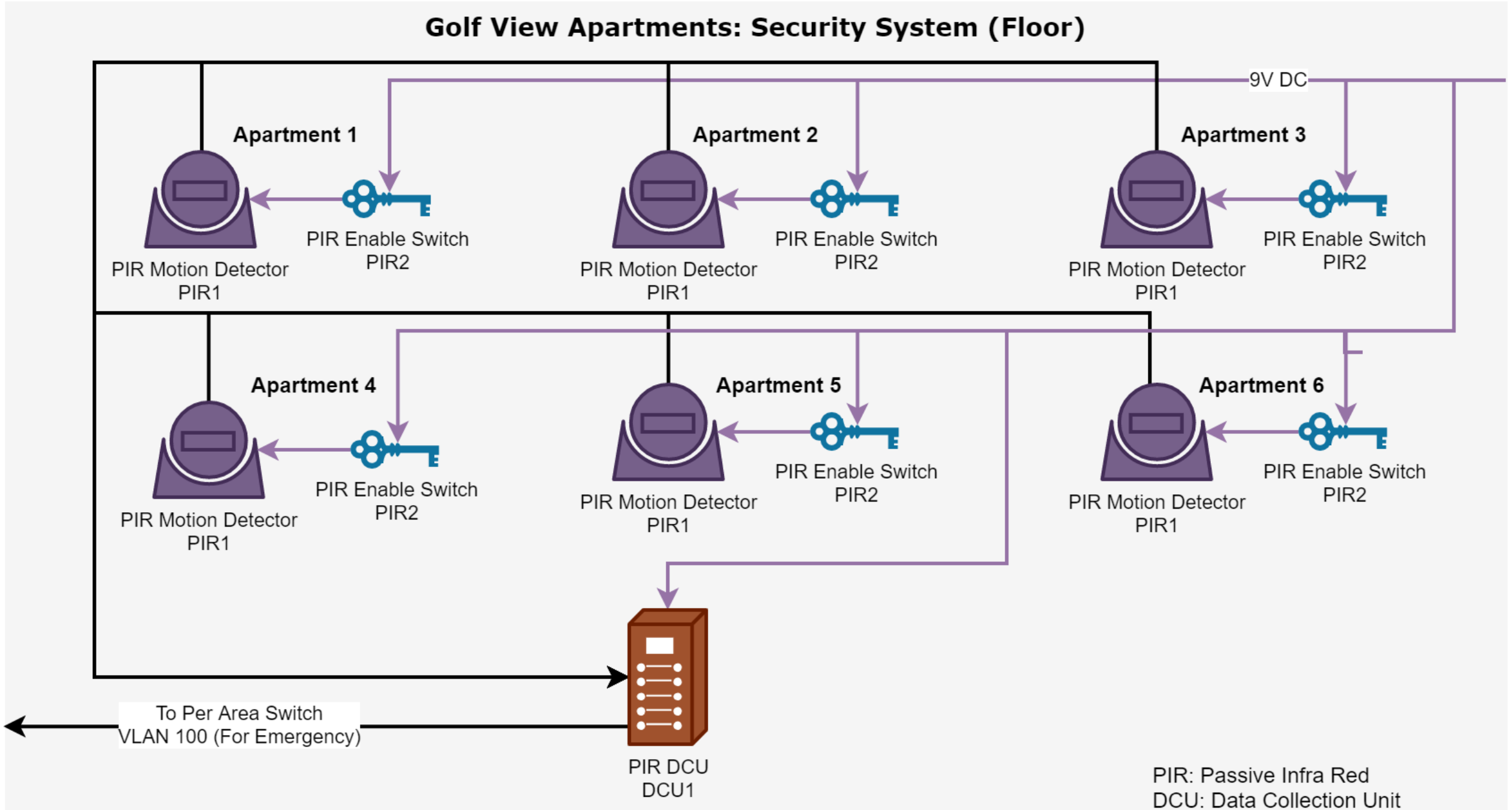
Golf View Apartments: Fire Alarm System (Central)



Golf View Apartments: Security System

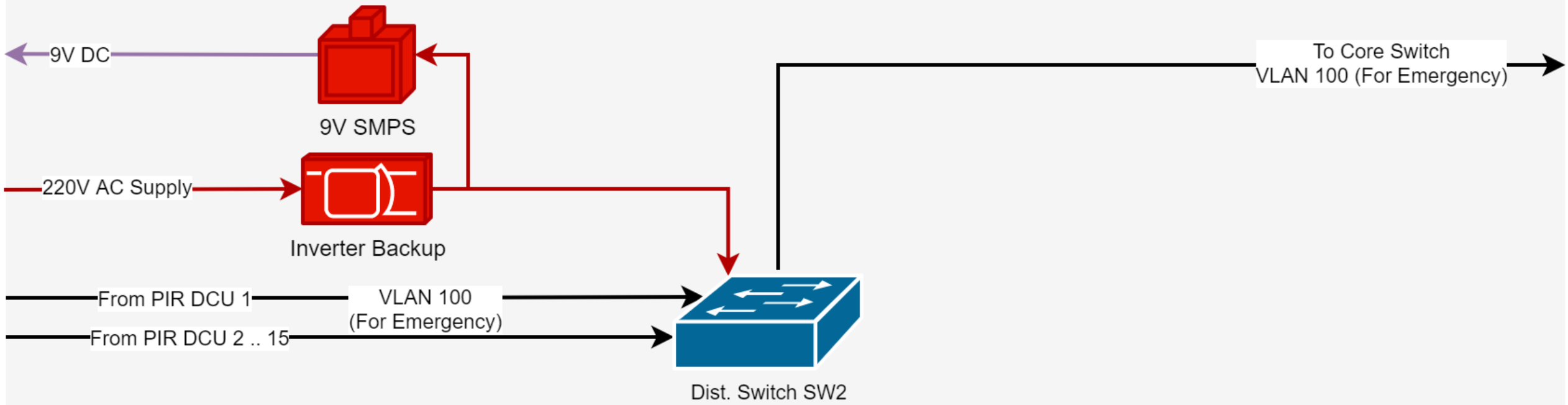
- We are using simple **PIR sensors**, that are able to detect motion as our security element. The sensor triggers an event when it **detects motion**, and this is sent to a **Data Collection Unit** (DCU).
- The sensors have a trigger **enable switch** which can be turned on and off. Normally, when people are staying in the flat, the switch is turned off.
- When the members are about to **leave their apartment** empty, they **turn on** the switch, which enables the PIR sensor. From now on, if any burglar enters the apartment, it can be detected by the PIR sensor. When residents come back, they remotely turn off the sensor.
- The **DCU** is connected with ethernet cable to a **managed router** on the floor. Any motion detect **events** are sent over IP packets to an Emergency server located with the Security.
- The DCU connected port is configured as **VLAN 100**, which is reserved for all **emergency devices** of the network.
- The managed switch is then connected with **Cat 6** cable to the per-Block managed Distribution switch at 1st floor.
- All per-Block Distribution switches are connected to the central **Core switch** (managed).
- An **Emergency-cum-DHCP server** is present in A-Block connected to the Core switch on **VLAN 100**. The DHCP server is used to assign IP address to all DCUs.
- In case an PIR sensor trigger event is detected, the Emergency server **alerts the security**, indicating the apartment number of the source.
- If it is not marked as **false alarm within 5-10 mins**, a message is sent to **nearest police department** through **GSM/GPRS modem** (with a backup in case).

Golf View Apartments: Security System (Floor)



PIR: Passive Infra Red
DCU: Data Collection Unit

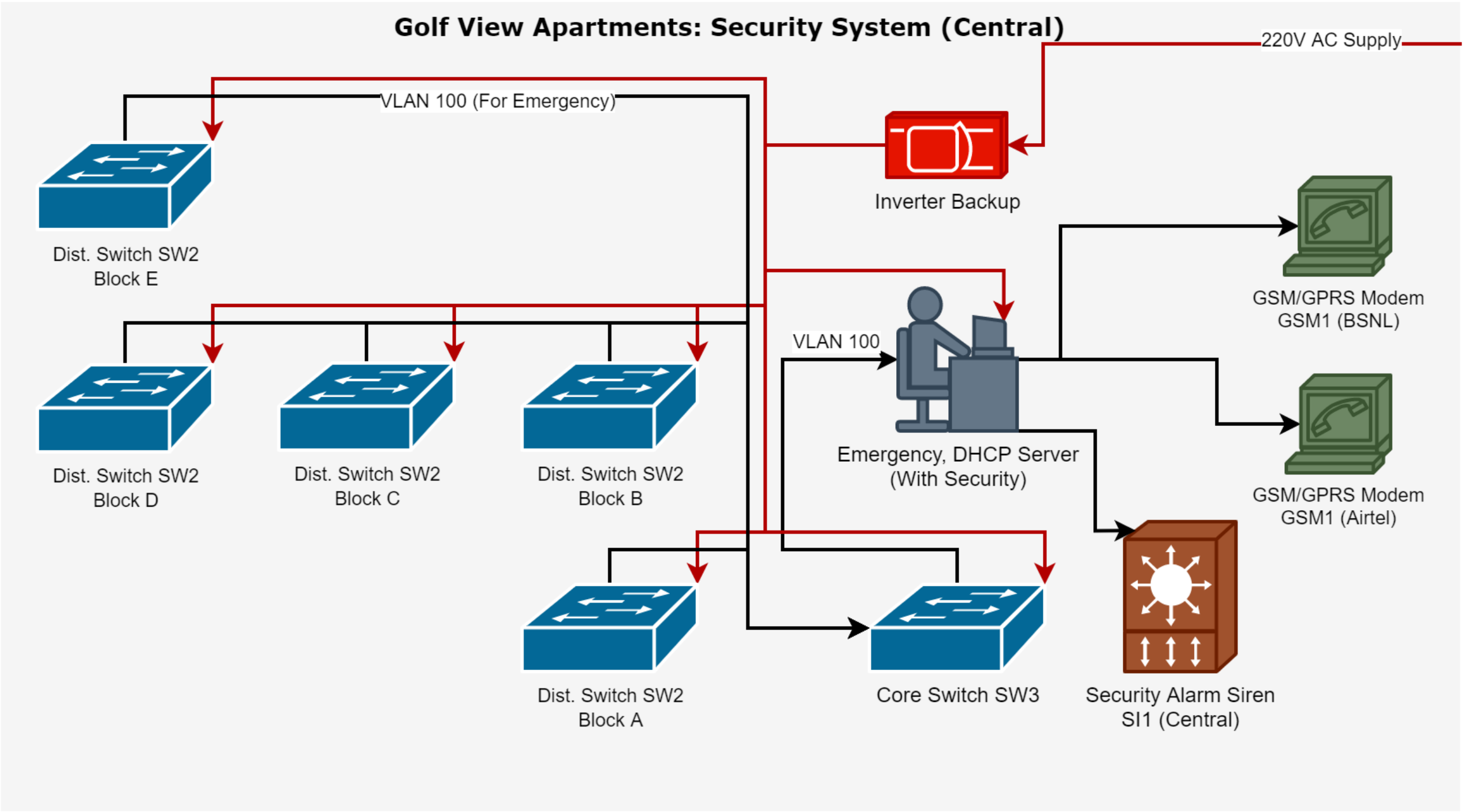
Golf View Apartments: Security System (Block)



Similar design for Club House

PIR: Passive Infra Red
DCU: Data Collection Unit

Golf View Apartments: Security System (Central)



Network Implementation (TODO)

- MikroTik CRS326-24G-2S+RM router: **₹18,000**
- Ubiquiti UF-SM-10G transciever: **₹4,000**
- TP-Link Jetstream T1600G-28TS switch: **₹1,90,000**
- TP-Link 10GBase-LR SFP+ LC Transceiver: **₹20,000**
- TP-Link TL-SG108E switch: **₹4,16,000**
- TP-Link TL-WA901N WiFi AP: **₹37,500**
- TP-Link TL-WR845N WiFi router: **₹6,54,500**
- 2U Wall mount Cabinet Box: **₹1,10,500**
- 12U Wall mount Network Rack: **₹48,000**
- Cat6 RJ45 Connector Plugs w/ Hood: **₹18,000**
- Cat6 Ethernet Cable (Roll): **₹1,50,000**
- RJ45 Cat6 Cable Jointer: **₹3,000**
- 1.5m Cat6 Patch Cable: **₹1,35,000**
- M6 Cage Nuts, Washers & screws: **₹27,000**
- Mass Rack 10" Tray: **₹36,000**
- D-Link 24-port Cat6 Patch Panel: **₹2,70,000**
- RJ45/11 Crimper, Cutter & Stripper Tool: **₹3,000**
- River Fox Punch Down Tool Cat 5e/6: **₹1,500**
- Moelissa MS-LT02 RJ45/11 Cable tester: **₹1,500**

- **Total Cost: ₹21,43,500**

RS1 MikroTik CRS326-24G-2S+RM Cloud Router Switch

- This is the router for devices (cameras, WiFi access points) common network. It does the job of a DHCP server, assigning private IP addresses to each common net device and translating any packets forwarded to the internet to public address (NAT/PAT).
- Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This is a separate connection taken by the Golf View Society and a common internet connection for internet access provided in Club House, Gardens, Playgrounds & Footpath.

- 24 x 1 Gb ethernet port
- 2 x 10 Gb SFP+ cages
- Dual boot RouterOS / SwOS

- 1 as the central router.
- **Quantity**: 1
- **Cost**: ₹18000 x 1 = **₹18,000**

Ubiquiti UF-SM-10G 1310nm 10km SFP+ Transceiver

- This Small Form-factor Pluggable (SFP) optical transceiver is to be inserted into the SFP+ cage of **RS1**, so that a 10Gpbs 1270/1330nm fiber line can be terminated at the router. The optical fiber must be a single-mode fiber upto 10km length. It accepts dual LC connector
- This is the router for devices (cameras, WiFi access points) common network. It does the job of a DHCP server, assigning private IP addresses to each common net device and translating any packets forwarded to the internet to public address (NAT/PAT).
- Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This is a separate connection taken by the Golf View Society and a common internet connection for internet access provided in Club House, Gardens, Playgrounds & Footpath.
- 2 per block as central switch.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹2000 x 2 = **₹4,000**

SW2 TP-Link Jetstream T1600G-28TS 24port Managed Switch

- This is the central switch that is for both personal & common net.
- In the personal net, each floor's router connect to this central switch. Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This conection is kept different for each block. The ISP's DHCP assigns public IP to all home routers in each flat.
- In the common net, switches from club, basement, footpath conect here. This is installed per block, so the access switches always connect to the nearest central switch. The central switches are the connect together from each block to the central router over Cat6 cable. As a whole they form a LAN behind the router.

- 24 x 1 Gb ethernet port
- 4 x SFP slots

- 2 per block as central switch.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹19000 x 10 = **₹1,90,000**

TP-Link 10GBase-LR SFP+ LC Transceiver

- This is used with private net central switches to conect to ISP. The connection is individually made for each block.
- Single mode optical fibre connection from ISP is terminated through (from ISP's central office) this transciever.

- Wave Length 1310 nm
- Fiber Type 9/125 µm Single-Mode
- Max. Cable Length 10km
- Data Rate 1.25 Gbps
- Data Rate 10Gbps
- Port Type LC/UPC

- 2 per central switch of personal net.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹2000 x 10 = **₹20,000**

SW1 TP-Link TL-SG108E 8-port GbE Unmanaged Switch

- This is an unmanaged switch that is used to make first level connections in both the personal and the common network. It then connects to the nearest central switch that is installed per block.

- 2 per floor (inc. club), 5 for basement, 5 for footpath, 1 for entry.
- **Quantity**: 2 x 14 floors x 4 blocks + 2 x 15 floors + 2 club + 5 basement + 5 footpath + 1 entry + 2 spares = 160
- **Cost**: ₹2600 x 160 = **₹4,16,000**

TP-Link TL-WA901N Wireless Access Point

- This a wireless access point without a router. It has the ability to extend WiFi. Used to provide internet connection in common areas.
- 1 in each room of club house + 15 across footpath
- **Quantity**: 4 rooms x 2 floors (club) + 15 footpath + 2 spares = 2**5**
- **Cost**: ₹1500 x 25 = **₹37,500**

TP-Link Archer A5 AC 1200 WiFi Dual Band Wireless Router

- This wireless router is provided to each flat. It is a dual band router to support more mobile devices.
- 1 for each flat
- **Quantity**: 1 x 384 flats + 1 spare = **385**
- **Cost**: ₹1700 x 385 = **₹6,54,500**

2U Wall mount Cabinet Box

- Holds the network devices onto the wall, for stable setup.
- 1 per floor + 2 for club + 1 for basement/block + 1 external/block + 1 entry/exit
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 2 club + (1 + 1) x 5 blocks + 1 entry + 1 spare = 8**5**
- **Cost**: ₹1300 x 85 = **₹1,10,500**

12U Wall mount Network Rack

- Holds the network devices onto the wall, for stable setup.
- 1 per block (for switches) + 1 for central router
- **Quantity**: 1 x 5 blocks + 1 = **6**
- **Cost**: ₹8000 x 6 = **₹48,000**

Cat6 RJ45 Connector Plugs w/ Hood

- This is the connector for Cat6 cable with staggered pins, which helps isolate signals at the port. It also minimizes distance from cable to reduce cross-talk.
- 2 per flat, 4 + 6 per floor (camera), 2 for external long connections, 2 for external short connections, 2 for block-block connections.
- **Quantity**: 2 x 384 flats + 10 x 14 floors x 4 blocks + 10 x 15 floors + 2 x (15 basement + 15 footpath cam + 15 wireless AP) + 2 x 2 entry/exit + 2 x (3 + 3 + 3) + 2 + 2 x 4 blocks + 400 spare = 2**000**
- **Cost**: ₹9 x 2000 = **₹18,000**

Cat6 Ethernet Cable (Roll)

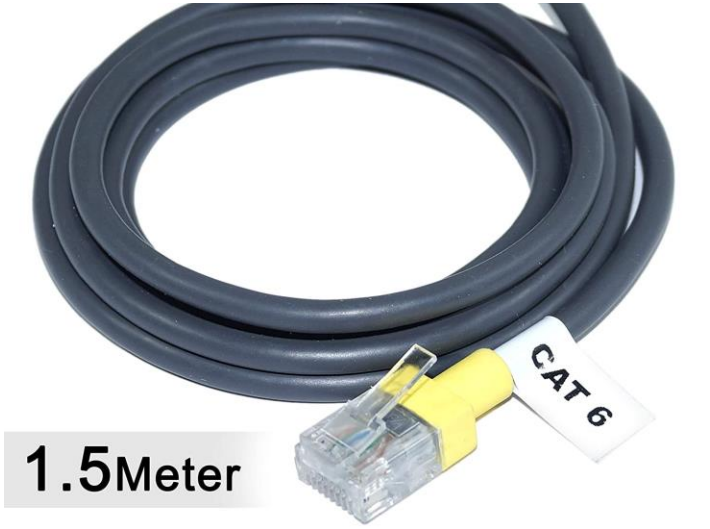
- Cat 6 cable supports 10Gbps utp 55m & 1Gbps upto 100m. Unlike Cat5e cable its wire pairs are twisted tighter, and it has a central plastic pair separator to maintain inter-pair distance as mentioned in the Cat6 specification. It is used for all cabling for uniformity sake.
- Avg. 10m per flat, avg. 40m + 30m (camera) per floor, 20m for external long connections, 10m for external short connections (including club house), 60m for block-block connections.
- **Quantity**: 10 x 384 flats + 70 x 2 x 14 floors x 4 blocks + 70 x 2 x 15 floors + 10 x (15 basement + 15 footpath cam + 15 wireless AP) + 10 x 2 entry/exit + 20 x (3 + 3 + 3) + 20 + 60 x 4 blocks + 310 spare = 1**5000**
- **Cost**: ₹10 x 15000 = **₹1,50,000**

RJ45 Cat6 Cable Jointer (Couple Plug)

- It is used to connect together 2 ethernet cables to form a longer cable. It also helps for maintaining some modularity.
- 2 per IP security camera & wireless AP.
- **Quantity**: 2 x (15 basement + 15 footpath cam + 15 wireless AP) + 2 x 2 entry/exit cam + 6 spares = **100**
- **Cost**: ₹30 x 100 = **₹3,000**

1.5m Cat6 Patch Cable

- It makes it easy to make a connection between a port in a patch panel to a port on a network device. It is usually made of stranded copper wire for repeated use.
- 16 needed per floor (inc. club house). 48 needed per block, central room & a few spares.
- **Quantity**: 16 x 14 floors x 4 blocks + 16 x 15 floors + 16 x 2 club + 48 x 5 blocks + 48 central + 44 spares = 1500
- **Cost**: ₹90 x 1500 = **₹1,35,000**



RJ45 Cat 6 Ethernet Cable Network LAN Cable

M6 Cage Nuts, Washers & Mounting screws for Server Rack & Cabinet

- It is used to mount network devices to racks.
- 16 needed per floor (inc. club house). 24 needed per block, central room & a few spares.
- **Quantity**: 16 x 14 floors x 4 blocks + 16 x 15 floors + 16 x 2 club + 24 x 5 blocks + 24 central + 38 spares = 1350
- **Cost**: ₹20 x 1350 = **₹27,000**

Mass Rack 10" Tray

- Used to store additional length of cables below patch panel.
- 1 needed per floor (inc. club house). 2 needed per block, central room & a few spares.
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 1 x 2 club + 2 x 5 blocks + 2 central + 5 spares = 90
- **Cost**: ₹400 x 90 = **₹36,000**

D-Link 24-port Cat6 Patch Panel

- It has ready to use RJ45 sockets on a panel that can be directly attacked to a network rack. This helps in cable management, and allows one to easily visualize, setup and debug network connections to switches / routers.
- 1 needed per floor (inc. club house). 2 needed per block, central room & a few spares.
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 1 x 2 club + 2 x 5 blocks + 2 central + 5 spares = 90
- **Cost**: ₹3000 x 90 = **₹2,70,000**

RJ45/11 Crimper, Cutter & Stripper Tool

- This is a multitool that enables ethernet cables to be cut, insulation stripped, and the crimped onto a, RJ45 connector.
- Would be useful when performing network setup to the flats, per floor cabinets as well as in network rack for server room. Preferable to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹600 x 5 = **₹3,000**

River Fox Punch Down Tool Cat 5e/6

- It helps connect LAN cable to RJ45 socket (Keystone) in a Wall socket or a Patch panel. After stripping the outer cover of the Cat6 cable & plastic pair-separator, and plugging it into a Keystone, a neat connection can be made with this tool.
- Would be useful when performing network setup to the flats, per floor cabinets as well as in network rack for server room. Preferable to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹300 x 5 = **₹1,500**

Moelissa MS-LT02 RJ45/11 Cable tester

- It helps check if a cable if properly connected to a network device (like switch). The remote helps identify wire you have connected to, if there are too many tangled wires.
- Would be useful for debugging connectivity issues when performing network setup / management. Perfereble to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹300 x 5 = **₹1,500**

LAN Design for Village/Rural Region

20173098 – Ram Pratap Bachina

What is this document?

This is the design document to create LAN for Abburu Village, AP state.

Problem Statement

India has internet users with 54% of total country's population and which is ranked second in world but total percentage use is not high and we also ranked 86th with 8.2 Mbps connectivity speed and our ranking down by 10 places compared with last year, according to Akmai. The remaining users of 46% is who doesn't use internet is because of several reasons but important reason for them to not get acquainted with broadband because of no connectivity to their villages. ISP see good ROI in cities and not in villages but due to pandemic world has incorporated new work style and new way of teaching next generation kids. With remote learning and working majorly everyone back to roots and expecting high speed internet or at least connectivity in their counties/villages.

What are the possible reasons for no connectivity in remote regions/villages?

a. Building a new network is always expensive considering the facts like cables, new hardware equipment, need of increase in electrical demand, cost of setup like poles and its rights.
b. Lack of state government co-operation with ISP
c. ISP is not ready to invest as they see less returns when it comes to rural areas.
d. Unable to find field workers with network knowledge in rural regions to support in case of technical issues
e. Size of town/village not enough size to support ISP.
f. Too expensive to buy new connection

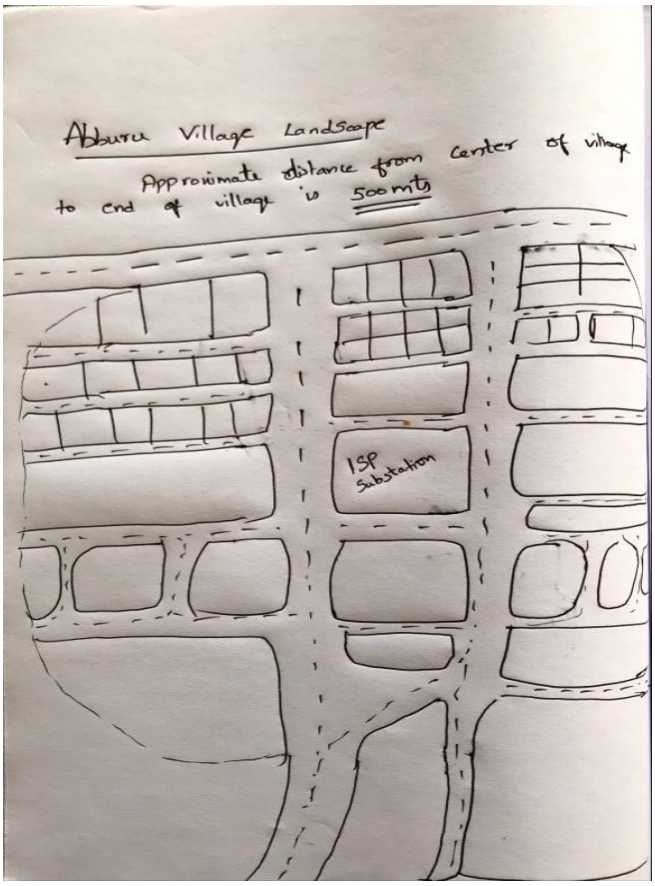
Need of Hour

Any public and private sector with digitalization, life of work is smoother and faster. There is latest increase in demand of IT employment and e-learning students for internet in rural regions due to pandemic and country with highest number of rural population if we can take the world of internet to rural areas it will increase internet usage percentage of India.

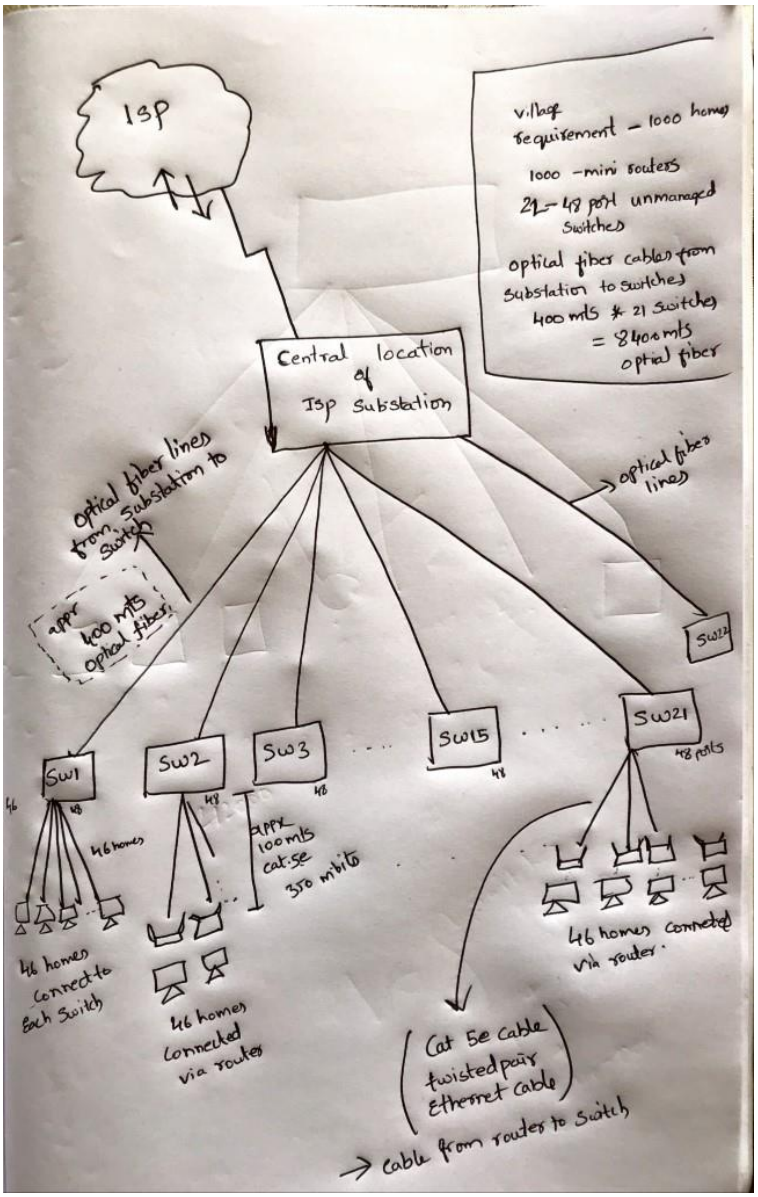
Identifying Village(Abburu) region and requirements

Total Population	4200+
Total Homes	Appx 1200
Internet Requirement	At least 1000
Speed requirement 10-18 Mbps	700 Homes
Speed Requirement 25-30 Mbps	300 Homes
House Sizes	1500 sqft – 300 sqft
Radius of village	500mts

Village Landscape



<u>Design idea for village</u>



REQUIREMENTS GATHERING

How much villagers ready to pay for broadband?

50% homes	200 – 300 rs per month
20% homes	300 – 400 rs per month

15% homes	400 – 500 rs per month
10% homes	100 –200 rs per month
5% homes	500+ rs per month

Note – Above information is collected from Village revenue officer (VRO) based on the percentage that villagers own and cable TV operator based on how much of money customers are happy and ready to pay for their cable tv connection

How much optical fiber/ broadband ISPs are charging for the required data speed

Internet speed	Price	Speed Post FuP	Setup charges (free router)
18Mbps	400	512kbps	6 months' payment
30 Mbps	500	1Mbps	6 months' payment

*Speed post Fair usage policy (FuP)

CHOOSING THE ROUTER (at user end)

Router requirements for village homes

Specification	Need?
Internet Access Ports LAN	2-3 Lan ports
Internet Access Ports WAN	1 WAN port
Internet Access Port Speed	100 Mbps
Wifi Speed	300 Mbps
Wifi standard	Wifi4 IEEE 802.11n
Range	50 mts

Range - Unlink cities we need high range antennas require in villages because houses area is huge, and people expect wireless to reach everywhere at the home surroundings.

2.4 GHz vs 5 GHz

Which is best suited router for village environment?

A larger area needs longer coverage, 2.4GHz suits for this requirement as it has a longer range and penetration ability. For small homes, and city flats 5GHz will not only provide greater speed but also help with minimum interference from cluttering networks.
Design decision to go with 2.4 GHz

What option in wi-fi to find to get the 2.4Ghz frequency?

Wi-fi standard - I have chosen wifi4 IEEE 802.11n other than 802.11 b/g because of it has features like

Table 1. Technology comparison.

	IEEE 802.11a	IEEE 802.11b	IEEE 802.11g	IEEE 802.11n
Frequency band	5.7 GHz	2.4 GHz	2.4 GHz	2.4 / 5 GHz
Average Theoretical speed	54 Mbps	11 Mbps	54 Mbps	600 Mbps
Modulation	OFDM	CCK modulated with QPSK	DSSS, CCK, OFDM	OFDM
Channel bandwidth	20 MHz	20 MHz	20 MHz	20 / 40 MHz
Coverage radius	35 m	38 m	38 m	75 m
Unlicensed spectrum	Yes (it depends on countries)	Yes	Yes	Yes (it depends on countries)
Radio Interference	Low	High	High	Low
Introduction cost	Medium-Low	Low	Low	High-medium
Device cost	Medium-Low	Low	Low	Medium
Mobility	Yes	Yes	Yes	Yes
Current use	Medium	High	High	High
Security	Medium	Medium	Medium	High

Table reference - https://www.semanticscholar.org/paper/WLAN-IEEE-802.11-a%2Fb%2Fg%2Fn-Indoor-Coverage-and-Study-Sendra-Pineda/25830e9d4035c908c623ddab77d860c2db3144be

Out in the world of routers with my design requirement there are plenty of router making companies I have chosen the top 5 companies based below parameters

1. Product quality and reliability
2. Price of router
3. customer support

- Netgear
- TP-LINK
- D-LINK
- Asus

Out of above brands cost for feature and number of years of warranty is best in TP-LINK along with my requirements to router.

TL-WR845N V4 - cost 950 /-

4. This one also has 3 fixed antennas - Multiple antennas form a signal-boosting array to cover more directions and large areas
5. Another best feature with this router has WISP mode(Connect to ISP directly with wirelessly if the home or region doesn't have the wired connection)

Note - This router will accept only ethernet cables will not support optical fiber

Why did I selected Ethernet port Router(TP-LINK **TL-WR845N V4**)?

Cost issues - as part of design we can also directly connect optical fiber cables to router via optical fiber modem and connect the modem's LAN port with the router's WAN port using an Ethernet cable.

Each home must have cost of either 4000/- or 2000/- if going with optical fiber to home (FTTH - **fiber**-to-the-**home**)

Therefore we need,

Optical fiber modem	1000/- to 10000/-
Router	1000/-

Or else

Router with inbuilt fiber optic modem	4000/-

So, I have decided to go with Ethernet port router

How much data is required for the entire village?

30000Mbps (30Gbps)

CHOOSING THE CABELS

Considerations

Optical Fiber cable (single mode optical fiber)

- Price – 50 rupees per meter
- Distance – 40 Kms
- Advantages -
    - No degradation of signal
    - Low dispersion
    - Well suited for long distance communication
-

Twisted pair cables

Cat 5e

- Price – 2 pair cat5e 4 rupees per meter
- Distance – 100 meters
- Speed – 350 Mbit/s over 100 meters

Cat 6

- Price – cat 6, 15 to 20 rupees per meter
- Distance – 100 meters
- Speed - 1 Gbps network speeds, CAT6 can also support higher data rates of 10Gbps. However, 10Gbps is only supported over shorter distances of **37-55** meters.

Coaxial cable

- Price – 15 to 18 rupees
- Distance – 500 meters
- Bandwidth – 10Mbps
    - **Coaxial cable for the internet**
    - Coaxial cables can be used to carry signals for internet connections, but internet signals run at higher frequencies than traditional analogue video.

RG6 VS RG59

Going with RG6 high bandwidth and high frequency compared with RG59

What is my choice of medium to connect to ethernet router and ethernet unmanaged switch?

Cat 5e unshielded twisted pair cable

Reason for selecting cat 5e

Network speed	30mbps is requirement	It can support up to 350Mbps
Amount of users	Cat 5e cable to each home for 2 to 3 devices	Tens of users can connect(Multiple homes by default)
Indoor/outdoor purpose	Using it to connect local switch at near main road 90 mts away	Can you in both cases with up to 100 mts
Interference	No interference	With interference frequency and speed reduces

- The factors that need to consider while choosing CAT 5e
    - Quality copper cable
    - Lifetime support vendor

What are the reasons for selecting cat 5e twisted pair ethernet cables?	• Whole 500 meters village is divided into 22 spots. • Each spot is installed with ethernet unmanaged switch • Distance between ethernet unmanaged switch and central ISP station is 400 meters away. • Distance between (spot)switch and home router is 100 meters • Each switch is connected with 46 mini routers or homes • Since all the mini routers are just ethernet(LAN cable) supported routers and twisted pair 5e cable is selected between mini router and switch

What is my choice of medium to connect ethernet unmanaged switch and ISP substation?

Reason for selecting fiber optical cable OM3, wavelength 850, maximum channel length 550 meters

Network speed	1500 mbps is requirement	It can support up to 1.5 gbps
Amount of users	Optical fiber cable from central substation to each switch which is 400 meters awy	Based on the Transmission requirement to users we can select OM1, OM2, OM3 and OM4 fiber cables
Indoor/outdoor purpose	Outdoor purpose	Can you in both cases
Interference	No interference	Very less

- The factors that need to consider while choosing OM3 single mode optical fiber
    - Only OM2 and OM3 gives the combination of transmission speed of 1gbps and distance of 550 meters(my requirement is 400 meters)

Ref doc - https://www.stl.tech/optical-interconnect-products/optical-fibre/pdf/Differences_between_OM1__OM2__OM3__OM4_.pdf

What are the reasons for selecting single mode OM2 fiber optic cable?	• Whole 500 meters village is divided into 22 spots.
	• Each spot is installed with ethernet unmanaged switch
	• Distance between ethernet unmanaged switch and central ISP station is 400 meters away in village.
	• Village speed requirement is 30Gbps
	• Total cost for installation
	  ▪ 400 meters * 22 switches = 8800 meters
	  ▪ 50 rupees for each meter = 4,40,000/-
	
	Only fiber optic is reasonable compared with coaxial or twisted pair cables. If I consider the coaxial cable extra cost must be spent on switches and buying converter modems

ISP central location is placed in center of village (if not, close to the center of village). Since the village radius is not more than 500 mts

CHOOSING THE SWITCH IN MY LAN DESIGN

What is the requirement?

- As connection requirement is 1000 homes and identified and divided whole village region into 22 spots if I install switch at every spot, 22 switches with 48 ports can give connections up to 1056 homes and this will be enough for current need.

- Switch is nearly or less than 100 meters away from each mini router.

- All the routers at home supports only cat 5e cables so medium between router and switch has to be ethernet twisted pair cable so the switch is also ethernet switch.

- Keeping the cost in mind each switch that connects home is unmanaged switch, and no of ports for each switch has 48 so cost per each varies based on the brand.

- Speed requirement for each switch is 1440 Mbps

- As we are connecting optical fiber from central managed switch at substation to ethernet switch is 400 meters we need switch with sfp port enabled for gigabit data as input

By considering all above parameters, investment and brand chosen the DES-1050G(D-LINK) - L2 unmanaged switch - DES-1050G

Why did I select L2 unmanaged switch - DES-1050G?

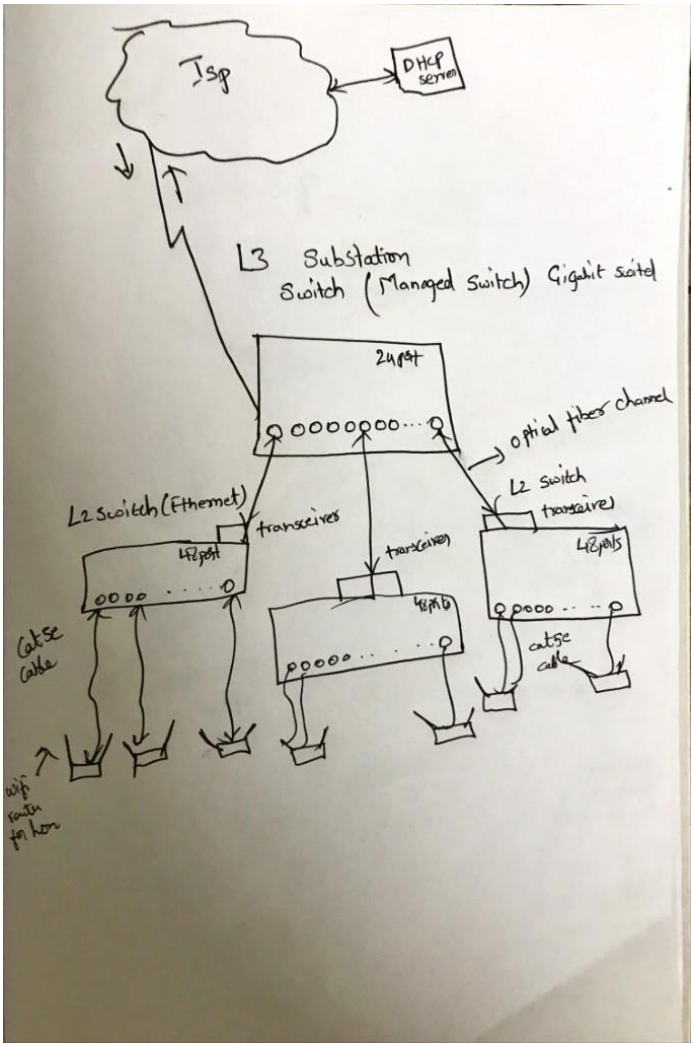
6. It has 48 ports
7. 2 Gigabit sfb ports (will use it to connect the transceiver)
8. Switching capacity 3.6Gbps (My requirement is 1.5 Gbps and may increase in future)
9. Why L2 – requirement is only about ethernet connection
10. Each port speed 100mbps
11. Price 16000/-

https://www.dlink.com/en/products/des-1050g-48-port-unmanaged-ethernet-switch-with-2-gigabit-coppersfp-ports

Need of Transceiver to connect ethernet switch sfp(short form-factor pluggable)

1000Base –LS SFP	We are connecting only on fibre from main switch to ethernet switch so, 1000 base LS is suggestable Considering - TP-LINK TL-SM311LS Gigabit SFP module, Single-mode, MiniGBIC, LC interface, Up to 10km distance Cost – 2000/- Install Transceiver at each switch

Core Switch(also called as ISP substation managed system)



How are 22 spots/sub-regions in village are connected (22 L2 switches)?

As this is multi switching environment all 22 unmanaged switches are connected to managed L3 switch and data is transferred through medium fiber optic

- I need one administrative switch which is L3 connected on top of all 22, L2 unmanaged switches. As all L2 switches are expecting 1.5Gbps and my administrative switch should have a capacity of 33Gbps.

- Along with that medium between L2 switch and L3 switch is fiber optic cable so, my administrative switch cannot be fast ethernet switch but optical fiber supported gigabit switch.

- As I have 22 switches my Administrative switch must have minimum of 24 ports.

- Should I consider **Connect Multiple Ethernet Switches by Switch Cluster?**
    - Reason for not going with switch cluster concept because Only specific cluster-capable switches from the same manufacturer can be clustered.
    - I selected 22 unmanaged switches from D-LINK company but my administrative switch is chosen from Cisco. So, I by passed this option and setup the multi-vendor switches as child and parent.

WS-C3850-24T - CISCO WS-C3850-24T-S STACKABLE 24 10/100/1000 ETHERNET PORTS switch serves my requirement

IP Addressing schema for the village

I am designing LAN for already existing **ISP** network which they **get the block of IPs from Indian registry for internet names and numbers(IRINN)**. With their block **everyday dynamic IP is generated and assigned to my host which is a public IP.** Dynamic IP allocation will happens at remote region or remote site where ISP is located 30 kms away from the Village through **DHCP server.**

Within the given range or pool of IP address allocated in ISP, where ISP saves the IP in DHCP database where server identifies the clients and allocated the IP based on given number of days.

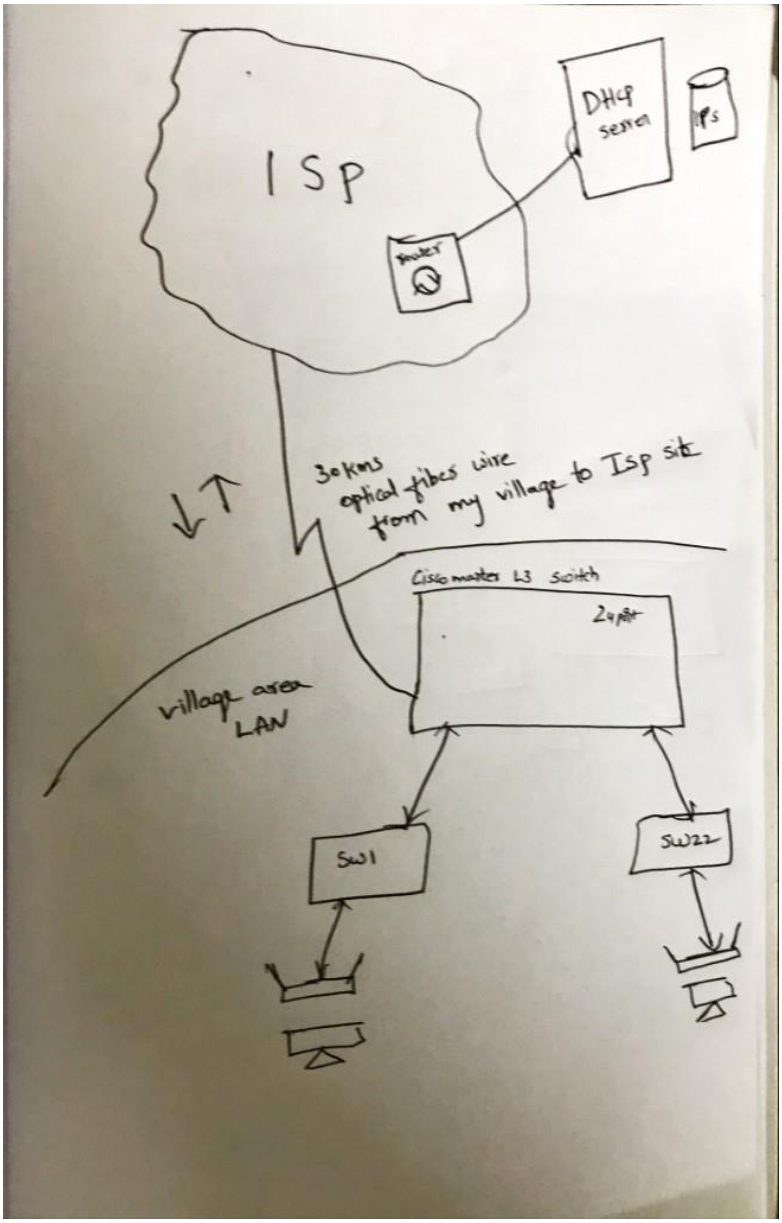
As my village has only 1000 host better I can go with class B

With class B

- Class B can have 14 bits for network and remaining for hosts
- But with Class B total of 65536 host can connect
- In this case I need consider the network bits as 22 and my subnet will be 255.255.252.0 (hosts 1022)

Main issue with class B is IP efficiency but ISP might be connected to several urban hosts and other LANs so IP inefficiency is not going to be a problem

How and where DHCP Server setup is located?



Total cost is required for setting the village with internet service (below table will gives brief idea total cost required to buy infrastructure and how much vendor ISP and end user need to spend for their connection)

Hardware	Requirement	Cost
Mini Routers for Home	1000 routers	950 rupees each router 950 * 1000 = 9,50,000/-

Cat 5e cable	100 meters * 46 ports in switch * 22 switches = 1,012,00 meters	Each meter 4 rupees 101200 meters * 4 rupees = 4,0,4800/-
Ethernet switch	22 switches 22, 48 port L2 ethernet switches	Each switch 16000 22 switches * 16000 =3,52,000/-
Transceivers	23 Transceivers 22 Ethernet switches and one L3 48 port switch	Each transceiver 1975/- 23 * 1975 = 43,450/-
OM2 Single mode optical fiber	400 meters * 22 = 8800 meters	Each meter 50 rupees 50 * 8800 = 4,40,000/-
L3 Managed switch	22 ports at least, 30gbps capacity,	60,000/- 80,000/-
Other(wiring, one time installations, electrical wirings to switches)		20,000/-
		• Total cost of setup 22,90250/- • 9,50,000 is spent by end users • 404800 will spend by end users (2290250-950000-404800) Total cost of ISP to my village = 935450/- Total cost of for end users = 13,50,000/- Each end user need to pay 1350/- for initial setup (1000*1350)

What are the other infrastructure and its cost not covered in this design?

As this is the optical fibered network, medium(optical fiber) installation from ISP headquarter which 30kms from village its cost and setup is not designed in this document. This document is primarily based on infra setup and cost within the village region.

This is not an expensive design and with requested data rate 30Mbps end users can also ready to pay 400 - 500 per month and ISP can invest initial amount into rural regions to get timely returns. For example now every village almost installing with local sub antennas for mobile networks. Moreover, this is optical fiber design data rates can increase and decrease based on need. In this design, each and every L2 fast ethernet switch is having 48 ports but left 2 ports available in case any new connection join in. As the network grows we can go ahead and increase the spots but unlike urban region, villages are not going to be expanded in area or with new connections but there is a scope of designing the LAN not only internet but also for other components like IPTV and IP-phone for all homes and camera setup across the village. Design can extend by adding some infrastructure(new switches) to handle these devices.

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1. Problem Statement

1.1 Background:

I live in a standalone apartment of 5-floors, where each floor has 3 flats. So total 15 flats in my apartment (as shown below)

1.2 Test case/Need for building LAN

File sharing between 15 apartments in a secured manner. May be also have a network printer.

1.3 Various options to build LAN

There are 3 options of building LAN that I have come up at the high level, where each one has its own benefits:

Option1: Wired LAN
Option2: Wireless LAN
Option3: Wired & Wireless LAN

1.4 Which Option I have chosen?

Answer to this question depends on the purpose of LAN design. Since, my purpose of building LAN is to share files, I have selected Wired LAN as my preferred choice.

When compared with Wireless option, Wired LAN offers easiest, fastest, and safest option of building LAN within a closed community like my standalone apartment.

2. Assumptions

1. First Assumption is that each flat already has network ready computers. Network ready means, Network Interface Card (NIC) installed already. Making sure computer has a RJ-45 network port on the back

2. Each flat doesn't already have RJ-45 jacks in the walls. So a network hub (Layer 1) or switch (Layer 2) or router (Layer 3) is needed.

My favorable choice is "Switch" for following reason: Switch is smarter than hub to determine the target of the forwarding data. No need for Router, as Internet access is optional in my LAN design

3. Expected speeds: around 1Gbps would suffice. Maximum speed of internet connection in my apartment is 100Mbps.

4. Cost (versus) speed: Not favoring any one of these metrics. Solution to provide fine balance between both. Also, maintenance of LAN should be minimal!

5. Internet connection: may not be needed.

6. Metrics: There are various metrics such as Cost, speed, security, reliability, bandwidth, data carrying-capacity. But, the two stand outs are: range and performance

3. Basic things needed for LAN implementation:

1. Equipment: Ethernet cables, Switches, computers
2. Connect first computer
3. Connect remaining devices

3.1 What Topology?

Star Topology: Switch is the central piece, helping to connect computers, printers, scanners and then router for internet connection

3.2 Concept @high level:

1) To build LAN, IP's must be in same subnet.

Use subnet mask as: 255.255.255.0. This way, we can use IP address from: 192.168.1.1 to 192.168.1.254

2) Run Ethernet cables around your flats and connect them through network switches at access, distribution, and core switch level.

4. Choosing Technology to implement LAN

The following Technologies are analyzed and finally selected Ethernet as my suitable LAN protocol

- Token Ring
  As name suggests, in this protocol, computers are arranged in a ring and single token is continuously passed from computer to computer.
  When a computer wants to send data to another computer, it waits for the token to come around and then attaches its data to it. The token is then passed to the next computer in the ring until it reaches the recipient computer. The recipient attaches two bits of data to the token to inform the sender that the data was received. Other computers can't send data until the ring is free again. This may sound slow, but was lightning fast for its time - up to **16Mpbs**

- Fiber Distributed Data Interface (FDDI)
  For transmitting data over fiber-optic cable over a span **of up to 124 miles**. FDDI is usually the backbone in WAN's. FDDI can carry up to 100 Mbps.

- Ethernet/Fast Ethernet
  Ethernet cables which are usually blue, yellow or red. Maximum range 328 feet.
  Ethernet can carry 10Mbps. Fast ethernet can carry 100Mbps.

4.1 Which suits my environment?

FDDI is more for long distance solution (For WAN). So, ruling out FDDI.

Fast Ethernet is for around 100Mbps. Since, 10Mbps suffice my requirement (as stated in assumptions section), hence, ruling out this option.

The other two options I have are: Token ring (or) Ethernet. Considering cost and speed, choosing Ethernet option.

Ethernet is cheaper than Token ring. Also, possession of token in token ring model makes it slower than Ethernet.

5. Selecting right ethernet cable for my network?

3 major choices are studied.

1) Coaxial
2) Twisted pair:
    a. Shielded Twisted pair (STP)
       STP is generally used in Token ring
    b. Unshielded Twisted pair (UTP)
       UTP in Ethernet networks
3) Fiber optic cable

Cable Type	Speed	Bandwidth	Distance
Fiber optic cable	10/100/1000 Mbps, 10/40/100/200 Gbps	Up to 4700 MHz	Up to 80 KM
Twisted Pair	Up to 10 Gbps	Up to 4700 MHz	Up to 100m
Coaxial Cable	10 Mbps	750 MHz (default)	Up to 500m

Considering speed and distance, twisted pair would suffice the need here. In twisted pair, going for Unshielded Twisted pair. (UTP is less costly than STP)

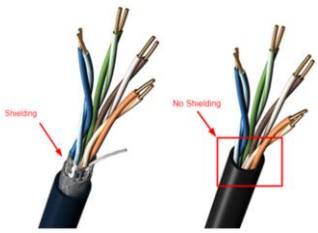
5.1 STP (vs) UTP differences:

I have chosen UTP for following reasons:

1) UTP cables are cheaper when compare with STP
2) In UTP, grounding cable is not required

Unshielded: Refers to lack of metallic shielding around the copper wires. By its very nature, the twisted-pair design helps minimize electronic interference by providing balanced signal transmission, making a physical shield unnecessary.

Unshield Twisted Pairs cable is susceptible to radio and electrical frequency interference. Hence, UTP's are generally used in short lengths such as inside a building or within a server room.



Since, most of our home internet connections are in <=100Mbps speed range, 1Gbps Ethernet cable would suffice the need here.

***
CAT: Category
CATe: e stands for Enhanced
***

5.2 Which UTP cable?

From below table, since maximum internet connection speed in my apartment is 100Mbps, CAT5/CAT5e are sufficient.

UTP Categories - Copper Cable

UTP Category	Data Rate	Max. Length	Cable Type	Application
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)

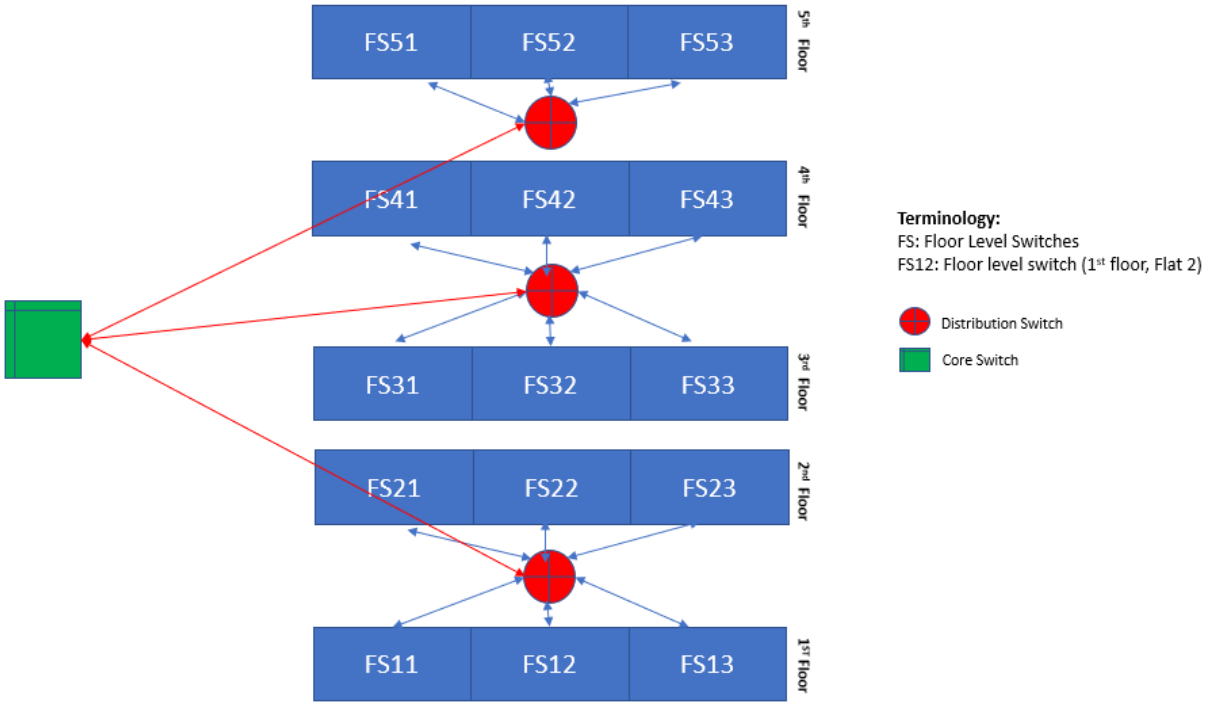
Firewall.cx

Figure 1. The Different UTP Categories and their specifications

6. Selecting right switch

My apartment has 5 floors. Each Floor has 3 flats. Total Flats: 15
Considering below diagram for Switches design. So, I basically have to select 3 levels of switches:

1) Switch for each individual flat ➔ Access switch
2) Distribution switch (Switch between couple of Floors)
3) Core switch (Switch that connects distribution switches)



6.1 Selecting Flat level (or) Access switches:

Since this is specific to each flat, we need more ports. May be a switch with 8 or 10 ports will be sufficient at flat/access level.

6.1.1 Managed (or) Unmanaged?

Since, all are of same priority in this file sharing application, choice is “Unmanaged”
Selection: 8-port 100Mb Unmanaged Switch
Quantity: 15

6.1.2 Distribution switches:

3 distribution switches are needed with maximum 8-port capacity.
Selection: 8-port 1Gb Unmanaged Switch

6.1.3 Core Switch:

1 core switch with 4-port 10Gbps Unmanaged

7. IP Management

For 15 floors, assuming 10 unique devices, total devices we have are: 250

The below IP management would suffice this requirement.

Use subnet mask as: 255.255.255.0. This way, we can use IP address from: 192.168.1.1 to 192.168.1.254

8.Future work

1) The above design document talks about Wired LAN. Future work can be on implementing Wireless LAN or combination of Wired & Wireless
2) Adding Internet end point on top of core switch

Subhajit Sahu
2018801013

LAN Design for Golf View Apartments

- **Personal Areas**:
- Block A: 6 flats x 15 floors = 90
- Block B: 5 flats x 14 floors = 70
- Block C: 4 flats x 14 floors = 56
- Block D: 7 flats x 14 floors = 98
- Block E: 5 flats x 14 floors = 70
- Total flats = **384**

- **Common Areas**:
- Club House: 4 rooms x 2 floors = 8
- Basement (private parking)
- Garden, Playgrounds
- Footpath, Guest parking
- Entrance, Exit Gate

Network Requirements

- **Personal Areas**:
- **200Mbps** private connection per **flat** (384).
- A flat may choose a lower or higher bandwidth.
- All flats in a **block** choose a **common ISP**.
- Each floor needs **3 security cameras** (2 stairs, 1 lift).
- Up to **6 security cameras** per **block** in **ground floor** (entrances).

- Flats: 1 WiFi router x 384 flats = 384

- **Common Areas**:
- **200Mbps** Public WiFi for each room in **club house**.
- **Basement** should support up to **15 security cameras**.
- **200Mbps** Public WiFi in garden, playgrounds, footpath (10+).
- Up to **15 security cameras** along the **footpath** (max).
- **2 HD security cameras** at **entrance, exit**.
- **Centralized security monitoring** at A-106 for all blocks.

- Club House: 4 WiFi AP x 2 floors = 8
- Garden, Playgrounds, Footpath: 10 WiFi AP (long range)

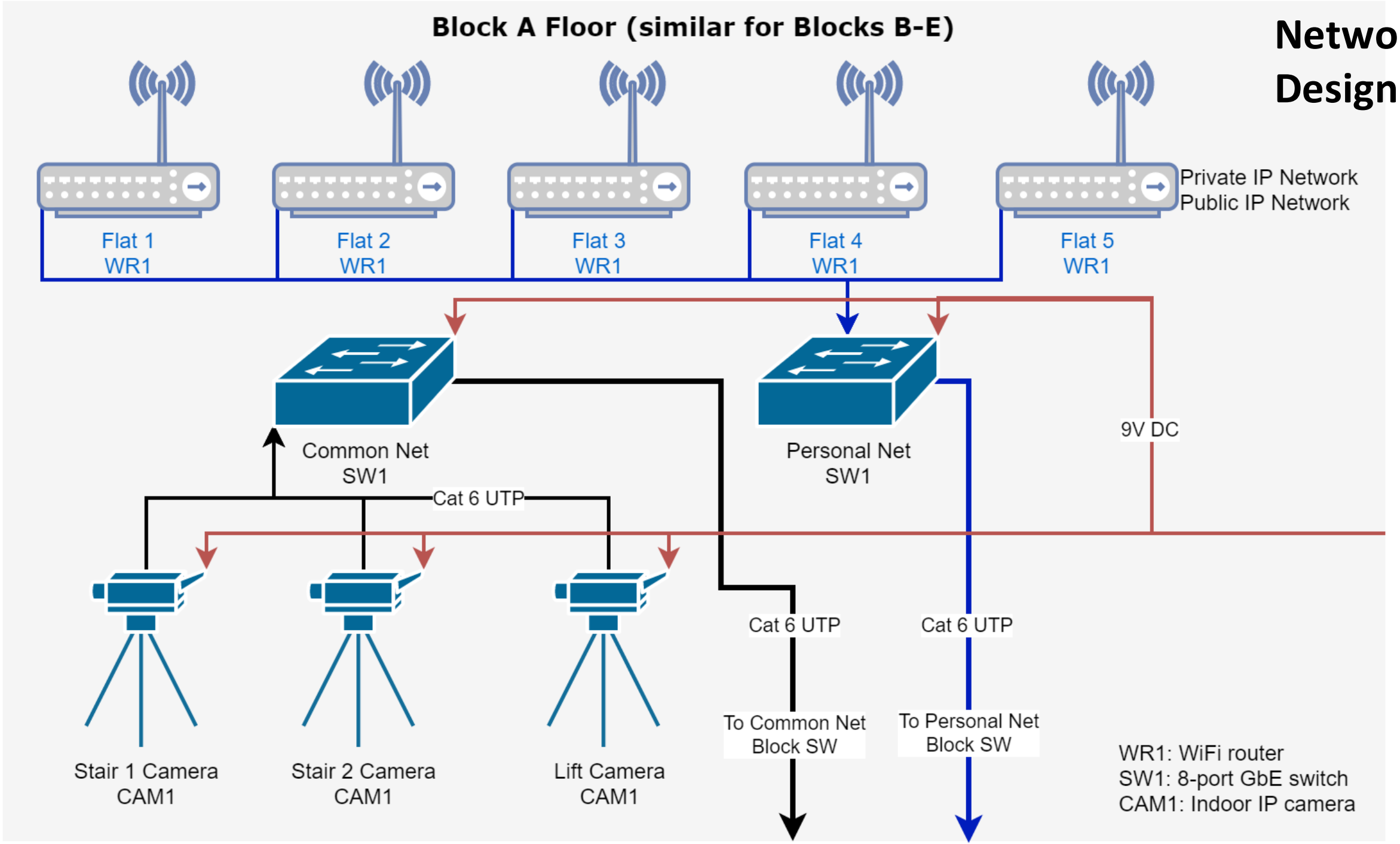
Network Plan: Personal Areas

- The network for Golf View Apartments requires a **personal (private) internet connection** per-user as well as a **public internet connection**, that is paid through their society expenses.
- For the **personal network**, each **flat** is provided with a WiFi router, which creates a **private LAN** within the flat.
- All devices in each flat receive a private IP address or the form 192.168.1.*, which the router translates to a public IP address when it forwards packets to the internet.
- The **router** itself recieves its **public IP address** from the **DHCP server** installed at **ISP's central office**. In order to make this work, all routers (from all flats) are connected into a single network, which it then linked with the ISP through **single-mode fiber** cable on the **switch**. A managed switch is used to allow rate-limiting per user if necessary.
- Routers of **each block** are connected up into a single network, and they are then connected to the ISP separately. This ensures it is possible to **switch ISP** for each block separately is so desired by the owners.
- **8-port gigabit unmanaged switches** connect all routers on a **floor** (4-7). Each such switch is then connected to the **central managed switch** per **block**. The central switch is a **10 gigabit switch** with **4 SFP ports** for optical fibre termination from ISP.
- Assuming an average of **6 flats per floor** with **200Mbps** connection a **1 Gb** switch should be enough as users are not all using full-bandwidth all the time.
- Similarly a **10 Gb** central switch is expected to be sufficient for an average of **14 floor** (per block).
- Per **floor** a **network cabinet**, w/ patch panel is used, and **network rack** w/ **patch panel** in **central room** (106).

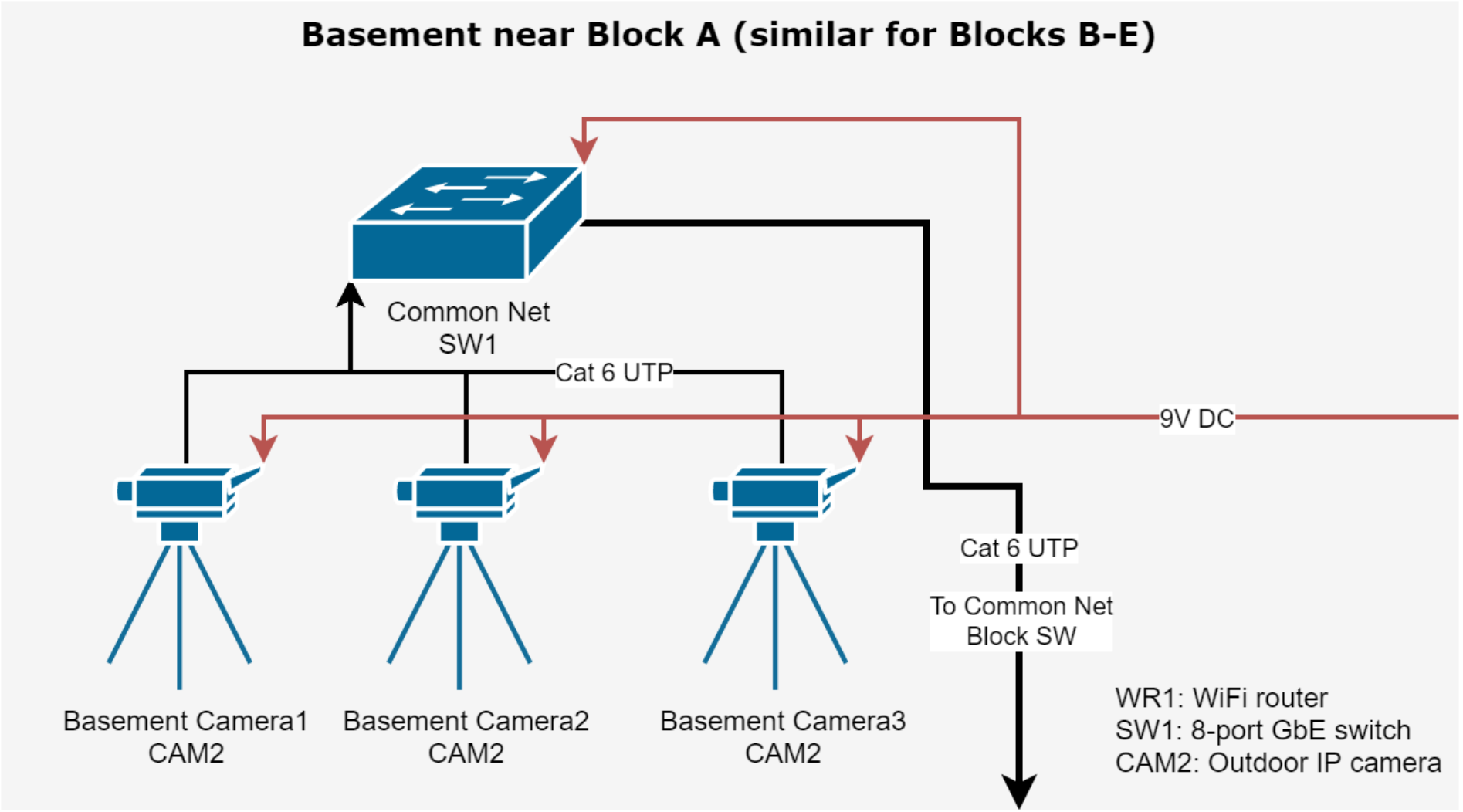
Network Plan: Common Areas

- The **common areas** for Golf View Apartments require a **public internet connection**, that is paid through their society expenses. This is designed as a separate network, which connects all **IP security cameras** and **wireless access points** on a local network. This local network is then connected through a **router** to an **ISP**.
- All the network devices (cameras, APs) are intially connected to other nearest ones with an **8-port gigabit unmanaged switch** (this includes the ones withing the club house), and later connected to the nearest **24-port 10 gigabit managed central switch** that is installed one per **block**.
- The central switch is to be kept in **flat 106** of each **block**. This flat is reserved by the management. This central switch is not connected to the Personal Net central switch also present at the same site.
- The per-**block central switches** are then connected with **Cat6 cable** (all ethernet cables used are Cat6) to the **central router** that is placed in Block A.
- This central router makes the common area devices into one **common private network**, assigning private IP addresses to each device withough its DHCP.
- The **router** in turn recieves its **public IP** from **ISP's DHCP** and its uses this to translate any packets sent from cameras & APs to public IP for the internet, vice versa.
- The central **router** is **10 gigabit** with **2 SFP** ports for optical fibre termination from ISP.
- The society doesn’t expect heavy internet usage from common areas and hence **10 GbE per-block switches** & **10 GbE central router** is considered sufficient.
- Uses same rack space as the Personal Net devices.

Network Design



Network Design



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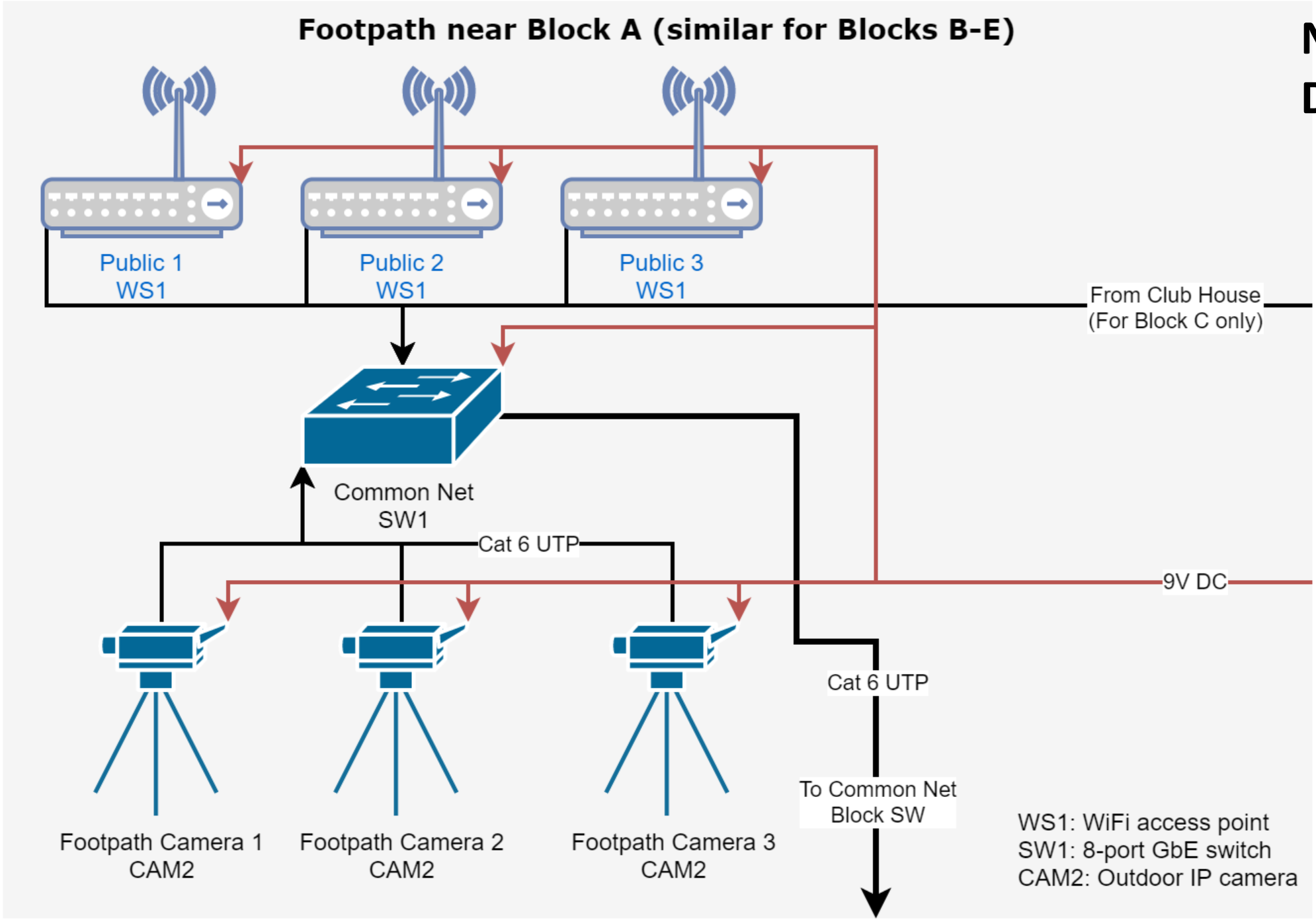

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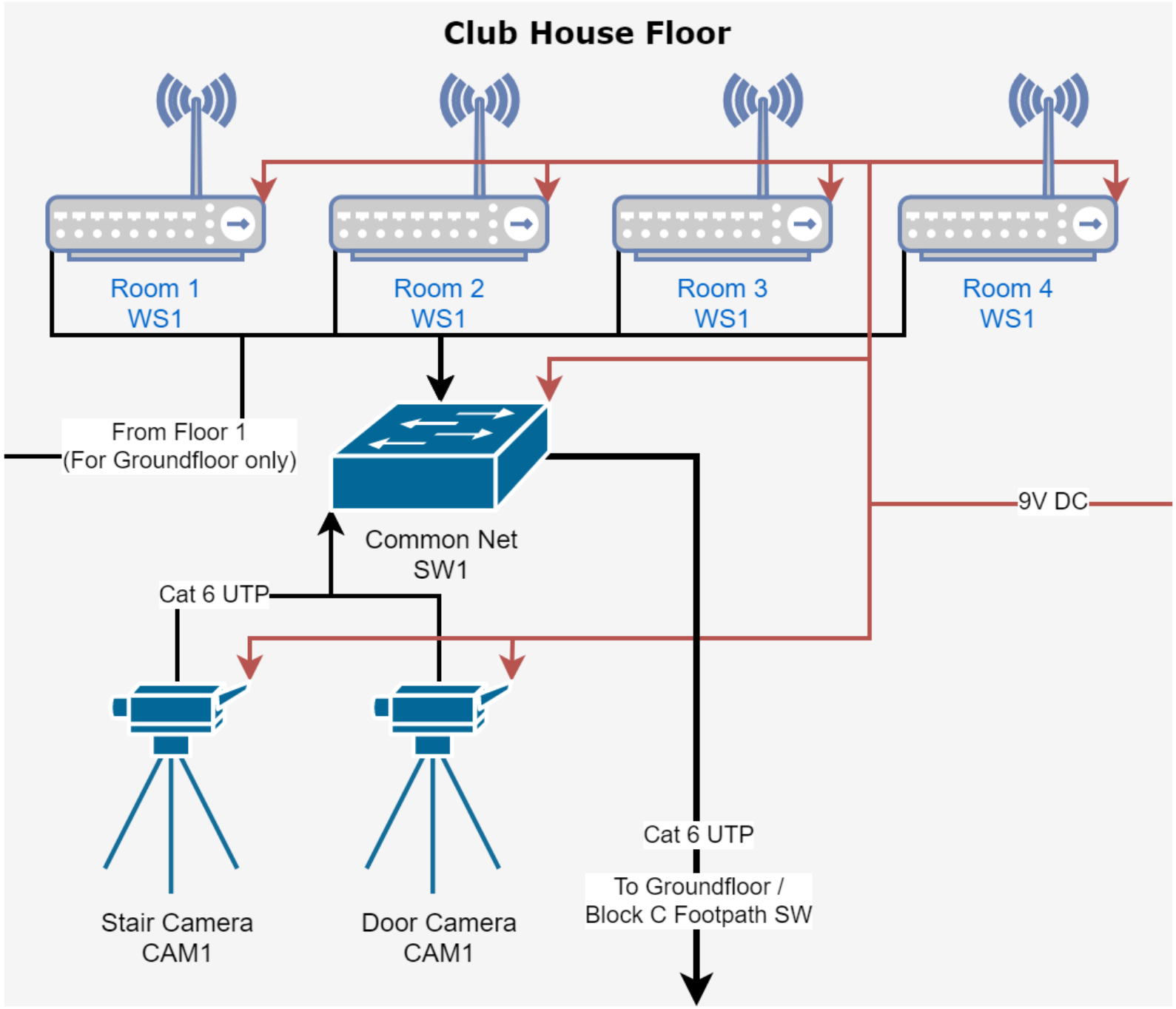

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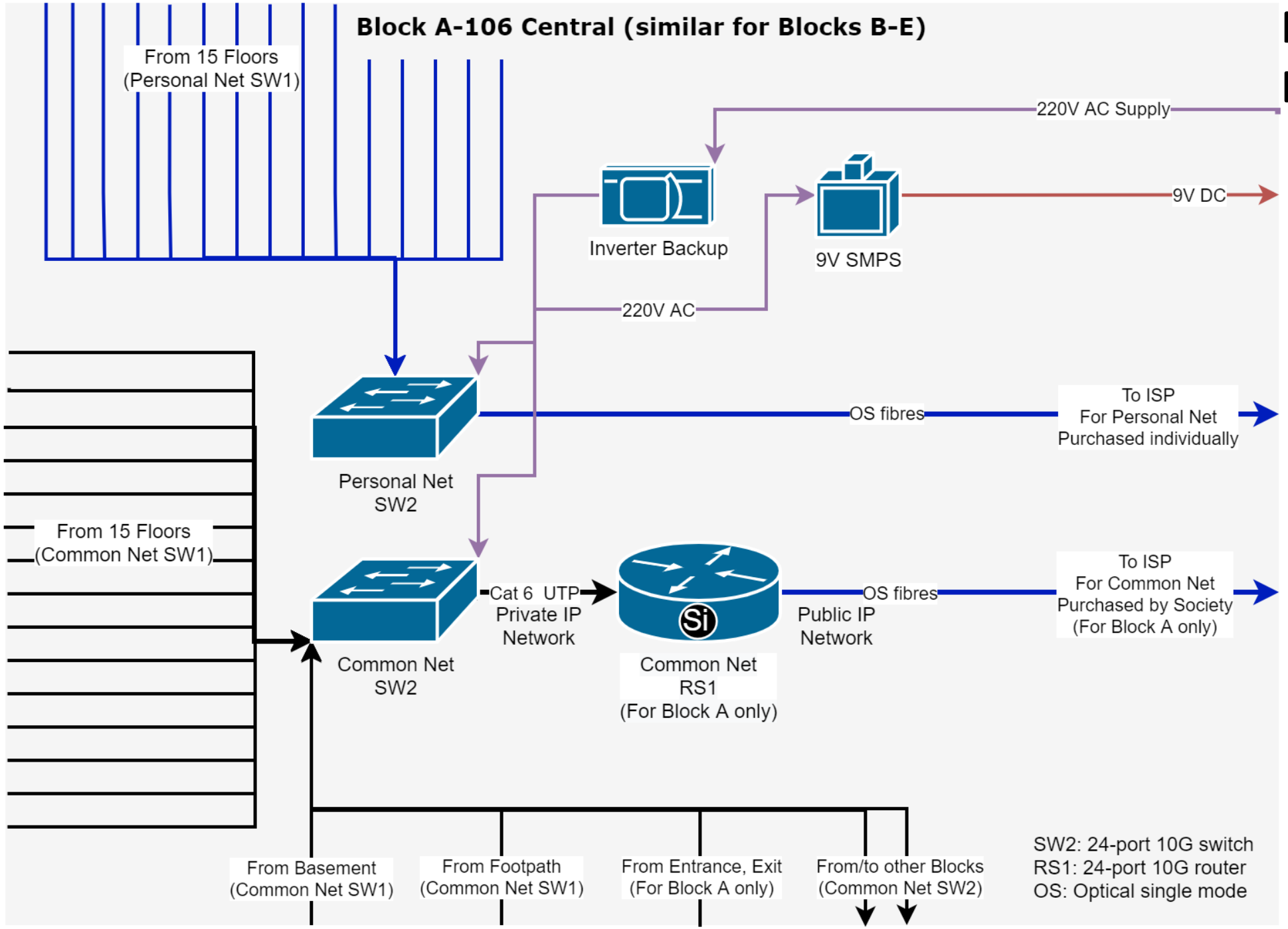
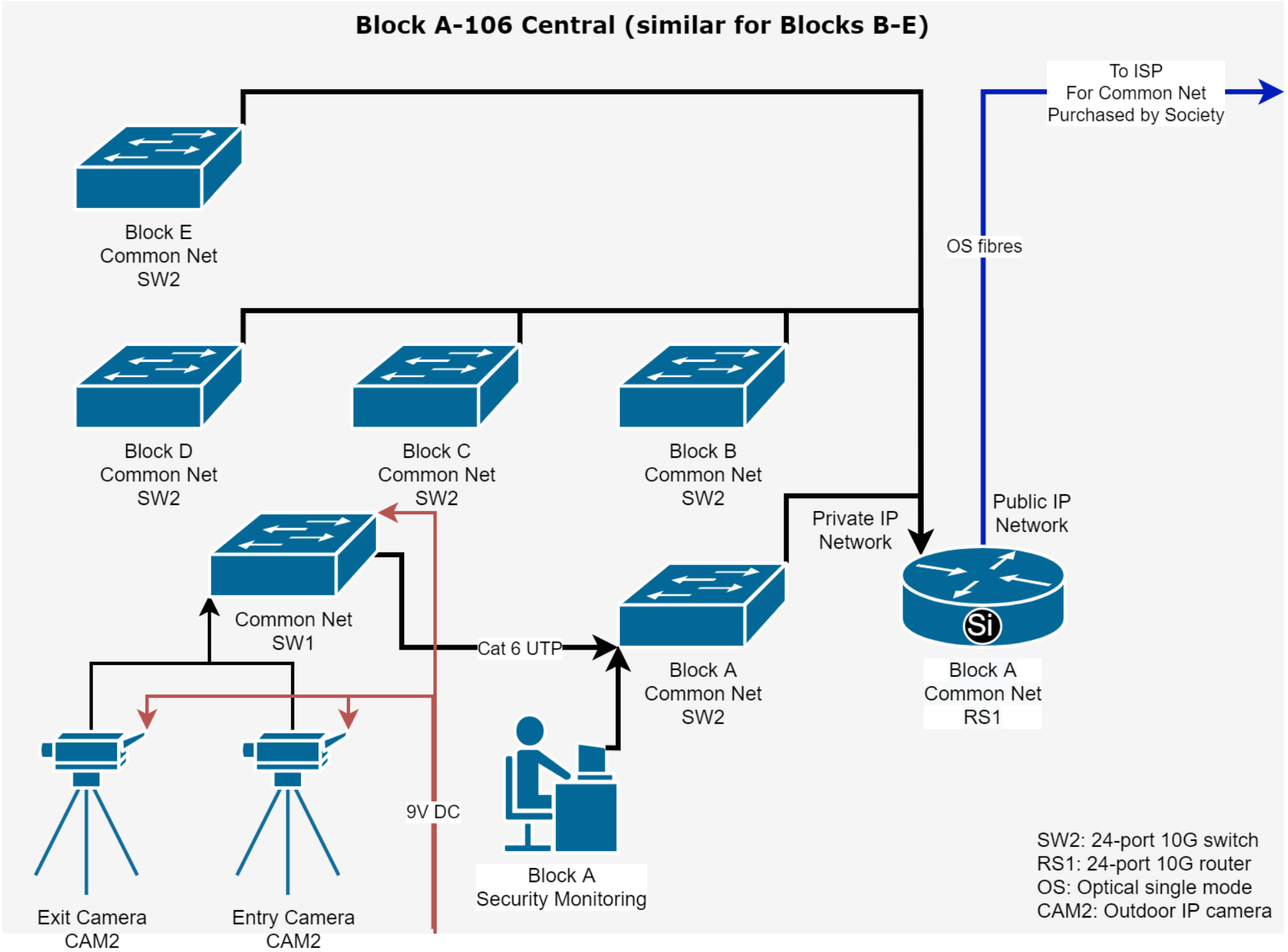


Network Design



Network Implementation

- MikroTik CRS326-24G-2S+RM router: **₹18,000**
- Ubiquiti UF-SM-10G transciever: **₹4,000**
- TP-Link Jetstream T1600G-28TS switch: **₹1,90,000**
- TP-Link 10GBase-LR SFP+ LC Transceiver: **₹20,000**
- TP-Link TL-SG108E switch: **₹4,16,000**
- TP-Link TL-WA901N WiFi AP: **₹37,500**
- TP-Link TL-WR845N WiFi router: **₹6,54,500**
- 2U Wall mount Cabinet Box: **₹1,10,500**
- 12U Wall mount Network Rack: **₹48,000**
- Cat6 RJ45 Connector Plugs w/ Hood: **₹18,000**
- Cat6 Ethernet Cable (Roll): **₹1,50,000**
- RJ45 Cat6 Cable Jointer: **₹3,000**
- 1.5m Cat6 Patch Cable: **₹1,35,000**
- M6 Cage Nuts, Washers & screws: **₹27,000**
- Mass Rack 10" Tray: **₹36,000**
- D-Link 24-port Cat6 Patch Panel: **₹2,70,000**
- RJ45/11 Crimper, Cutter & Stripper Tool: **₹3,000**
- River Fox Punch Down Tool Cat 5e/6: **₹1,500**
- Moelissa MS-LT02 RJ45/11 Cable tester: **₹1,500**

- **Total Cost: ₹21,43,500**

RS1 MikroTik CRS326-24G-2S+RM Cloud Router Switch

- This is the router for devices (cameras, WiFi access points) common network. It does the job of a DHCP server, assigning private IP addresses to each common net device and translating any packets forwarded to the internet to public address (NAT/PAT).
- Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This is a separate connection taken by the Golf View Society and a common internet connection for internet access provided in Club House, Gardens, Playgrounds & Footpath.

- 24 x 1 Gb ethernet port
- 2 x 10 Gb SFP+ cages
- Dual boot RouterOS / SwOS

- 1 as the central router.
- **Quantity**: 1
- **Cost**: ₹18000 x 1 = **₹18,000**

Ubiquiti UF-SM-10G 1310nm 10km SFP+ Transceiver

- This Small Form-factor Pluggable (SFP) optical transceiver is to be inserted into the SFP+ cage of **RS1**, so that a 10Gpbs 1270/1330nm fiber line can be terminated at the router. The optical fiber must be a single-mode fiber upto 10km length. It accepts dual LC connector
- This is the router for devices (cameras, WiFi access points) common network. It does the job of a DHCP server, assigning private IP addresses to each common net device and translating any packets forwarded to the internet to public address (NAT/PAT).
- Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This is a separate connection taken by the Golf View Society and a common internet connection for internet access provided in Club House, Gardens, Playgrounds & Footpath.
- 2 per block as central switch.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹2000 x 2 = **₹4,000**

SW2 TP-Link Jetstream T1600G-28TS 24port Managed Switch

- This is the central switch that is for both personal & common net.
- In the personal net, each floor's router connect to this central switch. Single mode optical fibre connection from ISP is terminated here (from ISP's central office). This conection is kept different for each block. The ISP's DHCP assigns public IP to all home routers in each flat.
- In the common net, switches from club, basement, footpath conect here. This is installed per block, so the access switches always connect to the nearest central switch. The central switches are the connect together from each block to the central router over Cat6 cable. As a whole they form a LAN behind the router.

- 24 x 1 Gb ethernet port
- 4 x SFP slots

- 2 per block as central switch.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹19000 x 10 = **₹1,90,000**

TP-Link 10GBase-LR SFP+ LC Transceiver

- This is used with private net central switches to conect to ISP. The connection is individually made for each block.
- Single mode optical fibre connection from ISP is terminated through (from ISP's central office) this transciever.

- Wave Length 1310 nm
- Fiber Type 9/125 µm Single-Mode
- Max. Cable Length 10km
- Data Rate 1.25 Gbps
- Data Rate 10Gbps
- Port Type LC/UPC

- 2 per central switch of personal net.
- **Quantity**: 2 x 5 blocks = 10
- **Cost**: ₹2000 x 10 = **₹20,000**

SW1 TP-Link TL-SG108E 8-port GbE Unmanaged Switch

- This is an unmanaged switch that is used to make first level connections in both the personal and the common network. It then connects to the nearest central switch that is installed per block.

- 2 per floor (inc. club), 5 for basement, 5 for footpath, 1 for entry.
- **Quantity**: 2 x 14 floors x 4 blocks + 2 x 15 floors + 2 club + 5 basement + 5 footpath + 1 entry + 2 spares = 160
- **Cost**: ₹2600 x 160 = **₹4,16,000**

TP-Link TL-WA901N Wireless Access Point

- This a wireless access point without a router. It has the ability to extend WiFi. Used to provide internet connection in common areas.
- 1 in each room of club house + 15 across footpath
- **Quantity**: 4 rooms x 2 floors (club) + 15 footpath + 2 spares = 2**5**
- **Cost**: ₹1500 x 25 = **₹37,500**

TP-Link Archer A5 AC 1200 WiFi Dual Band Wireless Router

- This wireless router is provided to each flat. It is a dual band router to support more mobile devices.
- 1 for each flat
- **Quantity**: 1 x 384 flats + 1 spare = **385**
- **Cost**: ₹1700 x 385 = **₹6,54,500**

2U Wall mount Cabinet Box

- Holds the network devices onto the wall, for stable setup.
- 1 per floor + 2 for club + 1 for basement/block + 1 external/block + 1 entry/exit
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 2 club + (1 + 1) x 5 blocks + 1 entry + 1 spare = 8**5**
- **Cost**: ₹1300 x 85 = **₹1,10,500**

12U Wall mount Network Rack

- Holds the network devices onto the wall, for stable setup.
- 1 per block (for switches) + 1 for central router
- **Quantity**: 1 x 5 blocks + 1 = **6**
- **Cost**: ₹8000 x 6 = **₹48,000**

Cat6 RJ45 Connector Plugs w/ Hood

- This is the connector for Cat6 cable with staggered pins, which helps isolate signals at the port. It also minimizes distance from cable to reduce cross-talk.
- 2 per flat, 4 + 6 per floor (camera), 2 for external long connections, 2 for external short connections, 2 for block-block connections.
- **Quantity**: 2 x 384 flats + 10 x 14 floors x 4 blocks + 10 x 15 floors + 2 x (15 basement + 15 footpath cam + 15 wireless AP) + 2 x 2 entry/exit + 2 x (3 + 3 + 3) + 2 + 2 x 4 blocks + 400 spare = 2**000**
- **Cost**: ₹9 x 2000 = **₹18,000**

Cat6 Ethernet Cable (Roll)

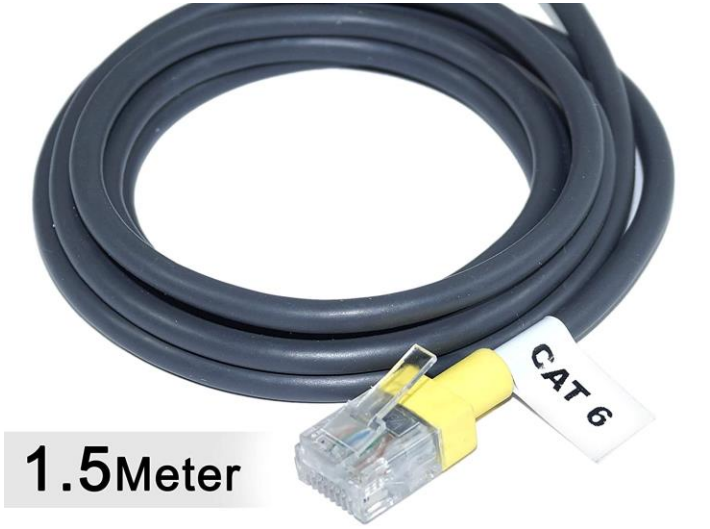
- Cat 6 cable supports 10Gbps utp 55m & 1Gbps upto 100m. Unlike Cat5e cable its wire pairs are twisted tighter, and it has a central plastic pair separator to maintain inter-pair distance as mentioned in the Cat6 specification. It is used for all cabling for uniformity sake.
- Avg. 10m per flat, avg. 40m + 30m (camera) per floor, 20m for external long connections, 10m for external short connections (including club house), 60m for block-block connections.
- **Quantity**: 10 x 384 flats + 70 x 2 x 14 floors x 4 blocks + 70 x 2 x 15 floors + 10 x (15 basement + 15 footpath cam + 15 wireless AP) + 10 x 2 entry/exit + 20 x (3 + 3 + 3) + 20 + 60 x 4 blocks + 310 spare = 1**5000**
- **Cost**: ₹10 x 15000 = **₹1,50,000**

RJ45 Cat6 Cable Jointer (Couple Plug)

- It is used to connect together 2 ethernet cables to form a longer cable. It also helps for maintaining some modularity.
- 2 per IP security camera & wireless AP.
- **Quantity**: 2 x (15 basement + 15 footpath cam + 15 wireless AP) + 2 x 2 entry/exit cam + 6 spares = **100**
- **Cost**: ₹30 x 100 = **₹3,000**

1.5m Cat6 Patch Cable

- It makes it easy to make a connection between a port in a patch panel to a port on a network device. It is usually made of stranded copper wire for repeated use.
- 16 needed per floor (inc. club house). 48 needed per block, central room & a few spares.
- **Quantity**: 16 x 14 floors x 4 blocks + 16 x 15 floors + 16 x 2 club + 48 x 5 blocks + 48 central + 44 spares = 1500
- **Cost**: ₹90 x 1500 = **₹1,35,000**



RJ45 Cat 6 Ethernet Cable Network LAN Cable

M6 Cage Nuts, Washers & Mounting screws for Server Rack & Cabinet

- It is used to mount network devices to racks.
- 16 needed per floor (inc. club house). 24 needed per block, central room & a few spares.
- **Quantity**: 16 x 14 floors x 4 blocks + 16 x 15 floors + 16 x 2 club + 24 x 5 blocks + 24 central + 38 spares = 1350
- **Cost**: ₹20 x 1350 = **₹27,000**

Mass Rack 10" Tray

- Used to store additional length of cables below patch panel.
- 1 needed per floor (inc. club house). 2 needed per block, central room & a few spares.
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 1 x 2 club + 2 x 5 blocks + 2 central + 5 spares = 90
- **Cost**: ₹400 x 90 = **₹36,000**

D-Link 24-port Cat6 Patch Panel

- It has ready to use RJ45 sockets on a panel that can be directly attacked to a network rack. This helps in cable management, and allows one to easily visualize, setup and debug network connections to switches / routers.
- 1 needed per floor (inc. club house). 2 needed per block, central room & a few spares.
- **Quantity**: 1 x 14 floors x 4 blocks + 1 x 15 floors + 1 x 2 club + 2 x 5 blocks + 2 central + 5 spares = 90
- **Cost**: ₹3000 x 90 = **₹2,70,000**

RJ45/11 Crimper, Cutter & Stripper Tool

- This is a multitool that enables ethernet cables to be cut, insulation stripped, and the crimped onto a, RJ45 connector.
- Would be useful when performing network setup to the flats, per floor cabinets as well as in network rack for server room. Preferable to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹600 x 5 = **₹3,000**

River Fox Punch Down Tool Cat 5e/6

- It helps connect LAN cable to RJ45 socket (Keystone) in a Wall socket or a Patch panel. After stripping the outer cover of the Cat6 cable & plastic pair-separator, and plugging it into a Keystone, a neat connection can be made with this tool.
- Would be useful when performing network setup to the flats, per floor cabinets as well as in network rack for server room. Preferable to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹300 x 5 = **₹1,500**

Moelissa MS-LT02 RJ45/11 Cable tester

- It helps check if a cable if properly connected to a network device (like switch). The remote helps identify wire you have connected to, if there are too many tangled wires.
- Would be useful for debugging connectivity issues when performing network setup / management. Perfereble to have one spare per block.
- **Quantity**: 5 blocks x 1 = **5**
- **Cost**: ₹300 x 5 = **₹1,500**