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. <mark>Unshielded Twisted pair (UTP)</mark>
       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.
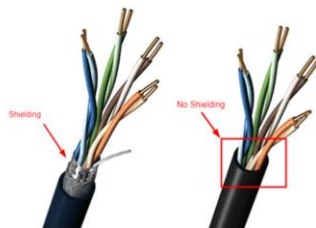
Since, most of our home internet connections are in <=100Mbps speed range, 1Gbps Ethernet cable would suffice the need here.

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CAT: Category
CAT<mark>e</mark>: e stands for Enhanced
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5.2 Which UTP cable?

From below table, since maximum internet connection speed in my apartment is 100Mbps, <mark>CAT5/CAT5e</mark> 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)

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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)
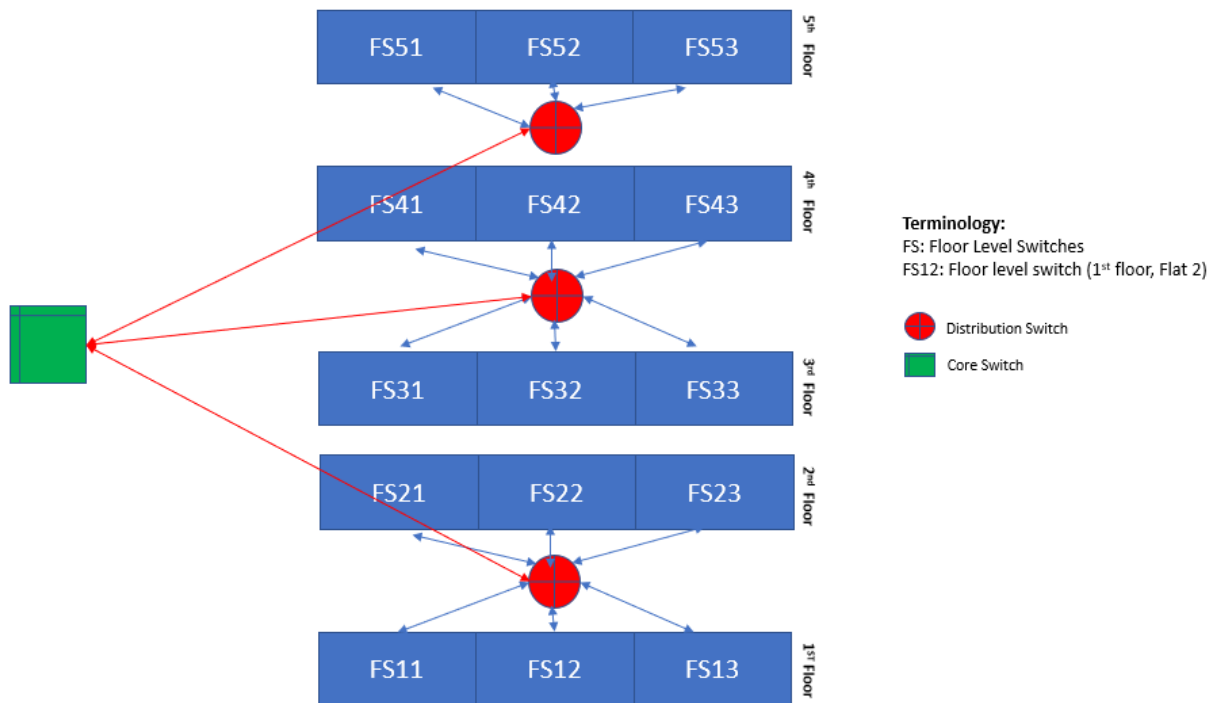
6.1 Selecting Flat level (or) Access switches:

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