Network Infrastructure in a Data Center

1. Purpose of Network Infrastructure in a Data Center

The network infrastructure is the backbone of a data center. It connects:

- Servers
- Storage devices
- Network switches and routers
- External networks (LAN and Internet)

Because a data center may have **hundreds or thousands of servers**, a simple cabling method is not enough. A structured, modular design is needed to keep the system:

- **Manageable**
- **Scalable**
- **Easy to troubleshoot**
- **Less prone to errors**

The chapter mainly focuses on how to design this infrastructure efficiently.

2. Network Cabling in a Data Center

A large number of cables are required to connect devices.

Example:

If a data center has 50 servers:

- Server to storage (fiber cables): 200
- Storage to admin network: 100
- Server to console server: 50
- Server to production network: 100
- **Total = 450 cables**

So, imagine how many cables a data center with 500 or 1000 servers needs! This is why cable management is very important.

Cables used:

- **Cat5/Cat5e/Cat6** (copper Ethernet cables)
- **Fiber optic cables** (for high-speed and long-distance)

3. Modular Cabling Design

Earlier, all cables were directly connected to a central network room. But this created:

- Cable chaos
- Maintenance difficulty
- Poor scalability

So, a **modular design using patch panels** is used.

Two main cabling methods:

1. **Direct connection to switches**
2. **Using patch panels** (best practice)

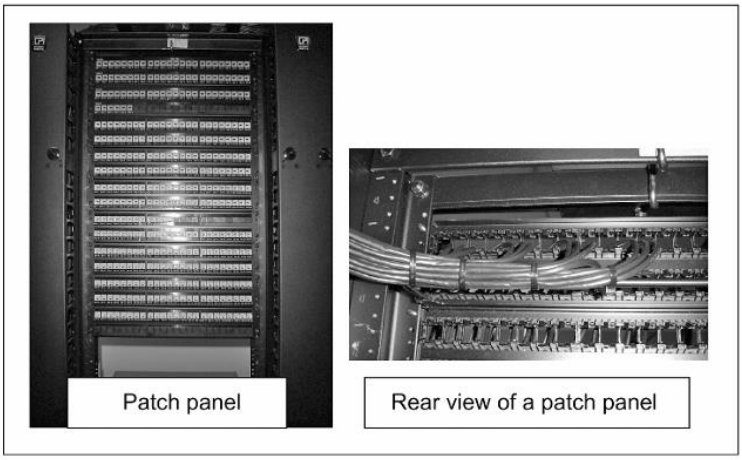

Figure 5-2 Patch panels.

With patch panels:

- Servers connect to a nearby patch panel.
- That patch panel connects to another patch panel in the network room.
- Then it connects to the switch.

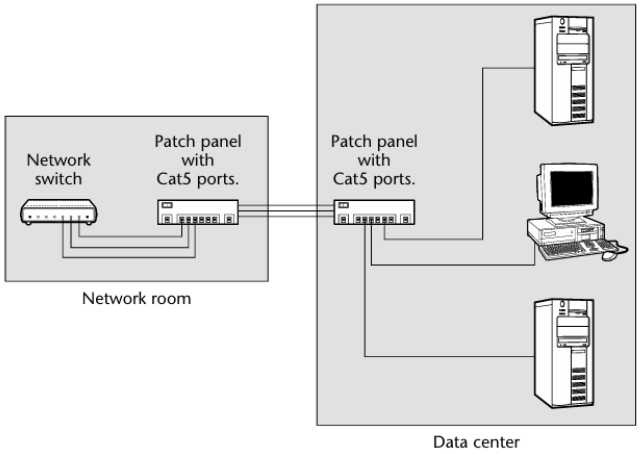

Figure 5-3 Use of a Cat5 patch panel to link computers in a data center to a switch in the network room.

This makes connections:

- Organized
- Easy to replace
- Easy to expand later

4. Patch Panels

A **patch panel** is a hardware device with many ports where cables are terminated.

Advantages:

- Keeps cables neat and localized
- Makes maintenance easier
- Prevents frequent unplugging from switches
- Allows easy fault detection

Very important point:

Patch panels must have extra unused ports because replacing them later is very difficult.

5. Points of Distribution (PODs)

A **POD (Point of Distribution)** is a dedicated rack that serves a group of server racks.

Example:

- A data center with 1000 racks can be divided into 50 PODs.
- Each POD serves about 20 server racks.

Each POD contains:

1. **Cross-patch ports** (connected to network room patch panels)
2. **Terminal servers** (for console access to servers)
3. **Network subswitches**

Benefit:
Instead of running long cables to the network room, you only run short cables to the POD, making installation easier and faster.

6. Terminal Servers (Console Servers)

A **terminal server** allows administrators to access a server's console remotely even if:

- The operating system is down
- The network service is not working

It connects to the console ports of servers through patch panels.

Uses:

- OS installation
- BIOS access
- Troubleshooting boot issues
- Remote troubleshooting

7. Subswitches in PODs

Small switches inside PODs connect local servers to:

- Backup networks
- Admin networks
- Internal networks

These subswitches connect to larger master switches using high-speed links to avoid bottlenecks.

8. Internet Access in Data Centers

Data centers connect to ISPs (Internet Service Providers) like:

- AT&T
- Sprint
- NTT

Two important ISP components:

(a) Network Infrastructure

Includes routers and switches of the ISP.

It must be:

- Reliable
- Multivendor compatible
- Redundant

(b) WAN Links

Two terms are used:

- **Transport** → The physical pipe (fiber, link)
- **Transit** → Actual Internet bandwidth

Analogy given:

If transport is the water pipe, transit is the water flowing through it.

So, a large pipe is useless if very little water flows. Similarly, high-speed links are pointless if transit bandwidth is low.

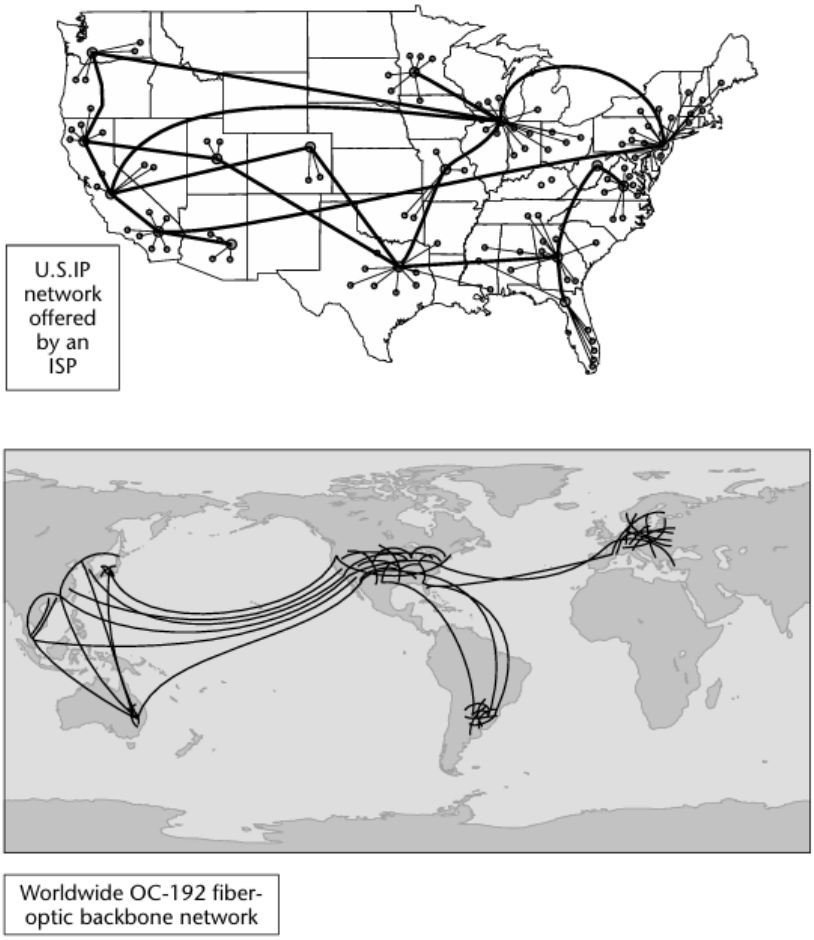

Figure 5-5 Portion of the U.S. and worldwide IP network.

9. Redundancy in Network Links

To ensure reliability:

- At least **3 fiber providers**
- At least **3 transit providers**

Even if one or two fail, the system must continue.

Example:
If one T3 link fails (45 Mbps), and you only have three T1 links (1.5 Mbps each), you lose most capacity. So, this is not proper redundancy.

10. Best Practices for Cabling

1. Label Everything

Each cable and port should be labeled with a unique ID (like AX25). This helps in quick identification and troubleshooting.

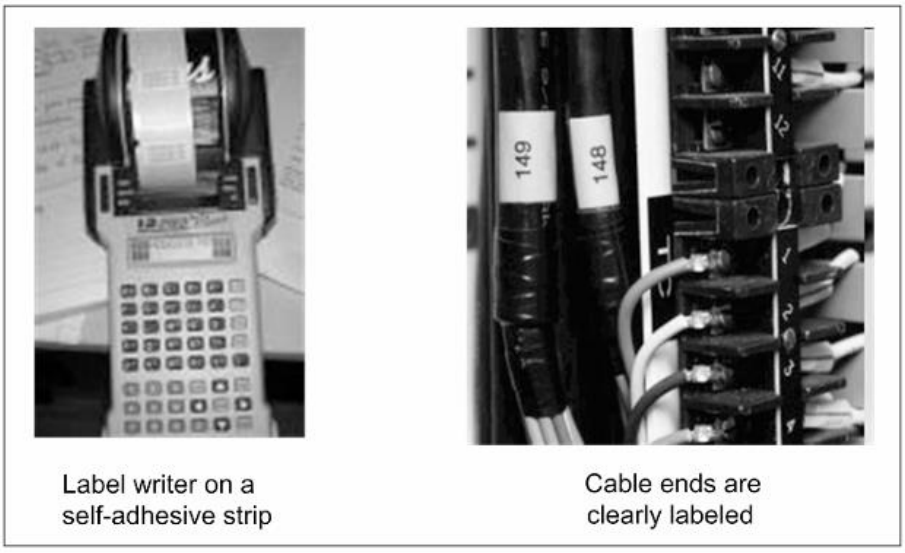

Figure 5-6 Label maker that prints the text on a self-laminating label that is easy to wrap around wires.

2. Color Code Cables

Different networks should use different colors:

- Front-end network – White
- Backend network – Yellow
- Backup network – Another color
- DMZ (Demilitarized Zone) network – Another color

This avoids confusion and mistakes.

3. Avoid Cable Tangling

- Use proper cable length
- Avoid coils
- Use cable trays
- Tie similar cables together
- Never leave loose cables on the floor

This helps airflow and prevents dust and hazards.

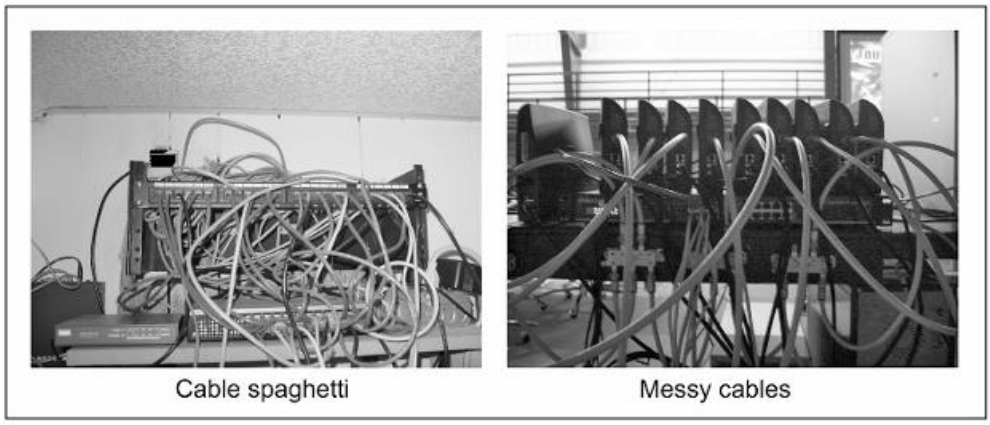

Figure 5-7 Cable mess.

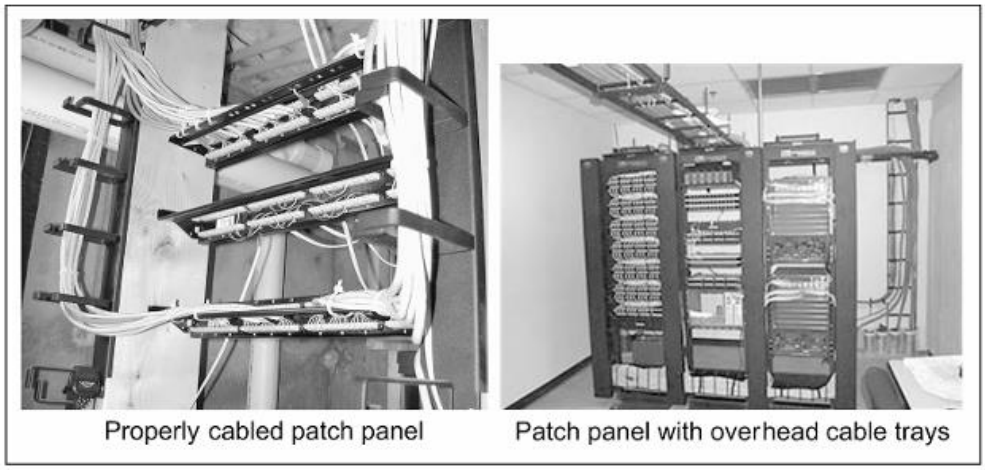

Figure 5-8 Patch panel with neatly tied cables.

4. Cable Testing

After installation, all cables must be tested using cable testers to check:

- Continuity
- Short circuit
- Open circuit
- Correct pinning

Testers must **never be used on live cables**.

Figure 5-9 Cat5 cable testers.

5. Cable Bending Radius

Cables must not be sharply bent, because it can:

- Damage internal wires
- Reduce signal quality
- Shorten cable life

11. Summary of Chapter 5 Key Points

1. Use **modular network design** instead of direct cabling.
2. Implement **patch panels and PODs** for structured cabling.
3. Ensure **ISP redundancy and reliability**.
4. Always **label, color code, and manage cables properly**.
5. Follow best practices to reduce downtime and maintenance issues.

These principles ensure that a data center network is:
✓ Reliable
✓ Scalable
✓ Easy to maintain
✓ Professional