Data Center Infrastructure and Equipment

- **Racks, Aisles, And Pods**
- Often, a data center occupies a single large open area without walls. Like a giant retail store, columns are spread throughout the area to support the ceiling.
- A data center can be huge. It comprises 148,000 square feet of space in a single large room.
- The distance from one end to the other is 710 feet, more than two football fields laid end to end. Sometime. the largest data centers can exceed 1,000,000 square feet.

Racks, Aisles, And Pods

Physically, racks holding equipment are placed side by side in rows, leaving *aisles* between them.

Logically, however, a data center is not merely composed of long rows of racks.

Instead, a data center is built by replicating a basic set of equipment known as a *pod*, sometimes written *PoD* for *Point of Delivery*.

In addition to servers, a pod includes storage and networking facilities plus *Power Distribution Units* (*PDUs*) that deliver electrical power to the pod; a pod may include management facilities used to configure, monitor, and operate the pod.

Pod Size

- **A** pod with 48 racks is considered “large,” and an average-size pod contains 12 to 16 racks.
- Three other factors have motivated the change:
- Incremental growth
- Manageability
- Power and cooling
- *Incremental growth:* Choosing a smaller pod size allows a data center owner to grow the data center continuously in small increments rather than waiting until a large pod is justified.
- *Manageability:* Management tools allow a data center owner to manage each pod independently. A smaller pod size makes it easier to find and repair problems, and keeps problems contained within a pod.
- *Power and cooling:* Interestingly, electrical power and cooling have become a major consideration when choosing a pod size.

Power And Cooling For A Pod

- Power consumption and cooling dominate many aspects of data center design because data centers consume huge amounts of power.
- For example, the Inner Mongolia Information Park owned by China Telecom consumes over 150 Megawatts of electric power, which is approximately the amount of electrical power consumed by a city of a million people.
- Together, data centers consume over 25 percent or above of the world's electricity.

Designers have invented several ways to reduce heat, including:

- Raised floor pathways and air cooling
- Thermal containment and hot/cold aisles
- Exhaust ducts (chimneys)
- Lights-out data centers

Raised Floor Pathways And Air Cooling

A metal support structure supports a floor from one to four feet above the concrete floor of the building.

The space between the real floor and the raised floor can be used to hold power cables and for air cooling.

Large outdoor air conditioning units (compressors) surround the building, and pipes carry compressed refrigerant to indoor units where it is used to chill air.

The chilled air is then forced under the raised floor.

Racks are, in turn, designed to allow the chilled air to flow up the sides of the rack.

Each piece of equipment in a rack contains a fan that blows the cool air through the unit, keeping the electronics cool.

Thermal Containment And Hot/Cold Aisles

Hot air leaves each piece of equipment, venting into the data center.

Overall air flow in the data center must be designed carefully to move hot air away from the racks,
ensuring that it cannot be accidentally drawn back into another piece of electronic equipment.

In particular, a designer must ensure that the hot air leaving one piece of electronic equipment is not pulled into another piece.
A technique known as *thermal containment* (or *aisle containment*) offers one solution.

Equipment is arranged to pull cold air from the sides of the rack and vent hot air out the back.
Figure 4.1 illustrates the concept by showing
rows of racks arranged to create alternating hot/cold aisles. Gray arrows indicate the flow of hot air from the back of each rack.
Cool air is forced under the floor and upward through the racks, absorbing heat from the equipment.

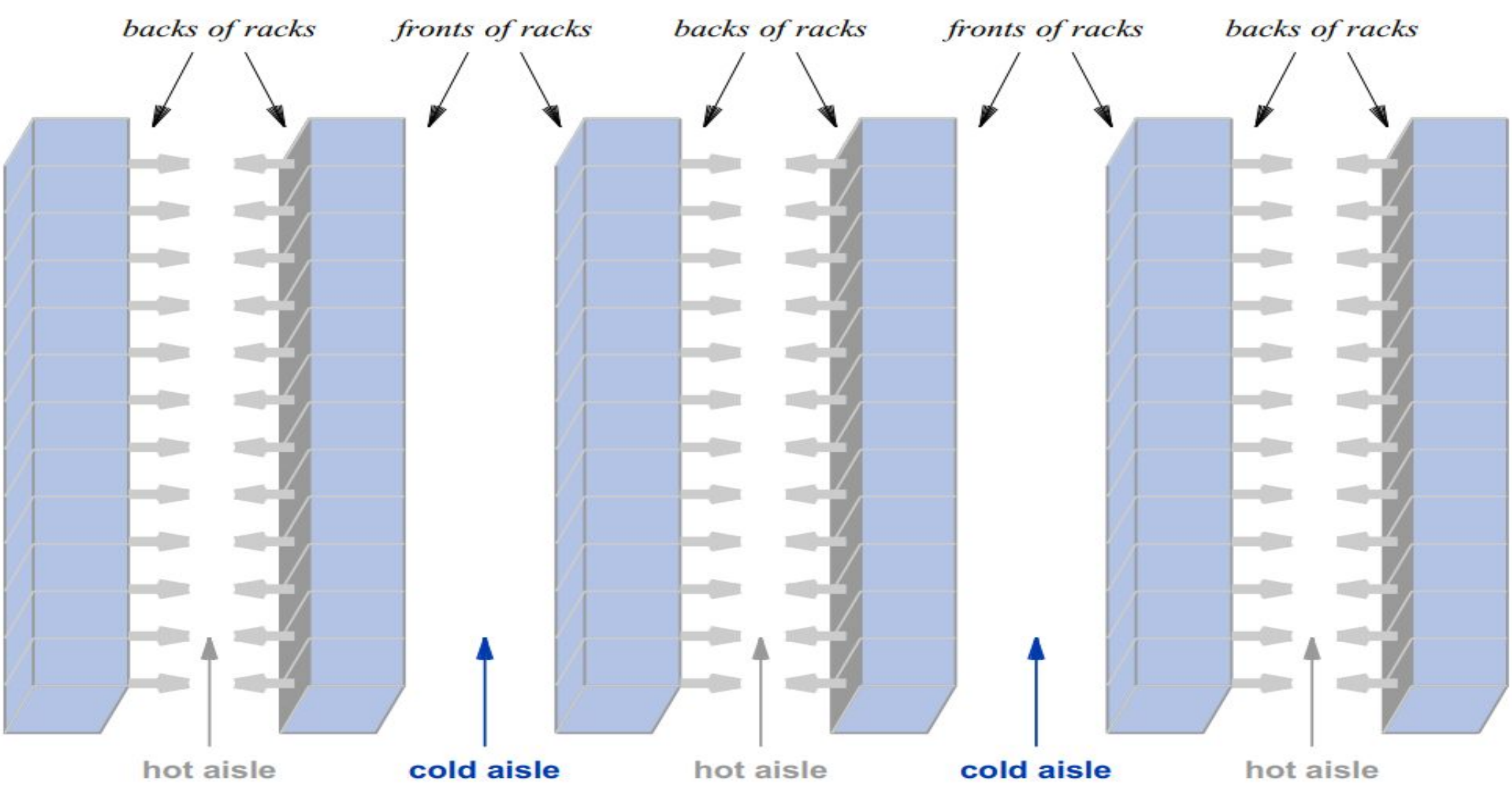

Figure 4.1 An illustration of hot/cold aisles that aid in thermal containment by keeping heated air from one piece of equipment from flowing into another piece of equipment.

Exhaust Ducts (Chimneys)

Despite fans in the ceiling that draw hot air upward, the temperature near racks with high power density can be higher than other areas of a data center.

Designers refer to such areas as *hot spots*. Designers employ a variety of techniques to reduce the temperature near hot spots, including leaving some slots in each rack empty, and leaving a completely empty rack between two especially hot racks.

For areas that generate inordinate heat, a vertical duct with a fan can be placed over the area with a fan to move hot air upward.

Industry uses the informal term *chimney* to refer to such ducts.
Placing a vertical duct over a hot spot is especially pertinent to pods because the center of a pod tends to form a hot spot.

Lights-Out Data Centers

An operational paradigm has been invented that helps reduce heat in a data center: minimize any extraneous use of electricity.

In particular, avoid keeping an area lit when no humans are working in the area. Known as a *lights-out data center*, the scheme means that entire parts of the data center operate in the dark.

For example, we will see that each network switch in a data center has at least two connections that can be used to reach other switches or the Internet. If one connection fails, automated software detects the failure and changes forwarding so network packets flow over the other connection.

In addition to reducing energy costs, the lights-out approach has three advantages. Using automated systems to monitor a data center offers owners cost savings by reducing the staff size;

automation is less likely than human operators to misconfigure equipment;

and restricting personnel in the data center reduces the threat of malicious attacks.