Cooling

GREEN COMPUTING
UNIT II - CHAPTER 4

BSC(IT) – SEM II

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Cooling cost & power cost

- Cooling cost can be up to 63% of IT departments power usage cost
- Electricity is paid for per kilowatt-hour (kWh)
- Power costs are different in different places. Different countries have different charges

Region	Commercial Power Cost in 2007 (Cents per kWh)	Commercial Power Cost in 2006 (Cents per kWh)
New England	14.79	14.66
Middle Atlantic	13.2	12.81
East North Central	8.62	8.18
West North Central	6.86	6.75
South Atlantic	8.63	8.42
East South Central	7.97	7.97
West South Central	9.37	9.33
Mountain	7.73	7.61
Pacific Contiguous	11.27	11.36
Pacific Noncontiguous	16.94	17.35

Causes of cost

- Increased power consumption as more servers and storage devices are deployed.
- Increased heat density in the racks because of increased computing power in a restricted space.
- Irregular heat load in the datacenter. This is exacerbated by poor planning for heat management as the topology of the datacenter changes.
- Increasing power costs across the U.S.
- A tendency to overcool datacenters. The "flood-cooling impulse" leads datacenter managers to overcool their datacenters by more than two and a half times what is needed.

Calculating cooling needs

- All the equipment in your server room generates heat
- All these sources of heat contribute to the **heat load** of the server room.
- This number is expressed in British Thermal Units (BTUs) or kW. One kilowatt is the same as 3412 BTUs
- For room, use **this formula**:

  Room Area BTU = Length (meters(m)) × Width (m) × 337
- For windows

  South Window BTU = South Facing Window Length (m) × Width (m) × 870

  North Window BTU = North Facing Window Length (m) × Width (m) × 165
- For people in the room

  the heat load goes up about 400 BTU per person So

  Total Occupant BTU = Number of occupants × 400
- Equipment BTU = Total wattage for all equipment × 3.5
- Lighting BTU = Total wattage for all lighting × 4.25
- Total Heat Load = Room Area BTU + Windows BTU + Total Occupant BTU + Equipment BTU + Lighting BTU

Reducing cooling cost

- Economizer

 it is used to utilize natural air in winter to cool down equipment.

Types

- **Air side**

 An air-side economizer regulates the use of outside air for cooling a room or a building. It employs sensors, ducts, and dampers to regulate the amount of cool air brought in. The sensors measure air temperature both inside and outside the building. If it notices that the outside air is suitably cold enough to cool the datacenter, it will adjust its dampers to draw in the outside air, making it the main source of cooling

- **Water side**

 A water-side economizer utilizes evaporative cooling to indirectly produce chilled water to cool a datacenter when outdoor conditions are cool. This is best for environments with temperatures below 55 degrees Fahrenheit for 3000 or more hours a year. Using economizers, chilled-water-plant energy consumption can be cut by up to 75 percent. Fluid in the cooling system passes through a coil to cool the room, thus eliminating the need for the compressor to operateWater-side economizers are especially beneficial, because not only do they save costs, but they don’t allow contaminants or altered humidity levels into the datacenter

- **<u>On demand cooling</u>**

  <u>Air to air</u> Smaller air-to-air coolers can be wheeled into the room needing cooling. They use flexible ductwork to connect to a window, and then the generated heat is transferred out of the building. They can be plugged into a standard 110-volt wall outlet. Larger units can be mounted on the outside of the building, with cool air being ducted through a window. These units operate on temporary 208-to-230-volt circuits.

  <u>Water based</u> These are much larger units, where a standard garden hose is connected to the device so that water flows in, cools down the equipment, and then is sent through a second hose to run down a drain.

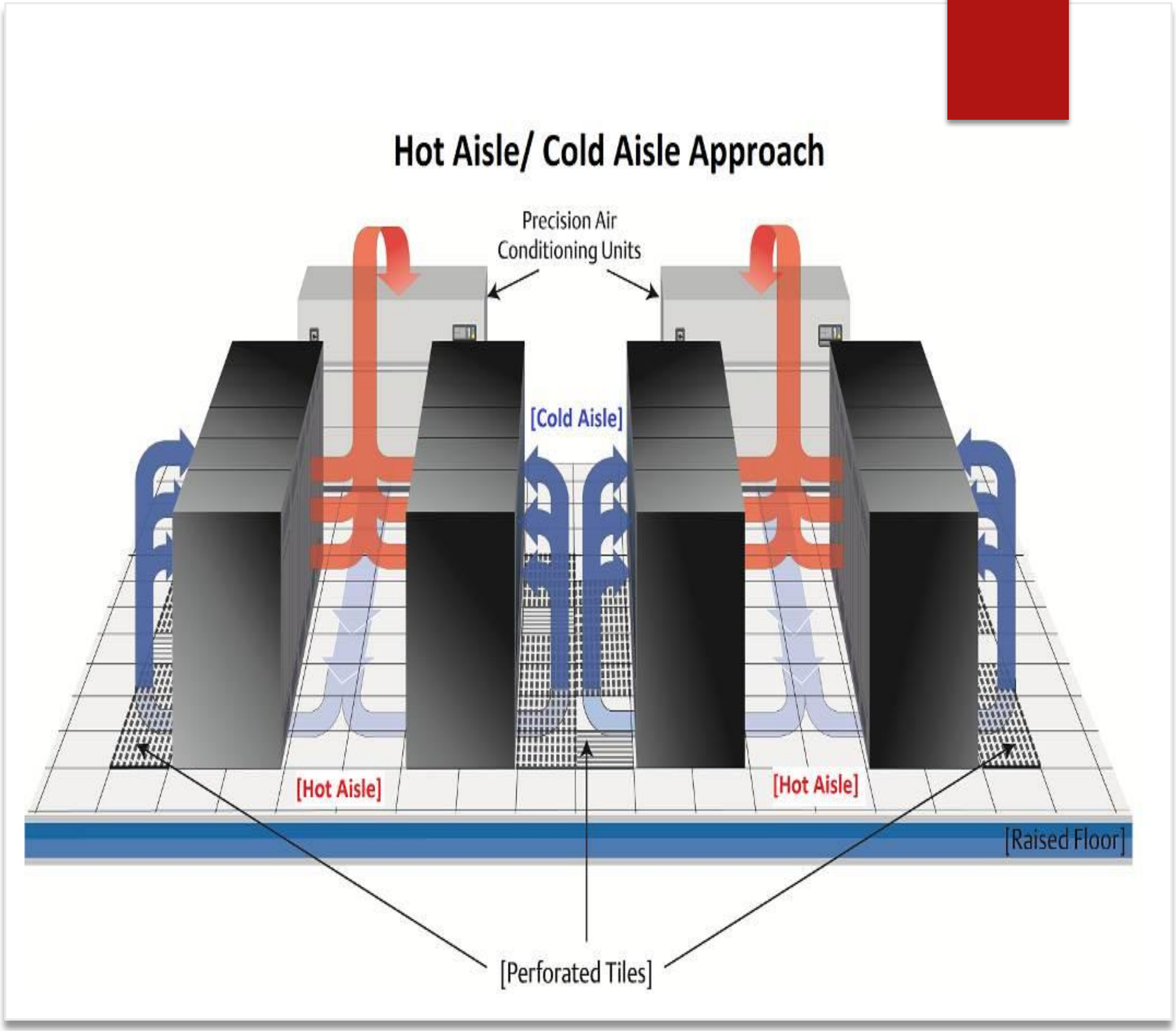
- **<u>HP's solution</u>**

  Dynamic Smart Cooling, uses sensors to control the temperature in specific areas of the datacenter. HP labs were able to reduce the power to cool a datacenter from 45.8 kW using a standard industry setup to 13.5 kW. It is managed by managed by specially designed software—to regulate the cold air delivered to a room based on the needs of specific computers.

Optimizing airflow

1. Hot Aisle / Cold Aisle :

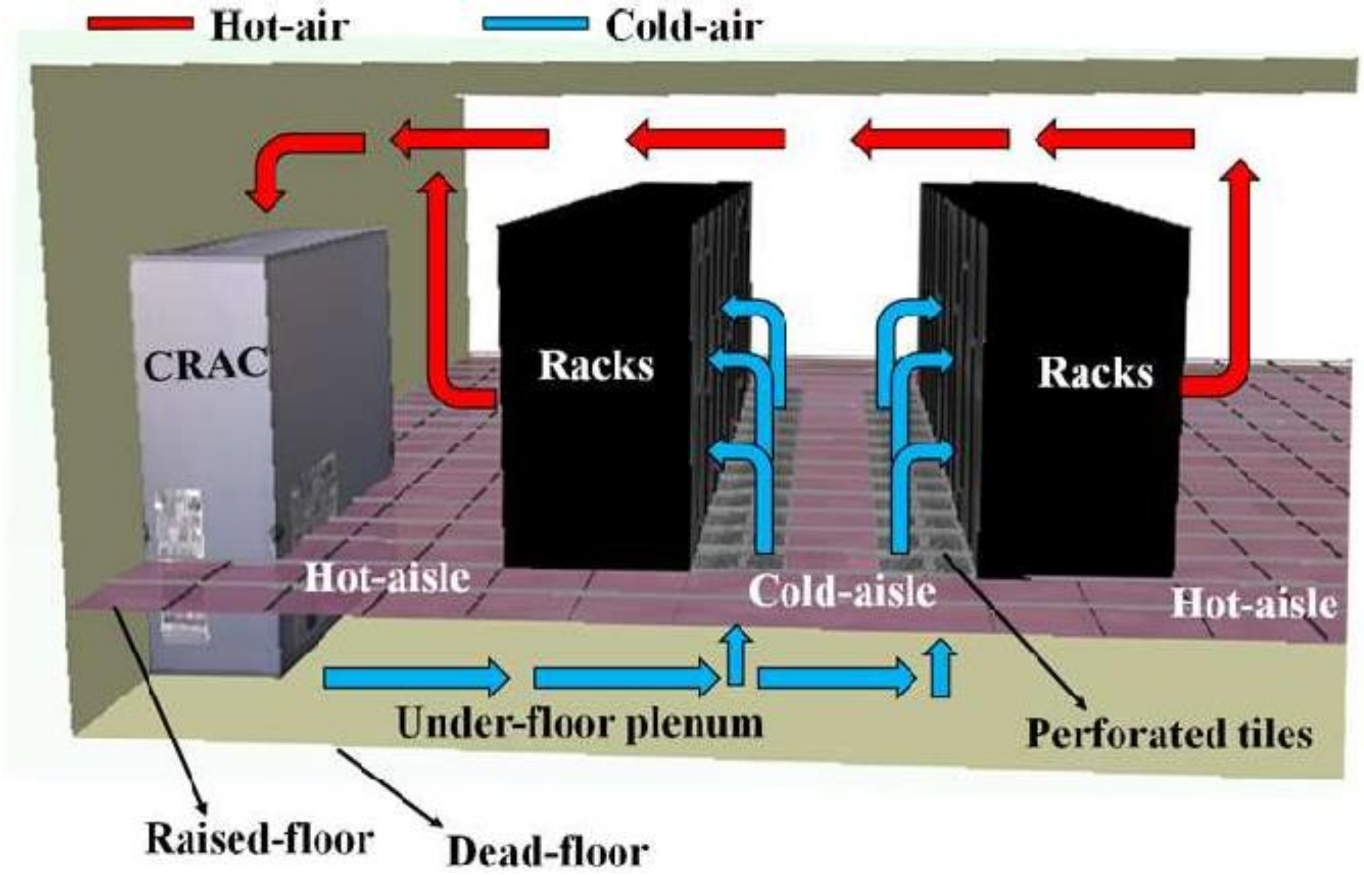
The cool sides of equipment are arranged together, whereas the hot sides of equipment face each other. This allows the equipment to draw in cool air, rather than air that has already been preheated by the rack of equipment in front of it. The cold aisles have perforated floor tiles to draw cooler air from the raised floor. Floor mounted cooling is placed at the end of hot aisles, but not parallel to the row of racks. This is because parallel placement can cause the hot exhaust to be drawn across the top of the racks and mixed with the cool air. It also decreases overall energy efficiency.



Optimizing airflow

2. Raised Floors:

Datacenters are conventionally built on a floor that is raised 18 to 36 inches. The higher the floor level, the more air that can be distributed under the floor and the more air that can be used by the cooling system.



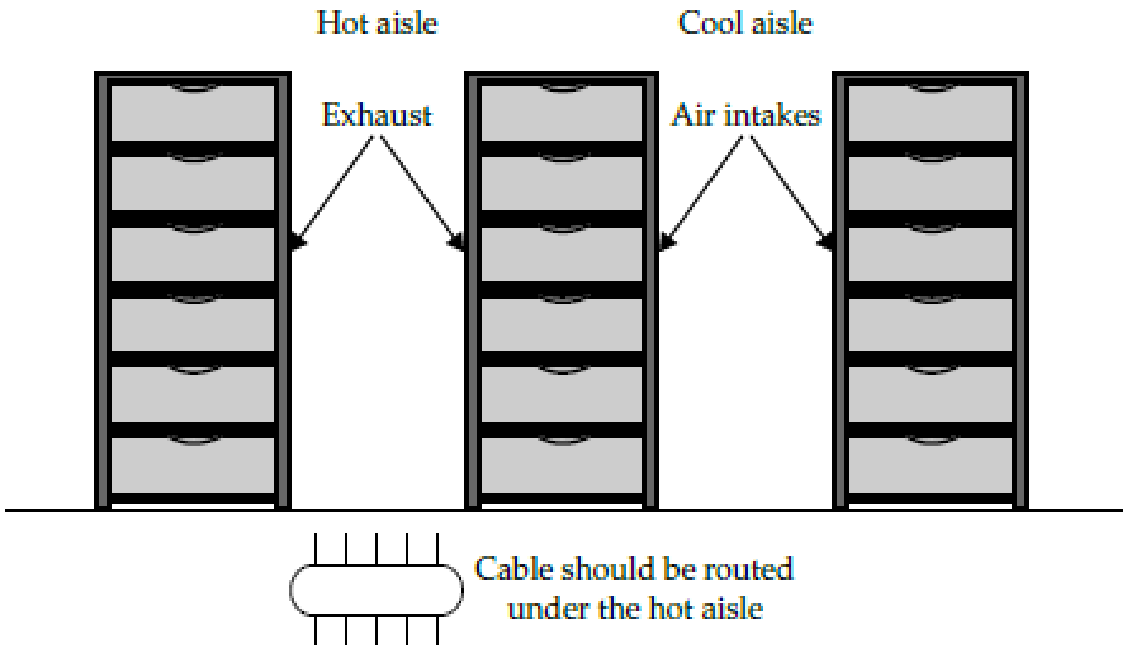
Optimizing airflow

3. Cable Management:

It’s best to route your cables under the hot aisle, as shown in

Figure. This reduces the cool air’s path to the equipment as it is drawn in through

the perforated tiles and into the equipment's’ cooling systems.



Optimizing airflow

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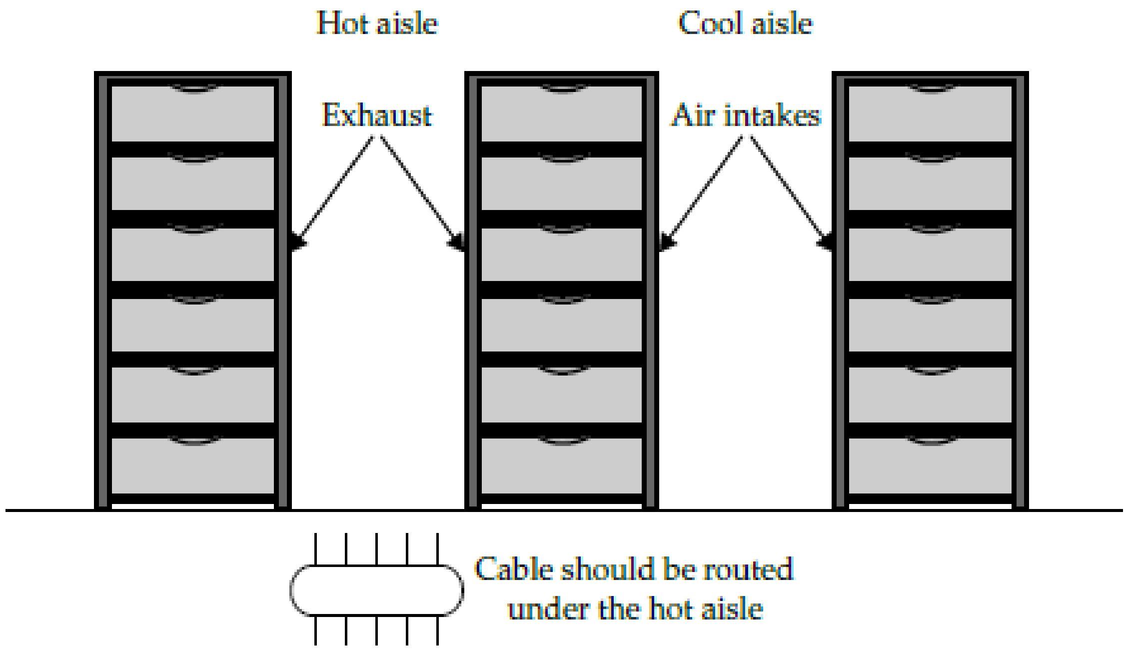
Some organizations are also running cabling above or through racks, rather than under the floors, to reduce the interference with the flow of air from below. Further, some organizations are deploying advanced power strips to bring the power load closer to the rack rather than running so many cables through the datacenter.



Optimizing airflow

4. Vapor Seal:

It’s also important to ensure you have a good vapor barrier in your datacenter, cutting it off from the rest of the building. If you have a poor vapor barrier, humidity will move into the datacenter during hot months and escape during the winter months. A good vapor seal reduces the costs to humidify or dehumidify.

Optimizing airflow

5. Prevent Recirculation of Equipment Exhaust:

1) Hot-aisle/cool aisle Employ the hot-aisle/cool-aisle design
2) Rigid enclosures Build rigid enclosures to keep exhaust heat from being sucked back into the device's cool air intakes.
3) Flexible strip curtains Use flexible strip curtains to block the open air above your racks that have been configured into a hot-aisle/cool-aisle layout.
4) Block unused rack locations with blanks Equipment typically draws in cool air from the front and exhausts it out the back. Blanking open areas under equipment prevents the exhaust from being drawn back into the device.
5) Design with cooling in mind Although most do, some equipment does not draw air in from the front and exhaust it out the back. Some have top-discharge or side-to-side designs. Configure your racks to ensure your equipment doesn't blow into the intake of other equipment.
6) Select racks with good airflow Buy racks that don't have an internal structure that would block the smooth flow of air to your equipment.

Optimizing airflow

6. Supply Air Directly to Heat

1) Use the correct diffusers The type of diffuser you would use in an office is not appropriate for a datacenter. Select diffusers that deliver air directly to the equipment that needs cooling.

2) Correctly place supply and returns Diffusers should be placed right by the equipment to be cooled. They should not be placed so they direct cooling air at heat

3) exhausts, but rather into the air intakes. Supplies and slotted floor tiles should not be placed near returns to prevent a cool air “short circuit.”

4) Minimize air leaks Systems that use a raised floor can lose cool air through cable accesses in hot aisles.

5) Optimize air conditioner placement In large datacenters, a computational fluid dynamics (CFD) model would be useful. This helps locate the best placement for cooling units. It also helps minimize the distance between air conditioner units and large loads.

6) Use properly sized plenums Return plenums need to be the right size to allow alot of air to flow through. Obstructions such as piping, cabling trays, and electrical conduits need to be taken into consideration when plenum space is calculated.

7) Provide enough supply Under-floor supply plenums must be big enough to allow enough air to service your equipment. Again, take into consideration obstacles such as piping, cabling trays, and electrical conduits.

Optimizing airflow

7. FANS

1) Fans also suck up a lot of power, especially when a lot of them are spinning at the same time. Take these tips into consideration to improve fan efficiency:
2) Use a low-pressure drop system Use low-pressure drop air handlers and ductwork. Make sure there is enough capacity in your under-floor plenums to allow air to flow.
3) Use redundant air handlers during normal operations It is more efficient to use auxiliary fans at a lower speed than a single fan at high speed. Power usage drops with the square of the velocity. As such, operating two fans at 50 percent capacity uses less power than one fan at full capacity.

Optimizing airflow

8. HUMIDITY

1) Establish a humidity sensor calibration schedule Humidity sensors drift and require frequent calibration—more so than temperature sensors. Also, incorrect humidity sensors are less likely to be noticed than incorrect temperature sensors. As such, establish a frequent test and calibration schedule for your humidity sensors.
2) Allow for sensor redundancy Make sure you have enough sensors to keep an eye on your datacenter’s humidity level. To ensure a tight control, multiple sensors should be used. At the very least use two, but more are better.
3) Manage humidity with a dedicated unit If ventilated air is used (maybe from an air-side economizer), control humidity with a single ventilation air handler.
4) Lock out economizers when necessary When using an air-side economizer, minimize the amount of air that’s brought in when the dew point is low. This saves money on having to humidify the dry air.
5) Centralize humidity control Each datacenter should have its own centralized humidity control system. Multiple systems wind up fighting each other, and the system becomes less efficient.


Thank you