An Introduction to Data Centres at NBI

By Paul Fretter January 2015

Supercomputers, server 'farms' and large-scale data stores are an essential infrastructure underpinning modern biological science. For reasons of cost, complexity and practicality it is not feasible to host these systems in a scientific laboratory. This paper outlines some of the basic design features of a data centre and the reasoning behind it.

A *data centre* is typically a room or even an entire building containing a significant number of computer systems for data processing and storage. By concentrating equipment in this way it not only frees up valuable space in the laboratory, but also makes financial sense as there are economies of scale to be made in management, maintenance, energy and security.

Figure 1 - Equipment racks in NBI's main data centre hall

A typical data centre has a main ***hall*** with rows of tall ***equipment racks*** containing computers (servers and supercomputers), data storage systems and network devices. There will also be mechanical equipment to keep the *hall* cool, and the whole room is likely to be on a ***raised floor*** with a number of strategically placed ***grilles*** to distribute cold air around the *hall*. Ancillary equipment necessary for providing the electrical supply and controlling the environment in the *hall* are located in a separate ***plant room***, as well as an ***external plant area*** for dissipating heat.

Electricity Supply

An unexpected power cut or even a short interruption would pose a real risk of data corruption and could even damage fragile electronic components. To guard against these risks it is common practice to install an Uninterruptable Power Supply (***UPS***) unit, either in the *plant room* or the data centre *hall* itself. As the name suggests, the purpose of a UPS is to provide a continuous power feed to the equipment even if the mains supply is interrupted, allowing sufficient time for a standby generator to start. A *UPS* comprises a means of storing energy, such as a set of high capacity batteries, a control unit and special circuits for charging the batteries and creating an artificial AC mains supply.

If the generator fails to start then there is sufficient battery capacity to last for 10-20 minutes to allow time for a controlled shutdown of the most critical computer systems, avoiding data corruption. The (protected) power supply is distributed to each *equipment rack* in the *hall*, where it is then further divided to provide power to each computer usually via multi-socket power strips, larger but similar in concept to the 4-way trailing sockets used domestically.

Fire Protection

Fire protection in the *hall* comprises several components. A sensitive Very Early Smoke Detection and Alarm (***VESDA***) system detects early signs of pre-combustion, and allows staff to take corrective action to prevent a fire. If a fire breaks out it will be detected by standard smoke and fire sensors, triggering the main fire alarm and, after thirty seconds, a fire-suppressant gas is automatically injected into the *hall* to extinguish the fire.

Cooling

When electricity is 'consumed' it is mostly converted into heat and thus the components within a computer get hot. Left unchecked, they could overheat and be permanently damaged, so it is essential to keep them cool. The most common method is by blowing cool air through the servers and thus transferring the heat into the air. In an enclosed space with many computer systems, the air would gradually warm up and thus be ineffective at cooling, so it is necessary to then remove heat from the air using a Computer Room Air Conditioning or ***CRAC unit***.

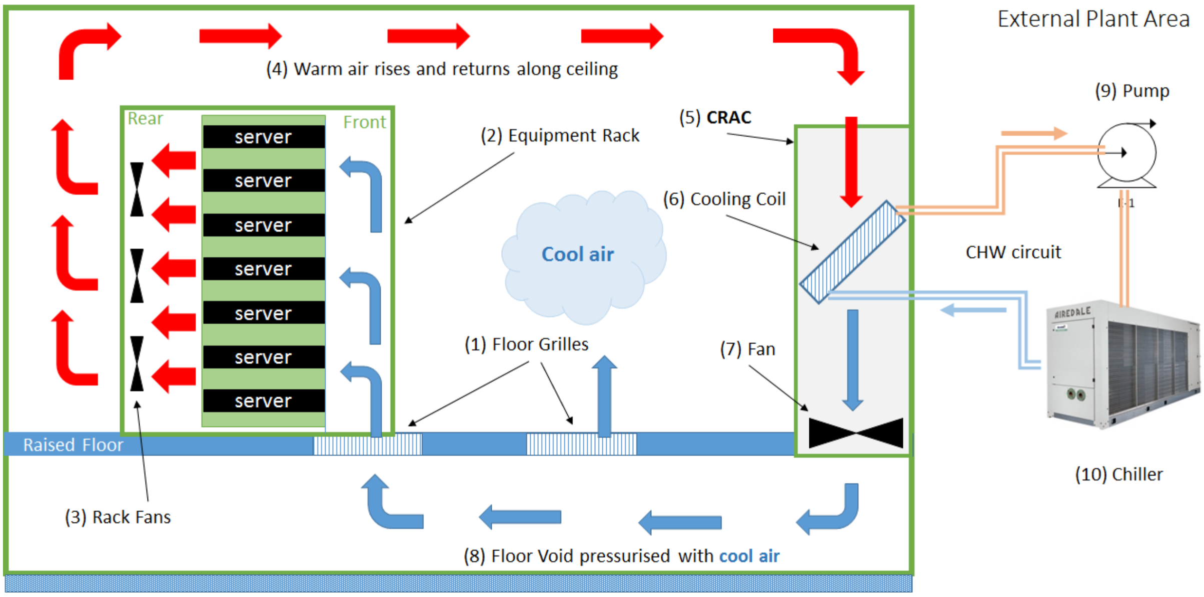

Figure 2- Simplified cooling diagram for an NBI data centre (cross section)

How it works…

Referring to figure 2 above, cool air flows up through *floor grilles (1)* into the front of the *equipment rack (2)* and is then drawn through the (hot) servers by the *rack fans (3)* at the rear. The warmed air is then exhausted into the room, where it rises towards the *ceiling (4)* and returns to the top of the *CRAC unit (5).* The warm air is drawn into the CRAC unit and passes over a *cooling coil (6)*, where the heat is transferred to a chilled water circuit and the now cooler air is forced into the floor void (8) by the fan (7), and thus completes the air circuit. As for the chilled water (CHW) circuit; the *pump* (9) moves the warmed water from the *cooling coil (6)* to a mechanical *chiller (10)*, which chills the water and returns it to the cooling coil. This approach is sufficient for about 60% of our computer systems, but supercomputers generate so much heat that we also fit another *cooling coil* to the back of the *equipment rack* (not shown).

Humidity

If the humidity of the air drops too low it can create problems with static electricity, and if too high the moisture can condense into liquid on cool surfaces. Air conditioning typically 'dries' the air and, in the UK climate at least, it is sufficient to provide a small but steady supply of outside air into the room as it has sufficient moisture content. By adjusting the balance between the air supplied and the air extracted we can tune the humidity and also the air pressure in the *hall*. It is important to maintain a slightly higher air pressure in the *hall*, relative to the adjacent corridor, to ensure that dust is not drawn in around the door frame. Sticky mats in the doorway remove loose particles brought in on the soles of footwear.

Networks

All network connections to the *data centre* are optical fibre cables contained in underground ducts. This offers very high capacity as well as security and immunity from electromagnetic interference or damage from lightning strikes. Once in the *hall*, all cabling is run at high level, leaving the floor void free for distributing cool air.

Data Backup

Even the most robustly designed data centre is not 100% immune from disaster, and it is good practice to keep a backup copy of the organisation's most important data, and duplicate servers for critical functions, in another data centre either nearby or remotely.