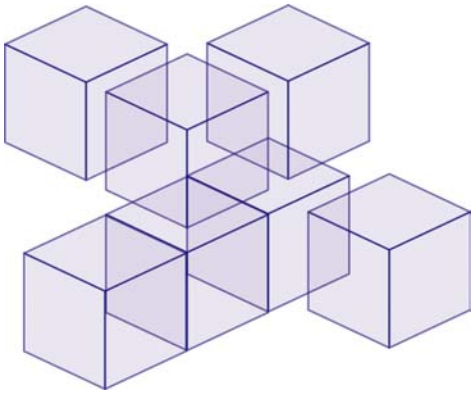


Data Centre Best Practices Summary

END2END

Delivering Successful Technology Rooms

1 END2END's Data Centre Best Practices

END2END design Data Centres/Computer Rooms based on 7 major principles:

- Understanding the Requirement
- Understanding the IT element and defining the Room Specifications
- Designing Modular Data Centres
- Creating Server Room availability by use of levels of Redundancy
- Creating the "Early Warning System"
- Remotely Managing the Data Centre
- Building with the right components – "fit for purpose" and resilient
- Documenting the Facility and Training personnel

1.1 Understanding the Requirement

Data Centres are often "put together" because real requirements were never evaluated or understood and without a Requirements Specification how can a design be created to match those needs. "Put together" Data Centres will never meet goals or expectations and will continually be a source of failure both operationally and commercially.

An Analysis of Requirements determines the exact needs ensuring that budgets are spent wisely and that the final Room meets all specifications. There are many Data Centres for example that are wildly over specified just because initial requirements were not properly defined. These Requirements should be ascertained using joint workshops with all relevant parties and look at all aspects from IT estate, commercial considerations, user/customer service levels, operational structure to physical site conditions.

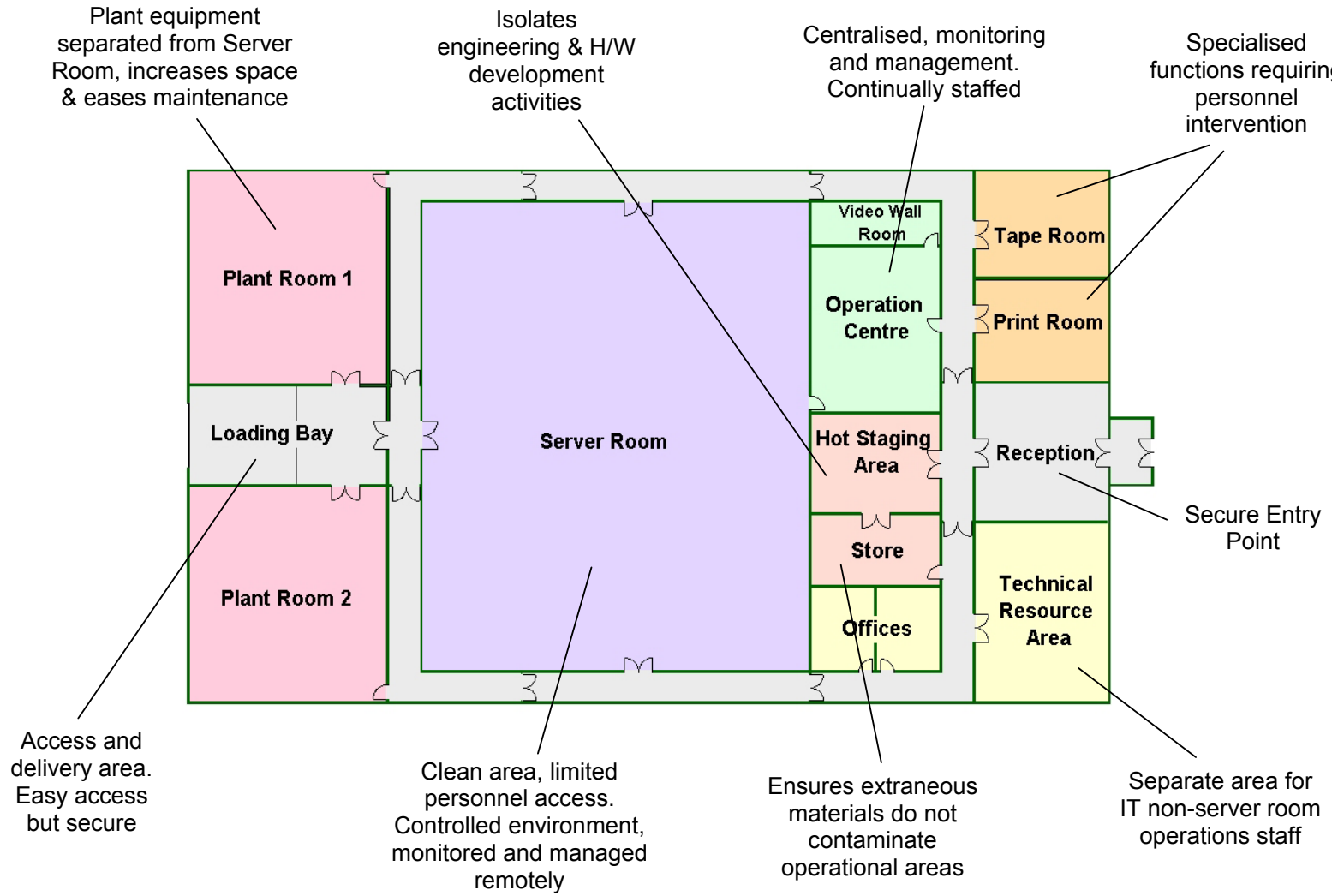
1.2 Understanding the IT Element and defining the Room Specifications

Fitting the Data Centre to the IT it will house is one of the most crucial factors in determining the size of the Data Centre and its overall environmental specifications. It involves:

1. Gaining a list of all known IT equipment to be housed in the Server Room, including:
   - IT equipment manufacturer, model and quantities for each type
   - Numbers of racks and types
   - Racking layouts, END2END may have to review this with the customer as racking some equipment (e.g. blade servers) can cause environmental problems. Too many to a cabinet can seriously affect the potential to cool the equipment and overload the local power distribution.
2. Obtaining from the Manufacturers information on:
   - Heat Emissions
   - Power Consumption
   - Maintenance Service Clearances (horizontal and vertical)
   - Footprints of Racks
3. Obtaining information on use of:
   - Dual Power supplies
   - Multiple Network Connections
4. Gathering information on future equipment predictions, including:
   - Type of kit (any standardisations)
   - Predicted amount of kit
5. Create and calculate the Room Environmental profile, including:
   - Maximum number of racks and types
   - Total Heat and Power figures
   - Equipment layout (on room floor) taking into account service clearances, optimum cooling layouts and power distribution system
   - Overall room size requirements, allowing for any environmental equipment, access requirements and health and safety regulations
   - Room height required including service clearances and optimal cooling requirements
   - Positioning of air grilles, taking into account inter-rack cooling distribution systems

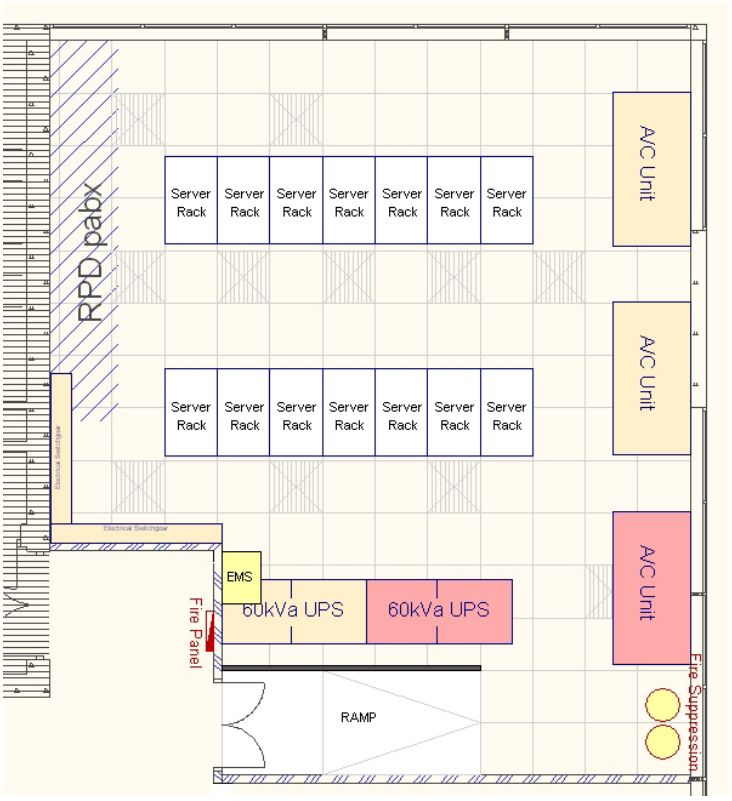
1.3 Designing Modular Data Centres

Data Centres that operate well do not intermix activities in different areas (e.g. personnel don't live in areas designed for IT equipment or use it as a corridor to get to another area). It's all about designing a layout based on functional elements and then ensuring that processes (including security) reinforce that layout. The diagram on the following page shows the typical types of room and defines their primary and only functionality. Whilst this is a generic layout, the same rules should apply to the design and construction of all Data Centres. No matter what their exact size or shape – The rules still apply!


Plant equipment separated from Server Room, increases space & eases maintenance
Isolates engineering & H/W development activities
Centralised, monitoring and management. Continually staffed
Specialised functions requiring personnel intervention
Plant Room 1
Loading Bay
Plant Room 2
Server Room
Video Wall Room
Operation Centre
Hot Staging Area
Store
Offices
Tape Room
Print Room
Reception
Technical Resource Area
Secure Entry Point
Access and delivery area. Easy access but secure
Clean area, limited personnel access. Controlled environment, monitored and managed remotely
Ensures extraneous materials do not contaminate operational areas
Separate area for IT non-server room operations staff

1.4 The Server Room – The Heart of the Data Centre

The Server is the real heart of the Data Centre. It houses all of the IT equipment and if designed correctly is a 'lights out' environment. 'Lights Out' really means that there is no real reason for personnel to have to enter the room (apart from new H/W installations) and this should be an objective for all Server Rooms. Personnel entering and working in a Server Room destabilise the environmental conditions and bring contaminants to what should be a 'clean' environment.



There are strict rules for positioning of racks and plant equipment and 'fit for purpose' standards for components that have to be adhered to (e.g. Downflow A/C – no wall or ceiling mounted units). Also, to ensure that 'lights out' can be truly achieved, the Server Room has to be equipped with a remote capability for monitoring and management. This means that operations personnel do not have to enter the area to manage the Data Centre effectively and that they can, in fact, be located in a different location altogether.

1.5 Creating Server Room Availability

Creating availability and reducing downtime for IT starts with the Environmental Fabric of the Server Room and the design of that fabric will determine the availability that can be expected from it. In Data Centre Design terminology it is about defining the "N" factor.

Note: "N" stands for Needs and it defines the basic components required to provide environmental services to the Server Room. An "N" Room will have just what it needs to supply the IT equipment of the Room.

END2END have defined 4 levels of Server Room based on the N factor:

- **Level 1 – No Redundancy**
- **Level 2 – Basic Redundancy**
- **Level 3 – High Redundancy**
- **Level 4 – Maximum Redundancy**

The following table defines those Levels in terms of the "N" factor and the site downtime and availability potentials of the Environmental Fabric of the Room.

	Level 1	Level 2	Level 3	Level 4
Power Distribution	**Single Source Single Path**	**Dual Source Single Path**	**Dual Source Dual Path**	**Dual Source Dual Path**
Component Redundancy	**N**	**N + 1**	**N + 1**	**N + N**
Site Downtime per annum	**18.5 hrs**	**10.3 hrs**	**3.2 hrs**	**0.8 hrs**
Availability	**99.789%**	**99.883%**	**99.963%**	**99.991%**

The trick when designing any Room's Environmental Fabric is to ensure that the cost v benefits analysis is undertaken. As Component Redundancy is increased, so does the cost and there is always a point where extra redundancy adds extra cost but no real extra value.

The following defines each Level in more detail:

Level 1 – No Redundancy (N)

- Single power source with single distribution path
- No redundant environmental fabric components (N=number required only)
- All maintenance requires shutdown of the room
- Failure of any environmental component will cause disruption to IT Operations

Level 2 – Basic Redundancy (N+1)

- Dual power source (e.g. backup generator with single distribution path)
- Redundant Environmental Fabric components (N+1= number required plus one standby)
- Some maintenance requires shutdown of the room
- Failure of most individual environmental components will not cause disruption to IT Operations

Level 3 – High Redundancy (N+1)

- Dual power source and dual distribution paths
- Redundant Environmental Fabric components (N+1, number required plus one standby)
- Maintenance requires minimal shutdown of the room
- Failure of individual environmental component will not cause disruption to IT Operations

Level 4 – Maximum Redundancy (N+N)

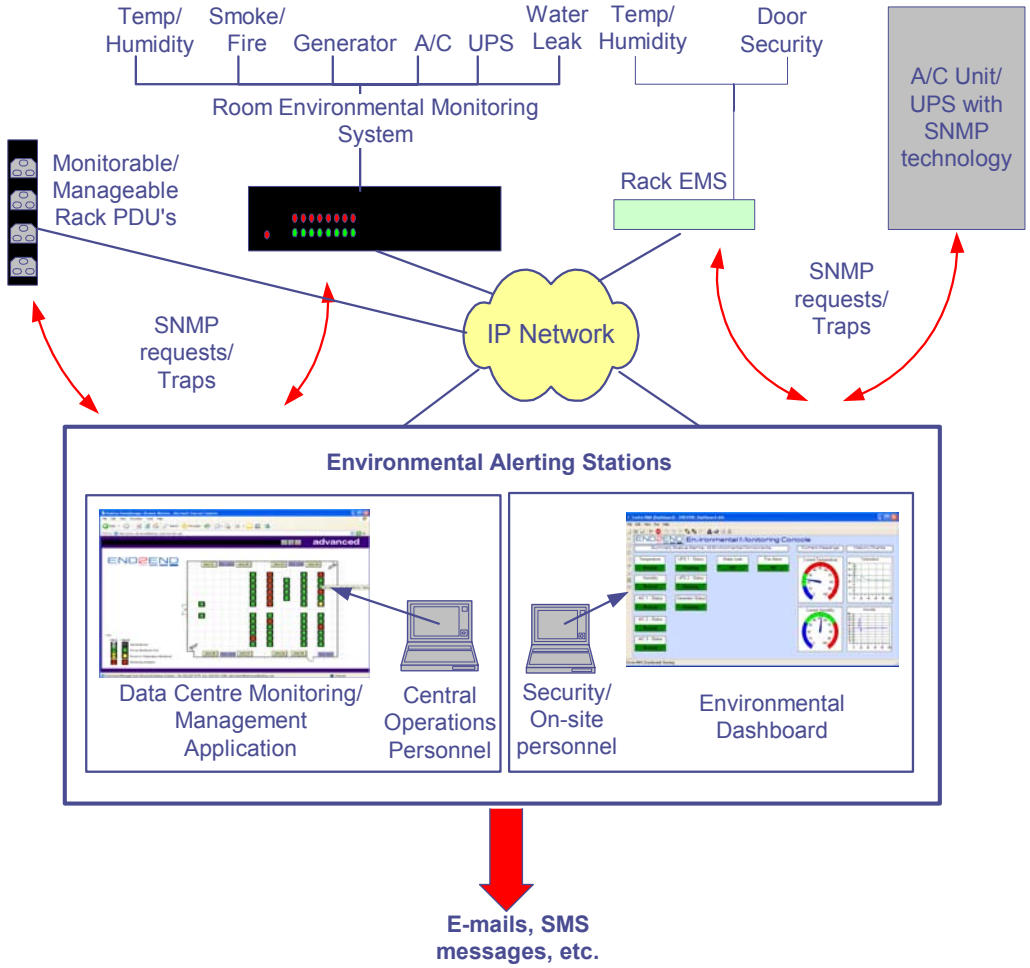
- Dual power source and distribution paths
- Redundant Environmental Fabric components, plus duplicate configurations (N+N = number required duplicated)
- Maintenance non disruptive
- IT Operations generally immune to unplanned events or failures

Final Note: Remember the Environmental Infrastructure is the foundation for all of the other levels that make up the Availability pyramid. Once the environment is correctly sorted you can then ensure that the other layers can support the service levels you require.

1.6 Creating the "Early Warning System" - Monitoring the Data Centre

Monitoring the Server Room

Environmental Monitoring of all of the factors in a Server Room is essential to ensure that prompt action can be taken when things are beginning to or have gone wrong. On many occasions the signs of potential failure can be spotted and fixed before any actual problem has occurred. This component of the Data Centre is often seen as optional. It is not! It is one of the most important elements that will ensure continued operation of the Centre.



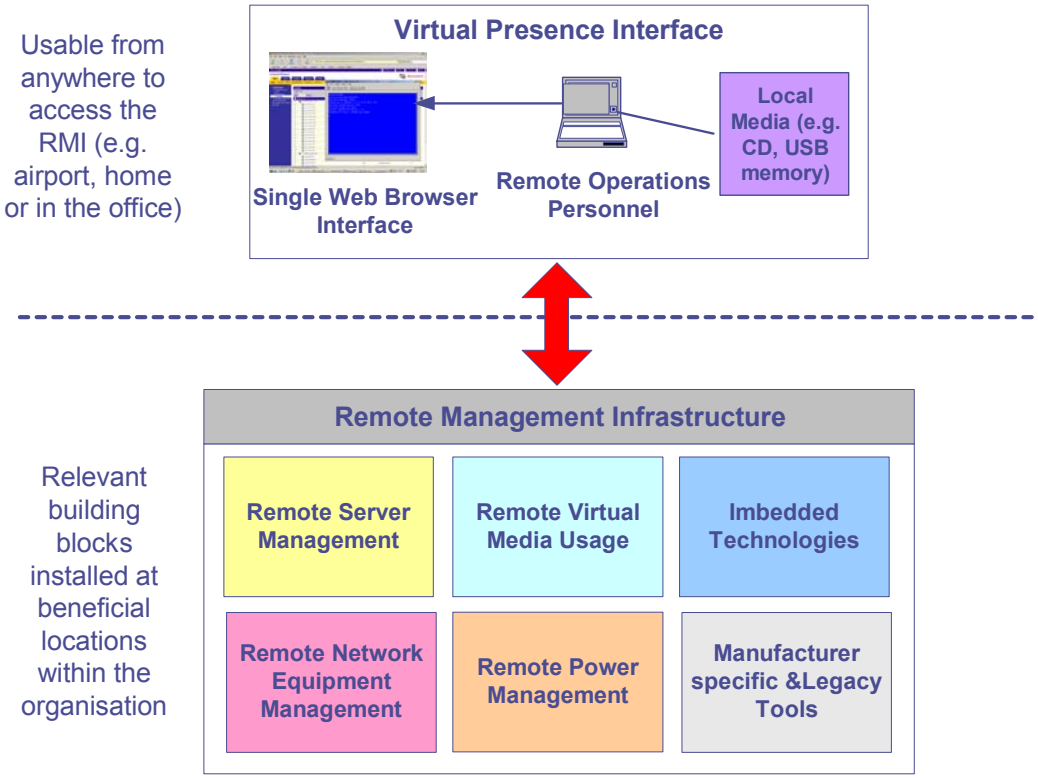
Monitoring the Server Room Racks

As well as monitoring the overall room, it is wise to monitor individual rack environments for power usage (via monitorable PDU's) and for internal temperatures.

In fact, Environmental Monitoring Systems should be included to monitor many or all of the following environmental factors:

1.7 Managing the "lights Out" Data Centre

A "lights out" Data Centre can only be achieved if a proper Remote Management infrastructure is implemented within the Data Centre, allowing for management of Servers and network equipment to be accessed and controlled "Out-of-band". This means that, for instance, servers could be managed at the bios level and even rebuilt totally from a remote location.



1.8 Building with the Right Components

This is one of the commonest areas for mistakes to be made. Many environmental components that are used for office space are not suitable for Server Room environments, the problem is that many suppliers do not understand the needs of sensitive and complex IT equipment and, therefore, it's no wonder that the wrong products are specified. The following table describes some of the major components of a Data Centre and the types of products required.

Functions and Benefits

Component	Function	Benefits
Electrical Switchgear	▪ Essential Supply PDU (Power Distribution Unit) - Local power distribution boards installed in the Computer Room to support the room. This 'Essential Load' PDU should be fed from a UPS - These can be duplicated to remove possible single points of failure	▪ Provides a single source of all power to the room and ensures that all equipment is fed from a conditioned supply and in dual mode provides protection against single component failure
Uninterruptible Power Supply (UPS)	▪ A centralised Uninterruptible Power Supply provides a short term source of power in the event of a power cut. The level of protection is dependant on the amount of battery autonomy installed. ▪ If conditioned, it also provides a high degree of filtering on the electrical supply removing noise, surges, sags and transients ▪ To give more availability, these can be 'paralleled' in redundant configurations	▪ Many intermittent hardware and software errors can be traced directly back to poor quality power supplies. These 'difficult to trace' errors can be completely removed by the addition of a conditioned UPS (beware: some UPS's, do not provide this ability) ▪ It also provides (via batteries) a power source in the event of a power failure. This typically provides sufficient time (normally 10-15 minutes) for a generator to start or for systems to be shutdown correctly. This can save costly hours recovering systems which have crashed
Air Conditioning Units	▪ For medium to large Computer Rooms, it is essential to use either: ▪ For low density racks, Close Control Down Flow Air Conditioning Units. They utilise the under floor void (plenum) via strategically placed grills to direct cooling precisely to the IT equipment, cooling up to 8kW ▪ For high density racks, Chilled Racks/rack heat exchangers, which work on a per rack basis and can cool 15-20kW	▪ Proper temperature and humidity control reduce the MTBF's for IT equipment significantly ▪ These units are designed to provide carefully regulated and conditioned air into a room to enable the temperature and humidity to be controlled precisely to meet defined operational specifications ▪ They ensure that IT equipment is cooled not just the space in the room

Functions and Benefits (continued)

Component	Function	Benefits
Fire Detection and Suppression	▪ Sensors throughout the Room detect the presence of smoke or fire. In the event of an incident, suppressant gas is released to extinguish the fire. The gas suppressant is stored in bottles in a liquid state ready for release when the system is activated. For modern rooms the gases used are FM200, Inergen or Argonite	▪ IT equipment is an expensive asset and even a minor fire can cause severe damage. IT equipment can be irreparably damaged by smoke on its own let alone the full effects of a larger blaze
Standby Generator Sets	▪ **Generator** A standby power source. The generator is powered by either diesel or gas depending on model purchased and is under the direct control of the site ▪ **AMF Panel** The Automatic Mains Failover Switch (also known as a Transfer load Panel) monitors the condition of the power and automatically switches to the best source of power to meet the parameters programmed	▪ A properly configured Generator set provides a site with complete protection against power failure ▪ Combined with a UPS, it ensures that downtime due to power outage is zero
Environmental Monitoring Systems (EMS)	▪ A modular system designed to actively monitor alerts from environmental components and to generate alarm signals. ▪ It can monitor for issues with temperature and humidity, UPS and Air conditioning failures, fire, water leaks. In fact the majority of potential problems ▪ Alert signals can be generated in the form of SNMP traps to Network Management stations, Email to key personnel or SMS messages	▪ Computer Rooms are typically 'lights out' environments. Failure of any environmental component can (in a short space of time) become a serious problem (e.g. even small fluctuations in temperature can cause severe failures of servers). Alerting can inform operators of the need to take action, before serious damage occurs
Security Access Systems	▪ These provide protection against unauthorised access to the Computer Room and includes security access Systems and CCTV monitoring systems	▪ Besides the obvious protection against deliberate sabotage, these ensure that numbers of personnel entering the Computer Room are kept to a minimum. Computer Rooms once set up correctly are best left undisturbed. Research shows that Computer Rooms which have a high level of human interaction are far more likely to fail.
Structured Cabling Systems	▪ Cat5e, Cat6 or fibre ▪ Structured means laid in proper runs (in basketwork) and connected to patch panels with all racks in the Server Room connected back to centralised patch racks ▪ Data cabling should be kept separate from power cables (at least 1m apart). Where they have to cross this should be at 90 degrees to prevent electrical interference of the data signals	▪ A good structured cabling system is one where all cables are in predefined runs and are labelled correctly for easy management ▪ Patching should be simple and neat and documentation precise ▪ If constructing a new Server Room, it is wise to lay all of the data cables required for the future al the same time. Laying extra cabling later is rarely done in a structured manner.

Functions and Benefits (continued)

Component	Function	Benefits
Remote Management Technologies	▪ KVM over IP appliances ▪ Serial over IP devices for managing network equipment ▪ Power cyclable power strips (PDUs)	▪ A combination of management technologies mean that all can be managed from anywhere as long as there is a possible IP connection.

1.9 Documenting the Operational Facility and Training personnel

Given that a great Data Centre has been created, it will all come to nothing unless that Environmental Fabric is documented fully and the Operations personnel (responsible for each of the elements) are trained thoroughly. Such documentation covers a wide spectrum of areas, including, but not limited to:

- **Common Naming Conventions** - use meaningful naming conventions and stick to them. It's OK to use friendly names such as "Gandalf" and "Skywalker" for the first name but these should be accompanied and associated with meaningful codes which should reflect the type of equipment and location These sorts of conventions ensure that finding equipment for engineers and relating logical maps to actual locations will be much easier

- **Operational Manuals** – the obvious items but they need to be written and integrated with other operational documentation (otherwise they tend to get mislaid)

- **Physical Schematics** – full electrical, data cabling diagrams etc.

- **Logical Topologies** – Logical layouts of Systems, Networks and environmental kit with their interconnections. If possible use Network Management type maps on-line, using the naming conventions to map the logical to the physical

- **Physical layouts** – The Server Room should have a complete physical layout kept of the position of equipment, its function etc tied back to any Asset/Inventory Management system used

- **Physical Equipment labelling** – often forgotten but labelling ties the piece of equipment shown on a logical map to where it actually resides. This is essential to ensure mistakes are not made by operations or maintenance engineers or time is wasted trying to actually find the right piece of equipment in the right rack

- **Physical Cable labelling** – often forgotten again but this is even more disastrous. A patch panel whilst allowing flexibility for connecting equipment is potentially a DR causing hazard. Simple rearrangement of a couple of fly leads can bring a Data Centre to its knees and finding what's exactly happened without labelling is like finding a needle in a haystack

- **Installation Planning** layouts – Ensuring that racks are laid out effectively to ensure optimum operation (e.g. a rack with too much equipment can be impossible to cool properly)

Important Note: All of this documentation is really useful but is only of use if it is kept fully up to date (Change and Configuration management are really important)