Designing Server Rooms

✦ Why should I do this?
  ➤ Painful and difficult
  ➤ But it can be a lot worse if someone else designs it
✦ Because it will make my work easier!
✦ Few thoughts about shared rooms
Preliminary Considerations

- What are the *business* requirements?
- Who will be responsible for what?
- What is the likely budget for this exercise?
- What is the starting point?
  - Renovating an existing room.
  - Building a completely new room
Renovation of Existing

Advantages

✦ Already know what equipment is involved
✦ May have part of the required infrastructure
✦ Easier to estimate requirements for equipment
✦ Power and air-conditioning requirements likely to be known
✦ May already have a “bad example”

Disadvantages

✦ Working around “live” systems
✦ Space may be too small
✦ Some existing equipment may be junk
✦ Can cost more than starting from nothing
Building a New Room

Advantages

✦ Can design exactly what is required
✦ If part of a complete new structure can have integrated design
✦ Not bound by previous decisions
✦ Power and air-conditioning requirements
✦ May not have organisational standards

Disadvantages

✦ Equipment to be installed “appears” after the fact
✦ Lead time required may be an issue
✦ Cost can be a problem since there’s one big bill
✦ Power and air-conditioning requirements partially known
✦ Possibly difficult sales job
Requirements

- Power - clean and reliable
- Air Conditioning - constant cool temperature and humidity
- Communications - the systems need to communicate
- Racks - storage or support as well as power and communications
- Fire Protection - Ordinary equipment is “not good enough”
- Security - a major reason for building the room
Planning and Politics

✦ Often viewed as a “cost”
✦ Calculate the business cost of downtime
  ➢ Employees unable to work
  ➢ Internet presence “off the air”
  ➢ Potential loss of data or other assets
✦ Estimates of the probability of the risks
✦ How does the room design reduce the risks?
Defining the Goals

- Why is this room being built?
- Is it likely to grow?
- Who uses it?
- What will the requirement be in 5 years? 10?
- How much space is required?
- What is absolutely necessary *right now*?
- If necessary, what could be added in next year’s budget?
Power 101 - Key Terms

- Volts - V
- Amperes - A
- Ohms - Ω
- Power Factor - \( \cos \Theta \)
- Load - the equipment that is doing useful work (and the losses)
- Power - Watts - W
- Kilovolt-Amperes - kVA
- Mains - the cables that eventually connect back to the generators
Power 101 - Direct Current (DC) Circuit

Diagram of a hand torch showing the electrical circuit
Power 101 - Parallel Circuit

Diagram of the electrical system of a car showing a parallel circuit
Power 101 - Alternating Current (AC)

Diagram of a sin wave
Diagram of the sin waves for current and voltage in an example circuit
Power 101 - How it Gets to Us

Representation of the electricity distribution system
Power 101 - What is Out There

♦ Reliability of the power supply
  ➤ Car hits power pole
  ➤ Underground cable hit by backhoe
  ➤ Generator workers strike
  ➤ Lightening hits cable or transformer

♦ Quality of the power supply
  ➤ Welder in the building next door
  ➤ High power motors stopping and starting
  ➤ Lights at the MCG switch on
  ➤ Trams drive past
Power 101 - Line Conditioning

- Electrical Filter - reduces the waveform disturbances
- Typically a “passive” device
- Cannot fix everything
- Equipment is still connected to the mains
- Really big spike or voltage dip will still get through
- Could not prevent shutdown due to 1/2 – 1 second outage
Power 101 - Standby UPS

✦ Least expensive option
✦ 350 VA for under $200 in shops
✦ Might be OK for home
✦ Originally had mechanical switching - now “solid-state”
✦ Saves money by simplicity and reduced requirement for high power components
✦ Filter equivalent to line conditioner
Power 101 - Standby UPS

Block schematic of a standby UPS. Image ©American Power Conversion Corp.
Power 101 - Line-Interactive UPS

✦ More expensive and sophisticated system
✦ 350 VA for under $500 in shops
✦ Probably still primarily a home unit
✦ Uses extensive semi-conductor circuits
✦ No switching time lag if mains power fails
✦ Filter effect superior to line conditioner
Power 101 - Line-Interactive UPS

Block schematic of a Line-Interactive UPS. Image ©APC Corp.
Power 101 - Delta-Conversion UPS

✦ More expensive and sophisticated system
✦ Not available in small units - starts at \( \approx 20 \text{ kVA} \)
✦ Less expensive than “true-online”
✦ Less expensive to operate than “true-online”
✦ No switching time lag if mains power fails
✦ Filter effect superior to line conditioner
✦ Frequency could be an issue
✦ Sophisticated electronics counteract flaws in the input waveform
Power 101 - Delta-Conversion UPS

Block schematic of an APC Delta-Conversion UPS. Image ©APC Corp.
Power 101 - “True - Online” UPS

✦ “Traditional” UPS system
✦ Not available in small units - starts at ≈ 20 kVA
✦ Price is ≈ $1000-1250 AUD / kVA
✦ Line losses due to double conversion $AC \Rightarrow DC \Rightarrow AC$
✦ No switching time lag if mains power fails since continuously online
✦ Filter effect superior to line conditioner since the AC in and out are isolated from each other
✦ Will maintain constant frequency if connected to a generator
Power 101 - “True - Online” UPS

Block schematic of a Line-Interactive UPS. Image ©APC Corp.
Power 101 - “True - Online” UPS Problems

- All power is first rectified (converted to DC)
- DC power is inverted (Converted to AC)
- Full wave rectifiers push harmonics onto the supply system
- Harmonics can affect other electricity users
- Utilities are beginning to charge extra for harmonic distortion
- Power factor problems can also occur
- Power factor affects utility bills
Power 101 - Power Conditioning

- Interactive system similar to the Delta-Conversion circuit
- Provides the inverse of the harmonics to remove them from the line
- Can provide savings of $\approx 10\text{-}20\%$ on electricity bills
- Cost of $\$10,000$ for 40 kVA unit
- Simpler and less expensive systems that use large capacitors are also available
- Capacitor systems primarily improve power factor
Diagram of an MGE SineWave Active Harmonic Filter with input and output waveforms. ©MGE UPS Systems.
Power 101 - Continuity of Supply

✦ Generally the continuity of electrical supply is good
✦ In CBD areas an outage of more than \(1\frac{1}{2}\) to 2 hours is highly unlikely
✦ Away from the CBD but still in urban areas still reasonably safe
✦ But if continuous operation is critical just an UPS may not be enough
Power 101 - Transfer Switch

❖ Big electrical systems are typically supplied from multiple sources
❖ Unsafe to connect these sources continuously
❖ Automatic transfer switch connects to secondary supply if the primary fails
❖ UPS maintains the continuity of supply during the switchover
❖ UPS protects against switching spikes and noise
Power 101 - Generators

- High cost option
- Purchase price
- Maintenance and testing
- Remember to make sure the fuel tank is full
- Depending on the size of the tank can supply power for days
Power 101 - Conclusions

✦ More money = more security of supply
✦ A classic case of the “90 / 10” rule
✦ When setting up UPS systems remember ancillary equipment
  ➤ Air-conditioning
  ➤ Lighting
  ➤ Security systems
✦ Test the system
✦ Set up automatic monitoring and shutdown to protect data
✦ Also needs an easily accessible “Panic Button”
Floor Systems

- Conventional approach to computer rooms is to have a raised floor
- Power supply system under the floor
- Communications cables may route under the floor
- Air-conditioning may also be supplied through the underfloor space
- Easily removable floor tiles for access to the underfloor space
Floor Systems

A good floor system should:

- Be strong enough to support the equipment
- Be able to support moving equipment
- Be designed to be anti-static to reduce the danger to equipment
- Be relatively dust free to reduce the need for cleaning
- Have a suitable ramp to allow movement of equipment or
- Be on the same level as the normal floor
Available Floor Systems

- MDF Core tiles (with or without metal sheathing)
- All Steel tiles
- Concrete supports at the corners of the tiles
- Steel adjustable supports at the corners (These may have pins to lock into the tiles)
- Steel adjustable supports with steel “stringers” to connect the supports and support the edge of the tiles
**Floor System Cost and Specifications**

✦ Costs can range from $125 to $275 per square meter

✦ Installation is generally included

✦ Installation will cost more on weekends - this may be necessary for a renovation project

✦ Floor loads are expressed as the load on a 25mm square
  ➤ Low end equipment at around 3kN or ≈ 300kg
  ➤ Top of the range ratings are ≈ 6kN or 600kg

✦ Remember that the “real” floor also needs to support this mass

✦ A properly designed raised floor will distribute the load to the “real” floor
Other Floor Considerations

- Removing the old floor for a renovation job
- In a new building - consider having all of the floor raised
- Have the contractor cut holes in a number of the tiles
- Get extra tiles for future modification requirements
- If the room is designed for expansion - make sure the floor takes this into consideration
- UPS battery cabinets and data storage safes are heavy
Air Conditioning - General Issues

• Machine room air conditioning is special
  ➤ Lower temperatures than offices (20°C)
  ➤ 24x7 operation
  ➤ Cooling in mid-winter - not quite as unusual any more
  ➤ Potential problems with humidity

• Property services groups often do not appreciate these issues

• Consultants may miss the issues also, depending on their focus
Refrigeration Type Air Conditioning

A - Hot air to Outside
B - Fan to help improve heat transfer from coils to outside.
C - Fan for more efficient transfer of cool air to inside.
D - Expansion Valve
E - Compressor
F - Cool Air to Inside

Diagram of Refrigerant Type Air-Conditioner
Chilled Water Air Conditioning

Diagram of a chilled water air conditioning system that operates from heat input
Diagram of a chilled water air conditioning system
Air Conditioning - Chillers

Refrigeration systems are not the only option

✦ Chilled water

✦ Large system on roof or in mechanical room

✦ Generally uses a “cooling tower”
  ➢ Can be a source of Legionella
  ➢ High maintenance

✦ Water in the vicinity of the machine room is a risk

✦ But can be used to achieve lower temperatures
Air Conditioning - Chillers continued

- Depending on property management strategy may not run 24x7
- Potentially a single point of failure
- Will probably still need humidity control
- Can have the wet part in the next room
  - Use ducting to carry cold air to where it is needed
  - Both output and return ducts may be required
  - Suitable drains to protect the machine room
Air Conditioning - Conclusions

- Make sure that property services and consultants understand requirements
- At a room temperature of 20°C the CPU temperature may approach 50°C
- This will only get worse as the speed of systems increase
- Relying on a single system may be too much of a risk
- If using several smaller systems the controls should allow integrated operation
Air Conditioning - Humidity

✦ Low Humidity is not an obvious issue
  ➢ Static electricity
  ➢ Air conditioner icing problems
  ➢ 50% is about right

✦ High humidity is no good either
  ➢ Moisture and electrical circuits
  ➢ Corrosion
  ➢ Non-condensing

✦ Why low humidity can contribute to icing

✦ PHB and the evaporative cooler
Security

✦ If an attacker gains physical access to machines - game over
✦ But remember that backup tapes are potentially an equal risk
✦ Access control is required
   ➤ Keyed lock
   ➤ Digital keypad locking system
   ➤ Swipe card system - centrally controlled
✦ Central control can mean that they think that they control who has access
Security

✦ Swipe cards can control both who and when
✦ Who needs to be on the access list?
✦ When do they need access?
✦ Political hot potato - management support of policy is required
  ➤ CEO and managers do not really need access
  ➤ Better to escort them and be able to explain features
  ➤ Tradespeople
  ➤ Contract cleaners
✦ Maybe it’s just paranoia, but a cleaner seems to have an ideal opportunity for espionage
Security

- Escort anyone who is not an administrator
  - Unintentional damage
  - Power disturbances
  - Moving delicate equipment
  - Dust and dirt
Security

- Video recording system
  - A record of what happened
  - May be important if there are access issues
  - Possibly vital in a shared room
Tape Storage

- Off site storage is best
- But some on site storage improves speed of restore
- Fire-resistant safe
- These are seriously heavy
- Consider making duplicates to send off site
Fire Suppression

✦ Sprinkler systems - Help!
✦ Dry chemical fire extinguishers - Oh No!
✦ Ordinary $CO_2$ fire extinguishers - still a problem
✦ Specialised systems are required
  ➤ Halon was great - but an environmental disaster
  ➤ Bulk $CO_2$ is an option
  ➤ Inergen seems like a good idea since it allows breathing
  ➤ Automatic system
Rack Systems

The argument in favour of generic racks

✦ Generic racks can be adapted to a variety of equipment
✦ Can provide a consistent and integrated appearance
✦ Can be customised to meet local needs
  ➤ Adding a communications conduit on the side opposite the power
  ➤ Three-phase power for large systems
  ➤ Two single phase supplies for redundant power supplies
✦ Can be cheaper than proprietary racks of equal quality
Proprietary Racks

- May be a problem to mount “Brand x” equipment
- May provide specialised features for the particular equipment
- Built-in UPS systems
- A “Beige Wall” of a particular brand equipment may look impressive
- But this may lock you into equipment from the supplier
Communications Cabling

- Under floor
- On walls
- Suspended from the roof
Under Floor

✦ Out of sight
✦ Power is usually there also
✦ Electrical induction can be an issue
✦ Induction not an issue with fibre
✦ Disciplined approach to installing and removing cables
Roof or Walls

✧ In clear view
✧ Usually away from the power circuits
✧ In cable trays - clear covers? - easily removable
✧ Could look messy - even if it is a lot neater than an under floor
Who Owns the Communications

✦ Central group
  ➢ Problem with the control
  ➢ May need large risers into the room and a local patch panel
  ➢ Having a requirement that the central group does all comms is often inefficient

✦ Locally administered
  ➢ Communications hub in a corner of the room is easy to manage
  ➢ Main routers and backbone switching
  ➢ Interconnections for the systems in the room

✦ Whatever you do - remember spare ports for growth
Other issues

✦ Mains panel with space for more circuit breakers
  ➤ Saves or eliminates downtime when adding powerpoints
  ➤ Upgrading the panel in future is expensive
  ➤ Price difference upfront is minimal

✦ Monitoring systems
  ➤ Temperature
  ➤ Humidity
  ➤ Power supply
  ➤ Critical systems
Finding Suppliers

✦ Organisation may have preferred contractors
✦ The World Wide Web - many companies publish a lot of information
✦ The Yellow Pages
✦ SAGE-AU Mailing list
  ➢ Off the record
  ➢ Good and bad stories
  ➢ Still your decision
Project Management and Co-Ordination

✦ Keeping it all on track
✦ Define the critical path
✦ Check with the contractors to make sure they can meet their targets
✦ Build a bit of slack into the timetable
✦ Possibly work backwards from the target time
Renovation Project Considerations

✦ Keeping critical systems online
✦ Protecting systems from the works
✦ Liaison with the contractors
  ➤ Get them what they need
  ➤ Make sure they meet the requirements
✦ Is temporary power or air conditioning an option?
✦ The inevitable spanner in the works
Machine Room Projects

Good Luck!
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