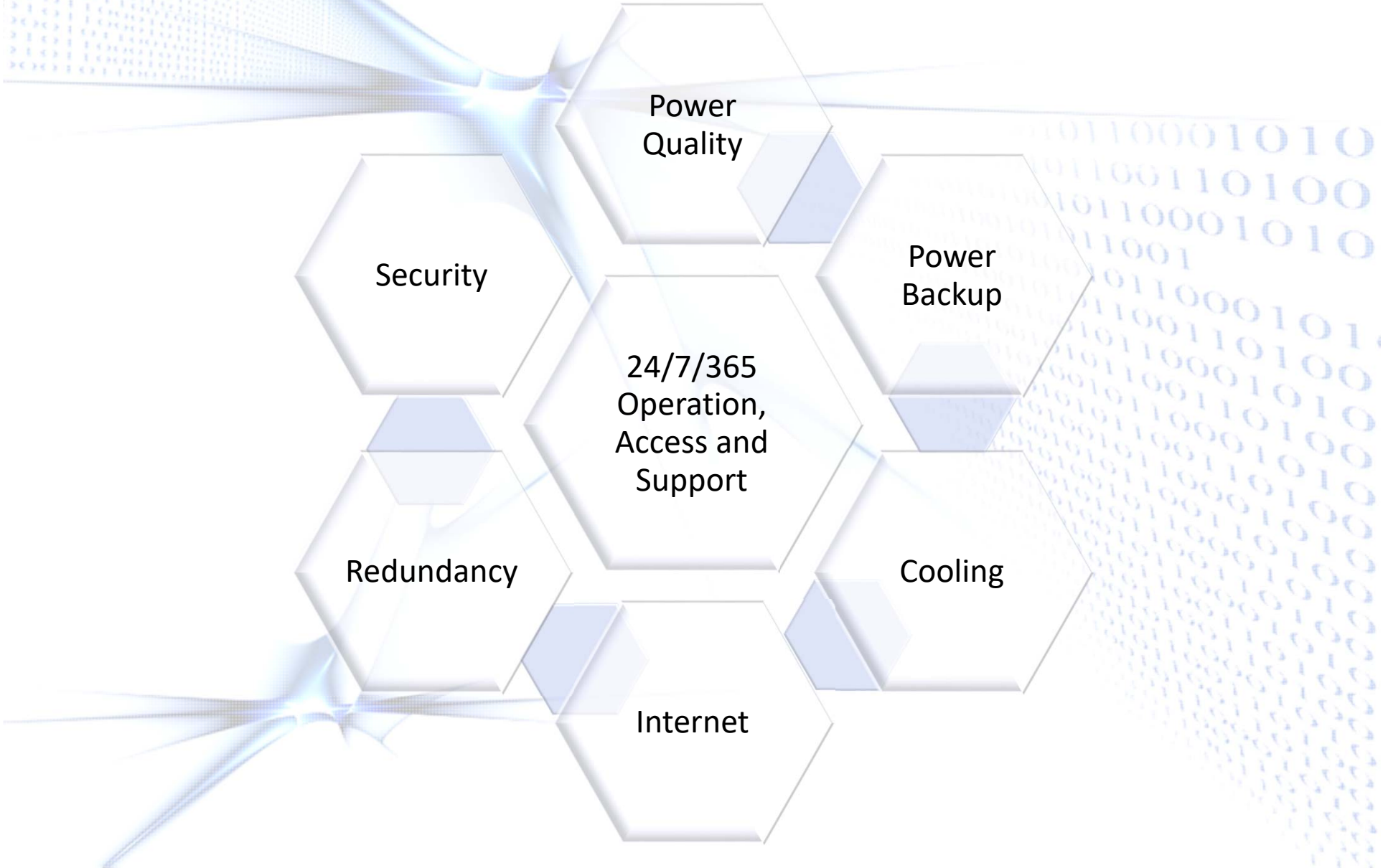
Data Centre Facility Design : Standard & Guideline

Session 1

- Importance of Data Centre
- Cause and Cost of Down-Time
- Topology Standards and Certification
- Tier-I / Rated-1 : Basic Component
- Tier-II / Rated-2 : Redundant Components
- Tier-III / Rated-3 : Concurrently Maintainable
- Tier-IV / Rated-4 : Fault Tolerant
- Environment Class Rating
- Engine Generator Rating
- Hybrid Topology : Best Practice and Definition

Critical Components of Data Centre



Revolution Towards Industry 4.0

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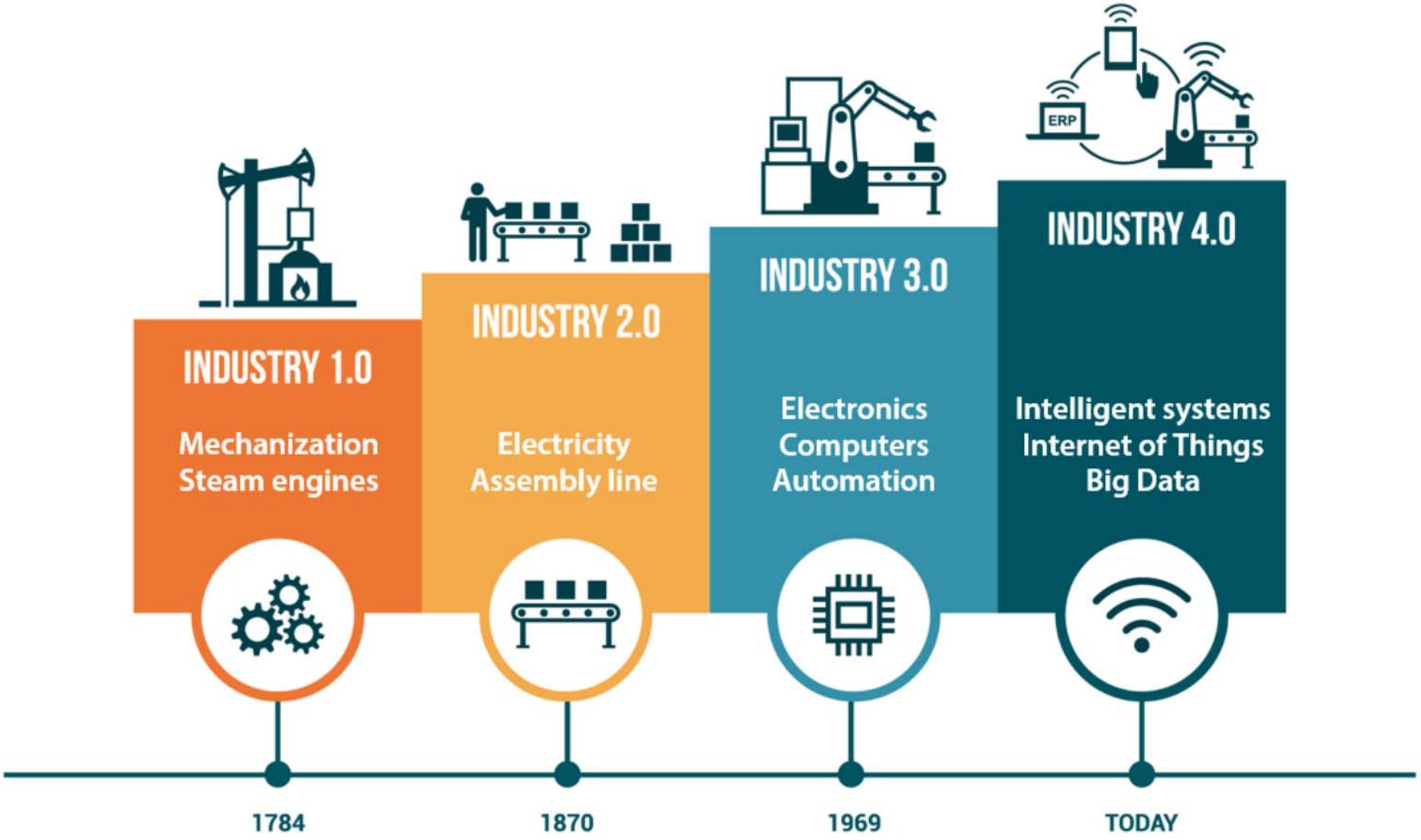
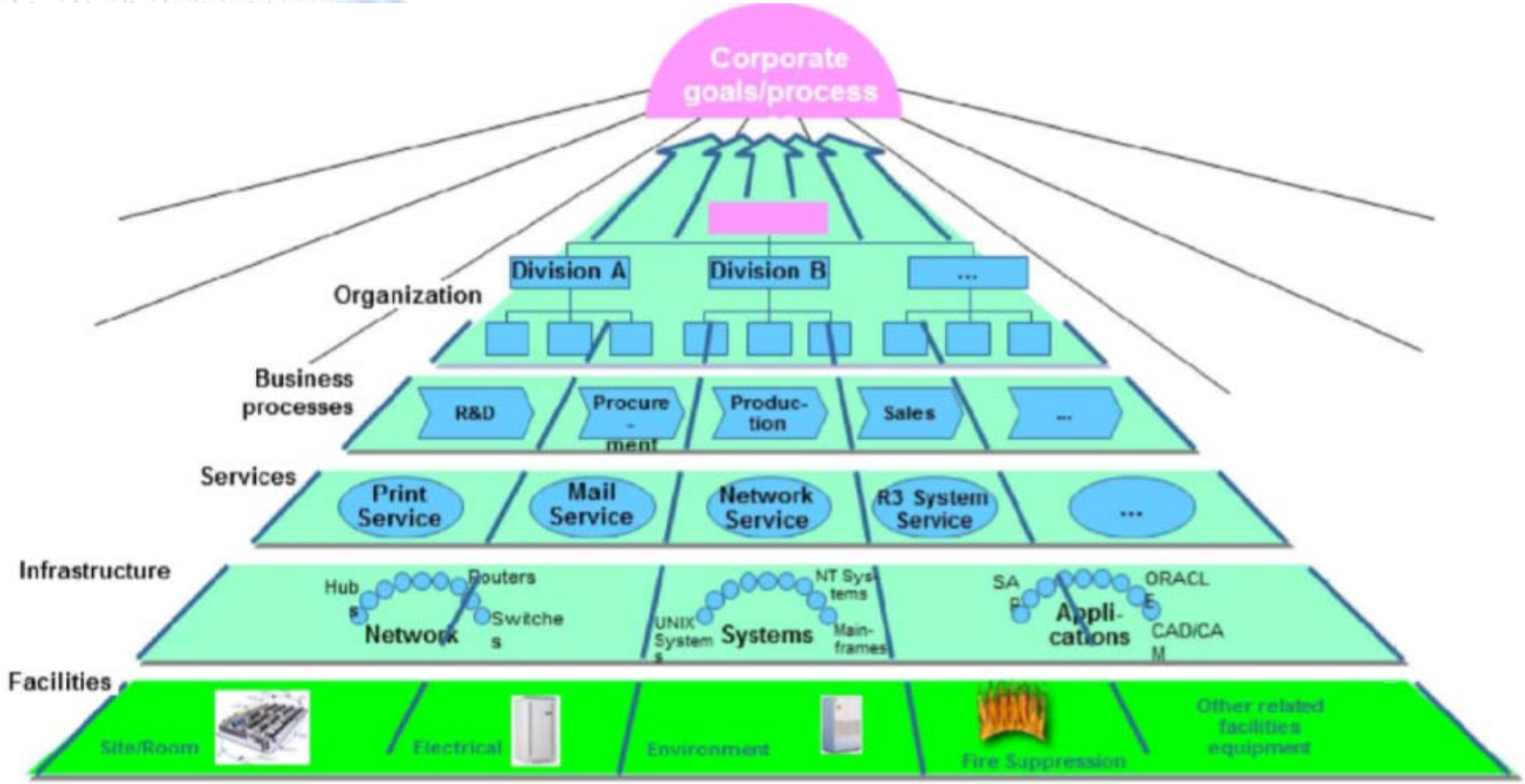
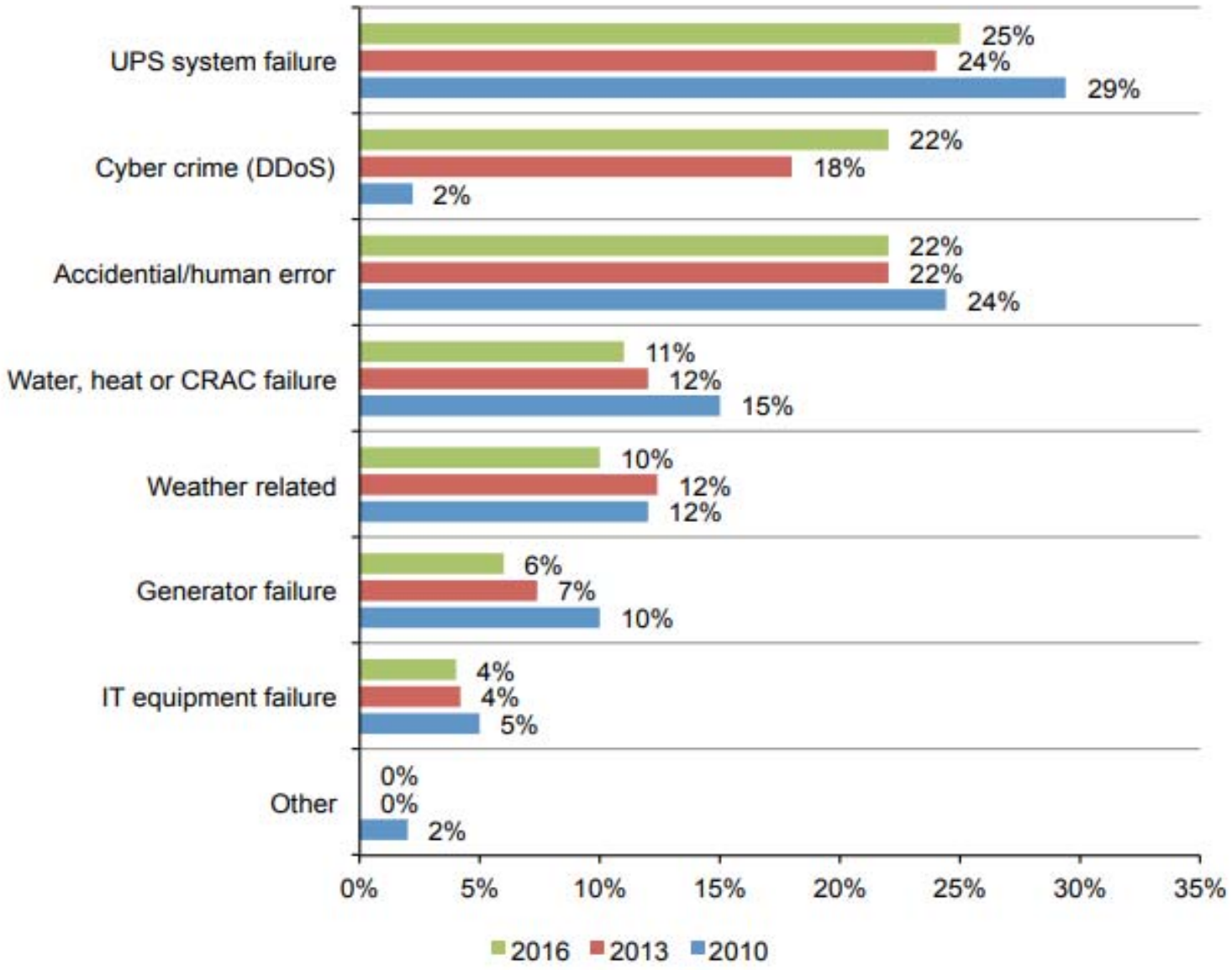


Data Centre in a Business Process

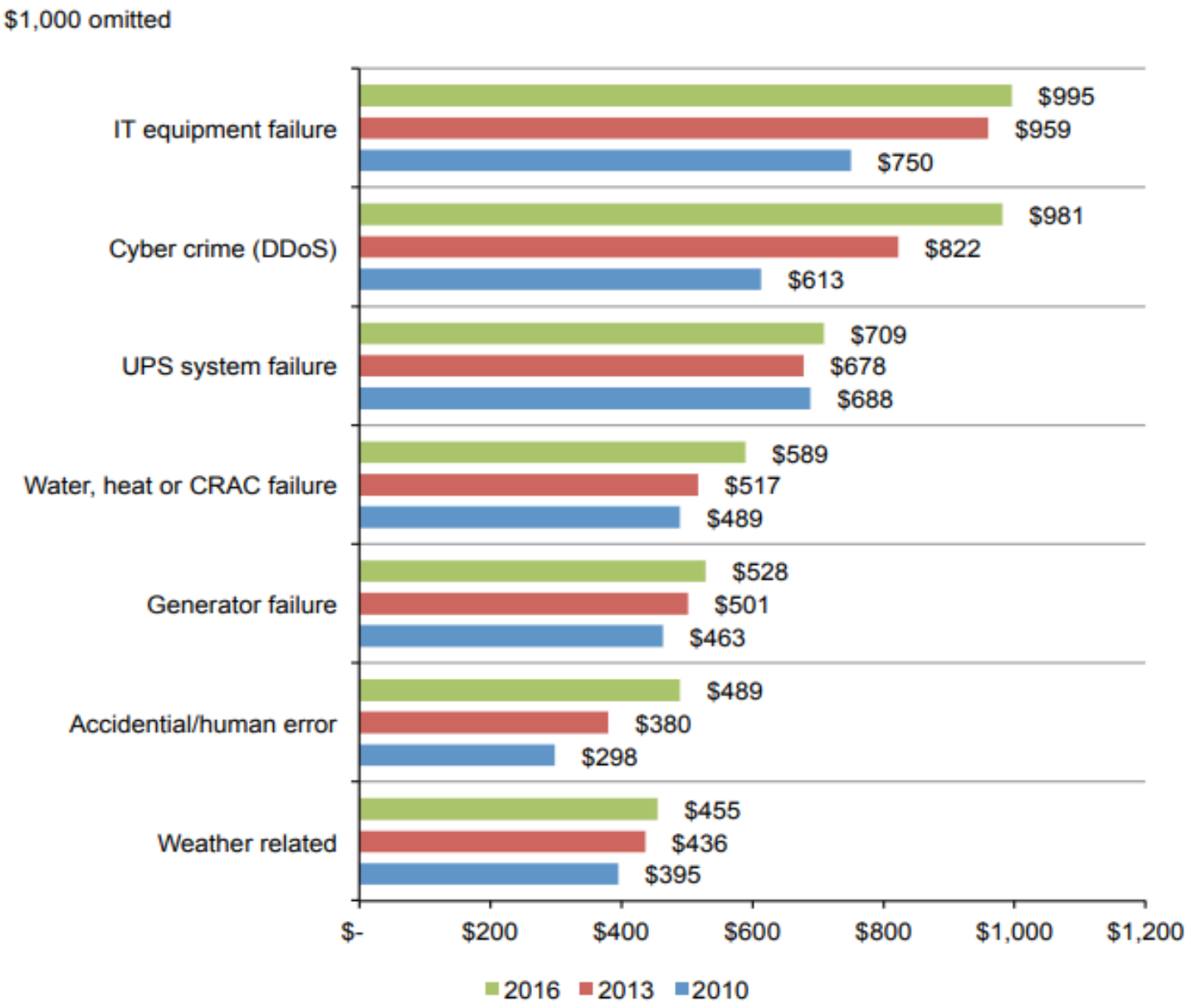


- Having high-performance ICT (Information and Communication Technology) resources on hand is essential for business processes to achieve corporate goals.

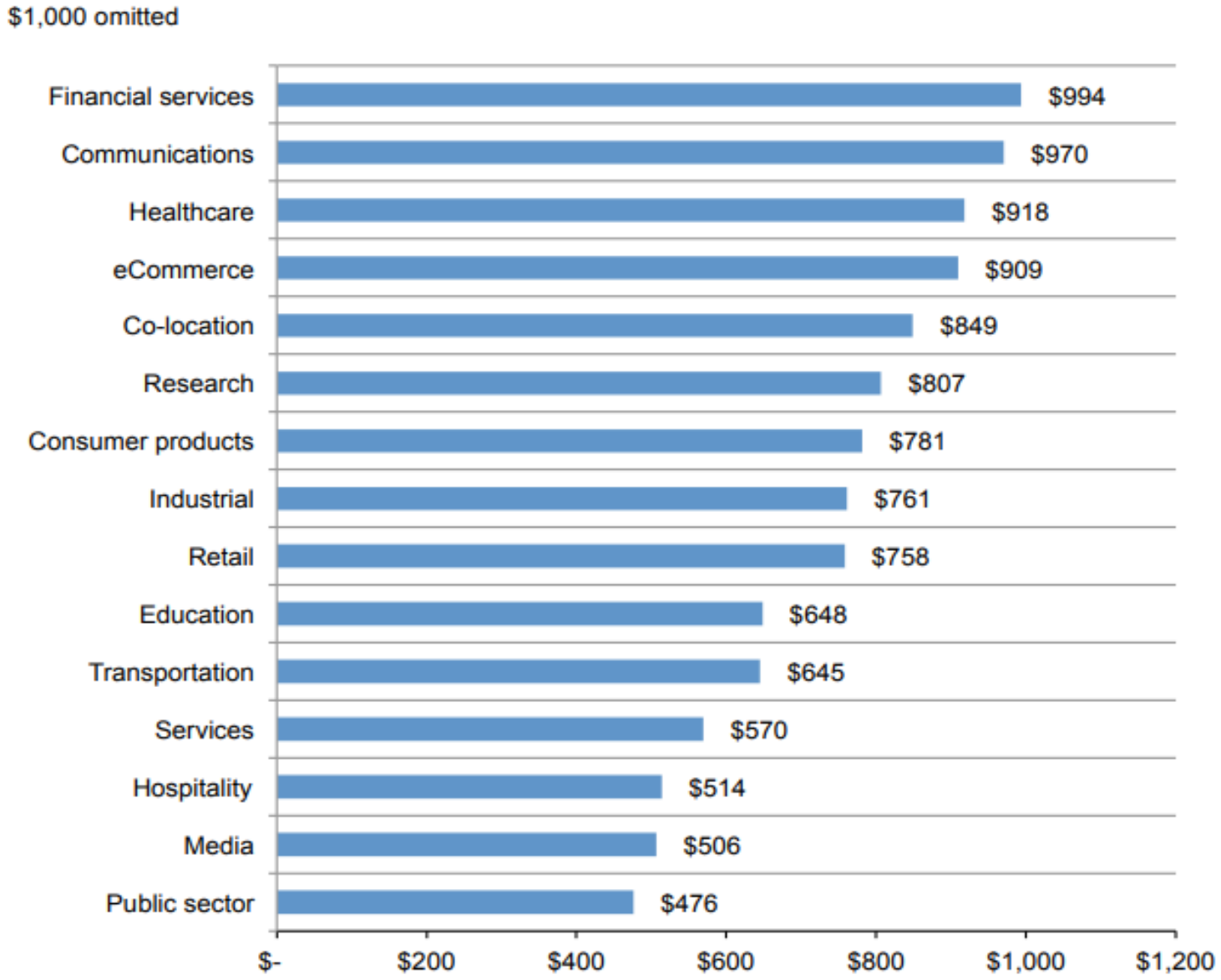
Root Cause of Down Time



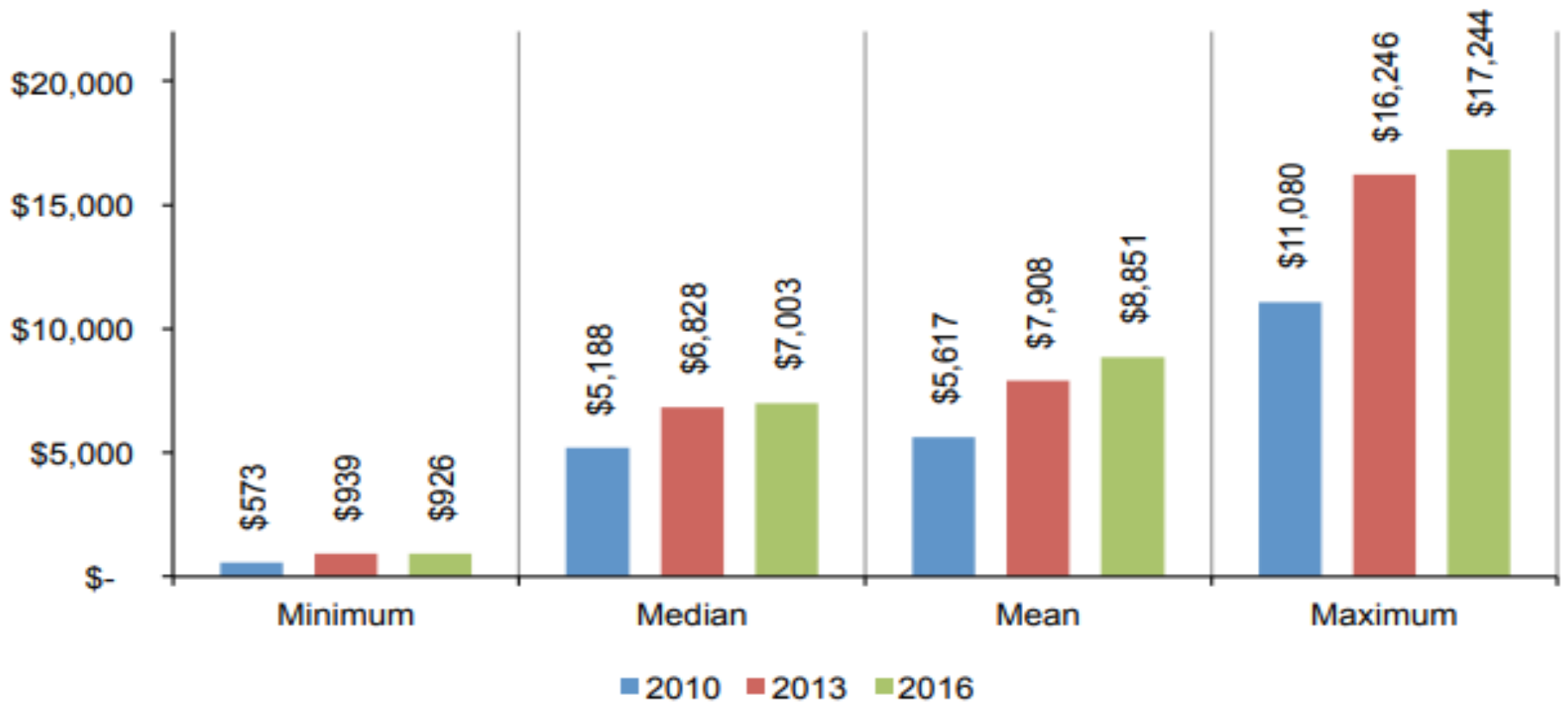
Cost of Down Time : Source of Failure



Cost of Down Time : Industry Segment



Cost per Minute of Down Time



2016 Global Down Time Highlights

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COMPANY/ DATACENTER(S)	DATE (S)	AFFECTED AREAS/ EXTENT	CAUSE	COST?
DELTA AIRLINES	8-Aug	All operational systems in NA.	Power surge, power/transfer switching failure; IT systems corrupted. Some servers didn't have dual power chords?	1800 flights cancelled. Quarterly earnings expected down 10%.
SW AIRLINES	20-Jul	All operational systems in NA. 12 hour outage, cancellations for several days.	Malfunctioning router triggered multiple problems (IT level).	"10s of millions of dollars"; 2,300 flights cancelled.
TELECITY LD8 (EQUINIX)	19-Jul	Some Linx traffic. BT broadand.	UPS failure	Not known/undisclosed
TELEHOUSE	21-Jul	UK and beyond. BT broadband/ email services in UK. 7-10 hours.	"Tripped circuit breaker".	Not known/undisclosed
FCA @ FUJITSU SUNNYVALE CA	Sep 24-27	System for managing 50,000 FCAs.	Transformer failure?	50K financial institutions unable to access. Strategically embarrassing.
ING BUCHAREST	10-Sep	Banking systems	Noise from fire suppression systems damages dozens of disk drives.	Systems down for 10 hours. Many storage systems and servers replaced.
SSP AT SOLIHULL DATACENTER.	Aug 26 – Sep 24 (?)	All core systems.	Power outage at Solihull triggered SAN problems. Second SAN failure followed. Attempting emergency migration to Tier 3.	40% of UK insurance brokers unable to access renewals data.
GLOBAL SWITCH 2, LONDON	10-Sep	Many customers affected, notably Claranet.	222ms high voltage drop/ circuit breaker/DRUPS caused 222ms break, triggering shutdowns. Claimed Tier 3 standards…	Not known/undisclosed
GLOBAL SWITCH 2, LONDON	6-Jun	Many customers affected.	Lightning strike led to several hours outage for some customers.	Not known/undisclosed

Complexity of DC even without ICT

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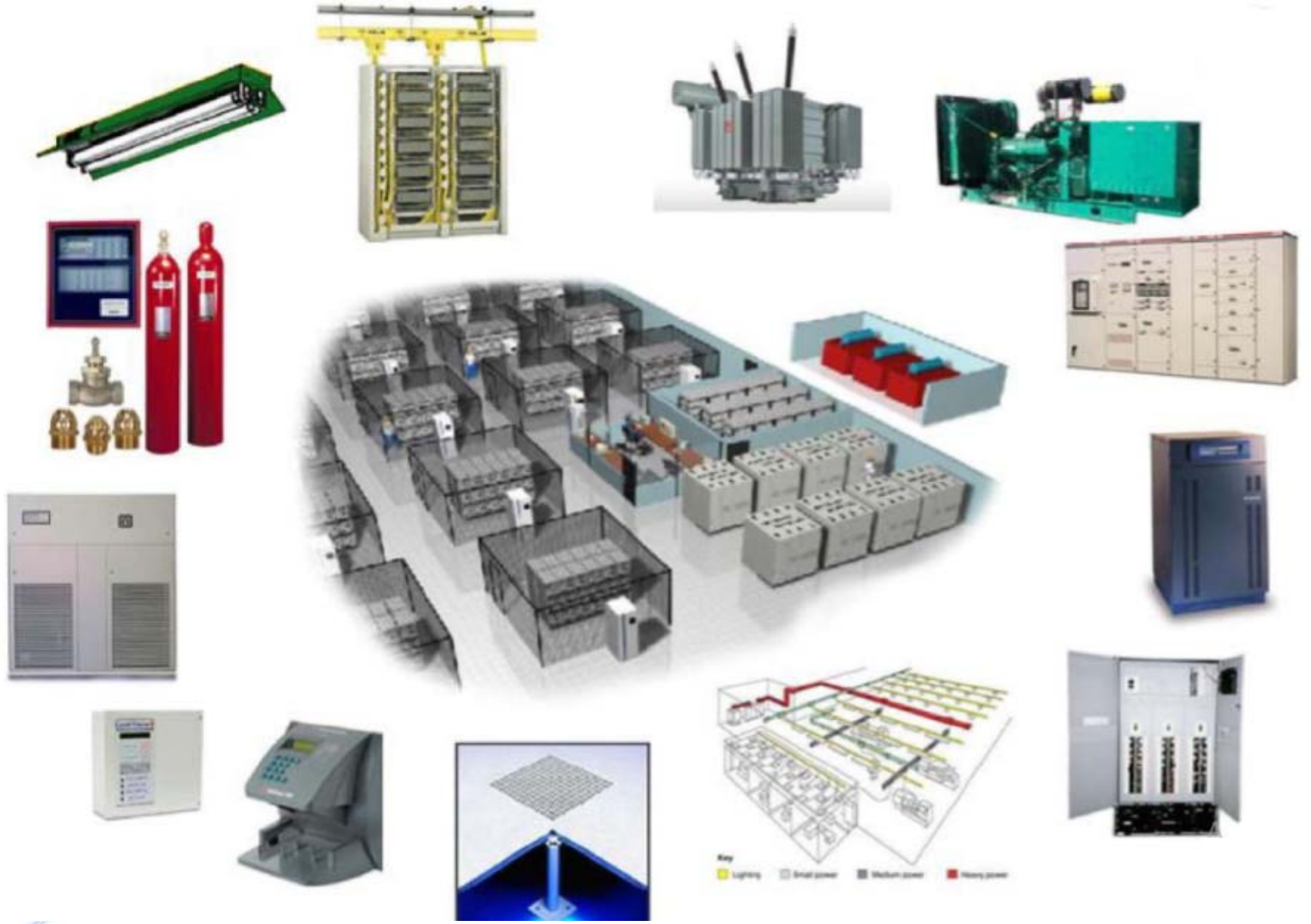
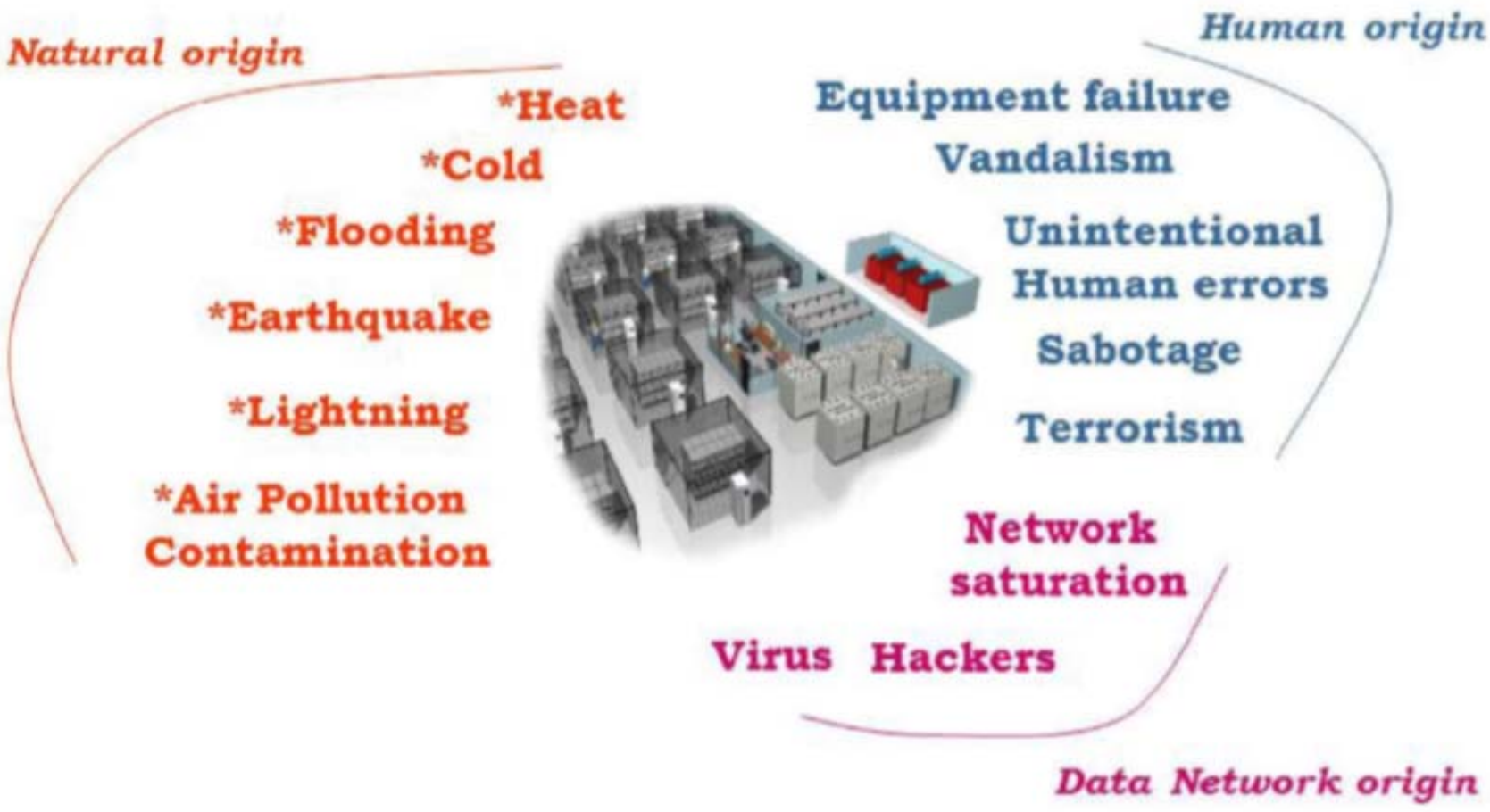


Risk Factors for Data Centre



*Unexpected Catastrophic events, normally impossible to predict.

Prominent Cause of Downtime/Failure

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- Human Error
  - No or poorly executed processes and work instructions
  - Unauthorized access
  - Accidents
  - Unnoticed Alarms
- Power Quality issues
  - Poor voltage/current/frequency regulation
  - High level of Common and Normal mode noise
  - High ground resistance
  - Harmonics
- Electro Magnetic Fields (EMF)
  - High radiation levels from power cables / UPS / Transformers / PDU / Lighting etc.
- Environmental Conditions
  - Temperature / Humidity
  - Wrong cooling principles
  - High levels of contamination

Standards and Certification

Standard → ↓ Guideline	UpTime [USA]	EPI based on TIA-942 [USA]	BICSI based on TIA-942 [USA]	SS-507 [Singapore]	EN-50600 [Europe]
Conformity	Tier : I - IV	Rated : 1 - 4	Class : 0 - 4	Pass / Fail	Class : 1 - 4
Availability of Standard	Yes	Yes (Paid)	Yes	Yes	Yes
Certification	Available	Available	Not Available	Available	Available
Scope of Topology	Tier Standard Electrical Mechanical Distribution OS Standard Other Element	Electrical Mechanical Distribution Architectural Telecom Site Location Safety-Security Efficiency	Electrical Mechanical Distribution Architectural Telecom Site Location Safety-Security	Electrical Mechanical Distribution Architectural Telecom Site Location Safety-Security	Electrical Mechanical Distribution Architectural Telecom Site Location Safety-Security Efficiency
Incorporation	Commercial	Non-Profit	Non-Profit	Non-Profit	Non-Profit
Accreditation	No	ANSI	ANSI	Spring	EN-CENELEC
Training Event	Yes	Yes	Yes	No	No
Auditor	UpTime Only	Multiple ORG	N/A	Multiple ORG	N/A

Topology Standard : Definition

Rated-1; Basic
Single path for power and cooling distribution, no redundant components.

Rated-2; Redundant components
Single path for power and cooling distribution, redundant components.

Rated-3; Concurrent Maintainable
Multiple power and cooling distribution paths, but only one path active, redundant components, concurrently maintainable, compartmentalized.

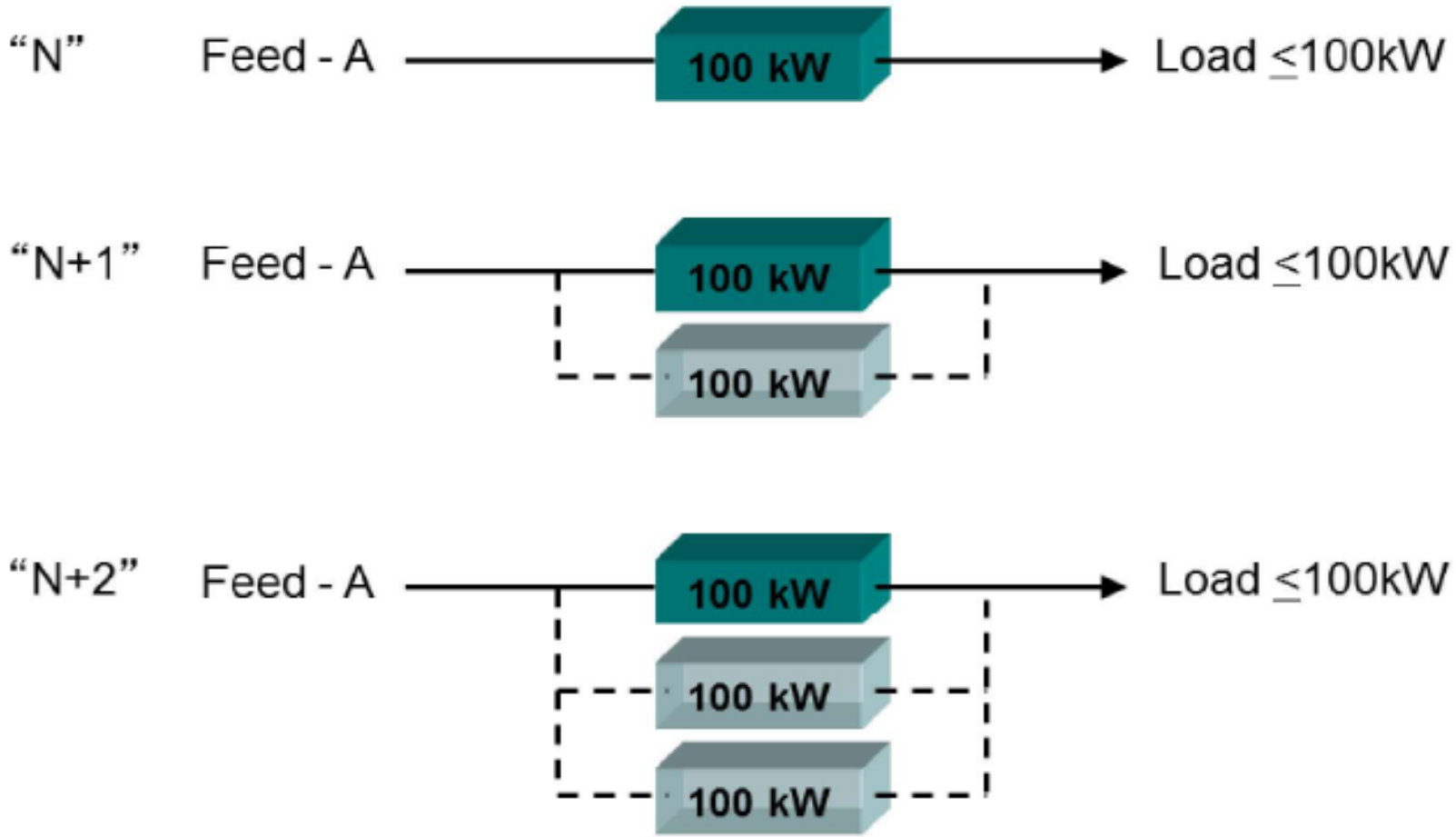
Rated-4; Fault Tolerant
Multiple active power and cooling distribution paths, redundant components, fault tolerant, concurrently maintainable, compartmentalized.

Tier Topology : Basic, RC, CM

Redundancy	Definition
N	System which meets the base requirements (**N**eed) and has no redundancy.
N+1	Redundancy provides one additional unit, module, path, or system in addition to the minimum required to satisfy the base requirement. The failure or maintenance of any single unit, module, or path will not disrupt operations.
N+2	Redundancy provides two additional units, modules paths, or systems in addition to the minimum requirement to satisfy the base requirement. The failure or maintenance of any two single units, modules or paths with not disrupt operations.

Topology Standard : N, N+1, N+2

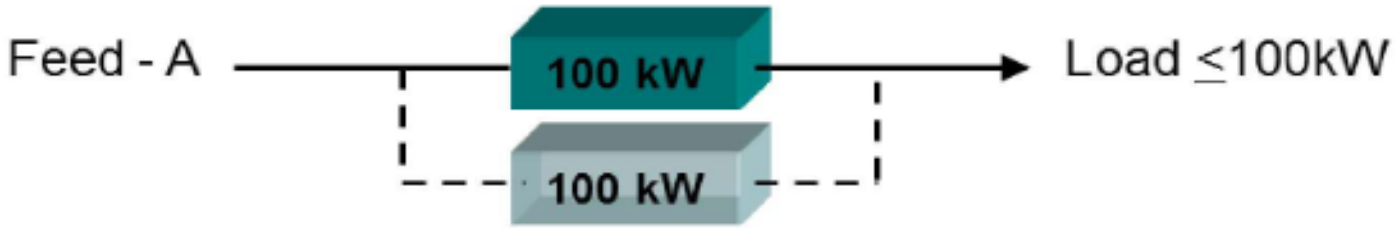
'N' Component redundancy levels



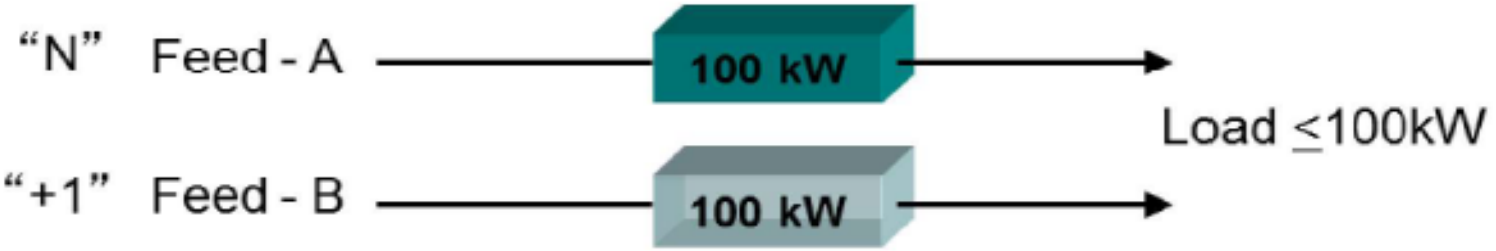
Topology Deployment : N+1

N+1 Implementations

- N+1 could mean component redundancy



- N+1 could mean path redundancy



Redundancy : Component vs Path

N+1 Implementations

- N+1 as path implementation leads to higher availability than N+1 at the component level
  - Multiple paths to ICT equipment have less Single Points of Failures (SPoF)
  - Multiple paths allow potential maintenance and faults anywhere in one path without disturbing the other path and therefore the ICT load
  - N+1 at component level still has SPoF at various levels as the distribution path remains single

Tier Topology : Fault Tolerant

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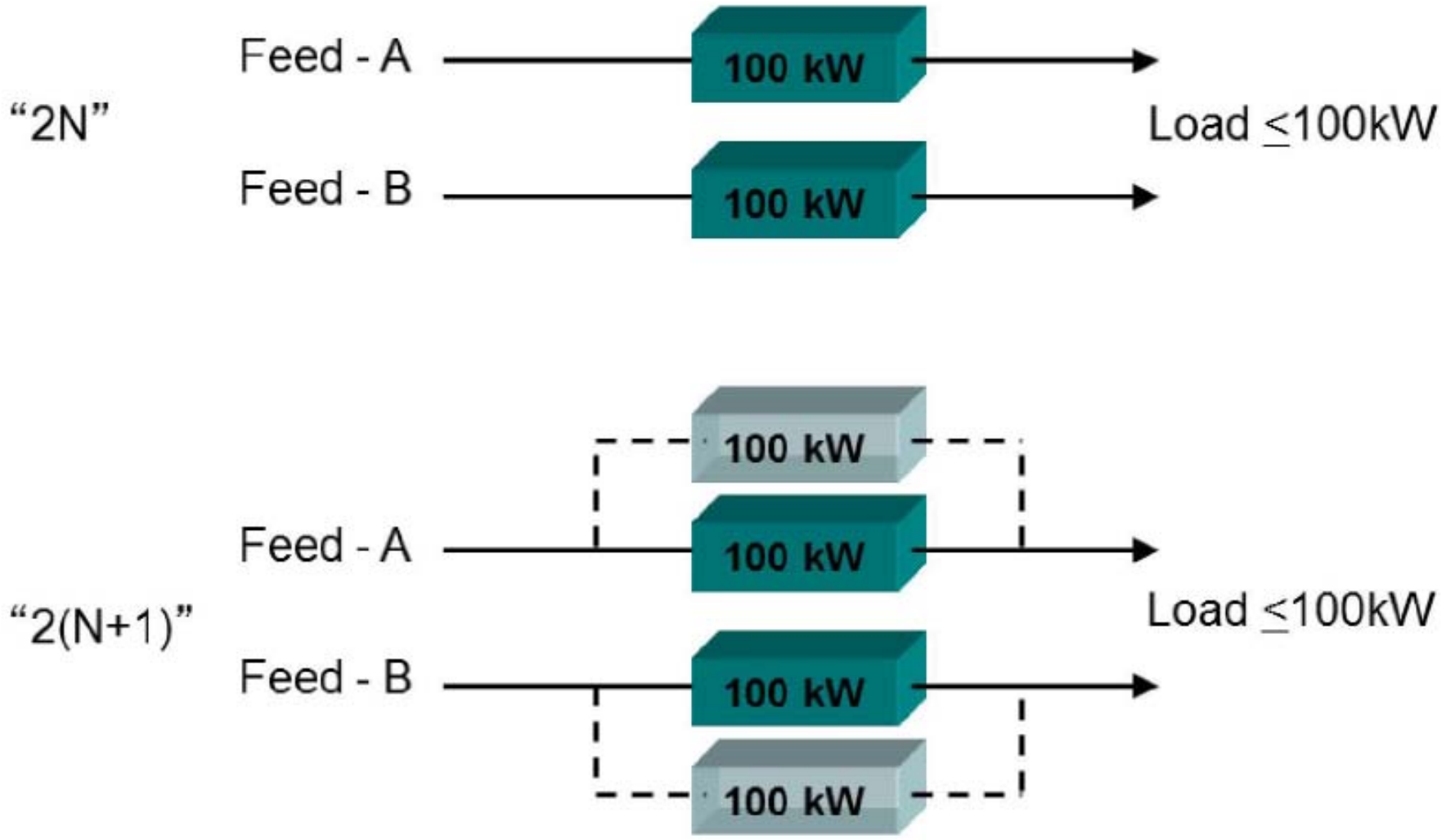
Redundancy	Definition
2N	Redundancy provides two complete units, modules, paths, or systems for every one required for a base system. "Failure or maintenance of one entire unit, module, path, or system will not disrupt operations.
2(N+1)	Redundancy provides two complete units, modules, paths, or systems each with "+1" additional capacity. Even in the event of failure or maintenance of one unit, module, path, or system, some redundancy will be provided and operations will not be disrupted.
2(N+2)	Redundancy provides two complete units, modules, paths, or systems each with "+2" additional capacity. Even in the event of failure or maintenance of one unit, module, path, or system, and one of the backup modules then still operations will not be disrupted.

Topology Deployment : Fault Tolerant

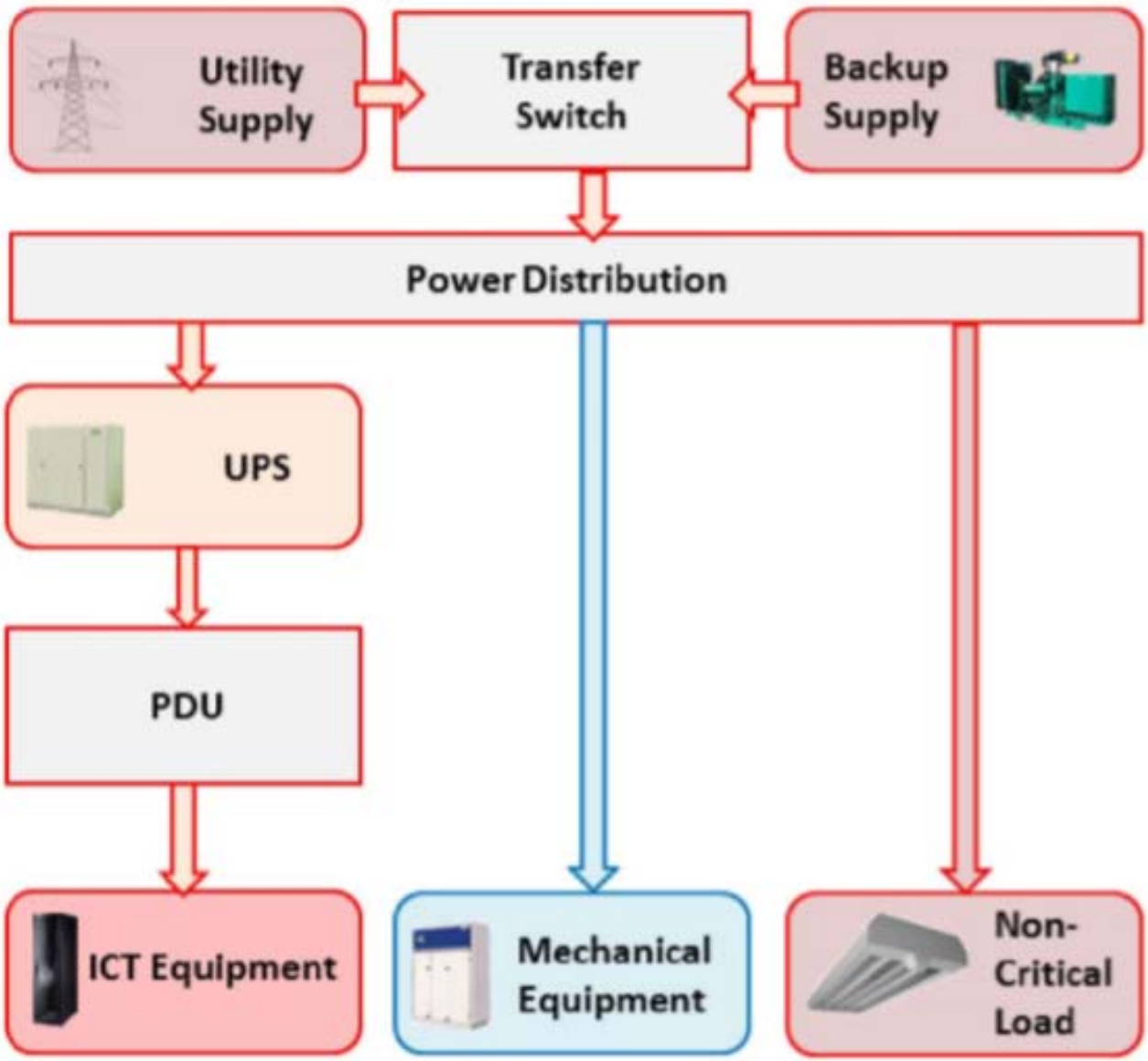


Topology Standard : UpTime and EPI

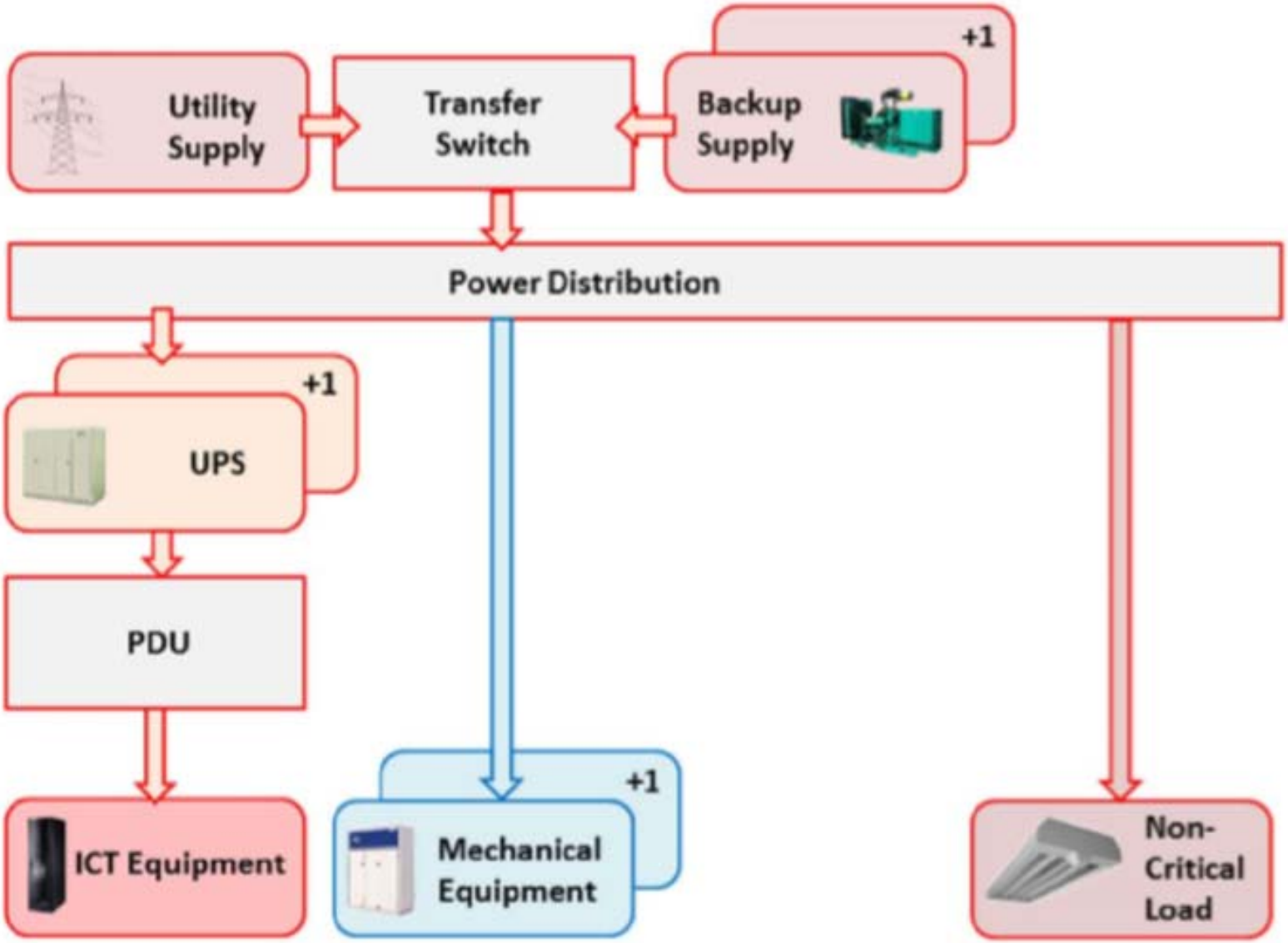
	Tier I	Tier II	Tier III	Tier IV
Active Capacity Components to Support the IT Load	N	N + 1	N + 1	N After Any Failure
Distribution Paths	1	1	1 Active and 1 Alternate	2 Simultaneously Active
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	No	Yes
Continuous Cooling	No	No	No	Yes

	Rated 1	Rated 2	Rated 3	Rated 4
Active Capacity Components to Support the IT Load	N	N + 1	N + 1	N + N
Distribution Paths	1	1	1 Active and 1 Alternate	2 Simultaneously Active
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	Yes	Yes
Continuous Cooling	No	No	No	No

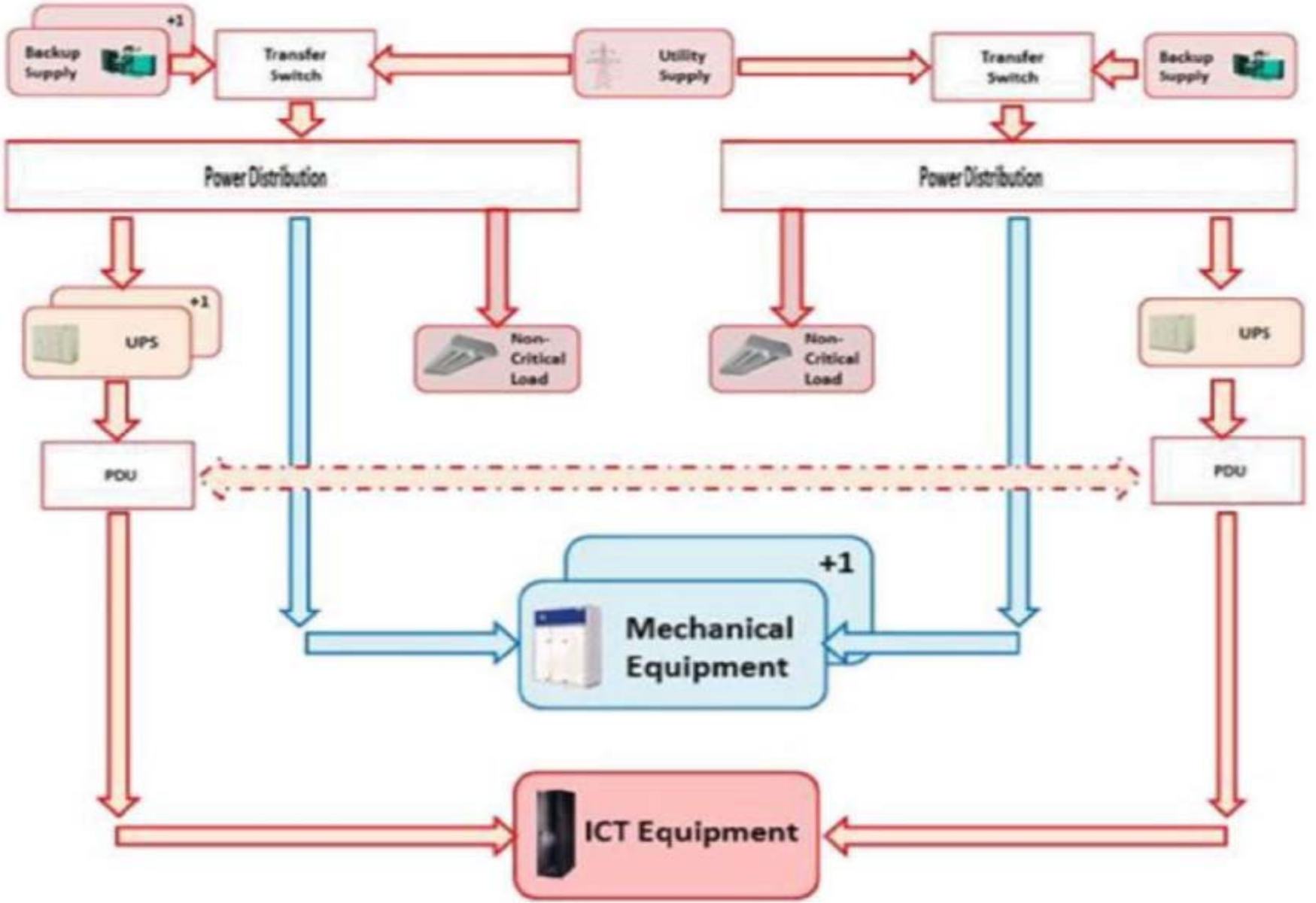
Simplest SLD : Basic Component



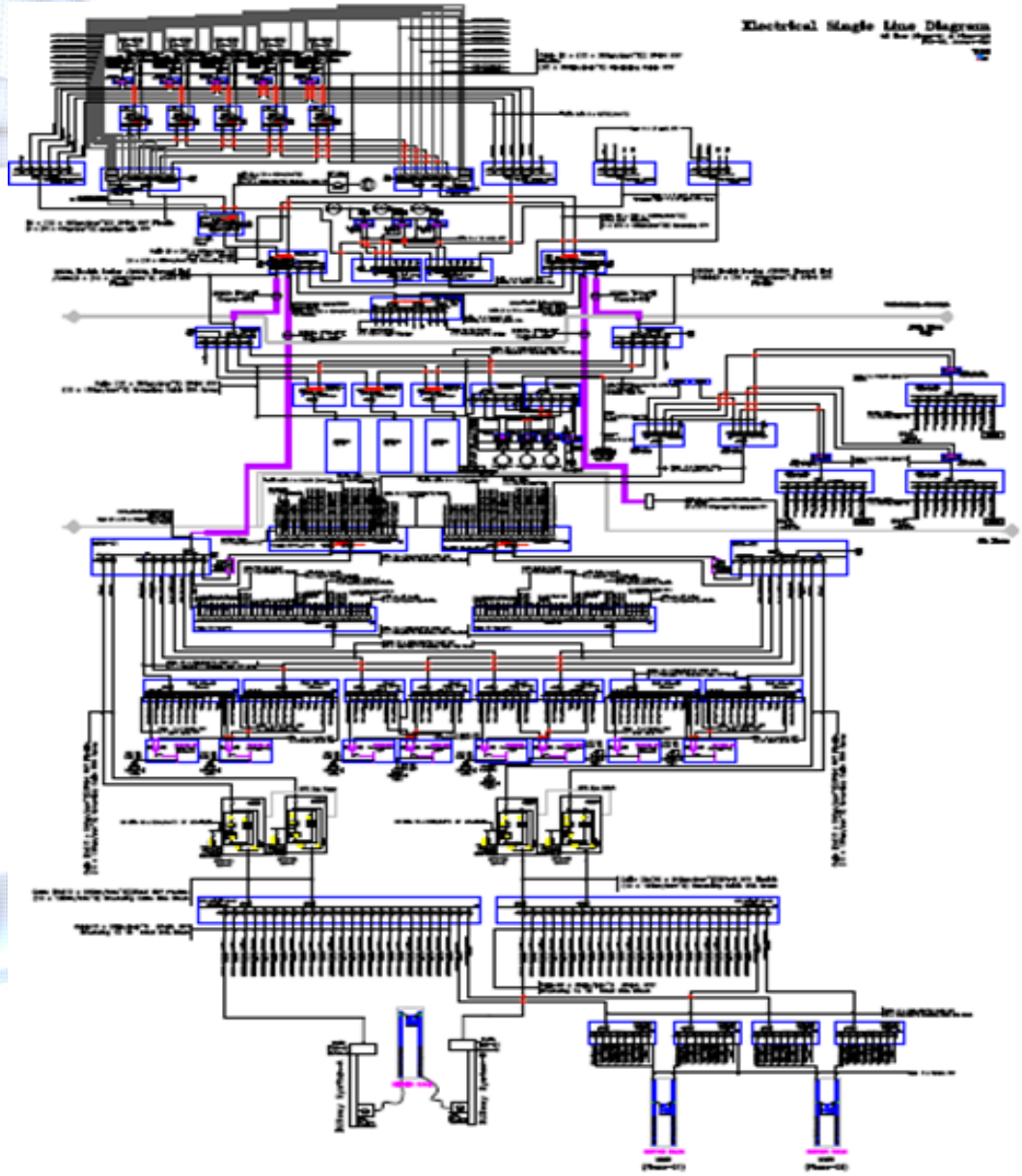
Simplest SLD : Redundant Component



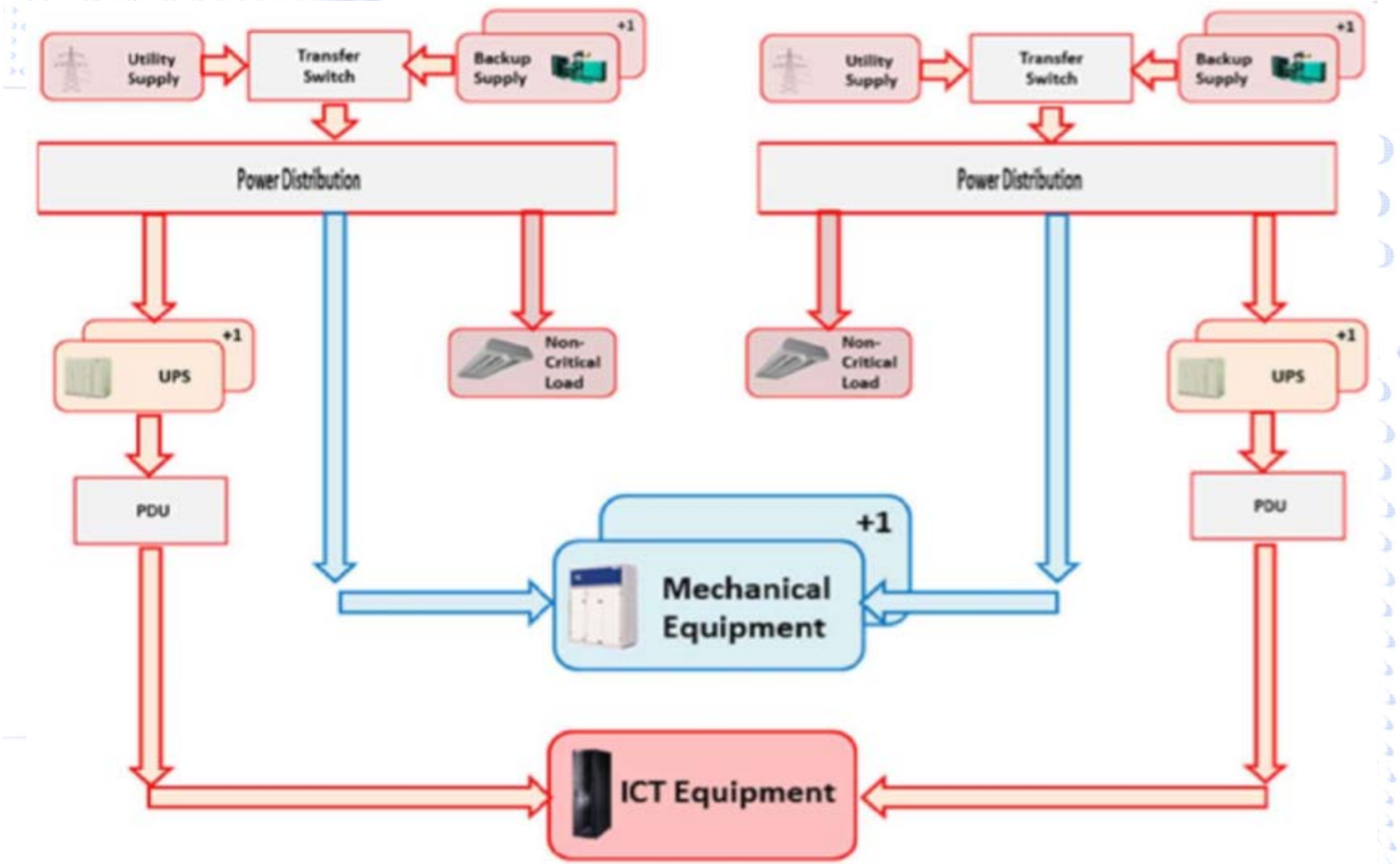
Simplest SLD : Concurrently Maintainable



Real Life SLD : Tier-III Compliant



Simplest SLD : Fault Tolerant



ASHRAE, 2011 : Environment Class

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2011	2008	Applications	ICT Equipment	Environmental Control
A1	1	Data Centre	Enterprise Servers /Storage	Tightly Controlled
A2	2		Volume Servers, Storage products, personal computers, workstations	Some Control
A3	n/a		Volume Servers, Storage products, personal computers, workstations	Some Control
A4	n/a		Volume Servers, Storage products, personal computers, workstations	Some Control
B	3	Office, Home, Transportable environment	Personal Computers, Laptops, printers	Minimal Control
C	4	Point of Sale, Factory etc.	Point Of Sale Equipment, Ruggedized Controllers, computers, PDA's etc.	No Control

ASHRAE, 2011 : Data Centre

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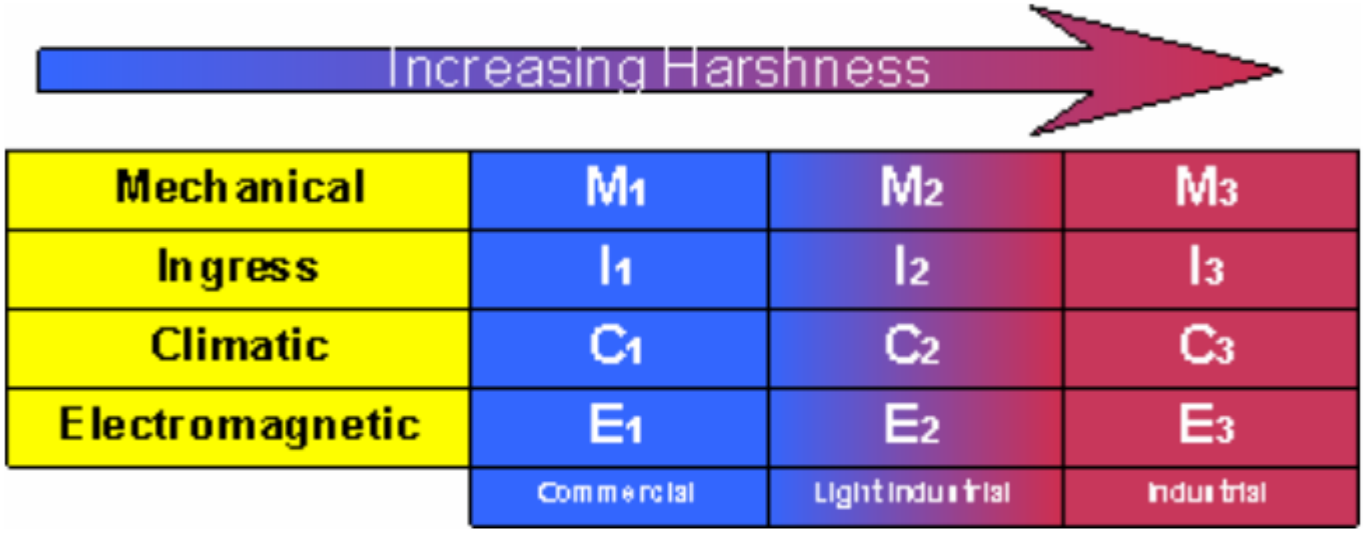
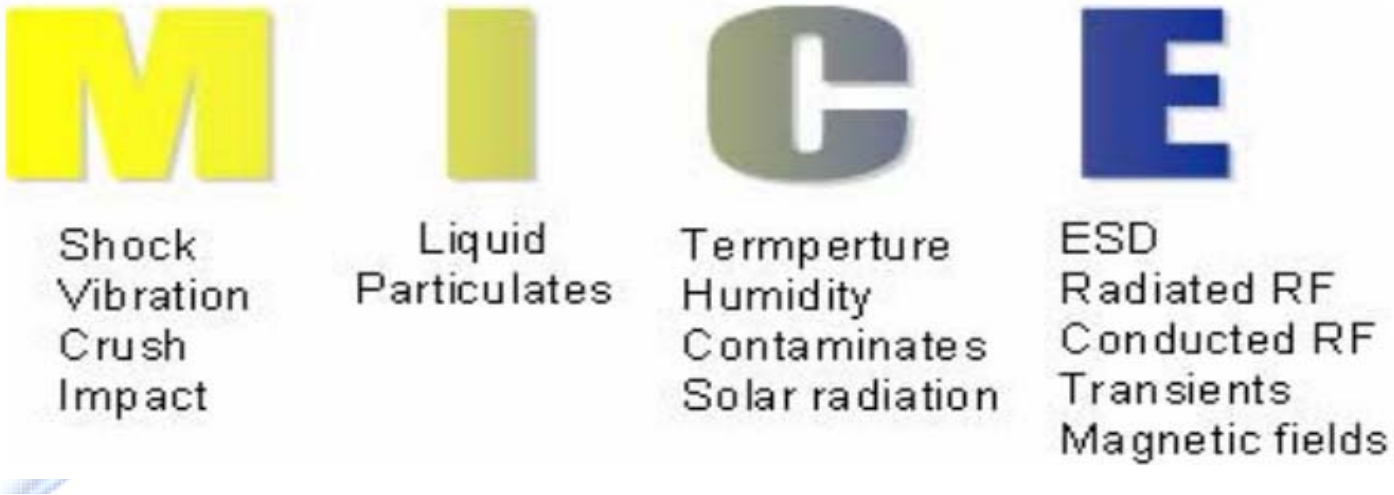
2011	Dry Bulb Temperature	Humidity	Dew Point	Max Elevation
	Recommended			
A1-A4	18 – 27 °C / 64.4 – 80.6 °F	5.5 °C DP to 60% RH and 15 °C DP		
	Allowable			
A1	15 – 32 °C / 59 - 89.6 °F	20 – 80% RH	17 °C	3050
A2	10 – 35 °C / 10 – 95 °F	20 – 80% RH	21 °C	3050
A3	5 – 40 °C / 41 - 104 °F	-12C DP and 8 - 85% RH	24 °C	3050
A4	5 – 45 °C / 41 - 113 °F	-12C DP and 8 - 90% RH	24 °C	3050

Environmental Class Rating





UpTime does not talk about Environmental Class Rating

Engine Generator Rating

Engine Generator Requirements	Tier I	Tier II	Tier III	Tier IV
Rating to Support design load	Any; up to nameplate rating to support design load	Any; up to nameplate rating to support design load	Capable of supporting design load for unlimited hours at site conditions	Capable of supporting design load for unlimited hours at site conditions
Continuous	No additional requirement for hours of operation limitations		Full nameplate capacity	
Prime			Option 1: 70% of nameplate capacity Option 2: Larger capacity than Option 1 with manufacturer letter	
Standby			Can be used for Tier III and Tier IV with manufacturer letter; Tier Certification capacity dependent on manufacturer letter	
Derating for Site Conditions	Additional derating may be required due to site conditions (ambient temperatures, elevation)—consult manufacturer requirements			

EPI requires Engine Generator to be Prime with Nameplate Capacity

Hybrid Topology : Best Practice

	Level 1	Level 2	Level 3	Level 4
Active Capacity Components to Support the IT Load	N	N + 1	N + 1	N + N
Distribution Paths	1	1	2 (Both Active)	2 (Both Active)
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	Yes	Yes
Continuous Cooling	No	No	No [Average < 5 KW] Yes [Average > 5 KW]	Yes
Site Selection	EPI	EPI	EPI	EPI
Civil / Structural	EPI	EPI	EPI	EPI
Architectural	EPI	EPI	EPI	EPI
MMR and Structured Cabling	EPI, IBP	EPI, IBP	EPI, IBP	EPI, IBP
Safety, Security, Fire Code	AHJ, EPI	AHJ, EPI	AHJ, EPI	AHJ, EPI
Efficiency [PUE, WUE, CUE, DCIE]	TGG	TGG	TGG	TGG

Hybrid Topology : Definition [Level 3]

Compliance Standard	Validation and Audit
Rated-3 and Tier-III Facility	‘Concurrent Maintainability’ is the philosophy behind the Rated-3 and Tier-III conformity. It requires to ensure that every capacity component as well as their distribution path can be removed / replaced / serviced on a planned basis without disrupting the ICT capabilities to the end-user. It applies to all active and passive components of MEP infrastructure. However, Architecture-Civil, Fire Suppression and Safety-Security provisions are out of this scope. Manual fail-over switching of electrical-power is allowed. Furthermore, it requires that each distribution path for power, cooling, ICT to be physically separated. Specifically transformer, generator, UPS, battery, chiller plant, carrier room / meet-me room and rack-space should remain 1 (one) hour fire-separated from each other. Additionally, no sharing of PDU, fire suppression and cooling is allowed as well.

Hybrid Topology : Definition [Level 4]

Compliance Standard	Validation and Audit
Rated-4 and Tier-IV Design	‘Fault Tolerant’ is the philosophy behind the Rated-4 and Tier-IV conformity. It requires to ensure that every capacity component in either of their distribution path can run on the full-load operation of the facility. Hence, capacity component as well as distribution path can tolerate a fault anywhere in the system while the facility is having planned down-time / maintenance without disrupting ICT capabilities to end-user. It applies to all active and passive components of MEP infrastructure. However, Architecture-Civil, Fire Suppression and Safety-Security provisions are out of this scope. Software tools for remote operation is required. Furthermore, it requires that each distribution path for power, cooling, ICT to be physically separated. Specifically transformer, generator, UPS, battery, chiller plant, carrier room / meet-me room and rack-space should remain 2 (two) hour fire-separated from each other. Additionally, no sharing of PDU, fire suppression and cooling is allowed along with manual fail-over switching of electrical-power.

Objective of Certification

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Criticality	Business characteristics	Effect on system design
1 (Lowest)	• Typically small businesses • Mostly cash-based • Limited online presence • Low dependence on IT • Perceive downtime as a tolerable inconvenience	• Numerous single points of failure in all aspects of design • No generator if UPS has 8 minutes of backup time • Extremely vulnerable to inclement weather conditions • Generally unable to sustain more than a 10 minute power outage
2	• Some amount of online revenue generation • Multiple servers • Phone system vital to business • Dependent on email • Some tolerance to scheduled downtime	• Some redundancy in power and cooling systems • Generator backup • Able to sustain 24 hour power outage • Minimal thought to site selection • Vapor barrier • Formal data room separate from other areas
3	• World-wide presence • Majority of revenue from online business • VoIP phone system • High dependence on IT • High cost of downtime • Highly recognized brand	• Two utility paths (active and passive) • Redundant power and cooling systems • Redundant service providers • Able to sustain 72-hour power outage • Careful site selection planning • One-hour fire rating • Allows for concurrent maintenance
4 (Highest)	• Multi-million dollar business • Majority of revenues from electronic transactions • Business model entirely dependent on IT • Extremely high cost of downtime	• Two independent utility paths • 2N power and cooling systems • Able to sustain 96 hour power outage • Stringent site selection criteria • Minimum two-hour fire rating • High level of physical security • 24/7 onsite maintenance staff

Session 2

- Hybrid Topology : Design Requirement
- Technology Selection : Cooling and UPS
- Raised Floor, Floor Loading and SRG
- Cable and Pipe Distribution
- Seismic Isolation for Rack and Facility
- Data Centre Efficiency : The Green Grid
- Safety, Security, Monitoring in Data Centre
- Technology Selection : Option & Thumb Rule
- Quiz : Topology and Design Misconception
- Question, Answer, Feedback, Advice

Hybrid Topology : Requirement

#	Site Selection Requirement
1	Ground Floor should be high-enough to sustain any flash flood based on 50 (fifty) years of flood history
2	Distance from Air-Port should be 8 Km / 5 miles
3	Distance from Rail-Station should be 0.8 Km / 0.5 miles
4	Within 3,050 m / 10,000 feet from the sea-level
5	Capability to Handle Seismic Activity based on 'Zone' Requirement
6	Away from Chemical Plant, Power Generation Plant and Establishment which could be categorized as 'Potential Target of Attack'

#	Metallurgical, Structural, Civil and Architectural Requirement
1	No use of Asbestos, Lead and Poly-Chlorinated Biphenyl
2	Permanent Shelter with Class-A roof (fully adhered roof)
3	Separate Parking for Employees and Visitors with Zoning
4	IBC-2006 (+ updates), NFAP-2001 (+ updates) to be followed along with Code of AHJ
5	Legal Hierarchy of Compliance : Law / Code of AHJ, DC Standards, International Standards

Hybrid Topology : Requirement

#	Metallurgical, Structural, Civil and Architectural Requirement
6	Rated-3 requires IIA / IIIA / VA and Rated-4 requires IA / IB level of construction
7	Vapour Barrier with plastic-sheet or latex-paint
8	Roof Slope for Rated-3 is 1:48 and for Rated-4 is 1:24
9	Floor Loading for Rated-3 and Rated-4 is 12 KN/m^2
10	Suspended Ceiling is not recommended
11	All the MEP and ICT equipment should be based on 'Seismic Zone' Requirement
12	No Exterior Windows in Data Hall / Computer Room
13	Access Control, Surveillance System and Fire Suppression System shall not be shared in case of the fire-separated zone / room
14	Monitoring should be continuous (recording should be activity based) along with minimum of 20 fps. Hence, PTZ camera is not acceptable
15	Dual-Factor authentication based Access Control
16	Single-Person Double Door Interlock based Man-Trap at the Entrance of Data Centre
17	Bullet Proof (Level-3 of UL-752) Window at the Reception / Guard Room (1st Entrance)
18	Doors should swing-away while getting out of any room (if Local Fire Code allows it)

Hybrid Topology : Requirement

#	Metallurgical, Structural, Civil and Architectural Requirement
19	Rated-3 requires 24/7 presence of security guards and Rated-4 requires 24/7 presence of both armed and security guards with walk-in escort and inspection patrol
20	Emergency Exit Sign, Exit Path Direction, etc. requires minimum 1 Lux light at all time. Unoccupied Rack-Space requires light to keep Surveillance System running smooth. Occupied Rack-Space requires 200 Lux (measured at 1m above the ground and 1m away from the rack) at the sides of the racks and 500 Lux at the front and back of the racks. However, use of night-vision camera and motion sensor will allow to go completely dark rack-space (Emergency Exit Sign, Exit Path Direction shall remain switched on at all time)
21	Reception / Entry-Lobby, UPS, Battery and Gen-Set rooms should have 2 (two) hour fire-separation for Rated-3 and 4 (four) hour fire-separation in case of Rated-4 facilities. For the rest of the walls, floors and ceilings of the fire separated zone / room it should be respectively 1 (one) and 2 (two) hours
22	Exclusive ramp / bay for Loading-Unloading and Shipping-Receiving should be followed by Warehouse and Staging area
23	Two entry-road and loading-bay along with One (sole) reception and exit-road for vehicle and human movement
24	Access Path and Exit Corridor Philosophy ‘What Come In Should Be Able to Go Out Again’

Hybrid Topology : Requirement

#	Mechanical, Electrical, Plumbing (MEP) Requirement
1	Rated-4 requires a Remote Operations Centre, Remote Switching of Light and PA system
2	DCIM (WLDS, EMS, BMS and Automatic Power Fail-Over Switch) or, IDC-IMS (DCIM and NMS) shall be used to mitigate the risk for Rated-4 Facility
3	EMF should be isolated / filtered and it should be measured from Rack PDU level
4	UPS and Battery rooms should have maintenance-aisle of minimum 1.2 meter
5	Rack to Rack distance both in hot and cold aisle should be minimum of 1.2 meter
6	DRUPS, Generator, Chiller, Cooling Tower, Valve, Fire Pump, Diesel Pump and Chilled Water Pumps should have maintenance-aisle of more than the width of equipment
7	Battery room need to be separated from UPS room, Switchgear room and Generator Plant. It's also needs to have sufficient natural-air ventilation and Shatter-Proof glass window in the door
8	Rated-3 allows the Generator / DRUPS to be placed in the Data Hall building with compliance of fire separation. Whereas, Rated-4 requires the Generator / DRUPS to be in separate building / weather proof enclosure with compliance of fire-separation
9	Diesel Reservoir and Water Reservoir need to carry at least 12 (twelve) hours of full-load operation along with redundancy in storage tank, pump and plumbing.

Hybrid Topology : Requirement

#	Mechanical, Electrical, Plumbing (MEP) Requirement
10	Generator / DRUPS Rooms and Diesel Reservoirs should be 9 m / 30 feet away from public area in case of Rated-3 and the distance should be 19 m / 60 feet in case of Rated-4
11	Data Halls should not have any external window, internals are allowed if they meet the fire-ratings and security
12	Rated-3 requires everyone to face 3 (three) access control till the Rack and Rated-4 requires 4 (four). However, recommendation is to have 1 (one) extra stage for both cases
13	Minimum 46 cm / 18 inch vertical clearance under fire suppression nozzles till 1st obstacle
14	Underground Up-Stream Utility Power Feeder is preferred over Overhead (optional)
15	Rated-3 requires Single Sub-Station (with Dedicated Distribution Feed for the Facility from Sub-Station) with N+1 Down-Stream Power Feeder. And, Rated-4 requires Dual Sub-Station (with Dual Dedicated Distribution Feed for the Facility from Sub-Station) with 2N Down-Stream Power Feeder
16	Both up-stream and down-stream power-feeders will remain separated by 20 meter till they are exclusively distributed inside Data Halls
17	Both up-stream and down-stream optical-fibres will remain separated by 20 meter till they are exclusively distributed inside Data Halls

Hybrid Topology : Requirement

#	Mechanical, Electrical, Plumbing (MEP) Requirement
18	UPS should be backed by Prime Generators (at least) not Standby Generators
19	Cogeneration Plant instead of 2nd Utility should use Continuous Generator neither Prime nor Standby
20	HT Switchgear Panel should have Surge Protection Device and Draw-Out Circuit Breakers
21	Generator with Battery Bank and UPS / DRUPS should be of N+1 configuration (where, N = 1 - 9. Hence, +1 redundant-component for every 9 needed-component) for Rated-3. Whereas, it is 2N configuration (N has no limit) for Rated-4. Furthermore, both Rated-3 and Rated-4 requires Dual-Bus system of Distribution
22	Chiller, Cooling Tower, AHU, In-Row AHU, Chilled Water Pump, etc. should be of N+1 configuration (where, N = 1 - 5. Hence, +1 redundant-component for every 5 needed-component) for Rated-3. Whereas, it is 2N configuration (N has no limit) for Rated-4. Furthermore, both Rated-3 and Rated-4 requires Dual Piping system of Distribution
23	Rated-3 and Rated-4 both requires a dedicated feeder in to the Automatic Bypass of the UPS and a dedicated Maintenance Bypass Feeder serving the UPS output PDU
24	If Static UPS (battery-bank) is used Rated-3 requires minimum 10 (ten) minutes and Rated-4 requires minimum 15 (fifteen) minutes of full-load operation

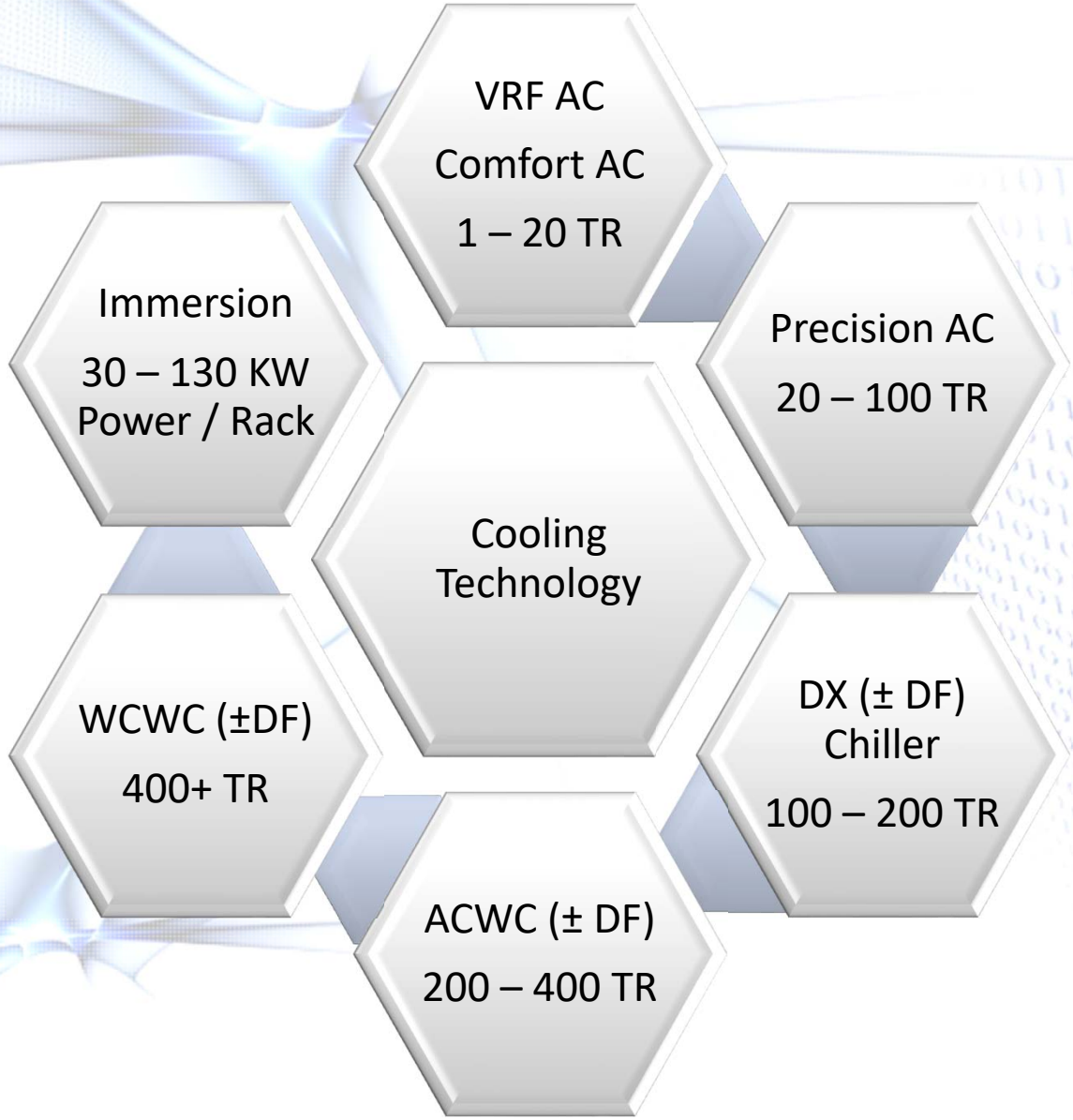
Hybrid Topology : Requirement

#	Mechanical, Electrical, Plumbing (MEP) Requirement
25	If DRUPS (fly-wheel) is used Rated-3 requires minimum 6 (six) seconds and Rated-4 requires minimum 9 (nine) seconds of full-load operation
26	ICT equipment, Safety-Security, Automation Software, Emergency Light and Signs, Chilled Water Pump and AHU should be under the UPS Power Supply. However, ICT and Mechanical Loads are recommended to serve with 2 (two) separate Distribution Network of N+1 configuration for Rated-3 facility. Whereas, Rated-4 requires the same provisioning of 2 (two) separate Distribution Network of 2N configuration
27	Chiller, Office Equipment, Lighting Load, Diesel and Water Pump, etc. should be under the Gen-Set Power Supply with dedicated Distribution Network of N+1 configuration for Rated-3 facility. Whereas, Rated-4 requires the same provisioning of Distribution Network of 2N configuration
28	Power Strips / Metered PDU / Tap-Off Box should also carry K-Rated Isolation Transformer or IGBT Harmonics Filter to eliminate the Common Mode Noise
29	Grounding and Signal Reference Grid as per IEEE Standard
30	HT and LT Panel along with Generator / DRUPS and each level of electrical distribution is recommended to have Surge Protection Device. Whereas, the requirement is to have Surge Protection in the MDB of Low Voltage Side

Hybrid Topology : Requirement

#	Mechanical, Electrical, Plumbing (MEP) Requirement
31	Generator-UPS / DRUPS, SPD, HT and LT Switchgear Panel, Motor Control, Chiller Plant, AHU, ATS, STS, Sensors, etc. are recommended to be monitored by CPM system (which needs to have Multiple Level, Multi-Channel Notification)
32	Rental Provisioning of Load Bank is required (for Testing, Audit and Initial Low-Load Stage)
33	Current Rating : [Phase 1 = Phase 2 = Phase 3 = Ground = 100%] and [Neutral = 200%]
34	Isolation Transformer [K-13 or Higher] and/or IGBT (in PDU) to be used for ICT Equipment
35	Common Mode Noise (CMN) is acceptable up to 1% of Phase to Neutral Voltage. Maximum Acceptable CMN is 3 Volt and Preferred CMN is less than 1 Volt
36	Form Factor of Panel / Distribution Boards are to be of 2B for Rated-3 and 3B for Rated-4
37	Data Hall Design should be designed as MICE-1 ($M_1I_1C_1E_1$)
38	Environmental Design should be designed as $M_1I_2C_1E_3$
39	HVAC System Design should be designed as per ASHRAE, 2011 (including Updates)
40	Fire Suppression Design should be as per NFPA 2001 (including Updates) and Code of AHJ
41	Telecom and Network Design as per TIA Standards
42	Data Halls should have Positive Air Pressure

Technology Selection : Cooling



Technology Selection : UPS

SANOG

DRUPS Diesel Rotary UPS + LT-Panel

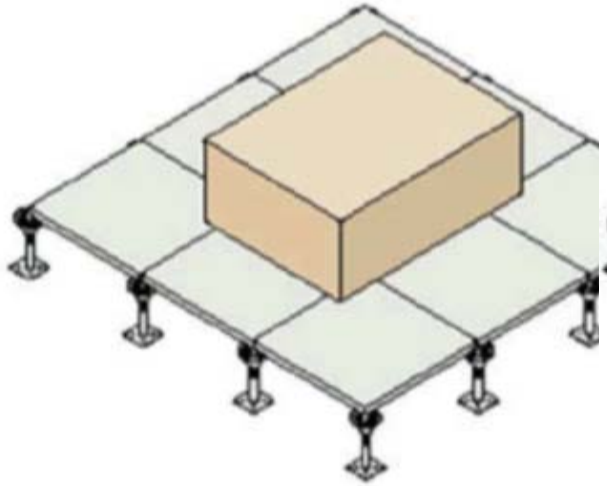
SUPS Static UPS + Battery Bank + Battery Room PAC + PFI + Many Distribution Panel + AVR + Generator + UPS and Gen-Set Synchronizers + Phase Plotter

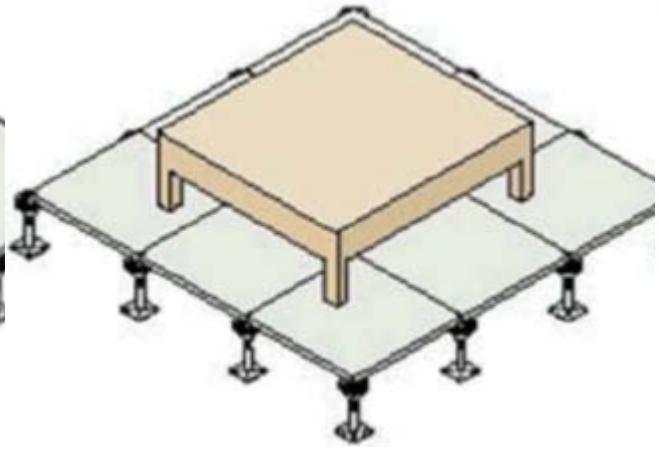
Description	DRUPS [1.5 MW]	SUPS [1.5 MW]
Capital Expenditure [CapEx]	1.0 Million USD	0.75 Million USD
Battery Backup	Not Required	Required (5 min)
Space Consumption	100%	182%
Life Time	25 Years	10 Years
Operational Expenditure [OpEx]	1.84 Million USD	5.46 Million USD
Pay Back [CapEx Difference]	9 Months	0 Months
Power Efficiency [AVR to BBT]	97%	92%
Continuous Cooling	Possible	Not Possible
Power Level	415 Volt | 11 KV | 33 KV	415 Volt
Signature Users	NTT, KDDI, Fujitsu, AWS, Global Switch, GE, Tele House, Google	Equinix, TM, CT, MS, AWS, Tata, Digital Realty, Facebook, Google
Market Share [as Clean & QPS]	18%	82%
Thumb Rule of Usage	Total Power > 3 MW OpEx is 1st Priority Continuous Cooling	Total Power < 3 MW CapEx is 1st Priority Backup Time > 30 s

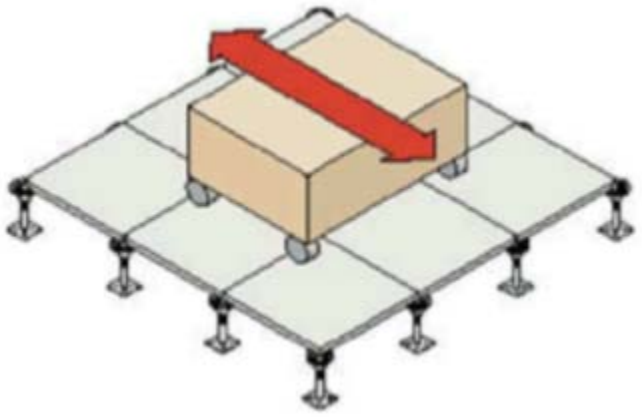
Raised Floor and Floor Loading

Raised Floor Selection

1. Die Formed Welded Steel Construction [Level-1 and Level-2]
2. Die Formed Welded Steel Shell with Cement-Filled Core [Level-3 and Level-4]
3. Galvanized Floor [Beware of Zinc Whiskers | Not Recommended]
4. Wood Filled Core [Beware of Rolling Load, Life | Not Recommended]
5. High Pressure Laminate [Recommended for Rack-Space]
6. Rubber Laminate [Recommended for Ramp, Access Floor, NOC, etc.]



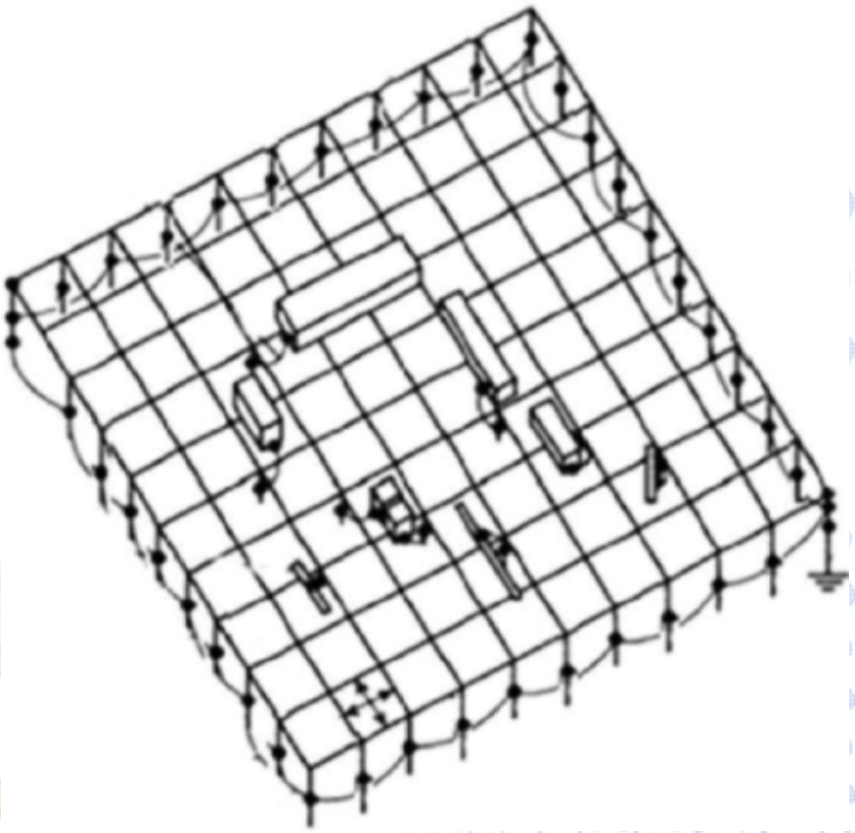




Signal Reference Grid and Ground

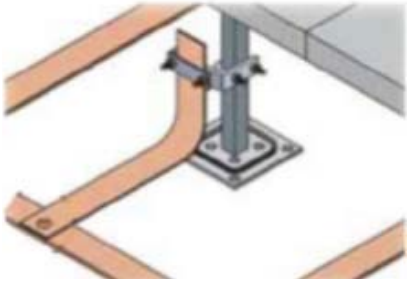
Raised Floor Guidelines

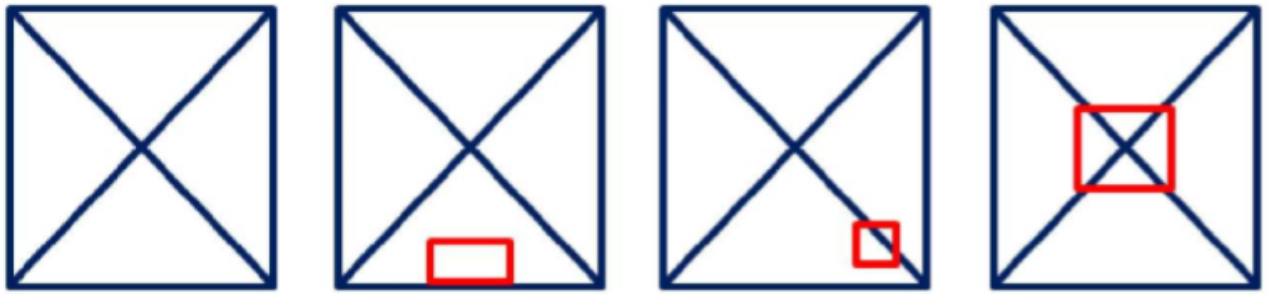
1. Height : 300 mm – 1 m
2. Ramp Slope = 1 : 12
3. Ramp Width : 600 mm
4. Aisle Width : 600 mm
5. Wheel Chair Road : 1 m
6. Hand Rail beside Ramp
7. No Plumbing (Optional)



Bonding-Earthling Guidelines

1. Individual Device Bond
2. Serial Bonding : NA
3. IEEE-1100 to Follow
4. Ground < 1 Ohm [6 Hole]
5. Code of AHJ to Follow

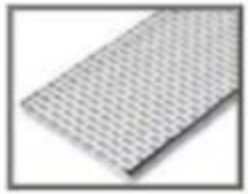




Cable and Pipe Distribution

– Trunking

– Trays

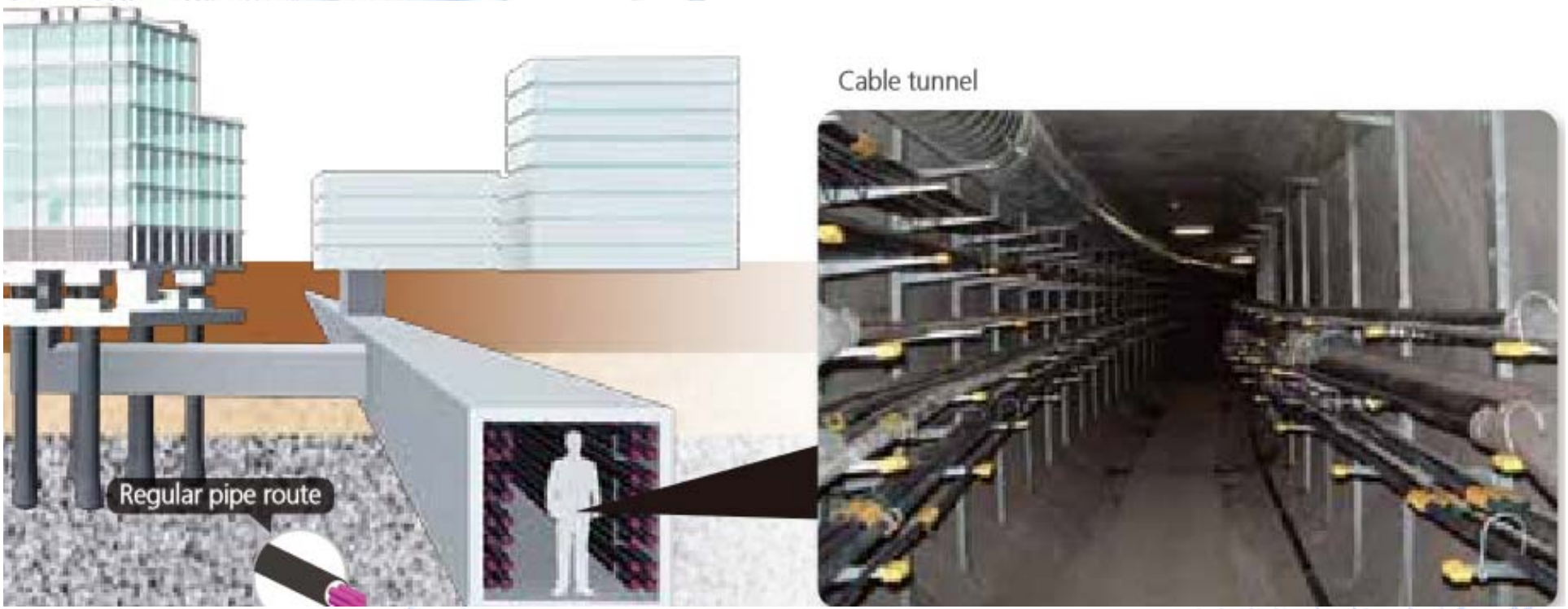


– Ladders

– Basket

- Solid Tray as Drain to Over-Head Water Pipe
- RCC Duct for Underground Cable Tunnel

Underground Cable Tunnel

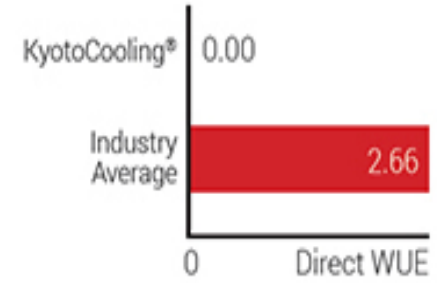


Data Centre Efficiency : The Green Grid

SANOG

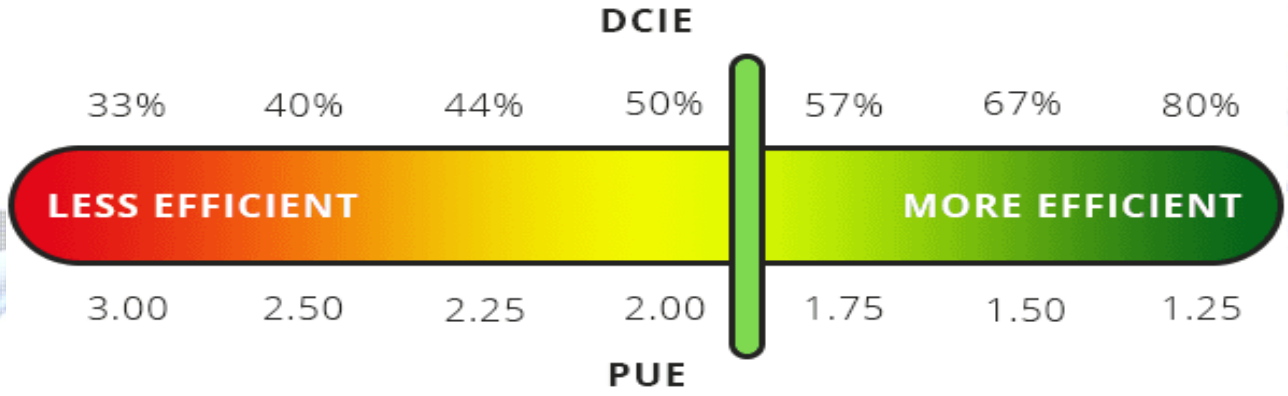
Metric Description	Metric Formulation
Power Usage Efficiency	$PUE = \frac{Total\ facility\ power}{Total\ IT\ power}$
Data Center Infrastructure Efficiency	$DCiE = \frac{Total\ IT\ power}{Total\ facility\ power}$
Carbon Usage Effectiveness	$CUE = \frac{Total\ CO2\ emissions\ from\ DC\ energy}{Total\ IT\ Equipment\ energy}$
IT Equipment Utilization	$ITEU = \frac{Total\ measured\ energy\ of\ IT}{Total\ specification\ energy\ of\ IT}$

$$\frac{\text{Annual Site Water Usage}}{\text{IT/Equipment Energy}} = \textbf{WUE}$$



Data Centre Efficiency Scale

PUE	DCiE	Level of Efficieny
3.0	33%	Very Inefficient
2.5	40%	Inefficient
2.0	50%	Average
1.5	67%	Efficient
1.2	83%	Very Efficient



PUE Calculation : Thumb Rule

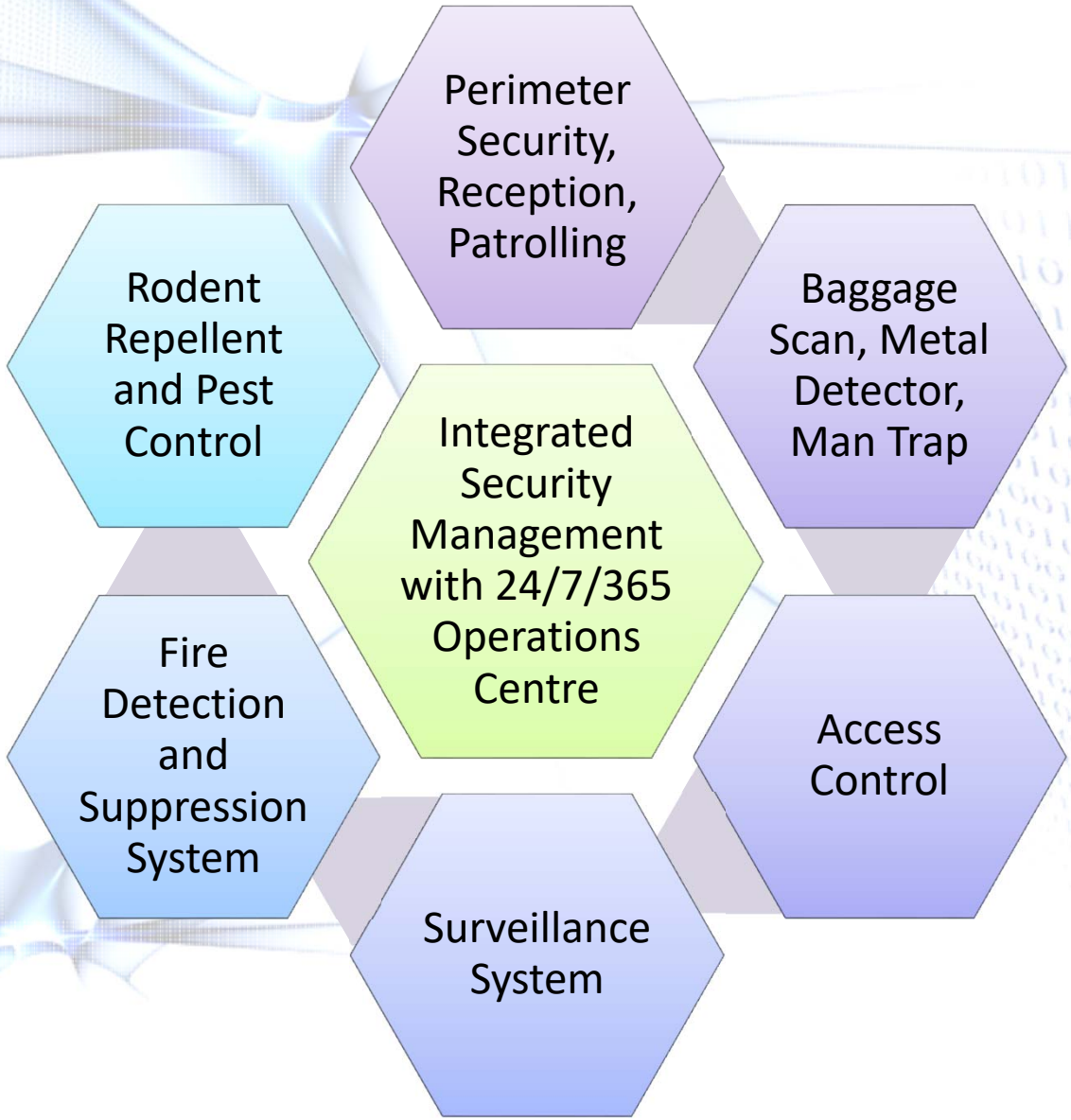
Cooling Technology	PUE
Natural / Free Cooling	1.3
Comfort AC	1.9
VRF System	1.85
Precision AC	1.8
DX Chiller (Scroll Compressor)	1.75
Air Cooled Chiller (Screw Compressor)	1.6
Water Cooled Chiller (Magnetic Compressor)	1.45
Water Cooled Chiller (Screw Compressor)	1.6
Water Cooled Chiller (Centrifugal Compressor)	1.7

Measurement
PDU Level

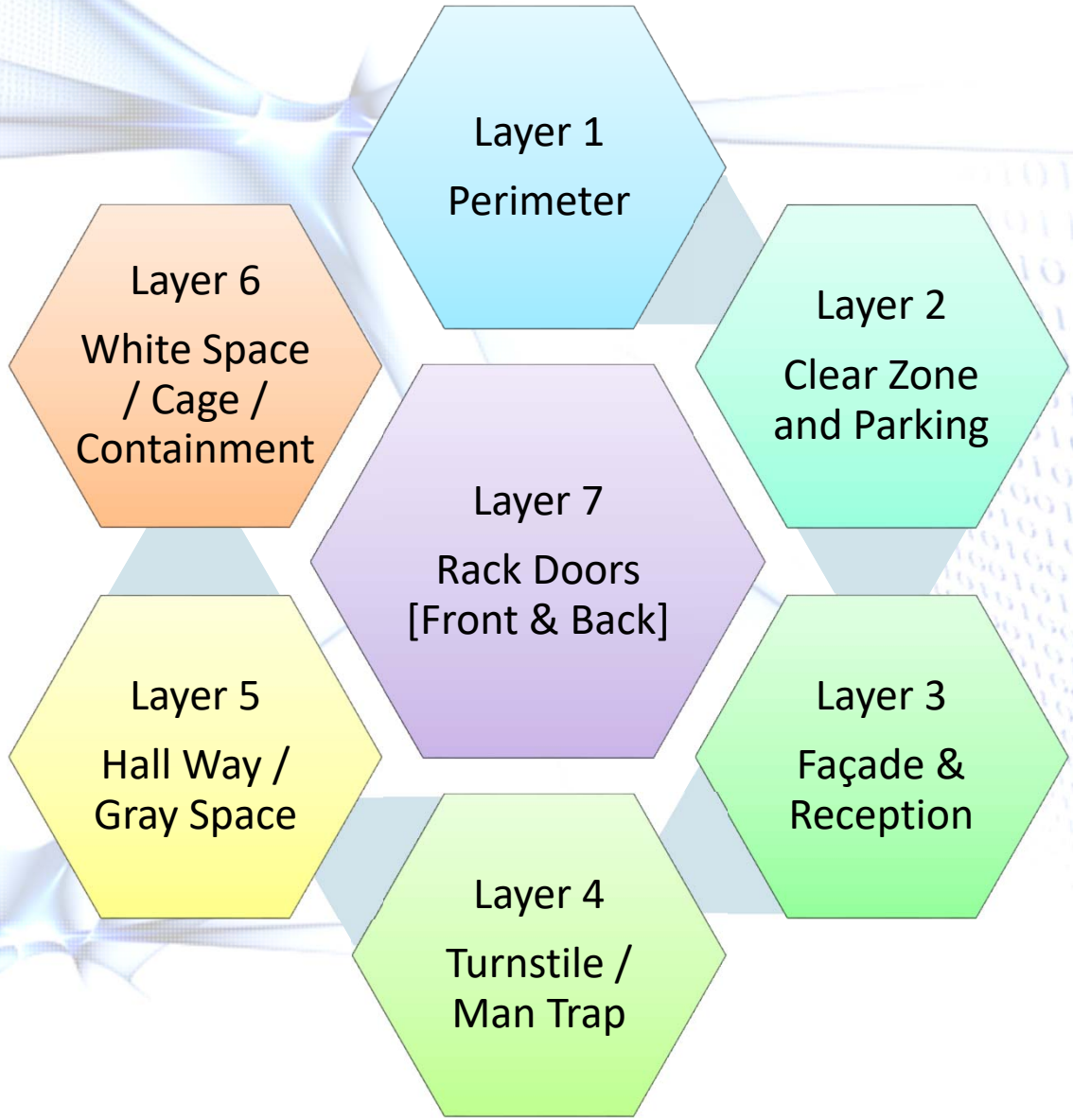
Green DC
PUE < 2 | DCIE > 50%

Inefficient DC
PUE > 2 | DCIE < 50%

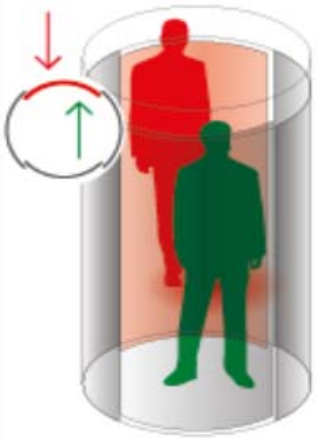
Physical Security and Risk Management



Access Control and Surveillance System



Layer 4 : Tailgating and Piggybacking

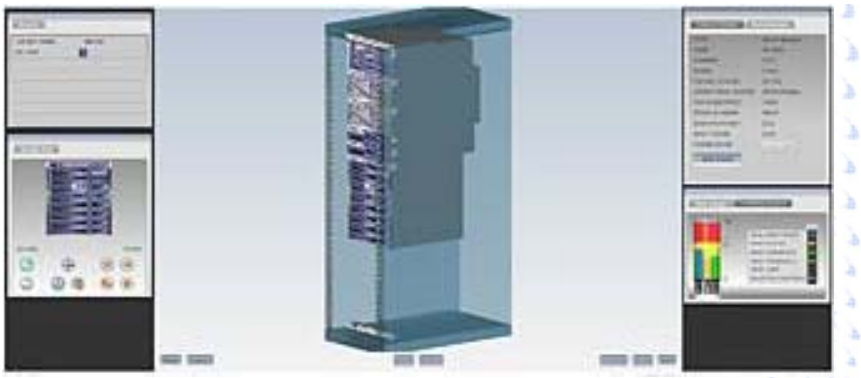


TAILGATING :
IN OPPOSTIE DIRECTION
DETECTION VIA: CONTACT MAT

TAILGATING :
IN SAME DIRECTION
DETECTION VIA: CONTACT MAT

PIGGYBACKING
DETECTION VIA:
WEIGHT SYSTEM AND STEREOVISION

Data Centre Infrastructure Management



Technology Selection and Options

Electrical and Power System

- [ ] Static UPS (Modular / Stand Alone) with DG, AVR, PFI, Battery Bank, Synchronize
- [ ] Dynamic Rotary UPS
- [ ] Flywheel UPS backed by Static UPS

Mechanical and HVAC System

- [ ] Water Cooled Water Chiller
- [ ] Air Cooled Water Chiller
- [ ] Precision Air Condition

Technology Selection and Options

SANOG

Access Control System

- [ ] Plum Vein + PIN + Access ID
- [ ] Finger Vein + PIN + Access ID
- [ ] Irish / Finger Print + PIN + Access ID

Fire Suppression System

- [ ] NOVEC 1230 + VESDA
- [ ] INERGEN + VESDA
- [ ] NAF S-125 / Water Mist + VESDA

Technology Selection and Options

SANOG

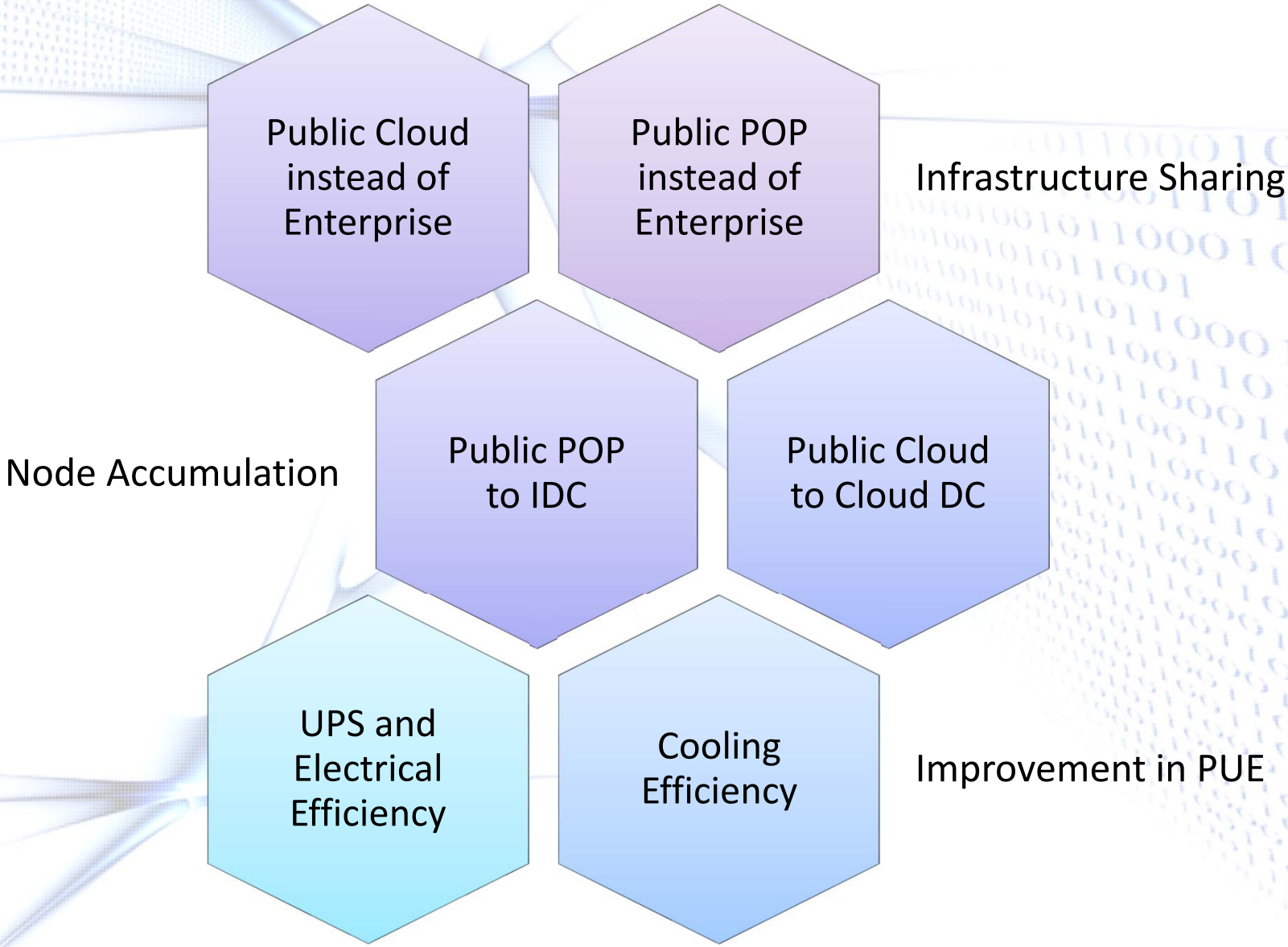
Power Distribution System

- Continuous Bus Way + Cast Resin BBT
- Continuous Bus Way + Sandwich BBT
- Cast Resin / Sandwich BBT (both use)

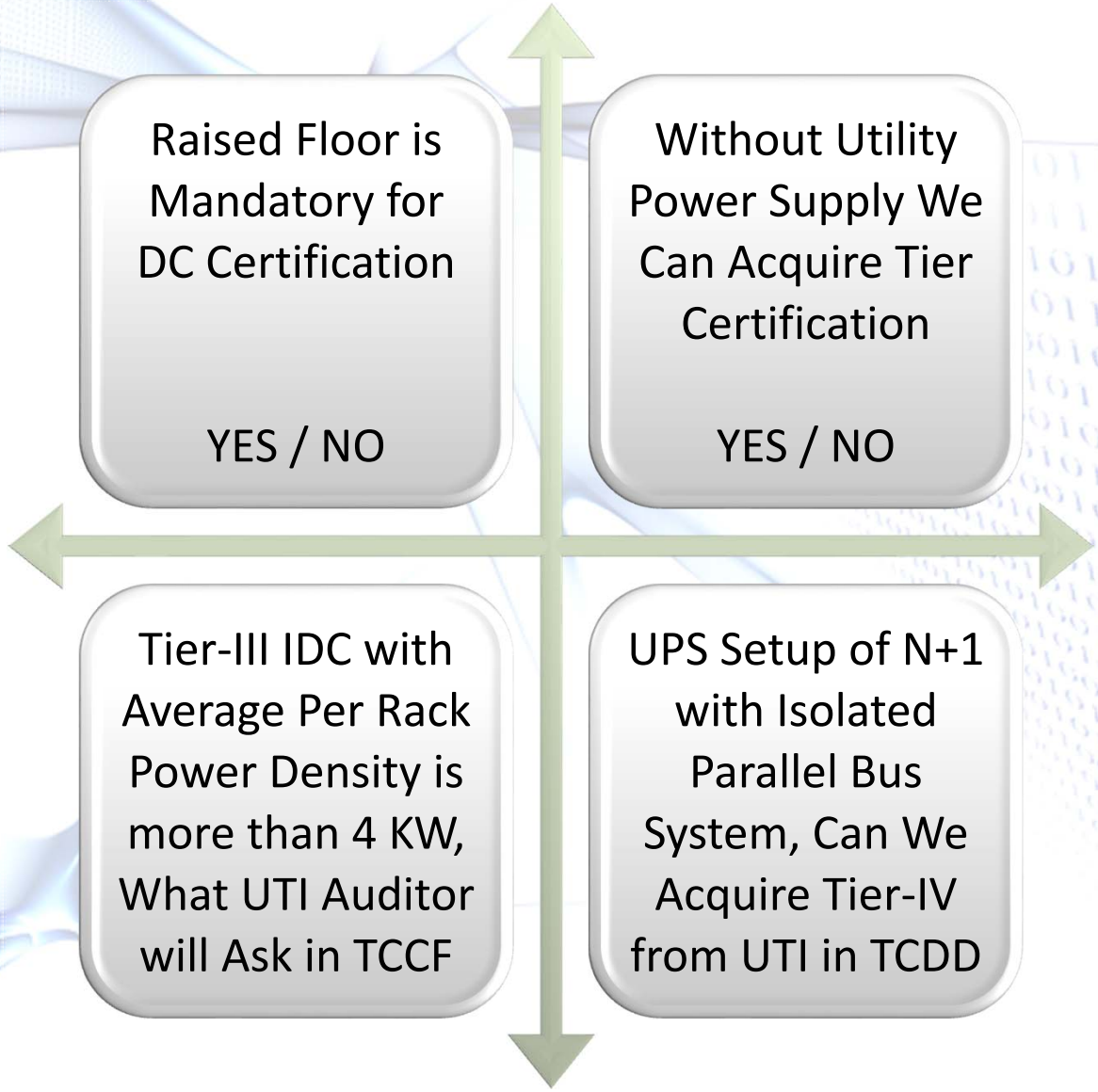
Cold Air and Hot Air Separation

- Slab Floor, Chimney Return
- Any Slab, Smart Aisle (Rack Sensing) Containment, Room Return
- Any (Raised / Slab) Slab, Aisle (Hot / Cold) Containment, Room Return

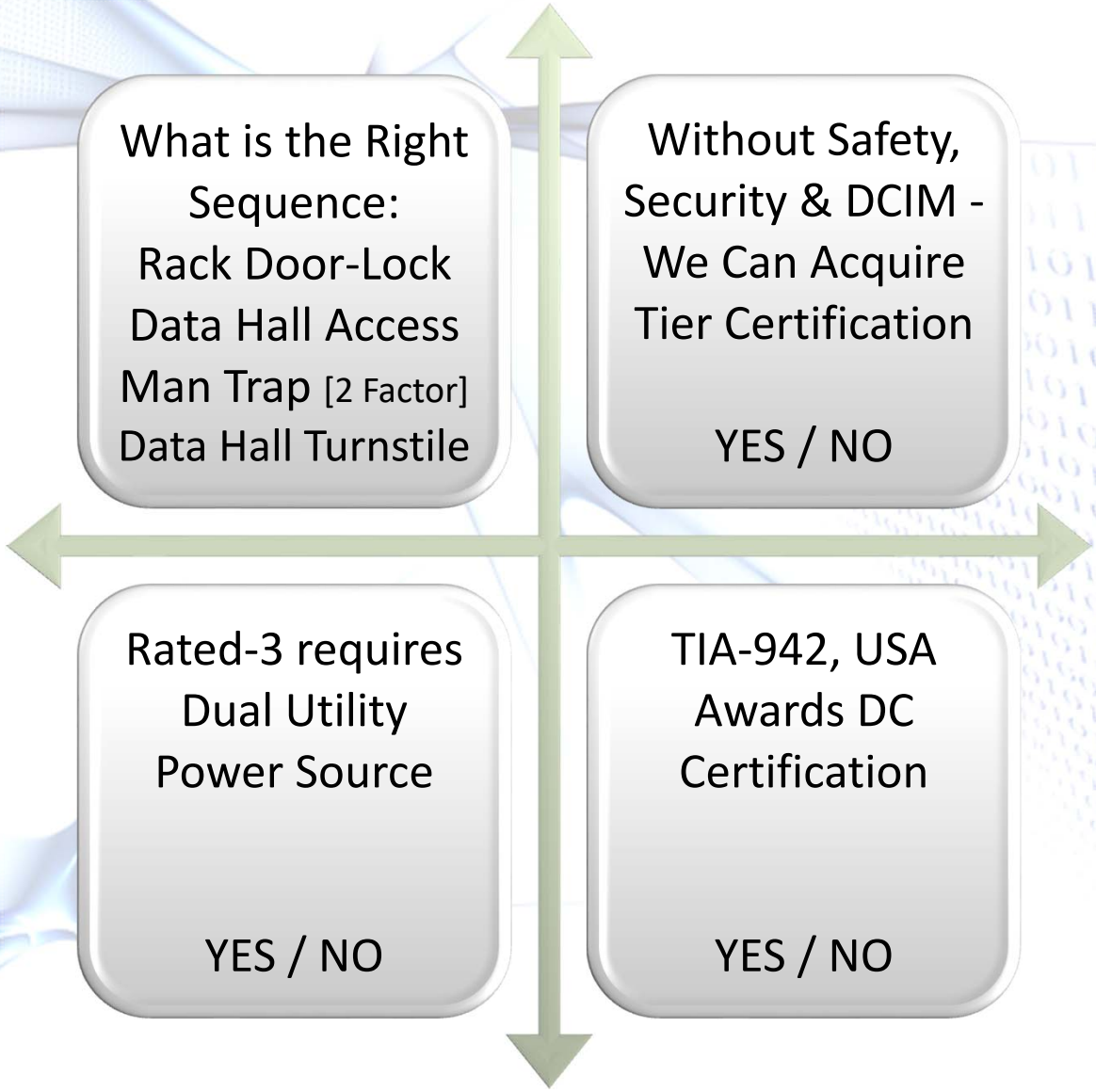
Transformation Towards Efficiency



Quiz : Tier Topology Misconception



Quiz : Design Misconception



Question, Comment, Feedback, Advice