

Astrikos

Analytics Driven Unified Operations & KPI Management



FOR DATA CENTRE INFRA

BY:

DR. CHINMAYA HEGDE (H.C.)

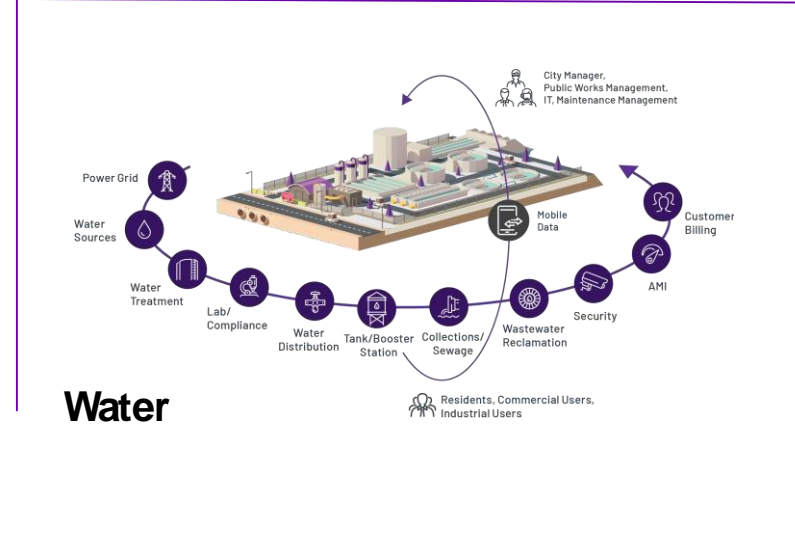
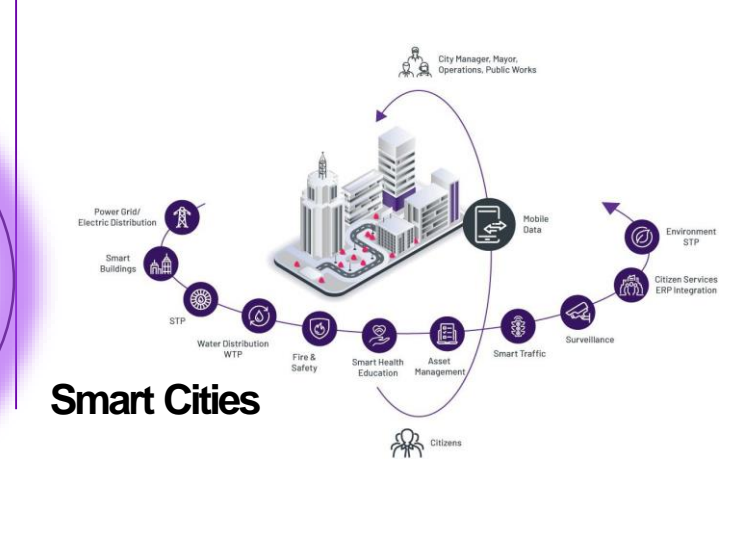
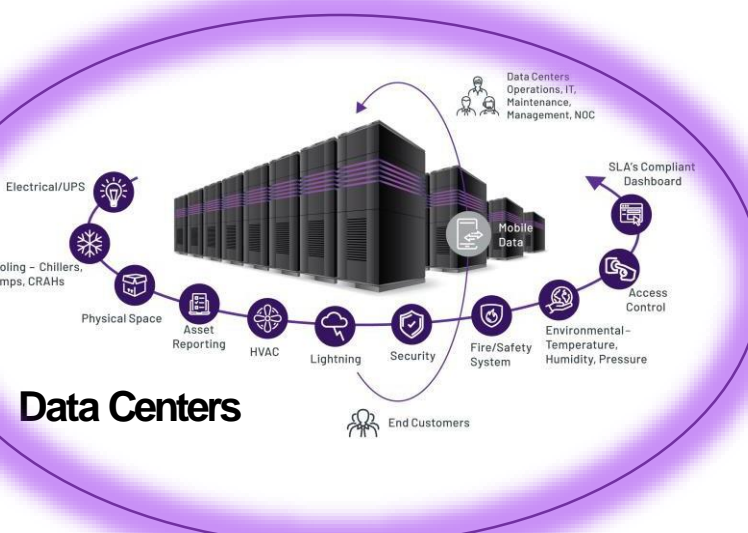
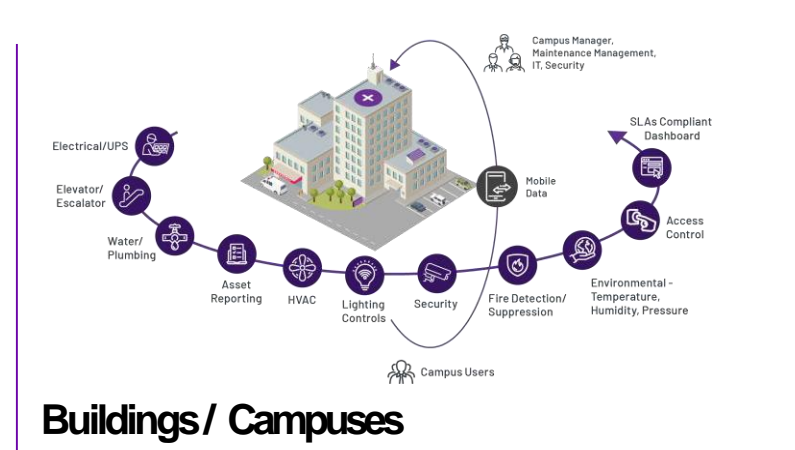
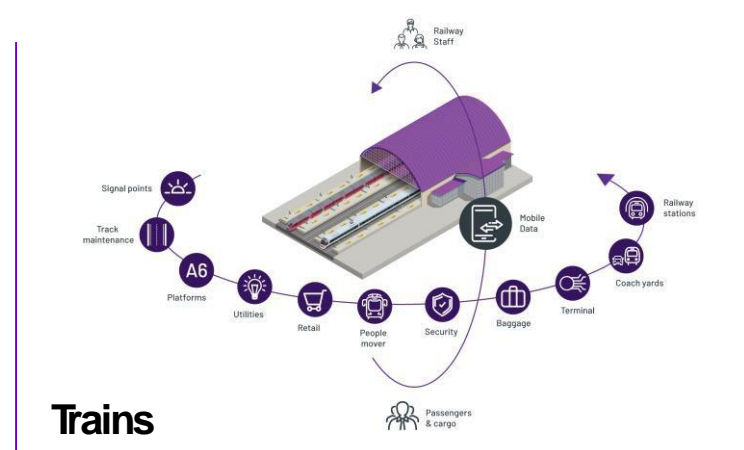
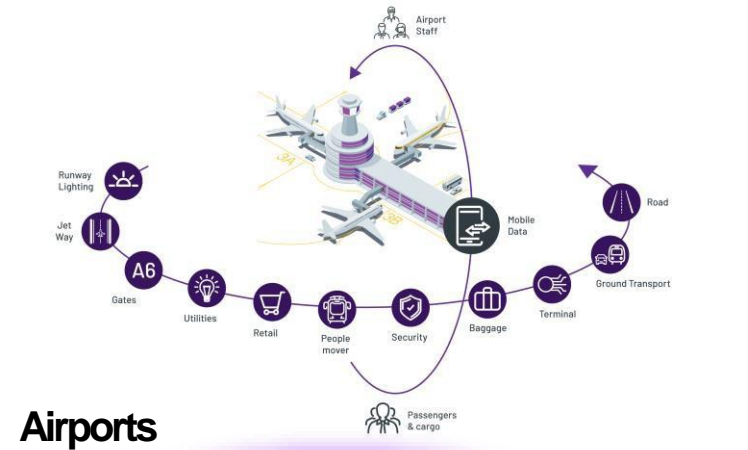
7th EDITION
DATA CENTRE INDIA 2020
VIRTUAL CONFERENCE

17th December, 2020 • 1030 - 1300 hrs



Shared Challenges Across Many Infrastructure Segments

Key drivers: Energy management, Safety/Regulations, Operational efficiency, Decision support



Data Center Drivers: Operators to customers

Uptime: With tiered standards in Service level agreements

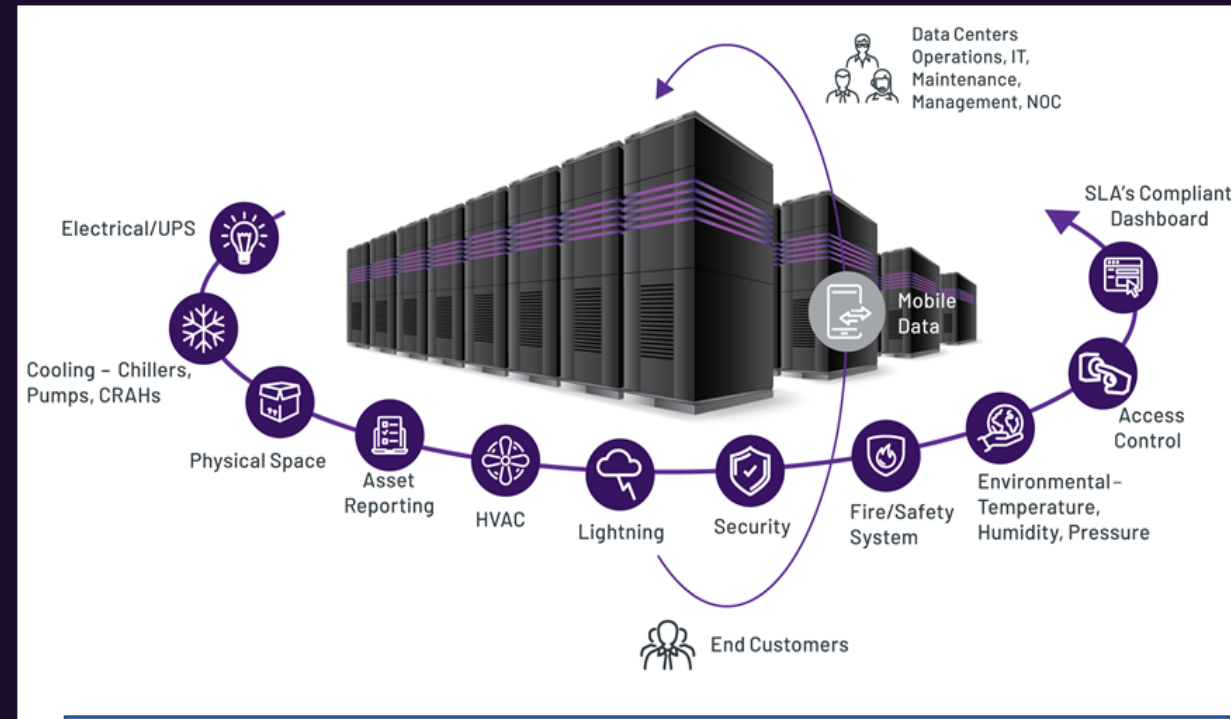
Operational
Challenges

KEY FINDING ON FAILURES

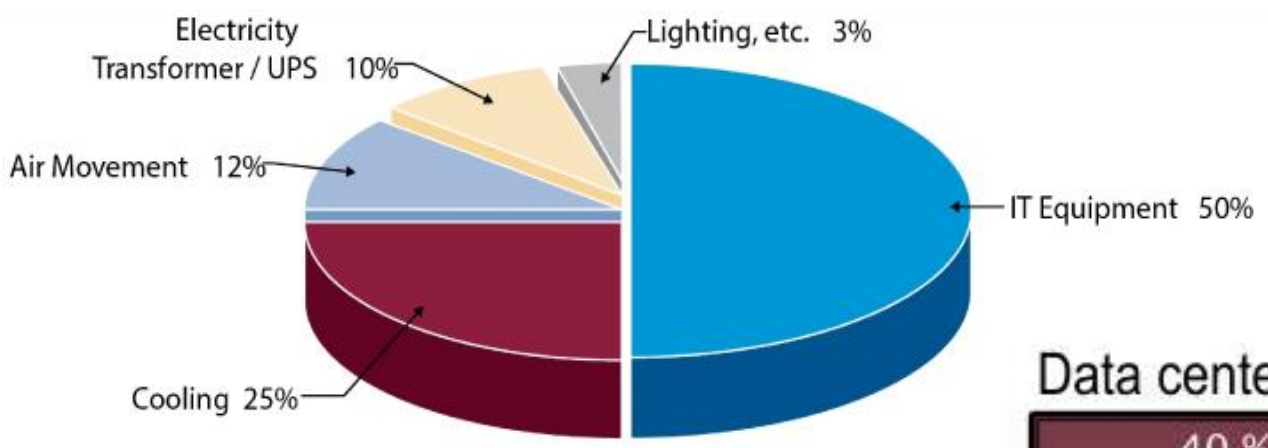
- Most SLA are very often broken
- Little understanding of likely financial and overall business impact
- 31% faced down time in past 1 years
- Power failure accounted for 36% , network failure accounted for 30% and 28% due to IT/Software failure
- 41 DCs reported outage had cost \$1 million. Out of this 1 outage costed \$50 million
- Around 3rd of all reported outage cost more than \$250k
- 80% responded some of these outages could have been prevented

FINDINGS OF UPTIME INSTITUTE ON ABNORMAL INCIDENT REPORTS

- Failure & downtime are common & increasing , despite of many advances
- Complexity and extensive use of 3rd parties making life difficult
- Biggest reason of failure is “ Shortfall in Management , staff activities and operation procedure”

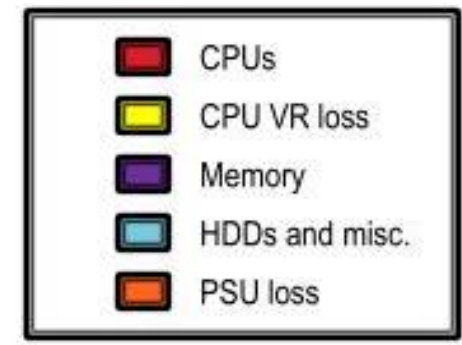
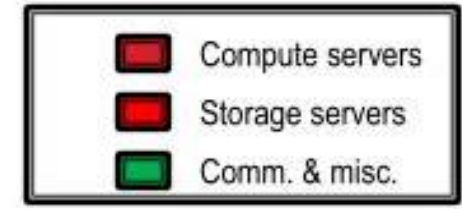
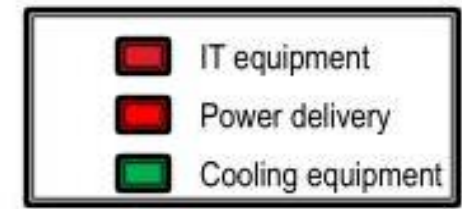
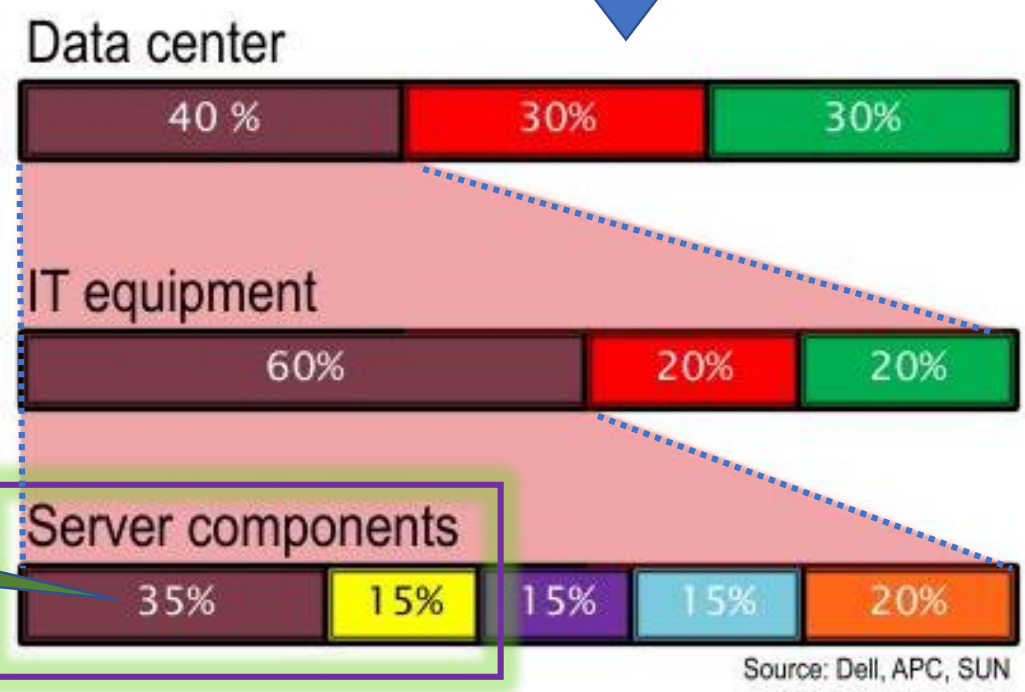


Data Center Energy Consumption



Cooling consumes 25% - 33% of power

Source: EYP Missions Critical Facilities Inc., New York

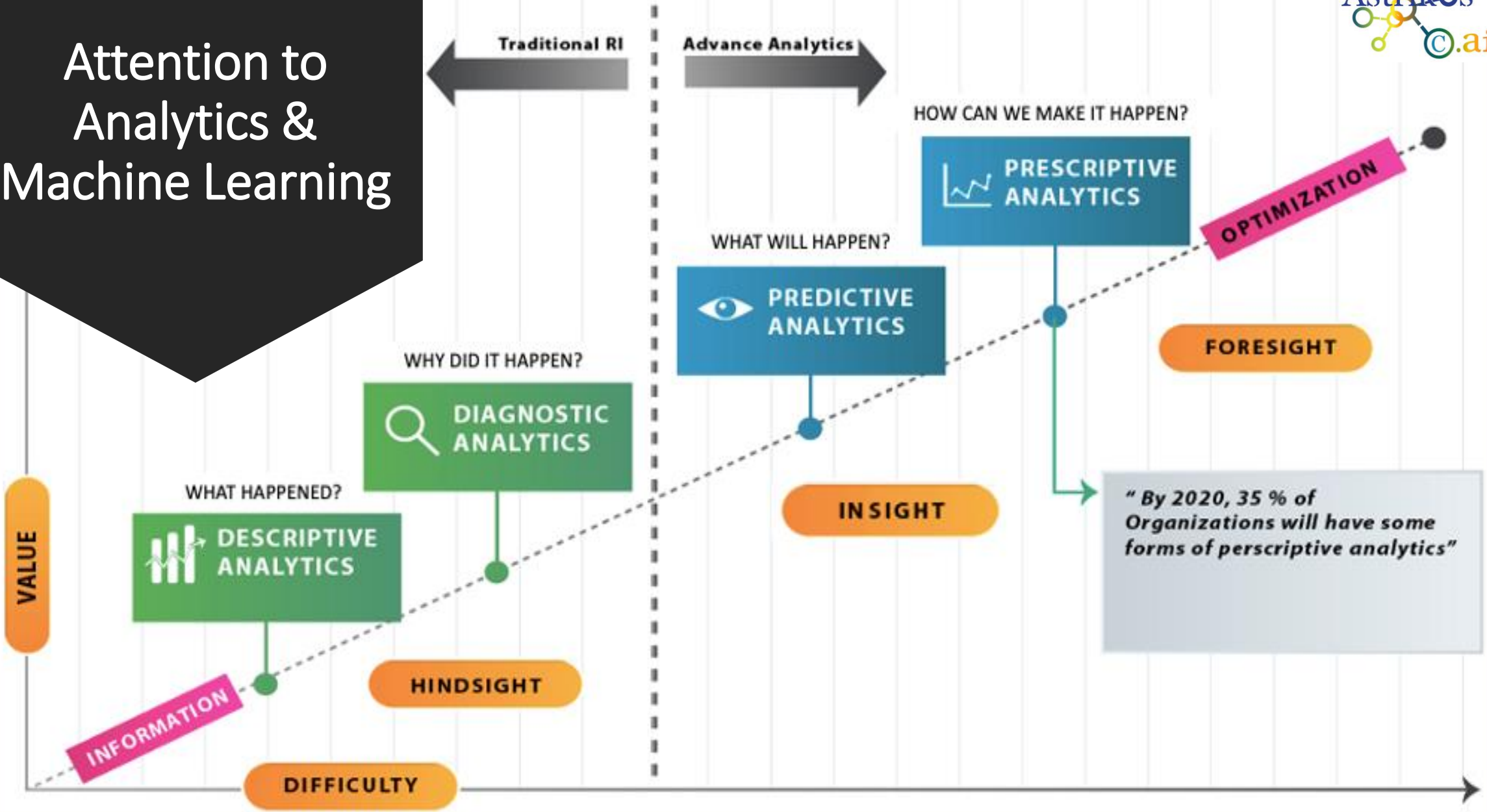


Source: Dell, APC, SUN

The breakdown leaves room for plenty of areas of improvement.

CPU uses about 10%-15% of total Data Centre power

Attention to Analytics & Machine Learning

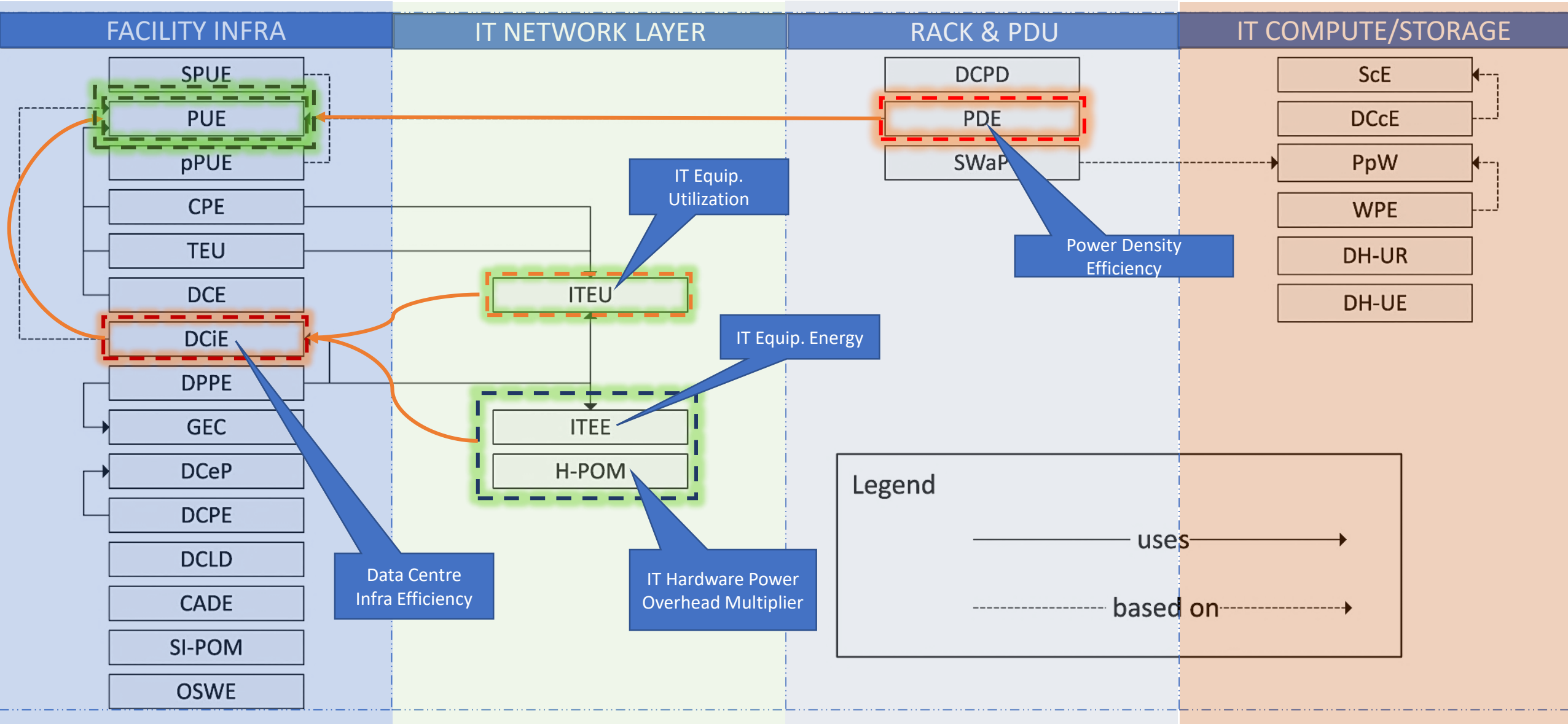




How Do We Do It ?



Energy KPI Dependency Matrix – PUE, DCE, DCiE



Data Samples for KPIs– Data Centre Components

IT_load	CCNR	PWP	CWP	COOL	LWT	CHL	RH	OVS	OWD
0.380406076	0.697498266	0.516174213	0.801418008	0.859520123	0.212347505	0.016579186	0.298095318	0.962414726	0.972968531
0.450582386	0.766739446	0.046843709	0.843757739	0.634318625	0.642345436	0.299270983	0.899336466	0.224244973	0.539410398
0.809097542	0.985738102	0.432815876	0.372138072	0.339145716	0.319462378	0.670555493	0.889055646	0.582042431	0.333390325
0.220330226	0.210281365	0.026591883	0.166369165	0.959198108	0.475254752	0.778161647	0.441568811	0.012473762	0.201526441
0.880755628	0.581984549	0.231273654	0.873500394	0.514036578	0.549533291	0.023990499	0.346656217	0.646453776	0.792550883
0.006180637	0.440713786	0.349648532	0.230399329	0.780986667	0.235580951	0.934817762	0.869929872	0.810115391	0.706063359
0.627367419	0.894106048	0.326455751	0.293482389	0.236592479	0.991173957	0.758180186	0.48175004	0.418947932	0.369547724
0.10974881	0.194931853	0.860779902	0.188362583	0.493280448	0.2866673	0.531440908	0.292645316	0.578588948	0.372465785
0.817593812	0.215678324	0.672915615	0.394167389	0.737245204	0.280063012	0.063755727	0.8746135	0.260371901	0.377951938
0.213879012	0.412287473	0.616525911	0.075220914	0.599874966	0.212487913	0.594464324	0.547721845	0.873398269	0.896441543
0.151055557	0.58864769	0.715260859	0.980665555	0.632178939	0.897074366	0.134328619	0.511787571	0.333445623	0.683884142
0.206978178	0.962126661	0.257078677	0.26263107	0.627236449	0.056023997	0.452461943	0.794916637	0.953571983	0.216873879
0.03066485	0.514982402	0.439250841	0.088151582	0.114345411	0.480603618	0.838376685	0.00812885	0.847240171	0.197180015
0.912711405	0.007983091	0.858247728	0.234544883	0.070126907	0.169020516	0.419046066	0.573233102	0.82049415	0.266511995
0.215845193	0.186986711	0.969922634	0.629000809	0.677789893	0.765451781	0.717295105	0.360109526	0.692459897	0.852841533
0.671599433	0.422192772	0.605794748	0.926422326	0.712179871	0.172421748	0.917904674	0.58082442	0.130848132	0.962122052
0.510283419	0.502050594	0.878108169	0.625607965	0.413039921	0.054349093	0.463927598	0.160165583	0.257418558	0.34332351
0.933983223	0.722857978	0.995401326	0.690520135	0.17817376	0.580451786	0.409338657	0.989188183	0.630293546	0.632592772
0.984399827	0.02953952	0.489984915	0.736232339	0.752980712	0.856079415	0.963779005	0.08215967	0.613306656	0.311091951
0.924116009	0.147037491	0.73016585	0.863188595	0.42774887	0.84551097	0.870222255	0.917209643	0.495295981	0.605245844
0.16431121	0.269565207	0.711848312	0.097280017	0.013007433	0.632004596	0.241943066	0.832001547	0.030383155	0.530183005
0.494275038	0.326400436	0.824775435	0.308084474	0.983627582	0.683623785	0.600303522	0.211538335	0.742738572	0.050194552
0.357327723	0.168435779	0.88675428	0.369617762	0.724697429	0.354574293	0.432373025	0.943373025	0.95658942	0.55532959

From Infrastructure Components:

- Power
- Chiller
- CRAC
- Environmental management

PUE Prediction

PUE_Future
2.014632875
2.231757743
1.587175393
1.8043673
2.076222269
2.221865299
2.559813885
1.725809704
1.668320065
1.962824169
1.928874037
2.106802879
1.905127868
1.866415471
2.123035959
2.155957646
2.071159376
2.573394914
2.052149236
1.953469955
1.76275314
2.207346712
2.029650489

time	user	user_name	request_id	action	changed_object_type	changed_object_id	related_object_type	related_object_id	object_repr	object_data
2020-07-18T11:35:30.469541+00:00	netbox	netbox	32e72829-741a-42b4-8a4b-7b0aee118fb2	Updated	dcim cable	44	dcim device	19	C13\2	{'type': 'power', 'color': '111111', 'label': '', 'length': 6, 'status': 'OK'}
2020-07-18T11:35:30.463225+00:00	netbox	netbox	32e72829-741a-42b4-8a4b-7b0aee118fb2	Updated	dcim power outlet	122	dcim device	19	C13\2	{'name': 'C13\2', 'tags': [], 'type': '', 'cable': 44, 'device': 19, 'length': 6, 'status': 'OK'}
2020-07-18T11:35:30.455628+00:00	netbox	netbox	32e72829-741a-42b4-8a4b-7b0aee118fb2	Updated	dcim power port	21	dcim device	25	PDU-B	{'name': 'PDU-B', 'tags': [], 'type': '', 'cable': 44, 'device': 25, 'status': 'OK'}
2020-07-18T11:35:30.448070+00:00	netbox	netbox	32e72829-741a-42b4-8a4b-7b0aee118fb2	Updated	dcim power port	21	dcim device	25	PDU-B	{'name': 'PDU-B', 'tags': [], 'type': '', 'cable': 44, 'device': 25, 'status': 'OK'}
2020-07-18T11:35:30.439090+00:00	netbox	netbox	32e72829-741a-42b4-8a4b-7b0aee118fb2	Updated	dcim power outlet	122	dcim device	19	C13\2	{'name': 'C13\2', 'tags': [], 'type': '', 'cable': 44, 'device': 19, 'length': 6, 'status': 'OK'}
2020-07-18T11:35:27.694703+00:00	netbox	netbox	772708cf-5594-4487-9fe9-59112549f9db	Updated	dcim cable	44	dcim device	19	C13\2	{'type': 'power', 'color': '111111', 'label': '', 'length': 6, 'status': 'OK'}
2020-07-18T11:35:27.687998+00:00	netbox	netbox	772708cf-5594-4487-9fe9-59112549f9db	Updated	dcim power outlet	122	dcim device	19	C13\2	{'name': 'C13\2', 'tags': [], 'type': '', 'cable': 44, 'device': 19, 'length': 6, 'status': 'OK'}
2020-07-18T11:35:27.680109+00:00	netbox	netbox	772708cf-5594-4487-9fe9-59112549f9db	Updated	dcim power port	21	dcim device	25	PDU-B	{'name': 'PDU-B', 'tags': [], 'type': '', 'cable': 44, 'device': 25, 'status': 'OK'}
2020-07-18T11:35:27.671105+00:00	netbox	netbox	772708cf-5594-4487-9fe9-59112549f9db	Updated	dcim power port	21	dcim device	25	PDU-B	{'name': 'PDU-B', 'tags': [], 'type': '', 'cable': 44, 'device': 25, 'status': 'OK'}

DCIM Data

name	device_role	tenant	manufacturer	device_type	status	site	rack_group	rack_name	position	face
1701_CORE_SWITCH	Core Switch	Starfleet	Dell	S4028-ON	Active	NCC-1701-D	MDF Room	MDF_RACK1	30	Front
1701_FW	Firewall	Starfleet	Palo Alto	PA-3020	Active	NCC-1701-D	MDF Room	MDF_RACK1	35	Front
1701_MDF_ACCESS-sw1	Access Switch	Starfleet	Cisco	WS-C3850-48U	Active	NCC-1701-D	MDF Room	MDF_RACK1	25	Front
1701_MDF_ACCESS-sw2	Access Switch	Starfleet	Cisco	WS-C3850-48U	Active	NCC-1701-D	MDF Room	MDF_RACK1	24	Front
1701_MDF_R1_PDU_A	PDU	Starfleet	Tripp Lite	PDU1230	Active	NCC-1701-D	MDF Room	MDF_RACK1	2	Front
1701_MDF_R1_PDU_B	PDU	Starfleet	Tripp Lite	PDU1230	Active	NCC-1701-D	MDF Room	MDF_RACK1	1	Front
1701_MDF_R1_U40	Copper Patch Panel	Starfleet	Commscope	CPPA-UDDM-SL-1U-24	Active	NCC-1701-D	MDF Room	MDF_RACK1	40	Front
1701_MDF_R1_U41	Copper Patch Panel	Starfleet	Commscope	CPPA-UDDM-SL-1U-24	Active	NCC-1701-D	MDF Room	MDF_RACK1	41	Front
1701_MDF_R1_U42	Fiber Patch Panel	Starfleet	Commscope	760231449 SD-1U	Active	NCC-1701-D	MDF Room	MDF_RACK1	42	Front
1701_RR_ACCESS	Access Switch	Starfleet	Cisco	WS-C3850-48U	Active	NCC-1701-D	READY_ROOM_IDF	READY_ROOM_IDF	5	Front
1701_RR_IDF_PDU	PDU	Starfleet	Tripp Lite	PDU1230	Active	NCC-1701-D	READY_ROOM_IDF	READY_ROOM_IDF	1	Front
1701_RR_IDF_U7	Copper Patch Panel	Starfleet	Commscope	CPPA-UDDM-SL-1U-24	Active	NCC-1701-D	READY_ROOM_IDF	READY_ROOM_IDF	7	Front
1701_RR_IDF_U8	Copper Patch Panel	Starfleet	Commscope	760231449 SD-1U	Active	NCC-1701-D	READY_ROOM_IDF	READY_ROOM_IDF	8	Front

Rack & PDU Management Data

Power consumption exceeded user-defined threshold, SNMP warning issued

The server **power** consumption exceeded a user-defined threshold and SNMP warning has been issued.

Power on request received by: [source]

iLO receives **power** on request from the listed source. The source can be the **power** buttons, wake-on-LAN, automatic **power** recovery.

Power Regulator setting changed by: [user name]

Power Regulator setting changed by the listed user.

Power-Off signal sent to host server by: [user name]

The server **Power-Off** request was sent by the list user.

Power-On signal sent to host server by: [user name]

The server **Power-On** request was sent by the list user.

Date/Time	Source	Description
Instructions: The iDRAC log contains information about iDRAC hardware. To sort the log by column, click a column header:		
2019 Jun 19 12:36:44	os[11852]	root login from 10.10.10.115
2019 Jun 19 12:30:10	fullttw[461]	Power Supply 2: Status = 0x00, IOUT = 0x0, VOUT= 0x0, TEMP= 0x0, FAN = 0x0, INPUT= 0x0
2019 Jun 19 12:30:10	fullttw[461]	Power Supply 1: Status = 0x00, IOUT = 0x0, VOUT= 0x0, TEMP= 0x0, FAN = 0x0, INPUT= 0x0
2019 Jun 19 12:30:02	fullttw[461]	Power Supply 2: Status = 0x2000, IOUT = 0x0, VOUT= 0x0, TEMP= 0x0, FAN = 0x0, INPUT= 0x8
2019 Jun 19 12:30:02	fullttw[461]	Power Supply 1: Status = 0x2000, IOUT = 0x0, VOUT= 0x0, TEMP= 0x0, FAN = 0x0, INPUT= 0x8
2019 Jun 19 04:19:18	os[14530]	root closing session from 10.10.10.115
2019 Jun 19 03:40:46	os[9766]	root login from 10.10.10.115
2019 Jun 19 03:29:02	os[8317]	root closing session from 10.10.10.115
2019 Jun 19 02:35:27	os[1685]	root login from 10.10.10.115
2019 Jun 19 00:51:10	os[21136]	root closing session from 10.10.10.115

Server/Storage/Racked Devices Data

Acronym	Full Name	Unit	Objective	Optimal	Category
APC	Adaptability Power Curve	Ratio	Maximize		1 Facility
CADE	Corporate Average Data Center Efficiency	Percentage	Maximize		1 Facility
CPE	Compute Power Efficiency	Percentage	Maximize		1 Facility
DCA	DCAdapt	Ratio	Minimize	Minus Infinity	Facility
DCcE	Data Center Compute Efficiency	Percentage	Maximize		1 Server
DCeP	Data Center Energy Productivity	UW/kWh	Maximize	Plus Infinity	Facility
DCiE	Data Center Infrastructure Efficiency	Percentage	Maximize		1 Facility
DCLD	Data Center Lighting Density	kW/ft2	Minimize		0 Facility
DCPD	Data Center Power Density	kW/Rack	Maximize	Plus Infinity	Rack
DCPE	Data Center Performance Efficiency	UW/Power	Maximize	Plus Infinity	Facility
DC-FVER	Data Center Fixed to Variable Energy Ratio	Ratio	Minimize		1 Facility
DH-UE	Deployed Hardware Utilization Efficiency	Percentage	Maximize		1 Server
DH-UR	Deployed Hardware Utilization Ratio	Ratio	Maximize		1 Server
DPPE	Data Center Performance Ratio	Ratio	Maximize		1 Facility
DWPE	Data center Workload Efficiency	Ratio	Maximize	Plus Infinity	Server
EES	Energy Expenses	Percentage	Minimize		1 Facility
EWR	Energy Wasted Ratio	Ratio	Minimize		0 Facility
GEC	Green Energy Coefficient	Percentage	Maximize		1 Facility
H-POM	IT Hardware Power Overhead Multiplier	Ratio	Minimize		1 IT Equipment
ITEE	IT Equipment Energy	Cap/kW	Maximize	Plus Infinity	IT Equipment
ITEU	IT Equipment Utilization	Percentage	Maximize		1 IT Equipment
OSWE	Operating System Workload Efficiency	OS/kW	Maximize	Plus Infinity	Facility
PDE	Power Density Efficiency	Percentage	Maximize		1 Rack
PESavings	Primary Energy Savings	Ratio	Maximize		1 Facility
PUElevel	Power Usage Effectiveness Level 1-4	Ratio	Minimize		1 Facility
PUEs	Scalability Power Usage Effectiveness Scalability	Percentage	Maximize		1 Facility
pPUE	Partial Power Usage Effectiveness	Ratio	Minimize		1 Facility
PpW	Performance per Watt	Perf/Watt	Maximize	Plus Infinity	Server
ScE	Server Compute Efficiency	Percentage	Maximize		1 Server
SI-POM	Site Infrastructure Power Overhead Multiplier	Ratio	Minimize		1 Facility
SPUE	Server Power Usage Efficiency	Ratio	Minimize		1 Facility
SWaP	Space, Watts and Performance	Ratio	Maximize		1 Rack
TUE	Total-Power Usage Effectiveness	Ratio	Minimize		1 Facility



30+ Energy KPIs

RELATIONSHIP BETWEEN KPIs

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



Interactive – Digital Twin – Explore Granular KPIs

Energy Efficiency KPIs

Month	PUE	DCIE	TUE	EWR	APC
Jan	65	60	60	60	60
Feb	75	80	80	80	80
Mar	75	80	80	80	80
Apr	80	85	85	85	85
May	100	105	105	105	105
Jun	85	85	85	85	85
Jul	75	75	75	75	75
Aug	105	105	105	105	105
Sep	85	85	85	85	85
Oct	55	55	55	55	55
Nov	55	55	55	55	55
Dec	85	85	85	85	85

- 0.87** Power Usage Effectiveness
- 0.452** Data Center Infrastructure Effectiveness
- 1.023** Energy Wasted Ratio
- 0.625** Total-Power Usage Effectiveness
- 0.125** Adaptability Power Curve

[Know More.](#)

[Cooling Efficiency KPIs](#)
[Green Metrics & Environmental KPIs](#)
[Capacity Management & Performance KPIs](#)
[Financial Impact KPIs](#)

Cooling Efficiency KPIs

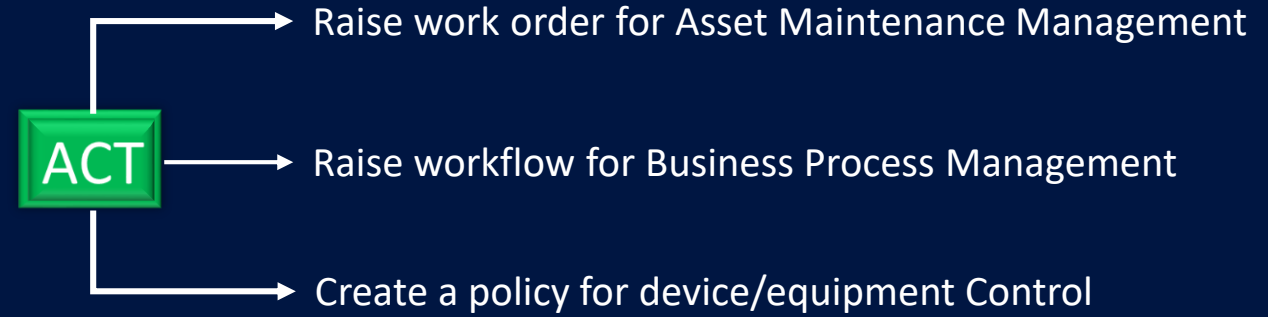
Month	Air Economizer Utilization Factor	DataCenter Cooling System Efficiency	Energy Efficiency Ratio	HVAC System Effectiveness
Jan	0.1	0.7	0.7	0.7
Feb	0.7	1.0	1.0	1.0
Mar	1.0	1.8	1.8	1.8
Apr	1.8	2.2	2.2	2.2
May	2.2	2.8	2.8	2.8
Jun	2.8	3.2	3.2	3.2
Jul	3.2	1.5	1.5	1.5
Aug	1.5	0.4	0.4	0.4
Sep	2.5	3.5	3.5	3.5
Oct	2.0	4.0	4.0	4.0
Nov	4.5	2.5	2.5	2.5
Dec	3.5	2.5	2.5	2.5

- 0.8** Air Economizer Utilization Factor
- 1.0** DataCenter Cooling System Efficiency
- 2.0** Energy Efficiency Ratio
- 1.0** HVAC System Effectiveness
- 1.0** Water Economizer Utilization Factor

[Know More.](#)

[Green Metrics & Environmental KPIs](#)
[Capacity Management & Performance KPIs](#)
[Financial Impact KPIs](#)

Advisory Alarms followed by Actions





AUDIT AND SELF-ASSESSMENT

Analytics driven self-assessment module for:

- Sustainable Energy Efficiency Compliance
- Data Center Compliances
- Sustainable Occupancy Compliance
- Building Equipment Sustainability
- Advisories to fill-in gaps and white spaces
- Action points to induce operational excellence by enabling bi-directional integration with UOC
- ML driven analytical reports for compliance health check





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