



# ITOM 3.1: DATA CENTER OPERATIONS AND MANAGEMENT (2-HOUR SESSION)

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**Schoolcraft**  
College

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AFCOM



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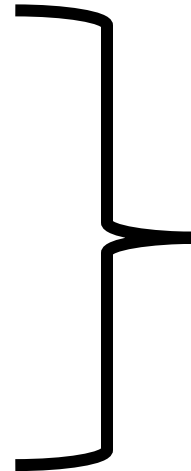
# Data Center Operations

Schoolcraft College

# The Turner CRIMMP© Data Center Design Model

CRIMMP – represents key strategies to be applied to the major resources and services provided by a data center. When fully considered and implemented, assures a robust, resilient, and available data center system that can meet the required RPO and RTO.

- **C** – Capacity
- **R** – Redundancy
- **I** – Infrastructure
- **M** – Monitoring
- **M** – Maintenance
- **P** – Policy



- Power
- Cooling
- Network
- Security
- Building/Floor Plan

## Fun Facts:

CRI... mostly relates to  
Data Center Design

...MMP mostly relates to  
Data Center Operations

Crimp – press together – squeeze together – to secure in place – to join firmly – to bond – to press or draw together, as the ends of something

# Operational Controls

- Operations manual containing processes and policies
- Compliance standards
  - SSAE16 SOC2, HIPAA, PCI, etc.
  - Quality control repository for audit artifacts
- Risk analysis and mitigation plan
- DCIM – Data Center Infrastructure Management
- Client deployment into data center
- Incident management and ticketing system
- Maintenance policies, practices, and protocols
- Disaster recovery plan and first responder guide
- Employee handbook





## Compliance Standards

- SSAE 16 – Statement on Standards for Attestation Engagements No. 16
  - Focuses on internal financial audits, not designed to provide an objective data center audit
  - AT Section 101 – Attestation Standards – used to implement SOC2 & SOC3
- SOC 1 – Service Organization Controls 1
- SOC 2 – Service Organization Controls 2
  - Audit designed for service control organizations
  - Provides a benchmark in which data center audit reports can be compared assuring the reader that the control criterion is the same in every audit
- SOC 3 – Service Organization Controls 3
  - General use report providing only auditor feedback, contains no descriptions of tests or results

# Compliance Standards

- AICPA – American Institute of Certified Public Accountants
  - Sets ethical audit standards for private companies, non-profit organizations, federal, state, and local governments
- HIPAA – Health Insurance Portability and Accountability Act of 1996
  - Health
- PCI – Payment Card Industry compliance





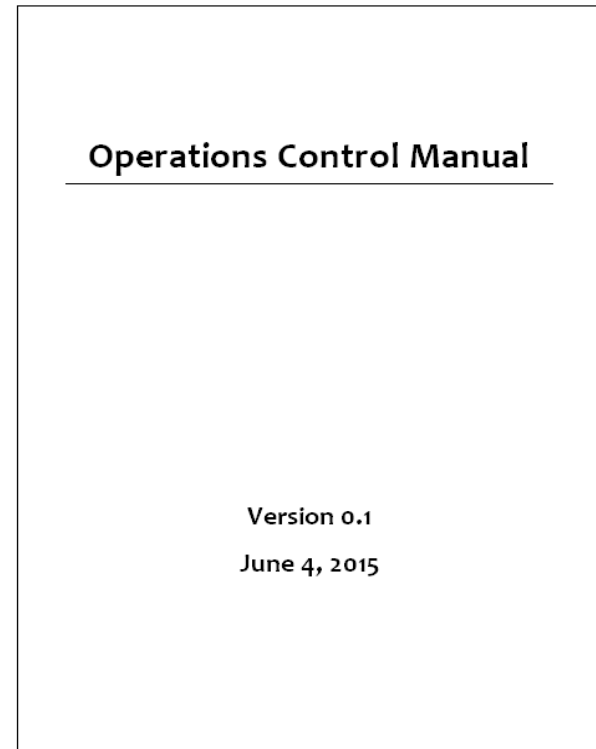
# Compliance

- Why is audit compliance required – Basically, it's not - Audit compliance is a way to communicate to your auditors and potential clients that you have a complete and mature operation, with control policies to prove it, and evidence (i.e., artifacts) to show that systems exist and that you follow your controls/policies
- Being in compliance can increase business potential – objective comparison
- Audit readiness/preparedness – Have control policies in the form of an operations guide, and have a repository of reports/emails, software screen images, etc. to act as artifacts that show you do what your policies say you do
- There are two ways to get ready for your first audit
  - Get a reputable auditor's "pre-audit questionnaire" and create real answers (controls or policies)/artifacts for every question (i.e., Operations Guide and artifact repository)
  - Hire a consultant familiar with the Control Points/Processes required by the audit spec and engage in a project to create the Control Points and Tests
- Documentation – Operations Guide & a list of artifacts from a successful audit



# Operations Manual

- Mission, strategy, philosophy
- Policies and procedures
  - How are you going to run your business
- Business guidelines
- Documented standards and tests
- Schedules
- Emergency contact list
- Org chart with separation of duties
- Job descriptions





## Policies and Procedures

- Purpose of Operations Control Manual is to document how you are going to run your business and what policies and procedures you are going to use
- In the past you were completely on your own to determine how much and how far you would go, and an audit (like SAS 70) just confirmed if you were actually doing what your Operations Manual said you were
- More recent audit models like SSAE16 SOC2 provide a model that represents required practices
- To determine what they are – you must read the audit model requirements – which is very confusing and jargon laden, or have a good example to follow, which are very hard to find since they represent the competitive advantage for other data centers, or an opportunity for professional services revenue for consultants
- Policies and procedures are created to make a better organization - by having a best-practices road map, insulating you from attrition, and allow for optimization

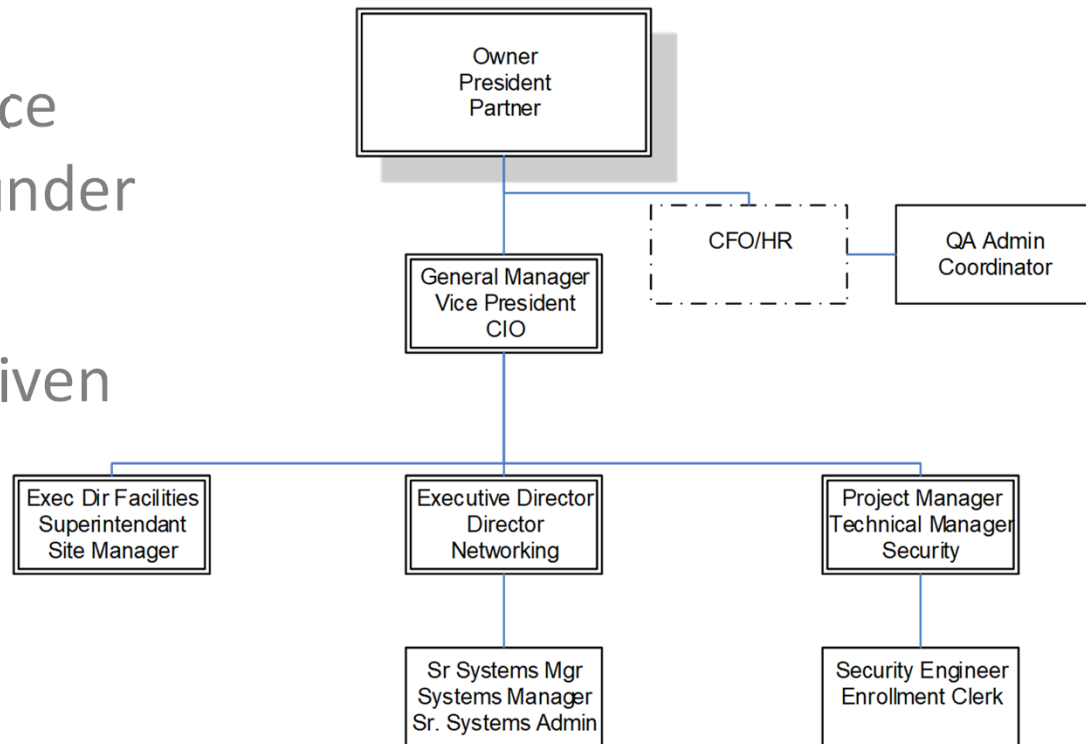


## Business Guidelines

- The guiding purpose and mission of your enterprise
- Business Guidelines outline how you handle clients (pricing, services, AUP, SLA, etc.), vendors, security, etc.
- Business Guidelines represent those things outside the audit requirements that make your company different from others and the means by which you intend to make money, contain cost, or create competitive advantage
- Examples of documents: Quoting model, invoicing and payment practices, (see also above), master agreement, etc.

## Sample Org Chart

- Separation of duties required
- Authority to enforce controls/policies under their control
- Many titles for a given role/position





## Job Descriptions

- Importance of job descriptions: Describes roles needed to execute the policies and procedures with sufficient “separation of duties” and authority to provide independent checks and balances to prove there is no chance of having “a fox guarding the chicken house” scenario
- Minimum number of positions required for a commercial Data Center – see org chart
- Examples of roles/responsibilities:
  - Owner, President, Partner
  - General Manager, VP, CIO
  - CFO, Human Resources
  - QA Admin, DC Coordinator
  - Exec Dir. Facilities, Site Manager
  - Exec Dir. Networking, Director
  - Senior System Manager, System Manager, Senior System Admin
  - Project Manager, Technical Manager, Security
  - Security Engineer, Enrollment Clerk

# Risk Analysis and Mitigation

- System Failure – It’s not “if” a system will fail, it’s “**when**” it will fail and “**what**” mitigation plan is in place
- Risk mitigation is key to sustaining a successful data center operation and for audit compliance – have a “what if” plan
- Having the proper protocol in place to prevent service interruption is imperative - a data center is only as good as its reputation
- 100% uptime is no longer a goal, it’s a requirement
- A risk mitigation process is as simple as two tools:
  - Risk analysis questionnaire with likelihood and impact scoring
  - Risk mitigation plan based on analysis results



# Risk Analysis Questionnaire

Annual Risk Assessment:				
Facility: Schoolcraft College		Address: 18600 Haggerty Rd, Livonia, MI. 48152		
Date Initiated:	By: Patrick R. Turner			
Date Revised:	By: Patrick R. Turner			
1. Answer the following questions for the facility as Yes or No (Y/N). Not applicable equates to No (N).				
2. For all "Yes" answers, estimate the impact (1-4) to the facility if the risk Impact if risk is not managed: 4 = Catastrophe; 3 = Critical; 2 = Marginal; 1 = Negligible				
3. Then rate the probability (1-4) that the risk will occur. Probability that the risk will occur: 4 = Highly Probable; 3 = Probable; 2 = Improbable; 1 = Highly Improbable				
4. The system will multiply the two values and note the Total Score.				
5. Transfer all items with a Total Score of 6 or greater to your Risk Mitigation Plan Worksheet by putting the "row number" of each risk with total score over 6 in the 1st column of the Plan sheet. Then develop a corresponding Risk Mitigation for				
	Y/N	Probability	Impact	Total Score
Power				0
Need Current maintenance agreement on: all generators?	N			0
Need Current maintenance agreement on: all UPS'?	N			0
Need Current maintenance agreement on: all the paralleling switchgear?	Y	4	2	8
Need Current maintenance agreement on: all all transfer switches?	Y	4	2	8
Power system has a single point of failure?	N			0
The risk of power capacity issues within the next 6 months is highly probable?	N			0

# Risk Mitigation Plan

Status	Category	Statement	Impact	Prob	Score	Mitigation	Action Person	Action Plan	Resources
	Power	Need Current maintenance agreement on: all the paralleling switchgear?	4	2	8	Avoidance	Pete	System is brand new and any repairs will be paid out of pocket.	None
	Power	Need Current maintenance agreement on: all transfer switches?	4	2	8	Reserves	Pete	Low maintenace equip. repairs will be paid out of pocket	None
	Power	In the last 3 years has the main facility circuit breaker balancing analysis been done?	4	4	16	Reduction	Pete	We have two vendors quoting this and will have done in Q1-14	Novack - planning and mgt.
	Power	No full capacity generator load test has been done in the last 6 months? On both generators?	2	3	6	Reduction	Pete	Full load test planned for February 2014	Novack - Done one at a time to assure bu power avail - Gen Set shedding





# Client Deployment

- Orientation process
- AUP (Acceptable Use Policies), Master Agreement, Operating-Restrictions
- Policies
  - Security
  - Accessibility
- Procedures
- SLA (Service Level Agreement)
  - Systems are available for operation and use as committed or agreed
  - Operational problems are identified and resolved in accordance with documented policies or service level agreements
  - Customer grievance is identified and documented
  - Customer information designated as confidential is protected
  - Physical access is documented in customer SLA
  - Customers are notified via email in the event an SLA is compromised

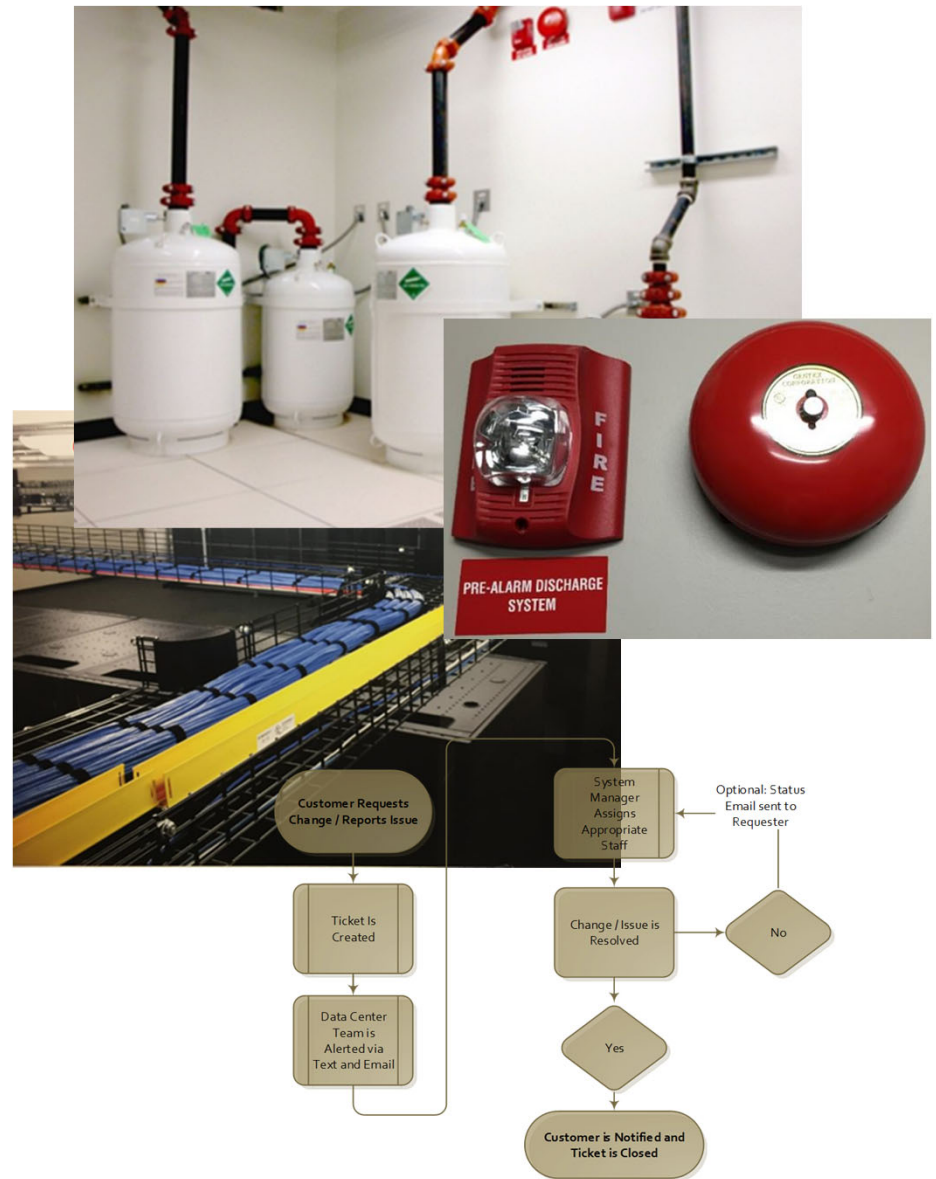
## Client Orientation Topics

- Badging and IDs
  - Photo ID, Prox Card and Fingerprinting
- Access Rights and Control
- Loading Dock Policies
- Security Policies
- Security Burglar Alarm
- Security Camera/Records



# Client Orientation Topics

- Fire Alarm and Suppression
- Rack Use
- Equipment Installation
- Cable Tray Use
- Monitoring
- Managed Services
- Ticketing System





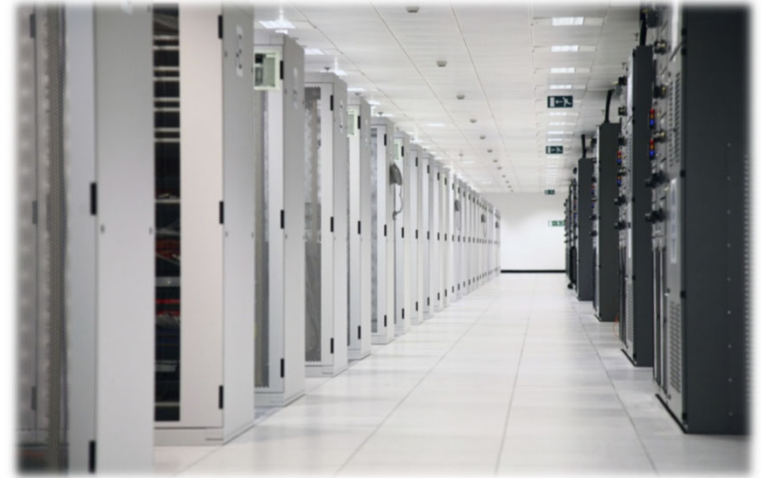
## Walk-Through Checklist

- Why do you need a walk-through checklist – you can't monitor "everything." The walk-through gives you a visual, auditory, tactile check on those things you can't or don't monitor. Blinking warning lights, odd or unusual noises, vibrations, odd smells, improper temperature or humidity, etc.
- How often does this need to happen – typically daily (sometimes multiple times per day if you have high client traffic) or at least weekly
- Who is involved in this - Typically performed by a data center operator or technician, or facilities person with a written list of what to look at and do



# DCIM – Data Center Infrastructure Management

- DCIM as defined by Gartner is the integration of information technology (IT) and **facility** management disciplines to centralize **monitoring, management, visualization, optimization** and **intelligent capacity planning** of a data center's critical systems
- DCIM solutions also provide the decision support technology to **drive greater *Efficiencies, Benchmarking and ROI*** in the Data Center

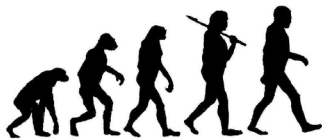


# The Evolution of DCIM



## Reactive

- Sirens, Strobes, and LEDs
- Local Annunciations



## Proactive

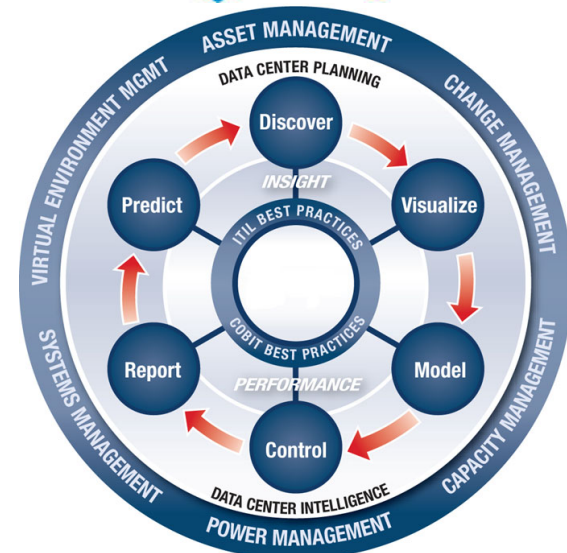
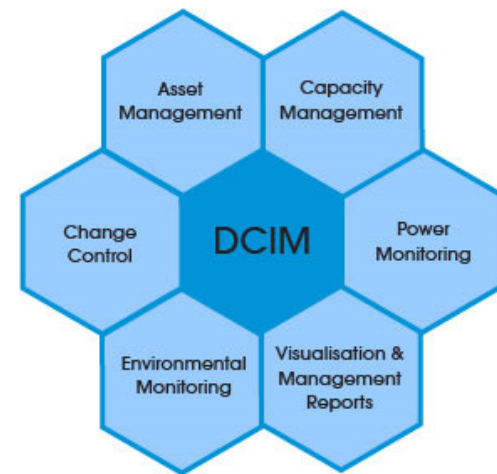
- Hardwired I/O
- Remote and Local Annunciations
- Early Asset Management
- Automation and Control

## Predictive

- Intelligent information collected via protocols
- Remote and Local Annunciations
- Correlate information
- Identify trends
- Integration with a variety of existing software

# DCIM – Data Center Infrastructure Management

- Documents where things are, how they relate, change, and are controlled
- One of the most confusing areas of Data Center Tools
- Many flavors and focuses
- Some main categories of DCIM:
  - Asset Management
  - Change Control
  - Customer Management
  - Monitoring and Control
- Typically labor intensive to configure or requires professional service





The consequences of data center downtime are high—**71%** say their **business model is dependent on the data center** to generate revenue & conduct e-commerce

The most common root causes of data center outages were

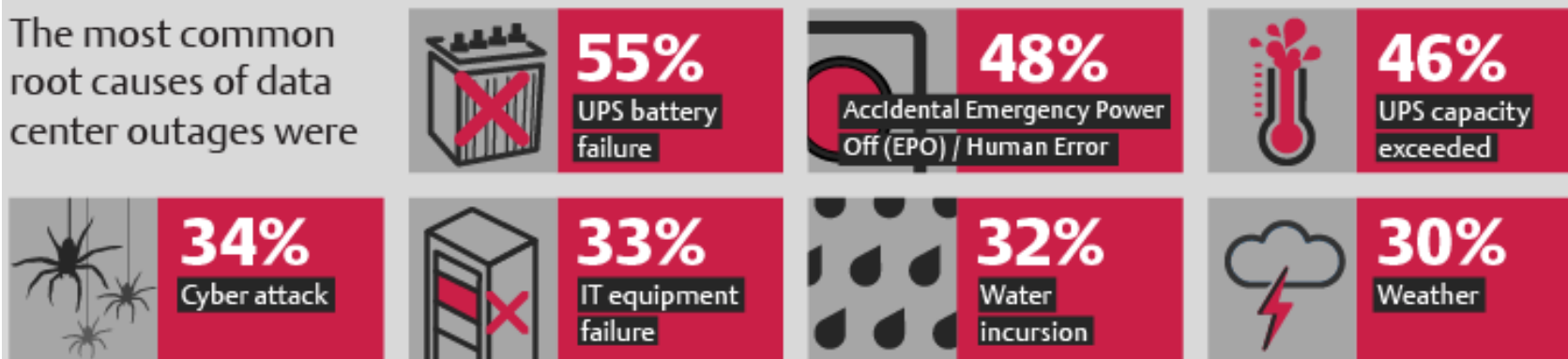
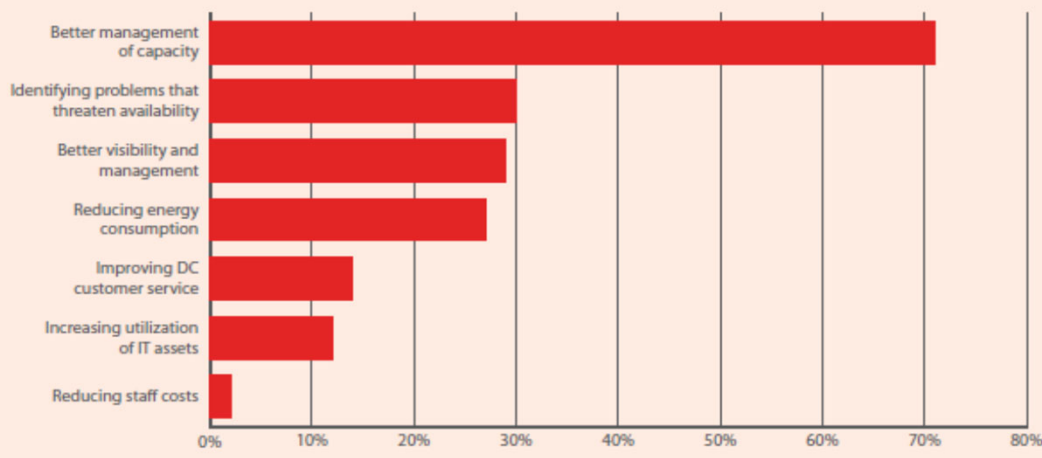


Figure 2: DCIM Adoption Drivers<sup>3</sup>



A study of 584 U.S. based data center professionals found that

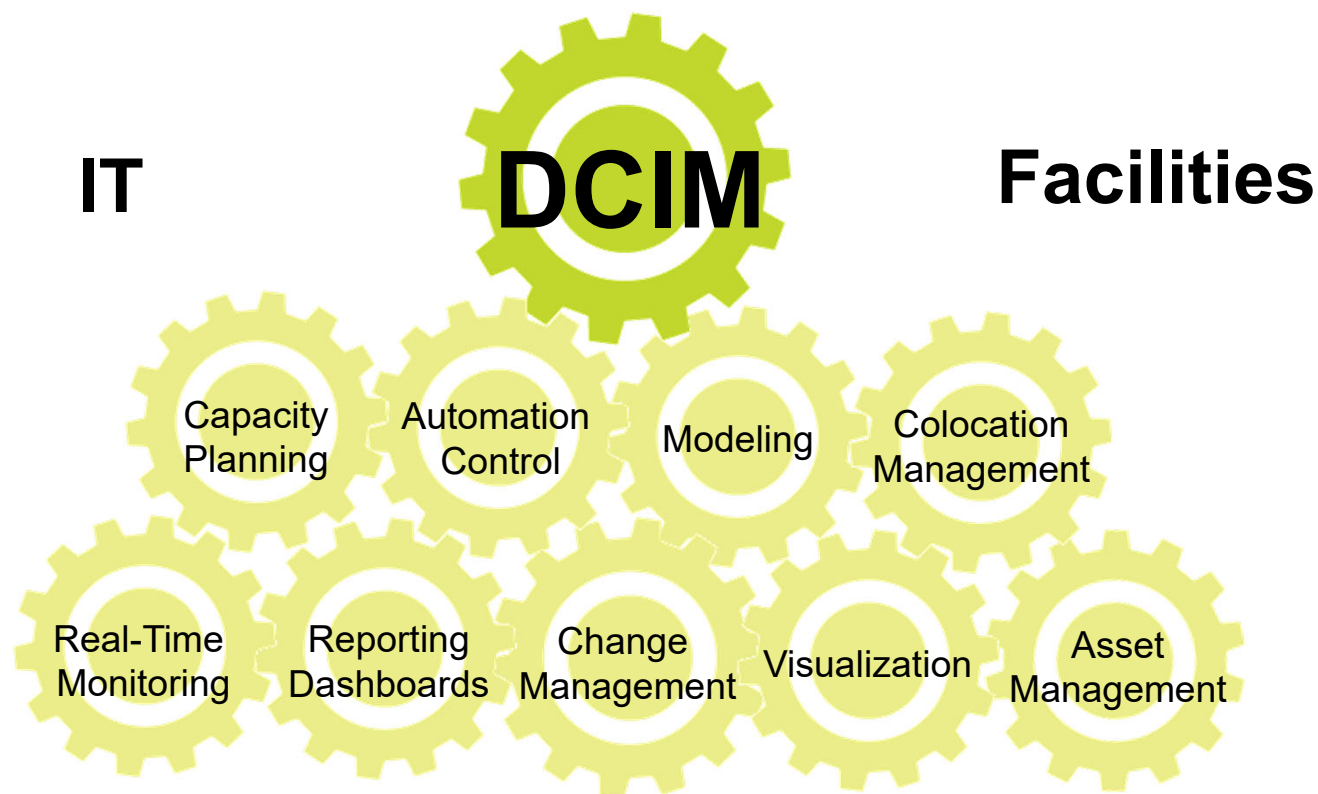
**91%** of data centers have experienced an **unplanned data center outage** in the past 24 months.<sup>2</sup>



<sup>2</sup> December 2013 Ponemon Institute Study and 2015 Uptime Study



# DCIM – Nine Core Elements



# DCIM – Asset Management

Think in terms of a hierarchical data system with “client” at top

- Customer(s)/Client
- Data Room(s)/Cage
- Rack(s) – Location (Row & #) - Size/Use
  - Power –
    - Panel
      - Breaker IDs – V, A, receptacle type, A/B redundancy
    - BusPlug ID(s)
      - Circuit ID(s) or PDU – CID, V, A, Plug(s), A/B redundancy
    - Static Transfer Switch V, A, Plug type
    - Branch Circuit Monitoring – CID, SNMP ID, BackNet, Modbus IDs,
    - Install Dates
  - Network – DIA (Direct Internet Access) or Carrier Circuit
  - Circuits
    - Elec (RJ45), Optical Fiber (Single Mode, MultiMode) (SC or LC con)
    - Bandwidth Requirements
    - Cross Connect – Carrier, CID, LGX locs, Ports,
    - DIA – HSRP, BW, IPs
    - Port(s), VLAN(s), IPs,
    - Install date
  - Monitoring
    - Port(s),
    - Bandwidth
  - Switch, Firewall, etc. (Spanning Tree)

# DCIM- Customer Management

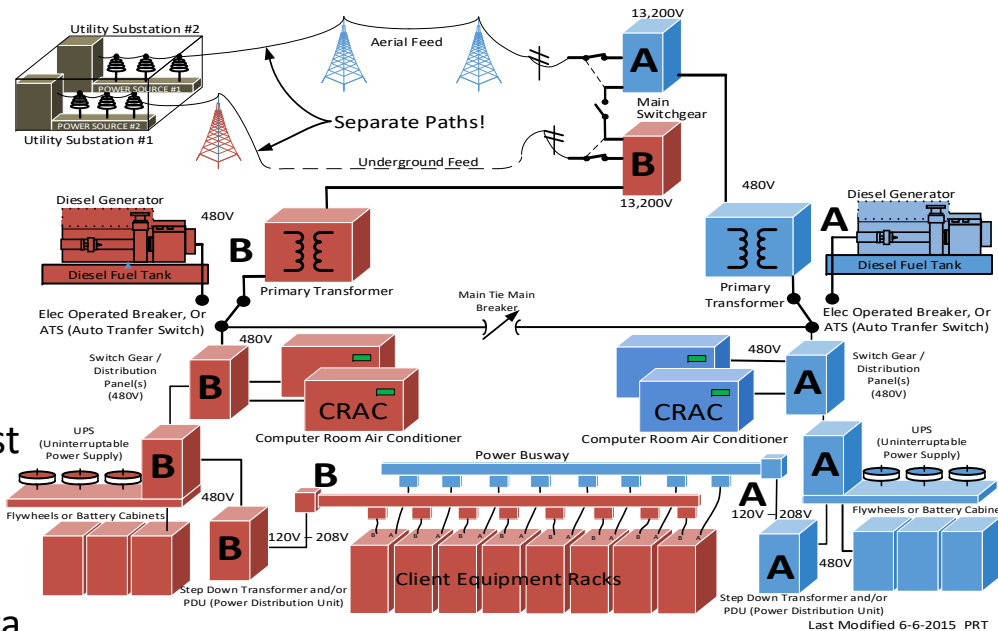
- Customer Management
- Customer(s)/Client(s)
  - Company Name, Main Contact
    - Contract Start Date – (Term Date)
    - Address(s) (Main, Billing, etc.)
    - Phone Numbers
    - Cage/Rack Lock Combination(s)
    - Access Authorizing Representative
      - Name, Title, Address, Email, Phone
    - Authorized Person to Access DC
      - Name(s), ID, Address, Phone(s), Email, Emergency Contact
      - Authorized Start Date – End Date
      - Key(s) (if required... Suite, Storage, etc.)



# DCIM- Monitoring

## Power Chain

- Utility Power
- Generator
- Switchgear
- ATS
- STS
- UPS
- TVSS
- Batteries
- Room Power Dist
- Branch Circuits
- Power Strips
- Outlet Level Data
- Relational One Line

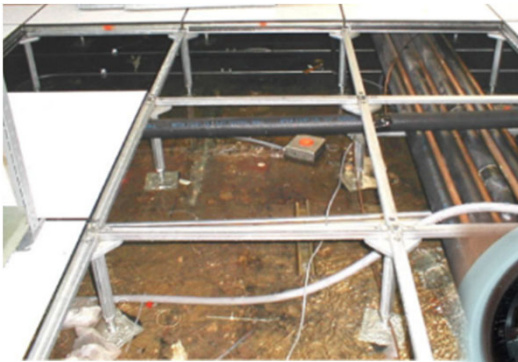


## Environmental

- Temperature
  - Rack inlet
  - Rack Exhaust
  - CRAC Return
- Humidity
- HVAC
  - CWS
  - Pumps
  - CRAC
  - Dry Cooler
  - VAV
  - Glycol Flow/Temp
  - Static Pressure
- Airflow
- Stratification

What **Can** you vs. what **Should** you?

# DCIM- Monitoring



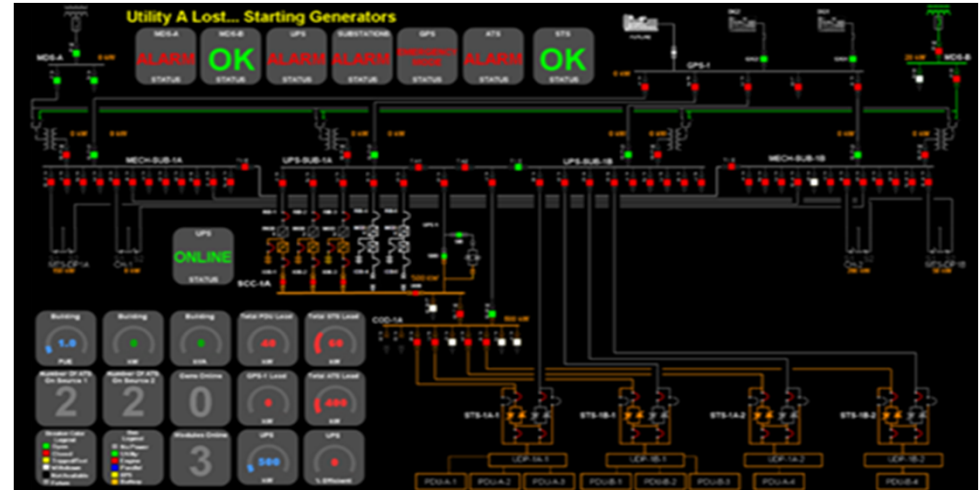
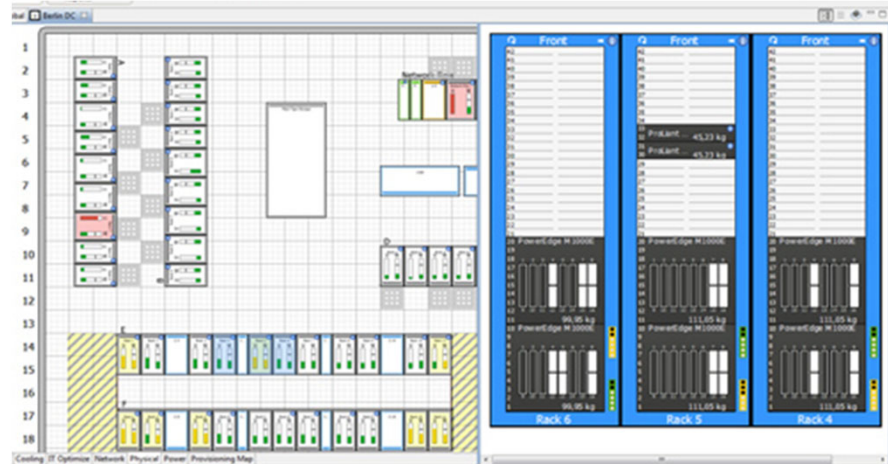
What **Can** you vs. what **Should** you?

## Other

- Water Leak Detection
- Access Control
- Cameras
- Door Contacts
- Motion Detectors
- Pre-Action/Fire
- Asset Management
- Network Connections
- Bandwidth
- Server Board Data
- VM resources
- Remote Facilities
- Fuel Management
- Security
- Lighting
- Other sensors or systems...

# DCIM- Monitoring

- Facility
  - Parking Lots (Video Surveillance)
  - Loading Docks (Access, Alarm, Video)
  - Windows (Glass Break Sensors)
  - Door Access System (Forced, Prop Alarms, Anti-Pass-Back)
- Data Room
  - Temperature
  - Humidity
  - Fire Suppression/Alarm
  - Burglar Alarm/Door Access/Man Trap
  - Security Video Surveillance
- Power - PUE
  - Facility
  - Data Room
  - Row/PDU
  - Rack/Branch Circuit
  - PDU/Outlet

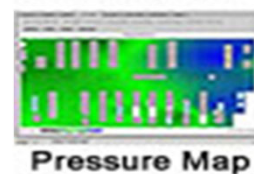
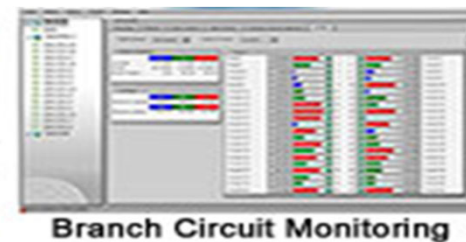
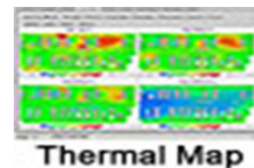


$$PUE = \frac{\text{Power to Racks}}{\text{Total D.C. Power}}$$

# DCIM- Monitoring

- Network
  - Facility
  - Carrier
  - DIA – Direct Internet Access
  - Customer/Circuit
- Processes/System Level (Trouble/Active Alarm)
  - Fire Alarm
  - Fire Suppression
  - Door Access
  - Video Surveillance
- Temperature
  - Room/Row/Rack/Device
- Humidity
  - Room Only
- Servers
  - NIC, Process, Peripheral
- Protocols – Dry Contact, SNMP, BackNet, Modbus, Proprietary

NODE	INTERFACE	RECEIVE	TRANSMIT
AS-7706	port-channel1001 - UCS Fabric Interconnect - A	1.307 Gbps	1.459 Gbps
AS-7706	Ethernet1/13 - SourcefireNexus	1.254 Gbps	1.093 Gbps
AS-7706	port-channel1002 - UCS Fabric Interconnect - B	1.37 Gbps	941.731 Mbps
AS-Cluster-A_FabricInterconnect	port-channel1 - U: Uplink	933.653 Mbps	1.363 Gbps
AS-7706	Ethernet2/35 - UCS Fabric Interconnect - A	904.481 Mbps	940.258 Mbps
AS-7706	Ethernet2/36 - UCS Fabric Interconnect - B	657.999 Mbps	696.33 Mbps
AS-7706	Ethernet1/35 - UCS Fabric Interconnect - A	529.841 Mbps	638.459 Mbps
AS-7706	Ethernet1/36 - UCS Fabric Interconnect - B	744.859 Mbps	405.051 Mbps
AS-7706	port-channel1 - *VPC-Link*	304.669 Mbps	372.231 Mbps
MC-7706	port-channel1 - *VPC-Link*	371.411 Mbps	299.663 Mbps





## DCIM – Predictive Analysis

- When will I run out of power?
- When will I run out of space?
- When will I run out of cooling?
- Historical information analysis
  - Anticipate future equipment failures
  - Preventative maintenance schedules
  - Tracking and auditing
- Capacity planning simulations
- Network Bandwidth and Port Capacity/Planning
- VM resource allocation



## DCIM – Vendor Selection

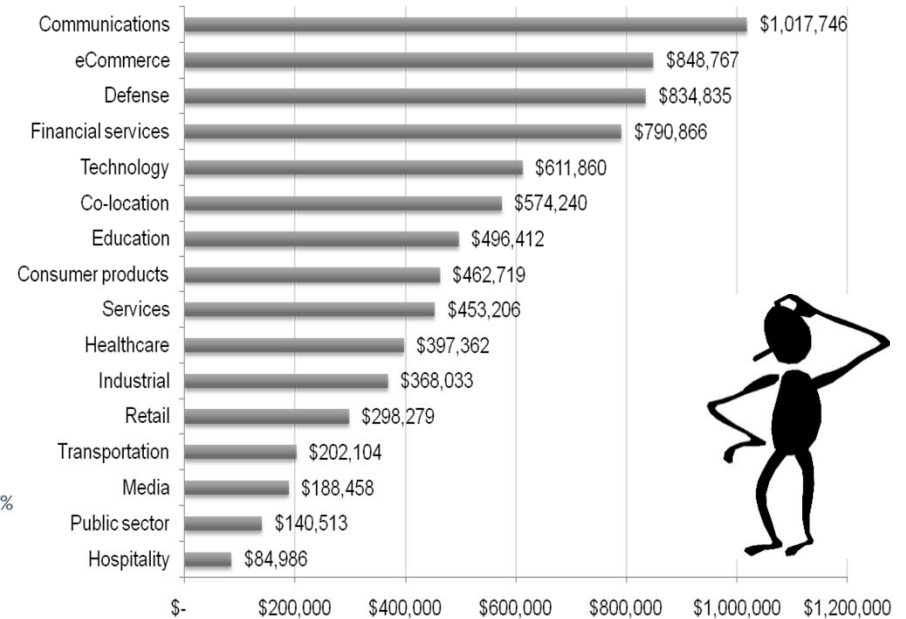
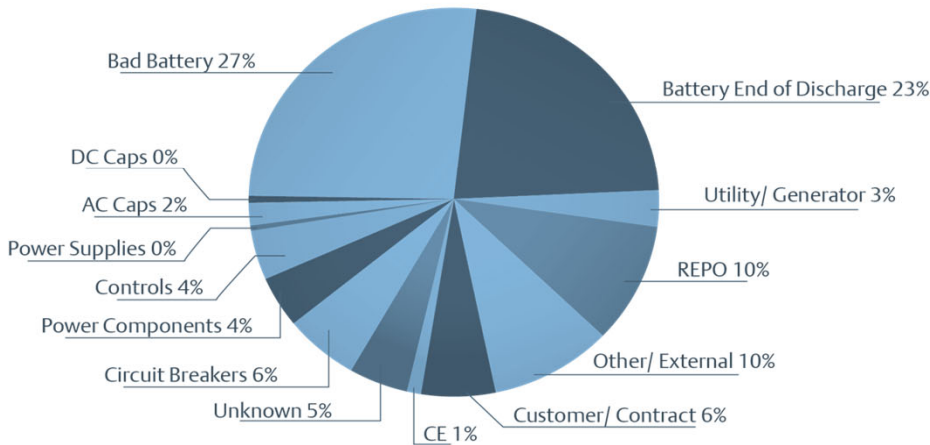
- What protocols do you support natively?
  - How do you manage protocols that are not native?
- What MFG or Vendors do you support?
- What notification methods are available?
- What customization can I do without calling you?
- What costs will be associated with growing this system?
- Do you modularize the solution? What do the modules include?
- How are systems supported?
- How do you accommodate unique LDAP/AD requirements?
- How much data can I store historically?
  - What reports are available to show this information?
- How do you handle API integrations?
- How does the system get backed up?
- What is the installed TCO?
- How are you involved with the growth path of my system?
- Can I customize my metric for my various datacenter locations?
- Customer References



# Cost of Data Center Outage

- Reputation
- Customer loss
- Loss of revenue
- Data loss

Causes of an outage



Cost of an outage



## Planned Service Interruptions

- Planned Service Interruptions should be rare if ever and never involve the data center services - 100% uptime goal
- Take extreme measures to avoid total DC down time
- Client communication – Data center clients must be made aware 2 to 3 weeks in advance of any outage effecting or potentially effecting their systems so they can inform you of conflict with schedule so plans can be changed
- This is typically done by email or a phone call to big clients
- Describe the nature of the outage, when it will occur, how long systems will be unavailable, and when systems will be fully back online if known

## Planned Service Interruptions

- Client communication
  - Reminder day before and day of interruption
  - Email 1 hr. prior and at time of maintenance window start
  - Email status updates periodically for longer maintenance windows
  - Email at conclusion of maintenance window with info on success, summarizing actions taken, and any client effecting consequences of actions taken





## Unplanned Service Interruptions

- Client communication – Data Center Clients need to be made aware immediately of an outage **EFFECTING THEIR SYSTEMS**
- Typically done by email and or text message within 5 to 15 minutes
  - Describe the nature of the outage and an estimate of when system will be fully back online if known
- As soon as possible describe exactly what services are unavailable
- Clients can subscribe to internal monitoring for instant alerts
- Root cause analysis – Describe in sufficient detail to be credible what caused the outage, why it happened, if known, and what will be done to avoid the same problem in the future
- Periodic updates for outages longer than typical (i.e., 15 min, 1 hour...)
- Standards (response policy) – aware 5-15 minutes, diagnose 15 min to 1 hr., resolution immediate to 4 hrs., max 24 hrs.

# Maintenance Practices and Protocols

- Preventative Maintenance agreements are in place
- Scheduled maintenance
  - CRACs and condensers
  - Primary transformers
  - Generator and switchgear
  - UPS
  - Breakers
  - Fire suppression and EPO
  - Transfer switch and control logic
- Transfer timing sequence testing
- Customer is given advance notification of any maintenance

## Generators

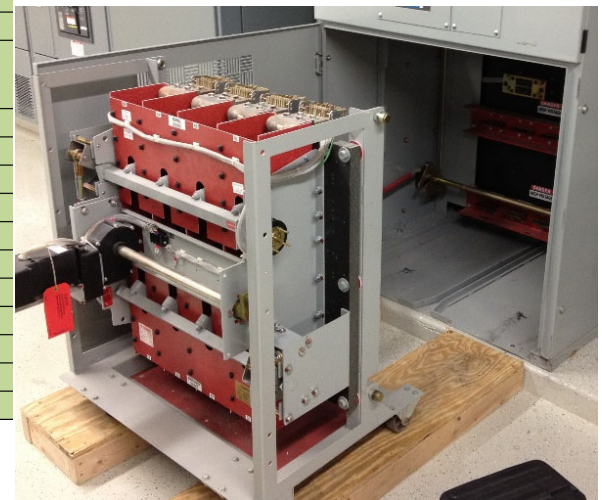
Manufacturer  
 Model #  
 Serial #  
 (kW rating) Size  
 Load Bank Testing  
 ATS Manufacturer  
 ATS Model  
 Number of PM's

## HVAC

Manufacturer  
 Model #  
 Serial #  
 Size  
 Number of PM's

## UPS

Manufacturer  
 Model #  
 Serial #  
 KVA size rating  
 #of Strings  
 #of Batteries per string  
 Battery model  
 Battery date  
 Service level  
 Annual load bank testing  
 External load bank testing requirements



# Maintenance Practices and Protocols

## Generator

- Radiator, Cooling, Hoses
- Heat Exchanger
- Belts/Pulleys/Chains
- Fuel & Governor System
- Fuel Tanks/Fuel Polishing
- Battery and Starting System
- Air Intake System
- Exhaust System
- Filters/Breathers
- Gen Set/Electrical System
- Lubrication & Oil System
- Control Panels
- Load Bank Testing



## Diesel Generator Maintenance Checklist

### General Operations

1. Make a walk around inspection of the complete installation. Make sure generator enclosure is water tight. Tighten gasket and seals as needed.
2. Check the unit for capacity to be online within 10-15 seconds. (IMPORTANT) Time Observed: \_\_\_\_\_
3. Check the unit for abnormal noise or vibration. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
4. Re-check the oil level after engine shutdown. Allow adequate time for drain down. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
5. Re-check for leaks with engine running. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
6. Check the inlet and discharge louvers for proper operation with engine running. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
7. Test over crank alarm for proper operation and illumination. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
8. Check and record voltage without load and adjust if needed. Value: \_\_\_\_\_
9. Check and record frequency without load and adjust if needed. Value: \_\_\_\_\_
10. Check and record cooling system temperature. Value: \_\_\_\_\_
11. Simulate power loss with customer's approval only. Ok? Yes: \_\_\_\_\_ No: \_\_\_\_\_
12. Check and record voltage with load and adjust if needed. Value: \_\_\_\_\_
13. Check and record frequency with load and adjust if needed. Value: \_\_\_\_\_
14. Check and record amperage with load. Value: \_\_\_\_\_



# Maintenance Practices and Protocols

## UPS

- Batteries
- Cables and Connections
- Capacitors (AC & DC)
- Filters and Fans
- Static Bypass System
- Maintenance Bypass System
- Inverter & Rectifier
- Transformer or Transistors
- EPO – Emergency Power Off
- Control System and Displays
- Alerts, Enunciators
- Breakers



### **UPS Minor Preventive Maintenance (PM)**

**(Visual Inspection)** – check for discoloration, damage, debris and cleanliness

- Check area for any safety concerns that may affect the safety of the technician, and or the customer. **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- Check subassemblies, wiring harnesses, contacts, cables and other major components for burns or broken wires. **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- Clean or replace all air filters as needed (DC@SC will Supply). **Replaced, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- Check all fans for slow start and free rotation. **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- Check AC input and output for proper wiring, grounding and verify to NEC code standards. **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**

**UPS Major PM** – Complete “UPS Minor PM” then perform the following:

- (Power Connections)** – Check torque, integrity and continuity-
  - Cables/Copper bus **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Inverter, Rectifier, Bypass, inductors, DC bus **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - AC and DC Capacitor banks **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Fuses (AC and DC) **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- (Operation of Bypass Circuit)**
  - Manually transfer UPS to Bypass and back. **Success, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Check aux contacts for continuity upon actuation **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- (Component identification) -**
  - Locate and record AC and DC capacitor model and serial # (record count) **Completed, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Locate and record fan/blower model and serial # (record count) **Completed, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- (Meter Readings)** – Hand held Volt/Ohm Meter- Measure and Record
  - Power Supply voltages **Ok, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - OEM specific parameters (calibrate if necessary where possible) **Done, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Calibrate Display (where possible) to meter readings **Complete, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- (\*System Operation Test)** – Upon Approval from Customer
  - Open utility feed to UPS rectifier input and allow UPS to go to battery for customer approved amount of time. **Success, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - Return utility feed to return to normal operation **Success, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
- (Service Report)** – Deliver to customer within 10 business days
  - Outline any problems found with recommendations **Complete, Yes: \_\_\_\_\_ No: \_\_\_\_\_**
  - If operation test is performed, note results of test **Complete, Yes: \_\_\_\_\_ No: \_\_\_\_\_**

# Maintenance Practices and Protocols

## Maintenance Inspection Checklist—Monthly

### 9.0 MAINTENANCE INSPECTION CHECKLIST—MONTHLY

### Computer Room Air Conditioner:

Date: \_\_\_\_\_ Prepared by: \_\_\_\_\_  
 Model #: \_\_\_\_\_ Serial #: \_\_\_\_\_

#### Filters

- \_\_\_\_\_ 1. Unrestricted air flow
- \_\_\_\_\_ 2. Check filter switch
- \_\_\_\_\_ 3. Wipe section clean

#### Blower Section

- \_\_\_\_\_ 1. Impellers free of debris
- \_\_\_\_\_ 2. Bearings free
- \_\_\_\_\_ 3. Belt tension and condition

#### Compressor Section

- \_\_\_\_\_ 1. Check for leaks
- \_\_\_\_\_ 2. Check oil levels

#### Air Cooled Condenser (if applicable)

- \_\_\_\_\_ 1. Condenser coil clean
- \_\_\_\_\_ 2. Motor mount tight
- \_\_\_\_\_ 3. Bearings free and in good condition
- \_\_\_\_\_ 4. Refrigerant lines properly supported

#### Refrigeration Cycle/Section

- \_\_\_\_\_ 1. Check suction pressure
- \_\_\_\_\_ 2. Check refrigerant lines
- \_\_\_\_\_ 3. Check head pressure
- \_\_\_\_\_ 4. Check for moisture (sight glass)
- \_\_\_\_\_ 5. Check discharge pressure
- \_\_\_\_\_ 6. Check hot gas bypass valve
- \_\_\_\_\_ 7. Check thermostatic exp. valve

#### Reheat

- \_\_\_\_\_ 1. Check reheat element operation
- \_\_\_\_\_ 2. Inspect elements for cleanliness and corrosion

#### Steam Generating Humidifier

- \_\_\_\_\_ 1. Check canister for deposits
- \_\_\_\_\_ 2. Check condition of steam hoses
- \_\_\_\_\_ 3. Check water make-up valve for leaks

#### Infrared Humidifier

- \_\_\_\_\_ 1. Check pan drain for clogs
- \_\_\_\_\_ 2. Check humidifier lamps
- \_\_\_\_\_ 3. Check pan for mineral deposits

- Compressors
- Condenser Coils, Fans, Controls
- Evaporator Coils
- Filters and Fans
- Humidification System
- Dampers
- Motor Starters, Capacitor
- Control System
- Heaters and Re-heaters
- Inspect Electrical Contactors
- Refrigerant Pressures
- Inspect Electrical Breakers
- Look for leaks



# Maintenance Practices and Protocols

## Primary Transformer

### Infrared Scanning

- Loose Connections
- Hot Spots
- Includes main switch gear
- Transfer Switch Connections

### Oil Analysis

- Chemical Analysis
- Decomposition
- Contamination

### Cooling Fin Inspection

### Visual Inspection

- Loose or damaged surfaces,
- doors and covers

### Transformer Inspection - Retrofill Corporation



**Transformer  
Inspection  
Retrofill**

2704 Normandy Road  
Royal Oak, MI 48073  
Tel: 248.549.4026  
Fax: 248.549.2641  
Cell: 248-953-8540  
dcampbell@tircorp.com

- High Voltage Maintenance
- Electrical Testing
- Fluid Testing
- Electrical Construction
- Transformer Repair/Sales
- Design/Build Services
- EPA Compliance
- Thermographic Surveys

### PROPOSAL

██████████ Proposal No. ██████████  
 Email: ██████████

On August 17, ██████████ TIR personnel performed the inspection and fluid sampling and analysis including dissolved gas and moisture from one transformer and performed a thermographic inspection of the transformer and adjacent main secondary distribution panels at your location. Complete reports are enclosed.

The fluid test results including the dissolved gas analysis are within industry standards.

The thermographic inspection indicated no abnormalities at this time.

The visual inspection did note fluid leaking from the top plug on the rear center fin.

Furnish equipment, material and labor to drain the fluid from one General Electric transformer, serial number ██████████ remove the top plug from the fin, clean, apply new sealant, reinstall and return fluid to unit.

A power interruption will be required. Power Company charges if any are not included.

We propose to furnish labor and material – complete and in accordance with above specifications, and subject to conditions of this agreement, for the sum of

<b>Normal Work Day, M-F, 8:00 am to 4:00 pm</b>	<b>\$1,145.00</b>
<b>After Store Hours or Saturday</b>	<b>\$1,369.00</b>
<b>Sunday/Holiday</b>	<b>\$1,657.00</b>

A signed copy of this proposal along with the terms and conditions must be in our office prior to scheduling any work. This proposal is valid for 30 days after the date upon which it was written.

Please review additional terms and conditions of this Proposal. These terms and conditions are incorporated by reference as if fully set forth herein and are part and parcel of this proposal. We propose to furnish labor and material - complete in accordance with above specifications, and subject to conditions of this agreement.

**Payment to be made as follows: NET THIRTY DAYS**

ACCEPTED. The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Respectfully Submitted,

**Transformer Inspection Retrofill**

Date of Acceptance \_\_\_\_\_

By \_\_\_\_\_

# Maintenance Practices and Protocols

- Transfer Switch/Big Breakers
  - Electrical Measurements
  - Hot Transfer Testing
  - Manual operation if available
  - Generator start circuitry
  - Mechanical component cleaning, lubrication, and wear inspection
    - Requires un-racking if possible
  - Settings Verification
    - Phase synchronization delays
    - Return to Normal power delays
    - Generator Cool down timing
  - Generator Exercise Set-up
    - Frequency Calendar
    - Load/no-load options
  - Alerts and monitoring testing



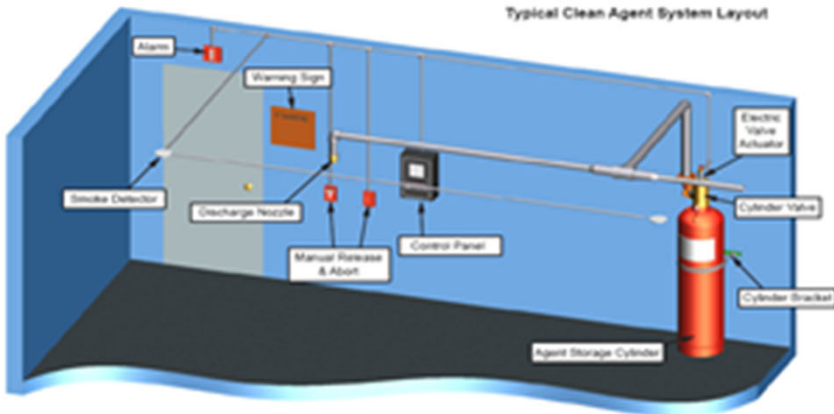
<p><b>Section 9 Maintenance</b></p> <p><b>⚠ DANGER HAZARD OF ELECTRICAL SHOCK</b></p> <p><b>Failure</b> injury</p> <p>Periodic maintenance on the component parts. The interval amount of usage and environmental conditions. Recommended inspection intervals throughout this manual, unless otherwise specified.</p> <p>Always inspect the switch before energizing.</p> <p><b>Transfer Switch Inspection</b> In general, the following general maintenance program must be followed for the electrical system.</p> <p>Periodic inspection of the transfer switch is subject to "Normal Operating Conditions" and "Harsh Operating Conditions" according to these conditions. If any of the following operating conditions occur, the switch must be inspected and maintained.</p> <p>These inspection and maintenance conditions cannot be established unless the manufacturer's instructions are followed.</p> <p>These inspection and maintenance conditions are superseded by component manufacturers' instructions. "Russellectric Conditions of Sale" apply.</p> <p><b>Ideal Operating Conditions</b> When the equipment is operated, it should be able to operate under the following conditions:</p> <p><b>Environmental</b></p> <ul style="list-style-type: none"> <li>• Ambient room temperature range is 50°F to 100°F</li> <li>• Altitude is less than 6600 ft (2012 m).</li> <li>• Equipment is located indoors in a climate controlled environment.</li> </ul>	<ul style="list-style-type: none"> <li>• Absence of dust or debris either airborne or settled.</li> <li>• Relative humidity is less than 70%.</li> <li>• Absence of corrosive vapors.</li> </ul> <p><b>Circuit Loading</b></p> <ul style="list-style-type: none"> <li>• Continuous load ratings.</li> <li>• Average load ratings.</li> <li>• Only resistive loads.</li> <li>• Transfer switch ratings.</li> <li>• Maximum operating temperature.</li> </ul> <p><b>Equipment Installation</b></p> <ul style="list-style-type: none"> <li>• Torque all bus bar joints, lugs, and bolts to their appropriate tightness at installation.</li> <li>• Securely tighten all control and communications wiring at installation.</li> <li>• Follow pre-energizing checkout rigorously.</li> </ul> <p><b>Normal Operating Conditions</b> When the equipment is operated, it should be inspected and maintained under the following conditions:</p> <p><b>Environmental</b></p> <ul style="list-style-type: none"> <li>• Ambient room temperature range is 50°F to 100°F</li> <li>• Altitude is less than 6600 ft (2012 m).</li> <li>• The effect of solar radiation is significant.</li> </ul> <p><b>Note: Refer to the product literature for more information.</b></p> <p><b>Circuit Loading</b></p> <ul style="list-style-type: none"> <li>• Transfer switch ratings.</li> <li>• Welding or jogging loads represent greater than 15% of a circuit's load.</li> </ul> <p><b>Equipment Installation</b></p> <ul style="list-style-type: none"> <li>• Torque all bus bar joints, lugs, and bolts to their appropriate tightness at installation.</li> <li>• Securely tighten all control and communications wiring at installation.</li> <li>• Follow pre-energizing checkout rigorously.</li> </ul> <p><b>General Inspection and Cleaning</b></p> <p><b>CAUTION HAZARD OF EQUIPMENT DAMAGE</b></p> <ul style="list-style-type: none"> <li>• Do not use an air hose to blow out the switch. The dust may settle inside relays and over current devices, causing overheating and improper operation.</li> <li>• Do not allow paint, chemicals, or petroleum based solvents to contact plastics or insulating materials.</li> </ul> <p><b>Failure to follow this instruction can result in equipment damage.</b></p> <ol style="list-style-type: none"> <li>1. Vacuum the switch interior to remove any dirt or dust deposits. Wipe all bus bars, insulators, cables, and so forth, with a clean, dry, lint-free cloth.</li> <li>2. Check the switch interior carefully for moisture, condensation build-up, or signs of any previous wetness. Moisture can cause insulation breakdown and rapid oxidation of current carrying parts. Inspect all conduit entrances and cracks between the enclosure panels for driving leaks. Condensation in conduits may be a source of moisture.</li> </ol> <p><b>Bus Bar Joints, Lug Terminations, and Insulating Materials</b></p> <p><b>CAUTION HAZARD OF EQUIPMENT DAMAGE</b></p> <ul style="list-style-type: none"> <li>• Do not stand or remove plating on any bus, splice plate, or terminal lug.</li> <li>• Damage to plating can result in overheating. Replace damaged part. Contact Russellectric Inc. Field Services at 1-800-654-3020.</li> </ul> <p><b>Failure to follow this instruction can result in equipment damage.</b></p> <ol style="list-style-type: none"> <li>1. Bus bar joints are maintenance-free. Do not retighten them after the pre-energizing checkout procedure is complete.</li> <li>2. Check all bus bar joints and terminal lugs for any pitting, corrosion, or discoloration resulting from high temperatures or subjection to high fault conditions. If any damage has occurred, replace the bus bars or lugs. If cleaning is required, use Lectra-Clean®, made by CRC.</li> <li>3. Inspect all insulating materials. Before re-energizing the switch, replace insulators having any visible damage (such as cracks).</li> </ol>
--	--

# Maintenance Practices and Protocols

 **Fire Defense Equipment Co., Inc.** 24 HOUR EMERGENCY SERVICE  
 4350 Delemere Boulevard, Royal Oak MI 48073-1807  
 Phone: 248/549-8113 Fax: 248/549-6260 Email: firedefense@firedefense.com

## Clean Agent System Inspection, Testing, and Maintenance Service (Complies with NFPA 2001, NFPA 72, Local Codes, and Manufacturer Recommendations)

Service Location	Bar Code	Area/Zone Protected	Service Date	Service Order #
██████████	1782	DATA CENTER "A", "B" & ELECTRICAL RM	██████████	██████████
Type of Service (check one): <input type="checkbox"/> Annual; <input checked="" type="checkbox"/> Semi-annual; <input type="checkbox"/> Quarterly; <input type="checkbox"/> Other: _____				
Item Inspected/Tested/Maintained	Qty	OK	Not OK	Comment/Note
1 Notify AHJ and/or alarm service prior to testing		x		██████████
2 How many separate areas are protected?	3			DATA CENTER "A", "B" & Electrical Rm.
3 Any changes in hazard area size		x		Last change & acceptance was ██████████ for Area "B"
4 Hazard area layout agrees with graphic/drawings		x	x	Current "As-Builts" being redone for newest add
5 Room seals visually appear to be OK		x		
6 Doors found blocked open	8	x		2 - Area "A", 4 - Area "B" & 2 - Electrical rm
7 Pipe and nozzle visual inspection OK		x		
8 Portable extinguishers appropriate for area?		x		
9 Control panel make and model				Fike Cheetah Xi
10 Control panel firmware version		x		V6.20
11 Control panel processor serial number				262076034
12 Disable suppression before testing		x		3 Red Selector switches
13 Disable interlocks before testing		x		3 Yellow Selector switches
14 Verify all terminals in panel are tight		x		
15 Remove GCA's / Impulse Valves before testing	6 / 3	x		Area "A" & Electrical rm = 3 GCA each / "B" = 3 1V
16 Battery voltage/amp hours	2			2 @ 12v - 18ah
17 Batteries last changed date		x		1/15/13
18 Battery voltages ok after load test?		x		Verified at ██████████ Acceptance test - OK & today



## Fire Suppression System (Clean Agent Assumed)

Requires defeating discharge valve pyrotechnical device

Test "Dead Man" hold button

Test manual release station(s)

Test dual detector delay system

Test audible alarm phases

Fire Alarm Integration

Test individual detectors

EPO integration testing

Test zone interaction/isolation

Agent Tank Inspection

Inspect agent levels

Inspect for over/under charging

Test discharge firing circuitry

Inspect for physical damage or wear

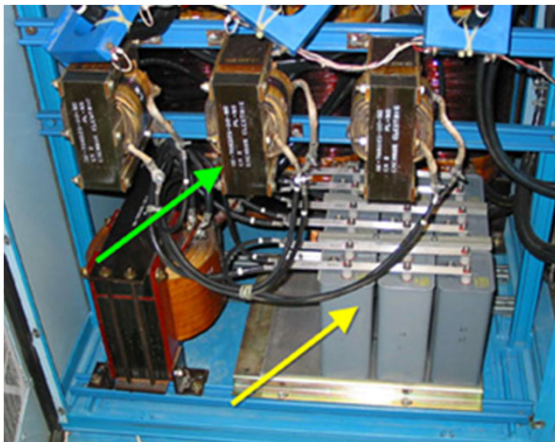
# Maintenance Practices and Protocols

## Hoses, Wires, Water Jacket

- Cracks
- Leaks
- Wear Patterns
- Pinching/Collapsing
- Over Temperature
- Rotting

## Electrical Connections

- Infra-Red Scanning
- Sparking
- Stained
- Mis-shapen (Budging Capacitors)



## Mechanical Parts

- Excessive Vibration
- Loose Fasteners/ Connections
- Unusual Noise
- Wear or Damage
- Bearing Whine/Rattle
- Loose, Broken or Missing Guards
- Un-locked or Loose Covers

## Measurements

- Electrical Amperages, Voltages, Phase balances
- Battery Float Levels



## Fluids, Lubricants Proper Levels

- Chemical Analysis (Break Down)
- Expected Life
- Color
- Contaminants
- Drying or Coagulation
- Odd or Burning Smell

## Power Quality Measurements

- Power Factor
- Sags
- Phase Drops or Loss
- Harmonic Noise



## Maintenance – Infrared Scans.

- What's that buzz? – what creates sound
- You may hear a 60 Hz buzz sound in the power room
- The electromagnetic pulsing of 60 Hz AC power can cause wires to vibrate
- Vibration, over time, can loosen threaded connections
- Vibrating can loosen connections in electrical panel
- When electrical connections become loose they heat up
- Infrared scanning for elevated temperature can identify loose connections
- This is particularly important regarding the bolted connections to large breakers





## Contracted Maintenance

- Maintenance is mandatory for all major data center systems
  - Generators, UPS, Switchgear, Primary Transformers, Large Breakers, CRACs, Fire Suppression, Fire Alarm, Fire Extinguishers, Burglar Alarms, etc.
- Manufacturer maintenance is very expensive but more comprehensive
- Third party maintenance companies can be much more economical and adequate for HA data centers if selected and managed properly
- Notification letter to selected maintenance vendor
- The secret is knowing what you are buying - Do your research and know what a reasonable PM (Preventative Maintenance) is for every system
- **MOST IMPORTANT: DO COMPETITIVE BID WITH RFP CONTAINING DETAILED REQUIREMENTS, TYPICALLY IN THE FORM OF A CHECK LIST – (Build from a Mfg. start up check list)**



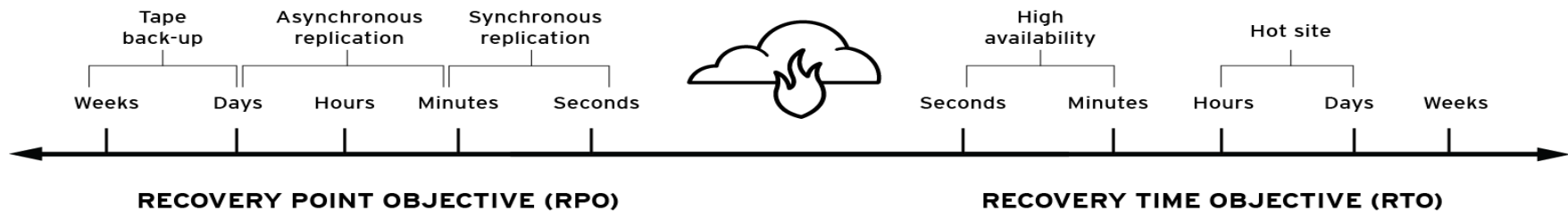


## Disaster Recovery

- A set of processes and systems used to take over if your facility or part of it becomes un-usable for a set period
- Business continuity planning
  - How an organization guards against loss of productivity, loss of systems, or future disasters
  - Depends on “risk tolerance” and “down time sensitivity”
  - Policy statement
  - Recovery strategies
  - Plan development
- First responder guide – who are the first people to swing into action

# Disaster Recovery

- First thing to define when planning a Disaster Recovery site:
  - **RPO – Recovery Point Objective** – time since last full backup - how much data can you afford to lose
  - **RTO – Recovery Time Objective** – time from outage to fully back online and in production – typically 1 hr. to several days





## Disaster Recovery

- Keep clients online and in operation
- Typically means another data center or a cold/warm/hot site
- The cloud and virtualization have revolutionized this industry
- Example of how to create:
  - Identify critical systems and applications – only plan to retain these in a disaster
  - Have management decide on their RPO and RTO targets for these systems/apps
  - Identify the capacity elements to run these – compute, storage, network, etc.
  - Create a “run-book” or script needed to replicate and “online” this system(s)
  - Assuming you are virtualized, replicate your target VMs and Data based on RPO
  - Create your Virtual Data Center at your DR site with DNS and Active Directory
    - This is the most challenging part of DR - to get to the RTO target you have defined

# First Responders

- DR events are rare... chaos, confusion, and frustration will be intense so your response plan should be near auto-pilot
- Guidelines, communication, and first response policy are the core
- If and when the data center or a critical application goes down hard, who needs to be involved in getting it/them back up
- Think this through and have a communication plan tailored for each critical application and total outage
- Standard protocols clearly and unambiguously define expected response times and responsibilities down to the individual and back-up individuals
- Have emergency contact information readily available and make sure everyone is absolutely aware – needs to be in-your-face – no brainer





# Uptime Institute Tier Rating

## Tier I- Basic Capacity

- Tier I – Infrastructure that includes a dedicated space for IT systems; an uninterruptible power supply (UPS); dedicated cooling equipment; and an engine generator

## Tier II – Redundant Capacity Components

- Tier II -The redundant components include power and cooling equipment such as UPS modules, chillers or pumps, and engine generators

## Tier III – Concurrently Maintainable

- Tier III – Does not require shutdown for maintenance or equipment replacement - Has same features as Tier II along with redundant distribution paths for power, network, etc.

## Tier IV – Fault Tolerance

- Tier IV – Builds on Tier III.... Active-Active



## Who Is Uptime Institute

- An unbiased advisory organization focused on improving the performance, efficiency, and reliability of business critical infrastructure through innovation, collaboration, and independent certifications
- Recognized globally for the creation and administration of the Tier Standard and Certifications for Data Center Design, Construction, and Operational Sustainability along with its Management & Operations reviews, FORCSS (Financial Opportunity Risk Compliance Sustainability Service Quality) methodology, and energy efficiency initiatives
- They have been in business and rating data centers since 1993

**Uptime**  
Institute™

**DATA CENTER WORLD**  
AFCOM®

# Incident Ticketing System

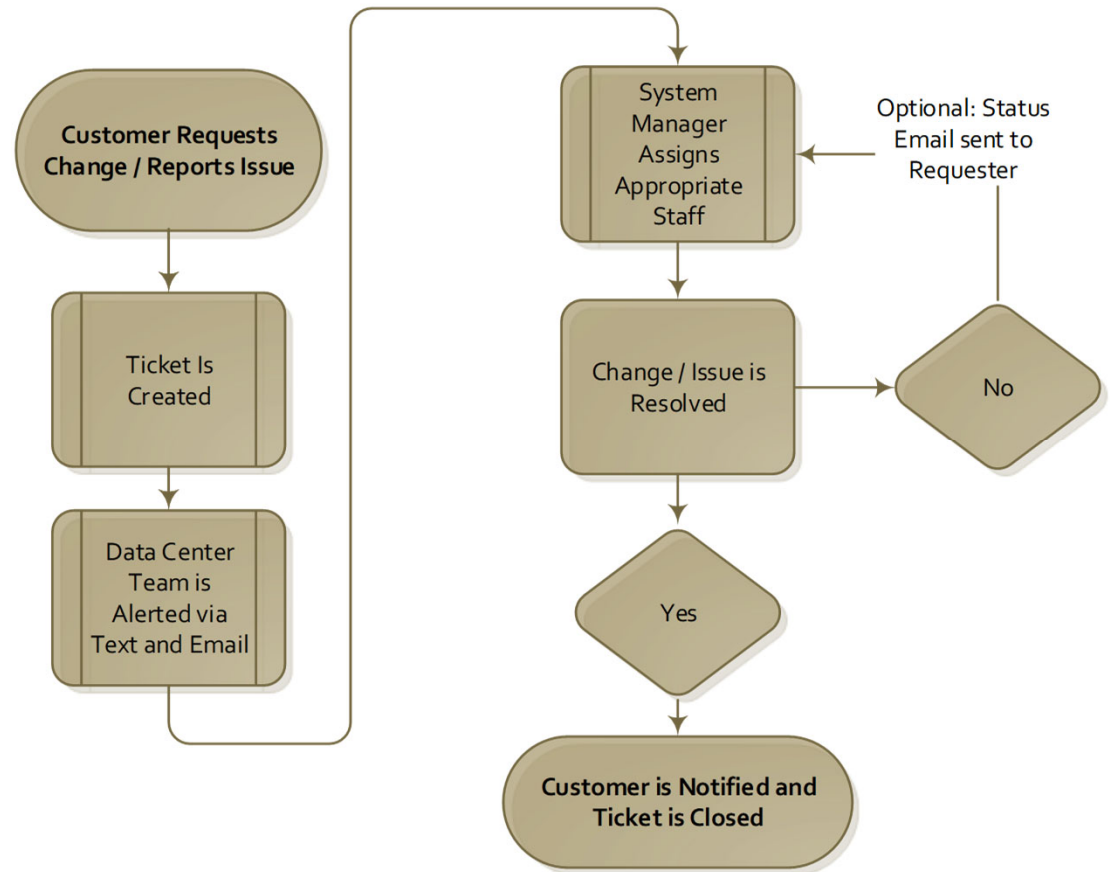
Tracking/Routing

Documentation

Resolution

Notification

Workflows



# Ticketing/Reporting

- Requestor with contact info
- Project, Product, System
- Project Manager
- Short description/title
- Description
- Task type – Category
- Technician assigned
- Status (open, hold, closed)
- Update/email - cc options
- Time
- Priority (critical, med, low)
- Start date... close date
- Comments/Follow-up
- Attachments
- Internal/External
- Reports
- History tracking

Support Centre
{ TICKETS }

Date Raised 
Time Raised 
Ticket Number **805-161-023** Copy

Client ID <u>ROD</u> (Rodent Incorporate...)	<span style="border: 1px solid gray; padding: 1px;">Build Caller List</span>	Assigned <span style="color: green;">✓</span>
Caller's Name <u>Michael Rodent</u>	<span style="border: 1px solid gray; padding: 1px;">Lookup Details</span>	Acknowledged <span style="color: green;">✓</span>
Caller's Telephone <u>020 7771 1234</u>		Completed
Caller's Email <u>michael@rodent.co.uk</u>		Signed-Off
Method of Contact <input checked="" type="radio"/> Email <input type="radio"/> Telephone <input type="radio"/> Meeting		
Office ID <u>ROD1</u> ()	<span style="border: 1px solid gray; padding: 1px;">Build Asset List</span>	

Find Open Tickets
Send Custom Email

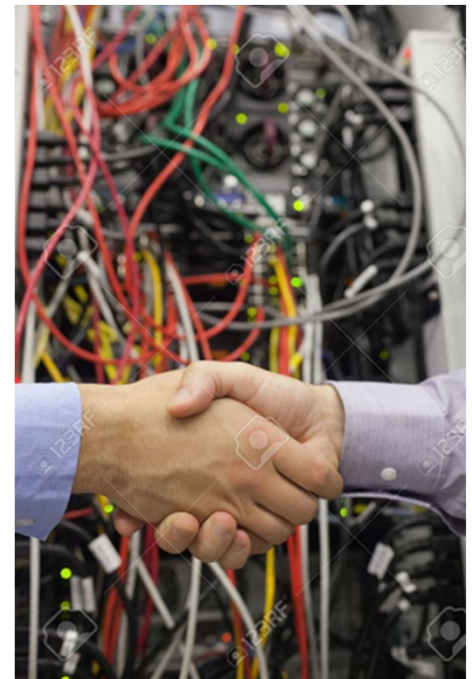
Issue	Progress	Solution	Notes	Time Log
Heading <u>Printing Issues</u>		Category <u>Software</u>		
Priority <u>X</u>	<span style="border: 1px solid gray; padding: 1px;">Calc Target</span>	Target Date/Time <u>Mon 16/6/08</u>	<u>17:30</u>	
Assigned To <u>Hill, Benny</u>	<span style="border: 1px solid gray; padding: 1px;">Set Date/Time</span>	Date/Time <u>Fri 16/5/08</u>	<u>10:23</u>	
Acknowledged By <u>Hancock, Tony</u>	<span style="border: 1px solid gray; padding: 1px;">Send Email</span>	Date/Time <u>Fri 16/5/08</u>	<u>10:23</u>	
Completed By _____	<span style="border: 1px solid gray; padding: 1px;">Set Date/Time</span>	Date/Time _____		
Signed-Off By _____	<span style="border: 1px solid gray; padding: 1px;">Send Email</span>	Date/Time _____		
Chargeable work	Est Hours <u>15</u>	<span style="border: 1px solid gray; padding: 1px;">Send Approval Request Email</span>	Sent D/T <u>Fri 16/5/08</u>	<u>11:06</u>
Approved By _____	<span style="border: 1px solid gray; padding: 1px;">Set Date/Time</span>	Date/Time _____		
Confirmed By _____	<span style="border: 1px solid gray; padding: 1px;">Send Confirmation To Caller</span>	Date/Time _____		

Created by \_\_\_\_\_ at 23:23 on 16 May 2008, modified by \_\_\_\_\_ at 23:25 on 16 May 2008



## Addressing Client Needs

- Customer service is a huge differentiator in the Colocation Data Center community
- Clients are looking for problem solvers not order takers
- Have a, “yes we can” attitude - How can I help you,... I don’t know but I will find out
- Don’t nickel and dime clients - Have extra rack screws, power cords, plug adapters, velcro, minor tools, crash cart(s), equipment cart, pallet jack, remote hands, etc.
- Be present for deliveries, questions, be able to recommend services, equipment, or solutions to common install problems



# Data Center Operations-Space

- Ways to sell space
  - Single device
  - Portion of a rack up to multiple racks
  - Private cage
- Managed services onsite – remote hands, set up, and configuration
- Utilization of space
- Cost effective
- Modularity



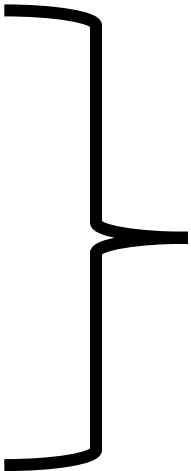




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CRIMMP – represents key strategies to be applied to the major resources and services provided by a data center. When fully considered and implemented, assures a robust, resilient, and available data center system that can meet the required RPO and RTO.

- **C** – Capacity
- **R** – Redundancy
- **I** – Infrastructure
- **M** – Monitoring
- **M** – Maintenance
- **P** – Policy



- Power
- Cooling
- Network
- Security
- Building/Floor Plan

Fun Facts:

CRI... mostly relates to Data Center Design

...MMP mostly relates to Data Center Operations

Crimp – press together – squeeze together – to secure in place – to join firmly – to bond – to press or draw together, as the ends of something



Data Center

**Questions?**



## 3 Key Things You Have Learned During this Session

1. The systems, processes, and policies typically used to run a successful data center
2. Operational best practices sufficient for various audit compliances for a commercial data center
3. Practical examples of tools that can be used to accomplish the above goals in an operational setting



Thank you

Patrick R. Turner, Vice President and Chief  
Information Officer  
Schoolcraft College  
18600 Haggerty  
Livonia, MI. 48185

