Monitoring Tools for Data Center Operations

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H5 Data Centers

Introduction

- Over the recent years, data centers have become a very important part of everyday lives as they provide support for:
  - Internet cloud solutions
  - Content streaming
  - Internet of Things (IoT)
  - Host social media sites
- To ensure all the equipment hosted at data centers operates properly, the data center critical infrastructure systems must operate without any interruption 24 x 7 including
  - Power systems
  - Cooling infrastructure
  - Network connectivity

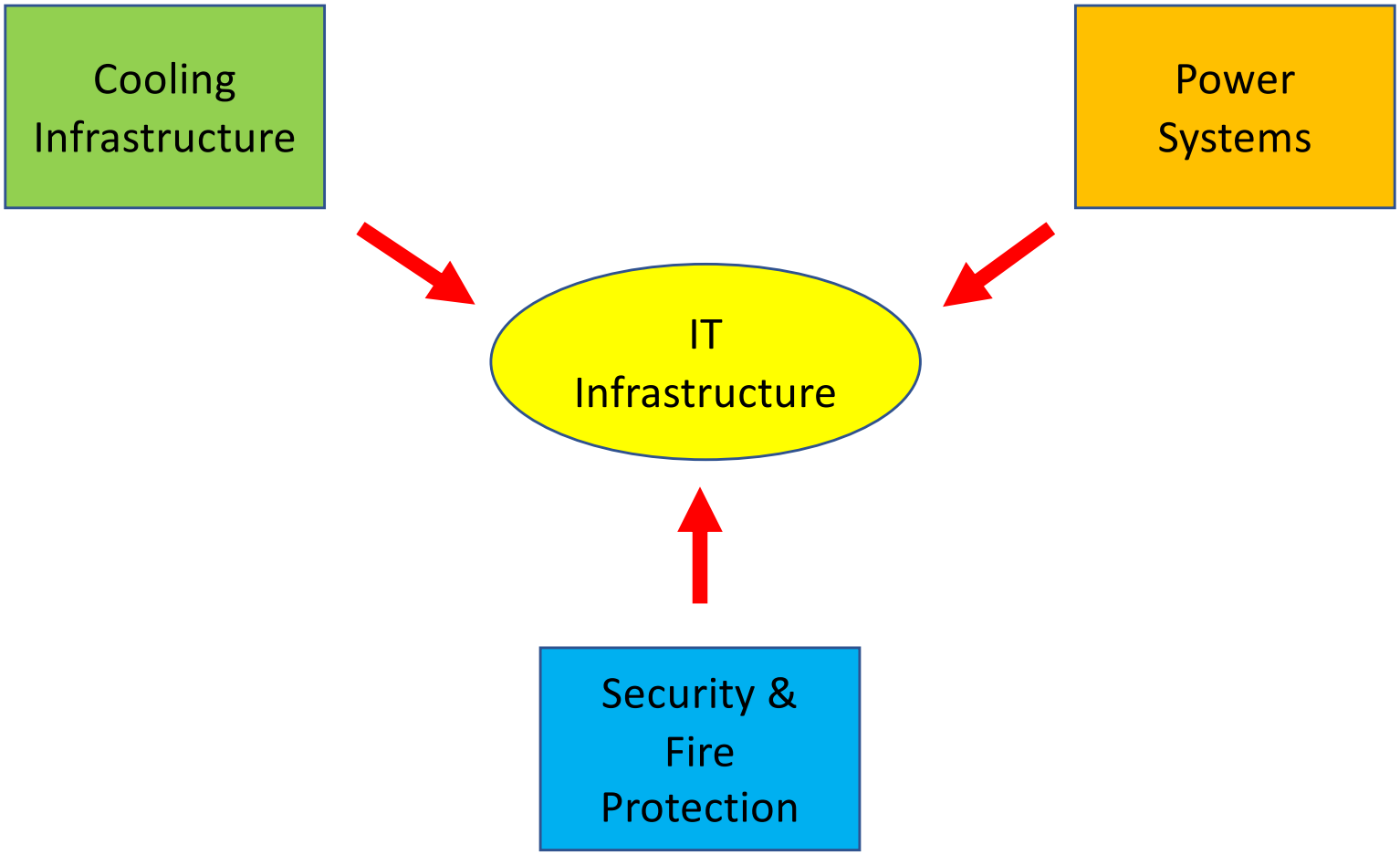
Introduction (cont'd)

- To achieve such uninterrupted 24 x 7 operation target data centers utilize
  - Highly trained personnel
  - Redundant infrastructure
  - Continue monitoring
  - Predicted fault analysis
  - Preventive maintenance
- This presentation reviews the different types of monitoring and management tools available for handling data center operations and critical infrastructure

Data Center Overview

- Data centers are designed to support the uninterrupted operation of the IT infrastructure within a secure environment
- IT infrastructure include servers, storage and network equipment that support Internet based applications
- Critical infrastructure which is used to support the IT infrastructure includes backup power generators, uninterrupted power systems (UPS), precision cooling systems, etc.

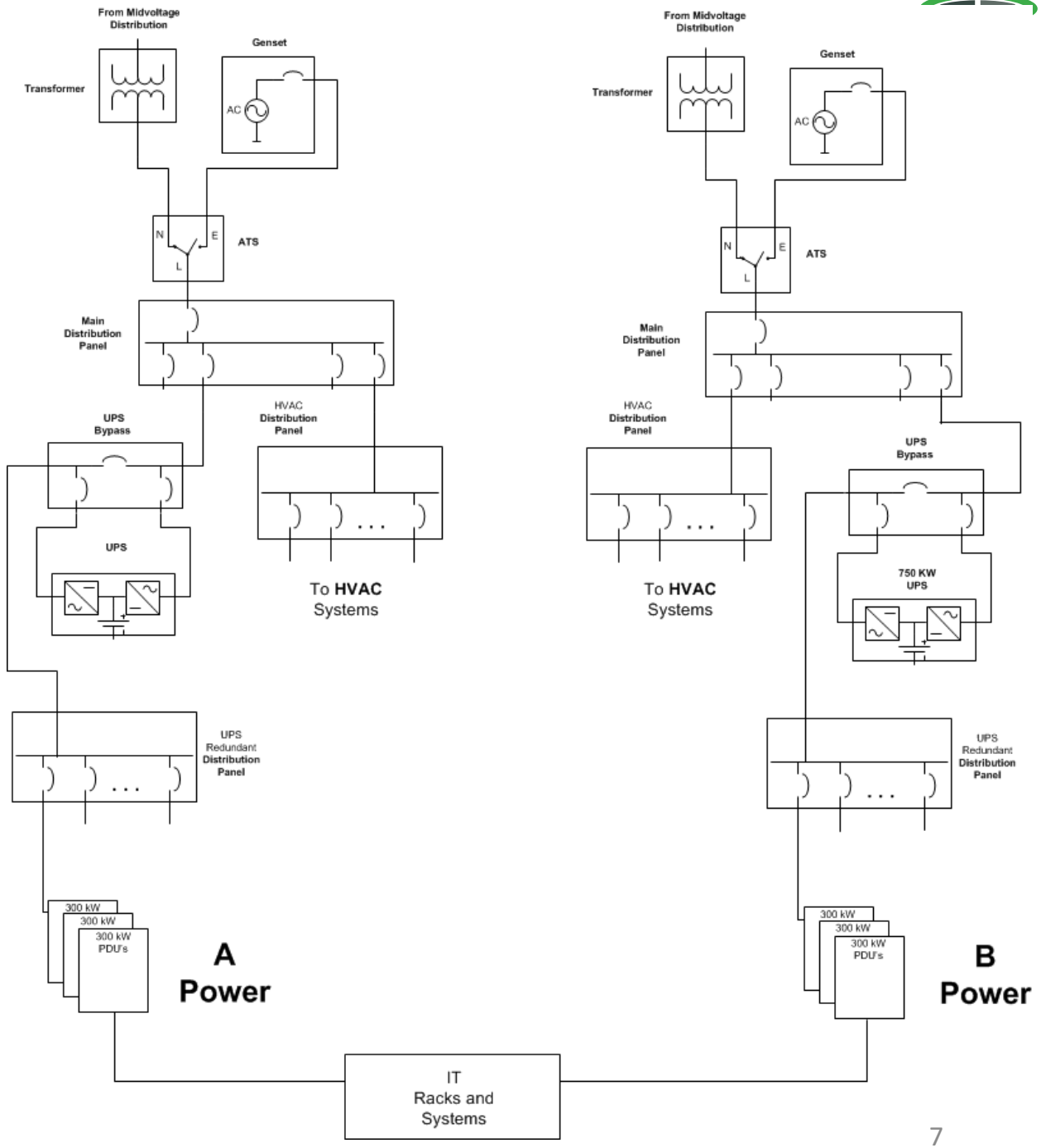
Data Centers



Data Center Power Systems

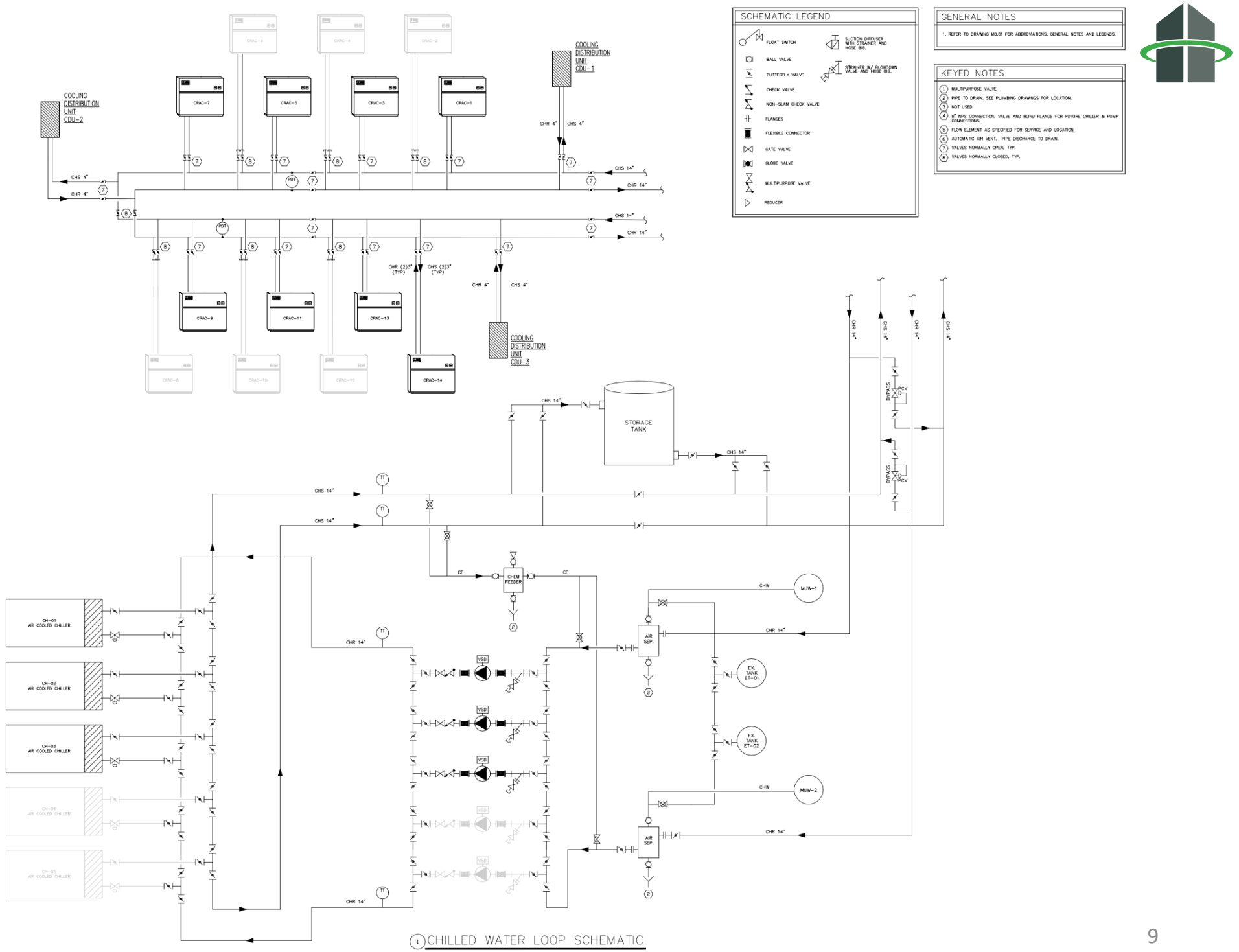
- Data center power systems are designed to provide redundant reliable power for the IT and environmental systems
- They rely in a backup power generator and uninterruptable power systems to ensure continue and clean supply of power
- For redundancy, multiple independent power line-ups are used to provide alternative power sources

Redundant Power Line-ups



Data Center Cooling Infrastructure

- Data centers utilize precision cooling technology to maintain adequate temperature and relative humidity for IT equipment. Common technologies include
  - Water based system using water- or air-cooled chillers and CRAH (computer room air handler) units
  - CRAC (computer room air conditioning) and condenser units
- According to ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), a class A1 data center can range in temperature from 59°F to 89.6°F and in relative humidity from 20% to 80%

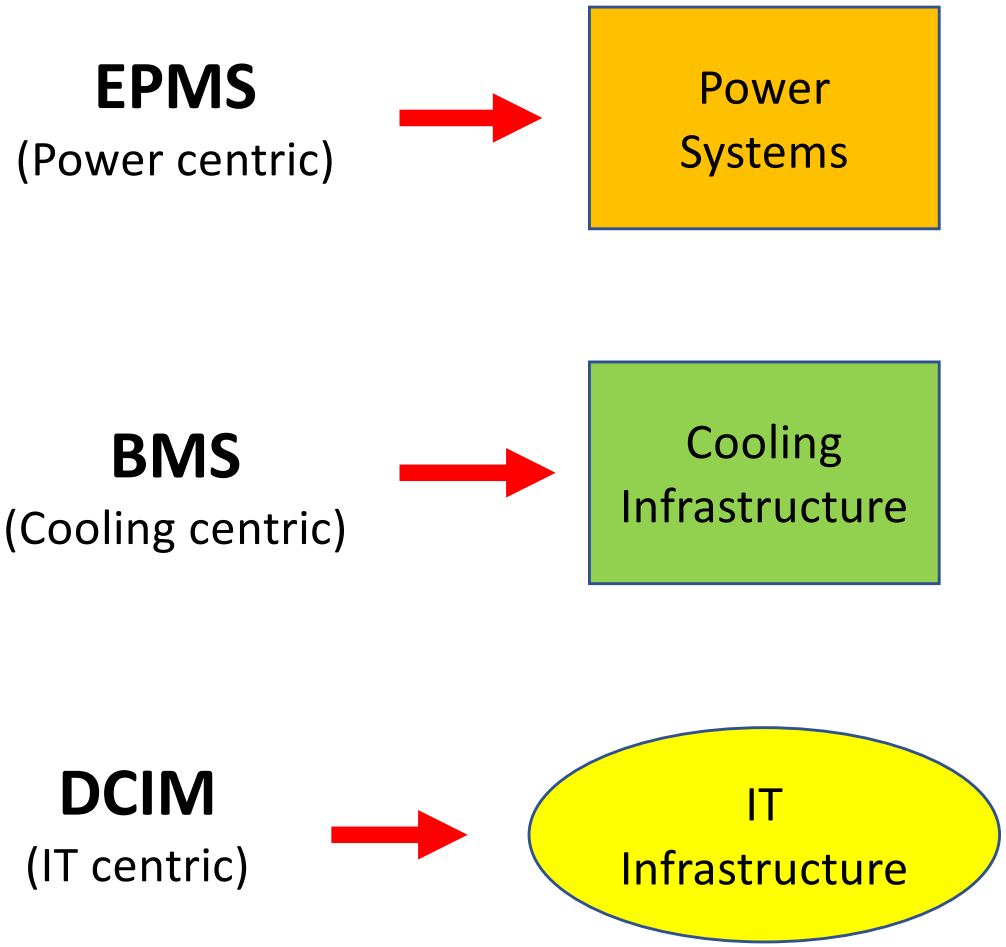


1 CHILLED WATER LOOP SCHEMATIC

Monitoring and Management Tools for Critical Infrastructure

- There are three (3) main groups of monitoring and management tools for supporting data center critical infrastructure
  - Electrical Power Management System (EPMS)
  - Building Management System (BMS)
  - Data Center Infrastructure Management (DCIM)
- All these different tools provide capability such as:
  - Obtain monitoring and performance information
  - Manage alarm and warning from equipment and systems
  - Control equipment and system configuration, allowing for set point adjustment
  - Collect statistics and trends from equipment and system performance

Monitoring Tools



Electrical Power Management System (EPMS)

- EPMS is a software system that provides detailed information about the flow of energy in a power distribution system
- Ensure safe, efficient, and compliant operation of electrical distribution systems, including all connected electrical equipment
- EPMS has been developed primarily by companies supplying electrical distribution equipment
  - It is a power system centric tool, and can also manage the life cycle of electrical equipment

Applications for EPMS

- In recent years, EPMS has featured significant advancements in power and energy analytic tools. In addition, device power meter and power quality sensor solutions have become cost-effective and available in most electrical equipment
- Types of applications typically used by EPMS includes:
  - Electrical system health and efficiency
  - Capacity management
  - Equipment monitoring
  - Power event analysis
  - Equipment management

Electrical System Health and Efficiency

- EPMS can continuously monitoring and analyze the following items
  - Monitor whether the three phases of power are balanced on all parts of the power distribution system will help maximize efficiency, avoid overloads, and identify any potential faults in loads such as motors
  - Monitoring for excessive neutral current can identify grounding problems and wasted energy
  - Power factor is another parameter that should be measured, since a low value indicates energy is being wasted
    - In addition, it could incur a penalty on the utility bill. This condition may need corrective steps, such as installing a capacitor bank

Capacity Management

- EPMS can assist with power capacity management with the following items
  - Analyzing historical trends help identify circuits that are more heavily loaded or, worse, at risk of tripping breakers due to overloading
    - This is especially vital when operating a critical facility with backup power systems, such as hospitals or data centers
  - It can also discover if there is extra, unused capacity in some circuits that could be used to address load balancing or to cost-effectively support dynamic environments where facility or process expansions are common

Equipment Monitoring

- EPMS can assist with improving overall power quality with the following items
  - Monitor power quality problems coming from the utility grid to determine nature, duration, etc.
  - Monitor power quality from within internal electrical distribution system
    - As facilities modernize to improve energy efficiency, the addition of LED lighting, VSD (variable speed drive for motors), and automation equipment can produce harmonics
    - Identifying and mitigating excessive harmonic distortion can help avoiding problems for sensitive equipment and improve energy efficiency

Power Event Analysis

- EPMS can assist with power event analysis with the following items
  - Electrical distribution networks regularly experience power disturbances that travel extremely quickly through the system and are short-lived
  - Advanced power quality monitoring devices capture these disturbances at distributed points in power system, while power management analytics help to quickly follow the sequence of events to isolate and respond to root causes

Equipment Management

- EPMS can assist with equipment management with the following items
  - Manage equipment inventory with warranty information, preventive maintenance scheduling, etc.
  - Track equipment failure and operational issues
  - Manage equipment changes on configuration and firmware upgrade
  - Collect information to predict power equipment failure with cloud-based analytics

Building Management System (BMS)

- BMS is a software system that provides management and monitoring for mechanical and electrical systems within a building or facility
  - Systems like security and fire protection can also be handled by the BMS
- It is a legacy system created to manage/monitor the safe and efficient operation of larger buildings and facilities
- BMS has been developed primarily by companies supplying cooling and building control equipment
  - It is an environmental centric tool, and can manage the life cycle of building or facility equipment

Applications for BMS

- Design to provide a single dashboard for operating systems of a building or a facility, including
  - Implement the control and operations for cooling system. It incorporates logic for operate chillers, pumps, air handlers, etc.
  - Control lighting operation throughout the building or facility
  - Manage the operation of elevators, access control, video surveillance cameras and overall security
  - Monitor and manages the fire protection systems
  - Provide support for energy management for a building or a facility

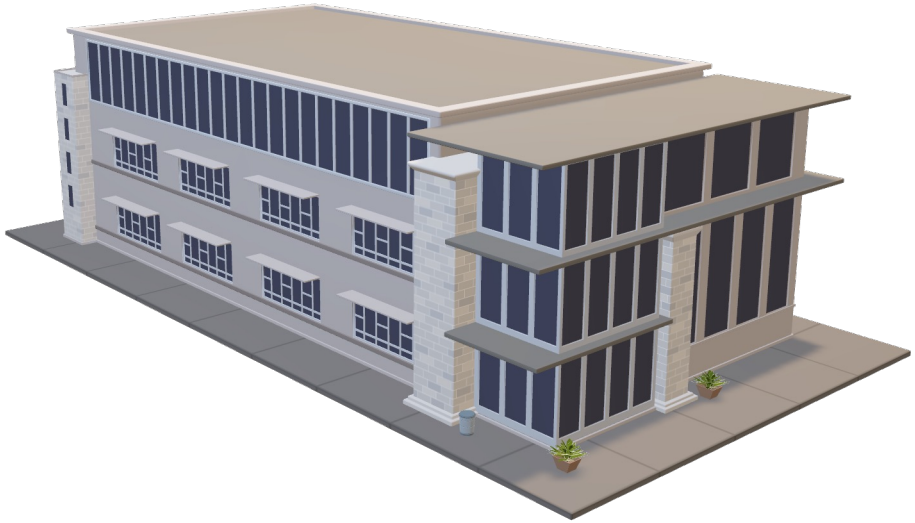
Applications for BMS

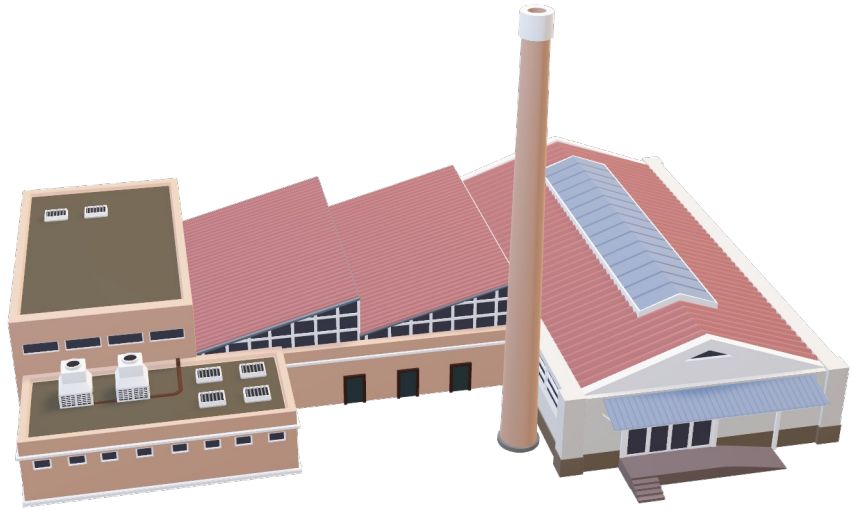
Lighting

Access Control

HVAC

Video Cameras





Elevator

Fire Protection

Security

Energy Management

Cooling Systems Control

- Large cooling systems require a precise control across multiple component for achieving proper and effective operation
  - Control of temperature and relative humidity through different areas of a building or a facility requires precise coordination between multiple cooling equipment such as chillers, pumps, air handlers, etc.
  - Variables such as water temperature, pressure, fan speed need to be controlled through a pre-defined logic to ensure proper operation
    - In addition, if redundancy is required, the control logic will increase in complexity
  - BMS is design to support such control logic and monitoring for proper operation of the cooling system

Data Center Infrastructure Management (DCIM)

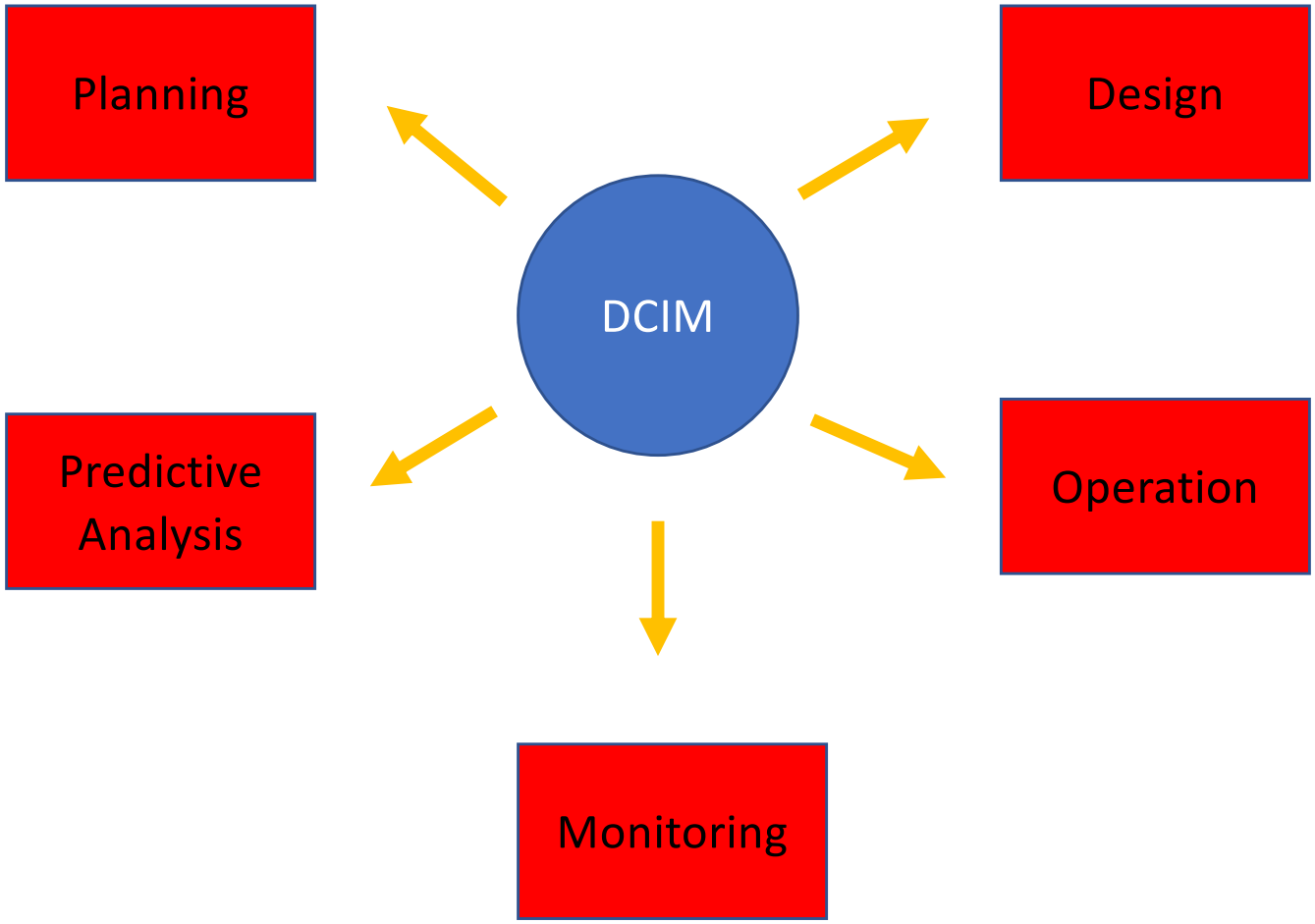
- DCIM is a software system used to monitor, measure, and manage and/or control data center utilization and energy consumption, covering both IT equipment and supporting infrastructure such as power and cooling systems
  - It is designed to assist the data center to achieve maximum energy efficiency and to prevent equipment problems that lead to downtime
- It can be viewed as an IT centric evolution of EPMS. It focus on the IT infrastructure and critical infrastructure required to operate the IT infrastructure
- DCIM software include to main components
  - Monitoring/automation module
  - Planning/implementation module

DCIM Components

- Monitoring and Automation
  - Deal with the IT room, facility power, environmental control, and security
    - Help ensure the data center is operating as designed and provides user-configurable thresholds for alarms on physical devices, including heat, ventilation and air conditioning
    - Report on real-time, average, and peak power use, and measures power usage effectiveness (PUE).
- Planning and Implementation
  - Focus on helping to facilitate data center changes, deployment of new equipment for peak efficiency, and track assets
    - Support “what-if” scenarios to help with planning and reducing total cost of ownership

PUE = IT Power/Total Power

Applications of DCIM



Design

- DCIM provides key information in designing the proper infrastructure
  - Power usage and availability, cooling capacity and network traffic data at the rack level help to determine the optimum placement of new servers and storage
    - Without such information, key decisions on new equipment placement at the data center would be based on estimated metrics
    - Too little equipment strands valuable data center resources (space, power and cooling)
    - Too much equipment increases the risk of shutdown due to exceeding the available resources

Operation

- DCIM can help to enforce standard processes for operating the data center
  - Contain the MOPs (method of procedures) and SOPs (standard operating procedures) for the organization
  - Manage the change control process for the organization, handling communication, scheduling, approval, etc.
  - These consistent, repeatable processes reduce operator errors which can account for many system outages

Monitoring

- DCIM provides operational data, including environmental data (such as temperature, relative humidity, air flow), power data (such as voltage, current, power) at each device, rack, zone and data center level, and network usage data
  - In addition, DCIM may also provide IT data such as server, storage and network device resources (i.e., usage for CPU, memory, disk, network)
  - This data can be used for warning and alerts when thresholds are exceeded, reducing the mean time to repair and increasing availability

Predictive Analysis

- DCIM analyzes the key performance indicators from the monitoring application as key input into the planning phase
  - Capacity planning decisions are made based data collected during the monitoring phase
  - Tracking the usage of key resources over time, for example, can provide valuable input to the decision on when to purchase new power or cooling equipment
  - DCIM is capable to analyze trends and determine when different system resources could become critical

Planning

- DCIM can be used to analyze “what if” scenarios such as server refreshes, impact of virtualization, and equipment moves, adds and changes
  - The main benefit of DCIM is the information gathering allowing for better planning decisions
  - Every aspect of data center management revolves around having complete and accurate information that is provided by the DCIM

Integrating Tools

- Based on the size and requirements of the data center, the three tools discussed in this presentation may be required for supporting operations
  - Smaller deployment may be able to operate without all three tools
- When deploying all three tools
  - It is necessary to ensure the configuration information matches among all tools
  - It may be required to elect a master tool to guarantee the proper matching configuration

Integrating Tools (cont'd)

- Warning and alarm information will need to be processed to ensure duplications are handled and no information is lost
  - Warning and alarm may need to be manually sorted by an operation center's personnel
  - Warning and alarm may also be aggregated in a centralized dashboard, part of a trouble ticketing system
- The different tools will be used to further investigate reported issues based on the specific system or equipment in question

Summary

- In order to data centers to achieve uninterrupted 24 x 7 operation target, they utilize different types of monitoring and management tools to support their operations
  - There are three different categories of tools
    - Electrical Power Management System (EPMS)
    - Building Management System (BMS)
    - Data Center Infrastructure Management (DCIM)
- The integration and coordination among these tools provide vital information for successfully monitoring and managing the data center operations

Questions?

Thank you!