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CHAPTER
Empowering
AFCOM's Local Chapter Program

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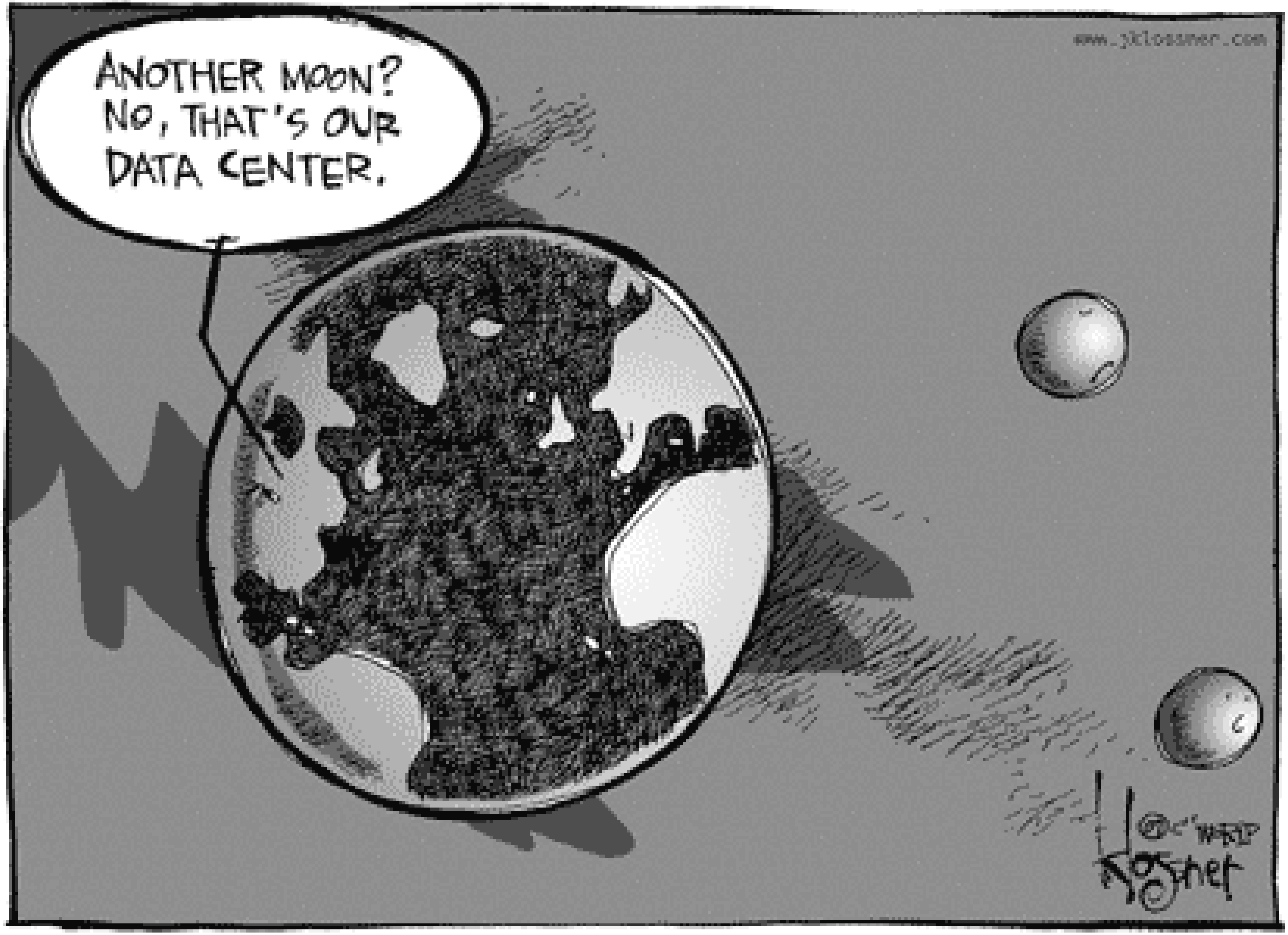
# Intelligent Cabinet PDUs and Gathering Useful Metrics

Server Technology

James Betts

AFCOM CHAPTER


ANOTHER MOON? NO, THAT'S OUR DATA CENTER.
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# Top Issues Faced in Data Centers

| | |
|---|---|
| Managing Heat | 63% |
| Increasing Power Density | 56% |
| Energy Efficiency | 39% |
| Availability | 35% |
| Space Constraints | 30% |
| Real-Time Monitoring | 29% |

*Source: DCUG Fall 2007*

# Power Trends at the Cabinet-Level

***EPA Reports:***

- **Servers to Double Power Consumption in 5 Yrs**
- **Server Power Consumed Exceeds Purchase Price**

# Issue: Increasing Power Density

***Basic Requirement:***

**Most Effectively Utilize Existing Cabinet Space**

***Issues Faced:***

**Maximizing Available Outlets**

**Maximizing Rack Space**

# Issue: Increasing Power Density

***Evolution of Power:***

- **120V / 20A**
- **208V / 30A**
- **208V / 3P / 30A & 60A**
- **Next Step is 208V / 3P / 100A to 400V**

***Increased kW's In = Increased kW's Out***

# Issue: Energy Efficiency

***Single to 3-Phase Power:***

| | |
|---|---|
| **208V/1P/30A** | **5.0 kW** |
| **208V/3P/30A** | **8.6 kW** |
| **208V/3P/60A** | **17.3 kW** |

**Allows for Mixed Outlets and Fewer Drops**

# Issue: Energy Efficiency

***Cabinet Electrical Growth and Projection:***

- **2000 4 kW**
- **2006 8 kW**
- **2011 30 kW**
- ***2009 55 kW***

**EPA Report 2007**

# Issue: Energy Efficiency

*Data Center Math*

| | |
|---|---|
| 1 Rack | = 5 kW |
| 5 kW @ 8,760 hours | = 43,800 kWh |
| @ $0.07 / kWh | = $3,100 / year |
| 300 Racks | = $1M / year |
| w/HVAC | = $2M / year |

# Issue: Energy Efficiency

***In Large Data Centers: Ghost Servers:***

- **8-10% of all servers have no identifiable function;**
- **150 out of 1,800 servers, 354 out of 3500.**

**Sun Microsystems, 2007**

# Issue: Energy Efficiency

*Five Quickest "Green" Returns:*

- **Consolidate and Virtualize Servers;**
- **Use Supplemental Cooling Units;**
- **Measure and Optimize;**
- **Implement Data Duplication;**
- **Find Rebates and Incentives.**

*Computerworld, D. Dunn 2008*

# Issue: Energy Efficiency

***Current Performance Methods:***

- **Power Usage Effectiveness** **PUE**

  ***Total DC Power / Data Processing Power***

- **Data Center infrastructure Efficiency** **DCiE**

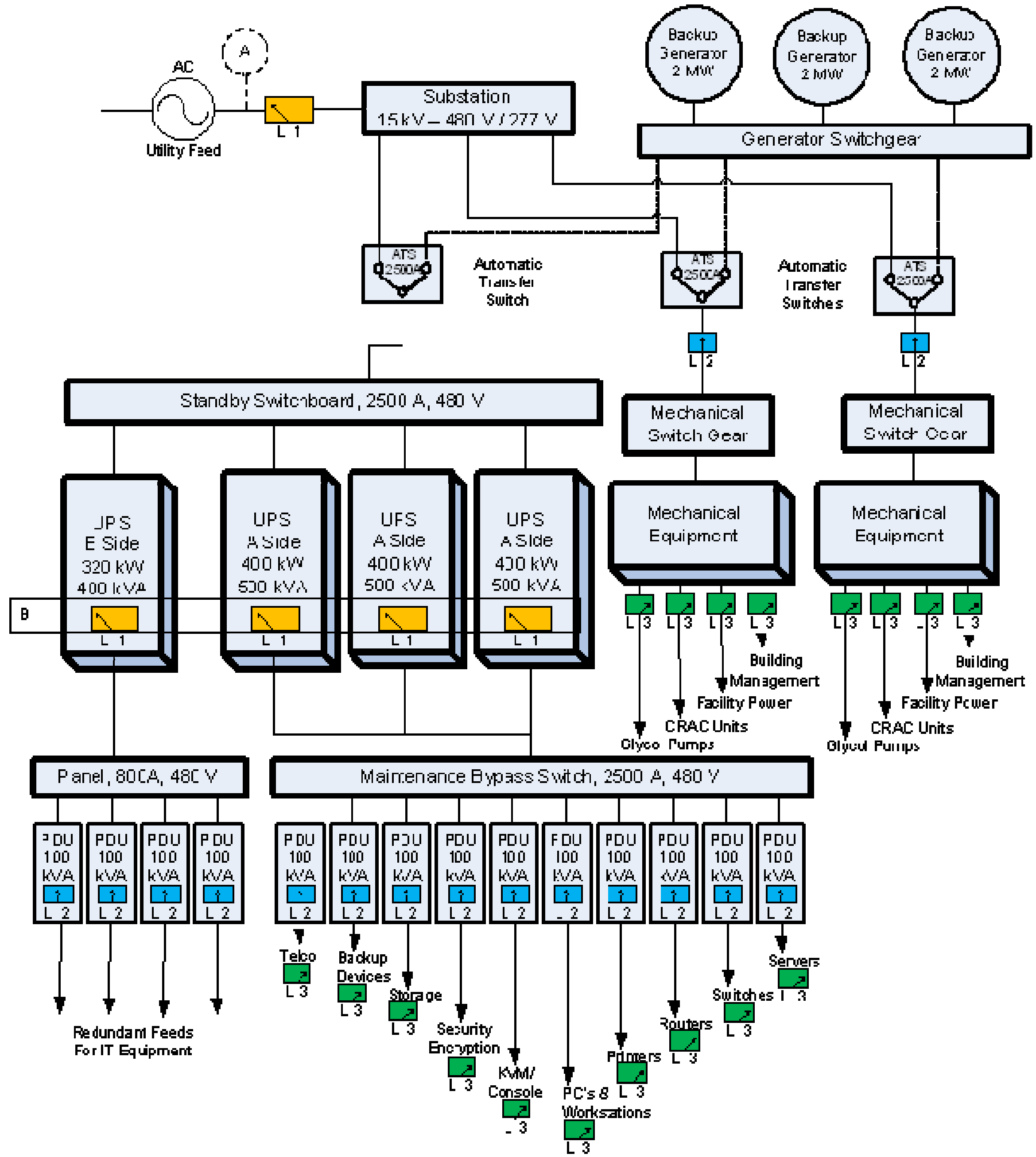
  ***Data Processing Power / Total DC Power***

# Issue: Energy Efficiency

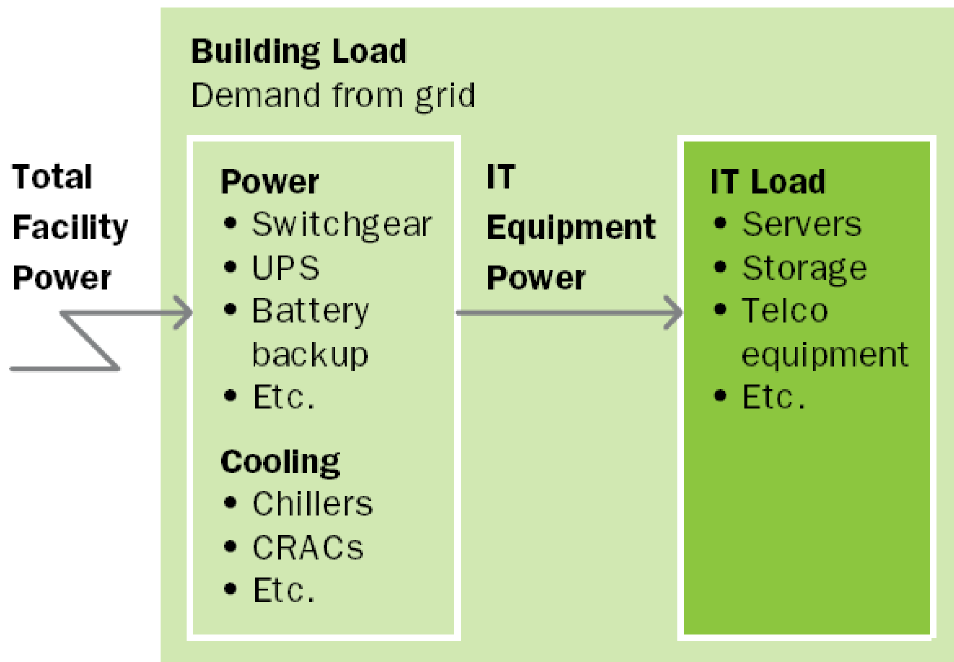
***How do we quantify PUE & DCIE?***

- **Where in the DC do we measure metrics?**
- **How often do we measure them?**

the green grid™
get connected to efficient IT



**PUE: Power Usage Effectiveness**
**DCE: Data Center Efficiency**




$$PUE = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

$$DCE = \frac{1}{PUE} = \frac{\text{IT Equipment Power}}{\text{Total Facility Power}}$$

# Issue: Energy Efficiency

*How do we quantify PUE & DCIE?*

- Where: L1, L2 or L3?
- When: Annually Monthly, Weekly?

**Green Grid Example: PUE = 1.3/L2/W**

| Total Energy Utilization - Chicago | |
|---|---|
| Description | Containers |
| Electrical Losses (kwh) | 16,863,000 |
| IT (kwh) | 148,701,000 |
| Mechanical (kwh) | 15,935,918 |
| | |
| | |
| PUE Electrical (Annual) | 1.11 |
| PUE Mechanical (Annual) | 0.11 |
| PUE Total (Annual) | 1.22 |
| PUE Peak (Annual) | 1.36 |

# Issue: Energy Efficiency

*How do we quantify PUE?*

- What about location and environment?
  - Is this in Miami or Fairbanks?
  - Is this on the $4^{th}$ floor or stand alone?

# Issue: Energy Efficiency

***So what is PUE?***

**It's the efficiency of your Physical Plant,**

**not your servers.**

**At the end of the day, the efficiency of your Physical Plant matters less than the energy consumed to perform a set amount of work.**

# Definitions

**Efficiency:**

**Is the focus on reducing costs by reducing required resources to produce work output**

**Productivity:**

**Is the focus on increasing work output for these given required resources.**

# Issue: Energy Efficiency

So how do you measure useful work produced?

DCxP = Data Center Productivity

CUPS = Compute Units per Second

# Issue: Energy Efficiency

DCeP = Data Center energy Productivity

$$\frac{\text{Useful Work Produced in the Data Center}}{\text{Total Energy Consumed for Useful Work}}$$

Green Grid looking at 7 different methods. Each will require detailed Power & Energy data and will compliment PUE

# Issue: Energy Efficiency

DCeP

Green Grid looking at 7 different methods.

Each will require detailed Power & Energy data and will compliment PUE

| | |
|---|---|
| Power: | kW |
| Energy : | kW / hour |
| Average Power: | kW / hour / hour |

# Issue: Energy Efficiency

**CUPS = Compute Units per Second**

**CUPS is a measure of server performance based on 2002 server standards. Estimates of increased server performance since then average 650%.**

**Efficiency = CUPS per Watts Consumed**

# Issue: Energy Efficiency

## CUPS = Compute Units per Second

| Intel x86 | 2002 | 2007 |
|---|---|---|
| T FLOPS | 3.7 | 3.7 |
| Servers | 512 | 53 Blades |
| GFLOPS/Server | 7.2 | 70 |

# Real-Time Monitoring

*Basic Requirements Points:*

- Points that provide Data:
  - Volts, Amps, kW, PF. Temp, Humidity
- Points that provide Status:
  - Equipment On/Off
  - Trouble Condition

*Either type can create alarms as long as normal conditions have been identified*

# Real-Time Monitoring

***What does monitoring do?***

***Reduces Risk***

***Increases Reliability***

***Improves Efficiency***

# Real-Time Monitoring

***Why do you implement monitoring?***

***Status Unknown***

***Equipment Fails***

***People Complain***

# Real-Time Monitoring

***Why monitoring at the Outlet Level?***

***Energy Savings***

*

*

# 1 Server Watt = 3 Watts of Total Consumption

| | |
|---|---|
| *Server:* | *1.00W* |
| *DC-DC & AC-DC:* | *0.49W* |
| *Power Distribution:* | *0.04W* |
| *UPS:* | *0.14W* |
| *Cooling:* | *1.07W* |
| *Switchgear:* | *0.01W* |
| *Total* | *2.84W* |

# Real-Time Monitoring

***Cabinet Level Device Monitoring:***

- **Allows Management of Idle Servers;**
  - **Turn On/Off/Reboot or Virtualize**
- **Capacity Planning;**
  - **Where do we have power available?**
  - **Where can we install new equipment?**

# Real-Time Monitoring

***Cabinet Level Device Monitoring:***

- **Provides Alarm Notification;**
  - **User Set-Points for Amps, Volts, kW**
  - **Monitor Power Factor for Potential Failure**
  - **Determine Hot Spots**

# Real-Time Monitoring

*Outlet Level Control:*

- Unauthorized Outlet Usage
- Schedule Lab Equipment Times
- Manage Servers for Specific Usage
- Schedule Maintenance or New Installs

# Real-Time Monitoring

**Secure Network Access CDU Management can Consolidate Information across Multiple Locations**

***Allows For:***

- **Centralized SNMP Trap Destination**
- **Time Based Reporting of Metrics**
- **Graphing & Trending of Metrics**

# Real-Time Monitoring

**Secure Network Access CDU Management con't**

***Allows For:***

– **True RMS Digital Readings (Polled Voltage)**
– **Grouping or Clustering of Outlets**
– **User Defined Load Shedding**
– **Multiple User Access Levels**

# Barriers to Improving U.S. Energy Efficiency

## *Why Efficiency is a Hard Sell*

***Structural Barriers***

**Conditions Beyond the Control of the End User:**

- **Distortions in Electrical Pricing**
- **Supply Infrastructure Limitations**

# Barriers to Improving U.S. Energy Efficiency

## *Why Efficiency is a Hard Sell*

***Behavioral Barriers***

**Conditions That Characterize the End User:**

- **Efficiency Attitudes and Awareness**
- **Perceived Risk of Efficiency Measurements**
- **Obtaining and Processing Information**
- **Limited Access to Capital**
- **Inconvenience**

Server Technology
Solutions for the Data Center Equipment Cabinet

# Server Technology

## Sentry Power Management Products
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