Data Center Infrastructure Management:
How to Optimize Data Center Operations

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Question of the Day

Question: Would any CFO run the corporate financial and accounting systems with spreadsheets?

Answer: Unlikely; not even for small businesses.

Any CFO of any company size would want to have access to reliable and accurate financial data at any time.

He would also want to use this data to predict the cash flow and financial health of the company.

So why would you run your data center, the technology nerve center of your company, with archaic tools and methods?

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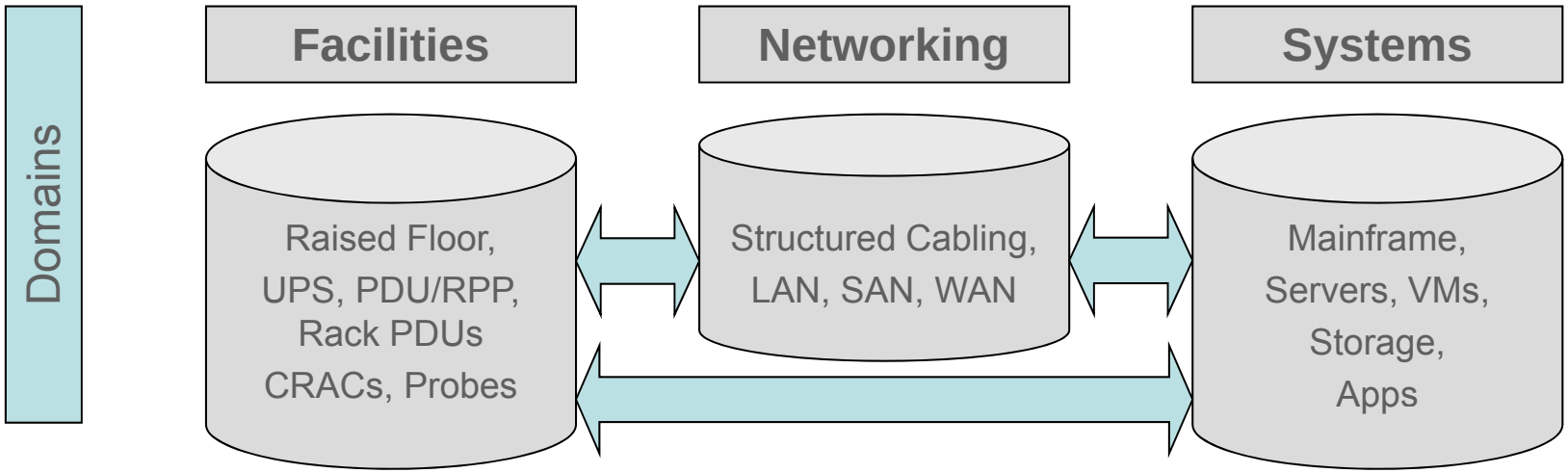
What Does an Enterprise Data Center Look Like?



Tools

Asset Tracking:
Spreadsheets,
Homegrown DBs

Floor Plan:
AutoCAD, Visio

Monitoring:
Sitescan, Foreseer,
Raritan, etc.

Cable/Net Tracking:
Spreadsheets,
Homegrown DBs

Configuration:
CiscoWorks, etc.

Monitoring:
HP OpenView, IBM
Tivoli

Asset Tracking:
Spreadsheets,
Homegrown DBs

CMDB:
HP OpenView, BMC
BladeLogic, etc.

Monitoring:
HP Insight Manager,
IBM Director

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Some Facts about Today's Data Center Management

- **Systems**
  - Disparate systems
  - Heterogeneous systems
  - Multi-vendor systems
- **Organizational Structure**
  - Multiple domains: Facilities and IT
  - Multiple groups within domains: IT network, IT systems (Windows), IT systems (Linux), IT systems (storage)
- **Problem with Today's Tools**
  - Discrete: Manage only one silo or a subset of silo
  - Static: Data does not reflect constant change in data center
  - Data Conflict: Multiple people manage the same data

Common Pain Points in Data Center Management

- Unable to manage relationships and dependencies among silos or even within silos
- Unable to get accurate views of current resources
- Unable to do accurate capacity planning
- Unable to enforce best practices and processes
- Unable to comply or it is too costly to comply with internal and external regulatory audits

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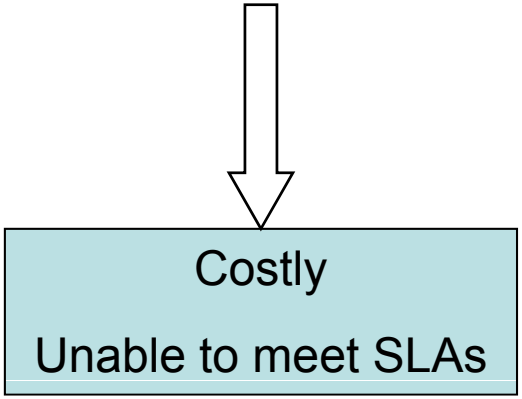
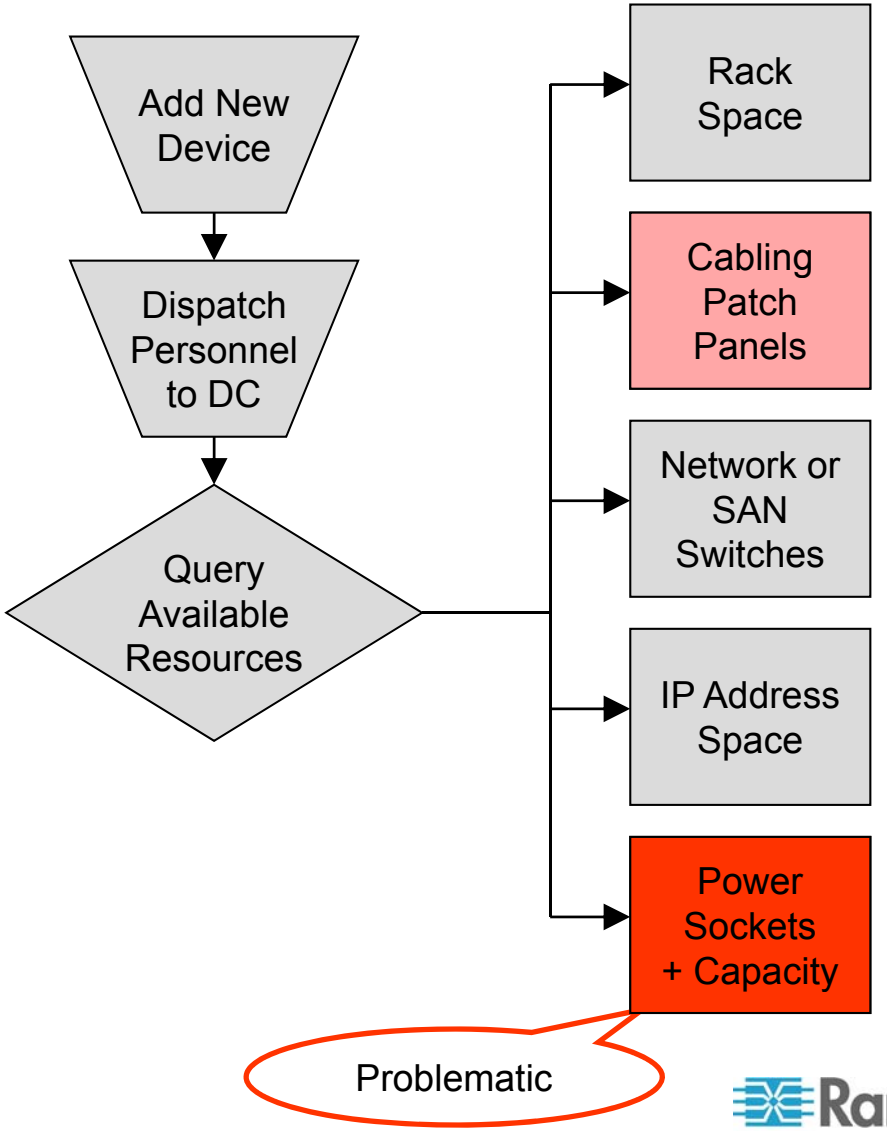
Manual Processes

- **Labor-intensive processes**
- **Slow, time-consuming**
- **Unreliable**
- **Prone to conflict and errors**





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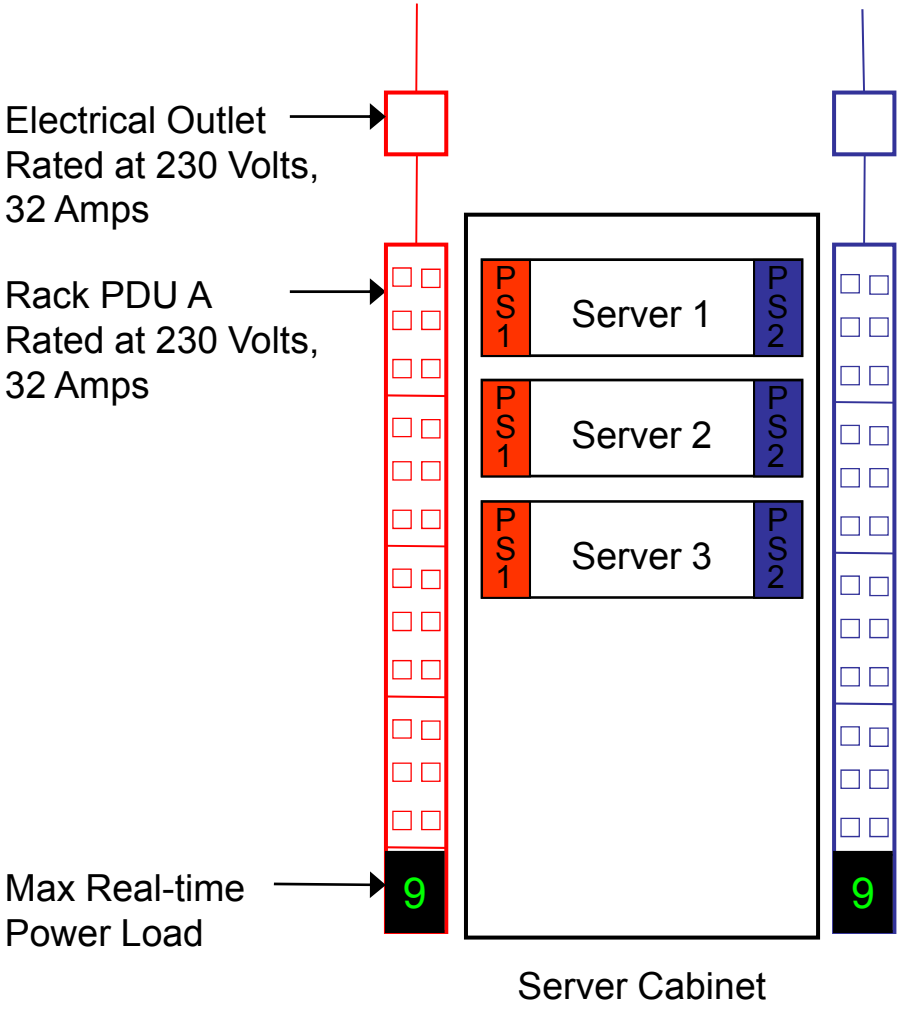
Determining Power Capacity

Why determining power capacity is problematic (not so simple)?

- **Need to understand power chain distribution**
- **Need to understand power chain diversity**
- **Having real-time load monitoring with intelligent rack PDUs helps, but they don't provide the complete picture**

Power Capacity Example 1 – Normal Conditions



- **Normal Conditions Facts**
  - Redundant power distribution to cabinet (rack PDU A and B)
  - Servers with dual load-sharing power supplies
  - Each power supply max real-time load under normal conditions (load-sharing) is 3 Amps
  - Total max real-time load on rack PDU A and rack B under normal conditions is 9 Amps each
- **How Much Available Power Capacity is There?**
- **Is there Enough Information to Determine Power Capacity?**

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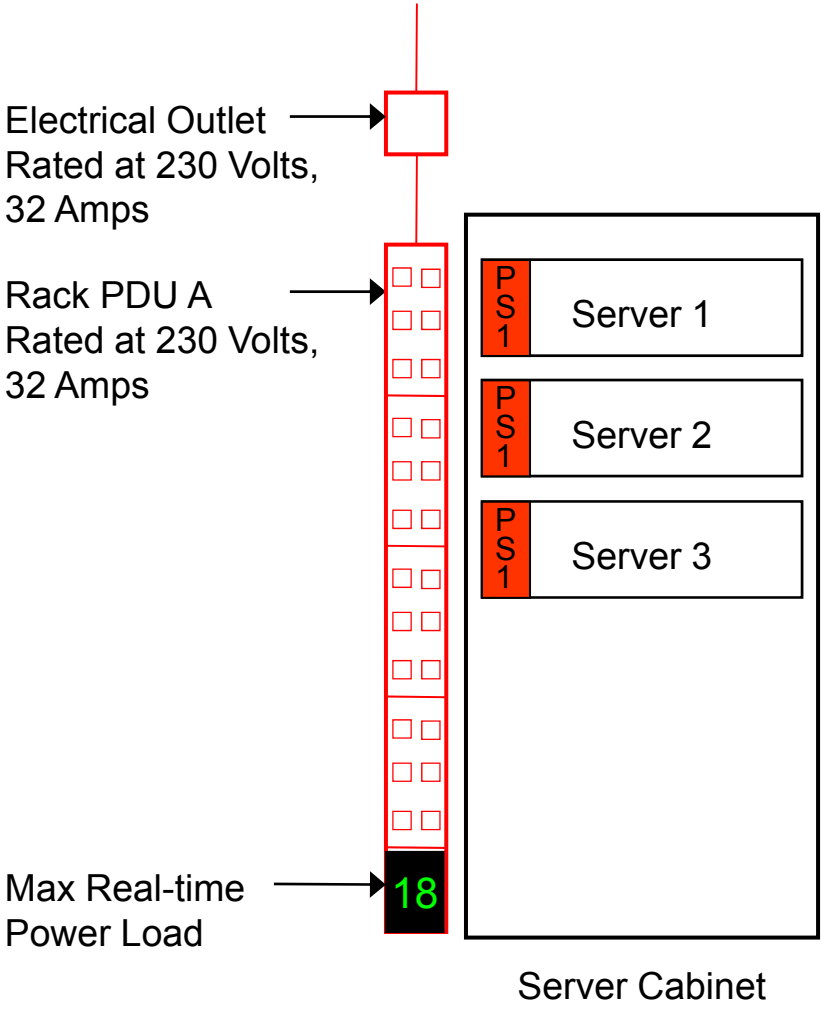
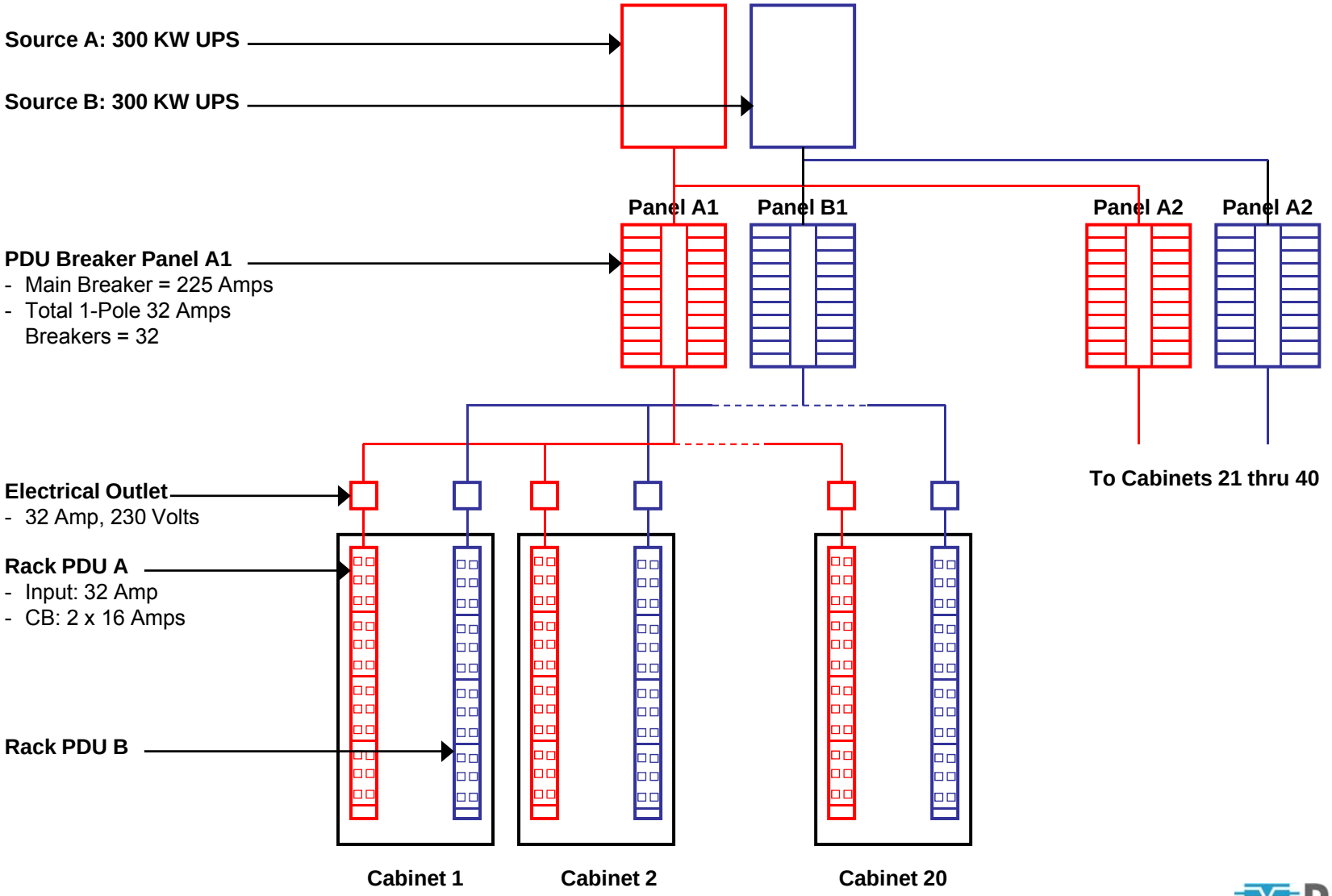
Power Capacity Example 2 – Power Chain B Failure



- **Failure Condition Facts**
  - Servers fail over to PS1s
  - Server power supply max real-time Load is now 6 Amps
  - Total max real-time load on rack PDU A is now 18 Amps
- **How Much Available Power Capacity is There?**
  - Appears that we have 14 Amps available
- **Is there Enough Information to Determine Power Capacity?**
  - No
  - We need to view the complete power chain

Power Chain Diversity Explained



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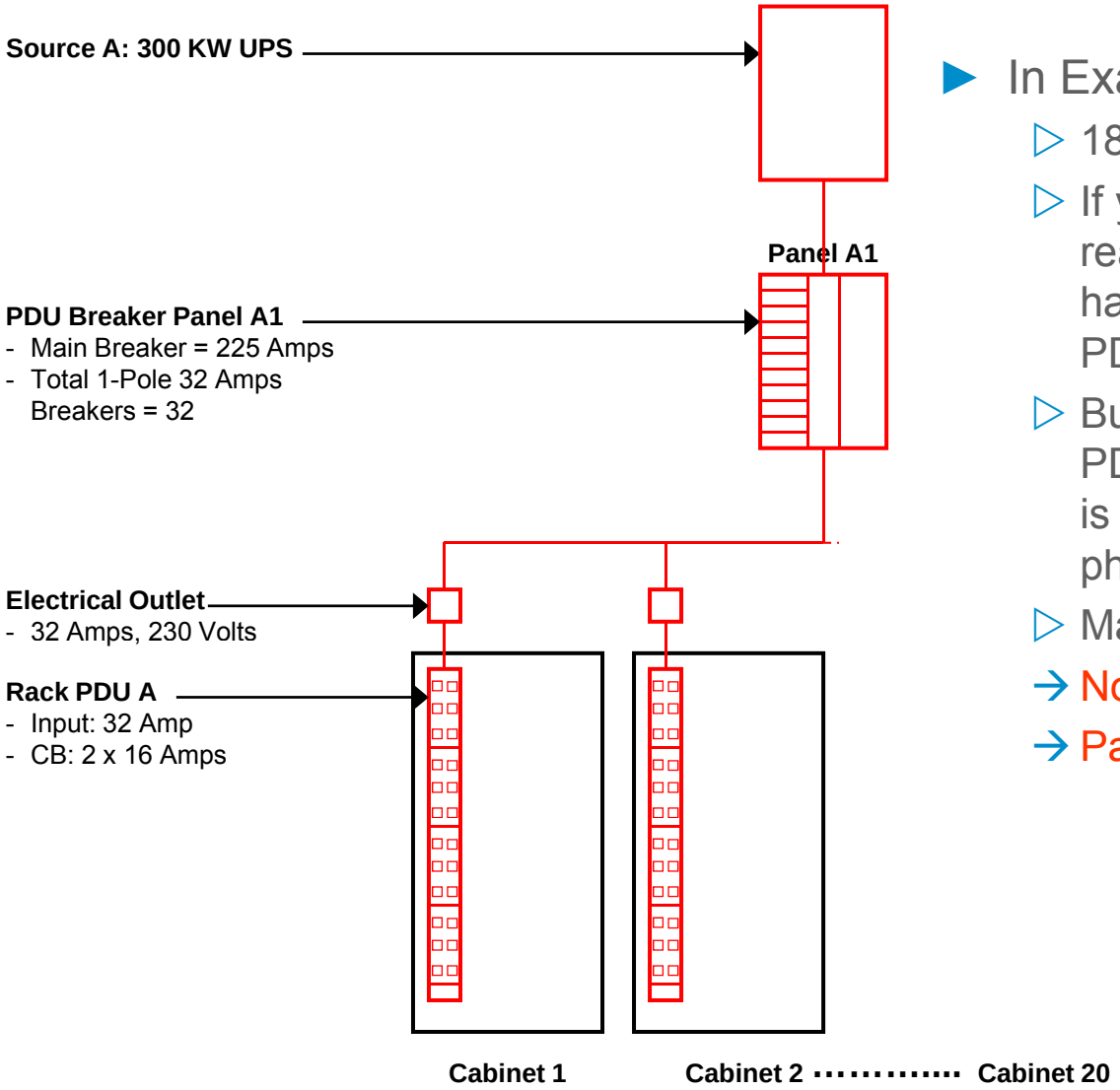
Power Chain Diversity – Power Chain B Failure



- In Example 2 – Chain B Failure
  - 18 Amps per rack PDU A
  - If you were to rely on real-time reading, it will appear that you have 14 Amps capacity per rack PDU A
  - But when you sum up all 20 rack PDU As, the total load in panel A1 is now 360 Amps (worst case phase)
  - Main panel breaker is 225 Amps
  - → Not enough capacity in panel A1
  - → Panel A1 main breaker will trip

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Additional Pointers about Power Provisioning

- Three electrical values to choose from:
  - Nameplate: Is generally over-rated by up to 70%
  - Real-time: Snapshot in time of power supply consumption. Will vary based on server load and redundancy levels
  - Budgeted: A value that is closer to the max real-time power over a defined duration and conditions.
- Which value to use in provisioning new systems
  - Nameplate: Will result in wasted provisioned power that can be otherwise distributed to other systems
  - Real-time: Can be misleading if server loads and power supply redundancy are not accounted for
  - Budgeted: A power consumption value that is reserved for each power supply to operate under all expected conditions such heavy server loads or failover scenarios
- How to calculate the budgeted values
  - Less sophisticated: Rule of thumb deretaing while accounting for redundancy configuration
  - More sophisticated: Use rack PDUs that monitor in real-time down to the socket under to measure the max consumption under various server load conditions while factoring in the redundancy configuration

Recap of Common Pain Points in Data Center Management

- Manual processes to query available resources when deploying or moving systems
- Unable to trace structured cabling, network and power circuits on the fly
- Unable to get accurate views of current resources so you can do capacity planning
- Unable to balance or provide cooling where it is needed
- Unable to enforce best practices and processes
- Unable to comply or it is too costly to comply with internal and external regulatory audits

So What is the Solution?

Data Center Infrastructure Management (DCIM) Systems

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What is a DCIM System?

- ***Beyond Asset Tracking*:** Enable visualization, tracking and management of all data center assets and their related physical and logical resources including structured cable plant, networks, power infrastructure, and cooling
- ***A Holistic Approach*:** Bridge the organizational and functional gaps across all domains including facilities, networking, and systems domains
- ***A Single Pane of Glass*:** Used by all data center domains and groups regardless of hierarchy including managers, system administrators, and technicians
- ***A Single Repository***: A single database to house all data from across all data centers and sites
- ***Process Driven*:** A change management system by which you can provision new systems and all their related physical and logical resources

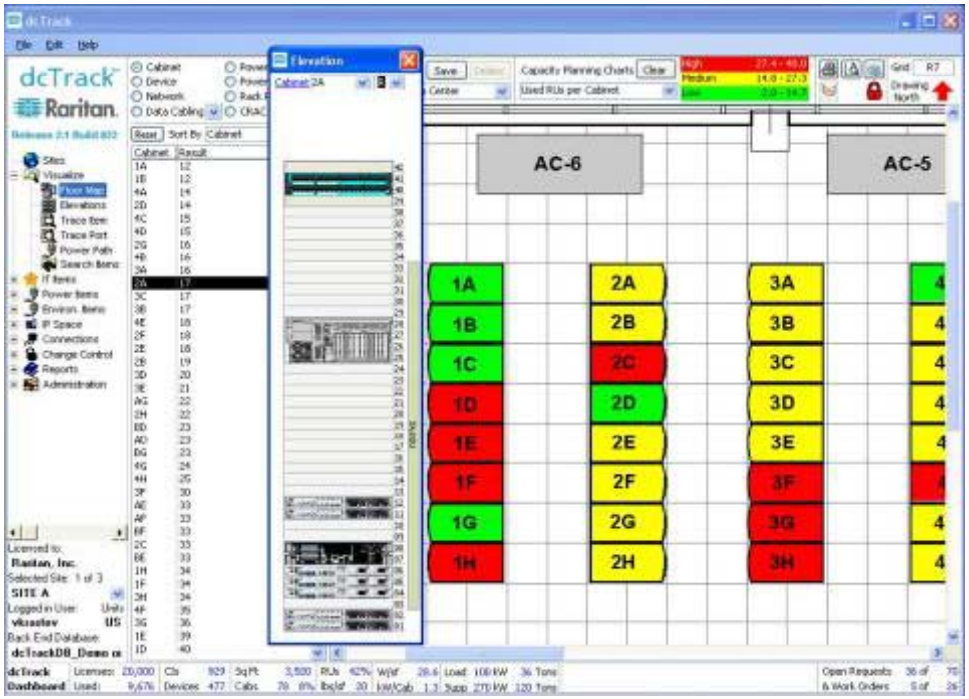
A DCIM system becomes the gate through which you will enter the data center to affect physical changes

Key Components of a DCIM System?

- **Visualization**
  - Data center floor plan (bird's eye view)
  - Racks
  - Servers and devices
  - Structured cabling and power infrastructure
  - Power and data ports
  - Power and data circuits
- **Asset Tracking**
- **Provisioning**
  - Assignment of new systems and their related resources
  - Moves, adds, and changes (MACs)
- **Change Management**
  - Requests
  - Reviews and approvals
  - Work orders
- **Real-time Monitoring**
  - SNMP
  - Modbus
- **Capacity Planning**
- **Reporting and Dashboards**

The Bird's Eye View

- Ability to view data center floor map views dynamically
  - Enhancement: Real-time links to existing Visio and AutoCAD floor plan drawings
- Dynamic color coding for easy capacity planning
  - Space planning
  - Environmental planning
  - Power planning
- Ability to drill down to granular details including devices, ports, and circuits



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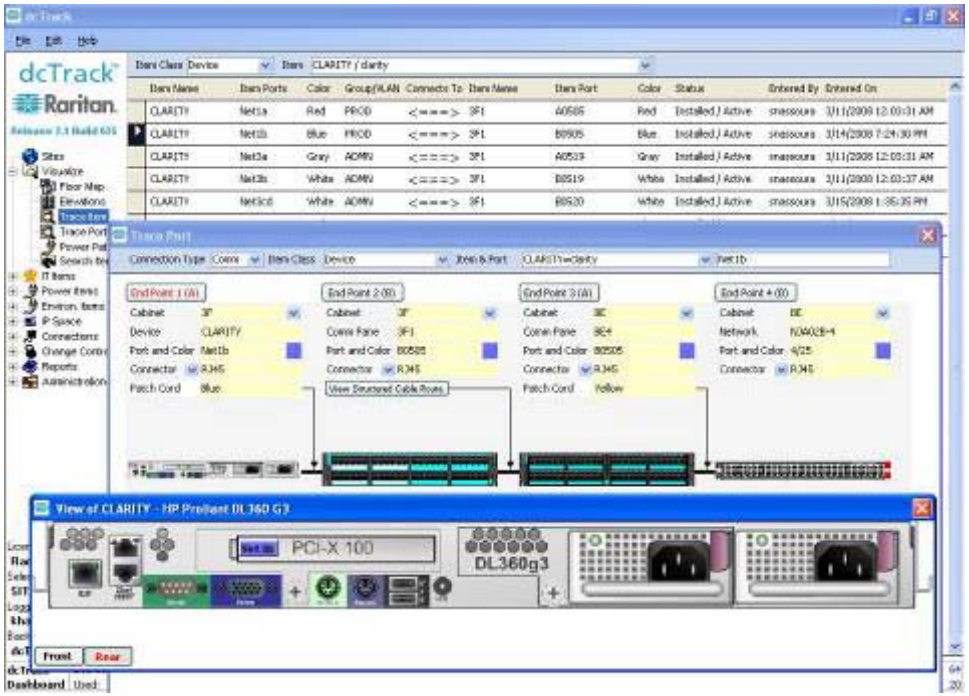
Trace Network and Power Circuits

- Ability to intelligently manage network and power circuits
- Ability to visualize circuits end-to-end including all intermediate hops
  - Structured cabling
  - Network connectivity
  - Power connectivity
- Ability to find and trace any circuit quickly and easily



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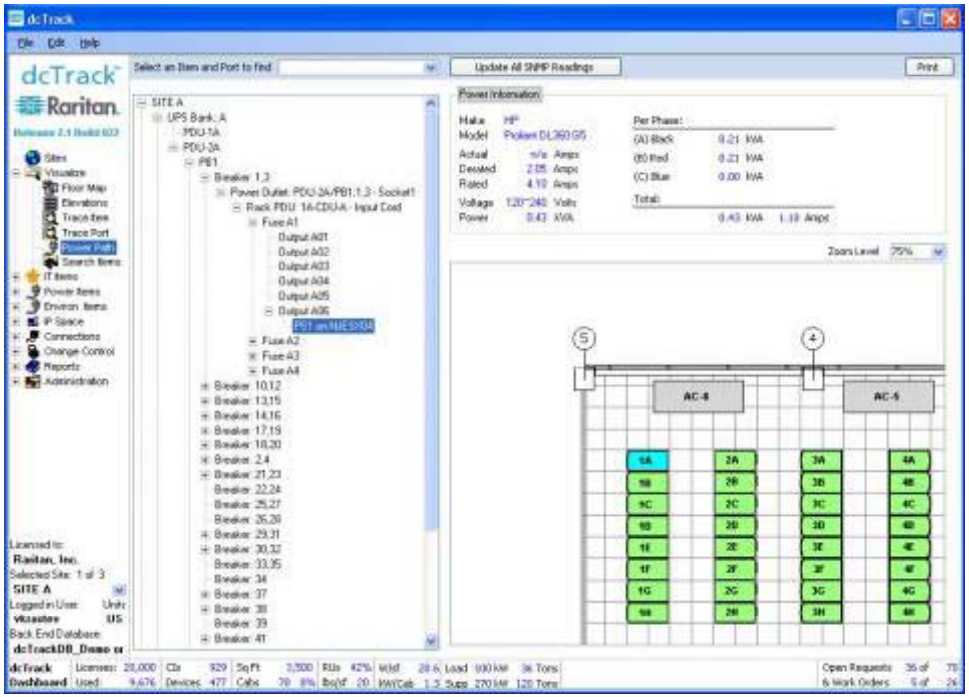
IP Space Management

- **An IP subnet calculator**
  - To create subnets regardless of the subnet masks
  - Treat all IP addresses within the subnet created as a resource similar to all other data center assets
  - Map subnets to network switches to facilitate management of VLANs
- **Assignment of IP Addresses**
  - Leverage the IP address database to assign IP addresses to servers and devices
  - Allow for Port Teaming (single IP per multiple interfaces) and virtual IPs (multiple IPs per a single interface)
- **Why Do It?**
  - Managing IP address space can be too complicated in large data centers
  - Managing IP address space in a spreadsheet is prone to errors
  - Eliminate double dipping into the IP space

Complete Visibility into the Power Chain

- Hierarchal management of power connections
- From the device power supply all the way up to the data center power feed including
  - Rack PDU sockets
  - Rack PDU branch circuit breakers
  - Electrical outlets and circuit breakers
  - Panel boards
  - PDU and main breakers
  - UPS
  - Switch gear and generators
  - Power feeds
- The power chain visibility allows for automation of new power circuit provisioning – accurately and reliably



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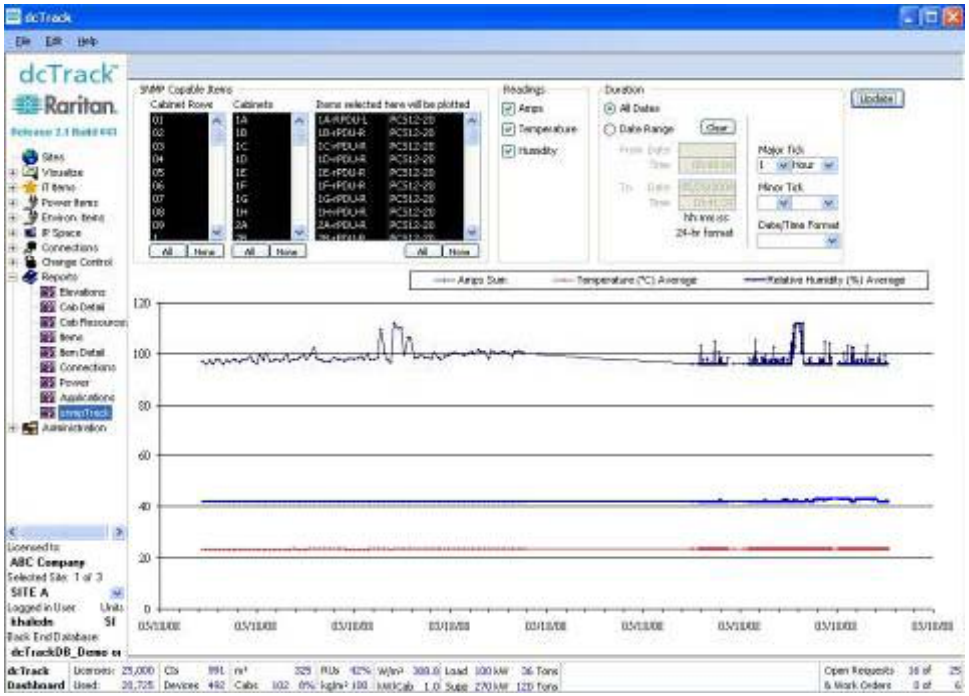
Real-Time Monitoring

- Real-time monitoring of devices
  - Rack PDUs
  - PDUs
  - UPS
  - CRACs
  - Environmental probes
- Store data over time for use in trending and capacity planning
- Monitor spikes in power, temperature and humidity



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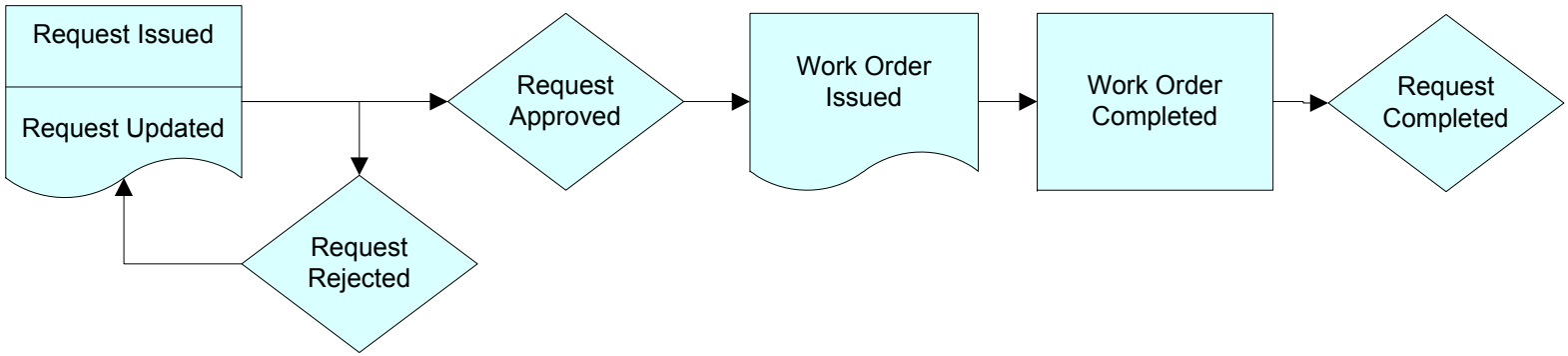
Provisioning Through Change Management

- Provision new devices based on available capacity and resources
- Provision power circuits, and network circuits based on rules such as color Coding, VLANs, and IP Subnets
- Change management to generate requests, approvals, and work orders
- Use email notifications to facilitate the process



Additional DCIM Applications

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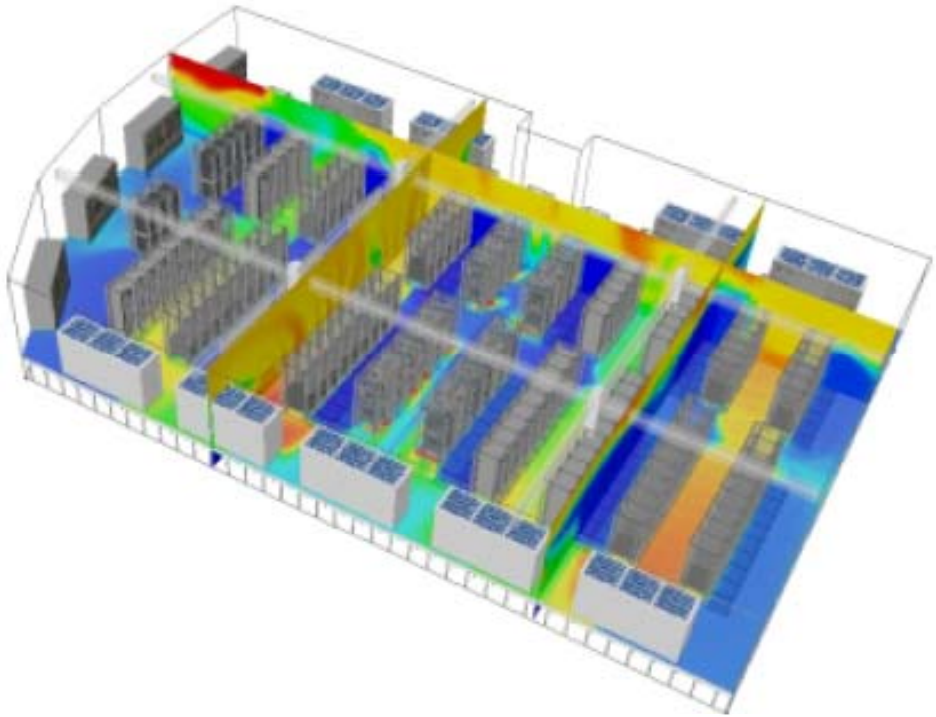
CFD Analysis

- CFD: Computational fluid dynamics
- CFD models are meant to analyze the 3D heat map to better understand how to optimize cooling distribution
- CFD systems will require significant data input and measurements to generate the models
- A good DCIM system will track and collect real-time data that can feed a CFD model
  - Power consumption
  - Temperature sensors
  - Raised floor openings and tile perforations



Energy Metrics: What Are They?

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

$$\text{DCiE} = \frac{\text{IT Equipment Power}}{\text{Total Facility Power}} \times 100\%$$

Carbon Emissions (kg) =

Energy (kwh) * Carbon Factor (kg/kwh)

*based on ~12k miles and ~4536kg

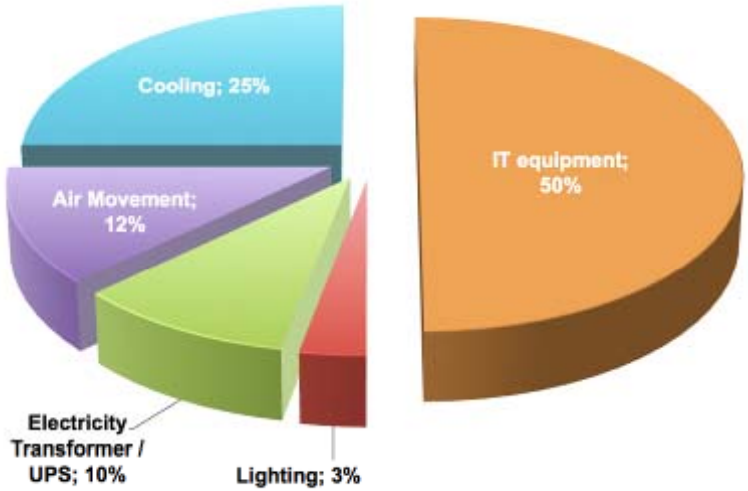
Energy Metrics: Examples

Assumptions: 10Mw total, 5 Mw IT, $0.10/kwh, 7x24 operation

PUE = 10 Mw/5 Mw = 2.0, DCiE = 50%

8760 hours x $0.10/kwh x 10 Mw =

$8.76M annual cost of power



Source: EYP Mission Critical Facilities Inc., New York

Example Carbon Factors:

PG&E = .24 kg/kwh
Con Ed = .35 kg/kwh

CO2 = 8760 hours x 10 Mw x .35 kg/kwh

CO2 = 30,660,000 kg (about 6759* cars)

*based on ~12k miles and ~4536kg

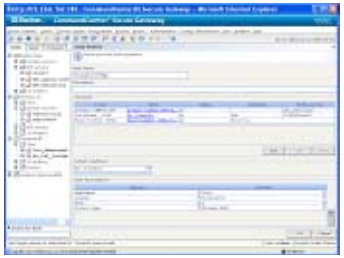
DCIM Benefits

- **Reduce Operational Expenses**
  - Automate manual and time-consuming processes
  - Eliminate the need to query available resources manually by sending technicians into the data center
  - Eliminate manual effort to trace and troubleshoot circuits and devices
- **Reduce and/or Defer Capital Expenses**
  - Through better capacity planning, maximize utilization of existing resources
  - By better provisioning and balancing of 3-phase power, increase utilization of power systems
  - Identify unused structured cabling to defer need to install new cable runs
- **Improve Performance and Response Time**
  - Reduce time to respond to customer requests by eliminating several manual cycles
- **Maintain True Lights-out Remote Data Centers**

DCIM Benefits (Cont.)

- **Achieve Green Data Center Initiatives**
  - By better measuring and monitoring energy consumption you will be able to reduce energy and related costs
  - Improve PUE/DCiE metrics
  - Make internal customers accountable for their energy consumption
  - Easily and frequently run CFD models and analysis using real-time data
- **Instantaneous Reporting**
  - Executive and management reports
  - Forecasting and trending

The Raritan Solution – Industry leading data center power, infrastructure, and operations management

Remote Access Management	Intelligent Rack Power Distribution	Power Management Software	Data Center Infrastructure Management
Single Access Point, Management and Control for KVM, Serial, and IP Devices	Socket-Level Metering and Switching, Environmental Monitoring	Analytics Reporting, Energy Management, Element Management	Visualization, Provisioning, Asset Tracking, Change Management, Capacity Planning
			dcTrack™
			

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