Nicholas C. Metropolis Center
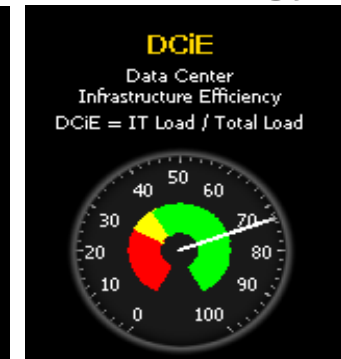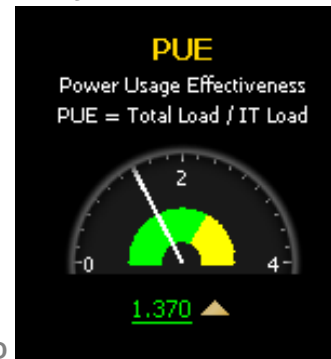
Monitoring and Improving Data Center Efficiencies

July 2011

LA-UR 11-03816

Why Monitor?

- **You can't control or manage what you don't measure (AHUs not on VFDs)**

- **First step in being able to determine the appropriate steps necessary to improve your energy efficiency**

- **Enable you to compare how efficient your facility is compared with other data centers around the world**

- **Creating benchmarks and starting points so you can track, report, and continually improve**

- **Demonstrate a measurable reduction in utility expenses**

- **Gain a comprehensive understanding of your data center's energy consumption**

PUE
Power Usage Effectiveness
PUE = Total Load / IT Load

2
0   4
1.370 ▲

DCiE
Data Center
Infrastructure Efficiency
DCiE = IT Load / Total Load

50
40   60
30   70
20   80
10   90
0   100

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What We Gained with Power and Thermal Monitoring

- **When IT demand power fluctuates, we can turn on/off air handling units to conserve energy**

- **Quickly identify hot spots on computer floor to adjust surrounding cooling**

- **Trend hot and cold aisle supply and exhaust temperatures**

- **Keep a steady PUE**

- **Use recorded data for future infrastructure upgrade planning and new computer installation**

- **Immediate notification of equipment change of state (Alarms)**

- **Easy access to all information via the network**

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Slide 3

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Benefits

- **Cost Savings**
  - ➢ **Equipment lifespan**
  - ➢ **Equipment maintenance**
  - ➢ **Utility bill**
- **Energy Savings**
  - ➢ **KWh's**
  - ➢ **Reducing carbon footprint**
- **Reduce PUE and increase DCiE**
- **Valuable history trending and reporting**

$$\$ \$ \$$$

CO_2

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Nicholas C. Metropolis Center
Power/Cooling/Space

- **Floor Space 43,000 sq. ft**

- **Electrical power availability to computer floor 19.2 MW**

- **Cooling chiller plant capacity 7,200 tons**

- **Air flow cooling capacity 3,360 tons (84 AHUs at 40-tons/unit)**

- **300 lb/sf floor loading**

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Air Systems at the SCC
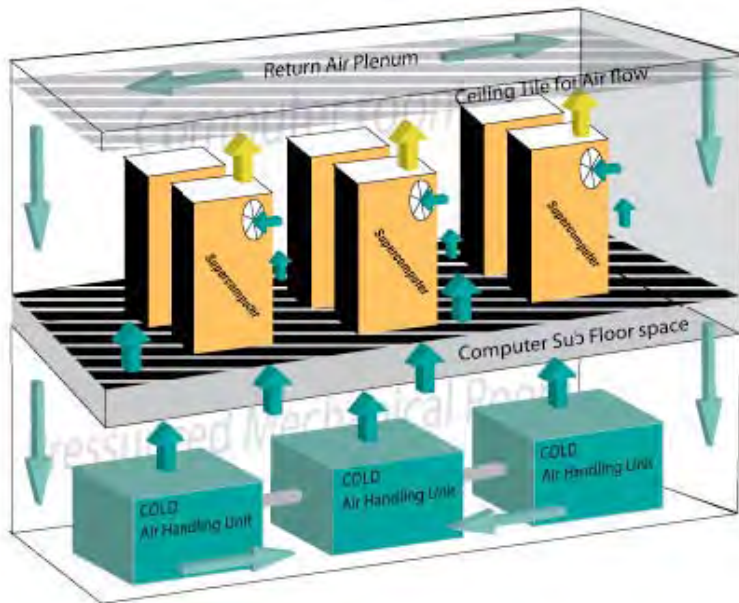
Cold air generated by the air handling units is forced up through perforated tiles above the computer room sub floor. The air passes through and removes heat from the supercomputers, then is vented through the ceiling tiles and return plenums to complete the path back to the air handling units below.

As heat densities associated with supercomputers increase, modeling becomes critical. This graphic shows a computer room air temperature profile.
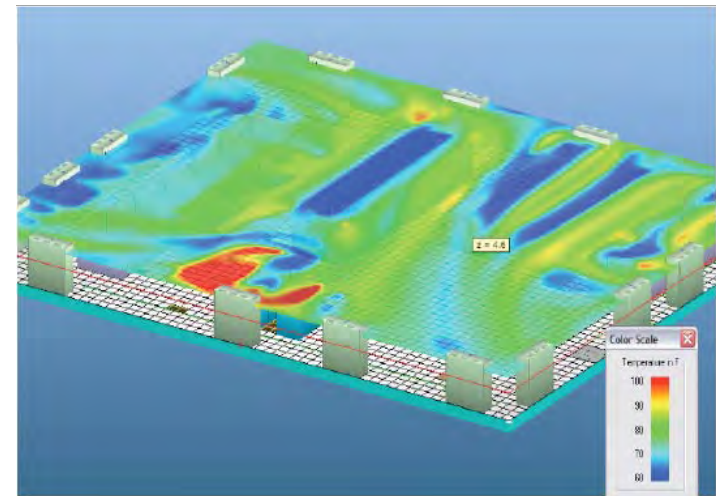
Opportunities for Increasing our Energy Efficiency

- **Power distribution**

- **Power factor correction**

- **Server load and computing operations**

- **Improved cooling methods**

- **Maximize available equipment loads**

- **Monitoring tools for energy usage management**
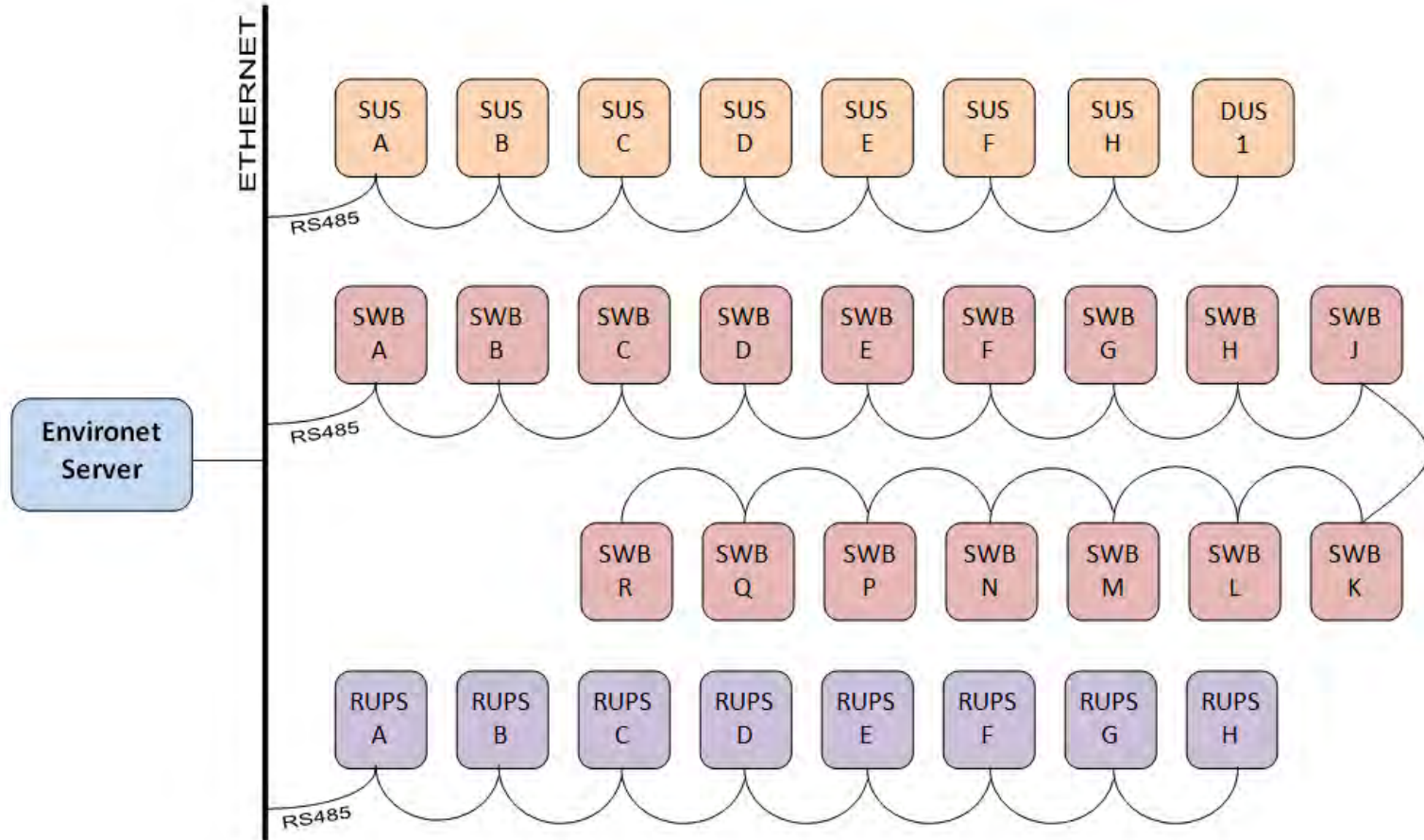
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Metropolis Center Equipment Monitoring

Using RS485 data transmission between facility electrical distribution equipment and an Environet server, we are able to view real-time meter readings of all supporting equipment through the network.

Example data points include:

- Power
  - Power Factor
  - Voltage
  - Current
  - kVA
  - kW

- Unit Status
  - Equipment Load Capacity
  - RUPs PB Relative Capacity
  - RUPs PB Speed & Frequency
  - Alarms

- Wireless Thermal Monitoring
  - Humidity
  - Temperature
  - Differential Pressure

Network Topology – Power Monitoring

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Multiple Equipment Summary View

Individual Substation View

Power Usage Effectiveness (PUE)

PUE is a measure of how efficiently a computer data center uses its power. It is a ratio of total facility power to IT equipment power.

Facility power: lighting, cooling, etc.
IT equipment: computer racks, storage, etc.

$$PUE = \frac{TOTAL\ FACILITY\ POWER}{IT\ EQUIPMENT\ POWER}$$
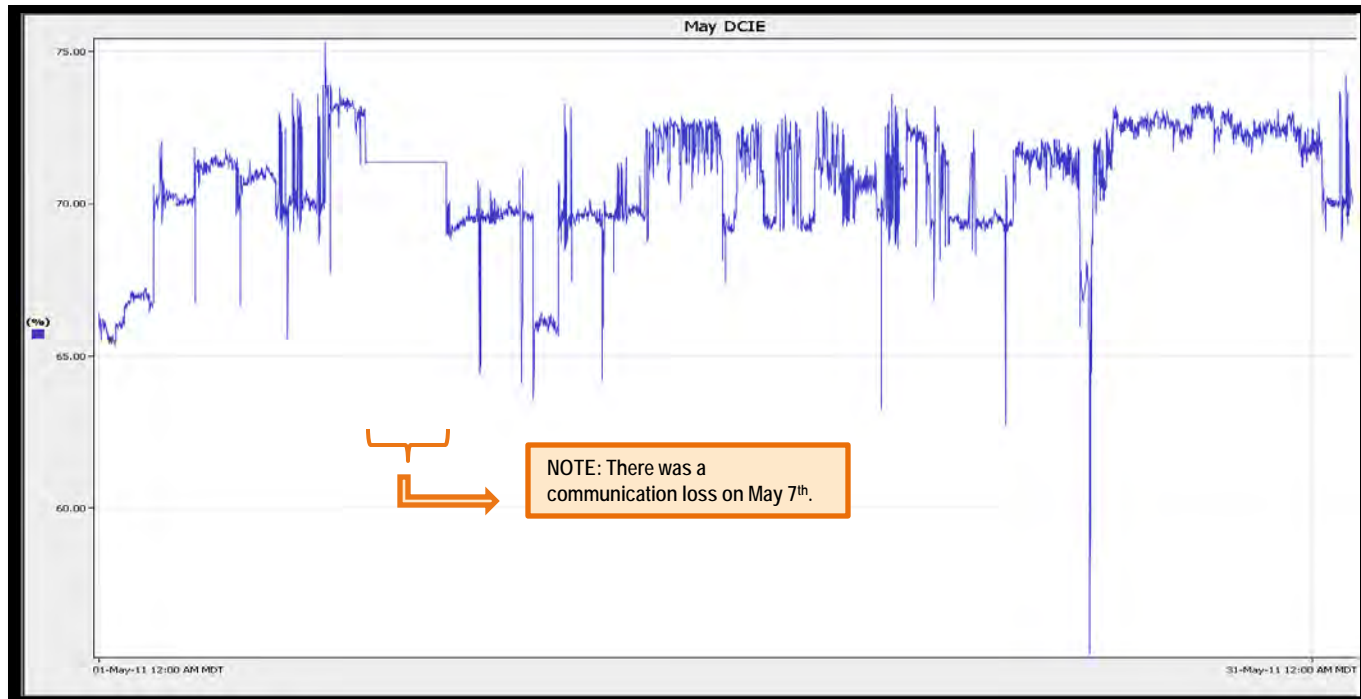

NOTE: There was a communication loss on May 7th.

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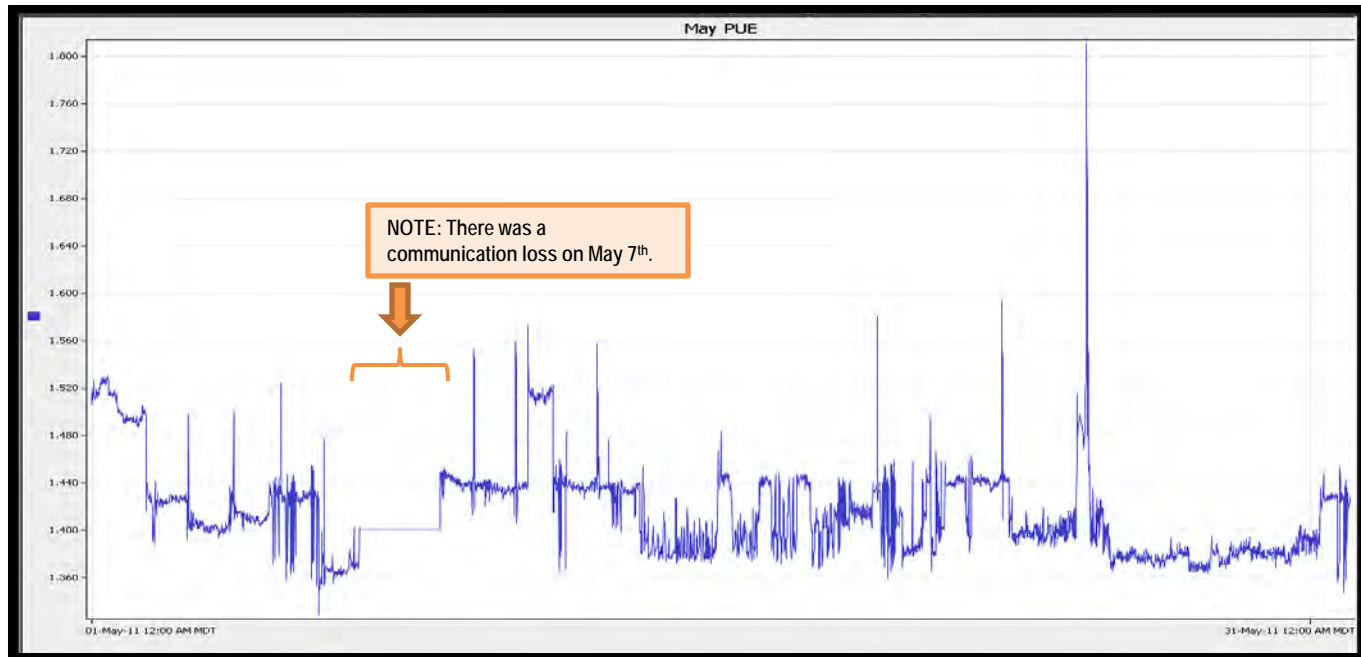
Data Center Infrastructure Efficiency (DCiE)

DCiE is the percentage value derived for measuring computer data center efficiency by taking the inverse of the PUE.

$$DCiE = \frac{IT\ EQUIPMENT\ POWER}{TOTAL\ FACILITY\ POWER} \times 100$$
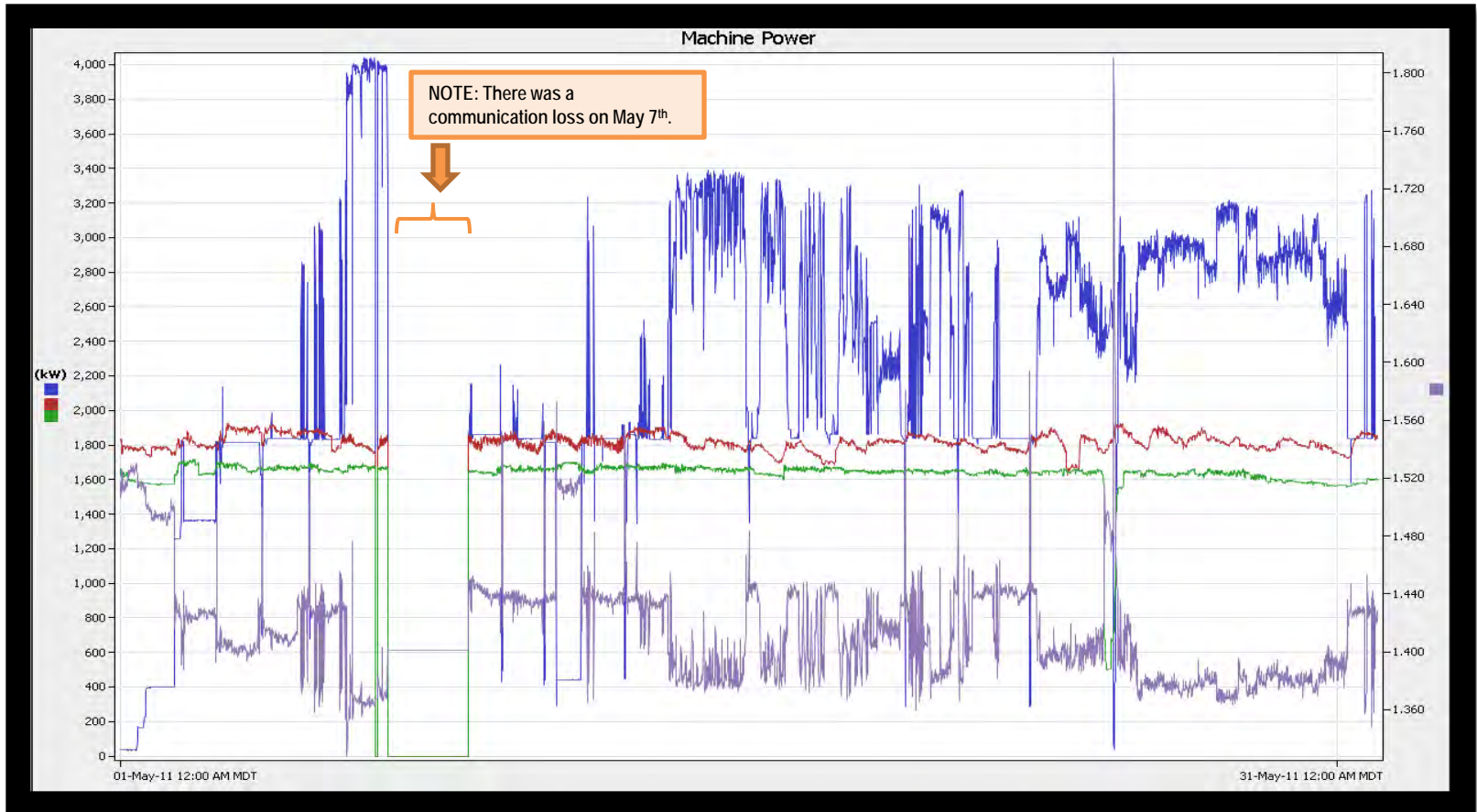

NOTE: There was a communication loss on May 7th.

History Trending Benefits

- **Direct correlation between PUE and IT and facility loads easily identifiable**

- **Keep record of all events for lessons learned (i.e. Equipment failure, lightning strikes, power outages, etc.)**

- **Identify potential problems before they happen**

- **Export data into charts and reports for documentation**

- **Identify energy saving opportunities (i.e. adjusting equipment loads according to their demand)**

- **Plan for data center upgrades using history information as a reference point**

- **Compare multiple data points in one convenient view and time period**

- **View overall data center performance**

U N C L A S S I F I E D

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Individual Machine Monitoring and Resulting PUE

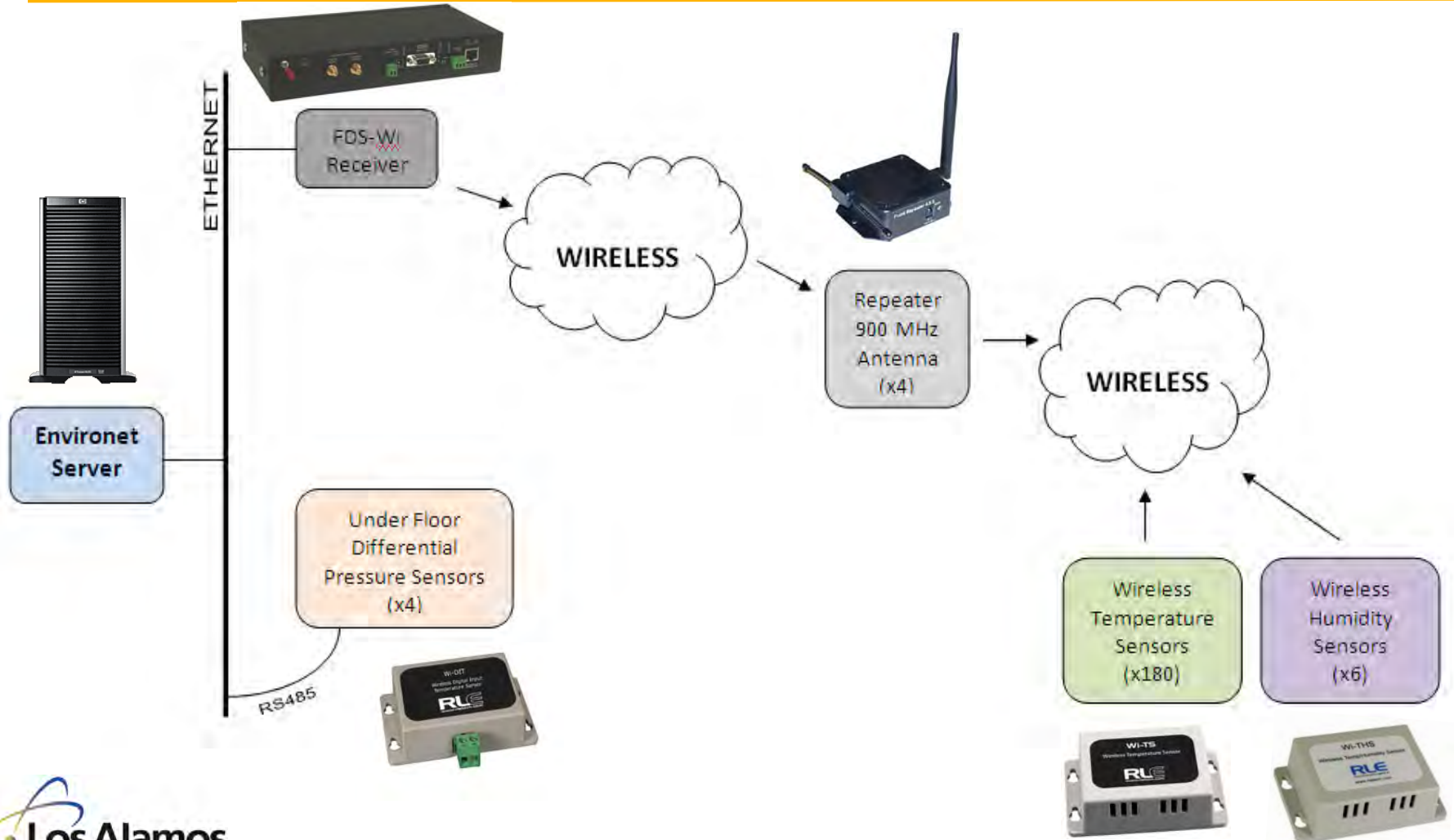# Metropolis Center Overall Performance
May 2011
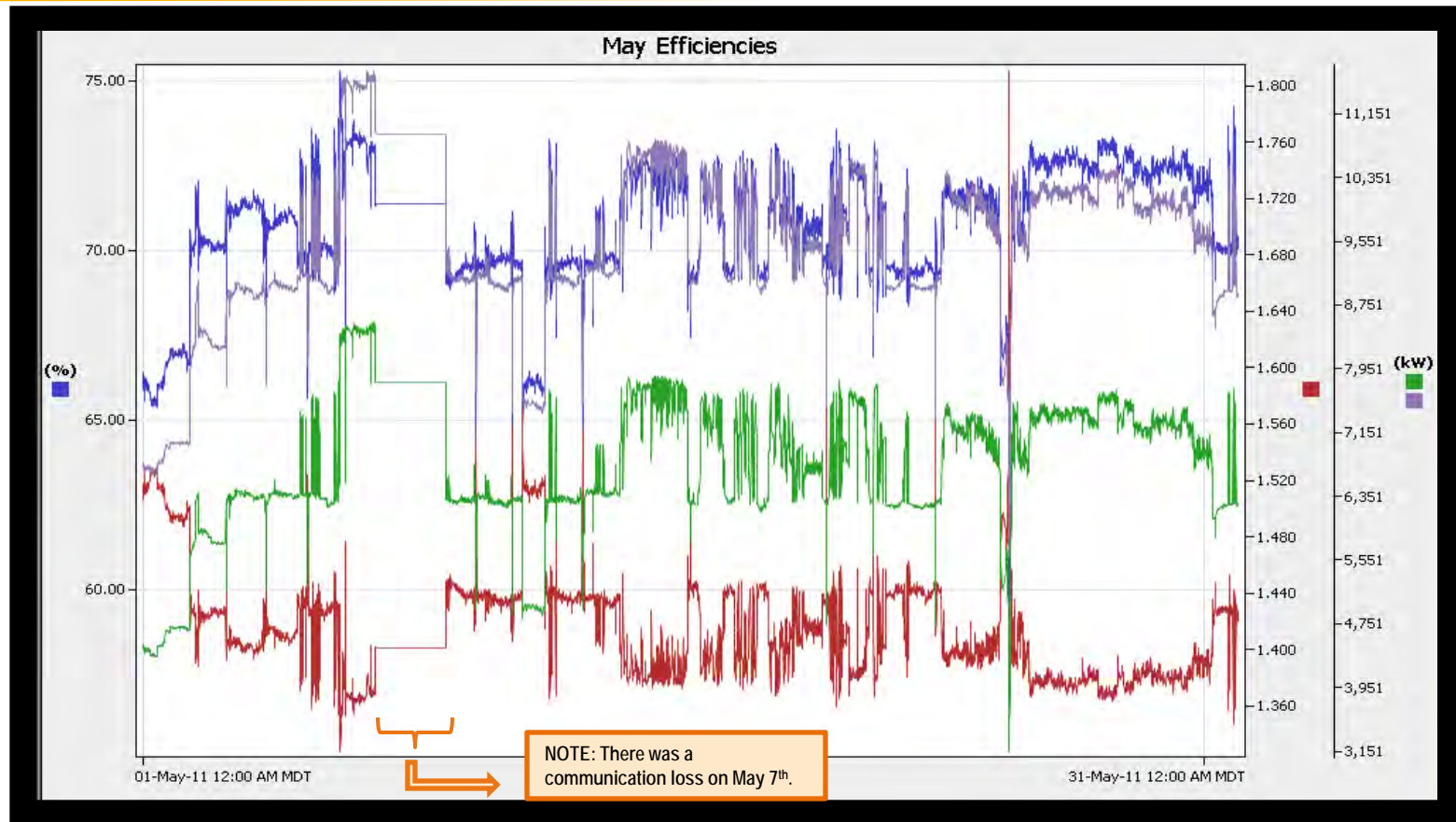
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Identify Direct Correlations

Cielo Power (kW)

Redtail Power (kW)

Roadrunner Power (kW)

Total IT Load (kW)

Total Facility Load (kW)

PUE

DCiE (%)

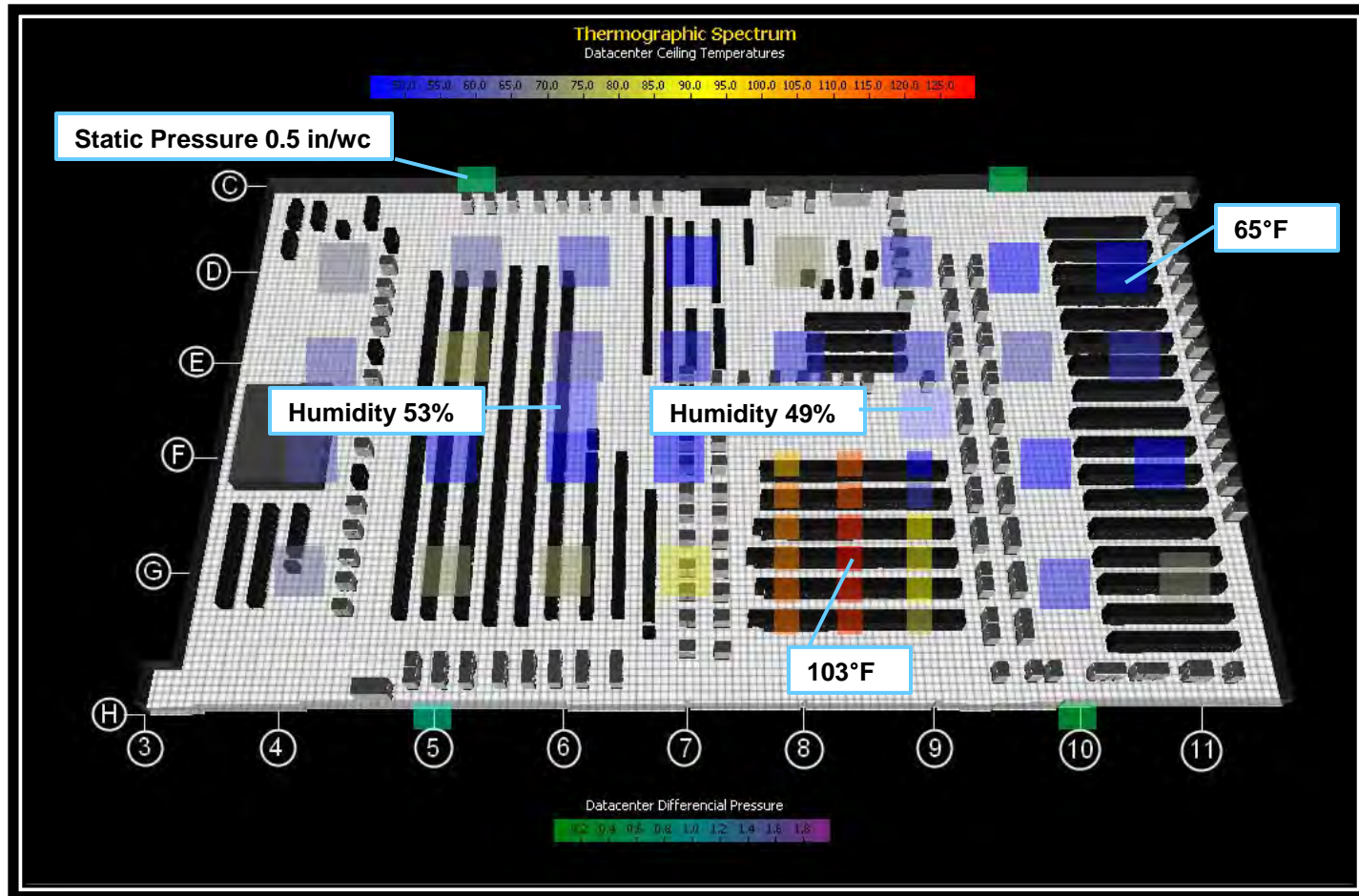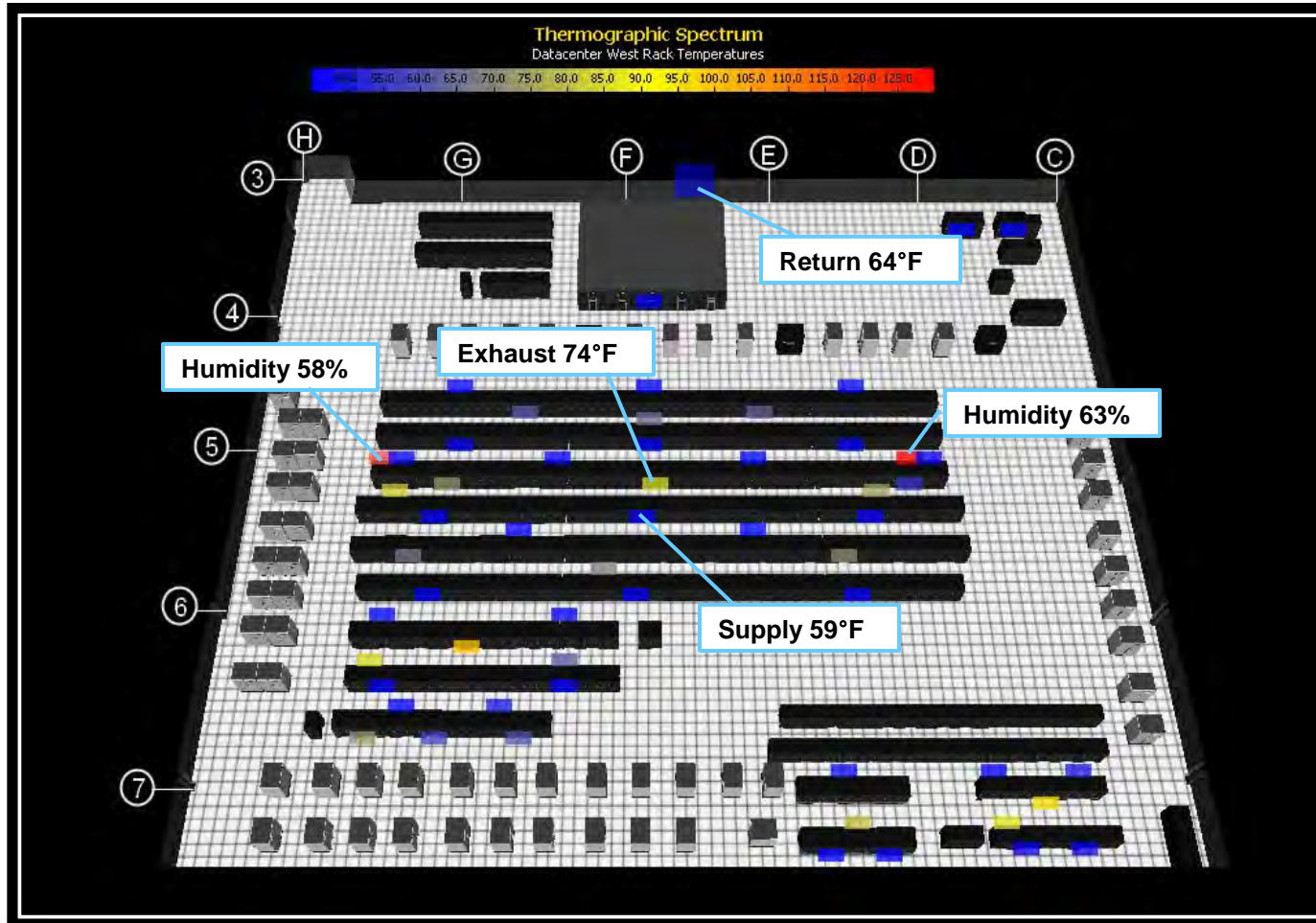Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

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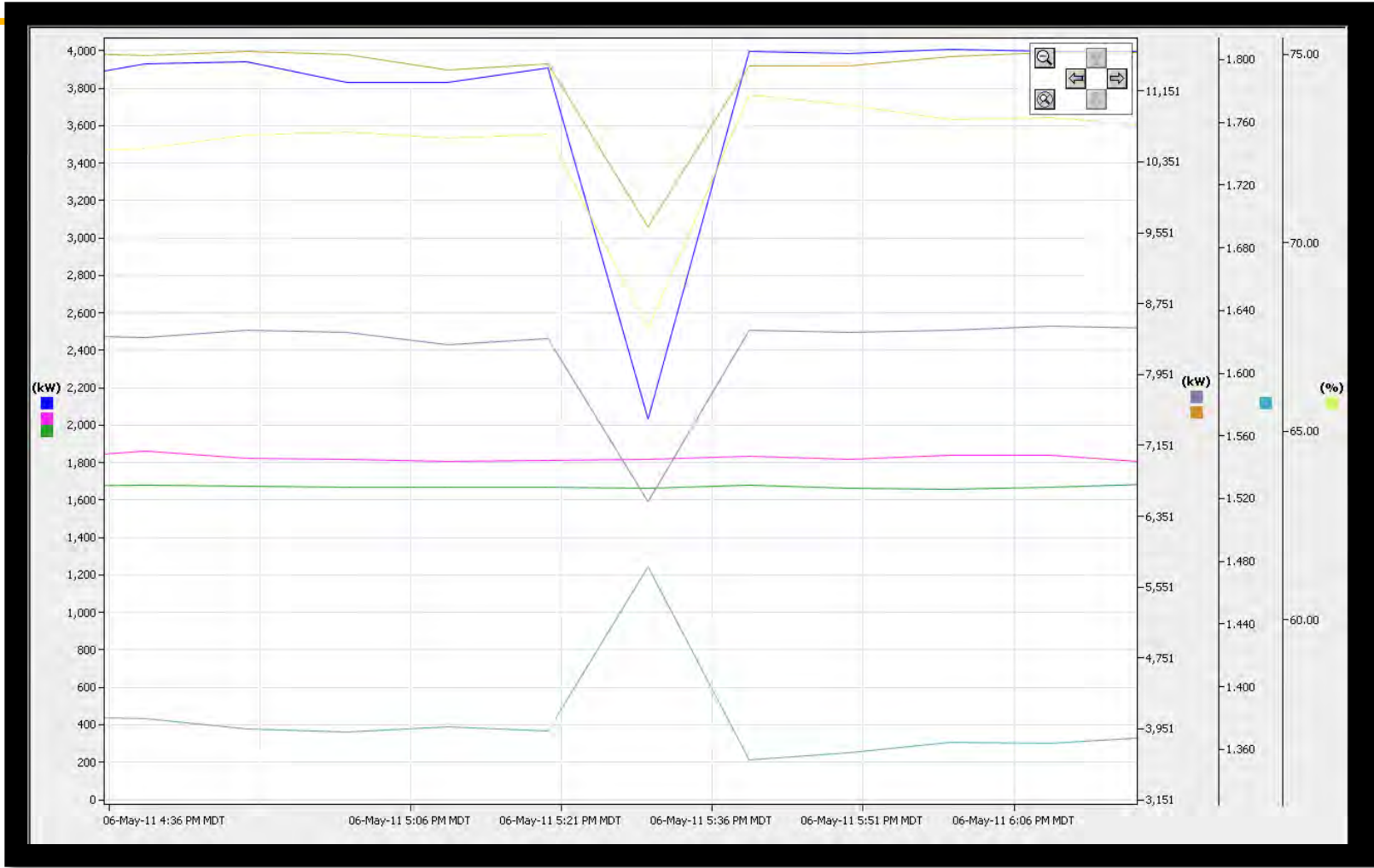
WIRELESS Network Topology – Thermal Monitoring

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Ceiling Temperatures, Humidity, and Under Floor Air Pressure

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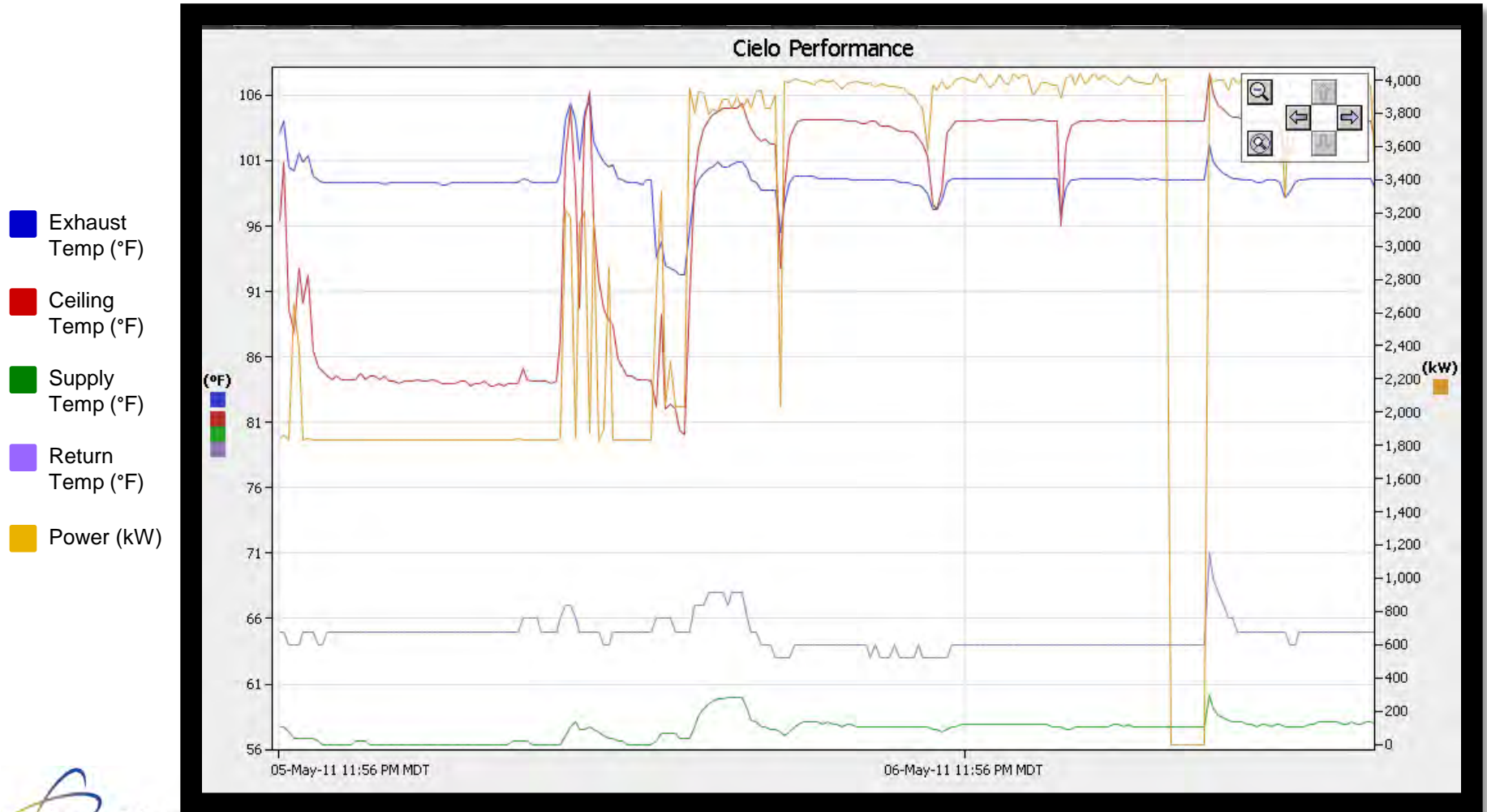
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Return Plenum, Rack Supply and Exhaust Temperatures, and Humidity - WEST

Return Plenum, Rack Supply and Exhaust Temperatures, and Humidity - EAST

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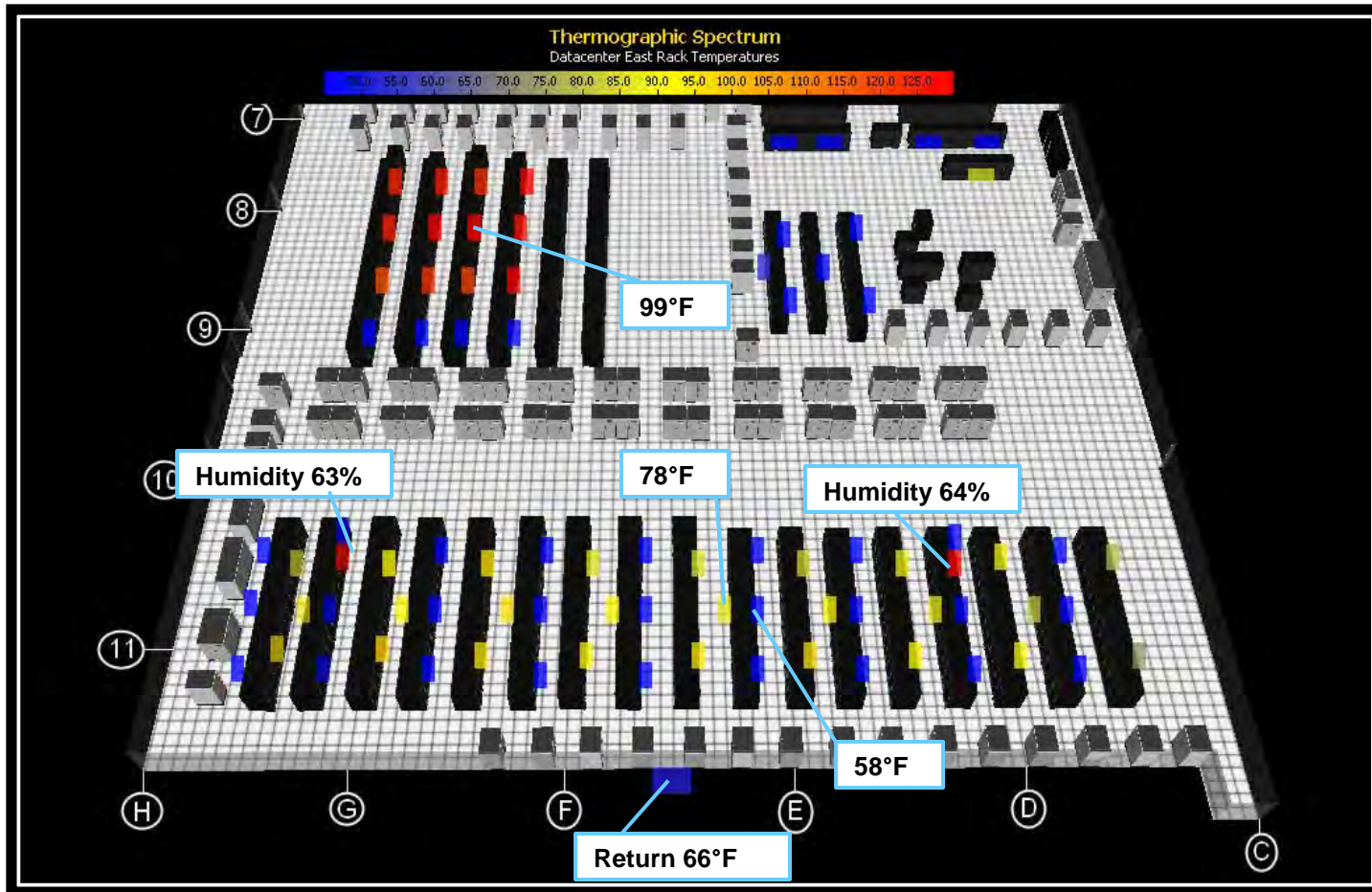
Wireless Information Summary from Cielo

SCC – Data Center Efficiencies

Live values recorded May 31, 2011 at 8:00 am

CIELO
1578 kW

ROADRUNNER
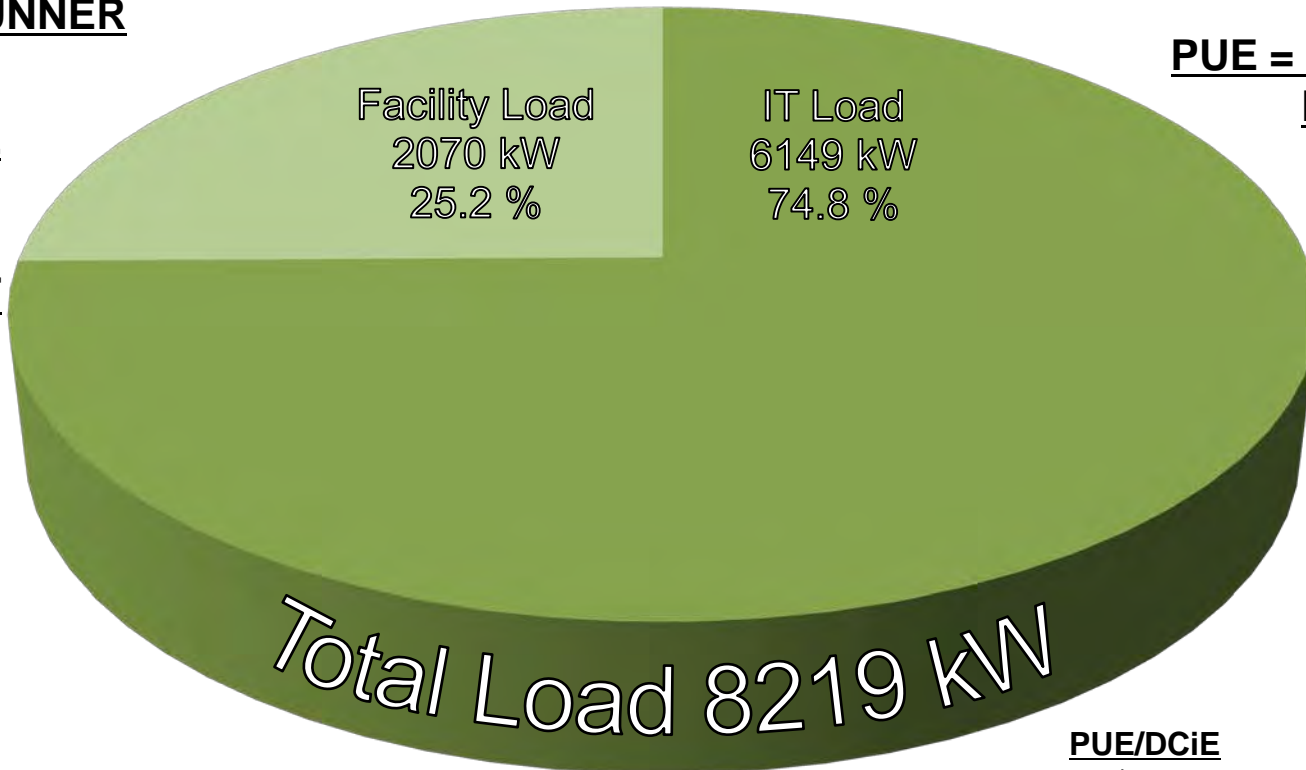1568 kW

REDTAIL
1746 kW

MISC. IT LOAD
1257 kW

DCiE = Data Center Infrastructure Efficiency
74.81 %

PUE = Power Usage Effectiveness
1.337

Facility Load
2070 kW
25.2 %

IT Load
6149 kW
74.8 %

Total Load 8219 kW

PUE/DCiE
2.0/50% =AVERAGE
1.5/67% = EFFICIENT
1.2/83% = VERY EFFICIENT

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Thank You

Questions

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