



Welcome to the future of mission critical

Rob Agar
Vice President, Enterprise Infrastructure Services
and Mission Critical Facilities

November 5, 2014



Agenda

- Project BlueGrass – Background and Objectives
- Data Center Strategy
- Basis of Design
- Site Selection Process
- Facility Design
- Utility Information (Routing, Diversity and Reliability)
- Electrical Architecture
- Operational Support and Management Team
- Technologies and Products in the Data Center Space
- Sustainability and LEED
- Heat Management Strategies
- Customer Visits: Strategy and Application Sessions

Why Project BlueGrass?

Upgrading Eaton's global data center infrastructure:

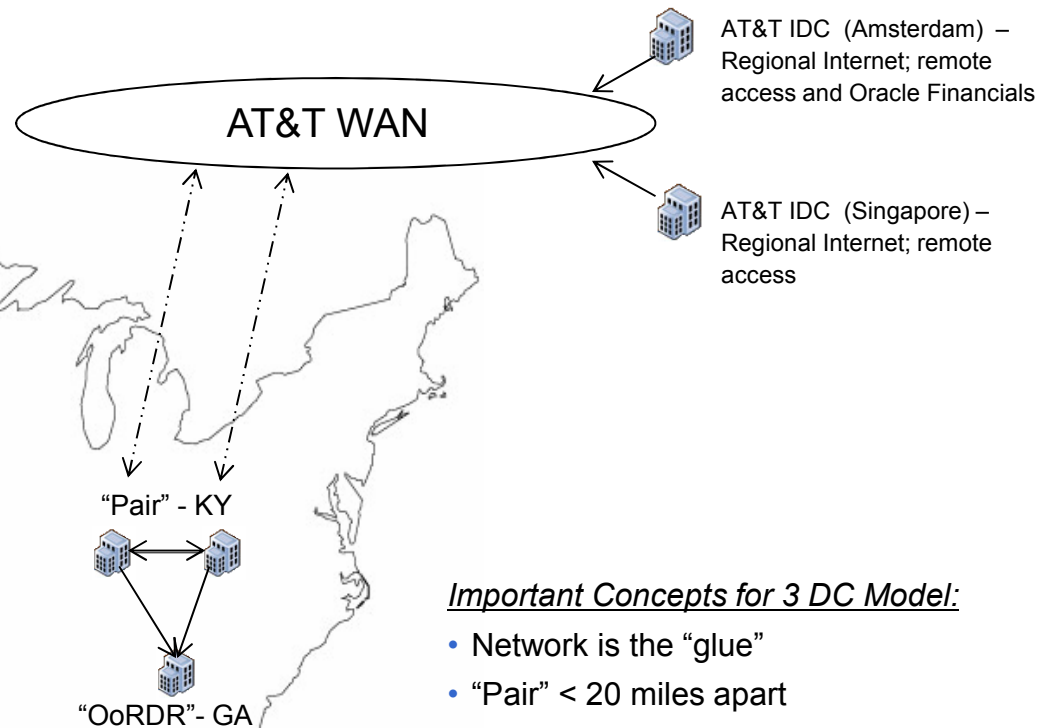
- Prior to 2004, Eaton had 2 main redundant data centers in Cleveland, and regional data centers in Scotland, China, Brazil, and Pennsylvania
- In 2005, the Enterprise Infrastructure Services Team developed a formal strategy for Eaton's global data center infrastructure
- Analysis showed that there were significant DC gaps that could limit Eaton's ability to meet the global needs of the business
- Recommendations: 1) consolidate the regional data centers into the 2 data centers in Cleveland; 2) Cleveland data centers were at an end-of-life state and out of capacity – replace; 3) move to 3 data center model (“pair” + OoRDR facility)

Eaton data center strategy (2005 – 2013+)

Future State

Strategy:

- 3 center model = 1 pair DCs+ Out of Region Disaster Recovery (OoRDR) facility
- OoRDR facility located with enough separation to mitigate risk of regional event (man-made or natural)
- AT&T Internet Data Centers (IDCs) for latency or regional application delivery requirements
- All existing regional data centers are consolidated into Louisville, KY “pair”



Important Concepts for 3 DC Model:

- Network is the “glue”
- “Pair” < 20 miles apart
- OoRDR must be > 250 miles from Pair
- Regional Event (Storm of the Century-1993)
- High Availability Services (HA)
- Recovery Time Objective (RTO)
- Recovery Point Objective (RPO)
- Application Portfolio (Tier 1 Applications)

Project requirements = “basis of design”

Business Requirements:

- 20 year+ “runway” or roadmap
- Support global needs for the business
- Flexible, agile and scalable in alignment with business change

Information Technology Requirements:

- Supports highly available application service delivery
- Adaptable to evolving application services needs of the business (big data, video and mobility)

Facility Requirements:

- Sustainability – environmentally “friendly” and energy efficient
- Heavy use of technology to drive high levels of automation, monitoring & management (staffing and resource optimization)
- Design / technologies provide 7 day by 24 hour levels of IT service delivery capability

Site selection process (2008–2009)

The World

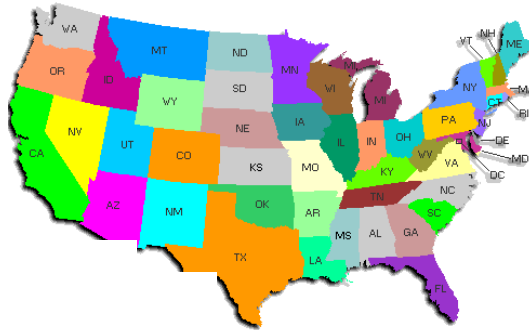


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Global Network Reliability

The U.S.

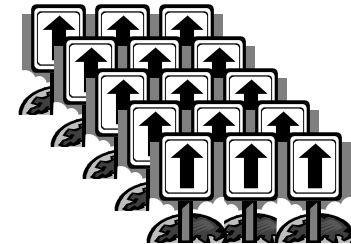


2



Natural Risks, Federal Declared Disaster Data (Tornadoes, Hurricanes) and AT&T Network Footprint.

15 Cities



Backup: Atlanta

3



Lexington / Louisville

AT&T Network Redundancy + Diversity From Cleveland's Power Grid + Current / Future Energy Costs & Energy Capacity Outlook.

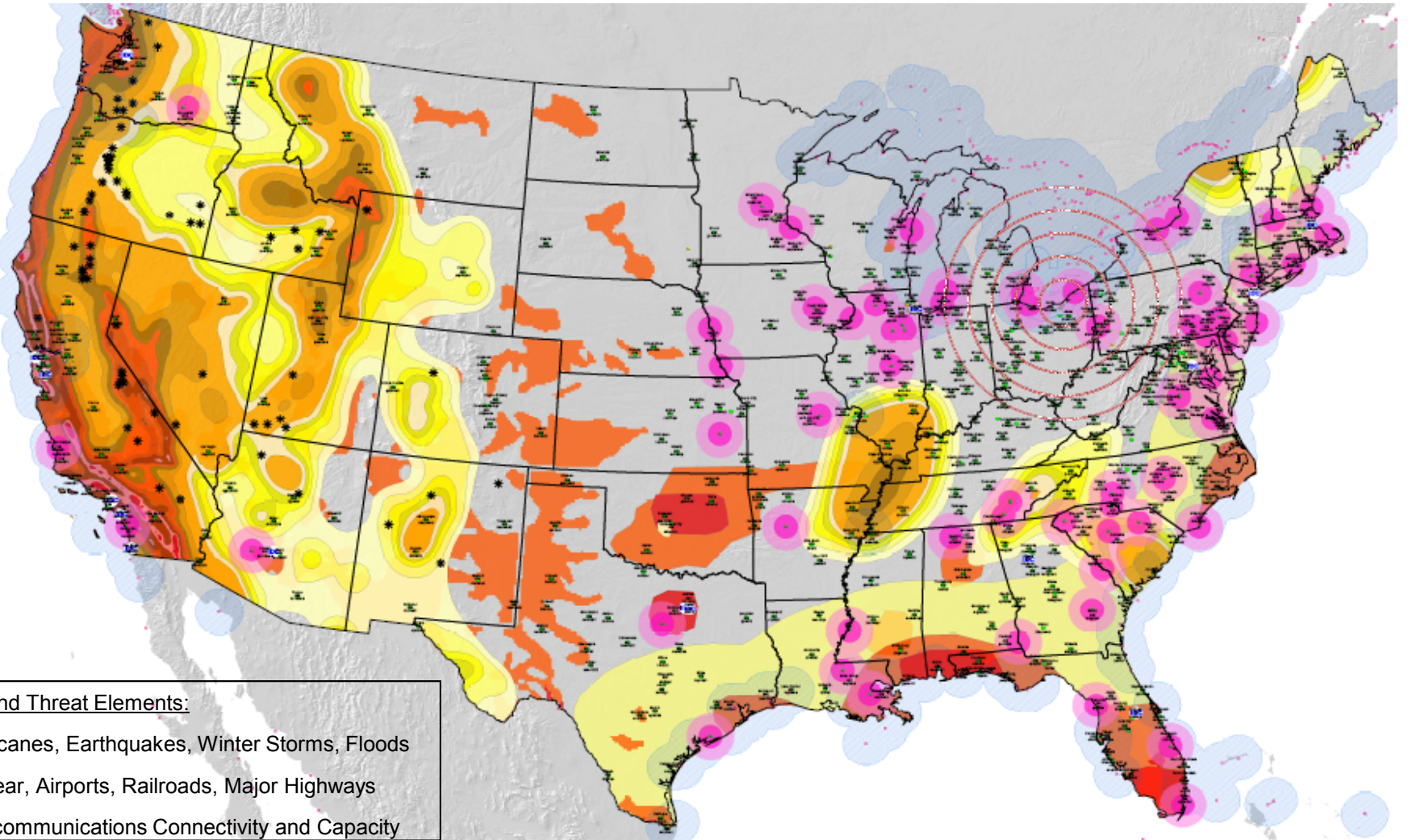
Selection of Property

4



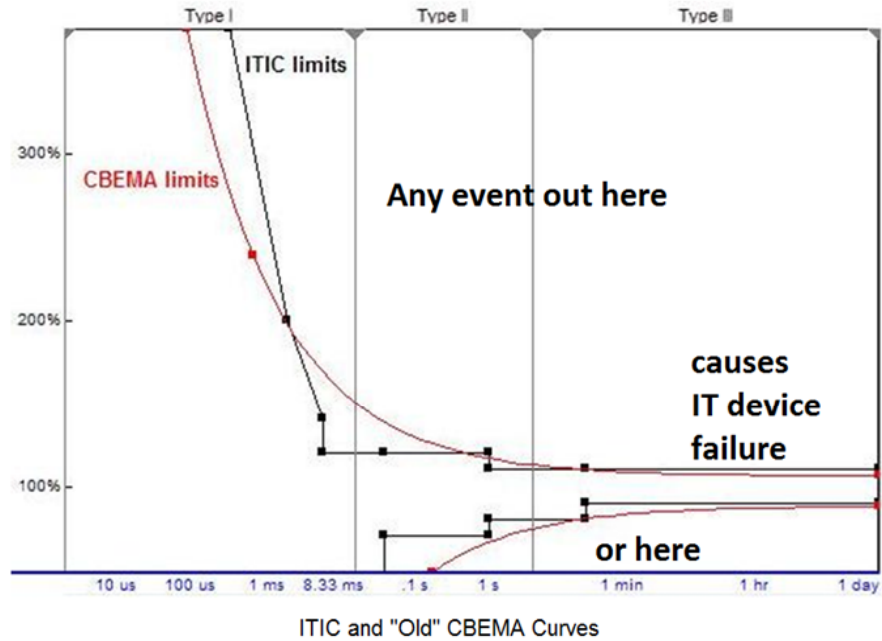
Property Searches With Due Diligence on Local Factors (Power + Network), Other Build-Out Costs.

Site selection process (2008–2009)



Utility Information (Service Reliability)

	RITC				BITC			
	Power Anomalies outside of the ITIC Curve				Power Anomalies outside of the ITIC Curve			
	Single-Side Events	Both-Side Events	On Gen Events	Total Events	Single-Side Events	Both-Side Events	On Gen Events	Total Events
Feb-11							0	0
Mar-11							0	0
Apr-11							1	1
May-11			0	7			0	3
Jun-11			0	0			0	1
Jul-11			0	1			0	3
Aug-11			0	4			1	4
Sep-11			0	2			0	0
Oct-11			0	0			0	0
Nov-11			0	0			0	0
Dec-11			0	0			0	0
Jan-12			0	0			0	0
Feb-12			0	0			0	0
Mar-12			0	0			1	3
Apr-12			0	0			0	1
May-12			0	8			0	1
Jun-12			0	0			0	1
Jul-12			0	7			0	10
Aug-12			0	5			0	1
Sep-12			0	0			0	6
Oct-12			0	2			0	5
Nov-12			0	0			0	0
Dec-12			0	5			0	5
Jan-13			0	2			0	4
Feb-13			0	3			0	2
Mar-13			0	4			0	5
Apr-13			0	3			0	2
May-13			0	4			0	3
Jun-13			0	6			1	1
Jul-13			0	5			0	2
Aug-13			0	2			0	5
Sep-13	2nd Utility Installed		0	2			0	0
Oct-13	0	2	0	2	1	1	0	2
Nov-13	1	2	0	3	3	0	0	3
Dec-13	2	0	0	2	3	1	0	4
Jan-14	4	0	1	4	4	0	0	4
Feb-14	3	3	0	6	4	0	0	4
Mar-14	1	0	0	1	0	0	0	0
Apr-14	3	1	0	4	0	1	0	1
May-14	8	0	0	8	2	0	0	2
Jun-14	4	3	0	7	2	4	0	6



Summary (5/2011 – 6/2014 = 38 months):

- Red Site – 1 incident (load moved to generator)
- Blue Site – 4 incidents (load moved to generator)

Our Mission Critical Facility Team

- Information Technology Team:
 - ❑ 1 Manager + 2 Engineers + 1 Open
 - ❑ Rack / stack, cap planning, monitoring / management, product development, IT commissioning
- Facility Team:
 - ❑ 1 Manager + 5 Resident Engineers
 - ❑ Operational support of electrical / mechanical infrastructure
 - ❑ Capacity planning, plant optimization, commissioning
 - ❑ Supplemented through the use of 3rd party maintenance contracts
- Years of experience on the team = 260 years
- Years of Eaton service = 130 years
- MoP Program recognized as industry “best practice”

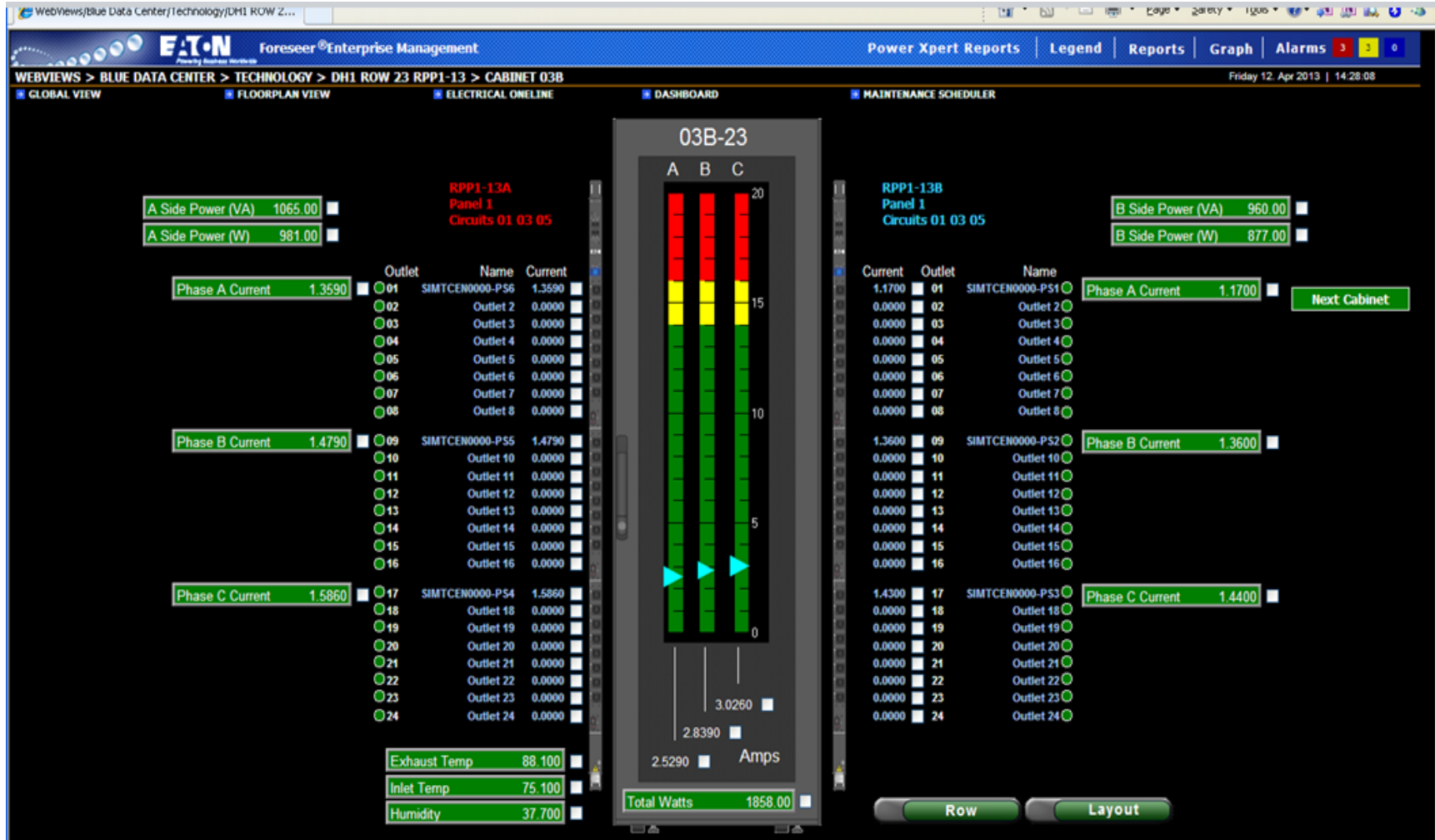
Project BlueGrass: BMS

Building Management System (BMS) Room

- High degree of automation and monitoring
- BMS monitors and manages all mechanical subsystems in the building
- Eaton's Foreseer Electrical Power Management System (EPMS) monitors all electrical subsystems in the building
- Foreseer provides strong trending, analytics and reporting capabilities
- BMS + EPMS platforms integrated (570 data points/sec)
- Over 30K data points collected



Foreseer extensions – branch circuit monitoring (rack level)

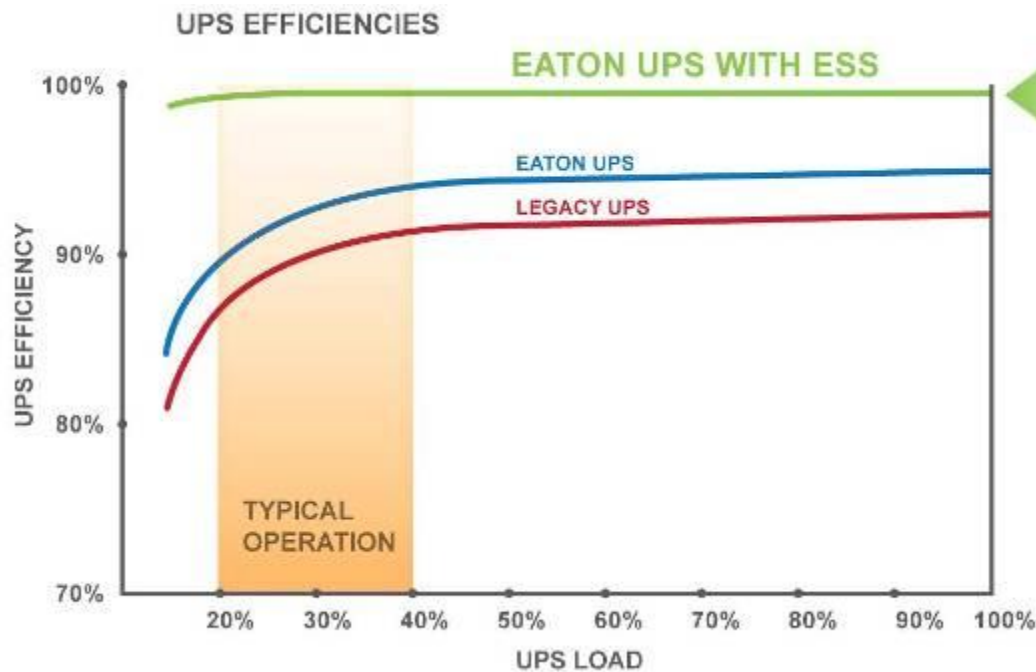


Eaton Power Xpert 9395 275-1100kVA UPS



Multi-Mode UPS lowers cost of operation

Maximum Efficiency Tracking



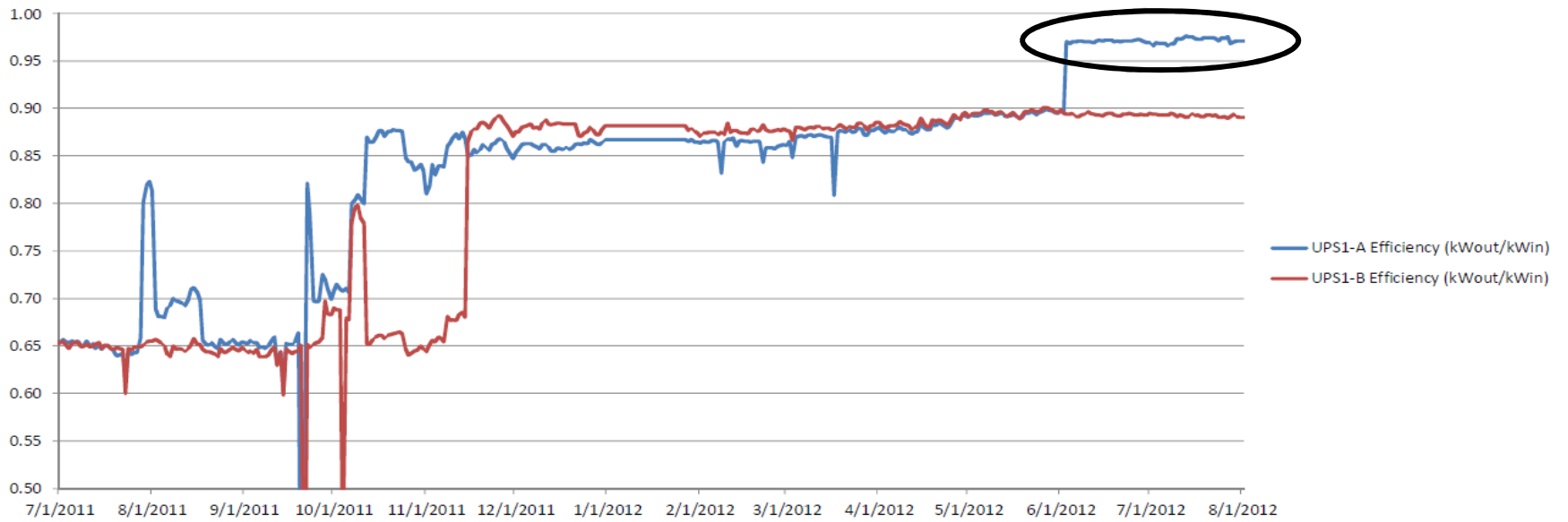
- **ESS and DCoD Efficiency – 98 to 99%** across the complete operating range
- **85% reduction in losses** compared to legacy transformer-based UPS
- **Continuous power tracking** and proprietary DSP algorithms combined with transformer free design topology ensures **critical loads are always protected**



Eaton Power Xpert 9395 UPS in ESS mode

UPS Efficiency

Higher is better (kWout/kWin)



Notes: Drops are due to maintenance. UPS1-A efficiency increased after firmware upgrade--unit is now utilizing ESS mode.

Eaton 93PM North America product launch

The 93PM is the latest addition to Eaton's family of UPS products:

- Small to medium data centers (or distributed designs)
- Power Rating – Scalable from 50kW to 200kW
- Configuration – Tower
- Topology – Double conversion online UPS with optional energy saver system mode
- Voltage – 480V / 3 Phase
- Efficiency:
 - Double conversion up to 97%
 - Energy Saver System (ESS) up to 99%
- In ESS mode will deliver transition times of less than 2 ms
- Dimensions – 74" X 22" X 42"
- Weight – 869 lbs.
- Designed to be used in both gray space and white space...
- Airflow supports front to top & front to back (hot aisle/cold isle containment)
- Supports "slim" chimneys allowing overhead bus way and cable tray systems

Eaton remote power panels (RPPs)



Eaton enclosures with HCS technology



Sustainability: The LEED framework

Leadership in Energy & Environmental Design (LEED):

A standard for environmentally-sustainable construction created by the U.S. Green Building Council

Project BlueGrass facilities are LEED Gold certified

Five principle areas for LEED certification:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality



LEED category: sustainable sites

- “Compactness”—reduce size and space
- Limiting “physical sprawl”
- Operate DC @ 400V to eliminate rack level transformers—50–60% footprint reduction on power distribution side
- Uninterruptible Power Supply (UPS)—50% smaller footprint than previous model
- Returning site to “natural” state (post construction) through the use of indigenous grasses, shrubs and trees



LEED category: water efficiency

- Heat is moved from the data halls to outside via a chilled water system
- Set point for data halls is set at 74 degrees F/23.33 degrees C
- Humidity is maintained at 47%, +/- 5%
- Higher temperature (historically 65-68 degrees F) saves water
- Water side economizer (WSE) technology provides “free cooling” in KY 70% of time
- WSE return on investment (ROI) is projected to be less than 3 years
- Use of Dolphin WaterCare System
 - Chemical-free water treatment technology
 - Prevents corrosion in pipes
 - Prevents microbial infestations
 - Protects local ecosystems



LEED category: energy and atmosphere

Information Technology (IT)

- Standardization, consolidation and virtualization of IT platforms (servers, storage, network)
- Utilize highly-efficient IT equipment
- Some server platforms realize 50% energy reduction
- Selection of technology is based on performance, price and energy efficiencies



Electrical infrastructure

- UPS—Industry leading product that deliver 99% efficiency
- Projected to save \$33,000 in energy costs per year per site

Variable frequency drives (VFDs) enable air handling fan speed adjustment to match actual demands of IT equipment

- Projected to save 10% to 50% in energy costs across various applications within plants

LEED category: energy and atmosphere

Mechanical infrastructure

- Water-side economizer technology projected to save \$60,000 in energy costs per year, per site
- Heat Containment System (HCS) Technology projected to lower air handling-related energy usage by up to 30%



Facility capabilities

- Energy efficient roof (40% reflectivity factor) and building color
- Use of occupancy and vacancy sensors to control lighting
- Use of lighting control scheduling

LEED category: materials and resources

- 95% of wood used was certified as harvested according to guidelines from the *Forest Stewardship Council (FSC)*, a non-profit organization devoted to encouraging the responsible management of the world's forests
- 46% of materials were “indigenous” to the region (defined as being within 500 miles of construction site), reducing transportation impact
- 115,000 total cubic yards of excess material removed from both sites. Material re-used in local road construction, property improvements, and a community project.
- These applications had a positive effect on the local communities and saved Eaton over \$100,000 in disposal costs



LEED category: indoor environmental quality

Goal: Ensure facilities are a desirable environment for employees

- Utilize natural light in the office area
- Utilize occupancy and vacancy sensors to control lighting
- Maintain cleanliness
- 600 square foot fitness center for employees

Data hall air temperatures (Project #40558)

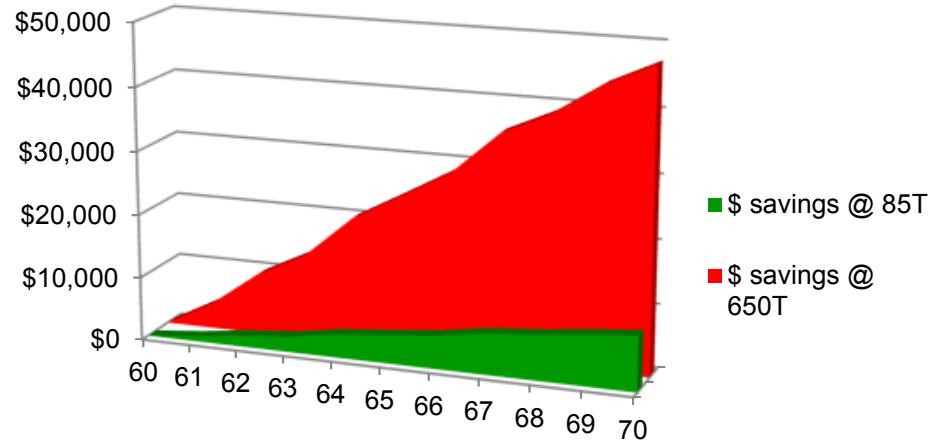
Analysis of energy (cost) savings by increasing the data hall supply temperature?

- Current State: Current supply air set point is 74 degrees Fahrenheit; currently use 68 degree chilled water with an economy transition set point of 60 degrees Fahrenheit.
- Analysis #1: Investigate utilizing supply air set point of 78 degrees Fahrenheit; 72 degree chilled water with an economy transition set point of 64 degrees Fahrenheit.
- Analysis #2: Investigate utilizing supply air set point of 81 degrees Fahrenheit; 75 degree chilled water with an economy transition set point of 67 degrees Fahrenheit.
- Determine energy (cost) impact
- Determine technology risks (to equipment and to operations of equipment)

Data hall air temperatures (Project #40558)

Chiller plant economy setpoint annual forecast savings (based on recorded 2012 weather data from Foreseer)

Econ setpoint dF	\$ savings @ 85T	\$ savings @ 650T
60	\$0	\$0
61	\$732	\$4,012
62	\$1,747	\$9,575
63	\$2,446	\$13,406
78F supply-> 64	\$3,660	\$20,064
65	\$4,426	\$24,260
66	\$5,208	\$28,546
81F supply-> 67	\$6,456	\$35,386
68	\$7,088	\$38,852
69	\$7,987	\$43,777
70	\$8,736	\$47,334



Significant annual savings can be realized with increasing load...

Data hall air temperatures (Project #40558)

Risks (Equipment and operation of equipment):

- ASHRAE TC9.9 Documents (Thermal Guidelines for ICT hardware)*
 - ❑ Elevating supply side air set point from 74°F (23°C) to 80.6°F (27°C) would result in an 18% higher failure rate of IT equipment.
 - ❑ By the chart, at 23°C, the Reliability X-Factor is 1.1
 - ❑ By the chart, at 27°C, the Reliability X-Factor is 1.3
 - ❑ A ratio of the two X-Factors (1.3 / 1.1) yields 1.18 = an increase of 18% in failure rate from the lower temperature to the higher one.
 - ❑ If we had 10 device failures in a year with ambient air temperature of 74°F, we would expect about 12 device failures in that same year if the temperature had been 80.6°F.

Example of the impact of loss of cooling in the data hall in Kentucky:

- March 2, 2012 we experienced a mechanical outage (15 minutes) during which space air temperature readings rose 3-6 degrees F, at 166kW total room load.
 - ❑ Room is designed for ten times that total power.
 - ❑ We would expect the temperature to rise roughly 10 times in full build out scenario (30-60 degrees)
 - ❑ Do we set environmental thresholds on our equipment to protect?.

*Note: Data from chart/figure 18, page 27.

Customer visits: strategy, technology and service sessions



Eaton Electrical Sector - Power Quality Operations invites you to participate in the

BlueGrass Project 2014 Tour April 7th-8th, 2014 • Louisville, Kentucky



Latin America 2014 Power Tour April 9th-11th, 2014 • Raleigh, North Carolina

Spaces are limited. Please confirm your assistance before Monday March 17th, 2014

www.eaton.com/powerquality

Welcome...

to the future of mission critical and Feel the Power.

The BlueGrass Project

In 2005, the IT leadership at Eaton began working on the definition of a data center model that would support its global business over the next 20+ years. The project (known as Project BlueGrass) constituted of two new redundant data centers (the "pair"), located within 20 miles of each other, that would support synchronous data replication (data mirroring) and IT application failover capabilities to ensure high service availability. A third CoDRR facility, at least 250 miles away, will provide out-of-region disaster recovery (CoDRR) support in the event that a regional disaster rendered the pair inoperable for an extended period of time.

Realizing the Vision

The design of this new sites is flexible, modular and scalable enough to stay in front of rapid business/IT change and demand. One of the key features in this project were the Environmental Responsibility Efforts that took into consideration that all facilities were built with natural materials and resources so they turned out to be sustainable sites with water and energy efficiency.

Construction of the new two new "identical" facilities in the greater Louisville, KY was completed in May of 2011. They moved into production on June of 2010 and have been fitted out and commissioned on the Information Technology side with new compute, storage and network infrastructure. To date, over 1,013 applications have been migrated from Cleveland, Ohio to Louisville, KY. The CoDRR facility is expected to be developed starting in 2013.

Hilton Garden Inn Louisville East • 1530 Aillant Avenue, Louisville, Kentucky 40299 USA
<http://hiltongardennlouisville.com/ev-hotels/kentucky/hilton-garden-inn-louisville-east-3DFLEG/accommodations/index.html>

We recommend you visit the following website in order to have a weather forecast for the days you will be visiting Louisville:
<http://www.weather.com/weather/right-now/USKY1096:1>

Power Tour Mission

Exclusive to Eaton, the Power Tour series was initially developed in 1990, primarily as an educational resource. While designed to showcase the industry's best power quality offerings, the Power Tour series is largely dedicated to pertinent industry topics of discussion such as elimination of downtime, effective power distribution, and beyond. Participants are additionally invited to explore Eaton's ISO 9001 Powerware Customer Experience Center.

Through the uniquely instructive Power Tour series, Eaton is committed to creating a learning environment based on industry expertise of emerging products and technologies, for the purpose of fostering continued education within the power quality industry.

Raleigh Marriott Crabtree Valley • 4500 Marriott Drive, Raleigh, North Carolina 27612 USA
<http://www.marriott.com/hotels/travel/runc-raleigh-marriott-crabtree-valley/>

We recommend you visit the following website in order to have a weather forecast for the days you will be visiting Raleigh:
<http://www.weather.com/weather/today/USNC0558>

AGENDA

Monday • April 7 th • Louisville	Thursday • April 10 th • Raleigh	Friday • April 11 th • Raleigh
Open Arrival 7:00 p.m. Meeting at the Lobby 7:00 - 7:30 p.m. Load Transportation 7:30 - 10:00 p.m. Welcome Dinner at Ruth's Restaurant	Breakfast 6:00 - 6:15 a.m. Welcome and Introduction Eaton Corporation Overview 6:15 - 6:30 a.m. Market Trends DC 6:30 - 10:00 a.m. Data Center Solutions 10:00 - 10:30 a.m. Break 10:30 - 12:45 p.m. Evaluating Power Solutions for Small to Large Enterprises 12:45 - 1:30 p.m. Lunch 1:30 - 2:15 p.m. Three Phase Introduction and Overview 2:15 - 2:45 p.m. Large Systems Group (LSG) 2:45 - 3:15 p.m. Blade UPS & ePDUs 3:15 - 3:30 p.m. Power Distribution: RPP, PDU, Line & Match Accessories 3:30 - 4:30 p.m. Break 4:30 - 4:45 p.m. Single Phase 4:45 - 5:15 p.m. Software & Connectivity 5:15 - 5:30 p.m. Questions & Answers 6:45 - 7:00 p.m. Load Transportation and travel to activity 7:00 - 7:30 p.m. Welcome Dinner at Vinnie's 7:30 p.m. Bowling	Breakfast 6:15 - 6:30 a.m. Load Transportation and travel to RPO 6:30 - 12:00 p.m. Customer Meet & Greet 12:00 - 12:45 p.m. Manufacturing Plant Tour Customer Experience Center Training Center Lunch - PowerExpert 12:45 - 1:45 p.m. Night Line (Air/Thermal Management) 1:45 - 2:00 p.m. Picture 2:00 - 2:15 p.m. Load Transportation and travel to Forum 2:30 - 2:45 p.m. Tour 2 nd Floor Customer Reliability Center 2:45 - 3:15 p.m. Questions & Answers Certificates 3:15 p.m. Load Transportation and travel to RDU Airport
Tuesday • April 8th • Louisville 6:30 - 7:30 a.m. Breakfast 7:30 a.m. Meeting at Lobby 7:45 a.m. Load Transportation 8:00 a.m. - 12:00 p.m. BlueGrass 12:00 - 12:30 p.m. Load Transportation 12:30 - 1:30 p.m. Lunch 1:30 - 1:45 p.m. City Tour 1:50 - 1:55 p.m. Visit to the mall 7:00 - 8:00 p.m. Dinner	Wednesday • April 9th • Raleigh Open Arrival Eaton Registration Customer Meet & Greet Lobby 6:45 - 7:00 p.m. Load Transportation 7:00 - 7:30 p.m. Welcome Dinner at Vinnie's	Dress Attire: Business Casual Thursday and Friday: Men: wear closed-toed shoes and safety glasses. Safety glasses will be provided at Eaton facility.

Eaton thanks you for being part of this experience and wants to share some important information with you.

All your accommodation and transportation services have been booked and confirmed according to your flight arrivals and departures. Within your arrival, there will be an Eaton representative waiting for you with an Eaton Logo sign so you can easily recognize them.

For assistance and additional information about your stay in Louisville, KY, please contact:

Robert F. Agar - robertagar@eaton.com - Tel. +1 444 954 5291
 Andrea Pérez - andraperez@eaton.com - Tel. +52 56 8503 2167 or 9000 5252
 Georgia Thomé - +55 11 3616 8515 - Cel. +55 11 97642 4680

For assistance and additional information about your stay in Raleigh, NC, please contact:

Temeka Weldon - temekaweldon@eaton.com - Tel. 919 870 3196 - Cell 919 247 6140
 Andrea Pérez - andraperez@eaton.com - Tel. +52 56 8503 2167 or 9000 5252
 Georgia Thomé - +55 11 3616 8515 - Cel. +55 11 97642 4680



Customer visits: strategy, technology and service sessions

- Formal program started in 2012 (24 months)
- We conduct customer visits at our facilities in Kentucky to share knowledge and experiences in the IT and data center space
- Customers have included leaders from IT, facility teams, engineering firms and our IT partners (AT&T, HP, Cisco, Oracle...)
- Since January of 2012, we have had over 300 companies and 850+ people visit our Red Site facility in Kentucky
- Hosted Eaton's 93PM NA Product launch on September 23 & 25
- We have conducted 4 tours of the Kentucky data center as part of 2014 Eaton Power Tour Program (LATAM, NE, SE and West Regions)
- Currently planning to have 6 tours of Kentucky data center in 2015 as part of Eaton Power Tour Program

Questions?

