Maximo GreenDataCenter
IBM – Global Leader in Data Center Management & Innovation

Worldwide: 488 datacenters, 61 strategic, 8.3/2.5m sq.ft.
Americas: 194 datacenters, 21 strategic, 4.7/1.3m sq.ft.

<table>
<thead>
<tr>
<th>IBM Datacenter portfolio</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
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<tr>
<td>Datacenters</td>
<td>61</td>
</tr>
<tr>
<td>Thousand sq.ft.</td>
<td>2536</td>
</tr>
<tr>
<td>Tactical</td>
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<tr>
<td>Datacenters</td>
<td>73</td>
</tr>
<tr>
<td>Thousand sq.ft.</td>
<td>1083</td>
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<tr>
<td>Client</td>
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<tr>
<td>Datacenters</td>
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</tr>
<tr>
<td>Thousand sq.ft.</td>
<td>4396</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Datacenters</td>
<td>488</td>
</tr>
<tr>
<td>Thousand sq.ft.</td>
<td>8329</td>
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</table>

Compute capability:

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>Mainframes</td>
<td>1,291</td>
</tr>
<tr>
<td>MIPs</td>
<td>1,067,458</td>
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<tr>
<td>Terabytes</td>
<td>10,312</td>
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<tr>
<td>Mid Range</td>
<td>206,355</td>
</tr>
<tr>
<td>End Users</td>
<td>3,735,388</td>
</tr>
</tbody>
</table>

Plus . . . Deep experience in helping our clients’ data center challenges

- Significant services deployment capability: over 3,300 resources for server, storage and data centers
- Global breadth: built >30M square feet of data centers; top 5 Chinese banks; India and Egypt telecomm
- Leverage experience from managing and deploying over 200,000 servers in over 400 centers

Awards & Recognition

<table>
<thead>
<tr>
<th>Award / Recognition</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWF Climate Leaders</td>
<td>2005</td>
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<tr>
<td>Climate Change</td>
<td>2005</td>
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<tr>
<td>USEPA Climate Protection Award 1998 and 2006</td>
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<tr>
<td>The Climate Group 2005</td>
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</tr>
<tr>
<td>Green Power Purchaser Award 2006</td>
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</tbody>
</table>

Early Actions & Results

Between 1990 and 2005, IBM’s global energy conservation actions reduced or avoided CO₂ emissions by an amount equal to 40% of our 1990 emissions.
We use the power approximately equivalent to the entire state of Connecticut - 6Bn kWh

All our ITD datacenters would fit into a space equivalent to Disneyland - 8m sq ft
Energy costs are 50% of the facilities lifetime operational costs.

Operating costs are 3x the capital costs and energy is up to 50% of the total costs.

Source: IBM Estimates
U.S. BUILDINGS IMPACTS ON RESOURCES

39% of total energy consumption

71% of electricity consumption

39% CO₂ emissions

30% of raw materials use

30% of waste output

12% of potable water consumption
Leadership in Energy and Environmental Design

A leading-edge system for certifying the greenest performing buildings in the world
LEED address the complete lifecycle of buildings:

- Homes
- Neighborhood Development (in pilot)
- Commercial Interiors
- Core & Shell
- New Construction
- Schools, Healthcare, Retail
- Existing Buildings Operations & Maintenance
Average Green Building Saves

- Maintenance and Operations 10%-15% Savings
IBM Data Center & Facilities Management

What is the problem we’re trying to solve?
• Constrained resources (space / power)
• High cost of infrastructure and operations
• No holistic view of IT & Facilities infrastructure resources

Why is it a problem?
• Inhibits revenue growth & responsiveness
• Increases cost of operations, which undermines competitiveness
• Inability to drive intelligent business decisions around E2E resource management

What is the high level solution?
• Jointly optimize IT & Facility DESIGN
• Jointly optimize IT & Facility OPERATIONS

IBM’s Green Data Center Energy Management objective is to:
▪ Develop innovative solutions strategy
▪ Deployment plans which integrate IT and facilities infrastructure
▪ Infuses state-of-the-art hardware and software technologies, in order to optimize economically feasible and environmentally responsible data center designs and operations.

IT Assets
(Servers, storage)

Data Center Infrastructure
(UPS, PDUs)

Building Systems
(HVAC, power, lighting, security)
IT and Facilities Integration - Crossing Traditional Boundaries

- Avoid IT service downtime caused by facility issue
- Space planning to optimize utilization of floor space
  - Predictive maintenance
  - Ability to efficiently deliver capacity and reliability to meet business need
- Can’t get needed power to grow the business
  - Facility automation creates data center-like characteristics
  - Servers required to manage asset monitoring
  - Want centralized management of IT, Environmental, and Facilities monitoring
- New regulations on power usage
  - Energy rebates for using smart assets

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IBM Strategy
- Integrated Maturity Roadmap

IT Infrastructure
Energy Efficiency Strategy

Centralization

- Consolidate from many to fewer data centers
- Reduce infrastructure complexity
- Improve facilities management
- Reduce staffing requirements
- Improve business resilience (manage fewer things better)
- Improve operational costs

Physical Consolidation

- Consolidate many servers into fewer on physical resource boundaries
- Reduce system management complexity
- Reduce physical footprints

Virtualization

- Remove physical resource boundaries
- Increase hardware utilization
- Allocate less than physical boundary
- Reduce software licensing costs

Application Integration

- Migrate many applications into fewer images
- Simplify IT environment
- Reduce operations resources
- Improve application specific monitoring and tuning

State-of-the-Art

- Integrated power management
- Direct liquid cooling
- Combined heat and power

Best Practices

- Hot and cold aisles
- Improved efficiency transformers, UPS, chillers, fans, and pumps
- Free cooling

Improved Operations

- Conservation techniques
- Infrastructure energy efficiency
- Improved airflow management

Facility Infrastructure
Energy Efficiency Strategy

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Maximo GreenDataCenter

- E2E Energy Efficiency Solution for DataCenter and Facility

- Holistic Approach to Data Center and Facility Management
- Lifecycle Management of Data Center and Facility
- Facilitates Best Practices for Energy Efficiency, Confirmation
- Monitors Operations Environment and Assets
- Optimization Analysis of Resources, Energy Effectiveness
Spatial Management with Maximo Spatial

- Holistic to detailed views
- Map and visualize data center facilities
  - Facility, building, floor, room, telephone, electrical, plumbing, substation, generators, UPS, PDU, CRAC
  - Racks, servers, storage, switches, routers, network
- Query, Analyze, and Symbolize results from aggregated internal and external data sources – monitoring data, assets, ERP, financials, usage
- Obtain information on power, temperature, and layout, and identify problem areas
- Enable improved facilities management in support of IT
- Associate Assets and Service Request Records
Lifecycle Management
with IBM, Maximo, and Tivoli Capabilities

- Asset Strategy – Requirements driven by organization’s mission and Business Goals
  - Maximo Today
- Plan – Plans and Policies that provide detailed frameworks for implementation of asset strategy
  - Maximo Today
- Engineering and Design - Appraise asset and asset management solutions to ensure that it adds maximum value at the least cost
- Create/procure - Carry out procurement processes to ensure that acquisition and outsourcing maximize the potential of the asset strategy
  - Maximo Today
- Operate - Operate assets more effectively through better information and processes
- Maintain - Maintain assets to reduce cost and limit downtime
  - Maximo Today
- Modify - Modify assets to reduce cost and limit downtime
  - Maximo Today
- Dispose - Make the best decisions on asset disposal integrating decisions into strategy, planning and procurement as appropriate
  - Maximo Today
Facility Management - (Best Practices & Confirmation) with Maximo Asset & Work Management

- Perform preventive maintenance of building systems to support occupancy requirements
- Reduce facility energy consumption with effective building system maintenance
- Efficiently manage and track work orders
- Optimize scheduling of maintenance personnel – assign work to the right people
- Manage lease, rental, and labor contracts
- Track inventory levels and keep optimal order quantities of spare parts and materials
- Maintain asset information such as asset hierarchies, configurations, warranty data and historical maintenance performed
Facility Management - (Best Practices & Confirmation) with Maximo Asset & Service Management

- Define and deliver service level commitments according to occupancy needs based on variables such as asset type, time of day, end user or incident nature
- Use workflow, escalations and automated response plans to ensure service levels are met
- Manage sub-contractors and sub-contractor SLAs
- Accomplish billing and charge-back to other business units
- Integrate with building systems for condition monitoring to automate
Start: Ensure space & power availability

Space
- floor mounted device layout

Power
- site / building infrastructure

Demand
- by site / building
  - equipment level @ nameplate kW

Implementation
- placement @ 4kW per rack
  - nameplate kW vs. peak loads
  - inhibited by billing methodology

Utilization reports & plans
- space: floor area
- power: building infrastructure

Future: Optimize space & power availability

Space Maximo EAM /Spatial
- floor mounted device layout
- rack elevation device placement
- floor load tracking & management
- device serial link to corporate IWs

Power/Thermal Maximo EAM/Spatial, ITM
- site/bldg infrastructure, PDU, IPDU/devices
- design: Configuration, “What if”, CFD
- operations: AEM, BMS, MMT modeling

Demand Maximo EAM/Spatial, ITM
- by site / building
  - equipment level @ peak loads
  - cross competency workflow integration

Implementation Maximo EAM/Spatial, ITM,TUAM
- optimal placement criteria
- accurate power/thermal data
- pinpointed use of liquid cooling
- bill actual resource consumption

Utilization reports & plans Maximo EAM/Spatial
- space: floor area & rack volume
- power: data center infrastructure
- assets: consolidate / virtualize

Proactive & Policy Based Management
Lifecycle Management – IBM IT Delivery
Data Center & Facilities Integration – Capabilities

**Space Management**
- DC (data center) portfolio
- ELE (sqft, lbs, kW sizing)
- CSC (UPS, GEN, CMP)
- Global Site / Building

**Maximo Spatial**
- Physical model
- Visualize & Analytics
- Suitability, cable tracing

**CFD Modeling - MMT**
- # Sensor and placement
- Cooling: design & assess
- Tile placement - “What if”

**ITM for Data Center**
- IT equipment
- SynapSense, IPDU+probes
- APC, Liebert, Eaton support

**ITM for Building**
- Bldg / area / non-AEM
- BCS, OSIsoft Pi Server
- Site / DC infrastructure

**Maximo Asset, CI’s**
- Device Discovery
- ITAM (physical devices)
- TADDM, CCMDB

**Maximo Asset, Work, Service**
- Engagement sizings
- Device prep, placement
- Installation / registration
- Work Management

**ITM/EAM Repository**

**Visualization / Analysis**
- 2D (floor layout), 3D (rack elevation), power, cooling, weight
- Optimal placement of equipment
- Power trace to floor PDU circuits
- Query / pinpoint devices, regions
- Asset mgmt collaboration

**IT Monitor / Operation**
- Active Energy Manager alerts & controls with AutoCAD layouts
- IBM Tivoli Monitoring w/ MMT
- ITUAM for revised billing methods
- HW / SW physical & logical assets
- CPU utilization metrics

**Building Monitor / Operation**
- Power / thermal measurements
- Status, alerts, and controls
- OSIsoft Pi Server metrics/analytics
- Filtered feeds to ITM / TDW
- Data Center PUE measurements

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Facility Alarm Integration – Intelligent Thresholding

- Facilities alerts can be integrated with IT events providing tighter awareness of “cause and effects” for IT incidents
  - What failed first – facilities or IT equipment
  - Awareness of failures and redundancies
  - Awareness of intermittent conditions

- Out of the box thresholding for key facilities metrics

- Event collection and processing via Tivoli event management capabilities
  - Aggregated events operable from existing IT event consoles
Energy management at an IT system level
- Integration to IT Hardware

- Tools for companies to meter, control, and even cap their power usage
- Intelligent “cruise control” for power consumption of servers
  - Direct connection to IBM Servers
  - Access to additional resources through Intelligent PDUs
- Connections to third party IT, data center, and facilities assets are planned by IBM
- Integration to non-IBM servers
Usage, Accounting, Charging for Accountability

- Aggregate power consumption data, and determine cost of power consumed
- Knows amount of power consumed, when it was consumed, and what used the power.
- Costs can then be allocated to those who used the server (Accountability).
Monitoring Power and Thermal

- Monitor power usage and thermal data from IT resources through embedded sensors or via remote sensors.

- Operations dashboard integrates traditional IT measurements and emerging environmental measurements onto common dashboard.

- Aggregation of IT and environmental metrics with ability to take manual or automated actions when needed.

- Intelligent thresholding and event generation.
Optimize data center thermal profile to eliminate hot spots and reduce energy consumption.

**Thermodynamic Savings:**
- reduces hotspots
- improves targeted air flow / air flow management
- removes plenum temperature variations

**Transport Savings:**
- improves ACU* utilization
- improves ACU* flows

* ACU = Air Conditioning Units

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5% of the hottest server covers 11 F ($$)

- low average temperature (67 F) – overcooled
- Simple provisioning will address hotspots
- reducing hotspots by 7F increases chiller efficiency by ~12%
- Enables free cooling using chiller bypass
- Interprets results & communicates guidance
  - service requests
  - autonomic commands
Broad base of Partners Enable Data Center & Facility Energy Management

IBM Tivoli Monitoring
Green Energy Adapters

Data Center Infrastructure Assets

Tivoli Green Management
(Monitor, Measure and Manage)

Tivoli Software
IBM® Systems Director and Active Energy Manager

IT Assets

3rd Party Servers and Storage

Facility Infrastructure Assets

IBM Tivoli Asset Management spatial visualization

IBM Systems

EATON

APC

3rd Party Servers and Storage

vmware

IBM Systems

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