AN ADVANCED ENERGY EFFICIENT RACK SERVER DESIGN WITH DISTRIBUTED BATTERY SUBSYSTEM

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OUTLINE

1. Why distributed BBS(Li-ion)
2. Key technologies & project progress
3. Architecture & design
4. BBS vs UPS
5. Test data analysis
6. Future plan & summary
SCORPIO RACK DEVELOPMENT IN CHINA

Overall Deployment

15000 racks
15 billion CNY

Scorpio rack deployment

Trend of single rack power density

DISADVANTAGES OF CURRENT SYSTEM POWER ARCHITECTURE

High power loss
Efficiency 88%~92%

High power density
Power Peak Draw Problem

Deployment unscalable
Real estate waste

Maintenance inconvenient
Environmentally Unfriendly

Utility Power
UPS/HVDC
PSU
Server
Acid-Battery

Traditional UPS power architecture

UPS room
Acid-battery room

12V power architecture
Providing extra power
Distributed deployment
Li-ion battery

12V distributed backup battery (Li-ion) subsystem (BBS)
KEY TECHNOLOGIES & PROJECT PROGRESS

1. Cell selection
   Power, energy, lifecycle and safety

2. Power architecture
   All 12V architecture, independent charge/discharge circuit

3. Automatic M&O
   Without manual operation

4. Fast switching
   Main/backup power fast switching

5. Battery protection
   Charge/discharge cut-off voltage, current, temperature

6. Fault alarm
   Detect and deal with faults in time

2015
feasibility analysis & system design

2016 Q1~Q3
specification & EVT & DVT

2016 Q4
PVT & dozen of racks deployed in Baidu YQ

2017
dozens of racks deployed

2018
hundreds of racks to be deployed
distributed deployment, data center → rack

SYSTEM POWER ARCHITECTURE WITH BBS

12V architecture, backup on DC side

18650 Li-ion battery as energy storage unit
BBS SUBSYSTEM ARCHITECTURE & DESIGN

BBS hardware design diagram

BBS management architecture diagram

Self Check Process

Automatically
1. check battery state of health (SoH)
2. judge whether self-check conditions are met
3. release 30% electricity when conditions are met
4. restore to charging state after discharging finished
DISTRIBUTED BBS VS UPS + ACID-BATTERY

- Efficiency: ↑ 10%
- Real Estate: ↓ 25%
- Automatic M&O
- On-demand Deployment

- Utility Power
  - UPS → PSU → Server: 88~92%
  - PSU → Server: 99.5%

- PSU
  - Regular dust cleaning
  - Capacitor replacement
  - Regular battery inspection
  - Manual charge/discharge test
  - On-line monitoring via BMS
  - Automatic self-check
  - Hot plug, online replacement

- BBS

- Traditional backup power
- IT Load

- Deployed with racks, saving one-time investment
TEST DATA ANALYSIS FOR POWER PEAK DRAW PROBLEM

- Power density increase
- Power peak draw problem
  - Dynamical power capping
  - Workload balancing placement
  - Battery backup system

Workload power characteristics based energy efficient design methodology

- Rack power budget: 9kw
- Peak power: 6.8 kw
- Threshold: 6.6 kw

Opportunistic area able to leverage BBS for rack density improvement

Extra power

BBS functionality on power peak draw problem addressing:
- able to save 2.4 kW power budget per rack
- no compromising performance
Preliminary findings:
• BBU can support rack power density increase 15% without significant influence on battery life and capacity.
FUTURE PLAN

- **Algorithm optimization**
  - Optimize BBS control algorithm/policy based on multiple dimensional factors modeling

- **Improve data sizing**
  - Implement machine learning tech for further research

- **Explore TCO benefits**
  - Consider draw power from utility to BBS during off-peak and use BBS energy during on-peak
Introduce an advanced energy efficient server design with distributed Li-battery system

- proves functionality of BBS solution for **power peak draw problem**
- achieves below benefits over traditional UPS power architecture

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<th>1st in China</th>
<th>On-demand deployment</th>
<th>Efficiency ↑ 10%</th>
<th>Real Estate ↓ 25%</th>
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Baidu deployed rack server with distributed BBS
Thanks