Enabling Datacenter Servers to Scale Out Economically and Sustainably

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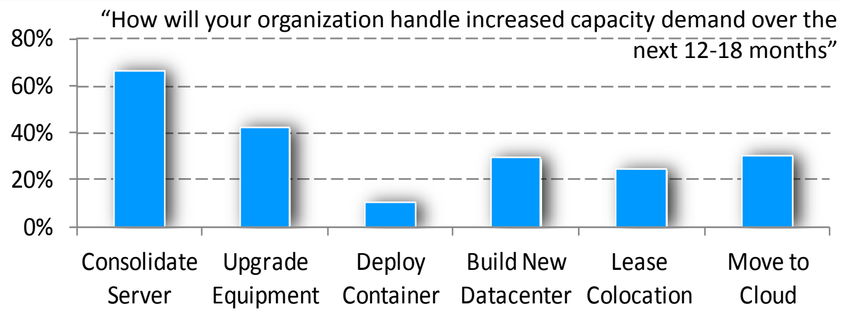
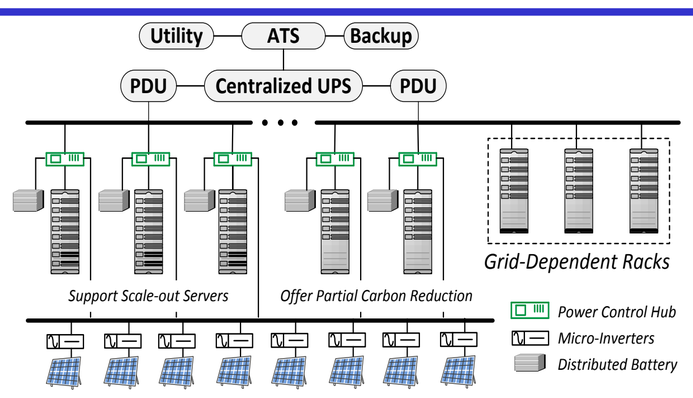
Introduction



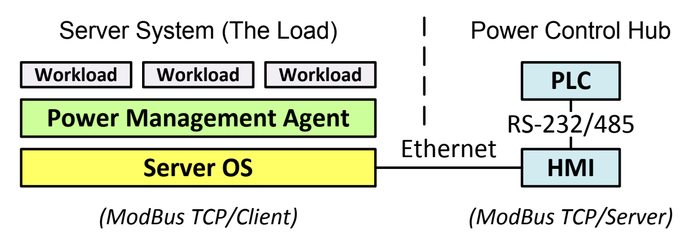
- **The 'scale-out' issue in datacenters**
  - Server consolidation limits workload performance through SW based or HW based control knobs. Conventional centralized power provisioning scheme does not scale well
- **Scale out power-constrained data centers**
  - Datacenters are power-constrained
  - Datacenters are carbon-constrained

Technical Approach

- **Scale-out model**
  - Distributed incremental integration
- **Modular power sources**
  - Distributed energy storage system
  - Solar power module with micro-inverters
- **Power control hub (PCH)**
  - A prototype that integrates battery charger, inverter, power source switch, control devices(PLC&HMI)
- **Dynamic energy source switching**
  - Autonomous mode
  - Coordinated mode

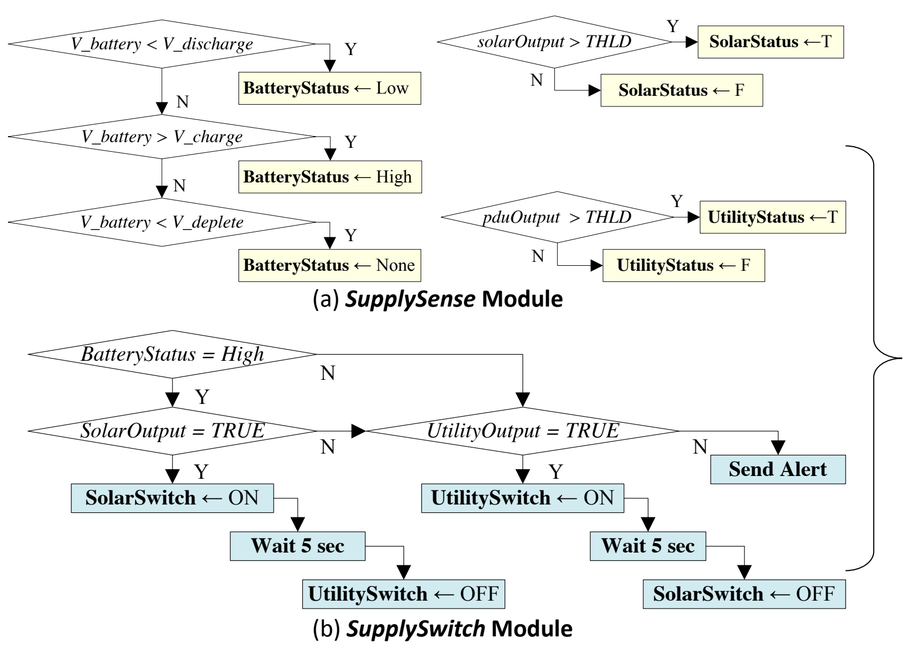


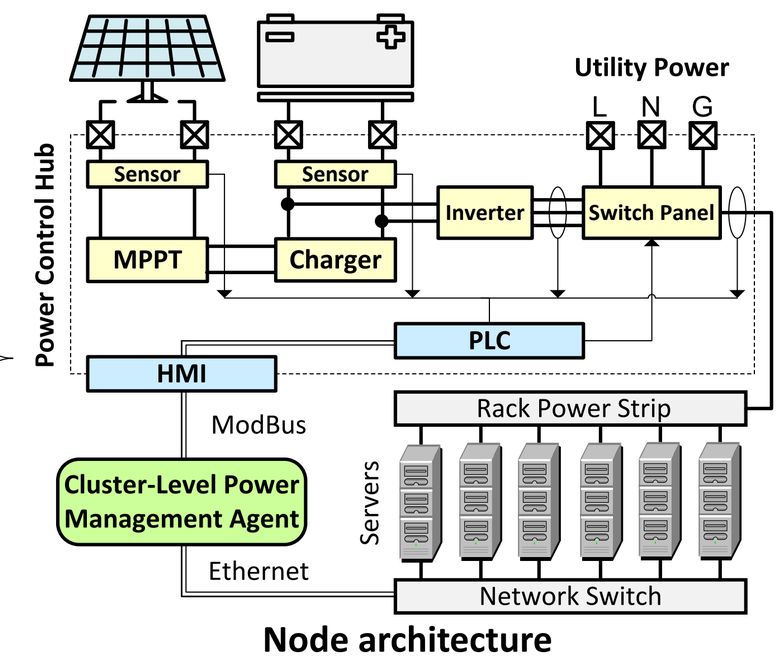
***Oasis* power provisioning architecture**



Power management agent and the data communication scheme inside of *Oasis node*.

System Implementation





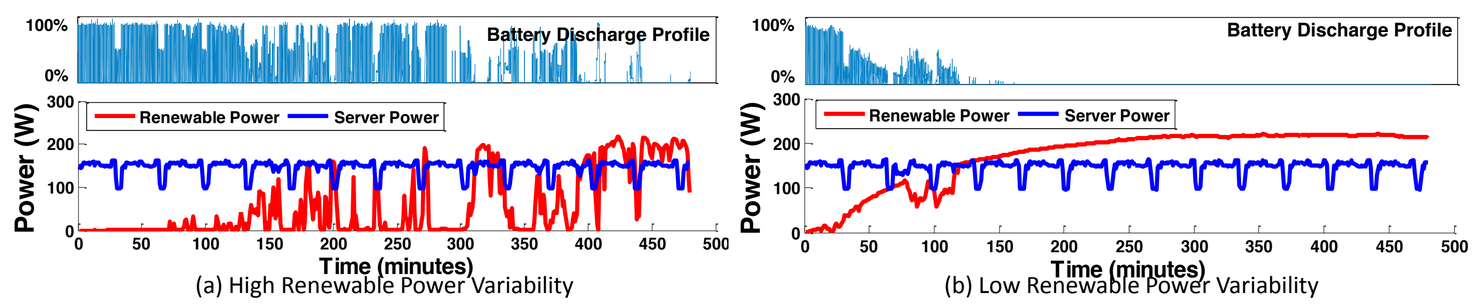
Node architecture

System prototype

Contributions

- **Fine-grained scale out power infrastructure**
  - *Oasis* leverages modular renewable power integration and distributed battery architecture to provide flexible power capacity increments
  - Could reduce CapEx by 25%
- **Prototyped research platform**
  - Power supply monitoring
  - Communication gateway
  - Power supply switching
- **Optimization algorithm**
  - *Oasis* could reduce workload execution delay to 1%, extend battery lifetime by over 50%, increase battery autonomy time by 1.9X

Experimental Results



(a) High Renewable Power Variability (b) Low Renewable Power Variability

Fig. 1: Battery discharging profile and the renewable power supply and server power demand traces (workload: Nutch, page indexing)

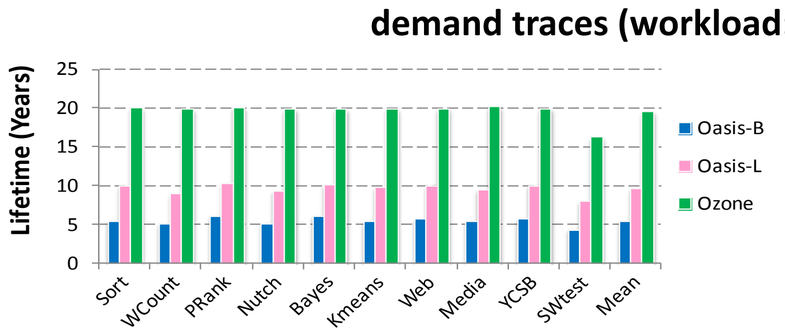


Fig. 2: The estimated battery lifetime

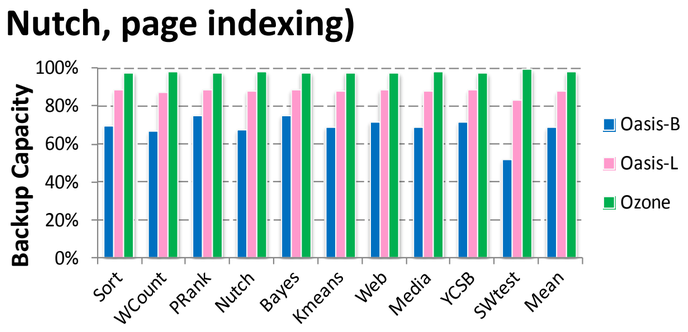


Fig. 3: The average battery backup capacity

Future Work

- **Battery management**
  - Optimize battery usage effectiveness
- **Renewable power prediction**
  - Minimize control overhead
- **Feedback control on server system**
  - Improve cloud server performance
  - Improve robustness

References

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2. Chao Li, Amer Qouneh, Tao Li, **iSwitch: Coordinating and Optimizing Renewable Energy Powered Server Clusters**, International Symposium on Computer Architecture (**ISCA**), June 2012