E-Rover: Energy Optimization Framework for Data Center Architectures in Multi-Server Environments

Technology #015-047-subramaniam

This invention efficiently optimizes energy consumption in multi-server environments subject to Quality of Service constraints. Server farms are becoming noticed for their high energy consumption, which is often disproportionate to their workloads. Consequently, energy management is now getting greater attention from data center owners and managers. As a solution to this problem, the framework to optimize energy consumption in data centers that is being developed by our researchers has demonstrated a much higher effectiveness over other energy management techniques, algorithms and policies. As we can see in the charts below, this framework reduces the current disproportionality existing between the server utilization rate and the corresponding energy consumption with a much higher efficiency than current energy management techniques, especially at lower utilization levels (energy consumption with E-Rover in blue).

While there are localized server-level energy optimization techniques, our framework has been able to provide much higher benefits because E-Rover explores system-wide optimizations by adopting a holistic approach that combines the servers and the network components. As a comprehensive energy optimization framework, E-Rover provides us with a set of advantages that have been repeatedly confirmed by the experiments performed in our simulators that model data center servers and networks, and verified using realistic system traces. This approach can have further potential benefits because energy savings in servers and network components can lead to reduction cooling costs.

A key innovative feature of this framework is its efficacy in dynamically orchestrating the usage of the off-the-shelf server sleep states in order to achieve improved results in energy consumption. In addition, the E-Rover framework generates the aforementioned high-level optimizations and at the same time still meets all QoS (Quality of Services) constraints such as the ones related to job service latency, as well as power envelope constraints.

Applications:

- Energy management in corporate data center networks
- Design of data center network architectures
- Large-scale multi-server farms

Advantages:

- High power/energy optimization
- Innovative approach to energy management by focusing on off-the-shelf server sleep states
• Scalability: E-Rover has been tested to be applied in environments from 10 to 10,000 servers

\[\text{Energy Rover - Short Execution Time Operations (4.2 ms)}\]
\[\text{Energy Rover - Long Execution Time Operations (194ms)}\]

**Inventors**

**Suresh Subramaniam**
Professor and Interim Chair

**Guru Venkataramani**
Asst. Professor at the Department of Electrical Engineering and Computer Engineering

**Jingxin Wu**
Ph.D. Candidate

**Fan Yao**
Ph.D. Candidate