Energy Saving using Parallel Computing

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I. Introduction

Data centers are the backbone of the modern economy [1], from the server rooms that power small to medium-sized organizations, to the enterprise data centers that support american corporations, to the server farms that run cloud computing services hosted by amazon, Facebook, Google, and others. However, the explosion of digital content, big data, e-commerce, and Internet traffic is also making data centers one of the fastest-growing users of electricity in developed countries, and one of the key drivers in the construction of new power plants in the united states.

While most media and public attention focuses on the largest data centers that power so-called cloud computing operations - companies that provide web-based and other Internet services to consumers and businesses?these hyper-scale cloud computing data centers represent only a small fraction of data center energy consumption in the united states.

In 2013, U.S. data centers consumed an estimated 91 billion kilowatt-hours of electricity. This is the equivalent annual output of 34 large (500-megawatt) coal-fired power plants, enough electricity to power all the households in New York City twice over. Data center electricity consumption is projected to increase to roughly 140 billion kilowatt-hours annually by 2020, the equivalent annual output of 50 power plants, costing american businesses $13 billion per year in electricity bills and causing the emission of nearly 150 million metric tons of carbon pollution annually.

The data center energy usage is illustrated in figure 1. The use of social media, email, tweets, song and movie downloads has resulted in growing demands on data centers. The internet traffic generated by this usage is shown in figure 2.

TABLE I
ESTIMATED U.S. DATA CENTER ELECTRICITY CONSUMPTION BY MARKET SEGMENT (2011) [1]

Segment	Servers (million)	Share	kWh/y
Small and Medium server rooms	4.9	49%	37.5
Enterprise/Corporate Data Centers	3.7	27%	20.5
Multi-Tenant Data Centers	2.7	19%	14.1
Hyper-scale Cloud Computing	0.9	4%	3.3
High-Performance Computing	0.1	1%	1.0
Total (rounded)	12.2	100%	76.4

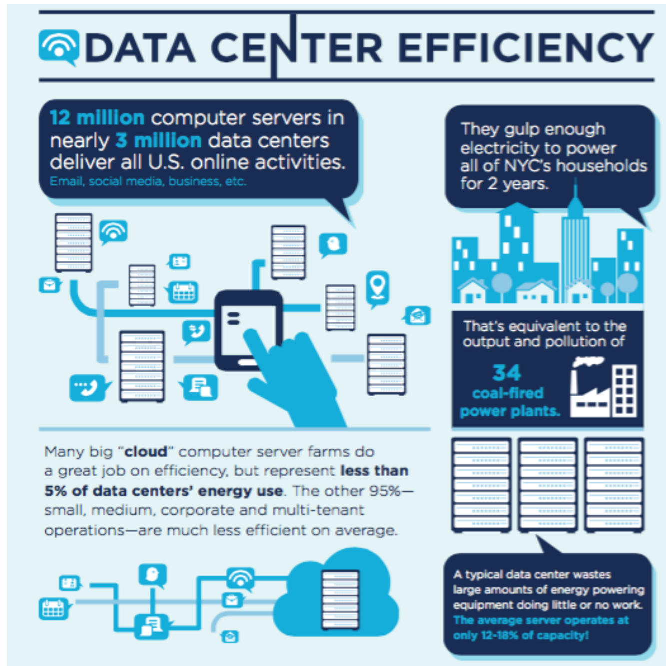

Fig. 1. Data Center Efficiency [1]

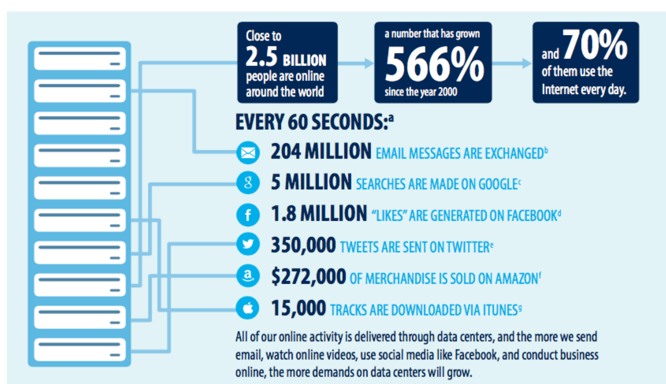

Fig. 2. Data Center Usage [1]

The estimated energy consumption by market segment for the year 2011 is shown in table I. As can be seen, the big cloud computing companies are very energy efficient and consume less that 5% of the total energy consumed. 95% of the energy is consumed by small, medium, corporate and multi-tenant operations.

A. Problem Statement

B. Contributions

II. Motivation and Background

A. Motivation

B. Technologies Used

III. Experiments

A. Subjects

B. Experimental Setup

C. Experimental Results

D. Threats to Validity

IV. Discussion

A. Results Analysis

V. Related Work

VI. Conclusion/Summary

References

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