Data Center Reduce Cost Energy and Low Latency

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Abstract— **At present, the data center is widespread in energy intensive and serious resource waste and other issues. How to efficiently integrate computing resources and reduce the energy consumption cost is a hotspot of research on the data center. Because of virtualization technology can achieve the efficient use of resources and simple management, so widely used in data center energy saving algorithm based on virtual machine migration on resource allocation and scheduling, implementation resource on the server load balance and reduce energy consumption of data centers. However, most existing algorithms for data center energy saving without considering the energy consumption of the virtual machine migration between server costs, excessive reliance on virtual machine migration can realize the average allocation of resources, but is likely to reach the purpose of reduce system energy consumption. Therefore, research on the energy consumption in the process of virtual machine migration overhead and reasonable design of energy-saving scheduling algorithm for data center power management is of great significance.**

Index Terms— **Data center □cost energy□low latency**

I. SUMMARY OF DATA CENTER

1.1 The definition of the data center

Data center as a management IT equipment and application of place, in their own when the scale of the enterprise or institution to achieve a certain degree, IT has become the implementation and application of IT technology, support enterprises or organizations operating at the heart of the department of j in today's society, data center plays a vital role in all walks of life, bearing the weight of the key business of the enterprise. To provide users with timely and reliable video, data mining and high performance computing, etc. therefore. The data center is the core of the information world, so to speak. Data Center is defined as: a Data Center (Data Center), refers to a place to house computer systems and related components of the premises and facilities, generally contain a large number of servers, redundancy and standby power, redundant Data communications connections, environmental controls (e.g., air conditioning, fire extinguisher) and safety equipment, etc.

1.2 data center data center includes hardware and software on logic

Hardware is the basis of the index according to the center facilities, including support systems and juice machine equipment, etc.; Software development index according to the installed programs and providing information services, etc. Support system including construction, power equipment, environmental control equipment, lighting up keeping and monitoring equipment, etc. Is to ensure that the upper computing devices necessary for normal and safe operation, is the basis of the data center :Computing devices, including servers, storage equipment, network equipment, communications equipment and so on, these devices supporting the upper business information system; Business system is to provide specific information for the enterprise or the public service of software system, its information service quality depends on the underlying support system and the computing equipment service ability. In the design, construction and maintenance of the process of data center, must consider this I a level, and an overall consideration, to guarantee the good operation data development, to provide users with high quality and reliable service.

II. DATA CENTER POWER MANAGEMENT

2.1 The Challenge of Energy Management

Reduce the use of data center energy is a complex and challenging work, because the user applications to computing resources and data growth so fast, so that the data center server and disk cannot be in the user response time for processing. In 2006, according to the epic report, data centers in the United States consumes 61 billion KWH, 1.5% of America's the total power consumption, electricity is about $4 _5, more than the sum of all American TV power consumption, electricity consumption is approximately equal to 5.8 million families. Predicts 2013, the United States in the data center will consume 120 billion KWH, accounted for 4.5% of the total power consumption, the electricity charges up to $10 billion, to meet the demand of data center power consumption, need to add 50% of the electricity.In China, energy consumption data center server, maintenance cost, operating domestic electricity at the data center has countless millions or even tens of millions of dollars. Mc Kinsey research data show that predicts 2020, the world of data scale will reach 44 times today, if the amount of data to the speed increase, so the world will add more data center, and the data center will become a "bottomless pit" power consumption.

Data center power consumption management problem has become the focus of hot spots. Energy problem is a major source of processor levels of energy consumption. Study abroad, IT equipment power consumption occupies about 50% of the whole data center, 40% of the energy consumed by the server. In sauna, for example, a large part of the data center node resource utilization is not more than 75%, even some nodes resource utilization rate lower than 50%, this creates a large chunk of data center resources waste. If you can further enhance the efficiency of the server can bring better energy saving effect of the data center.At present, the industry mainly from the power management technology and software management technology to improve the server

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capacity and reduce energy consumption. Power management technology is mainly based on the
system is the power of the power of the number of adjustment, the work of each power supply in the best efficiency point. Software management and energy saving technology mainly are to change the operating system kernel, optimization program execution queue or dynamic adjustment according to the load situation CPU frequency. High energy consumption is another major source of data center energy consumption level. So the level of energy consumption for data center, first of all, can from the perspective of the room construction give full consideration to the data center's location, environmental factors such as temperature and humidity.Then consider the data center deployment of servers, storage and other IT equipment and the cooling and power supply system for integrated design of the computer room. Finally, the data center of maintenance and management, upgrade, update and expansion fully consideration.

2.2 data center energy saving managements

Cloud computing, data as well as the user requests the explosion of growth. In advancing the process of building the next generation of green data center, each big Internet companies are actively exploring in the whole life cycle of the data center and the method of energy saving. In the face of challenges, in the new period, the cost of traditional data center is especially high. Compared with the traditional data center power consumption is high, the weakness of IT equipment load is low, the cloud data center has natural advantages, IT can load flexible deployment, resources can be approached on demand of real time adjustment, greatly avoids the waste. In order to speed up the process of data center energy consumption, through coordination with infrastructure software, IT equipment, pay attention to every link of the infrastructure system, minimize the energy consumption of the system. In combination with its own situation and used in a variety of energy-saving technologies, to create green data center of the reducing energy consumption laid a solid foundation.

(1) the world for the first time the ARM architecture of official business, and also for the first time the farm system in the service of large-scale application of cloud data center. ARM designed for cloud services, based on the cloud platform, the software and the CPU instruction set solution for light load calculation, high storage density, storage density increased 70%, the TCO (total cost of ownership) was reduced by 25%.

(2) in the domestic large-scale deployment of independent design of the whole cabinet server. The first independent development of the whole cabinet server has been in managing cloud data center online, independent research and development of the center bearing the match the data center, close to the business requirements and has the best TCO whole cabinet server solution.

(3) the domestic Internet industry data center has built the largest Wan Zhao clusters, cluster scale than _5000 nodes. Wan Zhao switches based on independent research and development, and low cost access to the medium, low power consumption compared with traditional gigabyte cluster, the cluster server nodes promoted 3-10 times, bandwidth and hardware procurement costs and TCO rose only 8% and less than 5%.

(4) The PUE of leading domestic, international first-class level. Such as M1 self-built housing best PUE 1.18, with an average annual PUE 1.37, the energy-efficiency 7 070, completely free cooling time for the whole year up to 4200 hours, accounting for 48% of the time for the whole year.

III. DATA CENTER ENERGY MANAGEMENT PROBLEMS

3.1 power fluctuations and energy oversubscribed

With the expansion of the data center and improvement of complexity, data center to handle tasks also tend to diversification, different tasks required for the energy supply of the difference are very big. To meet peak consumption data center power theory, designers often need oversubscribed limitation of energy supply, this part in an oversubscribed energy in a data center runs most of the time doesn't need to work, this creates a lot of unnecessary energy subscription costs.

3.2 Unconstrained growths in energy demand

Scalability of data centers is the data center architecture design is an important concern. Most of the data center can accord with the expansion of business scale to increase the number of servers and related supporting facilities. But along with the expansion of computing power, due to problems such as heat dissipation and architecture, data center energy consumption has a super proportional increase may be present, it makes the data center construction and maintenance cost have doubled.

3.3 spending, for heating and cooling

Temperature control device is an essential part of the data center facilities, and, with the increase of calorific value data center cooling refrigeration and heat recycling, is becoming a great research value.

3.4 The social cost of massive carbon emissions

With the public and the government's emphasis on environmental issues, a carbon tax for energy-intensive enterprises has become an international trend. As high power consumption of infrastructure, data center will inevitably bring to the enterprise it high environmental cost. This makes the data center providers will shift the focus to the emerging renewable clean energy.

IV. IMPROVE DATA CENTER ENERGY EFFICIENCY MEASURES

At present, in the center of the ascending data for existing energy use efficiency, the
solution is focused on the power of the main cap technology, load analysis and instruction level scheduling, the use of new materials, etc.

4.1 Power capping technology

According to statistics, data center each subscriber 1 watt power supply, whether or not effective in application, produces 10 to $25. However, power, the amount of data center according to the theoretical peak subscribe seldom happened in the process of actual operation. According to a study of Google's data center, the power consumption status of in the process of the operation of the data center, the actual power peak theory of 90% less than the running time, the horizontal axis of the ratio of peak power consumption and theory, the vertical axis cumulative distribution function for the runtime. Can see 90% power consumption peak theory running time is less than 10% in real terms, for these appear less likely oversubscribed energy supply obviously cost will bring a lot of waste.

In view of the data center power consumption fluctuation problem, an effective solution is power capping technology, through the coordinate data of the workload, make power curve tends to smooth the data center. While power cap technology needed to solve a major problem is the state of the energy consumption of uncertainty and unpredictability. Current research direction to solve the problem of the concentrated in two aspects:

□1□Off-line power consumption model of the theoretical framework and energy online heuristic scheduling algorithm

Large data center's energy supply framework is often very complex, in order to get the best energy supply and energy efficiency of the theoretical value, it is necessary for the structural design of a data center energy systems modeling, obtained can be used as a reference in the actual operation of the baseline values. In general, use large-scale distributed data center UPS to adjust energy peak load and response. In the theoretical model of energy supply, must want to consider the energy storage of massive UPS array, run time, the power life, efficiency and scalability, and many other factors at the same time, the server cluster, data centers often by task scheduling and delay the adjust the power requirements of each node in the cluster, and task migration overhead (cache misses, network bandwidth consumption and processor pipeline emptying, etc.) is also a theoretical model of factors must be considered.Through the static parameters, data center management data center power consumption model can be reduced to a linear minimization problem, and it provides the actual operation of the power consumption can be compared to baseline values. However, the theoretical model of offline to power consumption of each task is transcendental cognition. Therefore cannot be directly applied to the actual process of energy management. Online heuristic scheduling policy is real-time monitoring data center energy to run when the power consumption situation, at the server level, cluster level, across the cluster level three levels to adjust migration and delay task, thus reached the highest in the power budget constraint computing resources use efficiency.

(2)The design of distributed energy supply

UPS is the basic unit of the storage and release of energy, and can focus on data center UPS array in a logical node, can also be distributed in a different location of the data center. At present, distributed UPS backup power is being exposed to a lot of data center, including Google, the attention of the builders. Distributed by UPS arrays, data center operators can be more flexible to decide which standby power supply when connected to the power supply network in order to make up for the power supply of power equipment, and use of reserve power cut electricity peak pressure.

4.2 Program analyses and instruction level scheduling

Data center run by the computing tasks of power demand adjustment technology is an important part of power consumption management system. Through for program execution Basic Block (the analysis of Basic Block), can ask the similar degree of calculated instructions, if similar high degree of execution is continuous, it can save the values, decoding, control logic and multi-channel check device module in such aspects as task switching of power consumption. And the use of thread synchronization technology to delay related instructions, execution of multiple instructions can be similar to that of the bath.

Proposed drag at Princeton university (Execution Drafting) technology USES the power consumption characteristics of the above, using instruction granularity analysis technique to identify multiple sequence of instructions that ask the same or similar, using hardware Synchronizer of instructions (Synchronizer) delay some process or thread command line process, so as to make the similar instruction sequences to be aligned on a runtime asked (Alignment). When the first instruction assembly line process, a sequence of instructions that subsequently can follow the first instruction into the processor assembly line. Since knew subsequent instruction in the operation code, register to use similar to the first instruction, the processor can save some of the means, decoding and pipelining control energy costs.

4.3 The application of new material parts

In addition to the above software level solutions, using new material parts such as the super capacitor charge/discharge process balance irregular power fluctuations, combined the technology of dynamic load distribution, also can effectively eliminate the energy supply and consumption of q mismatch, to achieve high energy efficiency. Compared to the traditional chemical battery, super capacitor has the advantage to:

(1) high energy storage efficiency of the charge and discharge cycle and a very short;

(2) support for fast charging and instantaneous large current discharge□

(3) the service life of 2 to 3 orders of magnitude higher than conventional batteries. But as a result of the present stage of super capacitor cost is still high, so generally used super capacitor combined with the traditional battery energy storage model. And the use of thermal energy storage devices and phase change materials for thermal energy storage and release data centers also have got the preliminary validation. When the load of the data center, high heat quantity can through the heat storage equipment and curing phase change material, when the data center to reduce load rate, cooling capacity surplus is bigger, this part will be stored in heat release. Commercial operation due to the data center is compared commonly fixed load curve. This part of the heat storage material can be integrated as part of the data center cooling and cooling system, in a heating/cooling cycle regularity.

5. Conclusion

Data centres as the infrastructure of the era of large data. In the IT industry development of the future will play an increasingly important role. Energy consumption will become the center of data construction and operation of a major cost, and the public and the government to the problem of environmental value will let the data center supply more to consider the use of renewable energy.

Discussed in this article for the existing energy consumption management technology, such as power capping technology, powerful real-time monitoring and dynamic task scheduling technology, etc., have been in long-term commercial operation of the existing authentication, power control technology is more mature. Such as the use of new materials, new energy, it is in recent years, with the development of subject crossing, the new research direction, part of the design concept is just after the academic model research and small-scale test,commercial operation by the actual distance

and the distance. However, these trials of new technology represent the energy management system for the future research direction. With the expansion of the scale of the data center and functional diversity in the development of future visit, heterogeneous platforms, distributed data center architecture also bring new energy consumption problems inevitable. The conversion and utilization of renewable energy technology is still in testing and rapid development phase, there is still a very broad space forumining.

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