The growing appetite in cloud services leads to an unprecedented increase in electricity consumption of Data Centers (DC). For instance, according to a recent report, in the U.S. consumed about 1.8% of total U.S. electricity [5]. This energy consumption is among the source of pollution and global greenhouse gas (GHG) emissions of Information and Communication Technologies (ICT), and a fraction of the minerals and end-of-life product recycling. To reduce the negative impacts of ICT on global warming, many commitment to renewable energies are made. In last years, major Cloud actors like Amazon AWS, Apple or Microsoft are involved in projects to deploy solar power facilities [4]. This project targets a platform of data centers supplied by solar energy. Modern clouds are constituted of various data centers geographically distributed. These data centers are increasingly associated to photovoltaic (PV) power plants, targeting sustainability of electric needs. Photovoltaic energy is however volatile. A geographically distributed clouds can transfer its load within short time from one data center to another according to different criteria including the photovoltaic power generation. The challenge is to optimize data center workload distribution with respect to availability of solar power. The idea is to make the DC consumption to fit with the PV generation.

In a pre-maturation phase, a first approach has conducted to study a distributed cloud with photovoltaic panels, without BRP and batteries. This led to a first basic model and some heuristics tested on a devoted simulation platform. A realistic simulation platform has been developed, that simulate data centers using the DCsim (Data Center Simulator) discrete-event M&S tool. This simulator provides the power consumption of each data center as a function of time. In a first basic approach, the model was developed for homogenous servers and VMs, without VM migration [3]. This step was then extended to heterogeneous servers with migration [1], and then to a model with cooperative self-consumption [2], where PV energy excess are injected in the electricity network, and can, to a certain extent, leverage the global cloud consumption. However, none of these different studies implied batteries.

The first objective of this project consists in developing an accurate model including geographically distributed cloud associated with PV farms and batteries. The model will comprise precise cloud servers and network modeling, tight model for electric network and BRP, and a realistic battery model including charge and discharge rate, self discharge and battery aging. This platform modeling will be used to design scheduling heuristics targeting a reduction of the brown (non renewable) energy usage with low losses due to batteries usage. Intuitively, battery will mostly be discharged during night, but can also be used during the day when workload requests exceed PV production. This work will give a detailed probability end expectation estimate to formulate the optimization criteria. Online scheduling requests short delays for scheduling decisions. At a given time slot, waiting VMs scheduling imply to evaluate the distribution law of battery level and brown energy consumption for many future time slots, which are strongly correlated. An exact evaluation of expected battery level and brown energy consumption would thus imply complex formula that can not be computed within short time. With these estimates, scheduling decisions need to determine VMs allocation based on multiple criteria, including battery storage and brown energy consumption, but also battery aging and battery level distribution in the different DCs. This requires tradeoff between these different parameters according to available data and expectations.

The second objective corresponds to cloud dimensioning. The project targets dimensioning of PV and battery according to the DC sizes and the amount of arriving VMs, targeting brown energy reduction but also purely financial criteria. The objective is to determine the PV dimensioning for supplying the cloud and the battery dimensioning in particular for night computations. But it also consists in determining the DC dimensioning to accommodate the gap between prediction and PV production for a cloud purely devoted to PV farms infrastructure. This dimensioning problem will be formulated to include the environmental cost of manufacturing PV panels and servers. If this project focuses on brown energy reduction, the PV and servers manufacturing is a major cause of concern in the different sources of pollution related to cloud computing. A cloud dimensioning targeting the environmental concern cannot neglect this aspect of the issue. This dimensioning problem implies to take into account multiple optimization criteria, but also the capacity of the system to process all VMs directly after submission, including during peaks of activity. This implies…

Informations générales
- Thème/Domaine : Calcul distribué et à haute performance
- Système & réseaux (BAP E)
- Ville : Saint-Martin d’Heres
- Centre Inria : CRI Grenoble - Rhône-Alpes
- Date de prise de fonction souhaitée : 2019-09-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2019-04-28

Contacts
- Équipe Inria : DATAMOVE
- Directeur de thèse : Trystram Denis / denis.trystram@inria.fr

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Sécurité défense : Ce poste est susceptible d’être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L’autorisation d’accès à une zone est délivrée par le chef d’établissement, après avis ministériel favorable, tel que défini dans l’arrêté du 03 juillet 2012, relatif à la PPST Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l’annulation du recrutement.

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the knowledge of the maximum activity peaks workload. Another approach consists in delaying VM allocation during peaks under constraints of quality of service (VMs with deadline or penalty for delayed VMs). This implies a new criteria of quality of service for the dimensioning problem.

References


Principales activités

Research towards a PhD thesis in computer science.

Compétences

- Background in Algorithmic and Probabilities
- Programming skills (C/C++)
- Knowledges in scheduling and/or parallel processing are desirable
- Fluent in English

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération