Ecole Doctorale STIC

Sciences & Technologies de l'Information et de la Communication

ED STIC - Proposition de Sujets de Thèse

pour la campagne d'Allocation de thèses 2017

Axe Sophi@Stic :	SystèmesRéseaux|
Titre du sujet :	Third Generation Virtualization: Towards Applications' Ubiquity
Mention de thèse :	Informatique
HDR Directeur de thèse inscrit à l'ED STIC :	Guillaume Urvoy-keller

Co-encadrant de thèse éventuel :

Nom :	Lopez-Pacheco
Prénom :	Dino
Email :	dino.lopez@unice.fr
Téléphone :	+33 4 92 94 27 06

Email de contact pour ce sujet :	urvoy@unice.fr
Laboratoire d'accueil :	I3S

Description du sujet :

Context and Challenges
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The flexibility offered by virtualization is the key to the success of the cloud. Virtualization allows the share of computer hardware resources between multiple users or applications. The first-generation of virtualization, also known as heavy virtualization, consists in packaging one or several applications, alongside an entire operating systems (OS) such as Linux or Windows [1], into a so-called Virtual Machine (VM). An intermediate software layer, called the hypervisor, seats in between the VMs and the hardware and enables the correct operation of the VMs.
The second-generation of virtualization, known as lightweight virtualization, is an emerging technology, led by the emblematic Docker platform1, where only the application is isolated within

a so-called container. In this case, it is not necessary to embed the OS with the application [2], as all containers will share the OS of the physical machine.

We propose to introduce, in this PhD thesis, a third generation of virtualization to enhance the data centers sustainability or to enhance the Quality of Experience (QoE) of increasing popular applications for mobile devices, such as video streaming,gaming or virtual and augmented reality. We have identified three scenarios where current virtualization techniques are under-performing, and call for evolutions of these techniques.

Challenge 1 - Energy: Towards energy efficient data center. Management of energy is a crucial task in data centers (DCs), where one needs to jointly power and cool the servers [3]. VM consolidation, e.g. [4], where the VMs are packed on the smallest possible number of physical servers as a function of the total load of the data center, is a technique to reduce energy consumption. Hence, all the physical servers that do not host VMs at the end of the consolidation process can be powered off.

Challenge 2 - Mobility: Modern mobile applications with cloudlet computing support. The increase of bandwidth for mobile devices has catalyzed the introduction of a large range of applications. Consequently, nowadays, several applications for mobile devices are currently available, and new applications are being developed, such as live streaming (Periscope), videoconferencing (Skype, Hangout), gaming, or virtual and augmented reality [6, 7]. Offloading the computations required by the application to some virtual appliances in the cloud appears as a natural approach to alleviate the work carried out in mobile devices [8]. However, as the data center might be far away from the mobile device (in terms of latency), cloudlets, which are small data centers located at the edge of the network (e.g. with the controller of a group of 4G antennas), are now proposed as a solution to host these virtual appliances.

Challenge 3 - Off/On-loading: Privacy protection and Quality of Service reinforcement through off/on-loading application support. This 3rd challenge constitutes an extension of the 2nd one. Offloading the computation from the mobile device to the cloud or cloudlet can be beneficial to save energy. However, when the energy aspect is not the most important point (e.g., the device can be or is plugged to the electrical network) or for data privacy issues (offloading to the cloud is not possible), on-loading, i.e., relocating the application from the cloud/cloudlet to the mobile device is a must feature.

Approach
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The challenges described above call for an ubiquitous presence of the applications, where by ubiquity we mean no disruption of the application service, and the presence of the application, in a lightweight manner, at different vantage points, e.g., by replicating the application at different cloudlets or by anticipating the users mobility pattern but without moving all the data.
We propose to go one step further in the virtualization of applications/services to be able to address these new challenges. Indeed, while heavy virtualization decoupled hardware from

software, and light virtualization decoupled the application from the OS, we propose a third generation of virtualization whereby the application would be further split into two parts handled by the virtualization engine: a first part would be in charge of maintaining active network connections, and a second part would be in charge of core computations and data management. Decoupling these two activities is the key to address the aforementioned challenges.

The student shall propose and architect a new system to orchestrate the migration of front end or back end application processes. The evaluation of the proposal will be made through a proof of concept to be developed using the Minnie (datacenter) testbed of the SigNet or R2Lab (radio access) tesbed.

References
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