BASMATI: Cloud Brokerage Across Borders for Mobile Users and Applications

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Abstract. BASMATI aims at delivering an integrated platform that will support the dynamic needs of mobile applications and users through an end-to-end approach for cloud services. BASMATI will emphasize on enabling runtime adaptation of all assets, including user and application prediction models, federation patterns, resources and data management policies, brokerage and offloading decisions. BASMATI platform will coordinate all assets to react in response to real-world events in real-time.

1 Introduction

The explosion in numbers of mobile applications that we are using in our daily lives is unquestionable. Almost all of them are relying on some sort of web-based backend, usually in the form of a restful API or similar. The backend services are commonly delivered through cloud computing technologies, exploiting their ability to adapt to the demand and ultimately allowing more cost-effective solutions to the application providers. However the inherent characteristic of mobile apps, that is user mobility, can combine with other application contextual characteristics (e.g. highly asymmetric load bursts) and put a strain on the computing and storage infrastructure, that needs to compensate any QoS loss caused by the network. A standard approach to resolve the problem and avoid violating the SLA objectives is to leverage resources that are close to the users physical location for hosting backend app services. However, this solution also comes at a cost and implies some tradeoffs. At a local scale, a high spatial density of the use of mobile services can reduce the overall efficiency or unreasonably increase the cost of resource provisioning through scaling. At a global scale, the continuous maintenance of resource pools around the world has practical issues and drawbacks that can impair the cost-efficiency of such a solution.

BASMATI[8] is a joint South-Korean and EU Horizon 2020 project, active from June 2016 to August 2018 (26 months), that aims to develop an integrated brokerage platform targeting federated clouds that supports the dynamic needs of mobile applications and users. To tackle the issues mentioned above, BASMATI resolves to the development of a platform that will be able to: a) support mobile app services and their context; b) manage the infrastructure to achieve cost- effectiveness; c) supporting federation at a cloud infrastructure level, and; d) intelligent offloading and brokering of tasks including edge resources.

1.1 BASMATI Objectives

The BASMATI platform has been conceived, designed and developed having in mind the the peculiar requirements of the project use cases. However, the aim of the platform, currently still in development, is to address the project objectives in a broad sense. The consortium thus identified a set of very complex challenges that can be summarized around the following three main pillars.

Users and Application Knowledge In order to be able to properly react to the dynamic conditions affecting the cloud infrastructure supporting the backend of mobile applications, it is of paramount importance to understand the actual behavior of applications and their users, as well as to predict the future behavior of the two. BASMATI approaches this challenges by profiling the footprint of applications and analyzing the movement of users. This actually happens at two levels, macro and micro; the former focused on the movements of mass of users, the latter of the movement of single users within a defined area. The joint processing of the application- and user-derived information, that we call situational knowledge, gives to the BASMATI platform the ability of taking into account the actual characteristics of users and applications when modelling their behavior.

Resource Management The second pillar of challenges faced by BASMATI is contextualized in the area of Resource Management. When it is clear how applications and users will behave, it is fundamental to have a platform that can properly react in a consequent manner. To this end, the BASMATI platform needs to offer innovative ways to represent and manage cloud resources, to properly organize such resources in a federation and to provide effective ways to conduct resource brokering and select the best candidates for a given application to host. For the these tasks, current candidates approaches are based on meta-heuristics, such as Genetic Algorithms [2].

Application Adaptation The third and last pillar on which the BASMATI challenges are organized focuses on the actual adaptation of applications at runtime. Such support is a key enabler in a widely distributed and dynamic environment

[8] http://www.basmati.cloud/

in which applications go through changes both required to enable their migration, as well as to make them suitable to offer appropriate performances. This is particularly evident when the conditions of the platform changes and when users move around.

1.2 Project consortium

The BASMATI project brings together a consortium composed by research centres, universities, industrial companies and SMEs with a proven track record in various facets of the wide spectrum of Cloud Computing technologies and strong commitment towards innovation, and therefore well positioned to efficiently and effectively face the challenges defined in the call. The partnership involves 9 well-established organisations from Europe (Greece, Italy, Germany, Spain and France) and Korea. It comprises a leading European University (NTUA) with a high reputation in Cloud Computing one of the largest European R&D and technology transfer performers (CNR), two important European ICT Industries, with a proven expertise in EU research projects (ATOS and CAS); a leading University in Korea (SNU) and the most important research center in Korea, world leader for the number of US patents (ETRI), and two SMEs specialized in Cloud-based solutions (AMEN and INNO).

Organization name	**Short name**	**Country**
Institute of Communications and Computer Systems / National Technical University of Athens (Coordinator)	ICCS/NTUA	Greece
Consiglio Nazionale delle Ricerche	CNR	Italy
CAS Software AG	CAS	Germany
Atos Spain, SA	ATOS	Spain
Amenesik	AMEN	France
Electronics and Telecommunications Research Institute (Coordinator)	ETRI	South Korea
InnoGrid	INNO	South Korea
Seoul National University	SNU	South Korea

Table 1. BASMATI Consortium

2 Results and current state

During the 1st year, BASMATI put emphasis in defining the offloading and federation scenarios that are going to be supported by the platform. The criteria for prioritizing such multiple scenarios were based upon application needs, as well as upon available resources within the project lifetime. As such, the project aimed at developing tools that would allow a) the intelligent use of specialized devices and cloudlets at the edge of the computing and storage infrastructure,

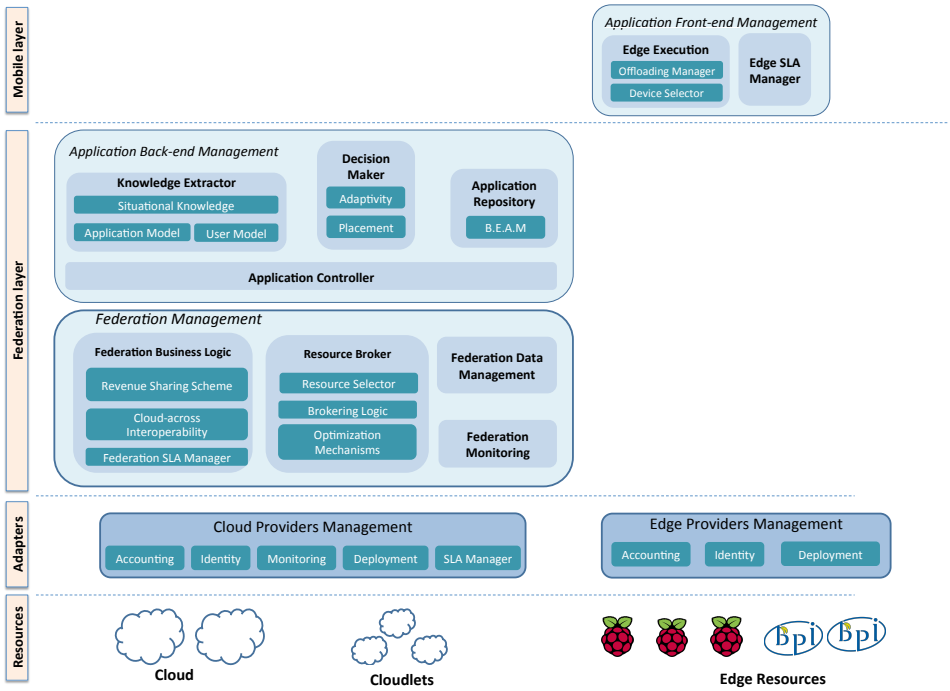

Fig. 1. BASMATI architecture

bringing about mobile services while being closer to the end user (thus alleviating network constraints) [3], and; b) smart migration of services and data to cloud resources owned by different providers, under different provision policies and business models [5, 4]. The consortium refers to the first case as offloading and to the second one as federation, seeking mainly cost-effective approaches to implement them in the frame of the pilot scenarios.

2.1 Architecture

The idea behind the design choices underlying the architecture is to provide a common ground to address key technological and research challenges that are identified by the requirement analysis, performed also in according to the knowledge and capabilities of the partners and the needs of the project, and which mainly focus on three core aspects [1]: (i) User, application and situation modelling and understanding; (ii) Runtime adaptivity and reconfiguration; (iii) Brokering and Offloading of application and services.

The BASMATI architecture is organized into multiple layers (see Figure 2). The Mobile layer contains components and functions that are expected to run on the end-user mobile devices, which interface to the lower layers of the BASMATI

platform. The Federation Layer represents the core part of the BASMATI infrastructure, and it is further decomposed in the two following logical layers. The Application Back-End Management, which manages the runtime execution of application on top of federated resources, and the Federation Management, which provides the specific features of BASMATI federation by building on top of standard (multi) Cloud features. The Adapter Layer contains those software modules designed to interface BASMATI federation with different Cloud providers. Finally, the Resources Layer groups together actual resources and services from different Cloud providers, Cloudlets and edge resources.

As the development of the component prototypes continues and the overall design is evolved and revised, sequential diagrams for static and dynamic scenarios are analysed. Such diagrams describe the high level interactions of the architecture components, both in a static scenario (i.e. place a new application to the cloud, terminate it) and in a dynamic one (e.g. what happens when an application violates the QoS requested by the users, which and how corrective actions can be performed).

2.2 Cloud federation infrastructure

According to the BASMATI terminology, a cloud federation is a result of, primarily, a business agreement between resource providers (not necessarily resource owners like Amazon) who team up in order to make their resources available to other members of the federation at a cost. Thus, the implementation and use of a cloud federation needs to attain a plethora of, often conflicting, objectives. The Cloud Provider Management, the Federated Resource Broker, the Federation Data Management (including Federated SLAs) and, mainly, the Federation Business Logic are the primary components dealing with this goal.

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