Accounting Models for Cloud Computing: A Systematic Mapping Study

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***Abstract*—Cloud services change the economics of computing by enabling users to pay only for the capacity that they actually use. In this context, cloud providers have their own accounting models including their billing mechanisms and pricing schemes to achieve this efficient pay-as-you-go model. Thus it is important to study this heterogeneity aiming to map out the existing accounting models to become possible new proposals or future standardizations. Therefore, this paper focuses on mapping accounting models for cloud computing, where a mapping study process was undertaken, and a total of 23 primary studies were considered, which evidenced 5 accounting models, 23 different pricing scheme types and 4 primary studies related to SLA (Service-Level Agreement) composition. Although the significant number of studies found address grid computing it was possible to identify one accounting model which was very complete from different points of view for cloud environments.**

***Index Terms*—Cloud Computing; mapping study; pricing scheme; accounting model; Service Level Agreement.**

I. Introduction

Cloud computing has become an established paradigm for running services on external infrastructure, where virtually unlimited capacity can be dynamically allocated. However this unlimited aspect in some cases can become expensive, and research projects have tried to mitigate it through the development of new architectures, exploring different accounting models [1] [2] [3] [4].

Accounting in cloud computing is a recent discipline, hence there have few attempts to find a model which considers all the accounting requirements, and none work has tried to address a mapping of the existing accounting models that could identify research gaps and encourage future proposals.

In this context, this paper introduces a mapping study performed between July and December, 2011, addressing accounting models for Cloud Computing environments and other aspects related also to Grid Computing.

We had to encompass the grid computing research field, mainly due to three considerations. The first point is the correlated aspects between cloud and grid computing, the second point is the older grid origin with probable relevant contributions and as final reason, the existing mature accounting models under this research area.

In [32] the authors perform a comparison between the six most known accounting systems in grid computing, evidencing the advantages and disadvantages of them whereas allowing to realise what aspects they have in common.

First, they use a proper taxonomy to describe their functions which make part of an accounting process (a set of operations that manages the data regarding the use of the resources [5]).

Next, they present a measurement unit mechanism to apply under the resource consumption and accordingly charge for it, called pricing scheme [6].

Finally, all of them worry about QoS Requirements and explores how to monitor this Quality of Service. In some cases establishing Service Level Agreements (SLA).

Based on aforementioned items and previous literature investigation, four research questions were derived to guide this mapping study, as follows:

- RQ1: Is there any taxonomy for concepts related to accounting process in cloud computing?
- RQ2: What are the existing accounting models for cloud computing?
- RQ3: What are the existing pricing schemes for cloud or grid computing?
- RQ4: What are the aspects taken into account to compose a SLA in cloud/grid computing scenario?

The remainder of the paper is structured as follows: Section II introduces the related work; Section III presents the systematic mapping study process; Section IV describes the main findings of the study; Section V presents the analysis of the results, studies classification and mapping; Section VI introduces some threats to validity. Finally, Section VII presents the conclusions and future research.

II. Related Work

Basically our research started motivated by the evolution in federated cloud infrastructures field, which two works stands out (RESERVOIR and JiT Clouds).

RESERVOIR Project [2] presents an architecture (including an advanced accounting model) that allows providers of cloud infrastructures to dynamically partner with each other to create a virtually infinite pool of resources.

JiT Clouds Project [7] also allows providers of cloud infrastructures to dynamically partner with each other, but with the advantage where providers does not need keep dedicated

resources to meet the service providers demands, however does not have an accounting model.

In [8] the authors present a comparative review of grid and cloud computing pricing models. Unlike our proposal, this paper is not a systematic study and related only with our RQ3.

III. Systematic Mapping Study Process

A Mapping Study is a systematic process that provides an overview and summarizes published paper results of a particular research area, by answering questions and categorizing the studies. As main benefit, it can be used to identify gaps in the existing research that will lead to topics for further investigation [9].

Therefore, a Systematic Mapping Study was used in this research to "map out" the accounting models for cloud computing, performing five steps (Questions Definition, Search, Screening, Keywording and Extraction) [9].

A. Conduct Search

The strategy used to construct the search terms, follows the same approach used in [10], since it is systematized in essence and defines steps to derive the search strings from the questions and the viewpoints of experts in the area and relevant papers. The strategy steps are described as follows:

- Derive major terms from the questions by identifying the population, intervention, outcomes and study design;
- Identify, by inquiries with experts in the field, alternative spellings and synonyms for major terms; and
- Check the keywords in the relevant papers.

The complete list of search strings and their combination are presented in Table I.

TABLE I
Search String

SLA OR "Service Level Agreement" OR billing OR pricing OR payment OR accounting AND "cloud computing" OR "grid computing" OR "Infrastructure as a Service" OR "Platform as a Service" OR "Software as a Service"

Firstly an *automatic search* was conducted in different search engines (IEEEXplore, ACM Digital Library, Scopus and ScienceDirect digital databases). It is important to mentioned that all search strings were calibrated regarding to each search engine. Next, a *manual search* was performed by visiting some important conference proceedings. As a results from the application of both search strategies 580 studies were collected.

At this point, the studies were excluded according to the exclusion criteria:

- Studies did not address or just mentioned accounting models/processes, pricing schemes, SLA composition on cloud/grid computing;
- Studies only available as abstracts or presentations; and
- Duplicate studies. When a study has been published in more than one publication, the most complete version will be considered.

B. Screening of Papers

Firstly, the exclusion criteria were applied on the title and abstract of the identified studies, resulting in 98 studies being selected. The large number of duplicated studies contributed to this large difference. Next, a second filter was applied, analysing the introduction and conclusion, which resulted in 23 studies ([1], [2], [3], [4], [5], [6], [8], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25] and [26]).

C. Keywording

A classification scheme was built which analysed the abstract, titles and keywords of the selected primary studies to identify different facets. This way, three different facets were used. They are described following:

- **Contribution Type**: Method, Process, Technique, Model and Framework [27];
- **Accounting Model Features**: Pricing, Metering, Mediation, Accounting, Roaming, Billing, Charging, Financial Clearing, Cloud Federation, Just in Time Clouds, User Interface, Security Support, SLA Support and Variable Payment Models;
- **Research Type**: Validation Research, Evaluation Research, Solution Proposal, Philosophical Papers, Opinion Papers, and Experience Papers [28] (see definitions in Table II).

TABLE II
Research Type Facet [28]

Class	Description
Validation Research	Techniques investigated are novel and have not yet been implemented in practice. Techniques used are for example experiments, i.e., work done in the lab.
Evaluation Research	Techniques are implemented in practice and an evaluation of the technique is conducted. That means, it is shown how the technique is implemented in practice (solution implementation) and what are the consequences of the implementation in terms of benefits and drawbacks (implementation evaluation). This also includes identification of problems in industry.
Solution Proposal	A solution for a problem is proposed, the solution can be either novel or a significant extension of an existing technique. The potential benefits and the applicability of the solution is shown by a small example or a good line of argumentation.
Philosophical Papers	These papers sketch a new way of looking at existing things by structuring the field inform of a taxonomy or conceptual framework.
Opinion Papers	These papers express the personal opinion of somebody whether a certain technique is good or bad, or how things should been done. They do not rely on related work and research methodologies.
Experience Papers	Experience papers explain what and how something has been done in practice. It has to be the personal experience of the author.

D. Data Extraction

A data extraction form was designed in order to gather the required information to address the objectives of this study, classifying and answering the research questions. The full paper was read and the following information was extracted

from each study: the research categorization (Contribution Type, Accounting Model Features and Research Type), in addition the information required to answer some of the research questions.

IV. Results

In this section, each topic presents the findings regarding to a specific research question, highlighting the evidences gathered from the data extraction process.

A. RQ1 - Is there any taxonomy for concepts related to accounting process in cloud computing?

In our research only one primary study effectively answered this question. The study [5] presents a taxonomy of full accounting process and its functions from the resource usage to the financial clearing. It is not applied only to cloud computing, but other areas related to Services on the Internet (see Table III).

TABLE III
Taxonomy of Accounting Process [5]

Concept	Function
Pricing	Function of giving a price to a certain resource usage.
Metering	Collects raw information regarding the resource usage of a certain service by a consumer and its usage.
Mediation	Is intended to do a first treatment of raw technical data by transforming these metering records into a data format that can be used for storing and further processing.
Accounting	Has the function of filtering and treat more accurately the records passed by mediation function.
Roaming	Allows using more than one provider while maintaining a formal, customer-vendor relationship just with one.
Billing	Also called of invoicing, is the process of transforming charge records into the final bill, summarizing the charge records of a certain time period and indicating the amount of monetary units to be paid by the customer.
Charging	Is the process of calculating the cost of a resource usage, the function that translates technical values into monetary units by applying a pricing function to the session records.
Financial Clearing	Includes activities from a commitment for a transaction to its settlement. In the case of resource accounting, this function implies the payment of a bill.

Although it was found only this taxonomy formally defined, other terms are widely used with the same meanings. For example, monitoring has the same sense of metering. According to [25] the metrics generated by the monitoring function can be used both for accounting purposes as for performance analysis. In other study [5], monitoring is a sub-function of metering that collects the information of a resource usage as raw data and provides usage metrics to the metering function.

B. RQ2 - What are the existing accounting models for cloud computing?

When performing the analysis, were found five primary studies ([1], [2], [3], [4] and [25]) that proposed some kind of accounting model, summarized following:

a) Flexible Accounting Model [1] - This paper proposes a flexible accounting model suitable to any service of cloud computing. This model is based on the accounting process of the Internet and it can fit any pricing scheme using jBilling accounting platform and mainly through the use of IPDR (Internet Protocol Detail Record).

b) A Model for Federated Clouds [2] - This primary study presents a solution for an accounting and billing architecture for use in federated cloud environments like the RESERVOIR project (funded by European Union). The model is organized in layers(Accounting, Billing and Business Layer)

c) ABS for SOA [3] - This primary study presents a framework wherein authentication of the clients and billing of services used by client is carried out. So this paper threats the security as an essential requirement in billing services. like generates instances of virtual machines for a particular time period ordered by user (time-based pricing scheme) in safe mode.

d) THEMIS [4] - This model proposed a mutually (provider and user) verifiable billing system called THEMIS to Cloud Computing scenario in which has as main requirements the transparency, security and low latency in billing transactions. Thus, the system introduces the concept of a *Cloud Notary Authority* to supervise billing transactions, using a level of security that is identical to that of a Public Key Infrastructure (PKI), combating the malicious behaviour of users and providers.

e) Cloud Supply Chain [25] - This model proposes the *Cloud Supply Chain* concept, which represents a network of interconnected businesses in the cloud computing area involved in the end-to-end provision of product and aggregated service packages required by end cloud service customers. This includes the actual provisioning of infrastructure services and the Information Model supporting monitoring, accounting and billing processes.

C. RQ3 - What are the existing pricing schemes for cloud or grid computing?

Table IV summarizes all the pricing schemes found with their respective concepts and in which study they were discussed.

There is a lot of work that mention some type of pricing scheme. However it is used different terms to the same pricing scheme meaning. In [8], [15] and [16] the authors refers to pricing schemes as *pricing models* and specially in [8] the pricing models are grouped in a general way called *economic models*. For example, the economic model *Commodity Market* (price defined based on amount of resource that users used) has as pricing models: *Usage Duration* and *Flat Fee*.

D. RQ4 - What are the aspects taken into account to compose a SLA in cloud/grid computing scenario?

In order to cloud providers supply clients with services that meet their quality constraints, they both need to negotiate the clients requirements and the provider's infrastructure capabilities. It is known as Service Level Agreement (SLA) . However, this is not an easy task, according to [29] there are many difficulties to formalize a SLA, such as lack of flexibility and precision. This way, to compound a SLA it is important to know which aspects have to be taken into account.

TABLE IV
PRICING SCHEMES

Pricing Scheme	Definition	Studies
Time-based	Pricing based on how long a service is used.	[24], [1], [6]
Paris-Metro pricing	Used for shared resources. Resources are split by the amount of users per split.	[1]
Priority pricing	Services are labelled and priced according to their priority.	[1]
Flat-rate	A fixed tariff for a specified amount of time.	[24], [1], [6]
Edge pricing	Calculation is done based on the distance between the service and the user.	[1]
Responsive pricing	Charging is activated only on service congestion.	[1]
Effective bandwidth pricing	Charging is based on an expected usage function.	[1]
Proportional fairness pricing	It is according to the user's willingness to pay, in other words, It is based on the real value of product or service.	[16], [1]
Cumulus pricing	Based on flat pricing and dynamically priced by using a credit point system.	[1]
Session-oriented	Based on the use given to the session.	[1]
One-off charge per service	One charge per service session.	[1]
Usage-based	Pricing based on the general use of the service for a period of time, e.g. a moth.	[6], [15], [1]
Content-based	Pricing based on the accessed content.	[1]
QoS-based	Pricing depends on the hired quality of service.	[22], [1]
Location-based	Pricing based on the access point of the user.	[1]
Service type	Pricing based on the usage of the service.	[1]
Volume-based	Pricing based on the volume of a metric (e.g. downloaded bytes).	[22], [1]
Differentiation on time-of-day	Pricing based on the hour when the service is used.	[1]
Progressive Co-design	Seller and buyer try to convene on a pricing plan. The seller announces a fixed price pair (p1, p2), where p1 ¡ p2. Subsequently, the buyer commits a consumption level quality related to each price announced and if agreed so he can buy additional units progressively if needed.	[6]
Competitor-Oriented (CO) Pricing	At first, the vendor agent needs to select the competitor to compete with. Then, the vendor simply decreases the price just below of the rival's price. This algorithm requires perfect information of the rival's price.	[20], [22], [16]
Cost-based	Following the approach of cost-based pricing, the price level is established using cost accounting. According to it price determination based on costs can make good sense for SaaS.	[16]
Supply and Demand based	In general way the unit price will vary until it settles at a point where the quantity demanded by consumers (at current price) will equal the quantity supplied by providers (at current price), resulting in an economic equilibrium of price and quantity.	[18], [23], [24], [26], [19], [20]
Real-Time Pricing (RTP)	Is a pricing model that dynamically changes its rate reacting to the classical supply and demand rule, but with the difference that there is only one supplier. Amazon Web Services (AWS) offer a simplified form of this pricing model called Spot Instances.	[26]
Derivative Follower Model	It's a kind of supply and demand based model simply adjusts prices by incrementally increasing or decreasing them until the observed profitability level falls, then the direction of price adjustment is reversed, thus seeking a local maximum of profitability.	[19], [20]
Hybrid Pricing Model	This model allows a third entity called Price Authority dynamically adjust prices within static limits to balance the workload on the basis of the queue wait times of jobs in grid environments.	[19]
Auction based	Services are priced in an auction and usually carried out by a third party, called the market maker, which collects the bids, selects the winners and computes the payments.	[17], [18], [1], [24]
English Auction	All bidders are free to increase their bids exceeding other offers. When none of the bidders are willing to raise the price anymore, the auction ends, and the highest bidder wins the item at the price of his bid.	[24]
First-Price Sealed-Bid Auction	Each bidder submits one bid without knowing the others' bids. The highest bidder wins the item at the price of his bid.	[24]
Vickrey	Each bidder submits one bid without knowing the others' bids. The highest bidder wins the item at the price of the second highest bidder.	[24]
Dutch Auction	The auctioneer starts with a high bid/price and continuously lowers the price until one of the bidders takes the item at the current price. It is similar to a first-price sealed-bid auction because in both cases the bid matters only if it is the highest, and no relevant information is revealed during the auction process.	[24]
Double Auction	In the double auction model, buy orders (bids) and sell orders (asks) may be submitted at any time during the trading period. If at any time there are open bids and asks that match or are compatible in terms of price and requirements (e.g., quantity of goods or shares), a trade is executed immediately.	[24]

When performing the analysis, few studies explicitly stated the formalization of SLA in Cloud/Grid Computing scenario. However 4 primary studies ([11], [12], [14] and [21]) are complementary. They are summarized following.

a) In [11] is introduced a framework that enables dynamic specification and verification of SLAs on the Cloud. Its main contribution to our research is an format of SLA-Description based on XML specification which defines the main Quality of Services (QoS) along with their threshold values agreed up on selection of cloud services. It also defines the period of service provision, the cost of using the service, and the possible actions that should be taken if QoS provision is frequently violated.

b) In [12] is presented a framework which the SLA pa-

rameters are specified by metrics. These metrics define how cloud service parameters can be measured and specify values of measurable parameters. In addition to specific metrics this study also propose general metrics that can be defined for SLA with any or all types of cloud users.

c) In [14] the authors addressed the use of Cloud Computing for web hosting providers by creating a Cloud Hosting Provider (CHP). They designed an SLA-aware web servers management system in order to address the resources outsourcing mechanism on the provider's part, defining important economic variables to this kind of technology.

d) In [21] is proposed an unambiguous and flexible language for formalizing SLAs and an architecture for specifying and monitoring SLA's on grid computing scenario. It references a typical SLA formulated by Morris et al. [29] that includes the components: *Purpose*, *Parties*, *Validity Period*, *Scope*, *Restrictions*, *Service-Level Objectives*, *Service-Level Indicators*, *Penalties*, *Optional Services*, *Exclusions* and *Administration*.

V. Analysis of the Results and Mapping of Studies

By analysing the results, it can enable us to present the number of studies tabulated in each category defined in this study. Thus, it is possible to identify what have been emphasized in past research and determine gaps and opportunities for future research [9].

A. Research Type Classification

TABLE V
RESEARCH TYPE CLASSIFICATION

Research Type	Studies	Quantity
Validation Research	[14], [17], [18], [8], [22],[23], [25]	7 (30,4%)
Evaluation Research	[4], [20], [1], [24], [26], [25]	6 (26%)
Solution Proposal	[11], [12], [13], [2], [15], [16], [3], [4], [19], [21], [22], [5]	12 (52,1%)
Philosophical Papers	[6]	1 (4,3%)
Opinion Papers	-	0 (0%)
Experience Papers	-	0 (0%)

Initially, let us analyse the studies distribution regarding to the research type classification (Table V).

It was notorious the "Opinion" and "Experience" papers inexistence, while a number of "Validation", "Evaluation" and mainly "Solution Proposal" was found. Perhaps the rationale was the contribution level desired by researches proposing evaluable solutions to have more scientific relevance.

However, another more important point was observed related to "Evaluation Research", it is notable the small quantity of studies that matches this facet indicating insufficient experimentation in industry.

Certainly there is progress in this direction, but the accelerated growth in the cloud providers number (reported by [30]) influences the degree of competitiveness, causing the non-disclosure of their proposals in the scientific community. This fact encourages us to perform another research analysing cloud provider's accounting models in practice and comparing them.

B. Contribution Type Classification

Table VI shows the contribution type classification scheme, which we can observe the most of studies propose concrete "Models" or "Frameworks" instead of address activities related to accounting functions. This way, few "Processes", "Techniques" and none "Method" was registered. One possible explanation may be the observation made earlier, regarding the lack of practical results disclosed by the industry. In this case, we can conclude that even small-scale, companies publish "what they did" (models and frameworks) but hide the "how they did" (processes, techniques and methods).

TABLE VI
CONTRIBUTION TYPE CLASSIFICATION

Contribution Type	Studies	Quantity
Method	-	0 (0%)
Process	[11], [4], [21], [5], [25]	5 (21,7%)
Technique	[14]	1 (4,3%)
Model	[13], [6], [2], [15], [16], [19], [20], [1], [21], [8], [22], [23], [24], [25]	14 (60,8%)
Framework	[11], [12], [6], [17], [18], [3]	6 (26%)

C. Research Types X Research Questions

There were an effort in analysing the relationship between the research questions and the research type, using a bubble plot to represent the interconnected frequencies (Figure 1).

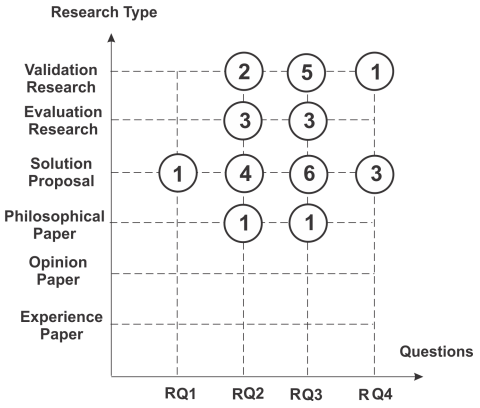

Fig. 1. Research type x Research questions

By analysing the chart upwards, none question was answered by papers that addressed personal opinion or experience, on the other hand one paper gave a big contribution, answering RQ2 and RQ3, classified as philosophical paper, discussing a general pricing scheme that can be applied to define variations for any computational element [12].

Most of the information (about 4 studies) related to accounting models comes from papers classified as "Solution Papers". Since this category includes 12 primary studies, it is clear that there has been few research effort directed to the issue of mitigating mechanisms aiming architecture improvements.

Related to RQ3, although the majority of studies was classified as "Solution Proposal" and "Validation Research",

the papers doesn't discusses how the pricing schemes could be applied in a detailed way, unlike give just short concepts. So, as our research aims to give a general overview mapping the pricing schemes, future researches can focus on explain how the pricing schemes can works in practice.

D. Accounting Models Analysis

The accounting models collected by this research were categorized according to their features (see Table VII).

TABLE VII
ACCOUNTING MODELS ANALYSIS

Studies	Features	Pricing	Metering	Mediation	Accounting	Roaming	Billing	Charging	Financial Clearing	Cloud Federation	Just in Time Clouds	User Interface	Security Support	SLA Support	Variable Payment Models
[1]		X	X	X	X	X	X	X	X			X	X	X	
[2]							X			X		X	X		X
[3]							X							X	
[4]							X						X		
[25]		X			X		X							X	X

Firstly, we used the taxonomy proposed by [5], aiming to check what functions the proposed models used. Thus, the terms *pricing*, *accounting* and *billing* appeared in more than one paper and with the same meanings, which this homogeneity indicates a certain taxonomy validity. Related to *accounting*, two information stands out:

- In [1] the authors disambiguated the expressions *accounting process* and *accounting function*. Whereas *accounting process* refer to a meta-concept that includes all the taxonomy functions, *accounting function* is related to recording and summarizing technical data in terms of money, transactions and events;
- In [25] the *accounting* and *billing* functions are grouped as integrated sub processes forming a type of macro-process.

Lastly, it is important to highlight that the term *billing* was cited by all primary studies. We attribute this result to the influence of other areas such as telephony that has used largely this term before cloud computing became a research trend.

Other features were derived from the most relevant aspects found in primary studies. *Cloud Federation* was the first feature. In this case it was observed a research gap in which only one accounting model [2] were directed to federated cloud infrastructures, needing to stress that this paper and [25] belong to the same research group (the RESERVOIR project [31]), showing as pioneer researchers in the area.

The feature *Just in Time Clouds* is a recent concept in which providers only allocate resources when they are demanded and only for the duration they are needed by their clients [7]. To explore this mechanism showed promise, because none accounting model addressed this feature. Something previously expected, due to be a recent issue.

The *User Interface Support* was analysed, noticing that some proposed models own a user interface that gives the access control to managing accounting mechanisms on the systems, but not all worried with this feature, only 40% of them had a final user or admin user interface support.

In *Security Support*, just 60% of studies at least cited some security mechanism like user authentication or transaction authorization. When analysed *SLA Support*, it was verified if the studies had SLA monitoring or the customer would choose their service quality desired, noticing that, as such *Security Support*, 60% fit this requirement. Therefore, *SLA* and *Security Support* have been showed as relevant topics of interest in accounting model field for cloud computing.

As last feature, it was investigated if the models were prepared to support different payment models (*Variable Payment Models*) such as Pre-Paid, Pos-Paid or Hybrid. These models are in no way unique to clouds and on the contrary they are well known to customers after being used for years in other utility markets, most notably the mobile phone industry [25]. Hence some accounting models (40%) are ready, for example, to work with resource consumption based on previous purchased credits (Pre-Paid).

It has to be mentioned that initially it was thought to include the term *monitoring*, however was preferred to use the term *SLA Support* instead, due its less ambiguous concept. According to [25], SLA and monitoring are strictly related each other, because the metric concept (from a monitoring point of view) is very semantically close to the "Key Performance Indicators" concept (from a SLA point of view).

Concluding, observing the fourteen features, one paper had a greater coverage. The primary study [1] proposed a flexible accounting model which can fit any service of cloud computing that encompassed almost all features taken into account by our classification. Therefore this paper can be used as a starting point for future accounting models propositions.

VI. THREATS TO VALIDITY

There are some threats to the validity of our study, which we briefly describe below.

- **Research Questions**: The research questions we defined cannot provide complete coverage of the accounting field related cloud and mainly grid computing, however, we had several discussions to validate the questions.
- **Publication Bias**: We cannot guarantee that all relevant studies were selected. We mitigated this threat as much as possible, by following references in the relevant studies.
- **Data Extraction**: The studies were classified based on our judgement, however, some studies could have been classified incorrectly. To mitigate this threat, the classification was performed by more than one researcher.

VII. CONCLUSION AND FUTURE WORK

We have introduced the results of a systematic mapping study about accounting models for cloud computing investigating scientific literature. In the end, starting from 580 papers, 23 filtered studies answered the research questions.

As major contribution, this paper provides an overview of the area and specific findings related to *i)* taxonomy for accounting process, *ii)* accounting models, *iii)* pricing schemes and *iv)* SLA composition.

i) The terms *pricing*, *accounting* and *billing* are the most used terms. Among these, the term *billing* surely is the main term in the area. This result is influenced by other fields such as telephony that has used largely this word before cloud computing became a research trend.

ii) In general there are few studies related to accounting models for cloud computing, mainly in industry environment. Besides there is a need for new proposals in federated cloud infrastructures whereas the topics related to SLA and Security have gained considerable attention.

iii) Despite the large amount of existing pricing scheme types, there is a need in expose how they could be applied in a detailed way, unlike give just short concepts.

iv) Related to SLA composition there are studies that propose possible general items to compose the contract (e.g. *Scope*, *Penalties*, *Restrictions*), others propose specific metrics to monitor the services quality and others presents mechanisms based on XML to specify metrics. Thus studying these results it is possible to develop new solutions combining ideas.

Future work will focus on analyse more accurately these mapping study results in order to match mainly the SLA composition ideas with accounting processes/models found to develop a more advanced accounting model. Also we intend to study the use on real market of the pricing schemes identified.

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