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# Distributed Infrastructure for an Academic Cloud

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**Abstract**— The various community infrastructure literature reveals the challenges in educational institutions to embrace cloud computing trends. Setting up an own data center in effect means a private cloud. If research on the open cloud services is available within the institution, then the rollout of such research products becomes an in-house implementation. Thus, even reducing the dependence on cloud vendors. Distribution of resources opens the channel for better communication within academic institutions. It also attracts opportunities to procure individual hardware with a bigger gain. Enormous spending and unaccounted credits fall into central budgets if not controlled in a structured manner. Also, increasing the overall data management cost as an institution needs a different perspective for its' long-term benefits. The expenses allow branching the cloud management tasks either in a vendor's private cloud or own Cloud if feasible. Bigdata does touch the academics to so much extent that such disparate de-central data management creates several pitfalls. The solution then suggested to have a controlled environment claimed as distributed computing. Infrastructure spending shoots up with a pay as you go model. We claim that a distributed infrastructure as an excellent opportunity in the computing when performed at the cost of trust of a private cloud. The open-source movements experiment the distributed clouds by promoting OpenStack swift.

**Keywords**- Academic Cloud Computing; Academic Data Centers Component; BigData; Infrastructure; Private Cloud.

## I. INTRODUCTION

This paper gives an overview of the various options available for academic cloud computing infrastructure. The project data of the institutions perish with the students and staff tenure. The process and documents across the departments de-centralized in the individuals' desktops or laptops. Utilization of the cloud vendors' services for the day-to-day operations of academics seems to be a new normal. The cost of storing the academic data public may unknowingly result in varying degrees of breach amounting to various defaulting per relevant laws. It can be via copy and reuse of important information resulting in no loss to significant loss directly or indirectly to valuable data sources. The presented literature review answers how academics in similar tiers can interact to avoid the various issues identified. This work's main contribution is to consider OpenStack for private clouds in institutions as the first step of distributed Infrastructure. The additional and second benefit is integrating systems and processes within similar institutions. The proposal helps quicker infrastructure investment decisions for new research projects. The paper is structured with a Literature review in Section 2 to understand the typical central and de-central computing. Section 3 proposed results from existing Tier1 and Tier2 institutions across the globe, suggesting a distributed infrastructure as the immediately available cloud option. Section 4 concludes the paper with recommendations for the market leader in private cloud that is the OpenStack swift distribution.

## II. LITERATURE REVIEW

Very few academic research topics are existing in the area of centrally sharing the resources. The resource provisioning for the academicians is taken care of by the central department of information technology or IT team who hosts the in-house ERP for most of the scenarios. The analysis result of nearly 30 articles consisted of major knowledge generated from direct journals, workshops, symposiums, and published books. The bulk of knowledge is available in the direct journal published articles. Arrived at prominent knowledge areas like Academic Cloud, Data centers in universities [2], [16] [3], Region or country specific research [13] [14] [19], global cloud providers etc. The knowledge areas are hierarchically tabulated in Table 1 though there are overlapping concepts discussed throughout.

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Table 1. Prominent Knowledge Areas

| **Prominent Knowledge Areas** | **Count** |
|---|---|
| In-house Information Technology | 17 |
| Outsourced Data Management | 10 |
| Data Centers | 3 |
| Governmental [17] | 4 |
| Community and Institutional [18] | 3 |

*A. De-Central Infrastructure*

Every department, including central Information Technology, could resist changes to the operating environment unless presented with non-disparate computing architecture. The central institutions, research wings with their hardware and software to procure and manage, seem much more feasible considering the smooth running of storage and processing. Many subdivisions or departments are liberal in using the cloud vendors and when required. There are studies reporting libraries managed in Cloud, and their advantages are listed [4]. The combined effort to procure such Infrastructure is not measured yet at the organization level. In a dispersed storage method, some in public and some private storages are more chaotic than an order. At any point in time, there is no way to attribute the Information Technology investment in a comprehensive context rather just another general infrastructure. The reported observations are the author's view augmented with similar experiences in the other universities or institutions. Owning project-based hardware is used just 1%, and that the ERP provided by the central Information Technology team is used to 100%. The spending imbalances are attributed to de-central Infrastructure, as presented in Fig.1.

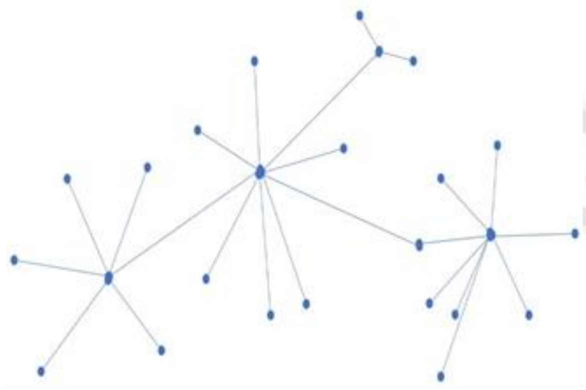

Fig.1. De-central Infrastructure

A de-central setup tackles the ownership issues in cloud federation by bringing out the parameters like overhead, throughput & resource allocation. Auction and pricing introduce the protocols and workload agnostics [6] [12]. There features are of a structure leading to an independent market economy.

*B. Central Infrastructure*

A main single office invests in hardware and software to provision compute, storage, network infrastructures including an ERP software to cater to its subdivisions or zonal office. All the departments supported so is called centralized system as in Fig. 2 [20]. Dataset for storage & HDD identifies the centralized homogenized applications [7]. Open-cirrus testbed for federation across application in a single full stack could be attended to. It increases the application to get distributed. As there is no hub communication is at endpoints. The control happens in the center of a network of devices.

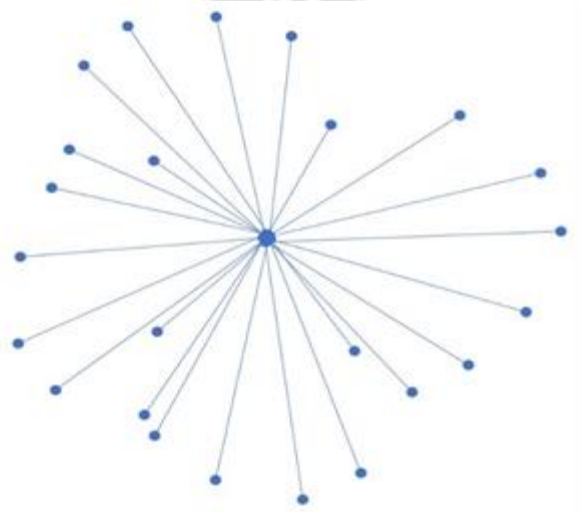

Fig.2. Central Infrastructure.

## III. Pitfalls and Opportunities

This work's research methodology bases its motivation by a framework proposed in the paper titled 5 major pitfalls and challenges in academic cloud computing [1]. Tier 1 universities' plan follows the techniques like Web to cloud [24], which remains an elite infrastructure. There are research works in Tier 2 institutions that already opened avenues mentioned as research agendas in the cloud [21]. This study's state of the art is for the silicon chips lifetime pushing hardware replacements within a short span. The hosting services must be constantly procuring, maintaining, and quickly looking for retirement and replacements of hardware. A professional hosting technology requirement in an academic setup date back to the days of having in-house ERP departments in the business. Are the academics prepared and planned for such growth of a hosting team in-house? There may be alternatives to outsourcing to vendors, which goes back to the original

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discussion of how reliable and costly monolithic vendors become. This kind of argument strengths the usage of dynamic allocation and usage in the form of centralization.

Tier3 Academic clouds, university databases are de-centralized, or vendor DBs depending on the risk level one could take. ScienceDirect, as a publishing platform, encourages a special community to showcase all academic cloud areas under one umbrella. Based on the geographical address, a device identifies and hooked up to specifies a community. The best practices are shared clearly within the user-defined community. As of now, ˜27 to 30 industry verticals are there in the universe. Out of that 10 of them are leading in SaaS cloud, the remaining 20 will be in the community of their own before actual transition steps depicted could be followed [5]. So, it is worth a benefit to look at the academic Cloud. 5 pitfalls, 5 opportunities listed by Barker, Varghese et al. [1] depict several possibilities, as summarized in Table 2. Many of these observations derived from an eight-year UK research program focused on Large Scale Complex IT Systems (LSCITS).

Table 2. Pitfalls and Opportunities

| **Pitfalls** | **Opportunities** |
|---|---|
| Infrastructure at Scale[a] | User driven research |
| Abstraction | Programming models |
| Non reproducible results | Bugs in large scale applications |
| Rebranding | Platform as a service environment[a] |
| Industrial relations | Elasticity |

[a] Note: Discussed in this study.

There is no direct connection of a pitfall to an opportunity. Rather one pitfall here in Infrastructure to scale can be overcome with another pitfall there with Platform as a Service. Similarly, one opportunity can be because of one of the more pitfalls. In Tier2 colleagues, there are existing opportunities exploited in the direction of elasticity and programming models. The proof is in the article published by students in Dublin, Ireland University. The article also insisted that abstraction is possible only in IaaS by academics as the critical production scenarios are very less in the Education industry. Similarly, one study could explore all the other pitfalls and hence set up environments for opportunities identified. It would be how leaders in academia understand the benefits of infrastructure expansions and related investments for further growth. In Tier2, there are opportunities explored in the direction of elasticity and programming models. The researchers explore all the other pitfalls from the lower-tiered institutions' perspective. Thereby helping the community set up environments by gaining on the opportunities identified. The deployment models have a distribution of hardware through several replication methods, as discussed in the Research Agenda in Cloud Technologies see Fig. 3 [22], [21].

Academia generated data is increasing very fast, with its private data centers growing at an unprecedented rate in pockets [10]. However, this has concerns about privacy and efficiency at the expense of resilience and environmental sustainability. Because of the dependence on Cloud vendors such as Google, Amazon, and Microsoft in parts and pieces [11]. Our response is an alternative model for Cloud conceptualization, providing a paradigm for the academics for utilizing networked personal computers for liberation from the centralized vendor model [19]. The alternative architecture, created by combining the Cloud with paradigms from Grid Computing, principles from Digital Ecosystems, and sustainability from Green Computing, while remaining true to the Internet's original vision. It is more of a cultural challenge than technical as dealing with distributed computing issues, including heterogeneous nodes, varying quality of service, and additional security constraints attended to in parts. Still, local collaboration among nearby institutions went bleak. However, cultural challenges are not insurmountable, and with the need to retain control over our digital lives and the potential environmental consequences, it is a challenge to pursue.

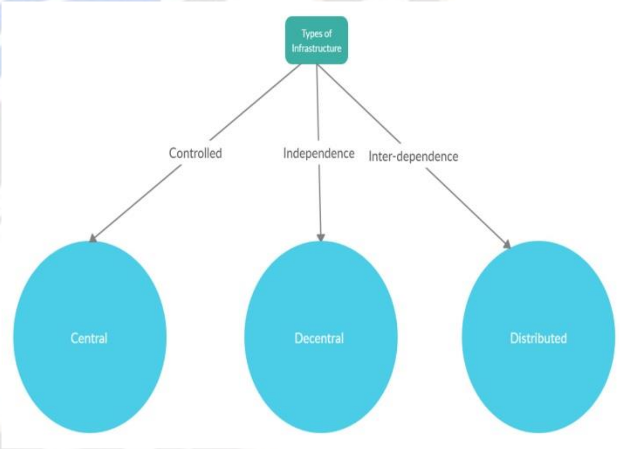


Fig.3. Types of Infrastructures.

Distributed Infrastructure For fault-tolerant handling of data and applications used by research in universities require a generic scientific application. A taxonomy analysis suggests a distributed infrastructure to help enhance storage. With the availability of OpenStack Swift to set up private clouds, it was making the plug and play of services feasible. When in distributed computing, the thought was to share a single task within a community of computers internally; the next level of cloud computing needs investment in distribution suggested in Fig. 4 [23].

Consolidation of data centers could be the first step towards having a master plan for future micro data centers, as suggested in [17]. That is to have the luxury of the information, technology, and communications growth [9]. Data centers' distribution can be outsourced based on the hardware's several types of utilization and setup. Enough policies available off the shelf to certify such center establishments [8]. The possible categories based on what type of data centers support one could seek are many. Cloud, Cooling, Reporting, Site Selection, Energy, Hyperscale, Machine Learning, Network, Storage, Co-location, Design, Markets, Internet of Things, Modular, & Servers were few categories. Cooperating computing is based on some similar works done in BOINC in 2004 and with slight variations as the Intercloud raised opportunities in the federation of cloud computing [18]. Open Cirrus testbed for federating across applications in a single full stack rolled as a framework. That is to help with application and system.

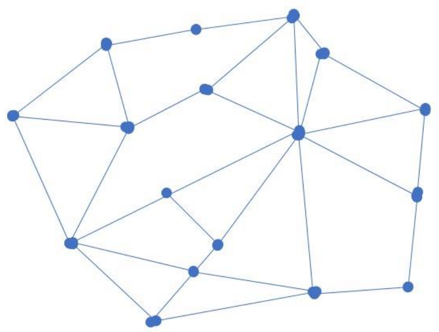

Fig.4. Distributed Infrastructure.

Research for distributed systems, such as PlanetLab, EmuLab, IBM/Google cluster, and Amazon EC2/S3. This innovative testbed for research & application development tool is a contribution to the University infrastructure as suggested in several studies [7] [15]. All the listed above and many more point to that inter-dependence enhances resource usage.

## IV. CONCLUSION & FURTHER RESEARCH

The analysis of concepts in the infrastructure sharing from the central to decentral is a first step in the journey to Cloud. And as further advancements, the role model infrastructure will be a possible showcase within the academics who are in the same tier to reuse existing upper Tier universities' frameworks. For the institutions down the value chain for mass education systems, suggestions are to investigate Open stack Swift by contributing the brand-new distributed Infrastructure that encompasses cloud computing in a trusted central setup. The mini-Cloud suggested can be the way forward to look at the ideas provided for a different world in the future, replacing NoSQL with NewSQL, enhanced ACID principles, and even challenging research like questioning the Moors' law [25].

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