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Designing an Energy-Efficient Cloud Network

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Abstract: The emerging cloud computing offers new computing models where resources such as online applications, computing power, storage and network infrastructure can be shared as services through the internet. The popular utility computing model adopted by most cloud computing providers (e.g., Amazon EC2, Rackspace) is inspiring features for customers whose demand on virtual resources vary with time. Energy consumption is the key concern in content distribution system and most distributed systems. These demands an accumulation of networked computing resources from one or multiple providers on data centres extending over the world. This paper has introduced a framework for energy efficient cloud computing services over non-bypass IP/WDM core networks. We have analysed three cloud services, namely; content delivery, Storage as a Service (StaaS) and virtual machines based applications. A mixed integer linear programming (MILP) optimization was developed for this purpose to study network related factors including the number and location of clouds in the network and the impact of demand, popularity and access frequency on the clouds placement, and cloud capability factors including the number of servers, switches and routers and amount of storage required at each cloud.

Keywords: Emerging Cloud, IP/WDM, Cloud Computing

1.1 INTRODUCTION

CLOUD computing exploits powerful resource management techniques to allow users to share a large pool of computational, network and storage resources over the Internet. The concept is inherited from research oriented grid computing and further expanded toward a business model where consumers are charged for the diverse offered services. Virtualization lies at the heart of cloud computing, where the requested resources are created, managed and removed flexibly over the existing physical machines such as servers, storage and networks. This opens the doors towards resource consolidation that cut the cost for the cloud provider and eventually, cloud consumers. However, cloud computing elastic management and economic advantages come at the cost of increased concerns regarding their privacy, availability and power consumption. Cloud computing has benefited from the work done on datacenters energy efficiency. However, the success of the cloud relies heavily on the network that connects the clouds to their users. This means that the expected popularity of the cloud services has implications on network. Designing future energy efficient clouds, therefore, requires the co-optimization of both external network and internal clouds resources. The lack of understanding of this interplay between the two domains of resources might cause eventual loss of power. For instance, a cloud provider might decide to migrate virtual machines (VMs) or content from one cloud location to another due to low cost or green renewable energy availability, however, the power consumption of the network through which users data traverse to/from the new cloud location might outweigh the gain of migration.

1.2 RELATED WORKS

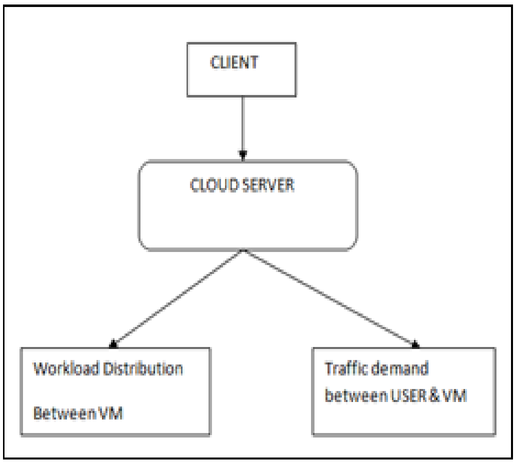

Fig: 1.2.1 Request submission

In the given figure 1.2.1 client send request to cloud server for particular task. Cloud server analyzed the request and send response to client as per as the request. A user request is defined by two dimensions: (i) the CPU utilization (normalized workload) of the VM and

(ii) the traffic demand between the VM and its user. a VM is defined as a logical entity created in response to a service request by one or more users sharing that VM.

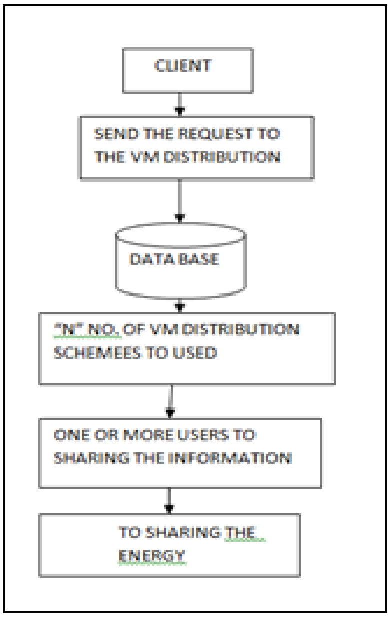

Fig: 1.2.2 VM Placement

In the given figure 1.2.2 we optimize the placement of VMs in IP/WDM networks to minimize the total energy consumption. We consider different VM distribution schemes. In our analysis, a VM is defined as a logical entity created in response to a service request by one or more users sharing that VM.Machine virtualization provides an economical solution to efficiently utilize the physical resources, opening the door for energy efficient dynamic infrastructure management as highlighted by many research efforts in this field. The use of multiple copies of active VMs to reduce the resource requirement for each copy of the VM by distributing the incoming requests among them to increase the energy efficiency.

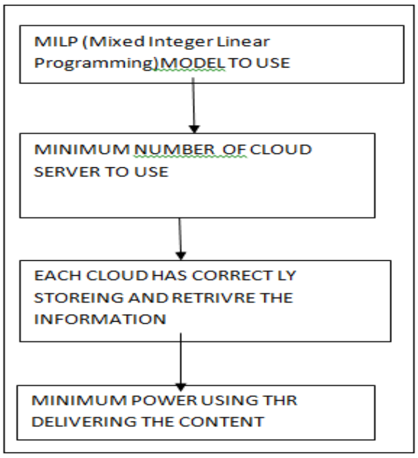

Fig: 1.2.3 Content delivery

In the given figure 1.3.3 we introduce the MILP model developed to minimize the power consumption of the cloud content delivery service over non-bypass IP/WDM networks. Given the client requests, the model responds by selecting the optimum number of clouds and their locations in the network as well as the capability of each cloud so that the total power consumption is minimized. The model also decides how to replicate content in the cloud according to its popularity so the minimum power possible is consumed in delivering content.

1.3 EXISTING SYSTEM

Cloud computing is expected to be the main factor that will dominate the future internet service model by offering a network based users applications. The Internet expansion in reach and capacity results in the increase of the energy consumption of the network equipment. Today the cost of transmission and switching equipment is considered one of the major barriers to the growth of the Internet. The success of the cloud relies heavily on the network that connects the clouds to their users. This means that the expected popularity of the cloud services has implications on network traffic, hence, network power consumption, especially if we consider the total path that information traverses from clouds storage through its servers, internal LAN, core, aggregation and access network up to the users' devices. For instance, transporting data in public and sometimes private clouds might be less energy efficient compared to serving the computational demands by traditional desktop.

1.4 PROPOSED SYSTEM

In this paper, we introduce a framework for designing energy efficient cloud computing services over non-bypass IP/WDM core networks. This paper extends the work by (i) studying the impact of small content (storage) size on the energy efficiency of cloud content delivery (ii) developing a real time heuristic for energy aware content delivery based on the content delivery model insights, (iii) extending the content delivery model to study the Storage as a Service (StaaS) application, (iv) developing a MILP model for energy aware cloud VM placement and designing a heuristic to mimic the model behaviour in real time. we develop a mixed integer linear programming (MILP) model to optimize cloud content delivery services. Our results indicate that replicating content into multiple clouds based on content popularity yields 43% total saving in power consumption compared to power un-aware centralized content delivery.

1.5 FUTURE ENHANCEMENT

Note that the placement decision of one VM (and one *PG* for the content delivery model) is independent of the others; therefore, the heuristics can be distributed among different servers to reduce the computation time as different instances will work in parallel. Note that our MILP model and heuristics are free to place

content, storage or VMs in the locations that minimize power consumption and select the optimum route between the user and the content, stored documents or VMs such that power is minimized. The model also allows a user to be served by
multiple VMs.

CONCLUSION

This paper has introduced a framework for energy efficient cloud computing services over non-bypass IP/WDM core networks. We have analysed three cloud services, namely; content delivery, Storage as a Service (StaaS) and virtual machines based applications. A mixed integer linear programming (MILP) optimization was developed for this purpose to study network related factors including the number and location of clouds in the network and the impact of demand, popularity and access frequency on the clouds placement, and cloud capability factors including the number of servers, switches and routers and amount of storage required at each cloud.

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