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Node Designing of Complex Networks in Cloud Computing Environment

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Abstract

As a result of the spreading various types of nodes and topological complexity of the cloud computing, it is an backbreaking task to characterize the nodes which are far more influential than others. The objective of our paper is to examine complex networking based cloud computing. Complex networks are a type of networks whose structure is irregular, complex and evolving dynamically. Its main goal is the analysis of small networks to that particular of system with millions of nodes. It has been found that none of the technique is way better for cloud computing. Therefore, this paper ends with the future scope to solve these issues.

Keywords: *Cloud Computing, Complex Networks*

1. Introduction

Complex networks are networks whose structure is complex and evolving dynamically [1]. Main focus of complex networks could be the analysis of small networks to that of system with thousands or innumerable nodes. Complex networks pay more attention on the network of dynamical units. This type of networks can be expanded as networks of networks [2]. The study of complex network is a new and active area of research inspired by real-world networks such as computer networks. In complex networks, resource allocation identified mapping a large quantity of workloads to the networks.

Cloud is a pool of heterogeneous resources such as software and hardware. It is a mesh of huge infrastructure and doesn't have relevance. Infrastructure describes the applications delivered to end users as services within the Internet. In order to make efficient usage of these resources and ensure their availability to the end users Computing is completed centered on certain criteria specified in Service Level Agreement SLA [3]. Infrastructure in the Cloud is made offered to the user's On-demand basis in pay-as-you-go-manner. Computation is completed with the aim to reach maximum resource utilization with higher availability at minimized cost.

2. Cloud Computing Overview

Cloud computing [4] is a technology for the internet and remote servers for maintaining applications and resources. Cloud computing allows clients to use resources without installation and access their files at any computer with internet connection. This technology allows for very much inefficient computing by centralizing processing, memory and bandwidth. Cloud computing is a type of network computing where an application runs on a server or servers rather than on a local computing device such as a PC, tablet or smart phone. Like a conventional client-server model, a user connects with a

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server to execution a job. The difference with cloud computing is that the computing process may run on one or more connected computers can be, utilizing concept of virtualization. With virtualization is one or more servers can be configured and splits into multiple virtual servers, all functioning independently and seem to the user to be a single physical device. Such virtual servers is not consist and can be moved in all directions and flaky up or down without affecting the end user. The computing resources have become grainy, which endow end user and operator avail including broad access across multiple devices, resource pooling, on-demand service, fast elasticity and service surveying capability.

Cloud computing is a mechanism of distributed computing focusing on confer a wide range of users with distributed access to virtualized infrastructure over the internet. It involves distributed computing networking, web services and virtualization. Idea behind cloud computing has focus interest of users towards of distributed and virtualization computing systems. It has appear as a popular solution to provide cheap and easy access to externalized IT resources. Through virtualization, cloud computing is able to address with the same physical infrastructure a large client base with different computational needs. The rapid growth in cloud computing increases severe security concerns.

2.2 Types of Cloud

2.2.1 Public Cloud: In Public cloud is available for public use alternatively for a large industry and is owned by an organization selling cloud services. Customer has no visibility and control Excess where the computing infrastructure is hosted. The computing infrastructure is shared among any organizations.

22.2. Private Cloud: The computing infrastructure is operated for the exclusive use of an organization. The cloud probably managed by the organization or third party. Private clouds are more costly and more secure when compared to public clouds. Private clouds may be either on or off premises. Externally hosted private clouds are also only used by one organization, but are hosted by third party specializing in cloud infrastructure. Externally hosted private clouds are inexpensive than On-premise private clouds.

2.2.3. Hybrid Cloud: Hybrid cloud combines multiple clouds (private community of public) where those clouds retain their unique identities, but are bound together as a unit. A related term is Cloud Bursting. In Cloud bursting organization is use their own computing infrastructure for common usage, but access the cloud for high load requirements. This ensure that a sudden increase in computing necessity is handled gracefully. Hybrid cloud may offer standardized or proprietary access to data and applications, as well as an application portability.

2.2.4. Community Cloud: Community cloud is one where the cloud has been organized to serve a common function or purpose. For example one organization or for several organization, but they share conman concerns such as their mission, security, policies, regulatory compliance needs and so on.

3. Classification Based Upon Service Provider

3.1 Infrastructure as a Service (Iaas)

Infrastructure as a service (IaaS) involve offering hardware related services using the principles of cloud computing. IaaS provides a virtual-machine, virtual storage, disk image library, virtual infrastructure, raw block storage, and file or object storage, load balancer, IP addresses, firewalls, virtual local area networks and software providers supply these resources on demand from their large pools installed in data centers bundles. The IaaS service provider manages all the infrastructure.

3.2 Platform as a Service (PaaS)

In the PaaS models, cloud providers deliver a computing platform, typically inclusive of programming language execution environment, operating system, and database and web server. Application developers can evolve and run their software solutions on a cloud platform without the cost and insolubility of buying and managing the basic hardware and software layers. The service provider manages the cloud infrastructure, the operating systems and the enabling software.

3.3 Software as a Service (SaaS)

SaaS includes a complete software offering at the cloud. Users can access a software application hosted by the cloud venders on pay-per-use basis. In the business model using software as a service, users are provided access to application software and databases. SaaS is a complete operating environment with applications, management, and the user interface. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes designated to as "on -demand software" and is commonly priced on a pay-per-use backbone. SaaS providers generally price applications using a subscription fee.

4. Load Balancing in Cloud Computing

Load balancing [5] is the technique of distributing the load between various resources in any system. Thus load requires to be distributed over the resources in cloud-based architecture, so that each resources does equal amount of work at time. Basic requirement is to provide some techniques to balance load to provide the solution of fast response for request. Cloud Load Balancers manage web traffic by distributing workloads among multiple servers and resources. They maximize throughput, minimize response time, and avoid overload.

Load balancing is a generic term that is used for distributing a processing load to smaller processing nodes for enhancing the overall performance of system. In a distributed system, it is the process of distributing load among various nodes of distributed system to improve resource utilization and job response time. An ideal load balancing algorithm should avoid overloading of any specific node. But, in cloud computing environment the selection of load balancing algorithm is not easy because it involves additional constraints like security, reliability etc. So, the main goal of a load balancing in a cloud computing is to improve the response time of job by distributing the total load of system.

Load balancers can work in two ways: one is cooperative where the nodes work simultaneously in order to achieve the common goal of optimizing the overall response time and other is non-cooperative where non-cooperative mode, the tasks run independently in order to improve the response time of local tasks.

Load balancing algorithms can be divided into two categories: static and dynamic load balancing algorithm. A static load balancing algorithm does not take into account the previous state while distributing the load. On the other hand, a dynamic load balancing algorithm checks the previous state of a node while distributing the load. In a dynamic load balanced system, the nodes can interact with each other generating more messages when compared to a non-distributed environment. However, selecting an appropriate server needs real time communication with the other nodes of the network. Dynamic load balancer uses policies for keeping track of updated information. Dynamic load balancers have four policies:

- **Transfer policy-**It is used when a selected job is needed for transfer from a local to a remote node.
- **Selection policy-**It is used when processors exchange information between them.

Location Policy-It is responsible for selecting a destination node for the transfer.

- **Information Policy-**It is used to maintain a record of all the nodes of the system.

The task of load balancing is shared among distributed servers. In a distributed system, dynamic load balancing can be done in two different ways. In the distributed one, the dynamic load balancing algorithm is executed by all nodes present in the system and the task of scheduling is shared among all nodes. Whereas, in the undistributed one, nodes work independently in order to achieve a common goal. We will be using three criteria for comparing the load balancing algorithms:

- **Throughput-** It can be estimated by calculating the total number of jobs executed within a fixed span of time without considering the virtual machine creation and destruction time.
- **Execution time-** It can be estimated by measuring the time taken for completing the following processes time for formation of virtual machines, processing time of a process and destruction time of a virtual machine. In general, any cloud computing algorithm performs the following decisions:
    - Client requests the cloud coordinator.
    - Cloud coordinator divides the task into cloudlet, and sends it to data centers.
    - Data center coordinators work on scheduling the tasks. It also selects the algorithm, which will be used for scheduling tasks.

5. Literature Review

Mini Singh Ahuja et al. [6] described a network in large network with average path length. Although regular networks and random graphs are useful idealizations in many real networks. In this networks the initial connections are replaced by randomly ones. Yet the network is more highly clustered than a random graph, in the sense if A is connected to B and B is connected to C, there is a significantly increased probability that A will also be connected to C.

They also described a network named scale-free for its degree distribution, i.e. In virtually real network, some nodes tend to be connected than others. To quantify this effect, let p_k denote the fraction of nodes that have k links called the amount and p_k is the amount distribution.

Juan, Chen, et al., [1] described the spectral properties of different real-world networks such as regular networks, random networks etc. In random networks, the littlest nonzero Eigen value grows linearly with respect to the probability p. It was shown a correlation relating to the Eigen value spectrum and degree sequence in the networks in scale-free networks.

Guo-hong, et al., [3] introduced an thorough relation relating to the evolution mechanism of cluster innovation networks and the risk-resistant capability of the networks. Finally, it was unearthed that the key element factors inducing the cascading breakdown of cluster innovation networks could be summarized into three areas: the distribution of inter-firm connections, the distribution of firms ‘risk-resistant capabilities, and the innovation capabilities of the enterprises within the cluster.

Chen, Pin-Yu, et al., [2] presented the IDD in complex networks by modified Susceptible-Infected model, that's been surprisingly suitable for multiple scenarios. Systematically categorizing such networks and examining conditions to adopt SI model for IDD in complex networks, the fundamental properties including mixing type, vertex connectivity and giant component size provide valid insights for quantitative analysis.

Li, Gang, et al., [7] described topological structure evolving model of complex supply networks from the perspective of Complex Networks. After investigating supply networks typical structural characteristics and formation mechanisms, Complex Supply Networks Evolving Model are proposed to mimic these structural characteristics. To validate CSNEM, three real supply chain networks are introduced.

Hu, Ziping, et al. [8] introduced the characteristics of complex networks affecting performance. Complex networks are typified as random networks and scale-free networks. The small-world network was found to have the most effective resilience due to the clustered feature. The outcomes help in gaining a greater comprehension of the field.

Yijun, Zhang, et al., [9] described the design problem of global asymptotical synchronization for complex networks with time varying delayed couplings. In the complex networks, every node was expressed with a neutral-type system. Using the LaSalle invariance principle and some properties of Kronecker product, a sufficient condition that stabilizes error system through adaptive control is derived, which ensures the dynamics of whole networks synchronize with the desirable synchronization manifold.

6. Complex Network

Networks are the keystone of complex systems that consists of many components. The structure of the networks would help us to understand the way the components interact with each other and the intrinsic properties of the complex system. Networks of interest vary from the Internet to the World Wide Web to scientific collaborations networks.

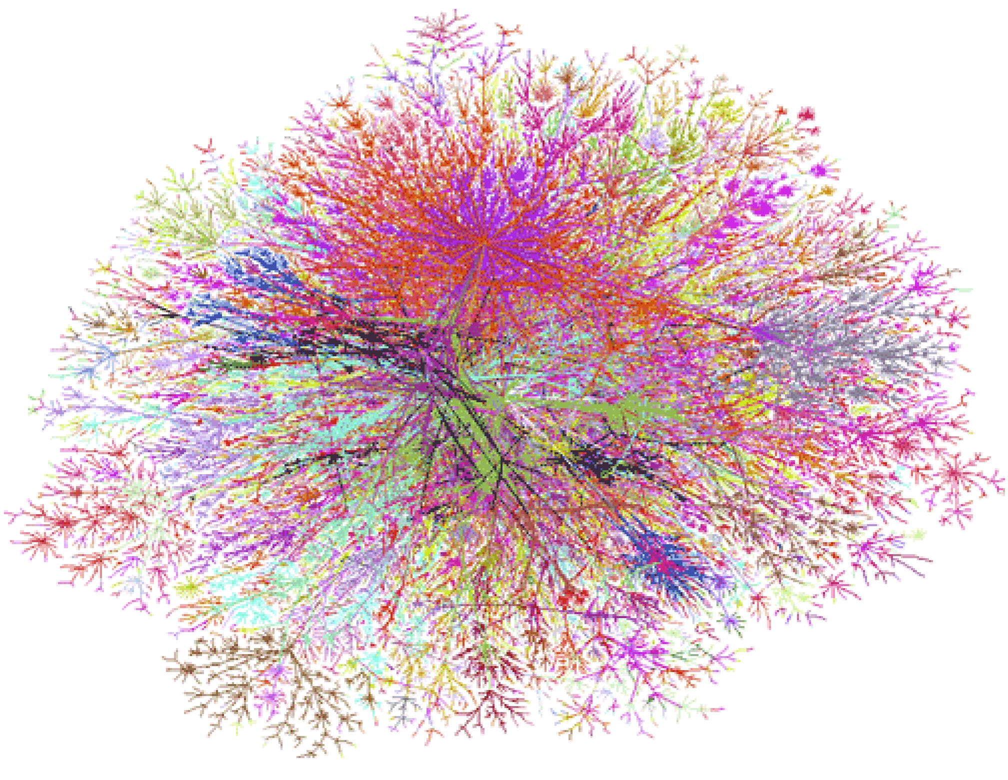

Figure 1. Complex Networks

There are basically three types of complex networks in terms of the geographical properties of the links: undirected, directed and weighted networks. For example, the Internet is a complex network of computers with links. The links of network have no direction that means the data, information and resources can go through the link anyway. The World Wide Web is a typical directed network. The nodes of the network are the web pages and the edges are the hyperlinks from one page to another. These links share a common character having no length. For example, once a hyper link from web page X to web page Y is created, a directed link from node X to Y is added in the network model. There is a third kind of network whose links have length or weight.

6. Concepts of Complex Networks

Here we discus different types of Complex Networks

6.1. Jump Point Network

The first idea is to do with the actual structure inside jump points. Rather than have Instantaneous travel, the inside of a jump point could be structured as a branching node network of junctions, each linked by several wormhole tunnels. Here's an example of a really complicated, overlapping node network.

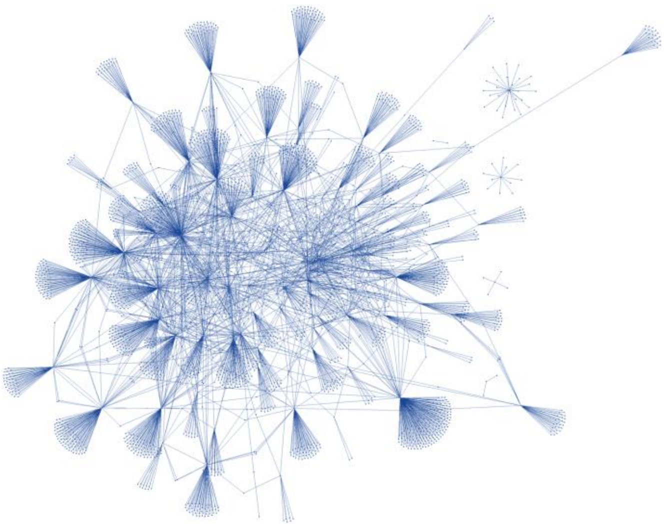

Figure 2. Jump Point

The network could be self-overlapping and the physical paths themselves need not be straight or equivalent to path traveled on the node diagram. This would create some of the *in-lore* descriptions of things at the same time.

For CIG to generate the jump points, this is where some very simple procedural generation would come in handy. Depending on the amount of art effort put in, the networks could be made pleasant to explore.

Charting a Jump Point

There would be multiple overlapping paths through the jump point, when charting the point. Some paths will be quicker and more efficient than others, while some will meander quite a bit before reaching the actual destination.

Replay Ability

Since there are many possible routes through a jump point, there are many opportunities to "re-chart" the jump point. The passage time through the jump point depends on either the "distance" traveled through the network or the actual transit time of the explorer.

Second, the networks may change over time with some connections disappearing, and some new ones appearing. This means that some routes may become invalid, but there might still be others that work. This makes jump points still navigable without making it so they have to be completely disabled or outright "evaporate" or move, until someone re-charts it.

If the best route through a major jump point would be invalid, this may be an in-game newsworthy event, which can inspire a "rush" of explorers to a system to re-chart the new jump point network, making for even more lasting exploration potential that doesn't get tapped out in the first couple months of the PU.

Fast-Growing Functions

Fast-growing functions would describe the concept of some notation for representing large numbers, that make an IMO shortlist problem infinitely more difficult and solve it by the well-ordering of the ordinal ε_0.

The second part of fast-growing functions would describe Harvey Friedman's *n* and *TREE* functions, before exploring models of computation to reach and surpass the Busy Beaver function Σ.

Fast-Growing Hierarchy

We'll define a sequence of increasingly fast-growing functions. For a relatively, let's begin with the function $f_1(n) = n+2$. Applying f_1 to the natural numbers gives the sequence {3, 4, 5, 6, 7, 8,…}.

Now, we use recursion to speed things up. For each positive integer α, we define $f_{\alpha+1}(n) = f_\alpha(f_\alpha(f_\alpha(\ldots f_\alpha(2)\ldots)))$, where there are $n-1$ copies of f_α. To avoid the ellipses, we can represent this as the recurrence $f_{\alpha+1}(n+1) = f_\alpha(f_{\alpha+1}(n))$ with initial condition $f_\alpha(1) = 2$.

So, $f_2(n) = 2n$ and $f_3(n) = 2^n$. We move from addition via multiplication to exponentiation, so it is clear that later terms will be quite fast indeed. The fourth function gives a tower 2^2^2^2^ … ^2 (evaluated from right to left) of *n* twos. Using Knuth's up-arrow notation, this is written as $2\uparrow\uparrow n$.

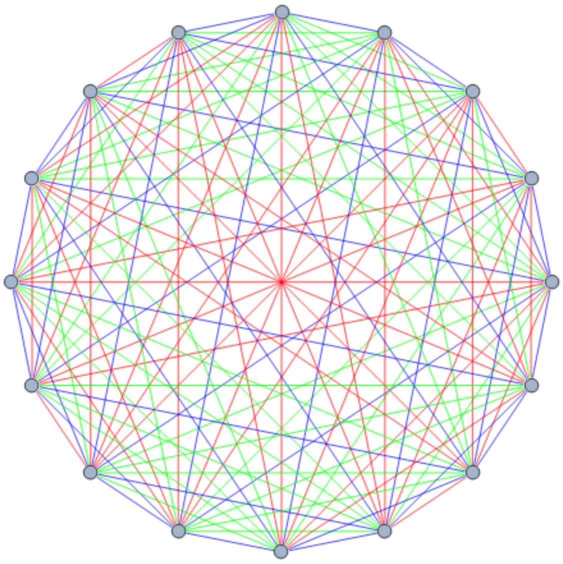

Figure 3. Complex Networks of Ramsey Theory

6.2. A Miraculous Cycle

It is possible to create a cycle in three-dimensional integer lattice with the following properties:

1. The three projections parallel to the unit vectors are all trees;
2. The cycle has threefold rotational symmetry;
3. The cycle is a trefoil knot.

The cycle is a beast named the Treefoil, inhabiting a 9 × 9 × 9 box. We can see the three projections and a three-dimensional perspective view below:

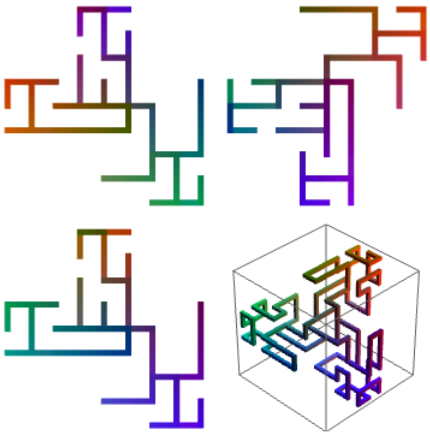

Figure 4. Miraculous Cycle

Here is an isometric projection of an earlier version, which that can be optimized to give the variant above.

6.3. Hopf Link

Hopf link is a pair of interlinked cycles, such that the projections of the resulting Hopf link are all trees:

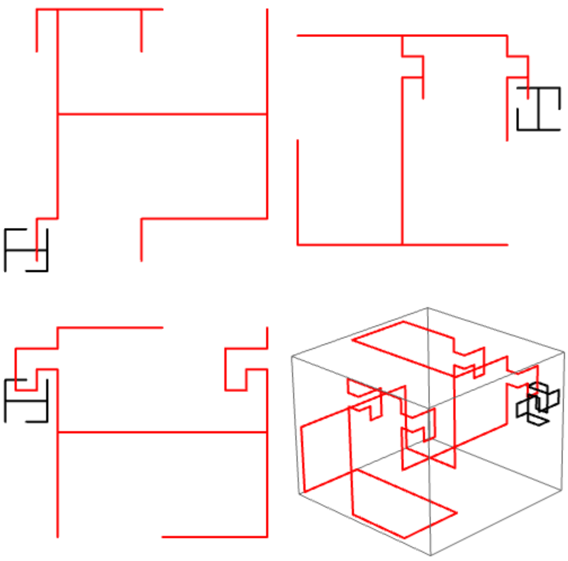

Figure 5. Hopf Link

The Hopf link is so named because of it features in the Hopf fibration where all circles are connected in this manner.

7. Conclusion and Future Scope

Complex networks are becoming popular way day by day to resolve many networking related problems within a proficient manner. In this paper we have discussed various types of complex network for cloud computing and existing complex networks with literature review. The approaches in cloud computing are very time consuming and not more scalable. Other issue is that the utilization of complex networks has been neglected for cloud computing. So in near future, the complex networks will be used for cloud computing environment to optimize the cloud web services further.

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