Computer Networks: Connectivity in the Digital Age

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***Abstract*— Advanced network architectures, emerging from current Internet technology, are distinguished from previous generations of network architectures. The advanced network architectures are designed to share network resources, computing power, and storage. This paper discusses the concepts of Grid Network architecture, Cloud Network architecture, and Cluster Network architectures. Furthermore, this paper provides insights into high-performance networking concepts and the essential characteristics of the advanced network technologies. This paper also focuses on advantages and disadvantages of advanced network architectures.**

INTRODUCTION:

I have always wondered how the computer world would be if the computer networks did not exist. Since invention of the Ethernet in 1973 by Dr. Robert M. Metcalfe(Schaefer, 2015), the computer network architectures have been evolving exponentially to meet the modern world demands of data transfer and communication needs. The computer network was initially designed to provide communication link between a few independent and standalone systems to create a homogeneous network. In recent years, businesses are investing heavily to implement advanced network architectures to connect billions of homogenous and heterogeneous computing systems (Hewlett-Packard, 2003). Businesses are implementing advanced network architectures, such as High-performance networks, Grid network architectures, Cloud network architectures, and Cluster network architectures, to meet the increasing demand for data transfer and communication needs.

The basic computer network practices include Direct Link Network, Internetworking, Internet Protocol, Transport process, and World Wide Web. The basic network practices are not cost-efficient. For example, the complex and larger network designs using basic technologies would need lot of infrastructure to build the links between nodes. Most of these nodes will not be used all the time. Therefore, the network is not cost-efficient. The cost-efficiency and optimization can be achieved through a nested connection of nodes and links, and by sharing the network resources using statistical multiplexing methods. With the availability of advanced technologies and concepts, the computer network architects are designing and developing cost-effective, optimized and robust network architectures for better connectivity(Guan, 2007). The advanced network types include High-performance networks (HPNs), Cloud network architectures, Grid network architectures, and Clustered network architectures.

High Performance Network Technologies

High Performance Networking is an advanced network technology that plays a vital role in the success of organizations data center operations as data volumes and near real-time data processing requirements continue to increase (Higgins, 2012). HPNs are efficient and cost-effective network architectures. HPNs are used to connect High-performance computing (HPC) systems that are used in several market segments including oil exploration, pharmaceutical research, financial services, aerodynamic simulations, weather forecasting, and a wide variety of other scientific applications. There are various types and concepts in HPNs, including Gigabit Ethernet, Scalable Coherent Interface (SCI), Myrinet, Giganet/cLAN, Internet2, Asynchronous Transfer Mode (ATM), Synchronous Optical NETwork (SONET), Dense Wavelength Division Multiplexing (DWDM) Optical Networking, Fibre Channel (FCS or FCAL), and High-Performance Parallel Interfaces (HiPPIs). High performance networks are designed to support applications that require high reliability, high bandwidth, and low latency. For example, Network architecture using DWDM technology helps organizations to have enough bandwidth for data flows to support complex operations such as datacenter replication and datacenter disaster recovery(Higgins, 2012).

The increase in virtual machine and processor core density promotes a transition to High-performance network as the required mechanism for attaching servers. Hundreds of enterprise systems on a single server will overwhelm a single network link. So enterprises are adopting High-performance networking, and this adoption demands advanced network architectures. The implementation of advanced network architectures will enable operational consistency as well as policy portability, so network and security policy follows the enterprise system as they move around data centers.

Cloud Network Architecture

The rapid increase in online connectivity resulted in Cloud network architecture. The adoption of cloud computing and cloud network architectures started in the 21st century (Mantri, Nandi, Kumar,& Kumar, 2011). Cloud network connects the pool of cloud computing resources which includes storage, servers, and databases. The cloud network classified into two types (i) Public and (ii) Private. The public cloud network connects the applications to internet allowing users to access the applications via internet whereas the private cloud connects the data centers using Virtual Private Network (VPN) technology.

Cloud network architectures cut the operational and capital costs and allow the enterprises to focus on strategic initiatives instead of maintain network architectures (Kaur & Kaur Rai, 2014). It provides the services on Infrastructure level, Platform level, and Software level. It provides many features such as speed, scalability of resources, parallel processing, just pay the used resources, choose another technology at any time to further work, 24/7 availability of services, device and location independent, provides reliability and security etc.

There are many advantages with Cloud network architectures, including sharing of resources, pay for only used resources and better hardware management. Cloud network architectures share resources to provide networking services to multiple systems. This allows scale up, or scale down the resources as needed. The Cloud architecture allows the enterprises to invest only on the resources that are required to support workload. In Cloud network architecture, it is easy to perform network management and monitoring as all systems run on the same hardware (Gandotra et al., 2011).

Grid Network Architecture

Grid network architecture is an advanced network architecture which is designed to share the network resources in a virtualized distributed computing environment. The Grid network architecture offers various benefits, including cost savings, sharing of resources, and decreasing the execution time (Heger, Carinhas, &Simco, 2006). Grid network employs use of loosely coupled multiple clusters that are geographically distributed and heterogeneous in nature (Raicu, 2008).

The main advantages of Grid network architectures are (i) access to additional resources (ii) resource balancing and (iii) reliability. In addition to connecting multiple CPUs, different data storages, Grid architectures also connect other networking resources including hardware and firmware. The Grid architectures create a single image by connecting multiple systems. The Grid architecture performs resource balancing by transfer the computation jobs to systems with low utilization.

Cluster Network Architecture

Cluster network architecture is another advanced networking architecture where several nodes connected to run as single network entity. The various nodes involved in cluster are connected to each other using high-performance local area networks. Performance and fault tolerance are the two main reasons to deploy a cluster networks. (Kaur&Kaur Rai, 2014). Cluster networks create cluster computing environment by tightly connect the nodes with a single system image, and centralized job management. Cluster networks support applications that require high computation in terms of response time, memory, and throughput (M.Tripathy&C.R. Tripathy, 2014). Each system in the Cluster architectures has its own CPUs, memory and network resources. The Cluster network architecture uses fast LAN technology with each node running its own instance of an operating system (Morilloa etal., 2008).

However, some may argue that advanced network architectures offer low performance, security and data loss issues. These, however, are not true. When deploying advanced architectures, enterprise must consider the limitations of network connectivity technology. The performance issues can be addressed by using appropriate technology to connect the nodes. For example, advanced network architectures with wide-area network (WAN) technology may not support the system workloads. In such cases, businesses should assess the limitations and implement appropriate network technology. The businesses that require high performance should consider using high performance network technologies (HPNs). HPNs offer high capacity, high bandwidth and low latency to support heavy workloads (Higgins, 2012). For example, Architectures with DWDM technology support up to 100 Giga bytes per second (Gbps). Security is another concern observed by few. The advanced network architectures with appropriate network filtering and intrusion detection techniques, such as Active Content Filtering, Web Application Vulnerability Detection, Malicious Sniffing Detection, and Intrusion Detection, will prevent security attacks (Ashktorab&Taghizadeh, 2012). Some may argue that Data security and leakage is another problem with advanced architectures. However, this is not true. With appropriate cryptographic management information, such as encryption keys, authentication codes, and access privileges, the data leakage can be prevented (Lee, 2012). The data related issues, performance issues, and security issues can be eliminated by equipping advanced network architectures with appropriate network tools and monitoring systems.

Conclusion

The advanced network architectures will connect multiple geographically distributed systems that appear to users as a single large network system. These architectures provide opportunities to share resources, data, and storage to perform complex computations. The advanced network architectures appear to be promising to connect various systems that support different workloads. Hence there is a potential scope for further research in these areas.

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