Routing Protocol in Cloud Computing

Ankita Wankhede, Dr. Muzzam A. Khan
Department of Computer Science and Engineering
University of Missouri Kansas City
Kansas City, MO, USA 64110

***Abstract* — Cloud Computing is a distributed architecture and an ever-evolving system model, it leverages the present world's omnipresence of Internet, the ability to Virtualize and provision the infrastructure, which makes the system more flexible, one of the main challenges with regards to them is, how do we Manage this system? Since this Infrastructure is setup on shared services like Internet, provider network the important aspect is routing the network correctly, which handles various functions like Data exchange, Storage, connectivity, and Security. This paper tries to discuss the various routing protocols that are used by different cloud system to add Security, provide more transparency to consumers while adhering to their business compliance policies and making the systems much more reliable.**

Keywords—: Cloud Computing, Routing Protocols, Algorithms, Protocols, Distributed system, Security.

I. INTRODUCTION

Cloud Computing has become one of the most highly endorsed technology. It offers multiple services to its users. With its capability of computing over the internet and providing secured and fast end user services, it has become most sought technology of the era. The application hosting solution is virtual and over a distributed architecture making it agile, scalable, and adaptable. Cloud is an ever-changing paradigm, which adds up the complexity of network, which is more like having an enterprise network dispersed on the Cloud, or having an Online IT Infrastructure. It becomes very critical to manage the network routing effectively and efficiently to manage the Data Security and other data exchanges between the users on Cloud system effectively.

Cloud computing introduces several concepts and technologies to the mix of Cloud architecture. The routing protocols are supposed to manage, the network routes in which traffic flow takes place between machines. These Machines are setup on the network at different positions and the traffic between them vary with time, the protocols also dynamically alter traffic based on the varying states of routers and connections because of multiple reasons such as failures, maintenance, and changes. Such decisions are made with least configuration changes from a user.

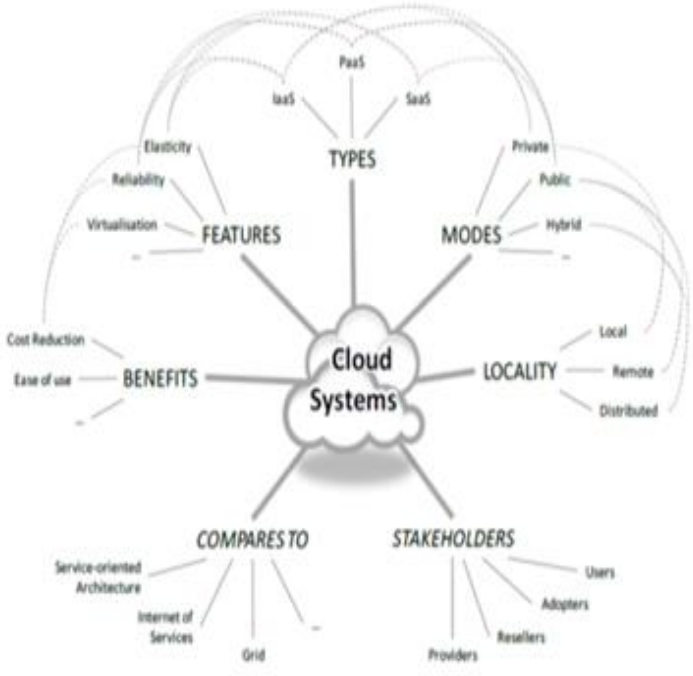

Figure 1. Overview of Cloud Systems [1]

Google, Apple, Microsoft, Amazon Salesforce.com are some of the premier companies currently delivering cloud solution to its customers, because of its simplicity the solution, it can be implemented in

Different service models, Saas (Software provided as a service), PaaS (platform provided as a service) and IaaS (Infrastructure provided as a service). Cloud solutions are usually customized and integrated to make them tailored as per user requirements. [2] We will try to read multiple research papers on how the routing of such a system would need to happen and explore the issues faced when setting up the cloud OS.

1.1 Characteristics

• Shared Infrastructure — Cloud uses its capability of being accessible over the internet to help setup the infrastructure, this provides multiple opportunities for Virtualization and enables user to use multiple storage zones and shared network and physical services. The cloud infrastructure, regardless of how it is setup, attempts to optimize the use of available IT capabilities.

• Dynamic Provisioning — On demand provisioning, allows admins to allocate services based on the usage and need. In addition, this does not require manual intervention, making it easy to increase or decrease the resources, as and when needed, the on-demand increase in provisioning needs to happen without changes to the security and system reliability.

• Network Access — Since most of the Cloud system are independent of platforms, it becomes necessary for the user to be able to access the Cloud systems over a laptop, Smart phone, or any other means possible deploying services in cloud gives the mobility to its user to utilize the services from different medium. Internet is the easiest way to get your application on any device you would prefer to work with. Ex. Gmail, Dropbox.

1.2 Service Models

Based on the need the users can choose different service model that suits best for their needs, the cloud services can be custom made and provided as per the user's requirements

• Software as a Service (SaaS) — the best example would be the cloud availability of Microsoft office web apps, In this service model the users purchase the complete services of the software, just like in outlook, office or Salesforce dotcom. In this Model, the user purchases services to use the applications which is completely designed maintained and hosted by the provider and hosted on the Cloud[4]

• Platform as a Service (PaaS) — in this service models, the users manage the applications and data and only request the infrastructure and platform that is maintained by the provider over the cloud. The Consumer is responsible for building and maintaining their application and data while the providers take care of network and platforms, however, there may be limitations on the requirements that are available on such a setup

• Infrastructure as a Service (IaaS) — Users are responsible for maintaining the application, data, security, services, and operating system while the physical servers, network and storage zones are provided over the cloud. Lot of limitations may come into play to find the right configuration the users would need for this service model.

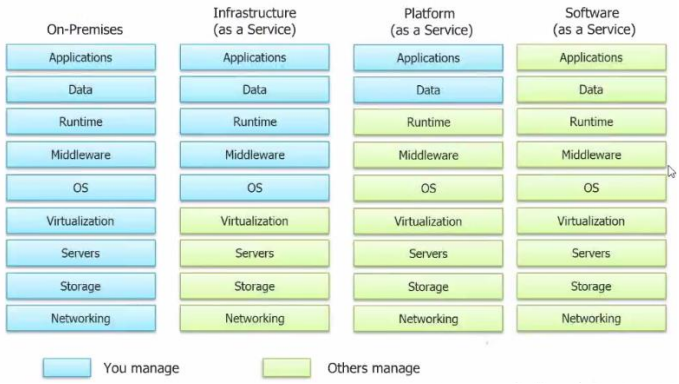

Figure 2. Cloud Computing and different Models in which services can be deployed [3]

1.3 Deployment Models

Based on the Consumers requirements the Cloud solution can be setup in 4 different models, the setup have different characteristics based on the user requirements and can be deployed. A Consumer may choose different deployment model for different business needs.

•Private Cloud — A private operation that in operated and maintained either with a secured third part or on own premises. The cloud infrastructure is operated and maintained privately.

• Community Cloud — this is the cheapest deployment model and used by companies when the information shared is nonpublic and non-critical in nature. This shared by many customers with similar intents and requirements form the community cloud. For example, healthcare and health provider networks. Security can be customized as per the user needs.

• Public Cloud — in this cloud deployment the infrastructure is available to the public on a commercial basis by a provider and accessed via internet. Examples like email services, drop box. The parent companies and consumers maintain these use, develop and deploy over them as per their needs.

• Hybrid Cloud — the infrastructure contains different clouds in multiple combinations, but they have the capability through their middleware to connect data and/or applications, which allow them to be moved from

one application to another. Usually a combination of private, public clouds. The combination helps keep the

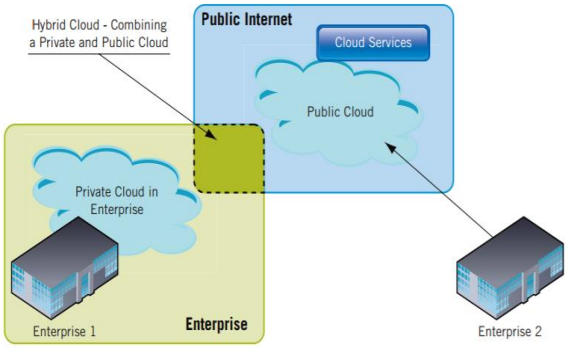

Figure 3. Cloud Computing Deployment Models [5]

data and other such services private and make the most use of services offered over the public setup.

II. LITERATURE REVIEW

2.Routing Algorithms and Protocols for Cloud Computing

There are multiple protocols that can be efficiently used for routing over a cloud environment; we discuss few such routing protocols below:

a. Proactive
b. Reactive
c. Hybrid

There are no one solution for all when it comes to routing, a lot of thought needs to go in what kind of a

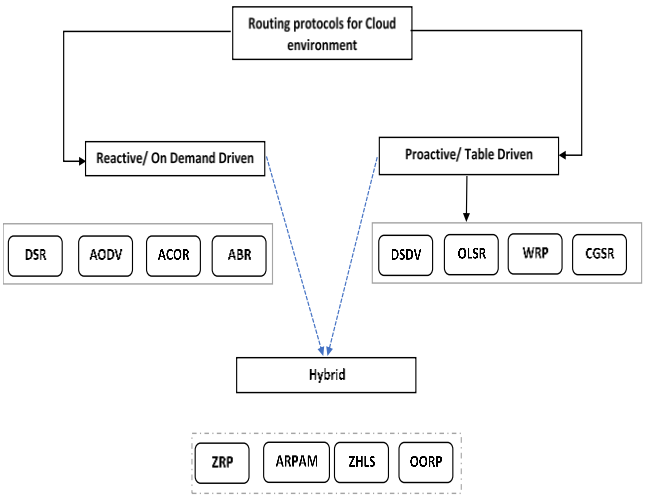

Figure 4. Routing Protocols for Cloud [6]

network is getting set up and how is it going to be used based multiple factor one can decide what is the best routing protocol that can fulfill the needs of its cloud environment. Let us see the examples of these protocols.

2.1 Proactive Protocols

These protocols maintain the information in a format or routing tables, such details are maintained by each node, which make sure it gathers and stores any change that may have occurred in the network, thus a continues process of evaluation is initiated. This keeps the protocol up to date on the path it would require in case of data transmission, though maintaining the information is an overhead but once the tables are updated it provides better performance when transmitting the packets as the path and route to take are already known.

A. Dynamic destination – Sequenced distance vector(DSDV)

This Protocol requires that the information of any change in topology be updated to its next node thus it contantly updates its tables and keep the information about all the network nodes up to date. Since this is a table driven protocol the info is constantly gather and stored as to how many hops would be required for a packet to be transfered to the next node, or changes that may have occurred in the network. To collect this info, it contantly pushes by distributing request at regular interval for information.[7]

Some of the advantages of DSDV are faster and efficient transmittion of packets, since information regarding all nodes is already available in the table and Routing information is avaialble all the time as any change to the network gets updated and the routing table stay up to date. On the other hand the main disadvantages of this approach is that it is not effiecient for Large networks, as gathering all information may become overhead,uses to much bandwidth and Since the tables are constantly updated, the routing path for protocol gets pre defined, thus making alternatives unavailable.

B. Optimized Link State Routing (OLSR):

The Optimized Link State Routing Protocol (OLSR) is is a protocol that can effectively work on different networks. OLSR is a proactive link-state routing protocol, that works on IP routing, instead of using all the connections, it tries to utilize only a small set, this helps reduce flooding as only a selected set of nodes join in transmission. The protocol is based on two primary concepts, one detecting its neighbor and selecting a set

of nodes that will be used for transferring packets, this avoids flooding of the network and provides the shortest path using which the information can be relayed [8]

One of the benefit of using this protocol is the that it selects a sub set of nodes call, as multipoint relay selection for transmission, this helps avoid flooding of the network. Since not all the nodes are used, it also helps manage energy efficiently and help transfer data with minimum hops. However, this puts a lot of strain in to maintaining the information on routing specific data is required. Also, it would require lot of time to reconstruct a broken link. Thus, it is more time consuming to discover an alternate path since it does not store information of all the nodes.

C. Wireless Routing protocol (WRP)

Wireless routing protocol belongs to a class of path-finding protocols; it is usually required for WRP to maintain four different tables at each node

1. Distance table
2. Routing table
3. Link-cost table, and
4. Message retransmission list table

One of the best feature of the protocol is that it helps avoid looping by using serialization, and each node can itself monitor whether it needs to update its tables based on information from its neighbor nodes. [9]

Some of the advantages of WRP are that it resolves the Count to infinity issue, as the shortest path are computed within limited time. Thus, provided routing are loop free and in case of Link failure, it only needs to update its neighboring node, thus reducing the updates. On the other end, the disadvantages of WRP are that it needs Four tables to be maintained. It is not scalable on large networks and the messages transmitted are usually big.

2.2 Reactive Protocols

Since these protocols are based on On-Demand and the network routes are set only when the packet needs to be transmitted, it makes them energy efficient and puts the network to better utilization, it helps routing overhead and continuous updating process thus making them efficient, the network usually is in sleep mode if no data is required to be transmitted, Since the routes are created when requested the information of routes are note required to be stored. The network is overflown with request when required and the data is transmitted, the process required the protocol to discover a path between source and destination. Some of the examples of Reactive routing protocols are discussed in details below

A. Ad hoc On-demand Distance Vector (AODV)

In AODV, is an on-demand routing protocol which sets up the connection between source and destination nodes when a request to transmit packets is received between them. The protocol is sits idle and conserver power until a connection is requested. When a request for routing is received the network node from where the information is to be transmitted, broadcasts a request for connection. The neighboring nodes receive the request and start flooding the network by sending a route request, if a neighbor node receives this request it prompts with a reply, in case of a response from a destination node the neighboring nodes keep track of its IP address, and initiates the transfer, if the message is transmitted successfully, the request gets junked, In case of failure an error is triggered and the process gets reinitiated. Nodes use sequence numbers in request that do not repeat. [10]

Pros of AODV is that Connection are established based on the request, On-demand. Also the protocol can quickly response to a changes in a network, making it adaptive to failures. However, too much time is required for processing. Large amount of congestion is created in case of link drop and too much time is spent building the routing tables.

B. Dynamic Source Routing Protocol DSR

DSR is another example of reactive protocol, however the protocol relies on two processes to setup routing in the network.

1. Route Discovery
2. Route maintenance

Usually the process of finding if destination exist and if it does what path needs to be traversed is defined as route discovery, in case such a destination does note exit then the requests for path are sent out to the nodes till it reaches the destination, where the information of the path is captured and stored for the next request. Route maintenance is responsible for notifying any failures while transmitting, it helps in detecting failures early and take the necessary action. [11]

Advantages of DSR protocol is that it reduces overhead by establishing routes only between the communication points. Alternate routing paths are also discovered with the request. And it becomes fast and easy to use alternative routes in case of failures. The design handles

lot of flaws as it is not appropriate for large networks. As the size grows with the length. And network may get flooded as the request for routes may be received by all nodes in the network.

C. Associativity Based routing (ABR)

ABR is similar in many ways to the DSR protocol but introduces few variations, one is that the route request data carries information regarding the path the request has traveled and the number of beacon for the path it has taken. When the target receives the request, it waits to receive more requests, and it is the destination that picks the path it wants to receive the data based on stable links available and shortest path the information can be delivered, this is known as "degrees of association stability", it may get tough to route when the networks are huge as it will add more complexity.

ABR routing presents with stable, loop free paths for routing. There are multiple paths available and choice is based on most stable link. Routing Paths are longlived.
It also faces issues as delays may be encountered due to broadcasts. Since it prefers more stable path for transmission, it does not necessarily be the shortest path.

2.3 Hybrid Protocol

Adding the best of Proactive and Reactive protocols, creates a new category of Hybrid protocols which have benefits of both the protocols and sometimes even the flaws of both, Routing typically gets initiated proactively and then is completed based on demand or reactively. They are effective on large networks as the concept of zones are introduced and packets are transferred within the zones and outside the zones.

We will discuss couple of hybrid protocols in the paper further to understand the how these are configured

A. Zone Routing Protocol (ZRP)

ZRP combines the features of table driven protocols and on demand protocol, each node forms a concept of zone, in which if the routing needs to happen it takes place like that of Table driven protocols, however at the same time the nodes do not maintain the global information of all nodes reducing the overhead, if the communication needs to happen between two zones, the protocol uses the on-demand features of reactive protocols are used. It has two sub protocols.

1. IARP or intra zone routing
2. IERP or Inter zone routing

Since the IARP maintains the table in case the communication needs to happen within a zone, it is almost immediate. [12, 13]

Its advantages are faster transfer in case the source and destinations are in intra zones. And is at disadvantage in case more number of nodes are activated, it is hard to be efficient. Response to request depends on the amount of traffic flowing through the network.

B. Zone Based Hierarchical Link State routing protocol (ZHLS)

ZHLS [15] is a hybrid routing protocol based on hierarchical peer to peer routing. In this protocol, the network is divided into multiple zones, no two zones coincide with each other. The Protocol maintains two tables, one for the network inside the zone know as intra zone routing table and other for information on all the zones known as inter zone routing table. Inside a zone, it uses the algorithms of proactive protocols. Each node has a zone ID and node ID which is used by the source to request information from destination and updated in the table, which are used to relay information. Each node transmits its Link state data in regular intervals, this updates table information at node level as well as at zone level. The transfer will use inter zone routing table info till it reaches the zone in which destination node is present, once it reaches here it will use the intra zone routing table information to forward the data packet.

Benefit of ZHLS is that Zones created do not intersect, thus help reduce overhead, also it helps reduce energy utilization, since not all nodes in every zone are in use, also in case of failure there are multiple alternate routes that can be used. However too much efforts goes into creating and maintaining the zones which is the main drawback of the system.

III. COMPARATIVE ANALYSIS TABLE

The below table is a comparison between various Cloud routing protocols on various parameters

Protocols ↓	Classification	Scalability	Power Usage	Volume	Mobility	N/W Overhead	Multi casting	Loop Free	Multiple Routes	Real Time
DSDV	Proactive	Poor	High	High	Limited	Maximum	No	Yes	No	Yes
OLSR	Proactive	Poor	High	High	Fixed	Moderate	No	Yes	No	No
WRP	Proactive	Limited	High	High	Possible	Moderate	No	Yes	Yes	Yes
AODV	Reactive	Limited	Low	Medium	Limited	Moderate	Yes	Yes	No	No
DSR	Reactive	Poor	Low	Medium	Limited	Moderate	No	Yes	Yes	No
ABR	Reactive	High	Low	Medium	Limited	Minimum	No	Yes	No	Yes
ZRP	Hybrid	High	Medium	Low	Possible	Moderate	No	Yes	Yes	Yes
ZHLS	Hybrid	High	Medium	High	Possible	Minimum	Yes	Yes	Yes	No

Table1.Comparison between various routing protocols for Cloud Systems

DSDV - Dynamic destination – Sequenced distance vector, OLSR - Optimized Link State Routing, WRP – Wireless Routing protocol, AODV - Ad hoc On-demand Distance Vector, DSR - Dynamic Source Routing Protocol, ABR – Associativity based routing protocol, ZRP – Zone routing protocol, ZHLS – Zone Based Hierarchical Link State routing protocol

IV. FUTURE WORK

Internet as of today itself is huge in many parameters, imagine having a network of Data centers routing information within themselves. Hosted on the internet or as we like to call it is cloud. The new vision of routing protocols should be able to handle such a vast and complicated network topology and would require routing protocols to be Autonomous; in fact, the very properties of cloud like adaptable, flexible, and scalable and many more should get encapsulated in the future protocols. Here are few such protocols being discussed.

PGBR (parameterized gradient based routing)
PGBR is based on the Bio-inspired algorithm of its parent PGBR routing protocol, which simulates a behavior of an organism which tries to work its way towards its target by sniffing and taking its environment into consideration.

In [14] analyzed that based on their results it is hard to scale the PGBR discovery mechanism which would be the primary requirement of the Cloud and by changing how the nodes calculate number of hops required to transmit a data over. The protocol uses the behavior of an organism like bacteria to look out the destination as it would look for food and make decisions based on its environment to decided which route to take.

Some of the benefits that can be laid out for PGBR are that the protocol displays faster route finding over a complex network topology. Multiple routing path are available which can adjust as per the need of the user. However, the routing algorithm may get complex with increased complexity in the network.

V. CONCLUSSION

Routing protocols introduced in our discussions are some of the many that are in use in the todays network. however, research on routing protocols for cloud is still a developing area. Multiple challenges present with regards to technologies, deployment, and many other concerns. Also defining standards in this area are a work in progress, but there is clear value in cloud computing as a solution for several IT requirements. In addition, it is important to have better efficient and secured routing protocols for cloud. Further research should direct and undertake studies in new fields of routing protocols with various factors such as mobility, security, performance, and efficient handling of resources in to consideration. The Bio-inspired algorithms like PGBR show much promise over its capability to be able to handle the complex network routing and topology and may need more work on them, however the lab results and experiments around them have shown outstanding results and may very well be the future of routing protocols for cloud systems.

VI. REFERENCES

[1] IBM Cloud," IBM, 17-Oct-2016. [Online]. Available:https://www.ibm.com/cloud-computing/learn-more/what-is-cloud-computing/. [Accessed: 21-Jul-2017]

[2] L. Wang, GregorLaszewski, Marcel Kunze, Jie Tao, ―Cloud Computing: A Perspective Study‖, New Generation ComputingAdvances of Distributed Information Processing, pp. 137-146, vol. 28, no. 2, 2008.

[3] G. D. Libero, "Cloud Computing Archives," Marketing Technology Brief. [Online]. Available: http://www.marketingtechnologybrief.com/tag/cloud-computing/. [Accessed: 21-Jul-2017].

[4] W. Voorsluys, J. Broberg, and R. Buyya, "Introduction to cloud computing," Cloud Computing, pp. 1-41, 2011.

[5]2017.[Online].Available: https://www.dialogic.com/~/media/products/docs/whitepapers/12023-cloud-computing-wp.pdf. [Accessed: 21-Jul- 2017].

[6] International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 5, May 2015

[7] G. Jose Moses, D. Sunil Kumar Prof.P. Suresh Varma N. Supriya, "A Simulation Based Study of AODV, DSR, DSDV Routing Protocols in MANET Using NS-2", in International Journal of Advanced Research in Computer Science and Software Engineering Volume 2, Issue 3, March 2012; Publication Year: 2012.

[8]A. Khapre and U. Lilhore, "MET OLSR – An Energy Effective OLSR based Routing Protocol", International Journal of Computer Applications, vol. 146, no. 13, pp.

1-4, 2016.

[9] M Subramanya Bhat, D Shwetha, T Devaraju J.; "A Performance Study of Proactive, Reactive and Hybrid Routing Protocols using Qualnet Simulator," International Journal of Computer Application, vol. 28, no. 5, August 2011

[10] G. RAJKUMAR, DR. K. DURAISAMY, "A Review of Ad Hoc On-Demand Distance Vector Routing Protocol for Mobile Ad Hoc Networks", in Journal of Theoretical and Applied Information Technology, Vol. 36 No.1, 15th February 2012, Publication Year: 2012.

[11]V.RAJESHKUMAR,P.SIVAKUMAR, "Comparative Study of AODV, DSDV and DSR Routing Protocols in MANET Using Network Simulator-2", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 12, December 2013; Publication Year: 2013.

[12] Nidhi Rani, Sonal Rana, "Energy Efficient Zone Routing Protocol" , International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 10, October 2015

[13] Nicklas Beijar, "Zone Routing Protocol (ZRP)", Networking Laboratory, Helsinki University of Technology, Vol. 2, Issue 8, December 2013; Publication Year: 2013.

[14] S. Balasubramaniam, J. Mineraud, P. Mcdonagh, P. Perry, L. Murphy, W. Donnelly, and D. Botvich. An Evaluation of Parameterized Gradient Based Routing with QoE Monitoring for Multiple IPTV Providers. IEEE Transactions on Broadcasting, 57(2):183–194, 2011.

[15] Guntash Kaur, Harpreet Kaur, "Flooding Control in ZHLS Hybrid Routing Protocol using MANET in OPNET", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 6 Issue 5, May 2016