Journal of Education for Pure Science- University of Thi-Qar
Vol.10, No.1 (March., 2020)
Website: jceps.utq.edu.iq Email: jceps@eps.utq.edu.iq

DOI: http://doi.org/10.32792/utq.jceps.10.01.022

An Efficient Scheme for Fault Tolerance in Cloud Environment

Intisar Neamah Manea[1], Dr. Khaldun. I.Arif[2]

[1] Computer Science Department, College of Technical Thi-Qar, Southern Technical University, Thi -Qar, Iraq
[2] Computer Science Department, College of Education for Pure Science, University of Thi-Qar,

Received 2/8/2019 Accepted 24/10/2019 Published 20/1/2020

Abstract:
A DCell network topology is designed to support infrastructure data center, and operations routing, and decision-making are a challenge for network designers routing the data packet from the source node to the target node, and selecting the shortest path. In this paper propose a new algorithm to address failures (Node, Link, Rack) The algorithm has three parts, part one: using the routing resolution to address link failure, selecting the average number of random paths for the server and selecting the shortest alternative path (time), delay, and throughput. To find out the adjacent nodes we use point to point. Part two: Handling Node Failure by finding the shortest two paths (disjoint). After reverting to the previous node, routing, checking and jumping to the alternate path protocol. Part Three: Addressing Rack Failure an alternative path is chosen for the same node level from the failed Rack1 to another Rack2 shortest path. When comparing the proposed algorithm with the algorithms used, it has excelled (transmission efficiency, high throughput, less time, less delay, bandwidth 100Mbps, fault tolerance).

Keywords: Network Topology, Fault Tolerance, Throughput, Delay, Total Time.

1. Introduction

The **D**ata **C**ell (DCell) network architecture was designed in 2008, to support the **D**ata **C**enter **N**etwork (**DCN**) and data center structures, where it has the scalability needed to support Google and Microsoft companies, the goal of network design. First, the network infrastructure is scalable and scalable for a large number of servers. Second: a fault-tolerant network in case of failure (Node, Link, Rack). Third: It has the ability to provide network capacity, high bandwidth. [1]

A distinctive feature of the DCell network is its one-level iterative structure, consisting of five modules, each containing four servers connected to an adapter. It is called a shelf, as shown in Figure 1. [2]

Most network problems talked about failures (Node, Link, Rack), and finding an alternative route when needed, in order to avoid failure, and to get the data packet to its destination, without data loss, using routing, local, decentralized, and control protocols. For the purpose of routing the packet to the destination

[3]. Dell nature supports high network capacity. In DCell, traffic distribution is equal to servers and links on the server, a partial type communication method [4].

The proposed algorithm made the network work transparently by addressing all failures, and there is no failure rate, and the ability of the algorithm to deliver the data packet to its destination without loss of data, when comparing the proposed algorithm with the algorithms used, it is superior to increasing Throughput and decreasing delay, with a nappy on transmission efficiency 100 Mbps.

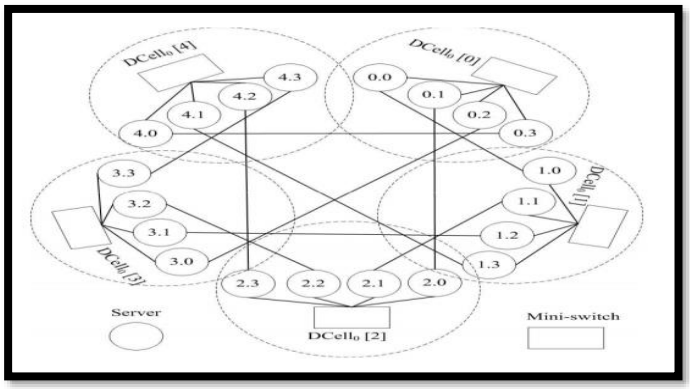


Figure 1: A DCell network

2. Methodology:

Propose an algorithm capable of handling failures within a DCell network, using the routing multipath protocol, Enhanced **I**nterior Gateway **R**outing **P**rotocol (**EIGRP**) that routing, check, and jump the alternative path in the event of a shorter path failure while maintaining transmission efficiency.

2.1 DCell Network Routing:

Routing network a DCell, based **D**ata **C**enter **N**etwork(**DCN**) cannot use a global Link State, Routing scheme DCell's goal is to interconnect up to millions of servers. The hierarchical **O**pen **S**hortest **P**ath **F**irst (**OSPF**), since it needs a backbone area to interconnect all the other areas. This creates both bandwidth bottleneck and single point failure. [4]. In this paper, we propose the EIGRP routing protocol for DCell network fault-tolerant routing, Is The most common these days, because it is a multi-path routing works on routers and switches, dynamic type works on various types of networks with high efficiency, and has several labels, including hybrid or mixed, can handle failures (Node, Link, Rack) [5].

2.2 Fault tolerance in DCell:

Is a mechanism to recover from the problems of failure within the network, due to the problem of devices and power outages, where there are many problems link and switches, servers and devices, as a result of the growth in the size of the network, the failure of servers, switches and Rack is a standard and not an exception, so require fault tolerance for DCell network. Recovering from failure when the basic path failure occurs, and finding many alternative routes for the purpose of continuing the work. The goal of using multi-path routing in the network is to avoid detection and preserve backup paths, better than single routing, because it leads to a failure to run an expensive mechanism such as flooding [6].

2.3 Dijkstra Algorithm:

Many network designers tried to write many algorithms, with the Dutch computer scientist (Edsger Dijkstra) finding the shortest route between the source node and a group of network nodes and reaching the destination node. As illustrated in Table 1, the main concept in writing the shortest path algorithm is to draw an unguided, weighted diagram, simulating network problems, and working on simple and uncomplicated solutions, provided that the data packet reaches its destination without data loss [7].

Notation	The Description
G	Undirected graph
V	Group of network nodes
E	Group of bidirectional links
vi-1,vi	Source node vi-1,target node vi
P(vi-1,vi)	Group of paths from node vi-1to vi
W(T)	The weight of the path, dependent on time
a(u ,v)	The amount of packet transfer from node u to node v
W(P)	Weight path
Min {w(p): u →v	If there exists a path from u to v
∞	In the absence of a path between two points will be worth infinitely
	Let a (u, v) ∈ E.
	Let a (u, v) = a (v, u), (u, v) ∈ E.
	And all the nodes of the chart are executed by the following equation:

$$W(T) = W(P) = \sum_{i-1}^{k} W(vi\text{-}1 , vi)$$

Calculate the shortest paths through the following equation

$$\delta(u ,v) = \begin{cases} \text{Min}\{w(T): u \rightarrow v\} \\ \infty \end{cases}$$

3. The Proposed Methods:

This section outlines proposed methods, where DCell network simulation is built using NS-3 simulation, and work is performed within the Cloud emulator environment. To resolve failure issues (Link, Node, Rack), choose the best (minimum time) path for the DCell network. The proposed design that has been added to the DCell network architecture is to add a router for each unit in the network, bringing the number of network nodes to 30 nodes, which means that each module, representing four servers connected to a small adapter connected to the router. Based on the proposed algorithm (DRMPRE), all network problems have been resolved, with high reliability in delivering data packets to the target, DCell network's ability to withstand errors, as well as relieve congestion.

3.1 Proposed Algorithm(DRMPRE):

DCell **R**outing **M**ulti**P**ath **E**nhanced (**DRMPE**), is a multi-path routing protocol, mechanical, internal, working on the DCell network layer, the nature of the proposed protocol, according to algorithms similar to EIGRP protocol, dynamic, hybrid, based on the distance vector algorithm, and link state algorithm. But it varies in terms of content.The proposed protocol, dealing with the entire network once, where the

network is examined and determine the shortest path based on the minimum time, for each node within the network, and stored in the routing table, and when sending the data packet, it is over the optimal path, and the protocol selects more than A backup path, an alternative to the original failed path, in case of failure of (Link, Node, Rack), and The information is saved in the topology table, the goal of this method is to redu**ce** the time and cost, In failures (node ,link ,Rack), . As shown in Figure (2)

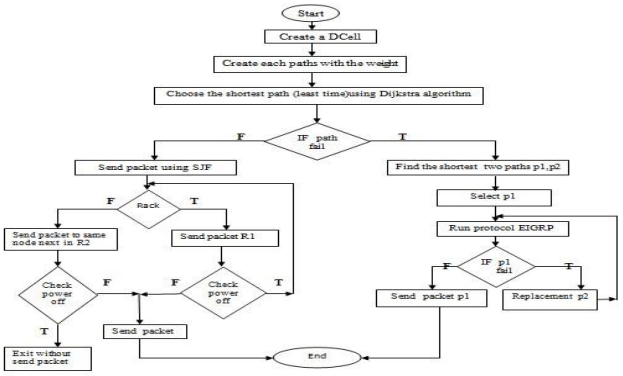


Figure 2: Algorithm(DRMPRE)

3.2 Method 1: DCell 6Paths:

When Link fails, in the multipath routing more than one path is chosen, instead of the failed path, the average number of paths for the server is randomly selected, and the shortest path is chosen instead of the failed path, using an Dijkstra Algorithm. As shown in the table (2)

Table 2: multipath from source node to destination node using Shortest path algorithm

Source	Destination	No- Path	Path
0	18	0	(0 1)
		1	(1 5)
		5	(5 14 16 21 27 28)
		8	(8 19)
		9	(9 19)
		14	(14 22 26)
		16	(16 9 28)
		19	(19 18)
		21	(21 19)
		22	(22 19)
		26	(26 19)
		27	(27 8)
		28	(28 19)

3.3 Method 2: DCell Node:

The problem of node failure is more complex, because node failure means the loss of all links, solving this problem, is to go back to the previous node and choose the shortest two paths disjoin. The goal of this method, is to reduce the time and cost.

Algorithm to Find Two Shortest Paths Disjoint

Input: Source, Destination, p0
Output: p1, p1

Step1: Specify the source node and the destination node
Step2: Select the node that precedes the failed node
Srep3: Find two shortest paths (disjoin)
Step4: Select first path
Step 5: Run Protocol
Step6: IF Failure
Step7: False: Send packet, go to step 10
Step8: True: Replacement Path2
Step9: Go to step 5
Step10: End

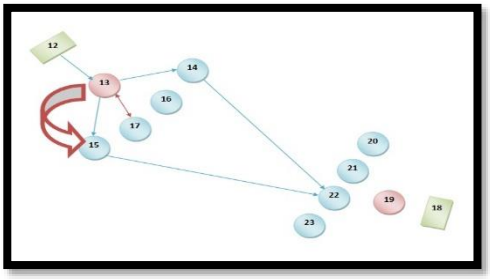


Figure 3: Shortest Paths Disjoint in DCell

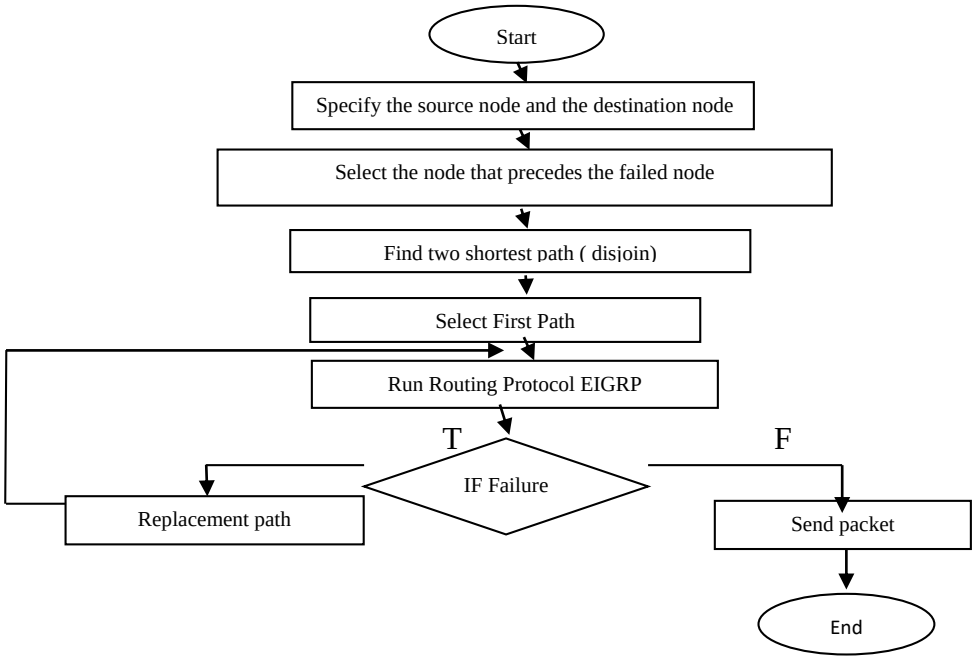


Figure 4: Shortest Path Disjoint Algorithm

3.4 Method 3: DCell Rack:

The proposed development method addresses the failure of the rack, when the power is off the rack, leads to the disconnection of part of the entire network, because the failure of the rack leads to the failure of

four servers connected to a switch connected to the router all, and to address this situation, find the shortest path on the same node level to reach Rack Another, this method has made the system work with transparency and without interruption of the system from working. Figure (5) illustrates the operation of the network.

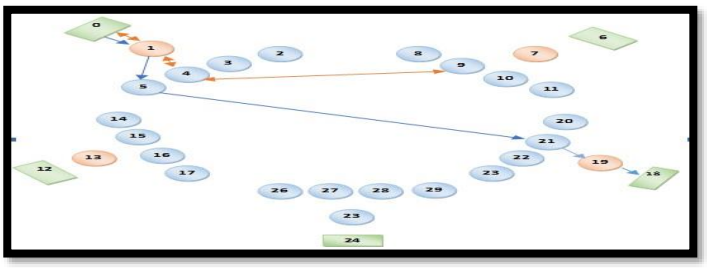


Figure 5: DCell Rack

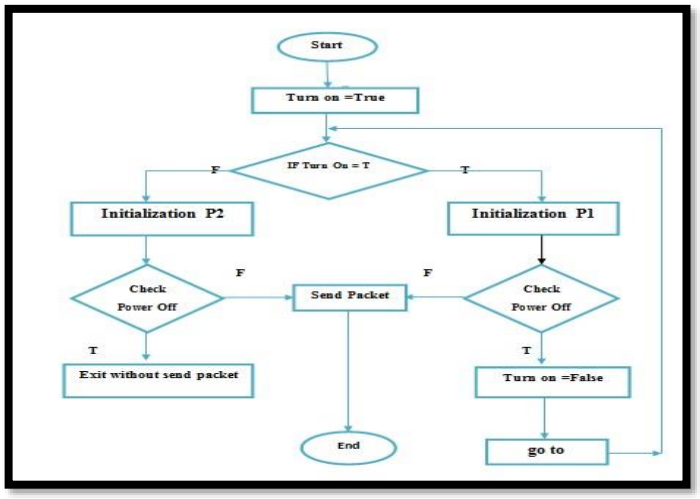


Figure 6: Rack Algorithm

Rack Algorithm
Input: Source, Destination, Graph
Output: p1**,** P2
Step 1: Turn on: Check the path and give it True value.
Step 2: Is the operator a True value.
Step 3: Yes: Initialization P1, go to step 5.
Step 4: No: Initialization P2, go to step 9.
Step 5: Check path p1, Is Power Off.
Step 6: No: Send packet, go to step 12.
Step 7: Yes: Turn on false value.
Step 8: Go to step 2.
Step 9: Check path p2, Is Power Off.
Step10: No: Send packet, go to step 12.
Step11: Yes: Stop sending data packet, due to system failure.
Step 12: End.

4. Results:

This section includes the results of the proposed algorithm, which addresses failures (Node, Link, Rack) within the DCell network. Through three tests of that layer on the network, DCell confirmed that it is a fault-tolerant network, capable of avoiding breakdowns by finding the shortest route, using a multi-route routing protocol. To avoid network failures, the aim of this method is to find more than one alternative path to the failed path, based on metrics (less time and low delay with high throughput in all cases).

4.1 Experiment 1:

In this experiment in case of link failure. Choose the average path number for the ore at random, and choose the shortest path.

Total Time (Path) is the time it takes for a data packet to reach its destination

(T. T = t1+t2+t3….tn), **t** is the weight of the node, T.**T** is the Total Time.

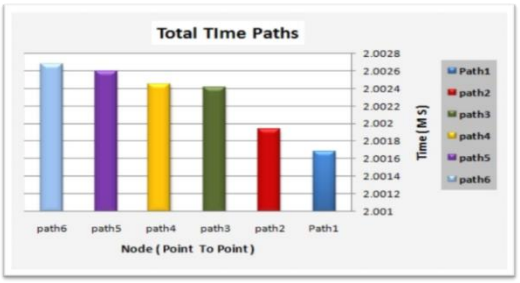
Delay is the difference between contract weights, for each packet reached its destination (D=d2 –d1)

D is the Delay; d is the weight node.

Throughput is how much data actually does travel through the channel successfully.

Table 3: Determine the total time and delay of 6 Path in the DCell network

Metric	Path1	Path2	Path3	Path4	Path5	Path6
Total Time(MS)	0.83276	0.96293	1.39293	1.36293	1.58293	1.57295
Delay (MS)	0.00509	0.03009	0.06009	0.12009	0.07009	0.04011
Throughput (Mbps)	1400	1260	1320	1110	1360	1350



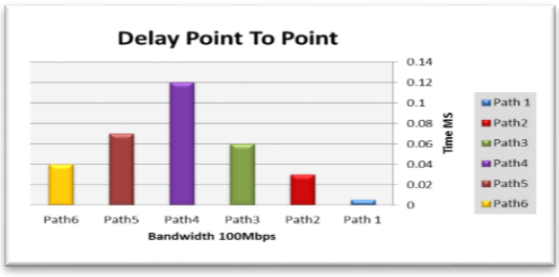


Figure 7: Total Time of Paths in the DCell Network **Figure 8: Delay (point to point) of DCell network paths**

4.2 Experiment 2:

In case of node failure, it is more difficult, because failure of the node means cutting all links, with other nodes, refer to the previous node, choose the shortest two paths, the goal of the proposed method, reduce the cost and time, jump operation and choose the alternative path and examine the path using the protocol Suggestion.

Table 4: Determine the total time and delay of Shortest Path (Disjoint) in the DCell network

Metric	Failed shortest path1	Path2	Path3
Total Time(MS)	0.03217	0.63234	0.74234
Delay (MS)	0.015	0.30009	0.35009
Throughput (Mbps)	380	1030	1080

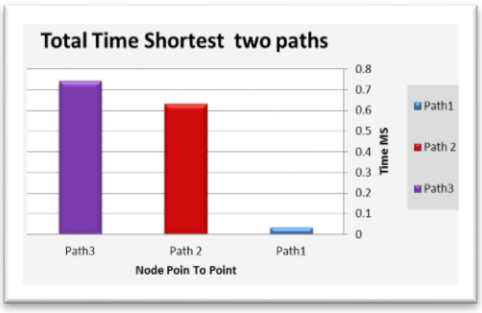


Figure 9: Total Time to the shortest two paths

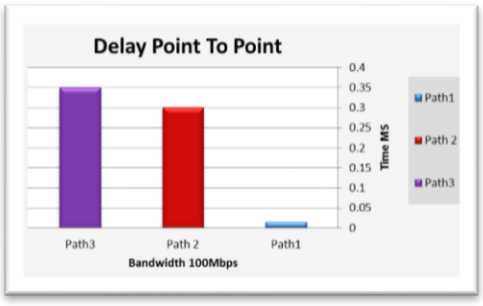


Figure 10: Total Time to the shortest two paths

4.3 Experiment 3:

If the Rack fails, the shortest path to the same node level is chosen from Rack1 to Rack2

Table 5: Determine the total time and delay of Rack in the DCell network

Metric	Failure Rack1	Rack2
Total Time(MS)	0.02526	0.04576
Delay (MS)	0.005	0.00509
Throughput (Mbps)	740	1340

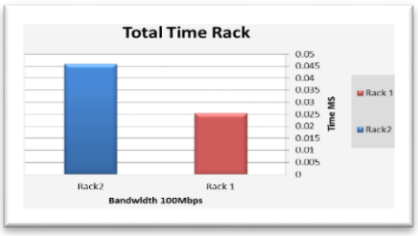


Figure 11: Total Time Rack in DCell Network

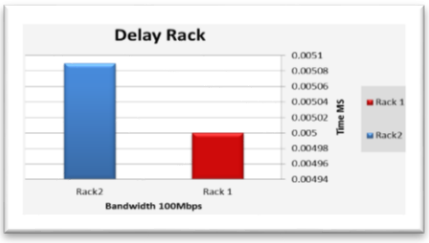


Figure 12: Delay Rack in DCell Network

5. Conclusions:

1. The proposed method has excelled in terms of high Throughput (1400 Mbps) when compared with the proposed methods.
2. The results of the implementation of the proposed methods, which were implemented on the network, by sending packets of data from the source node to their destination, the total time was less as possible (0.83276 MS), as well as, less delay (0.00509 MS).
3. The method of handling the failure of the carrier, when the power failure, which has not been pre-treated, where the shortest alternative route is found, is to transmit data packets in the shortest possible time (0.04576 MS), making network operates transparently.

Determine the shortest route and alternate route based on minimum time and low delay. These factors, identifying adjacent nodes, and sending the packet from one node to another, where the contract switches the transport policy for the alternate route. This is a way to avoid congestion and decide to direct Online, with the network's ability to tolerate The algorithms used were controllers to avoid congestion depending on the computer and not the actual application.

6. The Comparison:

When comparing the proposed algorithm (DRMPE) with the algorithms used (CS244)]8], (TCP ex Machina) [9]. It has excelled efficiently and improved performance, with high Throughput, less time and less delay, as well as maintaining transmission efficiency, and the comparison is shown in Table (6).

Table 6: Comparison between the results of the proposed algorithm with the algorithms used

Algorithm	Throughput Link Mbps	Total Time Link	Total Time Rack	Delay Time Link	Bandwidth Mbps	Cost
Proposed	1400	0.83276 Millie Second	0.04576 Millie Second	0.00509 Millie Second	100	Low
CS244	900	14 Second	No	Not mentioned	100	High
TCP ex Machina	1100,1300, 1700	Not mentioned	No	1.4, 1.7, 3.8 Millie Second	10,100,1000	High

6. Implementation:

Many programs, including cloud simulations, were implemented for the purpose of building a DCell network, but, did not give the desired result, because the cloud does not directly support the construction of networks, so, the work was on simulators, the network was built and simulated, and the decision-making decision, within the NS- 3, the implementation of process methods, within the cloud simulation, is an environment or editor to implement methods, emulators have been implemented within VMware, the network contains 20 hosts, each host contains a number of VM, exists in the data center.

6. REFERENCES:

[1] Guo, C. Wu, H., Tan, K., Shi, L., Zhang, Y., Lu, S. " DCell: a scalable and fault-tolerant network structure for data centers". ACM SIGCOMM Comput. Commun. Rev. **38**(4), 75–86 (2008)

[2] Yang Liu, Jogesh K. Muppala, Senior Member, et al " A Survey of Data Center Network Architectures" Spring erBriefs in Computer Science,2013.

[3] Ali Hammadi, Lotfi Mhamdi "A Survey on the architectures and energy efficiency in data center networks" Computer Communications 40 (2014) 1–21, Dar AL NASHER Elsevier.

[4] J. Moy. OSPF Version 2, April 1998. RFC 2328.

[5] Retana, Alvaro E., Russell I. White, and Yi Yang. "Method and apparatus to enable an IPex domain through EIGRP." U.S. Patent No. 7,940,668. 10 May 2011.

[6] Yang Liu, Jogesh K, Muppala Malathi, Mounir Hamdi and Dong Lin "Data Center Networks Topologies, Architectures and Fault-Tolerance Characteristics" Springer Science & Business Media, 2013.

[7] Hind. R. Mohammed and Abbas.H. Hassan "Fundamentals of Analysis and Design of Computer Algorithm" Book First Edition 2017, University of Kufa, Najaf, Iraq.

[8] Saachi Jain and Mitchell Dumovic" CS244 '17: Dcell: A Scalable and Fault-Tolerant Network Structure for Data Centers" June 5, 2017,General internet
[9] Jeffrey Pyke and Parth Shah "Reproducing TCP ex Machina: computer –Generated Congestion Control"15-July 2018, General internet.