Original Research Article

Comparative Algorithm for Energy Consumption of Component base Distributed Computing in 5G Networks

Abstract: In the present scenario, the wire network or wireless networks is the application across the world. So the wire networks used in various software industries, educational institutions and various enterprises used such as distributed data centers. During the data transmission works like a flow of electricity in linear way. So in this process during the data transmission exhibits from one stage to another the energy consumption in carbon footprint (i.e. CO_2). The data transmission is two types of methods (1) Communication Based (2) Component Based. Here in this paper concludes the compared study of component based energy consumption using Bellman-Ford Algorithm and Dijkstra's Algorithm. The results and finding measurement as discussed in this paper.

Keywords: *Energy Optimization, Bellman-Ford Algorithm, Distributed Computing Networks, Bellman- Ford Time Complexity, Energy Consumption, Dijkstra's Algorithm Time Complexity.*

1. Introduction

A distributed system is a collection of independent computers that appears to its users as a single connected system. Distributed computing network this deals with determining how packets will be routed (flow) from source to destination. It can be of three types: Static: Routes are based on static tables that are "wired into" the network and are rarely changed. Dynamic: All packets of one application can follow different routes depending upon the topology of the network, the shortest path and the current network load. Semi-Dynamic: A route is selected from start of each communication and then all the packets of the application follow the same route from source.

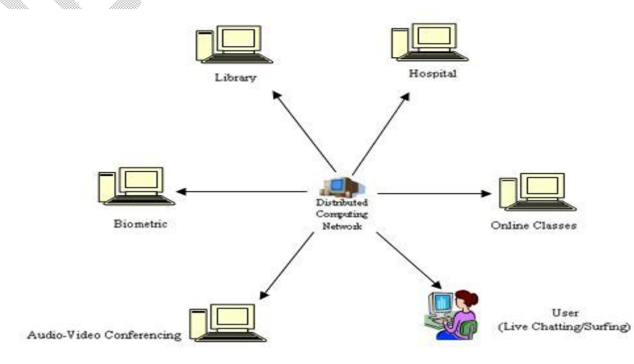


Figure 1. Distributed Computing Network

Power-aware and energy-aware systems are those where power or energy consumption is a principal design consideration. For example, power-aware systems may utilize techniques to change the system's behavior based on the amount of power being consumed. Energy-aware systems may modify the operation of the system based the amount of energy in components.

The distributed computing depended components based. There are various techniques to find the energy. The routing algorithm is based on single source.

Distributed computing is a much broader technology that has been around for more than three decades now. Simply stated, distributed computing is computing over distributed autonomous computers that communicate only over a network (Figure1). Distributed computing systems are usually treated differently from parallel computing systems or shared-memory systems, where multiple computers share a common memory pool that is used for communication between the processors. Distributed memory systems use multiple computers to solve a common problem, with computation distributed among the connected computers (nodes) and using message-passing to communicate between the nodes. For example, grid computing, studied in the previous section, is a form of distributed computing where the nodes may belong to different administrative domains. Another example is the network-based storage virtualization solution described in an earlier section the use distributed computing between data with metadata servers.

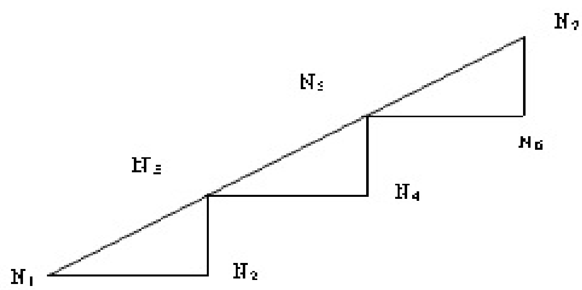


Figure.2 Step Network Topology

2. Literature Review

Biswas et al. [1] found the energy consumption of the well-known Chandy/Misra/Bryant and YAWNS synchronization algorithms. Distributed simulation algorithms require a significant amount. They described the Energy consumption of synchronization algorithms in distributed simulations. Jafari et al. [2] proposed the method of OPTICS density-based clustering in wireless sensor networks. It is the efficient algorithm can create cluster with different regions. They suggested OPTICS density-based clustering algorithm has better performance, compared to similar algorithms such as LEACH, SEP, EEHC, and DBSCAN and could increase network lifetime and the number of packets sent by reducing energy consumption. Kumar et al. **[3]** described Extended Lifetime with Minimum Energy Consumption (ELMEC) scheme is proposed for reducing energy consumption of cooperative communication in WSN and to increase the network lifetime. The transmission distance, number of cooperating nodes of the Virtual Multiple-Input-Multiple-Output (V-MIMO) and the modulation order are jointly optimised by the proposed scheme to augment the network lifetime and to consume minimum end-to-end energy. The total energy consumption per bit and network lifetime of the proposed scheme is compared with traditional minimum energy consumption scheme. of additional energy compared to a sequential execution. Further, different synchronization algorithms. Tabatabaei [4] the Cuckoo Optimization Algorithm was used to select the shortest route between the relay groups. The results shown that the process of selecting a stable route using the Cuckoo Optimization Algorithm and the TOPSIS algorithm has a valuable impact on the performance of networks, and the proposed algorithm shows better performance compared to the methods introduced in Tabatabaei and Behravesh with regard to the throughput and the end-to-end delay. Anand Chatterjee et al [5] this paper proposes new routing-chains protocol for energy-efficient networks in Gaussian and uniformly distributed sensor networks. The Gaussian distributed sensor networks is given name of the protocol is Gaussian routing-chains protocol for energy-efficient networks (GREEN). We have also presented a comparative analysis between the proposed green and udreen with existing protocol EECF. Lin et al. [6] have proposed a method for minimizing the energy for NP-complete problem solution by Dijkstra's algorithm and Yen's k-shortest paths algorithm. They have evaluated in Abilene network (eg. Real and synthetic traffic matrices). Andrews et al. [7] have proposed the model for routing and scheduling for energy saving in power mode scheduling. Anbazhagan et al. [8] have described the power management techniques for IEEE 802.16m network using power saving in heterogeneous traffic. They have proposed an algorithm combined cyclic binary exponent (CCBE) and combined truncated binary exponent (CTBE). Lewis et al. [9] have proposed to develop a system wide energy consumption model for servers, in hardware performance and experimental results. Bilal et al. [10] have proposed the energy efficiency which depends on (i) DCN architecture (eg. Electrical optical and hybrid) (ii) network traffic management (iii) network aware resource allocation and energy efficiency. Niewiadomska et al.[11] have described two level control framework for reducing the power consumption in computer network's, (i) Local control mechanism for network device , (ii) network wide control framework technique for reducing power consumption. Galinina et al. [12] have given the optimization of optimal power control scheme for reducing energy in 4G networks. Fang et al. [13] have formulated a stochastic optimization problem and design the control algorithm and evaluated the energy performance on throughput the data in networks. Alzamil et al.[14] have proposed a profiling system architecture which used for energy consumption, in cloud computing. Bianzino et al. [15] have investigated full system based architecture in computer networks for energy efficient wired networks. Niewiadomska-Szynkiewicz et al. [16] have described a Control system for reducing energy consumption in backbone computer network. Luca, Chiaraviglio., et al.[17**]** have evaluated particular algorithm or procedure to offer energy saving capabilities in networks, but rather we formulate a theoretical model based on random graph theory that allows to estimate the potential gains achievable by adopting sleep modes in networks where energy proportional devices are deployed.

3. Methodology Used

The Bellman–Ford algorithm is an algorithm that computes shortest paths from a single source vertex to all of the other vertices in a weighted graph. It is slower as comparatively Dijkstra's algorithm for the same problem and its solution, but more versatile, as it is capable of handling graphs in which some of the edge weights are negative numbers.

Bellman Ford algorithm works by over computation the length of the path from the starting vertex to all other vertices.

A very important application of Bellman Ford is to check if there is a negative cycle in the graph; Time Complexity of Bellman Ford algorithm is relatively high.

Time complexity of bellman algorithm is O (V.E) in case E=V2, O (V3)

3.1 Bellman-Ford Algorithm

Bellman-Ford Algorithm has many types of variants but the most common one is to find the shortest paths from the source vertex to all other vertices in a graph.

Time Complexity of Bellman-Ford Algorithm is O (V^2) but with min-priority queue the complexity is to O ((V+E) logV) with the use of Fibonacci series and the application of algorithm in major like Digital Mapping Services, Google Maps, Designate Servers, and IP Routing.

Algorithm 1: Bellman-Ford Algorithm

Input Data: A directed graph G (V, E), the starting vertex S, and the weight W of each edge

Result: shortest path from S to all other vertices in G

```
D[S] =0;

R=V – S;

C=cardinality (V);

For each vertex k ϵ R do
|     D[k] = ∞;
End

For each vertex i=1 to (C-1) do
|   For each edge (e1, e2) ϵ E do
|   |   Relax (e1, e2);
|   End
End

For each edge (e1, e2) ϵ E do
|   If D [e2] > D [e1] + W [e1, e2] then
|   |   Print ("Graph contains negative weight cycle");
|   End
End

Procedure Relax (e1, e2);

For each edge (e1, e2) in E do
|     If D [e2] > D [e1] + W [e1, e2] then
|     |   D [e2] = D [e1] + W [e1, e2];
|     |
|
```

End

End

However, if we have to find the shortest path between all pairs of vertices, both of the above methods would be expensive in terms of time. Discussed below is another algorithm designed for this case.

1. Set all vertices distances = infinity except for the source vertex, set the source distance =0
2. Push the source vertex in a min-priority queue in the form (distance, vertex), as the comparison in the min-priority queue will be according to vertices distances.
3. Pop the vertex with the minimum distance from the priority queue (at first the popped vertex = source).
4. Update the distances of the connected vertices to the popped vertex in case of "current vertex distance + edge weight < next vertex distance", then push the vertex with the new distance to the priority queue.
5. If the popped vertex is visited before, just continue without using it.
6. Apply the same algorithm again until the priority queue is empty.

3.2 Dijkstra's Algorithm

Dijkstra's Algorithm

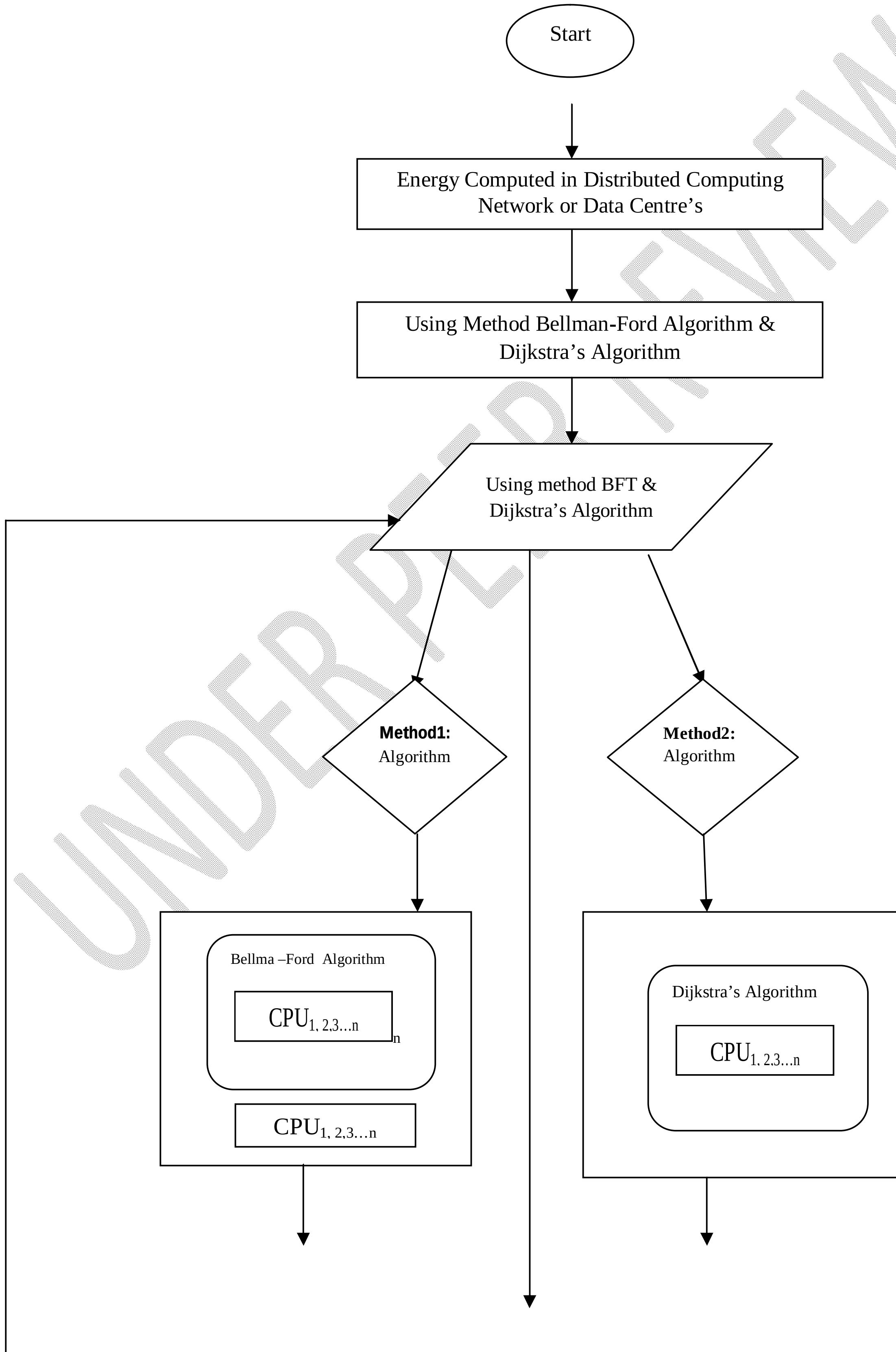
The following algorithm [18] for finding single-source shortest paths in a weighted graphs like directed or Undirected with no negative-weight edges. Dijkstra's algorithm solves the single-source shortest-paths problem on a weighted, directed graph $G = (V, E)$ for the case in which all edge weights are non negative. Let $w(u, v) \geq 0$ for each edge $(u, v) \in E$. As we shall see, with a good implementation, the running time of Dijkstra's algorithm is lower than that of the Bellman-Ford algorithm.
Dijkstra's algorithm maintains a set S of vertices whose final shortest-path weights from the source s have already been determined. The algorithm repeatedly selects the vertex $u \in V - S$ with the minimum shortest-path estimate, adds u to S, and relaxes all edges leaving u. In the following implementation, we use a min-priority queue Q of vertices, keyed by their d values.

Dijkstra(G, w, s)
Initialize-Single-Source (G, s)
$S \leftarrow \emptyset$
$Q \leftarrow V[G]$
while Q _= $\emptyset$
do $u \leftarrow$ EXTRACT-MIN(Q)
$S \leftarrow S \cup \{u\}$
for each vertex $v \in Adj[u]$

do RELAX*(u, v,w)*

this algorithm always selects the lightest or closest vertex in $V - S$ to add to set S, we say that it uses a greedy strategy.

Flow chart 1 : Flow chart showing study principle



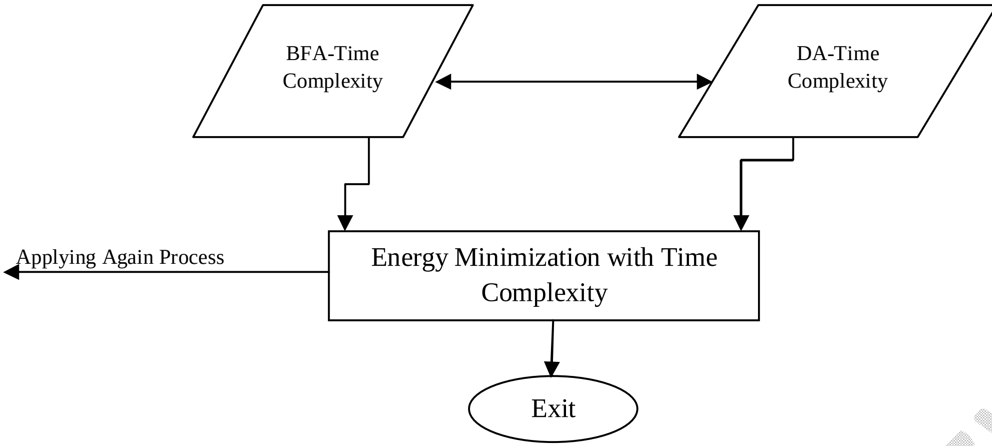


Table.1 Energy Computed By Various Components at Various Stages

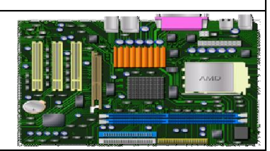
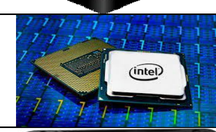
Sr No.	Device Name	Power Cons(Min) in Watts	Power Cons(Max) in Watts	Components wise energy consumption (in Watts)	Device Components
1	Mother Board (regular)	25	40	P_{MAX}=V×I=40×5=200 watt	
	High end mother board	45	80	P_{MAX}=V×I=80×5=400 watt	
2.	DDR1 RAM(2.5 Volts)	4	5.5	P_{MAX}=V×I=3 ×5.5=16.5	
	DDR2 RAM(1.8 Volts)	3	4.5	P_{MAX}=V×I=3 ×4.5=13.5	
	DDR3 RAM(1.5 Volts)	2	3	P_{MAX}=V×I=3 ×3=9 watt	
3.	Solid State Device(SSD)	0.6	2.8	18 watt	
4.	2.5” HDD	0.7	3	P_{MAX}=V×I=3 ×1.78A=5.34 Watt	
	3.5” HDD	6.5	9	P_{MAX}=V×I=9 ×1.78A=16.02Watt	
5.	Intel Top End CPU (Core i7-E)	30	55	130 to 150 W P=CV^{2}f= 140Watt	
6.	80 mm Case Fan	0.6	5 W	P=0.3×5=1.5Watt 0.6 to 1.8 W	

Table2. Time Computed in Various Stages in BFT and DTC

Time Parameter	T_0	T_{Sender}	T_{Dest}	T_{Worst}	Bellman-Ford Time Complexity	Dijkstras Time Complexity
Standby Mode	0	No	No	No	20 Sec	30 Sec
Active Mode	0	0.5	0.7	1.0	40 Sec	30 Sec
Idle Mode	0	0.4	0.6	1.0	27Sec	25Sec

Table3. Energy Computed In Various Components Used Dynamic Voltage Frequency Scaling (DVFS) For Processor

Node / Energy	N1		N2		N3		N4		N5		N6	
E_{MB}	25	40	25	40	25	40	26	40	27	40	25	40
E_{RAM}	4	5.5	4	5.5	4	5.5	4	5.5	4	5.5	4	5.5
E_{HDD}	6.5	9	5.5	9	6.5	9	6.5	9	6.5	9	6.5	9
E_{PROC}	30	55	30	55	30	55	30	55	30	55	30	55
E_{FAN}	0.6	5	0.6	5	0.6	5	0.6	5	0.6	5	0.6	5
E_{TotaL}	SYS_{N1}=**118**		SYS_{N2}=**104**		SYS_{N3}=**102**		SYS_{N4}=**105**		SYS_{N5}=**182**		SYS_{N6}=**135**	
E_{TotaL}=746 Watt												

Table 4. Node wise energy computed in Idle, Standby and Active mode

Processor/Energy	$Energy_{idle}$	$Energy_{Active}$	$Energy_{Standby}$	$Energy_{Total}$
SYS_{N1}	29	68	24	118
SYS_{N2}	32	24	22	104
SYS_{N3}	30	87	29	102
SYS_{N4}	27	28	24	105
SYS_{N5}	26	54	21	182
SYS_{N6}	38	57	30	135
	E_{TotaL}=**182**	E_{TotaL}=**318**	E_{TotaL}=**150**	E_{TotaL}=**650 watt**

Here CPU has no power, RAM maintains power everything else in standby mode, the screen and display are turned off of the computer. In idle mode process is any running process in program. The program uses computer resources, but is not actively being utilized. In active mode the client starts listening on a random node for incoming data connections from the server (i.e. client sends the file transfer protocol (FTP) command node to inform the server on which node is listening)

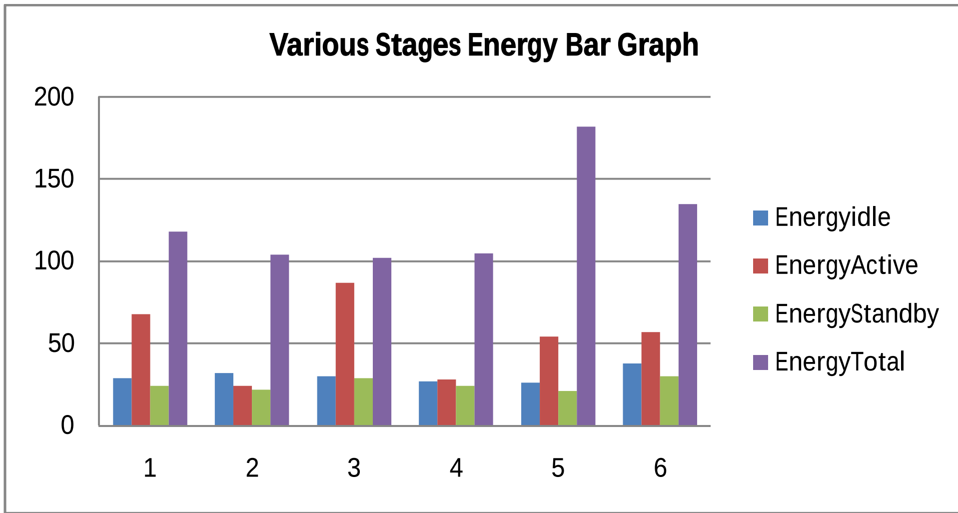
$$E=P/T \quad (1)$$

Here , E is the energy to be calculated and P is the power given in table 4 and time is calculated as given table 5 in active mode.

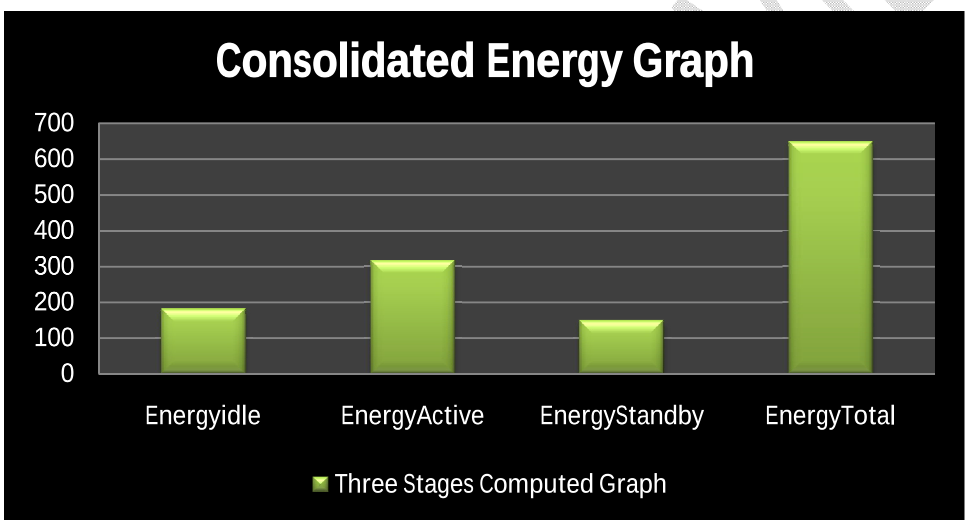
Table5. Energy Computed of Bellman-Ford Algorithm and Dijkstra's Algorithm for Single Source

Methods/Algorithm/ Energy Consumption	Standby Mode	Active Mode	Ideal Mode	Total Energy Consumption Component Based
BFA Time Complexity	08Sec	9.5Sec	8.5Sec	101.88 (in active Mode)
DA Time Complexity	07Sec	9 Sec	8.5Sec	96.22watt(in active Mode)

Graph between Bellman-Ford Algorithm time complexity, Dijkstra's Algorithm time complexity and Fuzzy Logic Methods time function.



Graph 1. **Various Stages Energy Bar Graph**



Graph2. Consolidated Energy Graph

4. Results & Discussion

In this paper the results represents the minimum energy consumption used by single source routing algorithm bellman algorithm and dijkstra's algorithm. Here three types of energy calculated firstly we have computed various types of energy computed in components using formula in table1. Secondly we have computed node wise energy calculated in minimum and maximum power from Node1 to Node 6 belongs to various components. Now finally node wise energy computed in various stages like idle mode, active mode and sleep mode and found the total energy as finally. Now as the result we have found the time complexity in the Bellman-Ford and Dijkstra's algorithm. Here the time is computed in the dijkstra's algorithm is best for single source algorithm instead to the Bellman-ford algorithm for sending data to destination in the networks. We take minimum time and energy found the formula as given above in equation1. It is compared concluded results. In future the algorithm used in fit for best routing algorithm in any network topology. The time complexity of packets flow from sender to destination find by this paper and concluded by the result of component base is best by to find the energy optimize and consumption is low for sender to destination. The best way to find the shortest path to find and latency will be low in the results for the same. So the futuristic algorithm for energy optimization in components wise the Dijkstra's algorithm is very useful for distributed computing and data centres.

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