# Minimization Techniques for Energy Consumption across the Distributed Computing Network

**THESIS**

SUBMITTED TO

**BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY**

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2018

Dedicated to

My Wife and Children

# DECLARATION

I, Kamlesh Kumar Verma, solemnly declare that this thesis of research on **"Minimization Techniques for Energy Consumption across the Distributed Computing Network"** is my original work. The study has been conducted under the guidance and supervision of **Prof. Vipin Saxena, Professor, Department of Computer Science** and co-supervision of **Dr. Raj Shree, Assistant Professor, Department of Information Technology, Babasaheb Bhimrao Ambedkar University (A Central University) , Lucknow-226025 (U.P.) India.** It is further declared that to the best of my knowledge and belief it has not been submitted earlier for the award of any degree. The thesis is essentially free from all kinds of plagiarism.

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# CERTIFICATE

This is to certify that the thesis titled "**Minimization Techniques for Energy Consumption across the Distributed Computing Network**" submitted by Mr. Kamlesh Kumar Verma is an original research work and has not been previously submitted in part or full for the award of any other degree or diploma to this or any other university.

The thesis submitted to Babasaheb Bhimrao Ambedkar University Lucknow satisfies all the requirements as stipulated in the Doctor of Philosophy (Ph.D.) regulations – 1999 as amended in 2010 and it is fit for submission and evaluation for the award of the degree of Doctor of Philosophy of the University.

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# LIST OF ABBREVIATIONS AND SYMBOLS

## ABBREVIATIONS

| | |
|---|---|
| SR | Service Requests |
| SFC | Service Flow Control |
| CQ | Component Queue |
| LPM | Local Power Management |
| DPM | Dynamic Power Management |
| SP | Service Provider |
| AL | Application Level |
| TPASN | Transmission Process across Step Network |
| QoS | Quality of Service |
| DSDV | Destination Sequenced Distance Vector |
| ICT | Information Communications Technology |
| BFAOT | Bellman-Ford Algorithm across Optimizations Techniques |
| SPM | System Power Management |
| SQ | Service Queue |
| AP | Access Points |
| ASP | Analysis Service Provider |
| SR | Request for Service |
| HDD | Hard Disk Drives |
| DSM | Distributed Shared Memory |
| MDP | Markov Decision Process |
| PDR | Packet Delivery Ratio |
| MANET | Mobile Adhoc Network |

| | |
|---|---|
| FCFS | First Come First Serve |
| MDPM | Markov Decision Process Model |
| IP | Internet Protocols |
| TCP | Transmission Control Protocols |
| OSI | Open System Interconnections |
| E2ED | End to End Delay |
| CBR | Constant Bit Rate |
| TT | Transmission Time |
| PD | Probability Distribution |
| DVS | Dynamic Voltage Scaling |
| RR | Round Robin |
| DVFS | Dynamic Voltage Frequency Scaling |
| TNs | Terminal Nodes |
| PEs | Peripheral Equipments |
| LSR | Link State Routing |
| DVR | Distance Vector Routing |
| DFS | Dynamic Frequency Scaling |
| ED | Energy Delay |

**SYMBOLS**

| | |
|---|---|
| $E_{eff}$ | Energy Efficiency |
| $E_{MB}$ | Motherboard Energy |
| $E_{Total}$ | Total Energy |
| $E_{Proc}$ | Processor Energy |

# LISTS OF PUBLICATIONS

## A. INTERNATIONAL JOURNALS

[1] **Kamlesh Kumar Verma and Vipin Saxena** *"A Framework for Dynamic Power Management at Network Level",* **International Journal of Computer Applications (IJCA), ISSN (0975-8887), Vol. 139(8), 34-39, April 2016.**

[2] **Kamlesh Kumar Verma and Vipin Saxena** *"An Energy Computation in Distributed Computing Environment through Bellman-Ford Algorithm",* **International Journal of Computer Applications (IJCA), ISSN (0975-8887), Vol. 142 (2), 01-06, May 2016.**

[3] **Kamlesh Kumar Verma** and Vipin Saxena *"Energy and End to End Delay Computation across Step Network under Distributed Environment",* **International Journal of Computer Applications (IJCA), ISSN (0975 – 8887), Vol. 153 (7), 01-05, Nov. 2016.**

[4] **Kamlesh Kumar Verma** and Vipin Saxena *"Optimization of Energy Consumption for Task Scheduling on Uni-Processor and Multiprocessor for Step Topology under Distributed Environment",* **International Journal of Computer Applications (IJCA), ISSN (0975 – 8887), Vol. 161 (8), 10-16, March 2017.**

[5] **Kamlesh Kumar Verma** and Vipin Saxena "*Power Management in the Computer Centre under Distributed Environment",* **International Journal of Advanced Research in Computer Science (IJARCS), ISSN (0976-5697), Vol. 8 (2), 01-07, April 2017.**

**[6]** **Kamlesh Kumar Verma** and Raj Shree "*A Survey of Energy Computation in Distributed Computing Networks",* **International Journal of Advanced Research in Computer Science (IJARCS), February2018. ISSN (0976-5697), Vol. 9 (1), pp. 939-944, DOI: http://dx.doi.org/10.26483/ijarcs.v9i1.5522, February 2018**.

**B. BOOK CHAPTER**

**[7]** **Kamlesh Kumar Verma** and Vipin Saxena *"Applications of Energy Optimization Techniques for Distributed Computing Networks",* published as a book chapter in **Recent Advances in Mathematical and Computational Sciences, ISBN No. 9789384 337674, pages 107-118, edited by R.C. Sobti et al. 2015.**

**C. LIST OF CONFERENCES**

**C.1 INTERNATIONAL CONFERENCES**

**[8]** **Kamlesh Kumar Verma and Vipin Saxena** *"Energy Consumption of University Data Centre in Step Networks under Distributed Environment using Floyd-Warshall Algorithm",* Springer Nature Singapore Pte Ltd. 2019, edited by K. Ray et al. (eds.), **Soft Computing: Theories and Applications, Advances in Intelligent Systems and Computing** 742, https://doi.org/10.1007/978-981-13-0589-4_10 , **Springer (ISSN: 2194-5357), 2017, Scopus Indexed.**

**C.2 CONFERENCES ATTENDED**

**[9]** **Kamlesh Kumar Verma** and Vipin Saxena "*A Technique for Energy Minimization across Distributed Computing Network",* presented in International Conference of Modelling and Computing (ICMC-2014), organized by Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow, from 10-11th July 2014.

**[10]** **Kamlesh Kumar Verma** and Vipin Saxena "*Applications of Energy Optimization Techniques for Distributed Computing Networks*", presented in 3rd Lucknow Science Congress (LUSCON-2015), organized by Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow from 31st Oct- 2 Nov 2015.

**[11]** **Kamlesh Kumar Verma** and Vipin Saxena *"Energy Efficiency Techniques for Distributed Computing",* presented in 4th Lucknow Science Congress (LUSCON- 2017), organized by Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow, from 3-4, March 2017.

**[12]** **Kamlesh Kumar Verma** and Vipin Saxena "*A Mathematical Modelling Approach to Energy Cost saving in Distributed Networks",* presented in National Conference on Recent Advances Mathematics and Applications (NCRAMA-2014), Department of Applied Mathematics, Babasaheb Bhimrao Ambedkar University, BBAU, Lucknow from 30-31st Oct 2014.

**[13]** **Kamlesh Kumar Verma** and Vipin Saxena *"A Survey of Energy Computation Techniques in Distributed Computing",* presented in National Conference on Mathematical Techniques in Engineering and Technology (MTET-2016), Babasaheb Bhimrao Ambedkar University, Lucknow from 30 - 31st March, 2016.

**D. LIST OF WORKSHOP ATTENDED**

**[1]** Five days workshop "*Networks and Information Security: Emerging Challenges and Practices",* Organized by Ansal Technical Institute (An Engineering College) Lucknow, 5-8th Dec 2013.

**[2]** Seven Days Workshop *"Network Simulator 2 (NS2) and Its Applications",* Organized by ITM Group of Institutions Gwalior, 18th -23th May, 2015.

**[3]** One Day National IEEE Workshop "*How to Avoid Plagiarism and Reference Management Tool Using Mendeley*", Organized by IEEE UP Section, GLA University, Mathura, UP. 3rd Oct 2015.

**[4]** Two days workshop "*International Research Workshop in Cloud Computing (RWCC 2016)",* Organized by Jawaharlal Nehru University, New Delhi, 22-23rd December 2016.

**[5]** Three Week Workshop *"Research Methodology Course (RMC-2017)",* Organized by Department of Information Technology, BBA University, Lucknow, 5Th Jan 2017-28Th Jan 2017.

**[6]** One Week Workshop "*Emerging Research Trends in Computer Science (ERTCS-2017)",* Organized by Department of Computer Science, BBA University Lucknow, 20Th -24 March 2017.

# Minimization Techniques for Energy Consumption across the Distributed Computing Network

## SUMMARY

Today, the issue of energy consumption (EC) in high-performance computing (HPC) or Distributed Computing Systems has a great deal of networking region. There are many algorithms which have been developed for energy consumption computing in different layers of Cloud Computing systems or in distributed computing (i.e. Hardware/Software layer, Service layer, Application layer and System layer). The algorithms are of two types: first, algorithms which directly try to improve the energy by frequency depended operation or scheduling algorithms and second algorithms which focus on improving the performance of the system, with the assumption that efficient running of a system may indirectly save more energy. The connected device generally emits the energy which is of different categories and it is major Challenge to optimize the entire energy of the system. The present work proposes an energy optimization for the electrical components used in the hand-held devices is a broad area of research. Energy principle for information technology contains its own specific energy behaviour. The energy costs in server center are now compatibility to the cost of hardware devices and other comparable devices. In the processor device system, heat existing is a major cause of limiting changes in the performance evaluation. In the laptop, scanners, computers, cell phones, printers, i-pods, and other digital devices, which are portable, reduced the power consumption converts into the battery long life manner. The energy consumption is now presenting challenges as a performance measure in computers, processing the task execution time. The energy is linked with the execution time capacity, where comparable patterns have been recognized by a combination of hardware devices, software devices and algorithms.

In the present work, we have investigated few ideal and effective techniques used for finding the energy consumption. The main goal of the energy consumption is to reduce the consumption of energy through proposed mathematical models. These techniques can be obtained while computing the best results in various techniques such as energy measurement techniques. The contributions of work are summarized below in the proposed chapters:

**CHAPTER I INTRODUCTION**

This chapter contains a precise introduction about the various aspects related to energy consumption information of research in distributed and parallel computing. The energy consumption of distributed computing network and green computing with the communication protocol in wired network or wireless networks are described. The network system exists of energy efficiency and energy consumption is a major challenging task for any computer network systems. In this chapter, the fundamentals of Unified Modelling Language (UML) are also described in brief.

**CHAPTER II REVIEW OF LITERATURE WORK**

This chapter describes the review of literature related to energy consumption in distributed systems and energy reduction techniques in distributed computing networks. The literature survey is done by several online libraries and consulting the online journals and white papers. At the end, the challenging problems related to the energy consumption in distributed computing of present work are described.

**CHAPTER III A FRAMEWORK FOR DYNAMIC POWER MANAGEMENT**

In this chapter, the energy computation methods have been proposed using power management techniques. The method is based on a framework for dynamic power management model. In the current scenario of computing, distributing is gaining popularity as many of users are connected with their handheld device across the globe. The connected device generally emits the energy which is of different categories and it is major challenge to optimize the entire energy of the system. The present work proposed a frame work for the dynamic power management for completion of tasks in minimum time frame which are routed from one node to another node across the network. For this purpose, a step topological network is selected at the application level of the model. Computed results are depicted for the dynamic power management in the forms of graphs.

The contents of this chapter have been published in the International Journal of computer Applications, Volume 139 (8), pp. 34-39, April 2016.

**CHAPTER IV AN ENERGY COMPUTATION IN DISTRIBUTED COMPUTING ENVIRONMENT**

In the present scenario, energy optimization for the electrical components used in the hand-held devices is a grey area of research. Energy principle for information technology contains its own specific energy behaviour. The energy costs in server centre are now compatibility to the cost of hardware devices and other compare devices. In the processor device system, heat existing is a major cause of limiting changes in the performance evaluation. In laptop, scanners, computers, cell phones, printers, i-pods, and other digital devices, which are portable, reduced the power consumption converts into the battery long life manner. The energy consumption is now presenting challenges as a performance measure in computers, processing the task execution time. The energy is linked with the execution time capacity, where comparable patterns have been recognised by a combination of hardware devices, software devices, and algorithms. In this chapter, the design of energy-efficient computer systems is proposed by the use of Bellman-ford algorithmic approach. A model is proposed for finding the performance of the system.

The contents of this chapter have been published in the International Journal of computer Applications, Volume 142 (2), pp. 01-06, May 2016.

**CHAPTER V ENERGY AND END TO END DELAY COMPUTATION ACROSS STEP NETWORK**

Distributed computing is widely used by many researchers due to several advantages in terms of low cost with high efficiency. In the present work, a step topological structure is explained and process model is designed through Markov chain. The energy is computed when information is transmitted from one node to another node. End to End delay is also computed in terms of the transmitted rate. Transmission time is also computed and results are represented in terms of table and graph. Since, it is newly developed topological structure under distributed environment, hence comparison on the said topological structure is not possible however it can be converted in the form of bus topology.

The contents of this chapter have been published in the International Journal of computer Applications, Volume 153 (7), pp. 01-05, Nov. 2016.

**CHAPTER VI OPTIMIZATION OF ENERGY CONSUMPTION FOR TASK SCHEDULING ON UNI-PROCESSOR AND MULTIPROCESSOR SYSTEMS**

Distributed computer networking plays a very crucial role in the Business, Industries, Education, Research and Development areas. Many users work on the heterogeneous devices which have different configurations. Different devices are connected across the step topological networks and an attempt is made to reduce the overall energy consumption when data is flowing from one device to another device. Optimization of energy consumption reduces the overall cost of transfer of data. Multiprocessor and Uni-processor cases are considered in special cases and computed results are represented in the form of tables. A well known Hungarian Methodology is used for optimization of the overall energy.

The contents of this chapter have been published in the International Journal of computer Applications, Volume 161 (8), pp. 10-16, March 2017.

**CHAPTER VII POWER MANAGEMENT IN THE COMPUTER CENTRE**

In the current scenario, many of the computer centres across worldwide are following the approach of distributed systems in which multiprocessors are arranged for timely run of tasks through task scheduling by means of effective networks topology. The centres contain many electrical devices which emit energy. In the present work, a case study of computer centre is considered in which devices are arranged under distributed environment for providing better facilities to the users. Each device is examined properly along with specifications and methods are proposed for optimization of power consumption. Results are represented in the form of tables and graphs.

The contents of this chapter have been published in the International Journal of Advanced Research in Computer Science (IJARCS), Vol. 8 (2), pp. 01-07, April 2017, India.

**CHAPTER VIII CONCLUSIONS AND FUTURE SCOPE**

Time to time the energy consumption of distributed computing is a big problem of a few years back and onwards. The energy is a concept of any network is very precious and the Quality of Services (QoS) of any computer networks. In the network's connection, the distributed systems of multi-processors are arranged for the time-dependent run of tasks through task scheduling algorithms of effective networks topology. This chapter concludes the entire research work presented in the chapters along with and future scope of work.

# Chapter I

## *Introduction*

# CHAPTER-I

# INTRODUCTION

This chapter presents the introductory primary information of research that informs about energy consumption of distributed computing network and green computing with the communication protocol in wired network. The existence of energy efficiency and energy consumption is a major challenging task for any network configuration. The measurement of energy consumption in an interconnecting network is not a simple task. It is a challenging work to find power management. The Qualities of Services (QoS) of the measurement of the distributed networks which have accuracy and frequency depending on the measurement devices like wattmeter. This chapter focuses on the work, which is essential to understand the core information included in routing protocols and scheduling of wired distributed computing networks. The work also discusses the problem statement followed by brief explanation for quick results of implementation techniques.

## 1.1 OVERVIEW

In the recent years, distributed computing has played a major role in computing networks. In distributed computing, the energy consumption has been a big challenge in networks. In data centre computing system must be of low cost and highly efficient. A desktop or laptop, multiple windows in operating system may appear on the computer screen for multiple computing. So, multiple windows release maximum energy consumption. Nowadays personal computers (PCs) may have more than one processor due to comprehensive research available for dual-core processors or multiprocessors arranged in network topology, which should be efficient and low-cost. Further in detail, a task has been defined as a piece of information like micro/macro, short process, subroutine, and subprogram and sub problem and for multiple tasks and scheduling algorithms are applicable for completion of tasks within minimum time. All tasks are processed in processor either in uni-processor or multi-processor in computer data centres. Active computer network is powered from the main power grid and it transmits information via network cables in the form of electrical signals. The energy can be consumed when the task is executed on the uni-processor or multi-processors connected across the step network. The electrical energy may be consumed by the hard disk, processors, motherboard, power supply unit, which is distinguished as a fixed energy and changeable energy. The advantages of distributed computing over centralized computing is that computing is a collection of various computer networks incorporated within a single server or computers. The computers are retrieving information with other related computers and all computers are connected to common component computer devices, for the operation of various computing operation. All the computer components are initially worked as purely on scheduling basis as synchronizing and asynchronies. The process may be first come first serve scheduling algorithm and Round-Robin is one of the most popular efficient approaches to the scheduling of the tasks. The component of the computing device consumes the electric energy component-wise, like motherboard, Central Processing Unit (CPU), and electromechanical devices (i.e. Fan and Chillers), and Hard disk. All the component devices consume more energy during action performance. The electric energy increases by the workload and it is a continuous process of synchronization if all components are parallel and distributed busy. The electric energy reduces the cost which may because of workload during sleep mode and due to the absence of data packets. The energy consumption concept in wired network is shown below in figure 1.1.

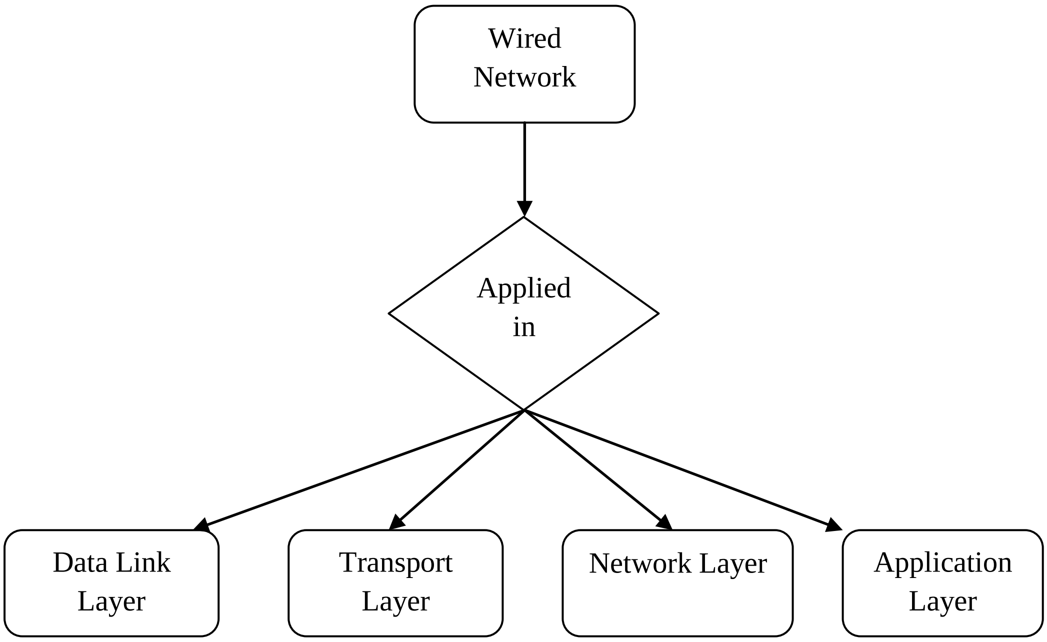



**Figure 1.1 Representation of Energy Optimization at Different Layers**

Energy efficient computing is mainly dependant on hardware or software computing components. The hardware components are as processors, storages, and picture display monitor devices. The performance and power management of the distributed network system is very effective. It depends on the contribution of networks nodes. In distributed computing systems, the data stores on networks, the nodes must be switched on and connected to each computer. If the participating nodes are wireless then it is more challenging on a network level architecture. The dynamic power management classifies into two types of components i.e. sleep or slow down modes and active modes. The dynamic power management has been proposed by a heuristic method for stochastic optimization technique. The heuristic dynamic power management technique is used for throughput the transmission. The stochastic theory is based on a stochastic model of a service request. The service requests are of three types. Firstly, each time a new job process is generated then it searches for a procedure to find the minimum power execution sequences; the sequence is also repeated. Secondly, this strategy is not effective in reducing the system energy by changing the working stage of devices with a multi-level stage. Thirdly, the exact knowledge of the device uses a process before the job is scheduled. A power management is attached to device components, system architectures and system resources and shared memory of device components. The application level scheduling is required for the power management of a system. The numbers of power saving techniques have been related to many types of standards and protocol power management in network topology and the power mode in IEEE 802.3 wire network, A local area network (LAN) card works in power saving mode and depends on data flow network.

Dynamic Voltage Frequency Scaling (DVFS) technique and task scheduling can be combined in two ways: (1) task scheduling and (2) loose time dependency. In task scheduling, the tasks graph is rescheduled on DVFS- processors in a cost function energy saving. They varies of energy and time control at the same time. In loose time saving, which works as a post-processing method of scheduling algorithms, the DVFS technique is used to minimise the energy consumption of tasks in a schedule generated by a separately by scheduler. So, the existing methods based on the DVFS technique have two major issues (1) most of them focus on task scheduling and do not sufficient take the loose time approaches for save more energy and (2) the time loose reformation methods use only one frequency for each task among the discrete set of a processors frequencies.

The dynamic power management depends on processor CPU. Application level supports the administrative level handling which involves to the users for shared data system level, and the flow control depends on path level.

This chapter presents the design, implementation, and network assessment, wire network device architecture that enables full device functionality, availability, and extended device life. Wire networks are unique, they have finite times. In the large-scale distributed network devices such as desktop, the power management is used to extend device. Energy saving technique is a very demanding area in the Information and Communication Technology (ICT) world. The energy consumption is very costly in the network for the system's parameters like CPU, motherboard, hard disk and the power level systems. There are three important factors for the energy consumptions namely data forwarding or data transmitting from source to destination, Speed to the flow of data and transmission of data packets. Further, there are three types of methods for finding the energy consumptions like dynamic voltage scaling, dynamic frequency scaling and clock gating [4]. These methods clock gating is very precious for network energy consumptions. At the dynamic voltage scaling, all devices work with the voltage-dependent component. In voltage scaling, the voltage varies with the network performance as if network's flow is high, then data transmission expresses high energy over the system design. The networks gain, the voltage is low then the data speed is low and energy consumption will be getting low. So frequency works, whereas the same as working with voltage if frequency and voltage with high, then energy is high consumption. But either frequency or voltage is related with reciprocal with each other (i.e. $f \alpha 1/v$). Complex network analysis has been used in many diverse fields of knowledge, from interdisciplinary subject like Biology, Chemistry and Mathematics, Sciences, from computer networks. The optimization problem arises in the design of energy saving. It is responsible for some significant physical attributes such as thermal, pressure, transmission and temperature. The Wired Network is composed of a set of access points (APs) that provides distributed connectivity to a set of terminal nodes (TNs). The problem of optimally designing in a wired networks consist of minimizing the power consumption of a wired network when the load is short, by powering-on just a subset of access points and associating terminal nodes to powered on the data rates between terminal nodes and access points. The protest of the natural variation in the network performance is that it occurs over short periods of time and leads to tricky reductions in data rates.

Mostly users can move around the service area and this has a direct impact on the link data rates, which are a function of the distance between users and access points. The data rates of the links are sensible to the fluctuation in the signal propagation. An optimization problem arises in the design of energy-saving in wired networks. We can verify the design of efficient reconfiguration algorithms to reduce the power consumption of the Wired Local Area Network (WLAN) architecture when the load is scarce. Most of the currently deployed enterprise WLAN are continuously operated at full power, i.e., all are always turned on with the transmission power set to the maximum. This produces a considerable waste of energy because the same power is employed at the peak hours and during the off-peak periods. We address this issue by proposing an optimization model that is used to take two kinds of decisions, one is available for each user and another is set of the transmission power level of each access point or terminal nodes. The area of wired network design requires the development of optimization models and methods. The problem is defined on a bipartite network structure, with a set of an access point that must be assigned to user terminals in order to satisfy the user demands, without exceeding the capacity of the connections between User Terminals. Each Terminal node must be assigned to single powered. Several different power levels are available for powering on each powered-on, then exactly one power levels must be associated with it. A key issue arises concerning the capacity of the connections between the access points and the terminal nodes the specific power levels assigned to a powered-on an affects, in a nonlinear way, the capacity of the connections between them and the user's terminals assigned to it. The assumption is that a transmission of capacity between terminal nodes and a nonnegative no decreasing function of the radiated power at the access points, which will be formally defined. The objective is to minimize the overall power consumption of the access points, which has two components. The first component includes the location and capacity dimensioning costs of the access i.e., the costs associated with powering-on access points and assigns. The second component concerns the assignment costs between a client node and access points, which are given by a linear dependency between the power consumed by the access points and the total demands assigned to the access points. It was assumed that the power consumed by an access node does not depend on the demands appointed to the first component of the objective function which was considered. The presence of the second component called node assignment costs supplies a more realistic problem estimation. In the distributed system, the linear system approximations of the nonlinear transmission capacity functions are also included in the formulation of energy consumption. Current techniques for improving energy efficiency include low power hardware design. The designs focus on the energy consumption in circuit and architecture level of the single node. The energy efficiency strategies in network level as different layers of the wired networks like as routing, scheduling, and media access control (MAC) at the node level, a large amount of energy is consumed by node components such as CPU, Motherboard, Hard disk and RAM.

$$Communication\,\mathrm{Cos}\,t \;\alpha\; \frac{1}{Computational\,\mathrm{Cos}\,t} \tag{1.1}$$

**1.2 DISTRIBUTED COMPUTING NETWORK**

The distributed computing network is an interconnected network of various resources like laptop, printers, mobile, desktop, and other peripheral devices connected to a server. The devices may communicate from one to one and many to one device for Applications. The network peripheral devices may send the process an application for retrieving the information via server and an application as per instruction sequencing process. Computer centres across world are following the approach of distributed systems in which multiprocessors are arranged for the timely run of tasks through task scheduling of effective networks topology. The centres contain many electrical devices which release energy as carbon, hence there is a big challenge to optimize the power consumption in the computer centre.

The methods for reducing energy consumption are of various types and matrices found for energy-related of data centre networks. It is divided into main categories (1) Network Workload. (2) The sleep mode approach. These two solutions can find the energy to save extra energy. A technique to find energy minimization or reducing is the research region in networks. In the computers, the CPU works as the major role of the power efficiency in consumption mode. So the energy consumption of CPU and networks load for energy is given below.

$$Energy = Packets\;Load \times \frac{Packets\;Throughput}{Data\;Packets\;Input} \tag{1.2}$$

Energy has a high impact on computer networks. Since last few years, centralized computing is almost obsolete due to the evolution of the distributed technology in which heterogeneous devices which have different configurations are well connected to the network. These devices may provide services on either fibre optics or wireless technology both of the technology needs either Local Area Network (LAN) card or wired LAN card. The controlling is not centralized but users may access or run tasks on the server as well as on its own machine. In this thesis, we have described a well known National Knowledge Network (NKN) which was established by Government of India in the computer centre located at Babasaheb Bhimrao Ambedkar University Lucknow, India. In this network, the devices are arranged according to the following figure:

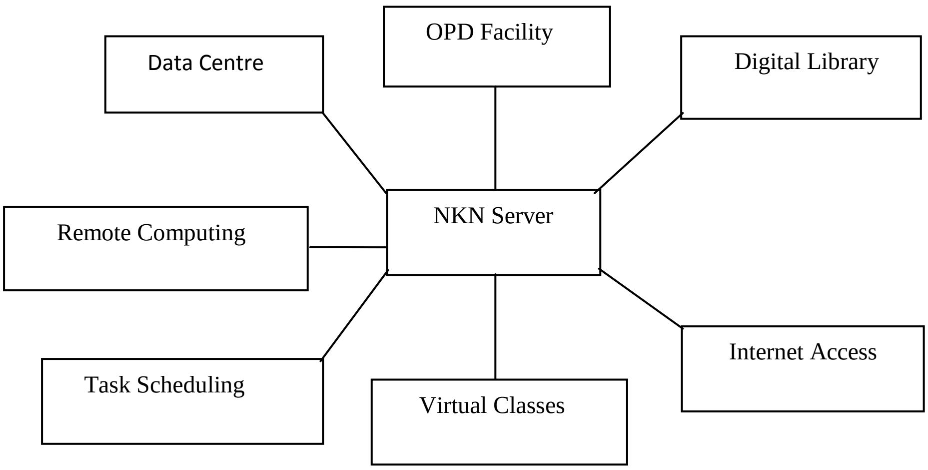



**Figure 1.2 Distributed Computing Network**

### 1.2.1 Evolution of Distributed Communication

In the early long stretches of processing, centralized server based applications were thought to be the best-fit answer for executing large scale information handling applications. With the coming of (PCs), the idea of programming programs running on independent machines turned out to be substantially more prevalent as far as the cost of ownership and the simplicity of application utilize. With the number of PC-based application programs running on independent machines growing, the communications between such application programs became extremely complex and added a growing challenge in the aspect of application-to application interaction. Of late, organize figuring picked up significance, and empowering remote procedure calls over a system convention called Transmission Control Protocol/Internet Protocol (TCP/IP) ended up being a broadly acknowledged route for application of process communication. Software applications running on an assortment of hardware stages, operating systems and distinctive systems confronted a few difficulties at the point when required to speak with each other and offer information. This requesting prerequisite prompts the idea of distributed computing applications. The distributed computing is a sort of processing in which diverse segments and questions containing an application can be situated on various computers connected with a system distributed computing model that gives a foundation empowering summons of protest capacities found anyplace on the system. The items are straightforward to the application also give preparing power as though they were neighbourhood to the application calling them. Some important features of Distributed computing are given below:

- Higher performance
- Collaboration
- Higher reliability and availability
- Scalability
- Extensibility
- Reuse
- Reduced cost

### 1.2.2 Step Distributed Network

In this network, there are at least three nodes connecting to the network and are communicated in the distributed manner. When it is extended towards step network, there are many computers connected to a server for various application operations. This network is beneficial as resource sharing, scalability, robustness, performance speed and cost are important factors of any network study. It is a challenging task for step network like as latency, synchronization process and failure data transmission, security, transparency, and scalability. A view of step network is shown below in figure 1.3.

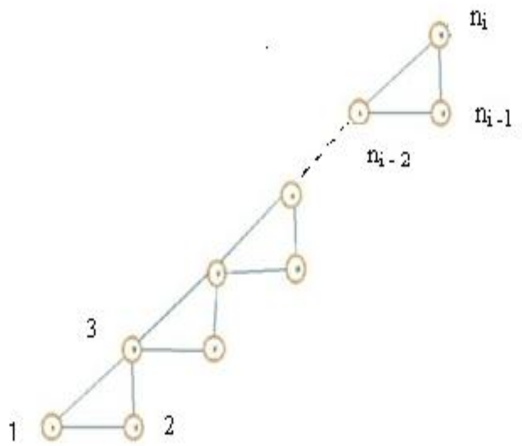



**Figure 1.3 A Static Step Network**

### 1.2.3 Characteristics of Distributed Computing

The followings are important properties of distributed computing:

- Resource sharing
- Computer Communications
- Data storage and accessibility
- Inherently distributed computations
- Access to mapped remote data and resources
- There are more reliability features as given below:

(a) Availability

(b) Integrity

(c) Fault Tolerance

- Increased performance and cost ratio
- Scalability
- Modularity and incremental expandability

### 1.2.4 Distributing Computing Applications

In the distributed computing applications have the following parameters and energy consumption data transmissions in data centres:

- Data Transmission
- Data Receiving
- Idle / Inactive Mode
- Sleeping Mode (off)

The above types of stages of transceiver release the energy or power during data transmission.

## 1.3 DISTRIBUTED SYSTEM MODELS

In the distributed system, the real-time systems are interconnected in series and parallel technology of any networks. There are different types of configuration of systems which are connected in networks. There are two types of models as (a) Architectural Models (b) Fundamental Models. These models define for the hardware and software aspects of a distributed system. These are briefly defined below:

### 1.3.1 Architectural Models

The architectural models of the distributed systems are connected to the individual computer components and functions are as given below:

i. The networks systems are seeking to define that how the computer system is useful for systems distribution of data and network workload for energy consumption.

ii. The interconnection relationships between the components of a distributed system and their function and scheme of communications between the computers.

A server is a process that requests from other processes running in a distributed environment. It is also responsible for providing distributed services with an integration of clients, results in a system wise view of services resources. The process and service oriented view can be defined in terms of service layers in figure 1.4. below:

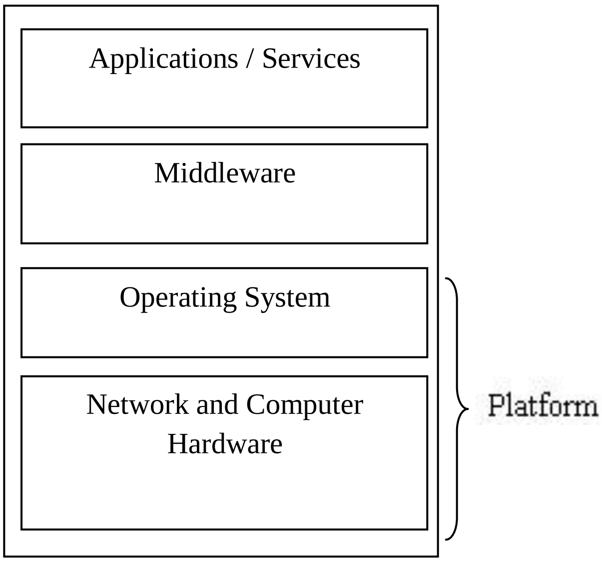



**Figure 1.4 Representation of Service Layers in Distributed System**

In the above figure, the platform is an abstraction of lowest level hardware and software layers. It provides services to the layers above them. The middleware is also a software layer, which is used to mask the heterogeneity of distributed system and provides convenient programming model to the application programmers. Briefly, it raises the level of communication activities through the support of abstraction such as the remote object, event notification, communication among the group of a process, data replication and data transmission in real time environment. In given model, multiple computers are attached with different operating system networks. They all computers have keep own power called local energy. So during all machines connected with series so they have consumed energy called host energy consumption. They all machines application perform synchronise actions in distributed manner they all applications are perform in briefly given in figure 1.5 below. These services on the top layer in the figure are domain service; utilize the services provided by the middleware.

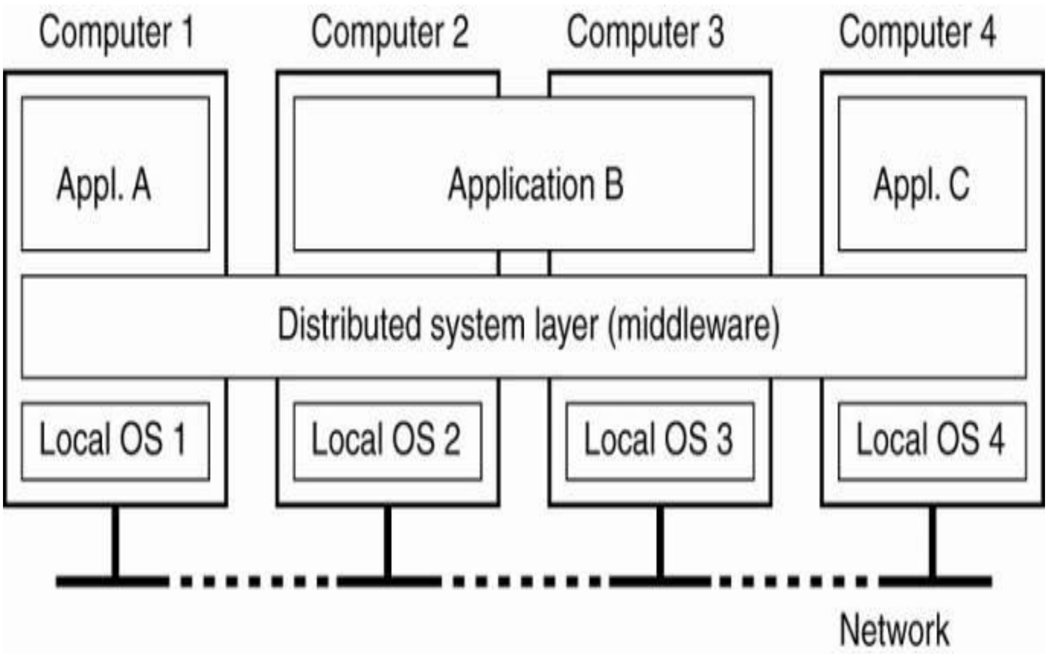



**Figure 1.5 Middleware of Distributed Computing System**

In the distributed system, processes with well defined responsibilities, have to interact with each other to perform any task. One can classify the architecture model of distributed system into the following sub models.

### 1.3.2 Fundamental Models

The fundamental model recognizes the behavioural characteristics of the components of the distributed system. One can classify the complete functional model into three sub models. The interaction model concerned with performance and reliability of processes and communication channel which is used to construct the distributed environment in the absence of a global clock. It elaborates an asynchronous system, in which one cannot impose any type of restriction bound on the aspects like, the process execution time, message delivery time and clock drift. Failure model specifies the failure of processes and communication mediums in a distributed computer systems. In this model, the masking technique is used, which is helpful in making the system more robust to the common failures in any distributed systems. Integrity and validity are some masking strategies, through which one can ensure the consistency and reliability of any distributed computer systems.

The security model identifies the possible threats that can commit related to process and communication channel in any distributed system. Some of these threats are related to the integrity aspects, which include the malicious users with messages. The main characteristics of the fundamental models are given as;

i. Interaction
ii. Failure
iii. Security

#### *1.3.2.1 Client Server Model*

It is the most popular model, widely used in networking and shown in figure 1.6 It shows the simple view, where the client processes is interact with individual server processes. At any time, any server can also play the role of client for the other servers. i.e. server often becomes the client for the local server that manages web pages at their end.

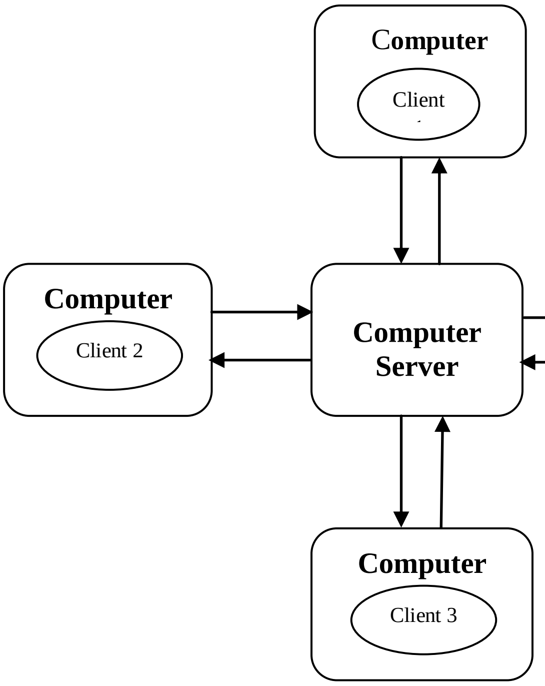



**Figure 1.6 Representation of Client Server Model**

### *1.3.2.2 Multiple Server Model*

The distributed services can be implemented on several servers with process on a separate host computer which is intended to serve the clients as their needed, which is shown in figure 1.7. In this case, object partition can be done based on the services or replies and can be also maintained on different hosts.

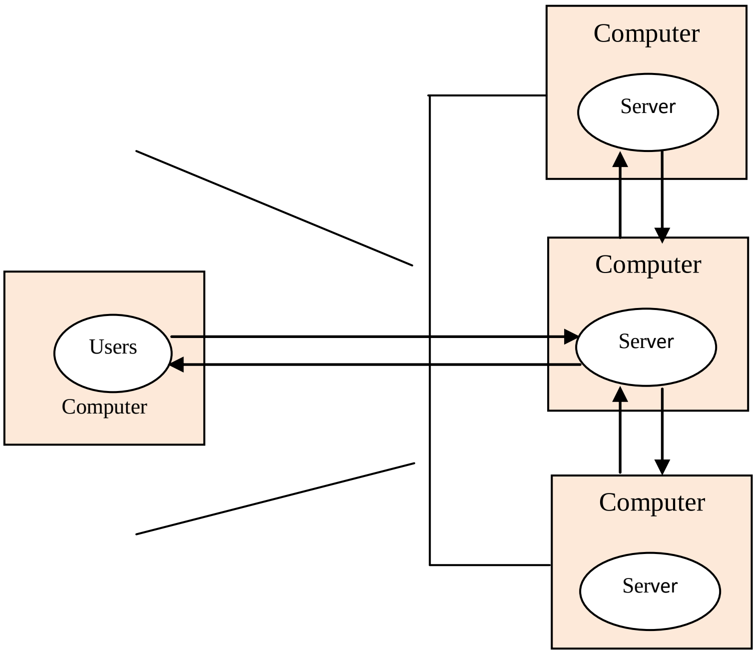



**Figure 1.7 Representation of Multiple Server Process Model**

### 1.3.2.3 Proxy Server Model

Cache memory is used to store the most recent data objects that are accessed. In this model if a client demands the objects, can be supplied directly to the client and if it is found in the cache resides at the proxy server, which can be shared by several clients. Web proxy servers provide a shared cache of web resources for its clients as shown in figure 1.8. The purpose of using proxy server is to increase the availability and performance by load reducing at the web server end.

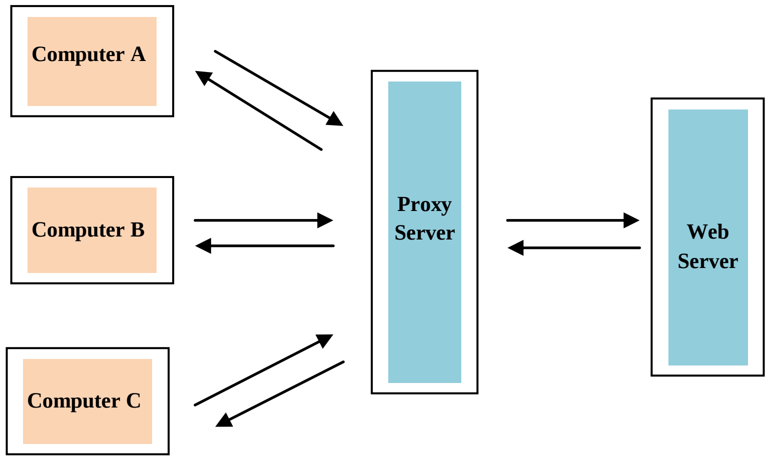



**Figure 1.8 Representation of Proxy Server Process Model**

### 1.3.2.4 Peer Processes Model

In this architecture model, all the processes running in a distributed environment play a similar role. They interact co-operatively as peers to perform any distributed task. In this sense, there is no distinction between client and server. The peer process is responsible for managing the resources and synchronizing and actions. The model is represented below in figure 1.9.

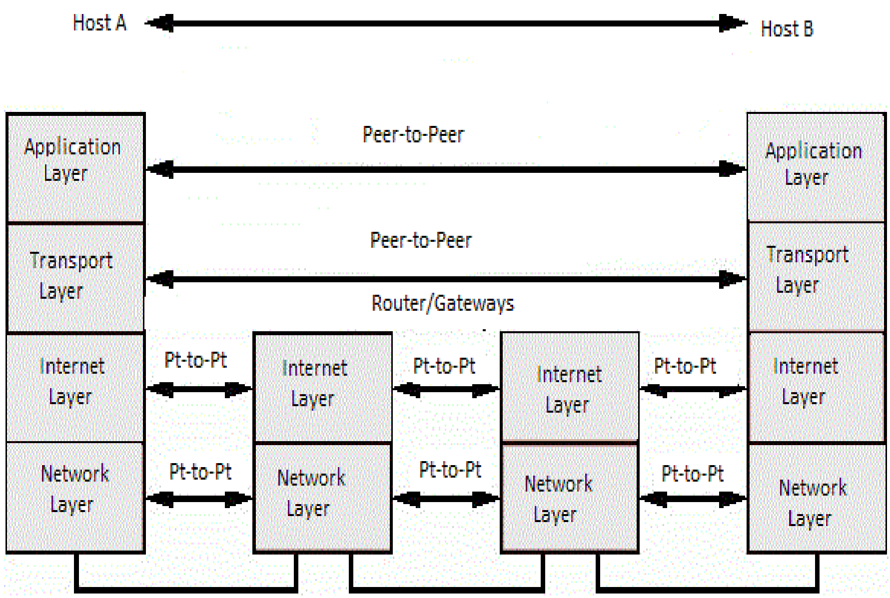



**Figure 1.9 Representation of Peer Processes Model**

## 1.4 ENERGY MANAGEMENT IN DISTRIBUTED COMPUTING NETWORKS

### 1.4.1 Energy Management

There are many definitions of energy in computer networks. In the computer networks and intercommunication process like E-mail, and others social networking sites have various types of application of energy management devices. In the hardware components, the computer networks are working in synchronization order and power consumption. The energy management is over handed by the distributed one by one device. Energy saving is not as simple as in single equipment. There are two main reasons: availability and connectivity are compulsory. The machines are interconnected to a network; the minimum single parts of the network may be switched off in order to lower energy consumption. The uninterruptible power supplies for central equipment as storage devices, servers etc. are often needed, consuming additional energy. The energy management is well accepted by the users, because it allows normal, comfortable working. The prototype energy management system, a small device consuming less than a Watt of power, was developed by a small electronics industries.

### 1.4.2 Load balancing

Load Balancing is the process of distributing data across dividing the services to provide scalability, reliability, and performance. This is a mechanism for indistinguishable allotment of various loads associated with wired network congestion. Various load balancing techniques have been designed for creating an energy efficient route between a source and the destination node in order to enhance the network lifetime. Many load balancing techniques can achieve the highest throughput and minimize the response time and minimize energy reduction, but some of the techniques consume a huge amount of power while distributing the workload among sensor devices. Sometimes many drawbacks can be found in many load balancing strategies which can reduce the transmission cost but enhance the routing overhead. Some of the existing studies only discussed various load balancing strategies and their application over wired networks and wired sensor networks for enhancing network lifetime and throughput but those strategies do not talk about how to minimize energy consumption issues happening due to routing.

The Load balance is used to increase capacity i.e. concurrent users and reliability of applications. Authors can improve certainly the overall energy performance of the applications by minimizing the loads on data centres.

A load balancer is a device that acts as a reverse proxy server and distributes network or application traffic across a number of load balancers are generally grouped into two categories: Transportation layer and application layer. In transportation layer in load balancers act upon data found in network and transport layer protocols like Internet Protocol, Transmission Control Protocol, File Transfer Protocol and connectionless

(UDP). In application layer load balancers distribute requests based upon data found in Application layer protocols such as Hypertext Transfer Protocol.

The energy consumption in distributed computing flow of data is explained by the figure 1.10. Users requests are received by both types (user and server) of load balancers and they are distributed to a particular server based on a configured algorithm. Some data centres and educational institution and industry standard algorithms of scheduling are as given as:

- Round robins
- Weighted round robin
- Least connections
- Least throughput time

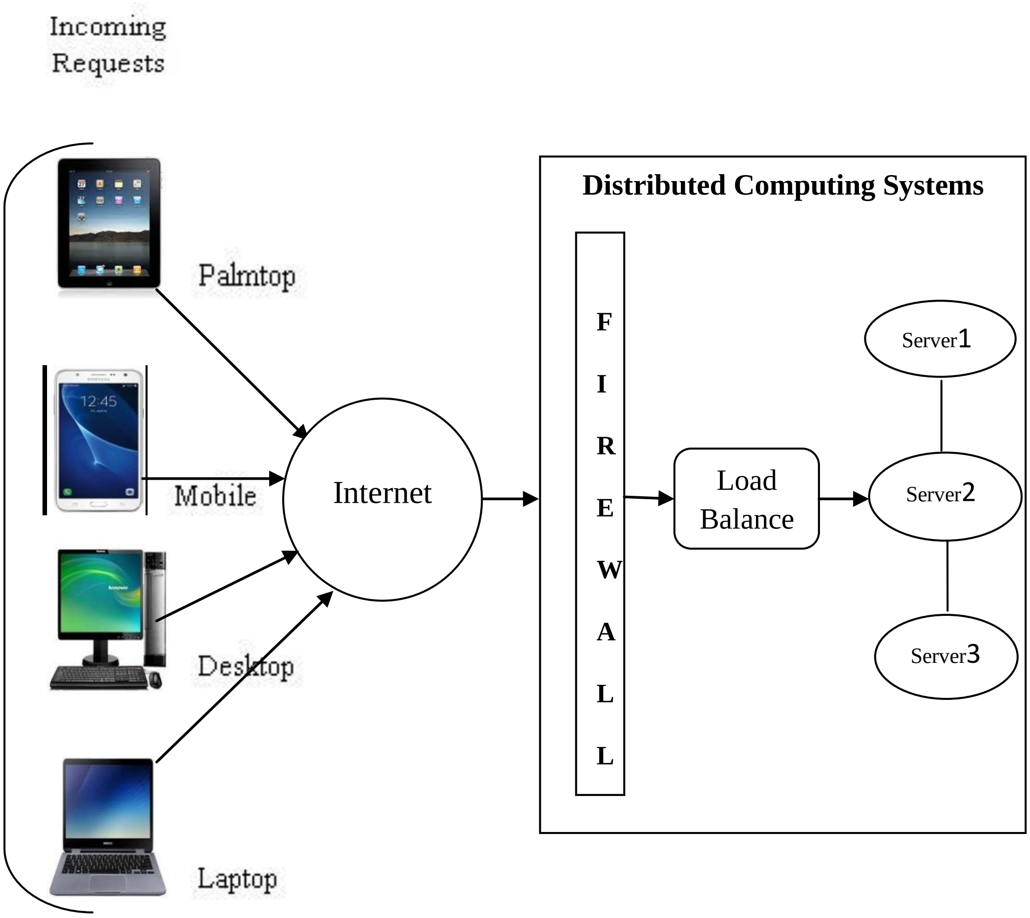



**Figure 1.10 Load Balancing in Network-Based Hardware**

### 1.4.3 Power Management

Power management in a distributed electrical network has some challenges like to enhance renewable power supply, optimize distribution or network's integrity. The conventional parameters are considered as costs and power constraints but load management is ignored to reduce the environmental impact that energy generation produces. The demand satisfaction is conditioned to the available power by means of strategies oriented to control consumption and to satisfy the future power demand as long as possible. The computer network is simulated to show the complex equilibrium that must be made to attend energy requests coming from a set of consuming centres. This case study lets us confirm the feasibility of the power supply solution based on load management. An EMC models the electronic system as a set of interacting power manageable components controlled by one or more power managers. We have described a model for power management devices as network level. We are not concerned about how power management components are designed; instead, we described on how they interact with each other and the operating environment. The purpose of this analysis is to understand what type and how much information should be exchanged between a power manager and system components in order to implement effective system-wide energy management strategies. We consider power management components (PMC's) describe dynamic power management for systems with several interacting components.

## 1.5 POWER SCHEDULING

The power is scheduling in distributed computing to flow of the physical device like as motherboards to backbone system and process control block (PCB). The power scheduling in a process during data communication is defined as follows

$$P(t) = V(t) \times I(t) \tag{1.3}$$

Where P (t) is the power consumed in time t, V (t) is the input supply voltage and I(t) is the input Current with time t.

The energy consumption in power scheduling over the time interval $t_1 - t_2$ is defined as:

$$E = \int_{t_1}^{t_2} P(t)dt \tag{1.4}$$

The above equation techniques reduce power consumption will save energy only if it does not increase the execution time. If the execution time is increasing then the equation as follows till the time factor t, whenever data should not be processed in during the communication. The Total Energy Consumption [10] equation will be given as below;

$$Total\ Energy\,(E_T) = \int_{t_1}^{t_2} P(t)dt_{Hard\ Disk} + \int_{t_2}^{t_3} P(t)dt_{Motherboard} + \int_{t_3}^{t_4} P(t)dt_{RAM} + \int_{t_4}^{t_5} P(t)dt_{CPU} \tag{1.5}$$

The sequencing of the input parameter could be changed according to the time factor during data processing the flow control of the power scheduling as given in figure 1.11;

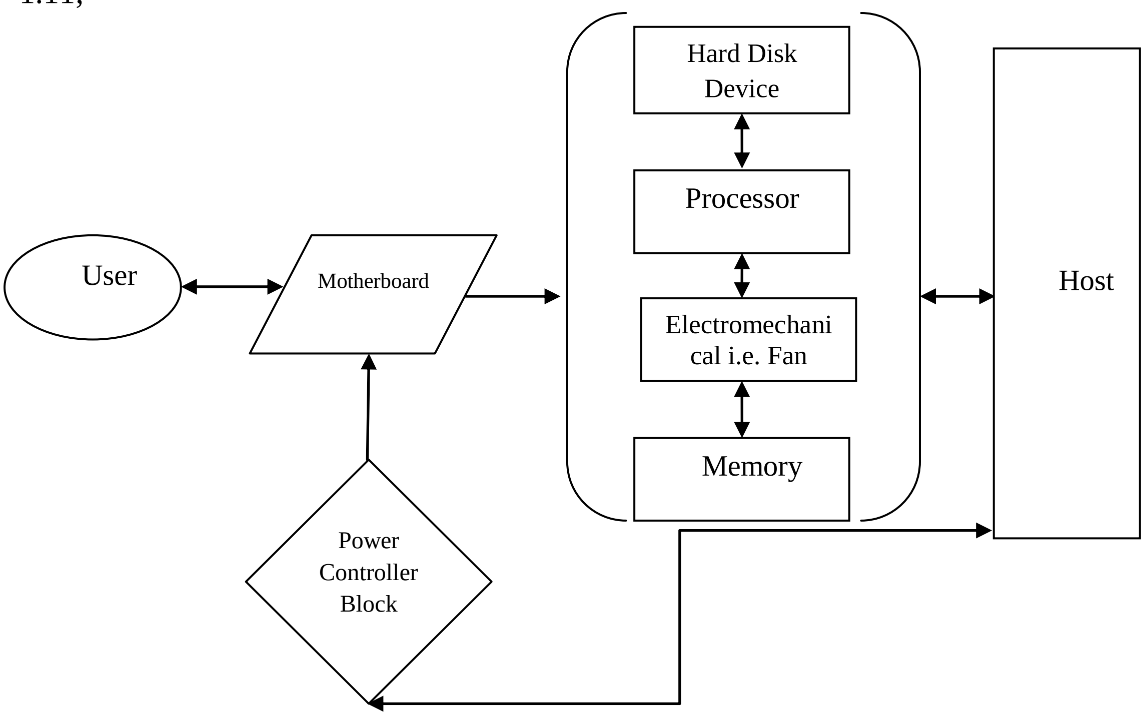



**Figure 1.11 Power Scheduling in Distributed Data Centre**

### 1.5.1 Power Consumption

In distributed computing, the energy is initially applied action of this system / User ID for modelling the working operation after that dynamic model or static model is applied in the system. The data receiver and sending from user side or systems will be based in choosing dynamic and static at once as represented in figure 1.12:

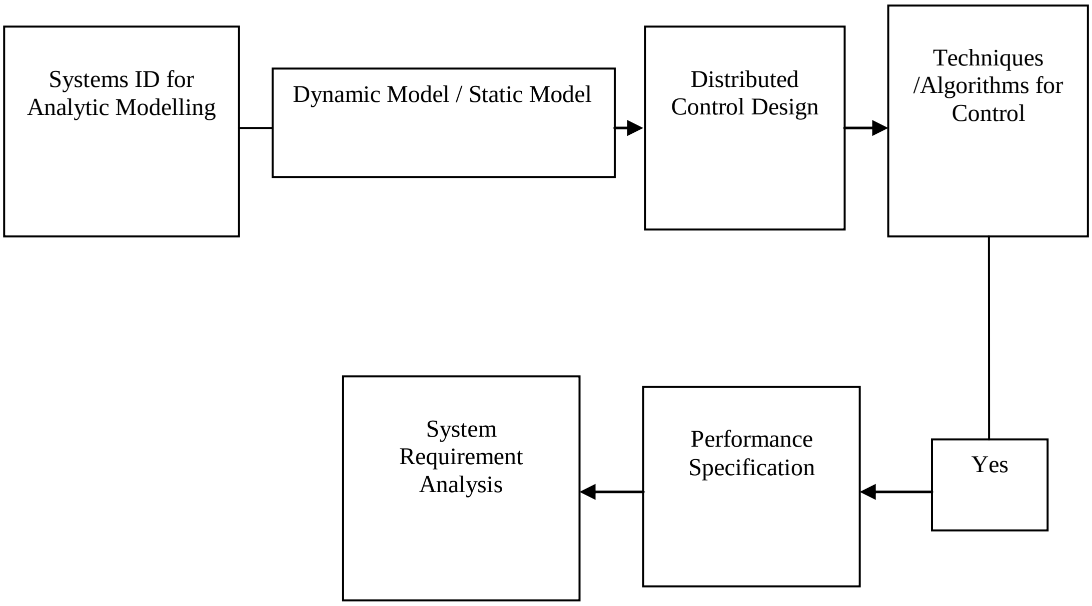



**Figure 1.12 Sequences for Energy Consumption in Distributed System**

### 1.5.2 Energy Measurement

In computer networks, energy management is a very needful concept. This is a highly challenging work for energy management in networks systems. The computer hardware devices are crucially rolled for energy efficiency. The energy is mostly based on machine to machine verifying for optimizing the energy consumption. Energy management can be more efficient if the power flow can be reserved during day time to be used in the peak hours to reduce the peak demand from the data centre.

In the data centre the dynamic power management DPM is a trivial task and the optimum policy is beneficial i.e., as soon as the system is idle, it can be transitioned to the deepest sleep state available. On the arrival of a request, the system is instantaneously activated. Unfortunately, most PMC's have non-negligible performance and power costs for state transitions. The development of smart grid data centre For instance, if entering a low-power state requires the power-supply shutdown, returning from this state to the active state requires a possibly long time in i.e. (1) turn on and stabilize the power supply and the clock (2) reinitialize the system (3) restore the context. When power state transitions have a cost, finding the optimal dynamic power management (DPM) policy becomes a difficult optimization problem. In this case, the DPM policy optimization is equivalent to a decision-making problem in which the PM must decide if and when it is performance and power dissipation viewpoint to transition to which low-power state in briefly given as figure 1.13

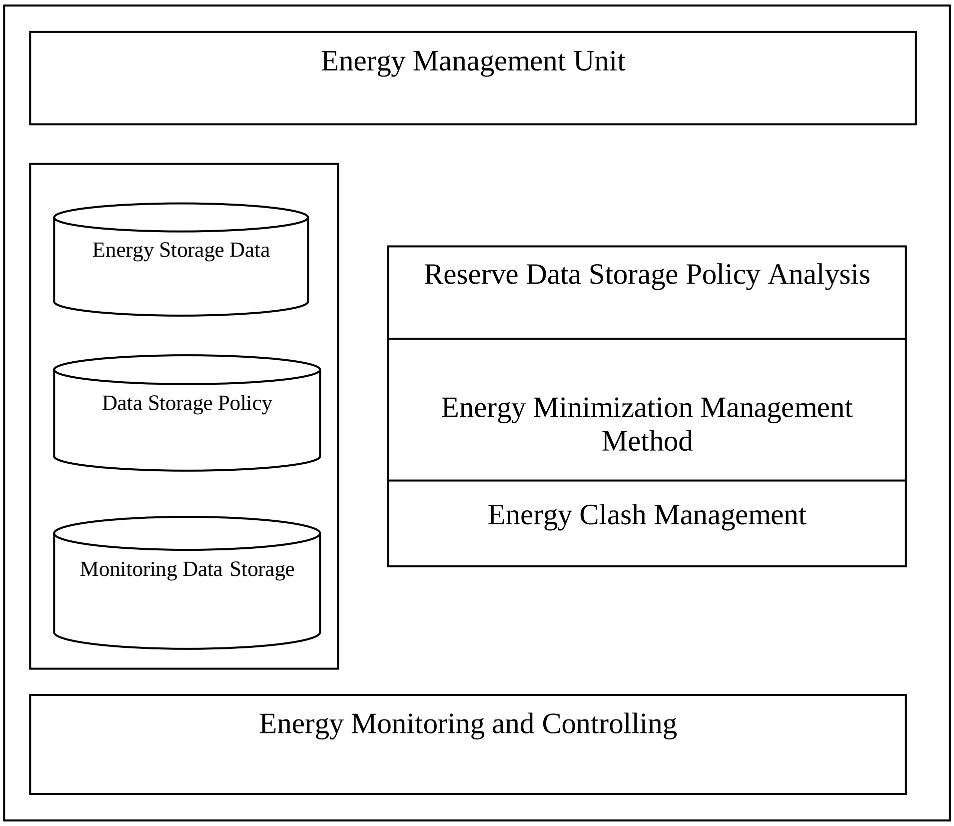



**Figure 1.13 Energy Management Units in Distributed System**

## 1.6 ENERGY CONSUMPTION IN DISTRIBUTED COMPUTING SYSTEM

The distributed computing systems are a collection of various computers and networks flow with one computer. Every vertices and edges are corresponding to the communications links. The degree of data communication varies depending on the application type. The following lists of energy saving techniques can be implemented to achieve network future maximization.

### 1.6.1 Data Aggregation

Data aggregation is required to reduce energy consumed in forwarding correlated data from adjacent nodes. The data aggregation implicitly builds cross layer design architecture. This has different benefits including energy efficiency and network maximization especially of nodes closer to the server.

### 1.6.2 Data Forwarding

Mostly data communication models including data forwarding mechanism based on cost function. This includes characters as expected transmission data, expected transmission time, transmission latency and packets throughput.

### 1.6.3 Static Vs Dynamic Data Communication Energy Consumption

A multiprocessor is the most power consuming device in a system. There are two common ways to reduce CPU power is to lower a clock rate so that voltage will be slower in power consumption. The energy consumption of the distributed computing network is of two types i.e. static and dynamic as given below;

#### 1.6.3.1 *Active Power Consumption Management*

It is used to optimize the power of a networks system while processing the data throughput.

There are three basic techniques to optimize the energy consumption

- Dynamic Voltage Frequency Scaling (DVFS)
- Adaptive Voltage Scaling
- Dynamic Power Switching

#### *1.6.3.2 Static Power Consumption Management*

The static power management in several modes like as standby to a deep sleep mode. It is the only important technique for static power utilization in networks for distributed computing systems.

## 1.7 UNIFIED MODELLING LANGUAGE (UML)

UML includes semantic concepts, notation, and guidelines. It has static, dynamic, environmental and organizational parts.

The UML captures information about the static structure and dynamic behaviour of a system. A system is modelled as a collection of discrete objects that interact to perform work that benefits an outside user.

UML (Unified Modelling Language) is a standard language for specifying, visualizing, constructing, and documenting of software programs. It has become an OMG standard. This tutorial gives a complete description of UML.

### 1.7.1 The UML 2.0

The following diagrams include in UML 2.0:

**(a)Static Diagram or Structure Diagram**

- Composite Structure Diagrams
- Deployment Diagrams
- Package Diagrams
- Profile Diagrams
- Class Diagrams

- Object Diagrams
- Component Diagrams

**(b) Dynamic Diagram or Behavioural Diagram**

- State Machine Diagrams
- Communication Diagrams
- Use Case Diagrams
- Activity Diagrams
- Sequence Diagrams
- Timing Diagrams
- Interaction Overview Diagrams

### 1.7.2 UML Tools

In 1994, James Rumbaugh have defined the rational software corporation after leaving the journal electric and this was the turning point for the rational because after that it evolved two most popular object oriented approaches Rumbaugh's OMT, which is dedicated towards objects analysis and Grady Booch's Booch method, which was for object oriented design. Later on both Rumbaugh and Booch's attempted to merge their approaches and started their work on a unified method.

There are various types of tools used in Unified Modelling Language (UML) which as following;

#### *1.7.2.1 Rational Rose XDE*

The Rational Rose Extended Development Environment (XDE) provides all of the basic elements of UML modelling in one robust product. It is applicable to analysis, architects, designers and implements, Rational Rose XDE gives common tools for creating and maintaining UML models of software development.

#### 1.7.2.2 Prosa UML Modeller

The Prosa UML is a software package that contains Business planning, IT development, embedded system development, Internet of things (IoT), development, and Database system development. It would handle supports of the Structured Analysis and Design in real-time (SA/SD/RT). They have some features given as Easy to using graphics editing, diagram/shapes integration, Multi-user systems Integrates with Office tools like Windows 7, 8, 8.1 and 10 supports Prosa/UML Object oriented design. Prosa/UML also supports best Unified Modelling structure.

#### 1.7.2.3 Plant UML

Plant UML is a component that features to quick writing:

- Sequence diagram
- Use case diagram
- Class diagram
- Activity diagram
- Component diagram
- State diagram
- Object diagram
- Deployment diagram
- Timing diagram

## 1.8 ENERGY CONSUMPTION TOOLS

The energy consumption is measured as the difference between energy level previous and after performing transmission by a node. The energy consumption is due to processing data and transmission of large data in large scale data centre. The reduction in energy consumption affects reliability of wired network and network lifetime capability. The energy consumption tools as given for finding the energy performance are given below;

Various types of network simulator like Network Simulator 2 (NS2), Network Simulator 3 (NS3), ICanCloud, OMNET 4++ etc.

All above tools are like virtual network window and live graphical presentation in the window network. All are mathematical works tools and give approximation values to find the energy consumption. Other mathematical tools are available to find the energy consumption like MATLAB, Global Mobile Simulator (GLOMOSIM). In these tools the NS2, NS3 are the best concluding results in network performance and network energy.

## 1.9 OBJECTIVES OF PRESENT WORK

The data collection problem is a fundamental research area where node to node or machine to machine communication takes place. A communication link is established between nodes making node to node i.e. client to server node. Main issue in data collection is saving of node energy. The transmission of data process consumes highest energy and low transmission energy. The topology control is beneficial for the limitation and control. The network nodes are organized to obtain the structure or graph of the network topology and then apply the routing algorithms and spanning graphs.

The objectives of this research are:

a. To propose a routing mechanism for improving energy efficiency and forwarding efficiency of nodes;

b. To propose an optimal solution for reducing energy utilization of nodes and increasing the life time of nodes;

c. To design the routing mechanism for delay tolerant networks by improving the forwarding decision of the packet;

d. Power control and management techniques in computers architectures for hardware components which varies according to the voltage (v), frequency (f) and processing time (t).

# Chapter II

## *Review of Literature Work*

# CHAPTER - II

## REVIEW OF LITERATURE WORK

Let us briefly explain some of the important references related to the present work. In the year 1992, Milenkovic [113] have reviewed a book for the scheduling process in data communication, concept and design for computer communication networks.

In the year 1999, Benini et al. [27] have determined the dynamic power management technique for reducing the power consumption of a complex network system. Authors have proposed performance interval and power consumption depended on workload. Newman and Watts [118] have proposed a real-space renormalization transformation for mathematical model a for a large-scale network system. In this model, Authors have described the transmission of the process in continuous phase or interval.

In the year 2000, Hwang and Wu [75] have described a system level power management technique for power saving. There was a new method for system shutdown developed by authors. Authors had introduced two mechanisms, (i) prediction-miss correction (ii) pre-wakeup.

In the year 2001, Jones et al. [84] have proposed a survey of energy efficiency for wired networks. Authors have discussed the all techniques for finding the energy. Authors have given various energy reduction technology and low power design architecture of computer design for networks. Qiu and Pedram [126] have invented a theory for Stochastic Modelling of a Power-Management System. Simunic et al. [141] have described the algorithms for reducing energy consumption at the system levels in low-power states. There are two classes of defining algorithms and proposed for performance measurement (i) timeout and (ii) predictive. Authors have categorized the algorithms based on stochastic for Performance Measurement and Time Indexed Semi Markov decision process (TISMDP) model in performance.

In the year 2002 , Bhatt and Miller [29] have written a stochastic Mathematical model used for network; Authors have described the various methods used for energy computation in wire or wireless. In this book the various methods uses the like integer linear programming. Irani et al. [77] have found the strategies for online Dynamic Power Management (DPM). Authors have two approaches (1) Theoretical basis mathematical computaion of DPM (Dynamic Power Management) for systems with multiple powers (2) The algorithm based probability generated different inputs for deterministic strategies. Sorber et al. [143] have described the design, implementation, and evaluation of Hierarchical Power Management Architecture (HPMA) for mobile systems. Wieselthier et al. [154] have given source-initiated multicast session traffic in an ad hoc wireless network, operating under hard constraints on the available transmission energy as well as on bandwidth and transceiver resources. Authors described the similarities and differences between energy-limited and energy-efficient communications.

In the year 2003, Gupta and Singh [63] have discovered the sleep mode technique used in distributed computing network. Authors have used technique in router and various computer devices for the energy saving. The Disruption Tolerant Networks (DTNs) technique is used in mobile computing. The DTN's are useful for wireless mobile networks in the end to end communication. Authors evaluated the energy consumed by wired communication. The energy can be using the low-power radio and high-power radio.

In the year 2004, Bergamo et al. [25] have given a routing algorithm for energy efficiency in adhoc networks. Authors have given distributed power control, how to manage and application of power controlling method. In this algorithm each node in the network estimates the power. Authors have also implement the algorithm for energy efficiency in networks, like- Dijkstra and Link State routing scheme in AODV network.

In the year 2005, Ren et al. [130] have implemented DVFS techniques for CPU energy consumption. The techniques have two types of scheduling division (i) inter-task DVFS (ii) intra-task DVFS. By the method of DVFS, we can reduce energy consumption also with real-time DVFS scheduling Ren and Marculescu [130] have discussed a hierarchical technique for DPM under no stationary service requests. The dynamic power management has targeted at extending battery life by low power modes when there is a reduced demand for service. Static power management strategies can affect to poor performance or unwanted powerful. Silberschatz et al. [140] have edited concepts for the scheduling and routing in distributed and parallel systems.

In the year 2006, A. Hassan, et al. [1] have discovered the evaluation the scalability and performance of High-Performance Cloud Computing (HPCC) on Microsoft Azure Cloud Systems (MACS). Baiamonte and Chiasserini [21] have described the energy saving for wireless Local Area Network (WLAN). Authors have proposed a new approach for distributed power allocation in channels. In this technique, a model based topology is worked in networks that affect the QoS and Power Saving Mode (PSM). Jun et al. [85] has found the Disruption Tolerant Networks (DTNs) technique in mobile computing. The DTN's are useful for wireless mobile networks in end to end communication. Authors evaluated the energy consumed by wireless communication. The energy can be using the low-power radio and high-power radio. Theocharous et al. [148] have discovered Machine Learning for Adaptive Power Management. In this technology Authors have defined the Adaptive Power Management (APM) systems for laptops and desktop computers decide when to place a component into various power saving states operated by the user. The APM system is to maximize the battery life while minimizing the annoyance to the user and long-time management.

In the year 2007, Chelius et al. [40] have explained the minimization of the power consumption to the nodes of wired sensor networks for lower and upper bound broadcasting. The theory is based on mathematical programming problem in sensor networks.

In the year 2008, Huang et al. [73] have described the topology for optimized link state routing in mobile ad hoc network MANET routing protocols. Jin et al. [82] have invented an energy-efficient multi-level clustering algorithm called (EEMC) collect data from machine to machine (M2M) communication. A sensor networks have limited capability because rechargeable energy resources, energy efficiency is a important issue in designing the topology architecture. Lewis et al. [96] have proposed to develop a system-wide energy consumption model for servers, in hardware performance and experimental results. Miao et al. [111] have surveyed Cross-layer design for energy-efficient optimization in wireless communication networks. Mikyung et al [112] have developed an energy-efficient real-time scheduling criteria and time scheme on dual-channel networks. Zhuo et al. [168] have given an algorithms duEDF a theory for energy consumption of system level CPU energy-efficient algorithm named Dynamic Utilization.

In the year 2009, Dietmair and Verl [51] have given a general framework model for energy consumption model for decision making and energy efficiency optimization.

In the year 2010, Abal et al. [3] have invented an algorithm based implementation for spatial search on a honeycomb network. In this algorithm to search problem on a honeycomb lattice with N sites and torus-like boundary conditions area is defined. The searching algorithm is dependent on path scheduling on hexagonal shape network invented by Ambainis, Kempe and Rivosh in 2005. The time complexity of this quantum search algorithm is O (√N logN). Ove and Lovric [122] have energy efficiency in wired access networks in the technologies like copper-based (e.g. hybrid fibre coax HFC) and two digital line, namely ADSL2+ and VDSL2. Authors have also discussed several optical access network are considered optical networks like as GPON, EPON , 10G-EPON and point to point (P2P) optical networks. Lloret et al. [101] discussed the energy consumption by analytically in a wireless local area sensor network. Authors have also proposed a new protocol based techniques implemented in its networks and save the energy wasted by the whole system.

In the year 2011, Ballga et al. [23] have predicted the analysis and technology for energy consumption of data throughput in network's like DSL, HFC networks, passive optical networks, machine to machine optical systems, W-CDMA, WiMAX. Bolla et al. [33] have described and survey of energy consumption for future and present in computer networks. Authors have developed various method of energy finding during data transmission. Bolla et al. [34] have discovered two features of green networking, (i) power consumption for next networking and (ii) the detailed survey of energy performance design mechanism issues. Gelenbe and Morfopoulou [59] have introduced a network framework for energy-aware routing in packet networks. Lange et al. [92] have proposed predicted for energy consumption in broadband network and the highest energy consumption growth rates are foreseen in the data centres and IP backbone networks. Lee et al. [93] have predicted an algorithm and implemented in the energy consumption of scheduling process for Distributed computing systems in various stages. Authors have defined scheduling path method on distributed system and applications in multiprocessor computer systems. They presented two energy measurement scheduling algorithms by Dynamic Voltage Scaling (DVS). The processors operate at different stages voltage supply levels at the expense of clock frequencies. Mostowfi and ken [117] have given new Energy Efficient Ethernet (EEE) policy of synchronous coalescing of packets in network hosts and edge routers. This policy provides extended idle periods for all ports of a LAN and thus enables energy savings Ethernet physical layer (PHY). Puype et al. [125] have developed a multi-level transmission Engineering (MLTE) for distributed systems. MLTE helps in improving network energy efficiency and information communication technology (ICT). This technology implements in the hardware devices and software applications. Authors proposed these techniques used in chip level hardware devices. Tekbiyik and Elif Uysal [147] have invented the shortest-path-based energy efficient routing algorithms for wired and sensor network. Wang et al. [151] have focused on solving the energy optimization problem for real-time multiprocessor systems in streaming pipelining with dynamic voltage scaling and dynamic power management in the complete transition process. A scheduling genetic algorithm is proposed for best scheduling process. Wang et al [152] have given an algorithm for energy optimization method. Authors have dynamic reconfiguration in real time scheduling for multitasking systems. Authors have used flexible parameter based on dynamic reconfiguration for completion of processes in a multitasking system. Wang et al. [153] have described an algorithm for energy optimization method. Authors used dynamic reconfiguration in real time scheduling for multitasking systems. Authors have used variable parameter based on dynamic reconfiguration for completion of processes in a multitasking system.

In the year 2012, Agnihotri et al. [5] have analysed Worst-case asymmetric distributed function computation they established two equivalence classes of compressible and incompressible functions to classify the set of all computable multivariate functions based on the minimum number of source bits needed in the worst-case to compute a function in the distributed function computation set-up. Alves et al. [13] have discovered a model for large-scale data centre and small-scale data centre for energy efficiency and throughput performance of power. Authors have also rate adaption on incremental decode-and-forward relaying data forwarding. Bianzino et al. [30] have investigated full system based architecture in computer networks for energy efficient wired networks. Boiardi et al. [32] have given a mathematical framework of energy related operation. Authors have given a joint framework and management of of networks architecture for energy approaches. Gaona et al. [58] have given the design of energy-efficient in hardware transactional memory systems. Cecile Orgerie et al. [39] have given framework which is prediction algorithms and scheduling management to optimize the energy in transmissions. Authors have introduced energy efficiency bandwidth for bulk Data Transfers in Wired Networks. The end-to-end energy cost model of such networks which described the energy consumed by a transfer for all the crossed equipments. This model is used to develop a new energy-aware framework adapted to bulk data transmission through the networks. Chiaraviglio et al. [44] have given a real algorithm for sleep mode systems. Authors have also given a model, based on random graph theory, to compute energy saving of variable transmission, QoS, and the number of allowed network systems. Coomonte et al. [46] have given a simplified energy consumption model for fiber-based next generation access networks. Authors have fiber-based NGAN architectures, i.e. Fiber to the House (FTTH) in both Passive Optical Network (PON) and Point-to-Point variations and fibre to transmission FTTx. Gelenbe et al. [60] have given an algorithm for power saving in packet networks by routing scheduling method. Gouvy et al. [61] have invented an energy aware routing algorithm for minimizing the energy consumption through mobile with connectivity in sensor networks. Heddeghem et al. [68] have computed energy consumption for Information Communication Technology (ICT) and evaluation from 2007 to 2012 on three main ICT categories: networks communications, personal computers, and various data centres. Herrer et al. [69] have developed sleeping algorithms and a mathematical model for the assumed energy savings and the average packet delay caused by forwarding traffic. Lin et al. [100] have given a theory for balance energy consumption in networks. Authors have proposed how control actions and measurement with can balance in wire sensor networks. Tseng et al. [149] have described a compression algorithm, which is designed to solve the problem of the link on/off and weight assignment problem issues to minimize a network’s energy consumption. Zeadally et al. [160] have proposed various recent techniques and solutions achieved to minimize energy consumption by communication devices, protocols, networks, end-user systems, and data centres. Authors have introduced scalable, cost-effective energy-efficient communications in the future.

Serrano et al. [137] have discussed classify of the mechanisms based on their time-scale operation. Authors have implemented to evaluation methodologies and undertake a quantitative comparison of their performance in greening wireless networks. William [155] has described the energy efficiency in distributed computing.

Zomaya and Choon Lee [169] have discovered have evolved the energy consumption of the data centre using the multiple frequencies for multiple processors to minimize the energy consumption.

In the year 2013, A. Montoya et al. [2] have invented Energy Load Balancing Strategy to Extend Lifetime in Wireless Sensor Networks. Al Aghbari [9] has given Energy-efficient distributed wireless sensor network scheme for cluster detection. The algorithm uses a grid-based clustering technique to detect clusters of similar stream values. The processing of the algorithm is distributed among different elements of the WSN in a hierarchical topology for more energy efficiency. Andrea et al. [16] have developed a network model for cost and benefits for dense topology for cloud or smart grid computing. Authors have implanted the network model for the complex network analysis (CNA). Andrews et al. [17] have proposed the model for routing and scheduling for energy saving in power mode scheduling. Anne et al. [18] have described a favourable scheduling algorithm for unified scheduling process. This scheduling process depends on probability, offline for energy consumption. Castañé et al. [38] haven framework energy consumption in distributed computing such framework is given as E-mc2: A formal framework for energy modelling in cloud computing. Authors have also developed different methods for measuring energy consumption in computer systems. Chiaraviglio et al. [42] have invented the model-based energy consumption mechanism such as device architecture and load for networks. Authors have proposed also the algorithm for energy saving capabilities in sleep mode and active mode. Chiaraviglio et al. [43] have proposed a mechanism for energy consumption for minimizing internet service provider (ISP) in distributed computing. Authors have given the formulation and solution based in network energy cost and reliability. simple and complete formulation, which results into an NP-hard problem that can be solved only for trivial cases. Curry et al. [48] have given a maturity based model also called the value based method for organizing, evaluating, and planning. Jin et al. [81] have invented an energy-efficient multi-level clustering algorithm called (EEMC) collect data from machine to machine (M2M) communication. As sensor networks have limited and non-rechargeable energy resources, energy efficiency is a very important issue in designing the topology, which affects the lifetime of sensor networks greatly. In this algorithm, the energy consumption is modelled and compared between single and the clustering scheme. Authors have analysed energy-efficient multi-level clustering algorithm called EEMC, which is designed to achieve minimum energy consumption in sensor networks. The cluster head election scheme is also considered in EEMC. EEMC terminates in O (log log N) iterations given N nodes. When the path loss and minimum latency. Yan et al. [158] have explained a numerical study of energy consumption which depends on time efficiency with five structural topologies and four different routing methods i.e. (i) ER Random Graph Model (ii) Kleinberg Small World Model (iii) Scale-Free Model (iv) Grid Model. Although different devices have a range of power consumption due to heavy load across the network, the overall time of execution increases and power is directly related to the time, therefore energy consumption increases. Authors have used a Mathematical technique to optimize the energy consumptions in distributed systems. Zhang [162] have described Energy-efficient task scheduling algorithms on heterogeneous computers with continuous and discrete speeds. Authors have discussed two hybrid algorithms for continuous and discrete speeds are created separately to obtain the best task schedule among candidate task schedules. Potential research applications include incorporating energy-efficient software into mobile devices, sensor networks, data centres, and cloud computing systems. Zhang et al. [164] have described Energy-Saving scheme that is based on downstream Packet Scheduling (ESPS) in Ethernet passive optical network. First, we design both an algorithm and follows packet scheduling at the optical network unit. Zhang et al. [165] have predicted a scheme based packet scheduling in Ethernet passive optical network, authors used an algorithm and discussed sleep based model for energy saving Approaches. Authors have also interpreted the energy consumption on sleeping and low loaded networks unit. Lei et al. [94] have given an algorithm for energy efficient scheduling in the data centre. In this proposed algorithm, there are two types of scheduling (i) Green- Oriented scheduling (ii) Time-Oriented Scheduling. Authors described a multi-objective energy efficiency task scheduling on a green data centre by Dynamic Voltage Frequency Scaling (DVFS) technology. Lent et al. [95] have given a model for subsets for network server performance and power consumption. Lin et al. [99] have proposed a theory of routing for the mobile-based agent in wireless sensor networks. Authors have depicted the unbalanced energy of a sensor network with uniform distribution in the data canter. The method of Energy finding of cluster routing based on a mobile agent in the data centre. Makkes [104] have developed a decision framework for placement of applications in clouds that minimizes their green network. The model of the framework architecture network for the energy consumption at the local sites and remote sites. We showed that the type of network connecting the two sites has a significant impact on the total. Mandal et al. [105] have given the model for content-placement techniques for different types of content distribution networks (CDNs) across telecommunication networks to energy reduction. Transmission of the network process is varying time variation between storage power consumption and transmission power capacity. Marsan et al. [106] have studied the base station sleep mode for reducing power consumption radio networks. The base station networks of sleep mode links are simulating and analysis. Niewiadomska et al. [120] have described a Control system for reducing energy consumption in backbone computer network. Noureddine et al. [121] have reviewed middleware approaches for energy management in distributed environments. Authors have also discussed middleware platforms and detail a number of applications, where energy management is applicable. Rincon et al. [132] have given an architecture that enables interaction between the data centres, which is designed to be progressively deployed, and without modification of the existing DC automation and framework systems. A Novel Collaboration Paradigm for Reducing Energy Consumption and Carbon Dioxide Emissions in Data Centres. Sakellari et al. [134] have proposed admission controls in wired networks have been traditionally used as a way to control traffic congestion and guarantee a quality of service. Authors have also described proposing an admission control mechanism which aims to keep the power consumption at the lowest possible level for more energy saving. Schien et al. [135] proposed a model to analyze and assessing variability for the energy consumption at the during downloading multimedia Applications. Sun et al. [145] have given game theory framework for a mobile ad-hoc network (MANET). Authors have also proposed game theory implemented for improving the transmission efficiency by Considering Non-Cooperation in Ad Hoc Networks.

In the year 2014, Addis et al. [4] have described an energy management of networks and cloud frameworks for finding the network performance. Anbazhagan et al. [15] have described the power management techniques for IEEE 802.16m network using power saving in heterogeneous traffic. Authors have proposed an algorithm combined cyclic binary exponent (CCBE) and combined truncated binary exponent (CTBE).

Bolla et al. [35] have described Burst2save mechanism for energy efficient network dynamics. This technique gave results the Quality of Service for data throughput and latency Bonetto et al. [36] have investigated the energy to traffic proportional and resource utilization for the Point of Point, while sleeping modes. Authors have proposed the energy efficiency in access and aggregation networks. Bilal et al. [31] have proposed the energy efficiency which depends on (i) DCN architecture i.e. electrical optical and hybrid (ii) network traffic management (iii) network aware resource allocation and energy efficiency. Bernardo et al. [26] have proposed to Optimized Power saving algorithm for Continuous Media Applications (OPAMA) proposed. This algorithms targeting for energy efficiency of client server component devices. These techniques for requirements networks like data aggregation techniques and OPAMA for a IEEE 802.11 connectivity of Power Save Mode (PSM) measurement. The algorithm uses the feedback on the end-user expected quality to establish a proper tradeoff between energy consumption and application performance. OPAMA was assessed in the OMNeT++ simulator. Bruschi et al [37] have given a model for incoming applied workload. Authors have applied the model for input hardware in all network distributed devices networks. Chen et al. [41] have described a new type of sensor called cable sensor, this type of sensor has a rectangular shape sensing area with a processor. Authors have given the energy efficient communication algorithms for wireless cable sensor network. There are two cases for proposed algorithm, one is the reducing power via transmission power of processors during connectivity network and another is scheduling cable sensor during network connectivity. There are two approaches which are reported to develop the distributed algorithm called DTRNG based on neighbour node connectivity graph. The second proposed method is the transition algorithm which has evaluated the minimum number of an active sensor to maintain and connectivity desire. Coiro et al. [45] have described a Genetic Algorithms for reducing power consumption in IP Backbone Networks. Coroama et al. [47] have given some method for reducing energy consumption firstly the top down analyses secondly model-based Approaches and thirdly bottom based Approaches for finding the reducing energy consumption. Da-. Elavarasan and Steffi [52] have given an algorithm for a delay aware network structure for WSN’s with consecutive data collection. Authors have also a reduction of energy data losses from peer to peer data transmission proposed. Fang et al. [53] have formulated a stochastic optimization problem and design the control algorithm and evaluated the energy performance on throughput the data in networks. Fatih [54] has described an energy efficiency QoS-based network selection scheme over heterogeneous WLAN – 3G networks. Galatolo et al. [55] have given of the any dynamic network to the reduction for energy computation of network energy. Heddeghem et al. [67] have described the mathematical power consumption model for the large telecommunication network. The power consumption in the computer devices such as internet protocol, switching, Ethernet and wavelength division multiplexing equipment. Galinina et al. [56] have given the optimization of optimal power control scheme for reducing energy in 4G networks. Guo et al. [62] defined mobile terminals, energy efficiency optimization is one of the most important issues due to battery power limitations, resource constraints and quality-of-service (QoS) requirements. Hashimoto et al. [65] have given TCP congestion control mechanisms in three manners (a) active mode (b) sleep mode (c) sleep mode with burst transmission. Honguntikar et al [71] have studied the optimization techniques incorporating evolutionary model in wireless sensor network. Authors have given various methods to define the network energy methods. Longley John [102] has discovered computability structures, and given models of computation such as labelled transition systems and process algebras. Author has considered a general notion of estimation between computability structures. Kim et al. [89] have proposed design a network configuration structure that permits each router to have its own addressing space for unique address allocation to its child nodes. So Authors have also design a node type like router or end device algorithm for estimating energy in distributed wireless networks. Menezes et al. [108] have given two models for estimation energy in equipment. In this model, the first model applies random sampling method for computation and second model applies power demand and operational energy in bottom-up connected devices. Authors have done both models with demonstrated and good correlation between connected data. Meo et al. [109] have given European community researches networking, including manufacturers, operators, research centres, measurement the energy demand for future telecom infrastructures, and to design energy-efficient, scalable and sustainable future networks. Radi et al. [128] have studied a survey of neighbour nodes, link evaluation and collection of tree protocols of the network. Sivaraman et al. [142] have given three new contributions to energy efficiency (i) the three performance switches like ports counts, traffic loads, packets size, and traffic burrstones. (ii) Powerful model for reducing the energy consumptions (iii) Energy saving via experimental based. Sharma and Nitin [138] have described a simulation method in real time distributed system for finding the entropy. Tarasyuk [146] has discovered a framework of discrete stochastic model for energy estimation and has implemented performance analysis of distributed systems. Vardalis et al. [150] have proposed Delay Tolerant Network (DTN) architecture facilitates the reducing energy conservation. Xia and Shihada [156] have proposed semi-open Jackson network model for data transmission and a Markov model for channel states transition. Authors have derived a difference equation of the system performance under any two different policies. The necessary and sufficient condition of optimal policy is obtained. We also prove that the system performance is monotonic with respect to the transmission rate and the optimal transmission rate can be either maximal or minimal. That is, the bang-bang controlling is an optimal control. Niewiadomska et al. [119] have described two-level control framework for reducing the power consumption in computer networks, (i) local control mechanism for network device, (ii) network-wide control framework technique for reducing power consumption. Zhang et al. [163] have predicted a scheme based packet scheduling in Ethernet passive optical network, authors used an algorithm and discussed sleep based model for energy saving Approaches. Authors have also interpreted the energy consumption on sleeping and low loaded networks unit.

In the year 2015, Jiang et al. [80] have found towards secure and reliable cloud storage data re-outsourcing of cloud storage and energy management. Quwaider et al. [127] have invented the theory for the mobile cloud computing and mobile cloud resources. Rengarajan et al [131] have described Energy-optimal base station density in cellular access networks with sleep modes. Authors have approached the maximum energy saving in wireless local area networks. Rubio-Largo et al. [133] have described a parallel multi objective approach based on the honey bees' behaviour for grooming low-speed traffic requests onto high-capacity optical channels. So this method of a parallel Multi objective scheme based on Honey Bees for traffic transmission in Networks. Petri et al. [124] have proposed a of study identifies the following contributions: (i) a comprehensive examination study to the HPC high performance computing like performance, cost, user perspectives and range of user activities, (ii) a comparison of two different execution environments such as

HTCondor and Comet Cloud (iii) a detailed performance analysis to locate the limiting factors of these execution environments.. Zdraveski et al. [159] have described an algorithm for the load balancing in power distribution networks in a cloud system. Padilha - Feltrin et al. [123] have described volt- var controlling for distribution network operation in multi objective optimization devices. Energy savings and peak demand relief through the voltage reduction procedure. Currently, due to the emergence of the distribution smart grids, these procedures are gaining renewed interest and attention. Moety et al. [114] have described the optimization models for power delay minimization theorem in green wired networks. Martinus et al [107] have given a strategy for distributed data centers and sub-network region. Authors have implemented the social network analysis of multi-scalar energy networks. Kiani et al [88] have given a theory of real-time tasks scheduling. This scheduling process is based on CPU and read-write tasks of the hard disk. The execution time of the process of the CPU and read-write time of hard disk without tasks missing. Krzysztof et al [90] have proposed Optical networks for cost-efficient and scalable provisioning of big data traffic two optical technologies, namely currently the most popular wavelength division multiplexing and a new emerging approach of elastic optical network (EON). The performance metrics related to both optical network resources (network capital expenditures/operating expenditures (OPEX) cost, power consumption optical spectrum usage) and computing resources (response time and OPEX cost) are investigated. Lyu et al. [103] have defined high-performance scheduling model with a cloud sensor system. In a cloud system, scheduling has performed optimization by Zero One programming method by task models. Li et al. [97] have described the coordination of the energy resources for the decentralized system. Energy resources are coordinated with each other system for efficient autonomous system and demand in large power the distributed networks, information exchange is indirect communications between the agents. Jiang et al. [78] have proposed a multicast routing algorithm for reducing energy consumption in topology network design. Jiwei et al. [83] have given Markov Decision Model for energy consumption in distributed computing. The Markov decision process uses in the computing devices as the task scheduling and algorithms for an optimal solution for the process throughput. Huang et al. [74] have invented the cloud data redundancy for highly reliable cloud storage systems and also demonstrate the improvement of saving of data redundancy computation in networks system. Hun et al. [70] have described Distributed hierarchical game-based algorithm for downlink power allocation in OFDMA femtocell networks. Authors have proposed (OFDMA) Orthogonal frequency division multiple access femtocell networks. This methodolgy is captured in the framework of a Stackelberg game, and the Stackelberg equilibrium is introduced as the problem solution. Balachennaiah et al. [22] have described an algorithm based technique for optimization the control of power loss and voltage stability in transmission time. Ahmed et al. [8] have proposed a framework for the energy efficient, the effect of network-centric parameters depending on the Application over the WLAN. Agostini et al. [6] have found the management of strategic multi-partner SME small and medium enterprises networks introduce the concepts of heavyweight, lightweight and internal or external network. Alonso et al. [12] have described the management for power consumption in fat tree communication networks. It is depended on network bandwidth in transport requirement. The coordination mechanism is asynchronously scalable. Al-Ayyoub et al. [10] have invented the theory for the optimizing techniques for ultra-scale cloud computing data centres. Ahirrao and Ingle [7] have discovered the measurement and scalable transactions in cloud data stores. Authors have also a novel workload-aware approach, with scalable workload-driven data partitioning based on data access of internet applications transmission processing. It is specially designed to scaling. Alzamil et al. [14] have proposed a profiling system architecture which used for energy consumption, in cloud computing. Ganji et al. [57] have proposed different method for energy consumption by uses of WLANs (Wireless Local Area Networks) for green campus. Authors have done two implantations (1) Historical Behavior in The Campus, or on (2) Current Access Points Utilization. Zulai et al. [170] have energy-efficient next-generation passive optical networks based on sleep mode and heuristic optimization in distributed systems.

In the year 2016, Alkhanak et al. [11] have proposed cost optimization approaches for scheduling in distributed systems and grid computing. Araujo et al. [19] have proposed two methods for energy efficient (i) integer linear programming (ii) heuristic algorithm to solve energy efficiency problem. They have computed energy consumption through routing by demands and link capacity. Banditwattanawong et al. [24] have invented intelligent cloud (i-cloud) performances which were stable and close to those of infinite cache size. Serrano et al. [136] have discussed classify of a mechanisms based on their time-scale operation. Authors have implemented to evaluation methodologies and undertake a quantitative comparison of their performance in greening wireless networks. Bharti et al. [28] have given task requirements aware Pre-Processing and scheduling (TRA) for CPU. The scheduling of processor is measured by the incoming tasks. Proposed energy monitoring system works on reducing message process and energy consumption. Da-Ren et al. [49] have implemented DVFS techniques for CPU energy consumption. The techniques have two types of scheduling division (i) Inter-Task DVFS (ii) Intra-Task DVFS. By the method of DVFS, we can reduce energy consumption also with real-time DVFS scheduling and robustness. Devi et al. [50] have developed a cost-efficient dynamic batch mode scheduling for assigning the task. Authors have used scheduling as many types (1) Round Robin Scheduling (2) Minimum-Minimum Scheduling (3) max-min to use the energy performance cost-effective scheduling. He and Li [66] described a fast diagnosis algorithm for the communication network in high-performance computers. Harbin et al. [64] have proposed the Transaction-Level Model algorithms for the networks. Authors have given two Application cases (1) Lightweight Transaction-Level Model (TLM) simulation models can produce latency of low energy. (2) Dynamic power consumption model. In the network performance of latency dynamic power modelling algorithms. Imran et al. [76] have proposed a Hybrid Optical Switch Architecture (HOSA). The hybrid system design works as slow and fast optical switches of the performance and reliability. Authors have also investigated the scalability cost and power consumption of design of the HOSA. The evaluation of the data centre by the network level simulation at the time of workload parameter latency, high throughput, and communication load. Jiang et al. [79] have formulated a mathematical methodology of integer linear programming (ILP). The computational complexity of the network utilization is maximum if a network is peak form but the low network utilization the unnecessary energy is the waste in a data centre. Li et al. [98] have developed a theorem for energy and time constrained task scheduling on multiprocessor computers with discrete speed levels. Mershad et al. [110] have given a mathematical model for evaluation and the utilization of a big data in distributed data centre. Rehaiem et al. [129] have discovered a scheduling priority based algorithms of real-time scheduling for embedded systems. In this method, authors used embedded systems with neural networks for low power consumption optimization. The combination of the DVS and neural Feedback scheduling process are used for energy optimization. Sousa et al. [144] have given an algorithm based on Meta heuristic technique for energy resource scheduling in smart grids. Shi et al. [139] have developed echo state networks (ESNs). Xiao et al. [157] described the energy consumption for heterogeneous distributed networks by the use of scheduling algorithms. In the algorithms, the problem has divided two sub problems (1) Task-based energy consumption (2) Task scheduling of low time complexity and application of Fourier transform parallel and distributed computing. Zhang et al. [161] have predicted a scheme based packet scheduling in Ethernet passive optical network, authors used an algorithm and discussed sleep based model for energy saving Approaches. Authors have also interpreted the energy consumption on sleeping and low loaded networks unit. Zhao et al. [167] have discovered a task scheduling method for datasets and tasks. In this method authors have defined two conditions (i) datasets of task scheduling or scheduling points (ii) tree cloud to tree cloud task scheduling. Mosa et al. [116] have developed Optimizing virtual machine placement for energy and SLA in clouds using utility functions. Zhang et al. [166] have investigated a multi-ring based on optical circuit (OCS) networks. Authors have developed integer linear program (ILP) and heuristic algorithm to solve the RSA problem.

In the year 2017, Avci et al. [20] have given a distributed algorithm for energy efficient in networks. Authors have clarified of requirement for the energy consumption and implementation of algorithms to define in wireless sensor networks. Kurose and Ross [91] have discussed and edited distributed networks theory in the form of top down approach. In this approach, the various techniques are used to follows the networks theory in energy estimation of the data. Khelladi et al. [87] have proposed an algorithm for on-demand multi-node charging solution. These techniques are one of the methods for the reduction of energy consumed. This method of the reduction of energy with time complexity and efficiency. Kaswan et al. [86] have developed an algorithm for designing efficient of mobile sinks. The algorithm used with k-means clustering for network efficiency. Authors have proposed also scheduling algorithms for effective data transportation. Huang et al. [72] have suggested the balancing of the energy consumption in network transportation. The energy consumption of the mobile sinks during the data transmits across the network. Authors have proposed an energy-aware clustering algorithm and energy aware routing algorithm. Moharir et al. [115] have defined an algorithm of tree type dens network and performance.

Other related links are [171-179] which were accessed in the present research work.

# Chapter III

## *A Framework for Dynamic Power Management*

# CHAPTER-III

## A FRAMEWORK FOR DYNAMIC POWER MANAGEMENT

In present scenario, distributed computing is gaining popularity as many of users are related with their handheld device across the internet world wide. The connected device generally released energy which is of different kinds and it is a major challenge to optimize the entire energy of the system in connected networks. In this chapter, a framework is considered for dynamic power management to fulfilment of tasks in the minimum time frame which is routed from one node to another adjacent node across the network. In this proposed framework, a step topological network is selected at the application level of the framework model. The framework model is designed for data process. The system also has own energy is called local energy, modeling and mathematical process also consider the external energy is called remote energy. The formula for any system can be written as:

$$(\text{Total Energy})_{\text{Systems}} = (\text{Remote Energy})_{\text{All Components}} + (\text{Local Energy})_{\text{Systems}} \qquad (3.1)$$

### 3.1 INTRODUCTION

In last few years back, the energy-efficient distributed computing is a major challenging area of research in distributed networks and parallel networks computing. It is generally depending on hardware or software computing components. The energy uses the data centers as a challenging and complex issue because computing operation and data are growing and disks are needed to process them fast enough within the required time period. Green cloud computing is not only the efficient processing and utilization of a computing infrastructure but also to minimize energy consumption. This is initially for making certain that the future growth of distributed computing is maintainable. Otherwise distributed computing with increasingly common frontend client devices interacting with back-end data centres will cause. Cloud computing can be a more sustainable to drive commercial, scientific, and technological advancements for future generations. Specifically, this chapter aims to define an architectural framework and principles for energy-efficient distributed computing. In energy-aware resource terms and allocation algorithms. The hardware components are as processors, storages, and picture display devices. The performance and power management of the distributed network system are very effective. It is depending on the contributions of networks nodes. In distributed computing systems, the data stores on networks, the nodes must be switched on and connected to each computer. If the participating nodes are wired then it is more challenging on a network level, the dynamic power management classifies into two types of components i.e. sleep modes or slow down and idle modes. It is a way of reducing power consumption. The dynamic power management has been proposed by the heuristic method for stochastic optimization technique. The heuristic dynamic power management technique is used for timeout transmission. The stochastic theory is based on a stochastic model of the service request. The service requests are of three types. Firstly, each time, a new job process is generated and then searches for the procedure to find the minimum power execution sequence, the sequence has also be repeated. Secondly, this strategy does not effective in reducing the system energy by changing the working stage of devices with the multi-level stage. Thirdly, the exact knowledge of the device uses a process before the job is scheduled. A power management has attached to device components, system architectures, system resources that are shared among these device components. The application level scheduling is requiring the power management for the system. The numbers of power saving techniques have been related to many types of standards and protocol. The Power management in network topology and the power mode in IEEE 802.3 wire network the network topology are on network break down. Then a local area network (LAN) card is working in power saving mode and depends on data flow. The dynamic power management is depending on software also. This division is integrating various power management techniques. The application level supports the administrative level handling which is contributing to the users for share system level, and the flow control depends on part level. This chapter presents the design, implementation, and network evaluation, wire network device architecture that enables full device functionality, availability, and extended device life. Wired networks are unique, they have finite times. In large-scale distributed network devices such as desktop, the power management is used to extend device. The main objective of this chapter is to present our ideas, discuss open research challenges in energy-aware resource management, and develop energy efficient policies and algorithms for large-scale data centers.

## 3.2 PROPOSED MODEL

Network system-level dynamic power management architecture is represented in the following figure. The model is divided into three parts which are represented in figure 3.1:

### 3.2.1 Application model

In the application level, many users work with the server system. The server is working as distributed computing system as a data core network. All others send the Application for processing with server interaction with the network. The server

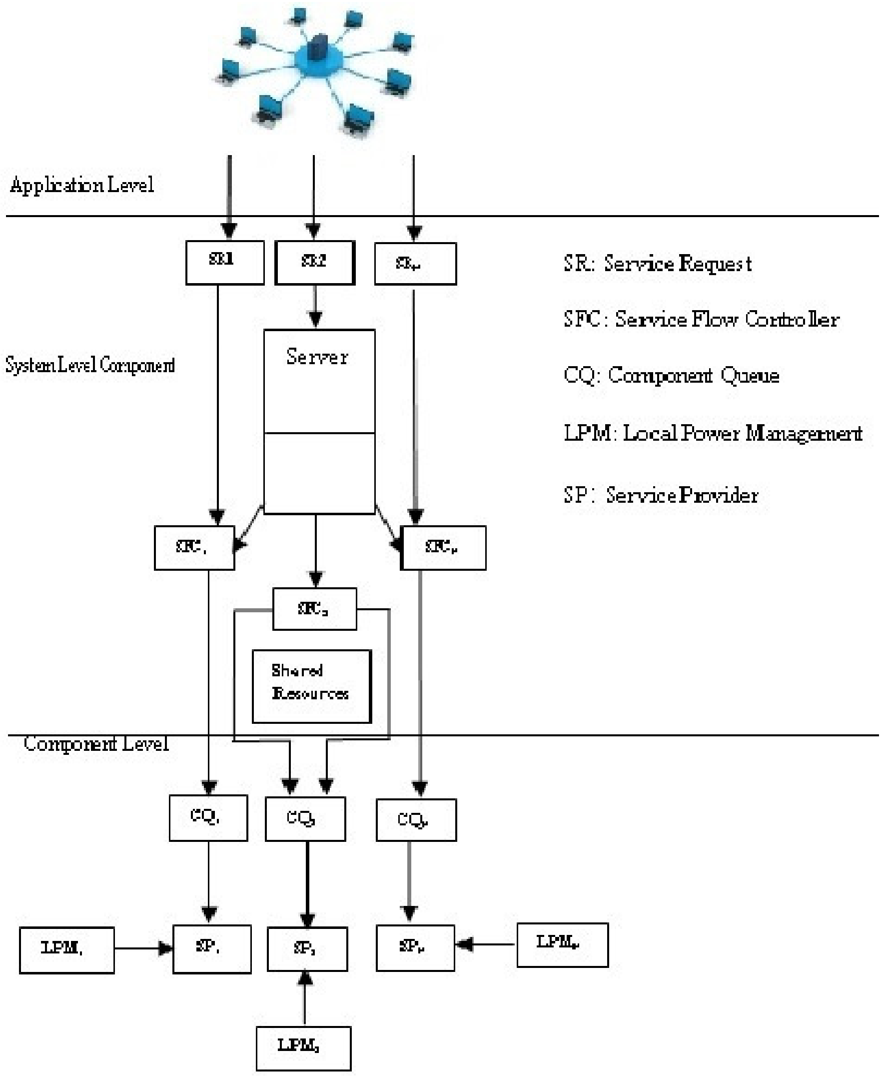



**Figure 3.1 A Network System-Level Dynamic Power Management Architecture**

permits to all users for synchronize process. The synchronized process is controlled by the administrator of such types of user operation by sequence. The users are interconnected across the step network as shown below figure 3.2:

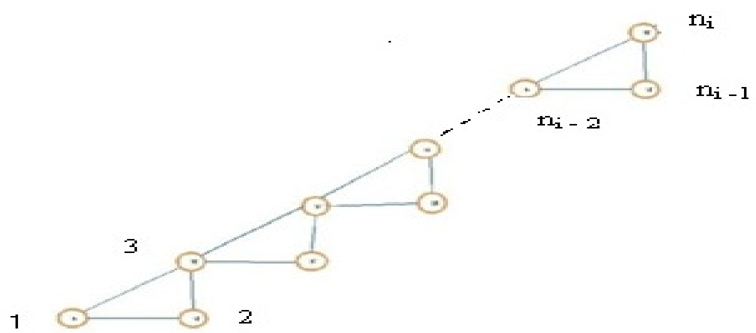



**Figure 3.2 A Step Network System**

In a fully deterministic program flow each program statement is executed in the same order. As the program transmits the same internal states for every execution, this yields not only a reproducible end result but also reproducible intermediate results. The disadvantage of this approach is the cost for achieving full determinism, especially for distributed applications, which will lose the bulk of their potential for parallel computation.

### 3.2.2 System Level

At the system level, the application server works on system level component. There are many services which request to organize the computing as first come first serve. After that, the service request is becoming complete then the next step is going to service flow control. The Service Flow Control (SFC) also works with the service request in minimum duration of the time interval with related to the request. It is working with data process and depends on throughput process and latency. The latency must be minimized in duration of such process operations.

### 3.2.3 Hardware Component Level

The hardware component level is attached to the computers. Every computer has own power management system known as local power management. Every service provider has own request related to control queue request in the synchronization process. All service providers interact with common resources and control on all components which request as the throughput process. In the above diagram, if the set of states (S) for all servers is S = {$S_1$, $S_2$……………..Sn} for all possible states with A= {$a_1$, $a_2$……………..$a_n$} for all possible actions, then the relation model is given below. R: S × A→R Specifies for taking action in state S (1) now let us define the transition model for the process. The transition model specifies the probability of transmission from state i to state j on taking action and the specified matrix.

$T_{ij}^{a}$ is given below table 3.1:

**Table 3.1 Transition Matrix**

$$\begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14}.......T_{1n} \\ T_{21} & T_{22} & T_{23} & T_{24}......T_{2n} \\ T_{31} & T_{32} & T_{33} & T_{34}......T_{3n} \\ T_{41} & T_{42} & T_{43} & T_{44}......T_{4n} \\ :::::::: & :::::::: & :::::::: & :::::::::::::::: \\ T_{n1} & T_{n2} & T_{n3} & T_{n4}......T_{nn} \end{bmatrix}$$

The above matrix indicates the process states $T_{11}$, $T_{22}$, $T_{33}$, $T_{44}$......$T_{nn}$, is diagonal which shows the process is ideal for next state and data throughput. If the transmissions state i to j on taking action and defines the specified matrix $T_{11}$, $T_{22}$, $T_{33}$, $T_{44}$......$T_{nn}$ is ideal. In the transmission matrix $T_{11}$, $T_{22}$, $T_{33}$, $T_{44}$......$T_{nn}$ is ideal, and all remaining may be in the waiting state for next state or failed transmission.

Power management is important for a range of embedded system applications from portable terminals and ad hoc sensor networks. The main focus of this area, the minimization of energy at the node level. The distributed system is much more complex because of the dynamic tradeoffs involved at several levels between local processing and communication/coordination. The correct way to think about it is to treat as a multi-level service in a distributed embedded system. The distributed power/performance related decision making and to ensure compliance with functionality and system energy constraints based on the runtime conditions. This is done by means of 'mediator'. These mediators are built in a model-based system specification that allows reasoning about the functional and non-functional properties of the system from the properties of the constituent components and the composition mechanism used middleware infrastructure that lends itself to platform-specific optimization for performance and size. In distributive systems adaptive and reflective middleware services are to meet the application requirements and to dynamically smooth the imbalances between demands and changing environments.

(a) The changes in the middleware, operating systems, and networks applications to continue to required service levels in resource availability, such as changes in network bandwidth or power levels.

(b) Changes at the Application level to either react to currently available levels of service or request new ones under changed circumstances, such as changing the transfer rate or resolution of information over a congested network.

In both instances, the middleware must determine if it needs to (or can) reallocate resources or change strategies to achieve the desired quality of services (QoS). Embedded Applications must be built in such a way that they can change their quality of services QoS demands as the conditions under which they operate change. Mechanisms for reconfiguration need to be put into place to implement new levels of QoS as required, mindful of both the individual and the aggregate points of view, and the conflicts that they may represent.

### 3.3 Numerical Results and Discussion

One can compute extensive numerical values as the size of step network grows. Authors have computed for five nodes as shown in figure 3.2 by considering the file size of 0.6 MB which is to be transmitted across the network. The transition time is computed for all possible combinations from $n_1$ node to $n_5$ node by using the following:

$$T_{ij}^{a} = k\,(Arrival\,Time + Generation\ Time) \tag{3.2}$$

Where $T_{ij}^{a}$ is the transmission time in state action a and k is the Load Factor? The minimum transition time is also computed by the use of Hungarian Method and it is computed as 3.014 milliseconds when the file is to be routed from $T_{14}$, $T_{22}$, $T_{31}$, $T_{33}$ and $T_{55}$. On the basis of above, the transition table is given below:

**Table 3.2 Computed Transition Table**

$$\begin{bmatrix} 0.540 & 0.594 & 0.570 & 0.564 & 0.710 \\ 0.560 & 0.588 & 0.564 & 0.688 & 0.656 \\ 0.510 & 0.582 & 0.540 & 0.578 & 0.662 \\ 0.630 & 0.606 & 0.570 & 0.698 & 0.652 \\ 0.688 & 0.735 & 0.757 & 0.751 & 0.782 \end{bmatrix}$$

The transmission in between of the network is considered as a minimum time for example if two routes exist between n1→n4 i.e. n1→n2→n4 or n1→n3→n4 then that route is selected which consumes minimum transmission time. The short route scheduling is very compulsory for the network processor. In such a manner, the data can be transmitted across the step network. Now the dynamic power management (DPM) is constructed to the point of view of whole System Power Management (SPM). This is utilized to derive a system-level policy and component level policy. The above model contains Application Level (AL), Service Queue (SQ), Service Control Flow (SCF) and Analysis Service Provider (ASP). The working functionality of the entire system is shown below:

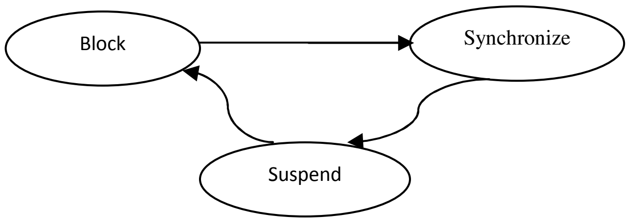



**Figure 3.3 Functions Initialization during DPM**

The SFC is modeled as a stationary. The state set of the SFC as SSFC= {Block, Suspend, Synchronize} and action flow of SFC is the set of action, ASFC = {Goto_Synchronize, Goto_Suspend, Goto_Block}.The details of state and transition of the SFC are explained.

**(a) Synchronize**

In this state, the SFC generates a run state process and classified two types of synchronized process in whole Universal Power Management (UPM).

i. Synchronized Service Queue (SSQ)

ii. None Synchronized Service Queue (NSSQ). The SSQ requests to the Service Provider (SP) on response time for next process zone. SP is decided in the process of that of a fixed time. If the fixed time for the process is not completed, then Go to NSSQ and vice versa.

**(b) Suspend**

In this state, the SFC continuously moves from SSQ to the SP. The SP will take up and provide requested services. Now a new component is added in that time Component Queue (CQ). The CQ is available on component level policy. The process is in SSQ by the acknowledged from SP at service request on the queue (SRQ). The SRQ moves towards a head for throughput one by one and burst it.

**(c) Block**

In this state, the SFC blocks all incoming SRQ from the entering the CQ of the SP. The main objective of the blocking various non synchronized processes is reduced and wake up times of SP and extend time utility the SP, synchronized process during sleep mode. Therefore,

The operation of a request for service (SR) = Waiting Time + Service Operations

$$SR = (W \times T) + (S \times O) \tag{3.3}$$

It is clear from the above that non-synchronization process over the network gives an increase in the transmission process with a heavy load on the system. The packet delivery fraction in service flow provider is based on the ratio of data packets transmission to those generated by sources. During the routing, load depends on routing packets sent per transmitted packets at the destination. Let us consider the SP with the fixed timeout policy and hard disk drive consists of two power states. (i.e. Active = 2.1 watt, Low power = 0.65 watt) and the transition power and time between the two states are 1.4 milliseconds and 0.4 milliseconds; the local power manager has two states as shown below in figure 3.4:

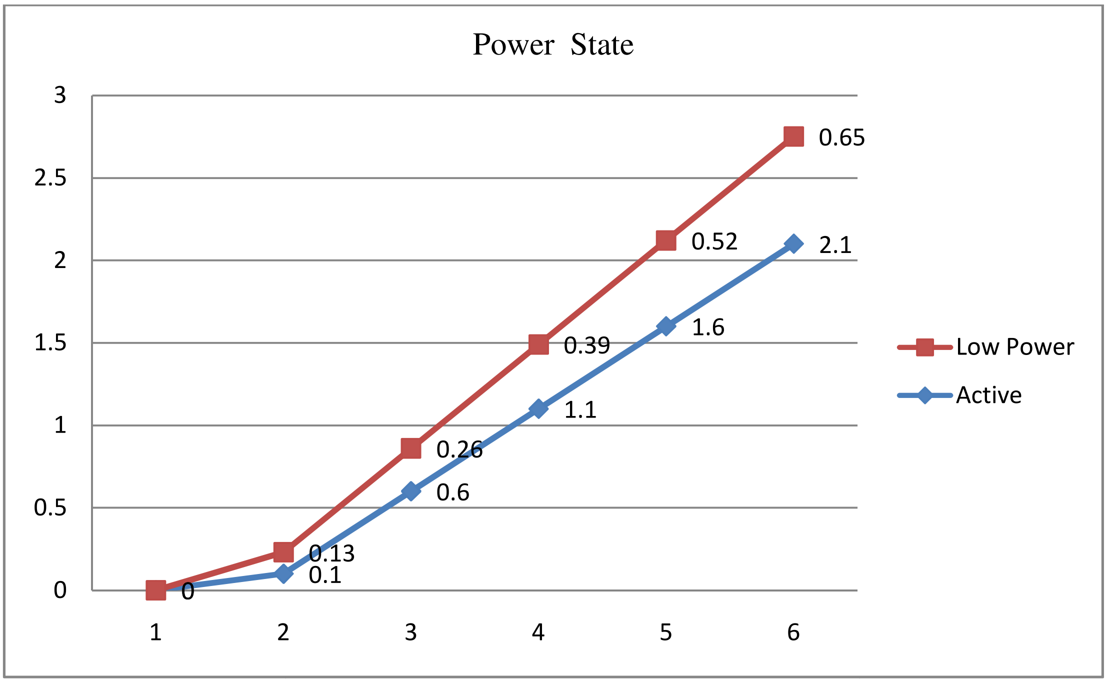



**Figure 3.4 Power State Process from User to Server**

The transmission processes from the user have local power management and the initial time depends on the user performance related to time and energy from time interval. If the initial time is 0.7 second and the power consumption is 0.2 watt, then transmission process is shown below:

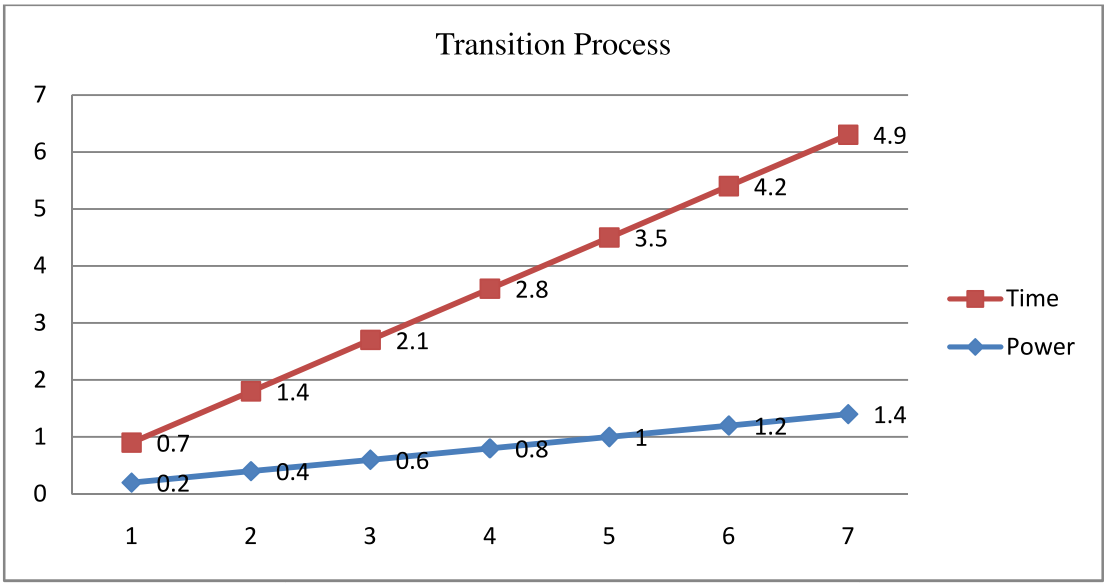



**Figure 3.5 Transmission Process across Step Network**

### 3.4 MAJOR FINDINGS

In this chapter, a model is proposed for distribution of the resources with three different levels across the distributed networks in which users are connected across the new network developed step network topology. In this model, the user's input by the admission controls users. The actions of users have direct access to the data from server request. At the time of data request process, the systems work with synchronizing or none/synchronize matter. The energy consumes at the time of data access the system release the power in watts. The systems also have self-energy release but the data process throughput the consolidated energy will highly or maximum. This framework model is beneficial for throughput data in following ways

(1) This model is well connected and all resources work with the same position.

(2) We can define individual energy or power or well defined consolidated power.

(3) We can also assume the resources position or how many devices contain works with the time of data processing or data centres services.

(4) We can determine the network efficiency and enhanced power if any stage as possible.

But this model has also some limitations which are as follows:

(1) Resource definition is not cleared in working.

(2) At the time of the power of the resource will restart time is maximum and time will more delay time.

(3) The power backup is compulsory otherwise any resource can be interrupted.

(4) Network maintenance and controls are difficult and the cost is high.

(5) The data security is more important in any network so this is very compulsory and management.

The energy consumption of the transmission time is optimized by the Hungarian technique by considering the limited nodes but it can be extended up to the finite numbers of nodes connected across the step topological network. In the proposed approach, the model is decomposed into three parts namely Application level system, component level and system level. Dynamic power management technique is used for optimization of the transmission of the processes. The experimental results have evaluated on five system connected over network server.

# Chapter IV

## *An Energy Computation in Distributed Computing Environment*

# CHAPTER –IV

## AN ENERGY COMPUTATION IN DISTRIBUTED COMPUTING ENVIRONMENT

In the current scenario, energy optimization for the electrical components used in the hand-held devices is a grey area of research. Energy principle for information technology contains its own specific energy behaviour. The energy costs in server centre are now compatibility with the cost of hardware devices and other comparable devices. In the processor device system, heat existing is a major cause of limiting changes in the performance evaluation. In the laptop, scanners, computers, cell phones, printers, i-pods, and other digital devices, which are portable, reduced the power consumption converts into the battery long life manner. The energy consumption is now presenting challenges as a performance measure in computers, processing the task execution time. The energy is linked with the execution time capacity, where comparable patterns have been recognised by a combination of hardware devices, software devices, and algorithms. In this chapter, the design of energy-efficient computer systems is proposed by the use of Bellman-Ford algorithmic Approach. A model is proposed for finding the performance of the system.

### 4.1 INTRODUCTION

Today's networks energy saving techniques is the very challenging area in the Information and Communication Technology (ICT) world. The energy consumption is very costly in the network for the system's parameters like CPU, motherboard, hard disk and the power level systems. There are three important factors for the energy consumptions namely

(a) Data forwarding or data transmitting from source to destination.

(b) Speed to the flow of data.

(c) Transmission of data packets.

There are three types of methods for finding the energy consumptions.

(a) Dynamic voltage scaling

(b) Dynamic frequency scaling

(c) Clock gating.

These methods are very precious for network energy consumptions. At the dynamic voltage scaling, all devices are working with the voltage-dependent component. In voltage scaling, the voltage varies with the network performance as if network's flow in high, then data transmission is capturing high energy over the system configuration. If the networks gain, the voltage is low then the data speed is low and energy consumption will be getting low. So frequency works, whereas the same as working with voltage if frequency and voltage with high, then energy is high consumption. But either frequency or voltage is related with reciprocal with each other. The basic formula of the input voltage and energy consumption formula are given as:

$$Voltage = \frac{Charge}{Capacitance} \tag{4.1}$$

Where charge is $Q = i \times t$ Coulomb, input current (I) and time taken (T)

$$Energy\ Consumption_{Resources} = \frac{Input\ Load}{Transmission\ per\ Scheduling\ Tasks} \tag{4.2}$$

Now consider the frequency scaling which explains to the technique that reduces the energy consumption by lower the processor's frequency. If high frequency enables high energy and lower frequency makes low energy consumption. If constraint occurs for the reduce voltage, energy to the workload balance will be reduced. These methods can be applied to other energy-consuming devices, as hard disk drives, motherboard, processor, and electromechanical devices. There are algorithms to find the minimal speed of data throughput and schedules for transmission packet scaling and finding the speed scaling. The power performance varies the main challenges for device system architecture and CPU temperature. In high temperatures performance varies according to reliability and cooling systems. The temperatures increase the energy consumption. The power optimization performance has been done for optimizing energy required for data storage and access data transmission.

## 4.2 METHODOLOGY

The collection of data for the data transmission in data centre server is like as packet flow if the data packets pass through the routing protocols algorithm. In the routing algorithm namely Bellman-ford algorithm developed by C. Perkins and P. Bhagat, in 1994 for distributed computing network as routing scheme under Destination Sequenced Distance Vector Routing (DSDV) protocols for the shortest path. The graph is denoted by , and the vertices and edges are representing the, $e$, then the graph is ( , $e$) and a link is $\mathcal{L}$, then the cost of function for the algorithm, $\mathcal{F}$ is given by

$$\mathcal{F} = \mathcal{L}_T + ( \; n, e n\text{-}1) \; \Phi \tag{4.3}$$

$$Energy = \frac{q^2}{c} \times Frequency \tag{4.4}$$

Where $\mathcal{L}_T$ is the total cost of links, $\mathcal{F}$ is a cost function, $\Phi$ is workload.

The algorithm consists of a set of operations that followed step by step for the solutions of the problem. It has two main features for the efficiency of an algorithm which are the (a) memory (b) computational time required for input size. The algorithm has two linear arrays F and H, fi ∈ F hi∈ H, where $i_{th}$ edge in G, if the graph has any self-loop then the process may be discarded. It is given in

**INPUT**:

*Directed Graph G= (v, e)*

*Edge lengths {$l_e$: e ∈ E} with no negative cycles, Vertex S∈V,*

*Bellman-Ford- BGL (G,w, s)*

*for each vertex v 2 V [G] do*

*d[v] = 1*

*end for*

*d[s] = 0*

*for i = 1 to |V [G]| do*

*Rest False*

*for each edge (u, v) 2 E [G] do*

*if d[v] > d[u] + w (u, v) then call Relaxation*

*d[v] d[u] + w (u, v) Relaxation step*

*Rest True*

*end if*

*end for*

*if Rest = False then*

*exit the loop*

*end if*

*end for*

*for each edge (u, v) 2 E[G] do*

*if d[v] > d[u] + w(u, v) then*

*return False*

*end if*

*end for*

*return True*

## 4.3 PROPOSED MODEL

### 4.3.1 Energy Saving Under Distributed Systems Using Bellman-Ford Algorithm

In the proposed model, the devices have consolidated attach in distributed computing manner. the parameter has the motherboard, HDD, memory and processor to reducing energy. They all parameters have own generalized features like voltage, frequency, current, and capacitor etc. so the above algorithm applied in parameter devices affect in action for transmission data. the proposed model of given figure 4.1:

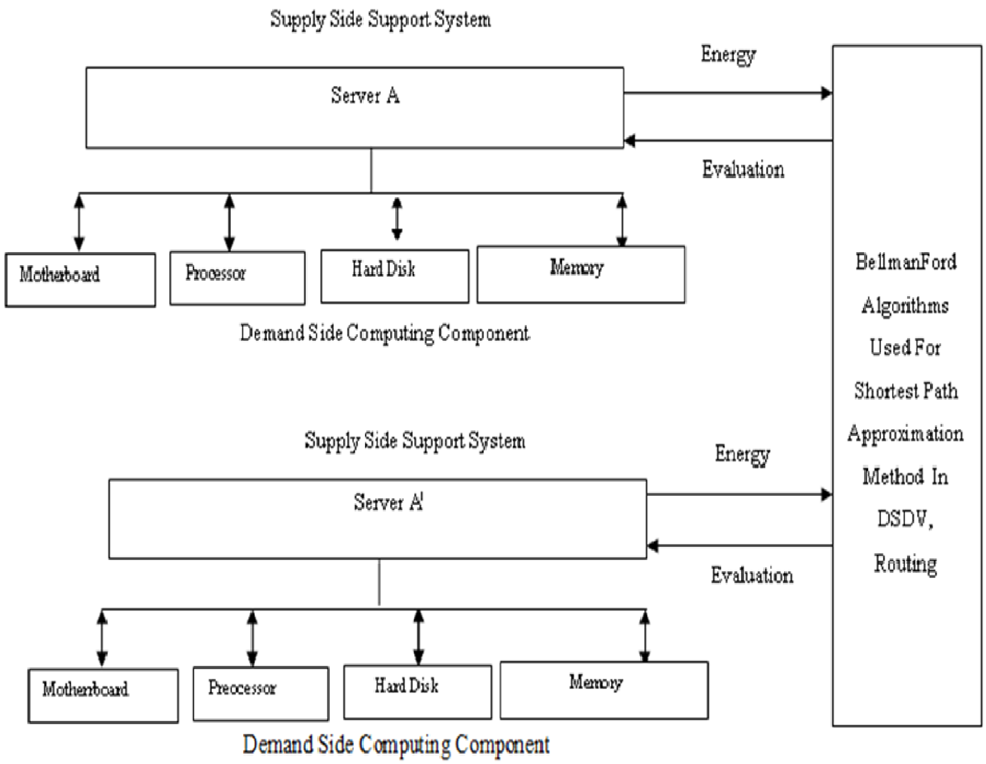



**Figure 4.1 Proposed Model for Energy Saving Under Distributed Environment**

The server energy is given by the following formula:

$$E_{eff} = \frac{W\ (workload)}{E_{Total}} \tag{4.5}$$

where $E_{eff}$. Is a server efficiency, and W is a workload, $E_{Total}$ is a energy used in the whole system. The energy processor is given by

$$E_{Proc.} = C_{eff} \times V^2 \times f \tag{4.6}$$

where $C_{eff}$, is the total capacitance, V is supply voltage and f is the frequency.

The energy for the motherboard is given by

$$\Sigma E_{MB} = V \times I \tag{4.7}$$

where V is voltage, $V_{min}$ =5 volt, $V_{max}$=12 volt, I is current in ampere, $I_{min}$ = 1A, $I_{max}$ = 8 Ampere.

The energy parameter for hard disk is given by

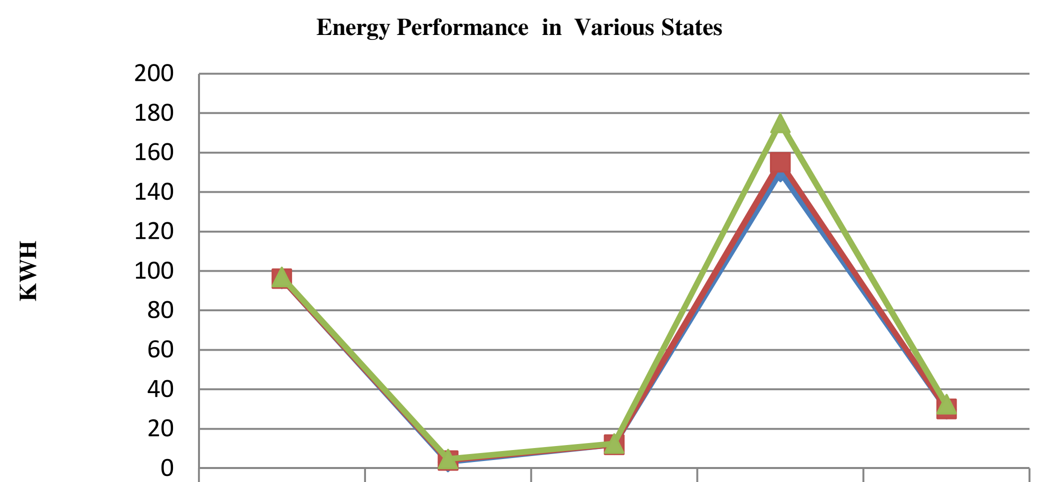
$$E_{Hdd} = \frac{\mu}{(J+\gamma)(L+R)} \tag{4.8}$$

The standard values are recorded in the following table 4.1

Total Energy Consumption over the System,

$$E_{Total} = 96 + 3.2 \times 10^{-11} + 11.904 + 150 + 29.895 = 287.799\text{Watt} \tag{4.9}$$

The variations in energy consumptions are depicted in the following figure 4.2:




| | MB | PROC | HDD | MEMORY | EM |
|---|---|---|---|---|---|
| ENERGY1 | 96 | 3.2 | 11.9 | 150 | 29.89 |
| ENERGY2 | 96.1 | 4 | 12 | 155 | 30.12 |
| ENERGY3 | 97 | 4.8 | 12.65 | 175 | 32.56 |

**Figure 4.2 Energy Performance in the Various States**

On the above aspects, let us now implementing the standard values of the hardware resources is taken and in table 4.1 after that the computed values by Bellman-ford algorithm for optimizing of the energy consumption which is recorded by table 4.2.

Computed Values through Bellman-ford Algorithm Now the total energy consumption over the system is given below:

**Table 4. 1 Standard Value of Various Electrical Components**

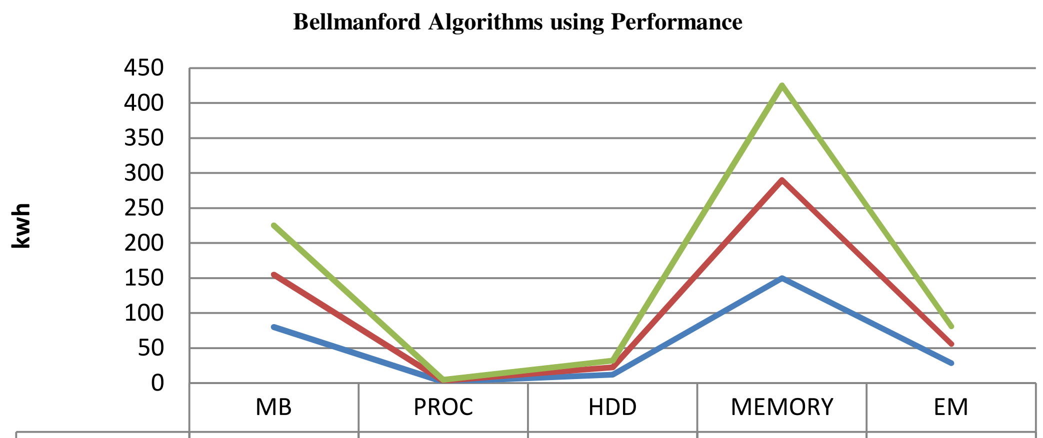
| Sr.No | Computing Component | Cap_ (C) | Voltage | Freq_(f) | Tem_ T | Curr_I | Energy_E Evaluated |
|---|---|---|---|---|---|---|---|
| 1. | Motherboard [31] | Input Depended | 5v(min) ,<br>12v (max) | Input Depended | $30^{0C}$ | 1A(min)<br>8A(max) | $E_{min}$=5 Watt.<br>$E_{max}$=96 Watt. |
| 2. | Processor [31] | $0.43\times 10^{-9}$ | -30V min to 30 V max | min(96mhz)max(6000mhz) | $44^{0C}$ | Input Depended | $3.2\times10^{-11}$MJ |
| 3. | HDD [31] | Input Depended | 5v(min), 12v (max) | 500Mhz (min)<br>1100Mhz(max | $40^{0C}$ | - | From Equation6.11.904 J |
| 4. | Memory [31] | Input Depended | Input Depended | Input Depended | $30^{0C}$ | Input Depended | $E_{min}$=30 Watt.<br>$E_{max}$=150Watt |
| 5. | Electromechanical | Input Depended | Fan=1.5 V | Input Depended | $30^{0C}$ | 19.93 Amp | P=VI,<br>P=29.895(W) |

**Table 4.2 Computed Values through Bellman-Ford Algorithm**

| Sr.No | Computing Component | Cap_C | Voltage_V | Frequency (f) | Current_I | Temp_T | Energy_E Evaluated |
|---|---|---|---|---|---|---|---|
| 1. | Motherboard | Input Depended | 5v (min) 12v (max) | Input Depended | 1 Amp(min)<br>8 Amp(max) | $30^{0C}$ | $E_{min}$=5 W<br>$E_{max}$=80 W |
| 2. | Processor | $0.43\times 10^{-9}$ | -30Vmin to30 Vmax | Min(96mhz)<br>(6000mhz) | Input Depended | $44^{0C}$ | $1.72\times10^{-8}$ MJ |
| 3. | HDD | Input Depended | 5v (min) 12v (max) | 500Mhz (min)<br>1100Mhz(max | Input Depended | $40^{0C}$ | By above formula 11.904 J |
| 4. | Memory | Input Depended | Input Depended | Input Depended | Input Depended | $30^{0C}$ | $E_{min}$=30 W<br>$E_{max}$=150W |
| 5. | Electromechanical | Input Depended | fan=1.5 V | Input Depended | 18.93Amp. | $30^{0C}$ | P = VI,<br>P=28.395 W |

$$E_{Total} = 80 + 1.72\times10^{-8} + 11.904 + 150 + 28.395 = 270.299 \text{Watt.} \quad (4.9)$$

After results, the following graph is given below in figure 4.2:




| | MB | PROC | HDD | MEMORY | EM |
|---|---|---|---|---|---|
| ENERGY3 | 70 | 1.42 | 9.8 | 135 | 25.56 |
| ENERGY2 | 75 | 1.5 | 10.5 | 140 | 27.12 |
| ENERGY1 | 80 | 1.72 | 11.9 | 150 | 28.395 |

**Figure 4.3 Energy Performance using Bellman-Ford Algorithm**

If we compare the equations (4.9) and (4.10), then it is observed that energy consumption is optimized through the Bellman-ford algorithm.

### 4.3.2 Bellman-ford algorithm for Shortest Path in DSDV Routing

Some features related to shortest path routing algorithm are given below:

*4.3.2.1 Carrier Sense Delay*

The Carrier sense delay, is introduced when the sender packet performs carrier sense. It's determined by the contention. its happens when carrier sense failed.

*4.3.2.2 Transmission Delay*

The transmission delay is determined by channel bandwidth, packet length and the coding scheme for transmission.

*4.3.2.3 Propagation Delay*

It is determined by the distance between the sending and receiving nodes. In distributed networks, the node distance is normally very small, and the propagation delay can normally.

*4.3.2.4 Processing Delay*

It is the receiver needs to process the packet before forwarding it to the next node. So due to the deployment mainly depends on the computing power of the node and the capacity of the network data processing.

*4.3.2.5 Queuing Delay*

It depends on the traffic workload. In the heavy traffic load, queuing delay.

There are some parameters belongs for finding energy performance.

i. Utilization

ii. Response time

iii. Throughput

iv. Room Temperature

**4.4 MAJOR FINDINGS**

In future, the shortest path problem simplifies the algorithm as the perfect result oriented scheme for energy performance in the network region. Whereas the major issue for network measurement and quality of services QoS are data flow and throughput performance. These algorithms can be implemented in any network data centre architecture. The network architecture is a well defined collection of a homogenous or heterogeneous system so the architecture must be created of any network topology. This algorithm has used in newly developed topology named as step network topology. The input values are taken with the devices on assumption bases after implemented the algorithm some output results are changeable by previously after that got results. We can arrange the network according to users demand. The advantages of this algorithm as

(1) We can find the energy consumption of small network architecture by the user admission control to the resources and devices followed in network design.

(2) In this algorithm the formula of the binding energy of the individual is compulsory.

(3) This algorithm used in wire network and wireless network.

These algorithms also have the limitation also. Which are given below:

(1) In this algorithm at the time of using the formula is compulsory. The all hardware devices working in topology the formula designs predefined.

(2) In this, the accurate initial values are compulsory for better result performance in energy consumption (in Watts) computed. In this chapter, the initial values have taken care and finding the results.

The maximum and input variables are taken carefully and formulas are created or taken standard formula for each and every device. The network structure is very essential for that energy consumption. The scheduling for data routing forwarding is mandatory. The energy cost affected in the environment, an ecological industrial company seeking to green the network for better performance. Day by day the network users are growing users with computers. So this is the very crucial green technology for the network is required for the architectural performance. The simple algorithm implements in data network. The Bellman-Ford algorithm applied on the shortest path routing is the better way to find the result of network reliability, costs, scalability and robustness. Here we got in energy saving 10% to 15% reducing over the network.

# Chapter V

# *Energy and End to End Delay Computation Across Step Network*

# CHAPTER –V

## ENERGY AND END TO END DELAY COMPUTATION ACROSS STEP NETWORK

Distributed computing is widely used by many researchers due to several advantages in terms of low cost with high efficiency. In this chapter, a step topological structure is considered and process model is designed through Markov chain. The energy is computed when information is transmitted from one node to another node. End to end delay is also computed in terms of the transmitted rate. Transmission time is also computed and results are represented in terms of tables and graph. Since it is newly developed topological structure under distributed environment, hence comparison on the said topological structure is not possible however it can be converted in the form of the bus topology.

### 5.1 MARKOV CHAIN DECISION PROCESS MODEL

Distributed computing system is well known computing system and it has several advantages over the centralized computing system in terms of cost and efficiency. A lots of research work is available on the distributed computing systems however less number of research papers are available for the step network which is a recently designed topological structure. Markov decision process model is used for discrete sequential data interpretation. This is a stochastic model for finding the process sequential definition. When the controlled processes are in actions for a distributed system then results affect the outcomes process output. The Markov chain process model is shown below in figure 5.1:

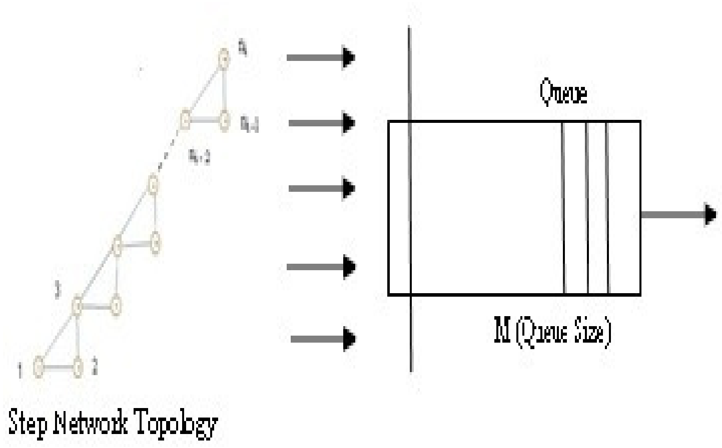



**Figure 5.1 Markov Chain Process Model used in Step Network Topology**

In this model, the probability distribution works on the next state which depends on the current state. A simple Markov process is, in which states can be observed directly. It may be autonomous or controlled process model by process sequencing. Markov Decision Process (MDP) as shown in figure 5.2 provides a mathematical platform for modelling of the research problems which are based on the decision making. It is a powerful analytical tool used for sequential decision under uncertainty. It is widely used in industrial and manufacturing applications. It is based upon the numbers of states in which outcomes are partly random and partly under the control of a decision results based on the decision variables. Markov decision process is also useful for major optimization problems solved via dynamic programming. Markov Decision Process was discovered on 1950. Dynamic programming is used by Markov Process. Markov process is used in different disciplines like robotics, automated control, economics, and manufacturing. A Markov decision process is a discrete-time stochastic control process. A Markov process is a stochastic process that operates on random sequences and outcome states according to certain probabilities condition.

Markov chains are integer time process $\lambda_n$, $n \geq 0$ for which each random variable $\lambda_n$ is integer valued and depends on the past only through most recent random variable $\lambda_n$

−1 for all integer $n \geq 1$. $\lambda_n$ , $n \in N$ is a discrete Markov chain on state space S=1……M, each time instant t, The system changes state and transition. The Markov chains follow stationary property. A first-order Markov chain, the Markov property states that the process state of the system at the time increases t+1 depends only on the state of the system time t. The step topology is queued based on Markov decision process and used the node wise probability to check the process sequentially. The process outcomes are the node as the first priority, and then next node process waits until the first process is completed. The process outcomes are depended on the time and data frames. The process is based on FCFS (first come first serve), and time priority bases.

Probability ($\lambda t+1=xt+1|\lambda t=\lambda 1\ldots\lambda t$=Probability ($\lambda t+1=xt+1|\lambda t = \lambda t$) (5.1)

A stationary equation implement with Markov property is independent of time. Then,

Probability ($\lambda t+1=\lambda i|\lambda t=\lambda j$) = Pi, j, Where for $\forall$ t and $\forall$i, $j\in 0\ldots N$ (5.2)

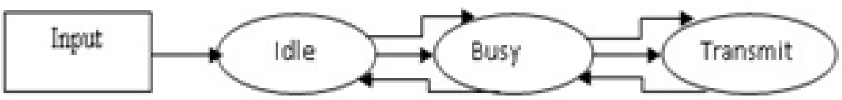



**Figure 5.2 Markov Decision Process Model**

Thus, we are testing at processes whose functions are the sequence of integers between 1…M. Thus Markov process is covered by transition fraction $P_{ij}$ and initial probability $P_{i0}$, Markov chains can be represented by graphs where each state is represented by a node and directed edge represents a non zero transition probability. If a Markov chain has M states then transition probability can be represented by an M x M matrix. The matrix T is stochastic matrix 1.

The Markov model processes are based on

### 5.1.1 Service Type

The service type is the independent and identical.

### 5.1.2 Service Time

(i) It can be deterministic or exponentially distributed.

(ii) It's dependent on the queue length.

### 5.1.3 Service Discipline

The service disciplines are as the following:

#### *5.1.3.1 FCFS*

The first come first serve process is based on time, frequency bandwidth and data packets. The service process time is minimum in FCFS and the process which comes first is automatically processed first by a server.

#### *5.1.3.2 Random Order*

The random number is used by network scheduling in a network topology. This random number is based on a time slot. The random time slot number is defined as $T_i \rightarrow \Delta t$. So the time dependency depends on the random number.

#### *5.1.3.3 Priorities Scheduling*

The all real-time systems usually used the pre-emptive priority scheduling systems. A process tasks must specify the time needed, the system can be complete the task.

#### *5.1.3.4 Processor Sharing*

The processor sharing is based on the dividing the total amount of time into an equal number of a process used in sharing. The total time is divided into equal slots of time to compete with each other and every process. The process sharing scheduling works as entry scheme for control policy systems.

#### *5.1.3.5 Service capacity*

The service capacity may be based on single server or a group of servers.

#### *5.1.3.6 Waiting Room*

In data transmission network finitely many cells can be buffered in a switch. The determination of good buffer sizes is the important factor in the design of communication networks.

## 5.2 WIRED CABLE TRANSITION IN DISTRIBUTED NETWORK SYSTEMS

The various formulae used in the work are given below:

### 5.2.1 The Packet Delivery Ratio (PDR)

The Packet Delivery Ratio is the packet frames per millisecond. It depends on the process state initial state to another state) and this is a relation between received packet and packet transmission in all system component such as CPU on system hardware component and given below:

$$Packet\ Delivery\ Ratio = \frac{No.of\ Received\ Packtes}{No.of\ Packets\ Transmitted} \tag{5.3}$$

### 5.2.2 The Transmission Control Messages

The transmission control messages are the method of controlling unit which is based on connection establishment and maintains a network conversation during. Which application programs can exchange data, the Transmission Control Protocol works with the Internet Protocol (IP), which defines how computers send packets of data to each other? The TCP and IP are the operations on the distributed network. TCP is a connection-oriented protocol, which works on a connection is established and maintained until the Application programs at each end finished exchanging messages. It breaks the data packets of the networks which can deliver, sends packets to network and accepts packets from the network and manages the data flow, to provide error-free data transmission for handling retransmission of dropped packets. In the Open

Systems Interconnection (OSI) Communication model, TCP covers layer 4 the Transport Layer, and parts of Layer 5, the Session Layer.

### 5.2.3 Average Transmission Time

The average transmission time is defined as the process coordinated over the packets transmission of sending and receiving data per unit time in milliseconds.

### 5.2.4 End to End Delay

$$\text{End to End delay} = \text{Processing Time} + \text{Queuing Time} + \text{Transmission Time} + \text{Propagation Time} \quad (5.4)$$

## 5.3 NUMERICAL RESULTS AND DISCUSSION

On the basis of above problem, a calculation of processing time is shown in table 5.1 this is computed for seven nodes which are connected to step network. The links between Nodes are $N_1N_2$, $N_2N_3$, $N_1N_3$, $N_3N_4$, $N_4N_5$, $N_3N_5$, $N_5N_6$, $N_6N_7$ and $N_5N_7$. The end to end delay is also recorded in the table by considering the packet size which is transmitted on the said links.

**Table 5.1 Computation of Processing Time and End to End Delay**

| Sr. No. | Nodes | Processing Time (ms) | E2E Delay (kbps) | Data Packets (kbps) | Transmission time (ms) |
|---|---|---|---|---|---|
| 1. | $N_1N_2$ | 0.6 | 379.42 | 62 | 5.11 |
| 2. | $N_2N_3$ | 0.8 | 602.9 | 72 | 5.89 |
| 3. | $N_1N_3$ | 0.4 | 1040.4 | 64 | 6.10 |
| 4. | $N_3N_4$ | 0.6 | 16747.27 | 1280 | 7.25 |
| 5. | $N_4N_5$ | 0.4 | 990.4 | 72 | 5.10 |
| 6. | $N_3N_5$ | 0.7 | 626.07 | 64 | 6.14 |
| 7. | $N_5N_6$ | 0.9 | 525.7 | 64 | 6.48 |
| 8. | $N_6N_7$ | 0.7 | 14318.4 | 1280 | 7.13 |
| 9. | $N_5N_7$ | 0.5 | 20480.5 | 1280 | 7.50 |

In above table, we have taken various nodes related to the processing assumption time and data packets. This computes end to end delay finding results and transmission times. The time is varying for the data packets and data packets in the transmission network layer. The network layer accepts the request then the data flow through the transport layer. The transmission data flow is buffered in the given time duration and process synchronization occurs at process sequences and the end to end delay of data is affected by the operation process. This is shown below in the following graph figure 5.3:

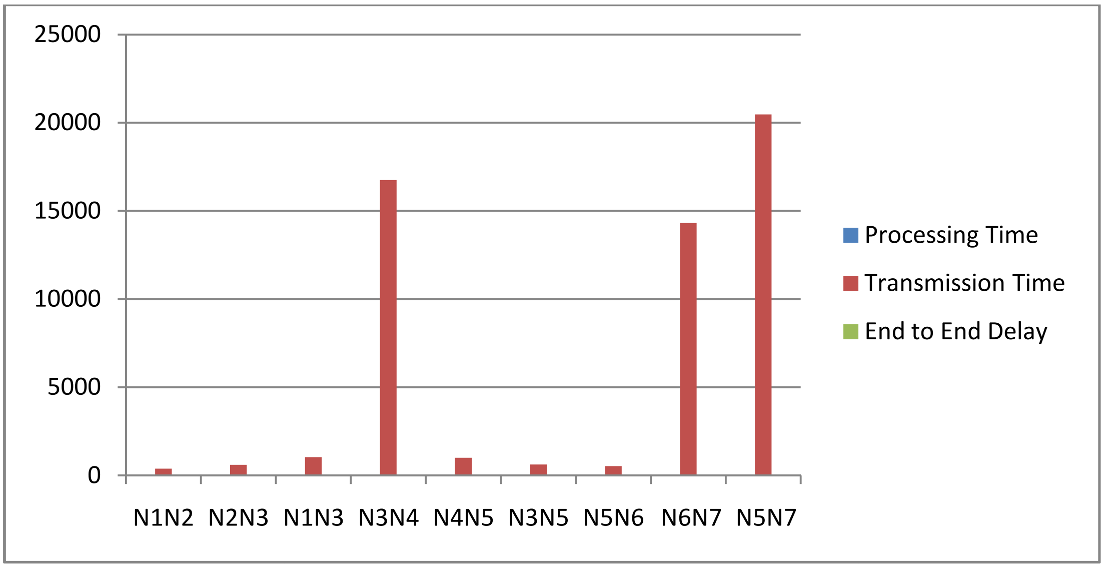



**Figure 5.3 Relations between Processing Time, Transmission Time and End To End Delay**

Let us assume that,

Number of Nodes - 200

Area Size - 600 × 600

MAC- 802.3

Simulation Time – 50 sec.

Traffic source – CBR (Constant Bit Rate)

Packet Size -512 Mbps

Transmit Power – 0395 w

Receiving Power – 0.395 w

Idle Power – 0.335 w

Initial Energy – 3.1 J

No. of Sources – 1,3,7,9.......................... $N_i$

Transmission Rates – 250, 500,750, and 1000 kbps.

On the basis of above, let us generate the Cost function of the model In this model $\phi_t$ are the real numbers, and $X_t$ are the correlated random variables

$$f(y) = x_t[\text{variable dependent for static or dynamic}]$$

$f(y) = x_t[\phi_s \; or \; \phi_d]$ × Stationary Equation during data flow on component

$$f(y)=\sum[(\phi_1 x_{t-1}+\phi_2 x_{t-2}+\ldots\ldots\ldots\phi_p x_{t-p}+\in_t)\times\lambda_s \, or \, \lambda_d]^{\alpha} \quad (5.5)$$

$$f(y)=\sum x_t.[(\lambda_s \, or \, \lambda_d)]^{\alpha t} \quad (5.6)$$

$$f(y)=\sum x_t.[(\lambda_s(t)^{\alpha t} \, or \, \lambda_d(t)^{\alpha t}]+f(w) \quad (5.7)$$

Where f (w) is fix power consumption

$$f(y)=\int\sum x_t.\lambda_s^{\alpha t} \, or \, \lambda_d^{\alpha t}+\int f(w)$$

$$f(y)=\int_{t_1}^{t_{n_i}}\sum x_t+\int_{t_{n_i}}^{t_T} f(w)$$

Total Power of the whole system,

$$P_T=\int f(y)\Rightarrow\int_{t_1}^{t_{n_i}}\sum x_t+\int_{t_{n_i}}^{t_T} f(w_i) \quad (5.8)$$

$$Pr(x) = pr(x_{ni}, x_n)$$

$$p_r(x)=pr(x_{n_i}, x_{n_{i-1}}\ldots\ldots\ldots\ldots\ldots x_{n_1}) \quad (5.9)$$

$$p_r(x)=pr(x_{n_i}, x_{n_{i-1}}\ldots\ldots\ldots\ldots\ldots x_{n_1}).pr(x_{n_{i-1}}/x_{n_{i-2}}\ldots\ldots\ldots\ldots x_{n_i})$$

$$P_r\,(N_1\,N_2\,N_3) = \text{pr}\,(N_1)\; pr(\frac{N_2}{N_1})\; \text{pr}(\frac{N_3}{N_1})\; pr(\frac{N_3}{N_3}) \tag{5.10}$$

$$P_r\,(N_3\,N_4\,N_5) = \text{pr}\,(N_3)\; pr(\frac{N_4}{N_3})\,\text{pr}(\frac{N_5}{N_3})\,\text{pr}(\frac{N_5}{N_4})\; pr(\frac{N_5}{N_5}) \tag{5.11}$$

$$P_r\,(N_5\,N_6\,N_7) = \text{pr}\,(N_5)\; pr(\frac{N_6}{N_5})\; \text{pr}(\frac{N_7}{N_6})\; \text{pr}(\frac{N_5}{N_4})\; pr(\frac{N_7}{N_7}) \tag{5.12}$$

$$P_r\,(N_{i-2}\,N_{i-1}\,N_i) = \text{pr}\,(N_{i-2})\; pr(\frac{N_{i-1}}{N_{i-2}})\; \text{pr}(\frac{N_i}{N_{i-1}})\; \text{pr}(\frac{N_i}{N_i}) \tag{5.13}$$

## 5.4 NODE DISTRIBUTION ENERGY

The node wise distribution of energy is given by table 5.2

**Table 5.2 Node Wise Distribution of Energy**

| Sr No. | Probability Distribution (Node) | Estimated Nodes | Node Values | Distributed Energy | Percentage Nodes Wise Energy (%) |
|---|---|---|---|---|---|
| 1. | $Pr\,(x_i = N_1 / N_{i-1})$ | $N_1$ | 0.6 | 120.4 kw | 30.89 % |
| 2. | $Pr\,(x_i = N_2 / N_{i-1})$ | $N_2$ | 0.8 | 796.48 kw | 47.84 % |
| 3. | $Pr\,(x_i = N_3 / N_{i-1})$ | $N_3$ | 0.7 | 640.00 kw | 21.26 % |
| 4. | $Pr\,(x_i = N_4 / N_{i-1})$ | $N_4$ | 0.6 | 700.48 kw | 96.42 % |
| 5. | $Pr\,(x_i = N_5 / N_{i-1})$ | $N_5$ | 0.9 | 768.0 kw | .361 % |
| 6. | $Pr\,(x_i = N_5 / N_{i-1})$ | $N_6$ | 0.4 | 120.4 kW | 8.22 % |
| 7. | $Pr\,(x_i = N_6 / N_{i-1})$ | $N_7$ | 0.9 | 700.41 kW | 91.36 % |
| 8. | $Pr\,(x_i = N_i / N_{i-1})$ | $N_i$ | $\phi$ | Null | Null |

$$Pr\,(N_5\,N_6 N_7) = a_{n_5} \times e_1(\text{packet frame}) + a_{n_6} \times e_2\,(\text{packet frame}) + a_{n_7} \times e_3(\text{packet frame}) \tag{5.14}$$

$$Pr(N_3 N_4 N_5) = a_{n_3} \times e_1 (\text{packet frame}) + a_{n_4} \times e_2 (\text{packet frame}) + a_{n_5} \times e_3 (\text{packet frame})$$

(5.15)

$$Pr(N_5 N_6 N_7) = a_{n_5} \times e_1 (\text{packet frame}) + a_{n_6} \times e_2 (\text{packet frame}) + a_{n_7} \times e_3 (\text{packet frame}) \quad (5.16)$$

We find that, every node power utilization in networks

$$\Pr(N_1 N_2 N_3) = 120.4\,kw$$

$$\Pr(N_3 N_4 N_5) = 796.48\,kw$$

$$\Pr(N_5 N_6 N_7) = 700.48\,kw$$

$$\Pr(N_1) = \frac{\Pr(N_1)}{\Pr(N_1 N_2 N_3)} \times 100$$

$$\Pr(N_2) = \frac{\Pr(N_2)}{\Pr(N_1 N_2 N_3)} \times 100$$

$$\Pr(N_3) = \frac{\Pr(N_3)}{\Pr(N_1 N_2 N_3)} \times 100$$

$$\Pr(N_4) = \frac{\Pr(N_4)}{\Pr(N_3 N_4 N_5)} \times 100$$

$$\Pr(N_5) = \frac{\Pr(N_5)}{\Pr(N_3 N_4 N_5)} \times 100$$

$$\Pr(N_6) = \frac{\Pr(N_6)}{\Pr(N_3 N_4 N_5)} \times 100$$

$$\Pr(N_7) = \frac{\Pr(N_7)}{\Pr(N_3 N_4 N_5)} \times 100$$

**Table 5.3 Energy Computation per Node Consumption in Topology**

| Energy / Node | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | $E_7$ |
|---|---|---|---|---|---|---|---|
| $N_1$ | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| $N_2$ | 0 | 47 | 0 | 0 | 0 | 0 | 0 |
| $N_3$ | 0 | 0 | 3.2 | 0 | 0 | 0 | 0 |
| $N_4$ | 0 | 0 | 0 | 96 | 0 | 0 | 0 |
| $N_5$ | 0 | 0 | 0 | 0 | .36 | 0 | 0 |
| $N_6$ | 0 | 0 | 0 | 0 | 0 | 8.2 | 0 |
| $N_7$ | 0 | 0 | 0 | 0 | 0 | 0 | 91 |

Total power consumption in step network is given below;

$$30 + 47 + 3.2 + 96 + 0.36 + 8.2 + 91 = 275.76 \text{ kW.} \tag{5.17}$$

## 5.5 MAJOR FINDINGS

The end to end delay energy consumption in step networks is computed which is used by Markov chain model. The assumption of time estimation and data frames used during transmit time is important results. The homogeneous computers are in discrete Time Markov chains are to provide high speed, strong scalable, measurement and simulation of large-scale data centres. The advantage of a Markov Chain Model (MCM) of a distributed system is first represented in a reduced form compact form. This model can be the concern to produce alternative system. They can execute paths and identify routing or scheduling in which system performance. These schemes allow to prediction of how a larger system will react in failures or success of high workload. Though computational effort increases in proportion to the number of paths scheduling. the cost is unaffected by the size of the system being modelled, expressed in terms of workload and number of computational resources, and is adaptable to systems that are non-homogenous with respect to time. The node wise explanation and percentage is also calculated. In the present work, the input time and data frames, which are used are limited, however, one can increase the number of nodes across the step network. The sequence of processes is varied with time and optimization of energy is computed through cost function.

# Chapter VI

## *Optimization of Energy Consumption for Task Scheduling on Uni-Processor and Multiprocessor Systems*

# CHAPTER- VI

## OPTIMIZATION OF ENERGY CONSUMPTION FOR TASK SCHEDULING ON UNI-PROCESSOR AND MULTIPROCESSOR SYSTEMS

Distributed computer networking plays a very crucial role in the Business, Industries, Education, Research and Development areas. Many users work on the heterogeneous devices which have different configurations. In distributed network communication takes place from one to one machine, one too many machines or many to one machine. Hence, tasks are migrated from one device to another device which is the important property of the distributed system. Due to rapid increase of the users on the devices connected across the distributed network, the management of the computer networks is a very big and challenging area of research. In the present work, different devices are connected across the step topological networks and an attempt is made to reduce the overall energy consumption when data is flowing from one device to another device. Optimization of energy consumption reduces the overall cost of transfer of data. in this chapter multiprocessor and Uni-processor cases are considered in special cases and computed results are represented in the form of tables. A well known Hungarian methodology is used for optimization of the overall energy.

### 6.1 INTRODUCTION

In the current scenario, distributed computing plays a vital role in computing. It takes an edge over the centralized computing system due to the low cost and higher efficiency. Multiple windows under the excellent operating system environment may appear on the computer screen for the multiple computing purposes. The personal computers may have more than one processor due to exhaustive research available for dual-core processors or even multiprocessors when arranged via a static network topology which should be efficient and low-cost involvement. Further, a task is defined a piece of macro, process, subroutine, subprogram, etc. and for multiple tasks scheduling algorithms are applicable for completion of tasks within minimum time. All tasks are executed on the processor taking either Uni-processor or multi-processor, of energy optimization is a big challenge for the resources. One can say that the energy can be consumed when task is executed on the Uni-processor or multi-processors connected across the step network. Electrical energy may be consumed by the hard disk, processors, motherboard, power supply etc. which is further categorized as a fixed energy and variable energy. Due to several advantages of distributed computing over the centralized computing, slowly-slowly, many organizations are shifting their computing labs from centralized system to distributed system. In this, computing is a collection of various computer networks incorporated with a single server or computers. The computers are retrieving information with each other related computers. In this, computing all computers are connected in common component computer devices, for the operation of various computing operation. All the computer components are initially worked as purely on scheduling basis as synchronize and asynchronies. The process may be FCFS (First Come First Serve), other job scheduling algorithm and Round-Robin is one of the most popular approaches of the scheduling of the tasks. The computing component consumes the electric energy component-wise, like chipset motherboard, a central processing unit, electromechanical devices (i.e. Fan, Chillers etc.), and hard disks. All the component devices consume more energy during action performance. The electric energy increases by the workload and it is a continuous process of synchronization if all components are busy. The electric energy reduces the cost which may be lack of workload during sleep mode and due to absence of data packets. There are two methods used for the reduction of the energy consumption. Firstly the component in sleep mode operation and secondly the rate of network operators to be applied through the workload. In this work, we have attempted to optimize consumed energy on the Uni-processor as well as the multiprocessors for the task scheduling. In the computer centre of the specification of Uni-processor and multiprocessors are considered consumed energy is computed. Energy of a system is computed for Uni-processor and multi-processor using Lagrangian multipliers methods in resource devices tasks and processes. For optimizing the energy consumption, a well known Hungarian method is used.

## 6.2 BACKGROUND

### 6.2.1 Distributed Computing Network

The distributed computing network is an interconnected network over various resources like laptop, printers, mobile, desktop, and other peripheral devices connected through a server. The devices may communicate from one to one and many to one device for Applications. The network peripheral devices may send the process Application for retrieving the information via server Application as per instruction sequencing process.

### 6.2.2 Step Distributed Network

In this network, there are at least three nodes linking to the network and communicated in a distributed manner. When it is extended towards step network, there are many computers connected to a server for various Application operations. In this network beneficial as resource sharing, scalability, robustness, performance speed and cost are important factors of study. It is challenging task for step network like as latency, synchronization process and failure data transmission, security, transparency and scalability. A view of step network is shown in previous figure 3.2:

## 6.3 ENERGY OPTIMIZATION METHODS

### 6.3.1 Dynamic Voltage Scaling (DVFS) Method

It is a very crucial technique used for reducing the energy consumption. If the voltage V decreases to the system then energy and frequency will also be getting low. If the voltage increases of power supply then the system increases the frequency and generating power. The dynamic voltage scaling technique is used for reducing the energy efficiency. In the computer architecture, the voltage used in a device wise component is increased or decreased, depending upon conditions. So it is beneficial for voltage balancing to the network's system. Voltage measurement is important for energy reducing very low values when operating at low speeds. The computation of voltage is done by given formula as;

$$V = \sqrt{\frac{P}{C \cdot f}} \tag{6.1}$$

Where, P, C and f are power, capacitance and frequency respectively.

DFS can be used for energy conservation for lowering the heat produced by a processor by lowering frequency. The low frequency will increase the amount of time and a processing element needs to complete a task. Energy is conserved with DFS because the Peripheral Equipment (PE) like Motherboard, Hard disk, CPU and other electromechanical components (i.e. fan) consumes less power when running at low frequency. The frequency is given by.

$$f = \frac{P}{CV^2} \tag{6.2}$$

### 6.3.2 Clock Gating

Clock gating is a third technique of energy optimization methodology commonly used to conserve energy on the processing element level. Clock gating adds additional logic to the processing elements. This disables certain portions of the switching activity from changing states. This method reduces the power by preventing the processing elements from constantly switching which accounts for a large fraction of the processing elements. The clock gating reduces the undesired switching on the parts of clock net by disabling the clock.

### 6.3.3 Routing Techniques

*6.3.3.1 Link State Routing*

The link state routing is a state description routing as the data transmission flow from one node to another neighbour node. In this method, routing for computation of shortest path is done by Dijkstra's Algorithm from a node to all other nodes. The Dijkstra's algorithm computes the end to end routes and finds the shortest path of the routing store to the next node address. This method is also used for reducing the energy consumption. This routing technique defines states of the node and used as linking state according to the process of time scheduling in the network topology. Routing used in this is as the scheduling constraints, which is minimum shortest task scheduling.

*6.3.3.2 Distance Vector Routing*

Another method is a distance-vector routing which defines the length of the shortest-path from each of its neighbour's node to every destination in the network and uses information status to measure its own distance and next successor router (r) to each destination. Each update message sent by a router to its neighbours contains a vector with one or more, each of which specifies as a minimum, the distance to a given destination's, each router sends only described information data flow. In this routing, the process scheduling is based on spanning distance. The spanning distance defines as the minimum shortest distance covered by the node vector.

## 6.4. METHODOLOGY

In the proposed model, different nodes which are arranged through the step topological structure as shown in figure1 make service requests which keep in the service queues. Let us consider each node is evaluated with the Uni-processor, computer with time constraint T and energy Constraint E. The transmission time for n nodes is represented by matrix $T_{i,j}$, since all nodes are autonomous collection to form distributed system then $r_i$ ( i=1…. n), represents of task scheduling i & sum of all $r_i$ is R, $p_i$ represents power allocated to each task scheduling i in terms of supply voltage, clock frequency, etc. Then execution speed of task i, $s_i = p_i^{(1/\alpha)}$, where $\alpha = 1+2/\varphi \geq 3$, $0< \varphi \leq 1$, and $\varphi$ is the linear change in supply voltage, and the energy consumption of a particular resource is given by;

$$Energy\ \alpha\ Power\ \ Input \times Amount\ of\ Workdone\ for\ Task(i)$$

$$E = r_i \ \ (p_i)^{1-\frac{1}{\alpha}} \tag{6.3}$$

The total energy consumption of resources is given,

$$E\ \left( p_1, p_2 \ldots\ldots\ldots\ldots p_n \right) \ = r_1 p_1^{1-\frac{1}{\alpha}} + r_2 p_2^{1-\frac{1}{\alpha}} + \ldots\ldots\ldots\ldots\ldots r_n p_n^{1-\frac{1}{\alpha}}$$

$$= \sum_{i=1}^{n} r_n\, p_n^{1-\frac{1}{\alpha}} \tag{6.4}$$

We should minimize E ($p_1$, $p_2$ .............$p_n$) but subject to time constraints and let schedule length $t_1$ , $t_2$..........$t_n$ does not exceed T then , let a function is considered on variables $p_1$, $p_2$ .............$p_n$ and is given as F($p_1$, $p_2$ .............$p_n$), which are less than of total time scheduling T given below;

$$F(p_1, p_2 \ldots\ldots\ldots\ldots p_n) = \frac{r_1}{p_1^{1/\alpha}} + \frac{r_2}{p_2^{1/\alpha}} \ldots\ldots\ldots\ldots\ldots\ldots \frac{r_n}{p_n^{1/\alpha}} \leq T \ ,$$

$$\sum_{i=1}^{n} \ \frac{r_n}{p_n^{1/\alpha}} \leq T \tag{6.5}$$

Now, Let $\lambda_i$ is Lagrangian multiplier formulated and then it is given below

$$\lambda_i = \frac{\nabla E}{\nabla F}$$

$$\nabla E = \lambda_i \nabla F \tag{6.6}$$

$$\frac{\partial E}{\partial p_i} = \lambda_i \frac{\partial F}{\partial p_i} \tag{6.7}$$

From equation (6.3) and equation (6.5), where $\lambda_i = p_i (1- \alpha)$ , for all $1 \le i \le n$.

$$r_i \, (1 - \frac{1}{\alpha}) \, \frac{1}{p_i^{1/\alpha}} = \lambda_i \; r_i \, (-\frac{1}{\alpha}) \, \frac{1}{p_i^{1+1/\alpha}}$$

$$1 - \frac{1}{\alpha} = -\frac{\lambda_i}{\alpha p_i}$$

$$p_i = \frac{\lambda_i}{(1-\alpha)} \tag{6.8}$$

$$E_i = \frac{R_i^{\alpha}}{T^{(\alpha-1)}}$$

$$R_i^{\alpha} = E_i T^{(\alpha-1)}$$

$$R_i = E_i^{\frac{1}{\alpha}} T^{\frac{(\alpha-1)}{\alpha}}$$

$$E_i = \frac{R_i^{\alpha}}{T^{(\alpha-1)}}$$

$$R_i = (E_i)^{\frac{1}{\alpha}} T^{(1-\frac{1}{\alpha})}$$

$$E = \sum_{i=1}^{n} r_i \left(\frac{\lambda_i}{1-\alpha}\right)^{1-1/\alpha} \tag{6.9}$$

$$R = r_1 + r_2 + \dots\dots\dots + r_n$$

$$R = \sum_{i}^{n} r_i$$

$$T = (p_i)^{1/\alpha} / R \tag{6.10}$$

Where R is the total task scheduling of the n tasks for resources, In the case of multiprocessor, the energy consumption is given by

$$R = E_i^{\frac{1}{\alpha}} \times T^{(1 - 1/\alpha)} \tag{6.11}$$

The above formula used for multiprocessor for finding the energy for different resources.

**6.5 PROPOSED WORK**

In the present work, the following cases are described below based on the above formulae:

**6.5.1 Uni-processor Case**

A Uni-processor system has a single computer processor, which is used to execute many tasks. All the tasks are related to a single processor and also to various operations controlled by the single processor computer. The power supply of the Uni-processor does not change and at the fixed time by the component devices. The limitations of a single processor are limited to controlling tasks. Let the coefficient $\alpha = 3, 4, 5$, then Lagrangian multiplier $\lambda_i$ is calculated by the equation (6.7), for the Uni-processor as given a

$$\lambda_i = p_i(1 - \alpha) \tag{6.12}$$

Where $\lambda_i$ is the Lagrangian Multiplier and processes $p_i$ are different tasks scheduling and the power supply is taken as uniform by the equation 8.

$$E = \sum r_i \left(\frac{\lambda_i}{1 - \alpha}\right)^{1 - \frac{1}{\alpha}} \tag{6.13}$$

The energy consumption of the Uni-processor can be obtained by putting the value of Lagrangian multiplier and coefficient α in above formula. The energy consumption is calculated by Lagrangian values in different task scheduling with the varying values, simultaneously. The energy consumption of the Uni-processor with the Lagrangian multiplier and coefficient λ are demonstrated based on Lagrangian values through different resource tasks scheduling with $\alpha = 3, 4, 5$.

**Table 6.1 Uni-Processor Related to Various Component Wise Specification**

| Serial No. | Hardware | Specification | Max Power (in Watts) |
|---|---|---|---|
| 1. | HDD | 1TB Seagate, Model No. ST1000DM003, Model Name : Barracuda | Max Power 4.0- Power 9.0 Watt |
| 2. | Motherboard | Asus i5,3.5 Ghz | 80 Watt |
| 3. | RAM | DDR2, DIMM, Clock Speed 200. | 5.5Watt |
| 4. | CPU | Intel core i5,6402P, Size of Cache 6.0 MB, Clock Speed 30Watt,3.40 GHz | 95 Watt |
| 5. | DVD | Time read single layer 28.3, Time read double layer 25.7, Speed 0.8x | 30 Watt |
| 6. | Electromechanical (i.e. Fan) | Blade 120 mm,2000 rpm | 6 Watt |
| 7. | Graphics Video Card | NA | 258 Watt |
| 8. | Battery | NA | 300 Watt |

**Table 6.2 Computation of Energy Consumption for Uni-Processor ($\alpha$ = 3, 4, 5)**

| Sr. no. | Power ($P_i$) | Tasks | Lagrangian Multiplier for ($\alpha$ =3) | Energy Consumption ($e_i$) for ($\alpha$=3) | Lagrangian Multiplier for ($\alpha$ =4) | Energy Consumption ($e_i$) for ($\alpha$=4) | Lagrangian Multiplier for ($\alpha$ =5) | Energy Consumption ($e_i$) for ($\alpha$=5) |
|---|---|---|---|---|---|---|---|---|
| 1. | $P_1$ | 100 | 0.0052 | 1.80 | 0.0030 | 0.560 | 0.0025 | 0.270 |
| 2. | $P_2$ | 105 | 0.0047 | 1.81 | 0.0031 | 0.588 | 0.0023 | 1.680 |
| 3. | $P_3$ | 110 | 0.0045 | 1.76 | 0.0030 | 0.616 | 0.0027 | 0.220 |
| 4. | $P_4$ | 115 | 0.0043 | 1.84 | 0.0031 | 0.644 | 0.0021 | 0.260 |
| 5. | $P_5$ | 120 | 0.0041 | 1.86 | 0.0027 | 3.480 | 0.0020 | 2.640 |
| 6. | $P_6$ | 125 | 0.0046 | 1.93 | 0.0026 | 0.587 | 0.0019 | 2.610 |
| 7. | $P_7$ | 130 | 0.0038 | 2.07 | 0.0025 | 0.611 | 0.0019 | 0.247 |
| 8. | $P_8$ | 135 | 0.0037 | 2.02 | 0.0024 | 3.51 | 0.0018 | 0.0675 |

For the Uni-processor, the following devices are considered with standard specification configuration.

Now the energy computation with the different resource scheduling $r_i$ is considered with power supply and standard specification of component-wise, the standard power supply max values is taken. Let $r_1$, $r_2$, $r_3$, $r_4$, $r_5$, $r_6$, $r_7$ and $r_8$ are the various tasks scheduling for the multiprocessor component devices. Let $r_1$ =100, $r_2$=105, $r_3$= 110, $r_4$ = 115, $r_5$ =120, $r_6$ = 125, $r_7$ =130 and $r_8$ =135 at different state when information flow from on multi-core shared memory. The formula used for finding energy for each component based with a different task is given by equation (6.7). The following matrix represented in the form of table is designed for the eight resources by taking combinations in the form of 8x8 ($e_i$ x $r_i$)

$$E = \sum p_i^{1-\frac{1}{\alpha}} \times r_i \tag{6.14}$$

To compute the optimal result, a well-known Hungarian method is used and a final matrix is given below by the following steps;

Draw lines through Appropriate rows and columns so that all the zero entries of the cost matrix are Covered and the minimum number of such lines is used and optimize the above matrix, a well-known Hungarian method is used and final matrix is given below, The formula is used for finding the energy, where $p_i$ is power of hardware device and computed values as given in table 6.3:

$$E = (9)^{2/3} \times 100 = 426.3 \text{ Joule} \quad (6.15)$$

**Table 6.3 Computation of Energy Consumption**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 426 | 652 | **544** | 567 | 610 | 763 | 697 | 479 |
| 1851 | 2824 | 2353 | 2447 | **2636** | 3314 | 3012 | 2071 |
| 2075 | **3169** | 2641 | 2746 | 2958 | 3698 | 3381 | 2354 |
| **313** | 470 | 392 | 417 | 439 | 548 | 501 | 345 |
| 4128 | 3192 | 5160 | 5366 | 5779 | 7224 | **6605** | 4541 |
| 976 | 1464 | 1220 | **1268** | 1366 | 1708 | 1562 | 1074 |
| 136 | 498 | 415 | 431 | 465 | 581 | 531 | **365** |
| 927 | 6850 | 5708 | 5937 | 6394 | **7992** | 7307 | 5024 |
| 36 | 201 | **0** | 0 | 55 | 921 | 368 | 15 |
| 582 | 0 | 162 | 91 | **0** | 341 | 24 | 394 |
| 703 | **0** | 219 | 137 | 23 | 302 | 0 | 456 |
| **0** | 234 | 3 | 1 | 77 | 987 | 415 | 0 |
| 1874 | 3201 | 924 | 741 | 426 | 0 | **0** | 1493 |
| 187 | 90 | 25 | **0** | 0 | 677 | 204 | 121 |
| 197 | 226 | 0 | 7 | 71 | 974 | 405 | **0** |
| 5843 | 311 | 1144 | 938 | 579 | **0** | 66 | 1778 |

The optimal values of Uni-processor represented as underlined, measured by the Hungarian Method, and the optimized value of energy consumption is given below:

$$E_{Min} = [313 \quad 3169 \quad 544 \quad 1268 \quad 2636 \quad 7992 \quad 6605 \quad 365]$$

$$E_{Min} = 22892 \text{ KJ.} \quad (6.15)$$

The relationship between energy and resource is also shown below in figure 6.2:

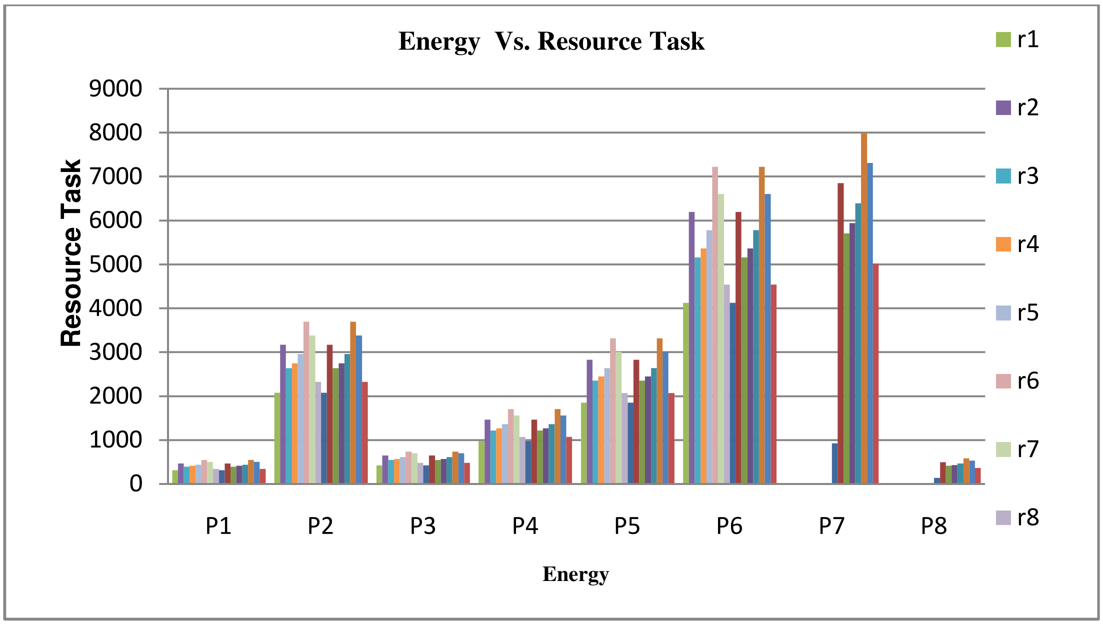



**Figure 6.1 Relationship between Energy and Resource Task in a Uni-Processor**

In Uni-processor, the different component of power supply fixed with the maximum value in unit released by each component. The different resource aspect task scheduling is computed for finding the energy consumption with different tasks; energy is computed at different task scheduling. One by one, each component has been computed by the estimation process with different interval task scheduling. The energy optimal paths are computed above and overall energy is optimized by Hungarian optimization method i.e. 22892 KJ.

### 6.5.2 Multiprocessor case

In the multiprocessor system, the use of two or more central processing units (CPU's) within a single computer system is available. The multiprocessor system has better performance in terms of cost and tasks scheduling. It's also called multi-core system with each one is sharing the common main memory as well as the peripherals. It has better throughput, hardware sharing within processors. Energy consumption parameters for multiprocessor system are Task Time Scheduling (ms), Input Power Supplying and Energy-Delay (ED).

Let us consider the execution time of each process as T=10 milliseconds in multiprocessor and the execution on different task R is to be computed by the equation (6.11) and computed resources for eight processes are also demonstrated column-wise results as given below:

$$R_1=\begin{bmatrix}36\\33\\62\\34\\51\\65\\89\\92\end{bmatrix}\quad R_2=\begin{bmatrix}32\\34\\75\\98\\41\\56\\78\\102\end{bmatrix}\quad R_3=\begin{bmatrix}41\\70\\73\\37\\35\\100\\98\\60\end{bmatrix}\quad R_4=\begin{bmatrix}37\\81\\45\\79\\109\\40\\59\\106\end{bmatrix}\quad R_5=\begin{bmatrix}66\\65\\39\\47\\84\\88\\118\\119\end{bmatrix}\quad R_6=\begin{bmatrix}52\\77\\74\\65\\58\\46\\101\\48\end{bmatrix}\quad R_7=\begin{bmatrix}84\\51\\55\\71\\107\\100\\89\\52\end{bmatrix}\quad R_8=\begin{bmatrix}46\\82\\71\\53\\85\\99\\48\\57\end{bmatrix}$$

The relationship matrix with different resources R power supply and energy between each component-wise $E_i$ with same time for multiprocessor across the step distribution network is given below in 8x8 ($E_i$ x $R_i$).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36 | 33 | 62 | **34** | 51 | 65 | 89 | 92 |
| 32 | **34** | 75 | 98 | 41 | 56 | 78 | 102 |
| 41 | 70 | 73 | 37 | **35** | 100 | 98 | 60 |
| **37** | 81 | 45 | 79 | 109 | 40 | 59 | 106 |
| 66 | 65 | **39** | 47 | 84 | 88 | 118 | 119 |
| 52 | 77 | 74 | 65 | 58 | **46** | 101 | 48 |
| 84 | 51 | 55 | 71 | 107 | 100 | 89 | **52** |
| 46 | 82 | 71 | 53 | 85 | 99 | **48** | 57 |

The above matrix is further optimized by the use of Hungarian Method and 0 values represent the optimized cell. After computed values have such results as given:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 0 | 29 | **0** | 18 | 32 | 54 | 58 |
| 0 | **0** | 41 | 63 | 7 | 22 | 42 | 67 |
| 8 | 35 | 38 | 1 | **0** | 65 | 61 | 24 |
| **0** | 42 | 6 | 39 | 70 | 1 | 18 | 66 |
| 29 | 26 | **0** | 7 | 45 | 49 | 77 | 79 |
| 8 | 31 | 28 | 18 | 12 | **0** | 53 | 1 |
| 35 | 0 | 4 | 19 | 56 | 49 | 36 | **0** |
| 2 | 36 | 25 | 6 | 39 | 53 | **0** | 10 |

The optimal values of the above matrix are recorded below:

$$E_{Min} = [37 \quad 34 \quad 39 \quad 34 \quad 35 \quad 46 \quad 48 \quad 52]$$

$$E_{Min} = 325 \text{ J} \tag{6.16}$$

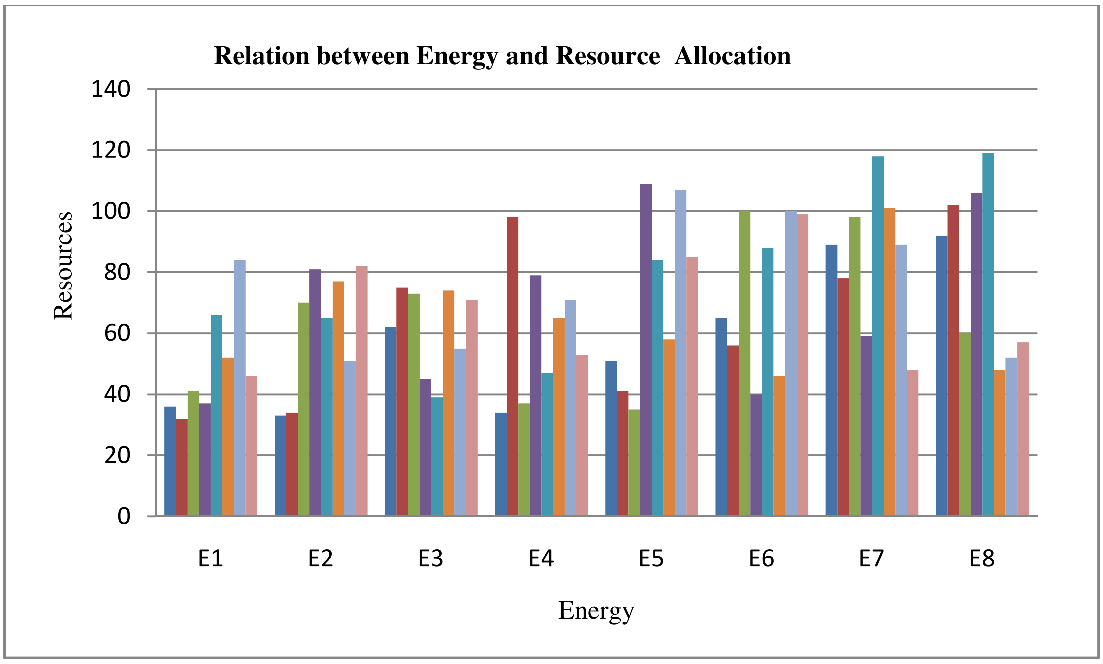



**Figure 6.2 Energy Optimization Based on Various Resource Components in Multiprocessor**

A relationship between resource and energy is also shown above in figure 6.3, in the multiprocessor, there is low energy consumption used for step topology network in comparison of Uni-processor case. There are three nodes and energy is calculated for each node. The local power management has each and every component; the local maximum power supply by the component is stable and does not change. The comparison of energy consumption between Uni-processor and multiprocessor is shown below in figure 6.4:

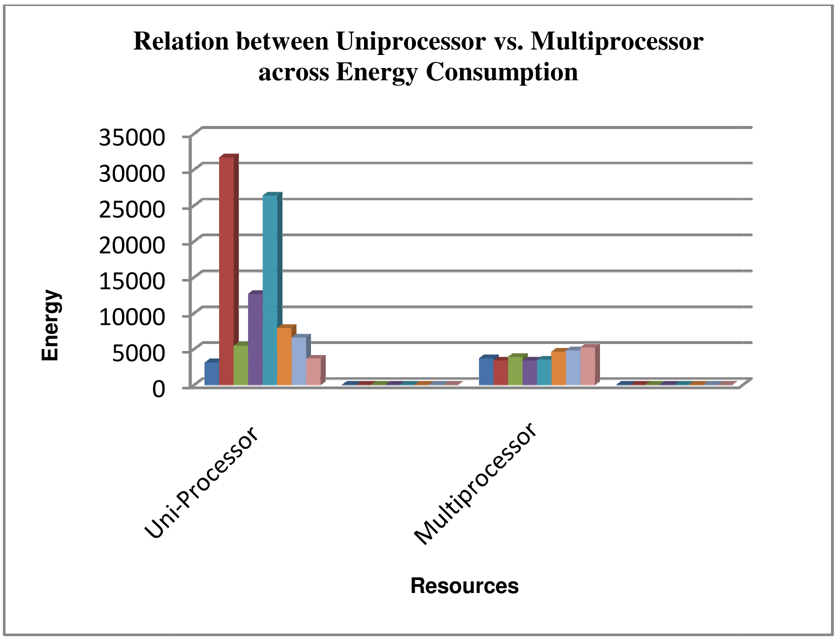



**Figure 6.3 Comparison of Uni-Processor and Multiprocessor with Energy Consumption Matrices**

## 6.6 MAJOR FINDINGS

In this chapter, a model for energy optimization for step network defines the power measurement in the distributed computing environment. When information is transferred from one device to another device there are two cases arises one for Uni-processor and another for multiprocessor. In the computer, the processor role is very important at the working time. The processor in a personal computer or embedded in small devices is often i.e. microprocessor. The multiprocessor elements are contained on a single integrated circuitry (IC) chip. The power measurement of the Uni-processor reduces the power with the use of different power allocation by components. The optimal values are given by Hungarian and Lagrangian methods. The power measurement in the multiprocessor is also computed with different resource allocations at the same time and also for different time interval further the optimal values are observed which are measured through Hungarian Method. If one compares the energy consumption between Uni-processor and multiprocessor. It is further observed that energy is optimized in case of multiprocessor in comparison of Uni-processor. The Uni-Processor works with a single task in computer work and multiprocessor works with multiple tasks in a computer in networks.

# Chapter VII

## *Power Management in the Computer Centre*

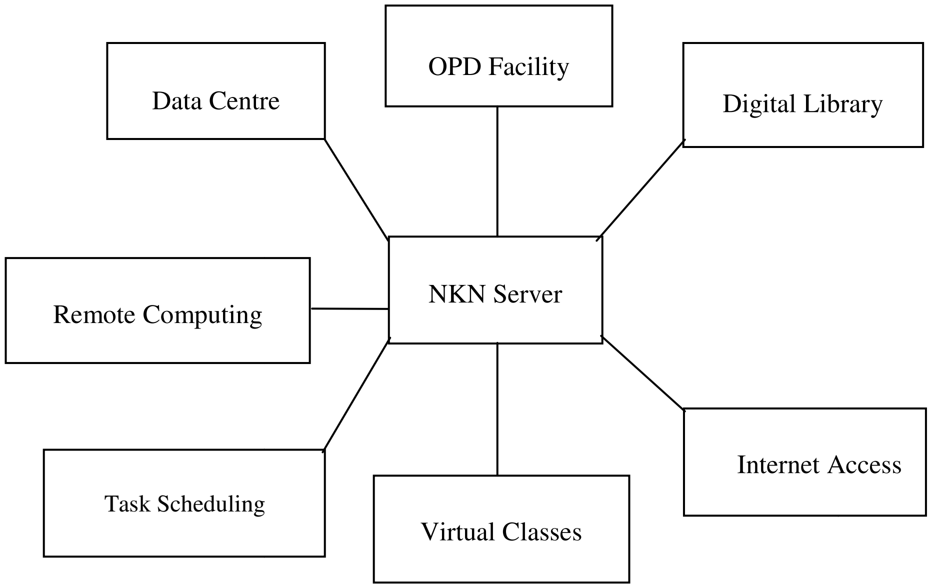
# CHAPTER – VII

# POWER MANAGEMENT IN THE COMPUTER CENTRE

In present scenario, the computer centres across worldwide approach of distributed systems in which multiprocessors are arranged for a timely run of tasks through task scheduling of network topology. The centres contain many electrical devices which emit energy hence there is a big challenge to optimize the power consumption in the computer centre. In this chapter, a case study of computer centre is considered in which devices are arranged under distributed computing systems for providing better opportunity to users. All devices of measuring properly along with specifications and methods are proposed for optimization of energy consumption.

## 7.1 INTRODUCTION

Since last few years, centralized computing is almost obsolete due to the evolution of the distributed technology in which heterogeneous devices which have different configurations are well connected across the network. These devices may provide services on either on fibre optics or wireless technology both of the technology needs either Local Area Network (LAN) card or wireless LAN card. In this approach, control is not a centralized but users may access or run tasks on the server as well as on its own machine. In this chapter, a well known National Knowledge Network (NKN) was established by Government of India in the computer centre located at Babasaheb Bhimrao Ambedkar University, Lucknow, India. In this network, the devices are arranged according to the following figure 7.1




**7.1 Distributed Computing System**

The specific design of consideration for National Knowledge Networks (NKNs) was to create an infrastructure that can scale and adapt to future requirements.

NKN design is to encourage, enable, enrich and empower for user community to test and implement innovative ideas without any restriction from the network technology and its administration.

### 7.1.1 Data Centre Network Design

NKN design follows all the current standards to permit seamless inter-operability amongst technologies and seamless integration amongst different original equipment manufacturers.

### 7.1.2 Data Centre Security Requirements

With the growing number of incidences reported by computer emergency response team (CERT) and the increasing challenges posed by innovations in convergence, keeping the network alive can be possible only with very stringent security measures designed, implemented and deployed. Any specific requirement for limiting access to services should be deliverable as part of a security policy. The Central Command

Control created to react to such situations should address till-date and forecasted attacks.

### 7.1.3 Service Requirements

These requirements are essential for transparent delivery of services based on either as in telephonic or the general requirements for a particular service. These requirements might differ between service providers, and possibly even between different tiers of a similar service.

### 7.1.4 Network Requirements

These requirements are network-specific and can be connected for specific services specific delivery mechanism client could be variety of devices like PC/ PDA/ any other device and access mechanisms like intranet / Internet. The design will serve to the overall performance goal of the NKN infrastructure. Operational requirements - The NKN is designed to cater to the requirements of tracking, troubleshooting, health monitoring and proactive performance monitoring.

In the above technology, a router model CISCO 7609 is used to provide access to the server and through this server, users may get the services like OPD facility, online medicine treatment facility, online Examination, video conferencing, online report generation, digital library, remote computing, virtual classes, tasks computing through data centres, internet access and many more. For optimizing the performance of the above devices used for providing the said facilities to the users, a number of processors are used by means of the static step network. In the reference to figures 7.1 and previous figure 3.2, different network devices are well interconnected in the computer centre as shown below in figure 7.2. In this working chapter a step topology works in data centre. The specifications of devices used in the computer centre are summarized below in following table 7.1:

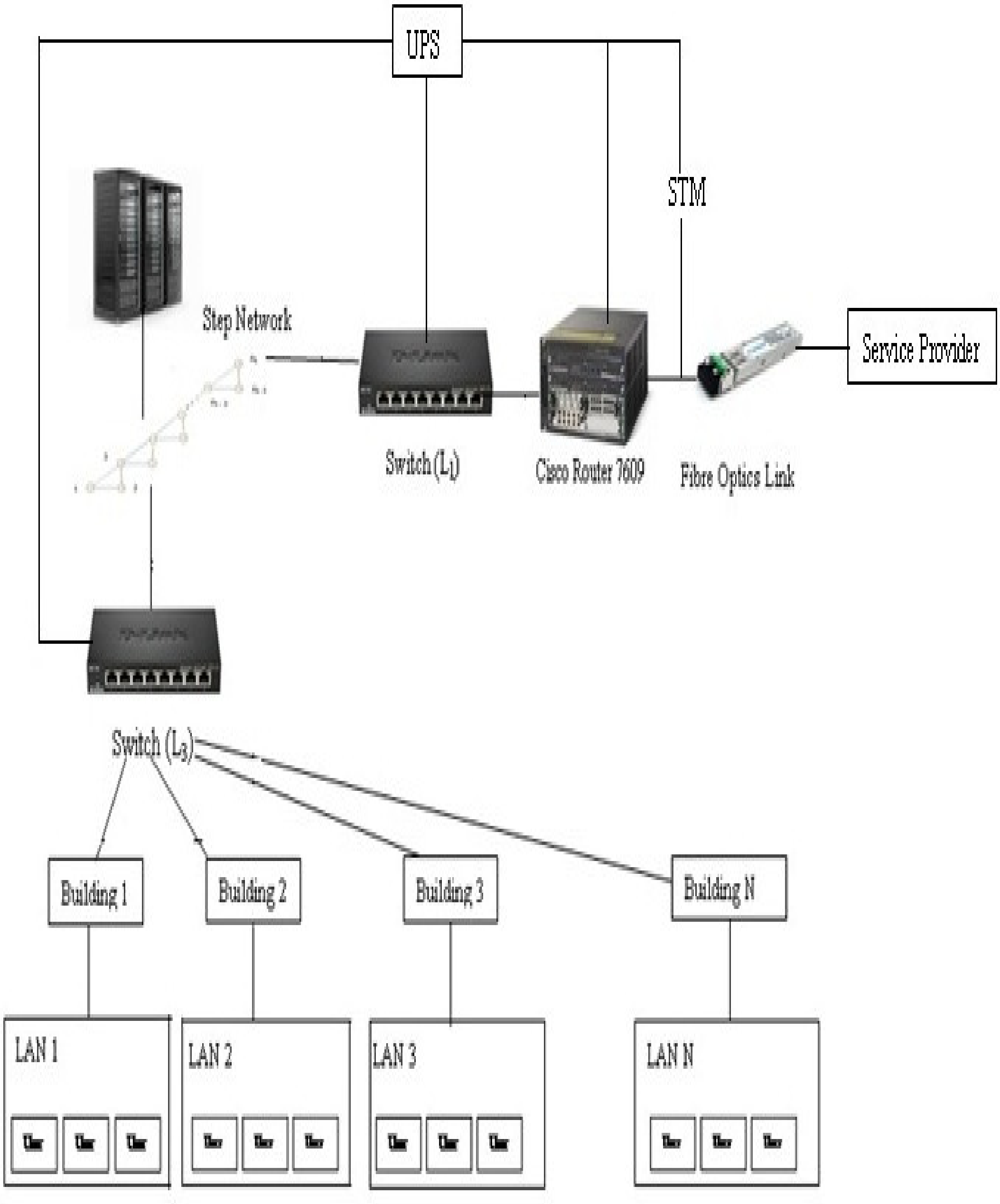



**Figure 7.2 Interconnection of Devices in the Computer Centre of the University**

The above setup has been established in Babasaheb Bhimrao Ambedkar University (BBAU), Lucknow and represented in previously figure 7.2, It is a service provider provides the fibre connectivity to (STM).

**Table 7.1 Specifications of Devices used in the Computer Centre**

| Name of Device | Specification | Power Consumption |
|---|---|---|
| **Name of Device**<br>Router Cisco 7609 | **Specification**<br>**1. Dimensions** (H x W x D)<br>36.75 x 17.2 x 20.7 in. (93.3 x 43.1 x 53.3 cm)<br>**2. Power requirements:**<br>(a)– 208 to 240 VAC<br>(b)– 48 to -60 VDC<br>**3. Input Current** - 30A<br>**4.-Environmental Features**:<br>(a) Operating temperature: 32 to 104°F (0 to 40°C) (b)Storage Temperature: -4 to 149°F (-20 to 65°C) | **Power Consumption**<br>**Power Consumption**:<br>1300W Max (100-120 VAC).2500W<br>Max (200-240 VAC or -48 to -60 VDC). |
| L1 Switch - Coriant (switchgear)7090 Series 7090-92M | **1. Dimension**: 442 x 220 x 180.<br>**2. Model :** Coriant , hiT 7090 92G<br>**3.Fabric CAacity**: 92Gbps<br>**4.Hardware Protection**: Control, timing and fabric module protection for hiT 7090 240G and hiT 7090 92G. | Maximum Power Consumption = 400w |
| L3Switch<br>D Link DGS-3120 , 24PC | **1.Dimensions** (W x D x H) = (440 x 310 x 44 mm)<br>**2. Model:** DGS-3120-24PC: 24-Port Gigabit , L2 Stackable Managed, PoE Switch including 4 x Combo 1000BASE-T/SFP ports and 2 x 10 Gbps stacking ports (24 x PoE ports, smart fans),<br>**3. Switching Capacity** -88 Gbps, | PoE = Power Over Ethernet Load (Min): 482.7 Watts (with 70W )<br>PoE = Power Over Ethernet Load (Max): 935.1 Watts (with 740W ) |
| Firewall Proxy<br>HP Proliant DL580G7<br>(Endian Firewall Community) | **1.Dimensions:** 4u Rack, 6.94 X 19 X 27.55 Inches (17.6 X 48.3 X 70 Cm) 100lbs Max<br>**2.Rail Kit:** Rack Rail Kit 50/60 Hz<br>3. Hewlett-Packard Company, Model No. HSTNS- 2131, Server / Storage - HSTNS-2131 (HP Proliant DL580 G7)<br>**3. Cache Memory**- 24mb (1 X 24mb) Level 3 Cache Ports: 6 Usb 2.0 Ports.<br>**4. Processors:** 2 X Intel Xeon 10 Core Processor E7-4860 2.26ghz 24mb Smart Cache 6.4 Gt/S Qpi Tdp 130w | Maximum Power Consumption HP 1200W ,100/110-120/200- 240 Volt Current supply at per 9/9/5 amp |

A link from STM is given to the CISCO router 7609, and then different processors are arranged through step network connected through the $L_1$ switch for distribution to the various buildings, link from servers is given to L3 switch which is used for NKN servers to the different buildings located in the BBAU campus of the University.

By the use of Table 7.1, different parameters are considered which are variable from time to time and a mathematical method is proposed to optimize the power consumption used in the above devices, since the power consumption is directly dependent on time hence is varied as per time variation for scheduling of the various tasks given by the users.

## 7.2 MATERIALS AND METHODS

In a data centre, there are many devices, when are connected in series and every device consumes power itself called Local Power Management (LPM). The LPM is derived from each and every hardware configuration. The configurated devices are integrated of many embedded systems, and the embedded system is connected through integrative circuits. The integrative circuits are depending on the power consumption.

The different devices are represented by different formulas or Energy like Central Processing Unit (CPU) which varies the energy consumption represented by $P \alpha CV^2$, there are two types of energy consumption of the devices (a) dynamic energy consumption (b) static energy consumption. The dynamic energy consumption is depending over the full connectivity devices on voltage and conductance or consolidated devices. The static energy consumption is fixed over the devices. The server energy consumption is proportional to the CPU utilization. The dynamic energy consumption also depends on NP-completeness problem. The energy consumption of the data centres also depends on the server and different types of servers are used to optimize the workload of the power optimization.

On the basis of above concept, a National Knowledge Network (NKN) is established by Government of India, which is a capacity for providing authenticity and reliable connectivity. The NKN provides the research, innovation and multidisciplinary area and communication for the research area. The NKN has certain features in the research area and other services as given below. It is a high-speed backbone connectivity which will enable knowledge and information sharing amongst NKN connected institutes. The services provided by NKN are shown in figure 7.1.

**a.** It permits cooperative research, development and innovation with NKN connected institutes;

**b.** It is allowing advanced distance education in specialized fields like engineering, science, medicine etc;

**c.** It is authorizing an ultra-high speed e-governance backbone;

**d.** It is providing a connection between different sector by sector networks in the field of research;

**e.** It is providing OPD facility, video conferencing facility, remote computing, and digital library facility and many more.

## 7.3 UML ACTIVITY DIAGRAM

The process classification in the data centre is represented through Unified Modelling Language (UML) activity diagram. It is shown in figure 7.3 in which flow of the information in the data centre is a method of transmission. Firstly, the process of initializes incoming process at a specific time and go through for the resource analysis and the process is registered in the process block.

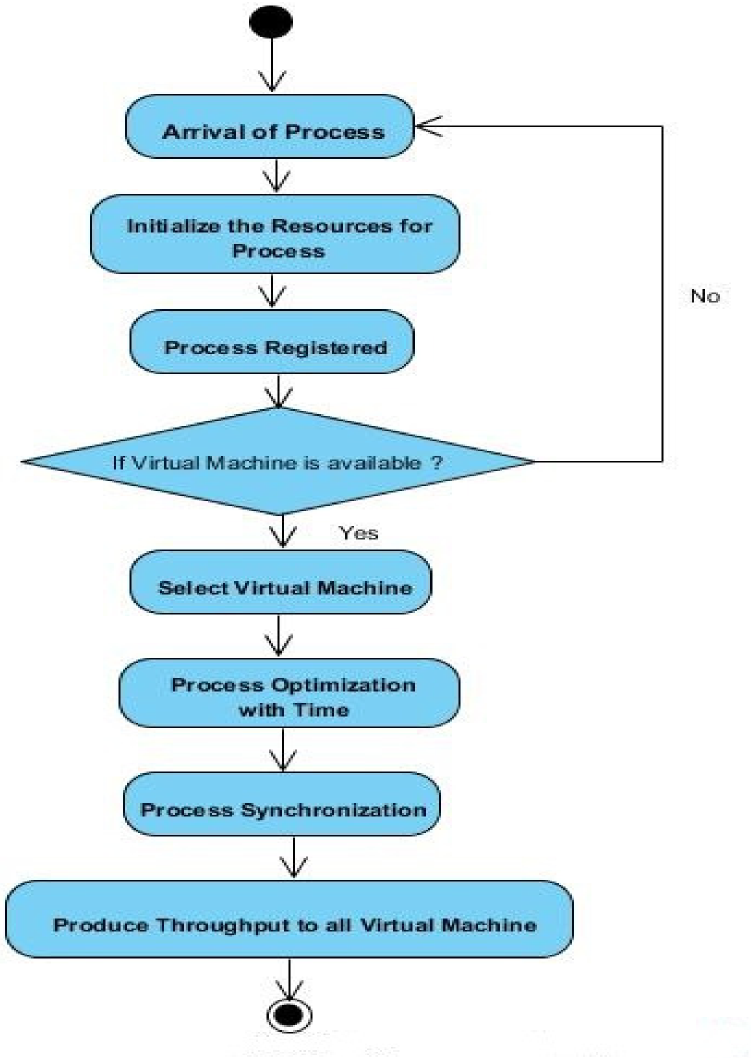



**Figure 7.3 UML Activities for Process Classification**

Now the process entered in a virtual machine and proceeded with the minimum energy cost and power utility chamber, Now then the process flows in hard disks, memory, and CPU with a specific time interval. Now that the same process in all virtual machine and process synchronizes throughput to all devices. Now the final process gets energy cost measured with the data flow in the data centre.

## 7.4 METHODS OF ENERGY EFFICIENCY IN DATA CENTRE

The data centre uses the energy consumption major components. Suitable methods for efficient energy consumption are described below:

### 7.4.1 Information Technology for Equipment

The energy consumption of data delivery packets in IT components is very vast. During the period of the execution process, the energy consumption of all IT equipment is consolidated consumption and individual components. These Approaches are working on IT equipment with working load on CPU, hard disk, motherboard, and other electromechanical devices components.

### 7.4.2 Cooling

The cooling in data centres is commonly provided by Computer Room Air Conditioning (CRAC) units. The CRAC units work in the data centre, for minimizing the energy consumption in the equipment. The air handling units are covered the distributing the air throughout the data centre using the devices like fans, filters, and cooling coils. The fans works with the server's pulls are cold air and reduce their heat. At this time the warmed air toward the ceiling and receive the CRAC unit.

### 7.4.3 Electric Power Delivery

The power delivery is performed in the data centre to storage devices and networks IT equipment to facilitate the storage and transmission of data. The power delivery systems provide voltage regulation, backup power, and AC/DC converters. The power delivery of electricity is first supplied to UPS, and then Power Distribution Unit (PDU). The PDU units convert the AC voltage into the DC voltage. The DC voltage performs as work all internal hardware devices like, CPU, memory, disk drives, chipset, and fans.

### 7.4.4 Heat Removal

The maintaining and controlling of temperature or humidity is the main feature of air conditioning systems in data centres. The all electronic devices have consumed the energy as heat delivery. The rack of blade servers requires the power up to 20-25 kilowatts.

### 7.4.5 Energy Efficiency

The energy efficiency of data reliability in data centres depends on the designers and operators. The power and cooling systems in data centres must be efficient for the energy efficiency. Many software programs and hardware devices consume the power allocation and released the carbon footprint. The energy efficiency is increased by the design of device architectural and software Applications.

### 7.4.6 Power Vs Energy

- The power and energy are different. Power is measured in a particular point in respect of time but the energy consumption is measured in over a period of time.
- Power is measured in kilowatts (kW) but the energy is measured in kilowatts hours (Kwh).
- The highest power Approached is very important aspect at any point of time for power based design, while energy consumption over a period of time is the important aspect for energy based design.

### 7.4.7 Performance Vs Productivity

- The performance and productivity are distinct from the data centre. The performance of the data centre is measured as quality of services (QoS) of the networks availability and their design, while the productivity is measured as the throughput data packets in an amount of quality assurance.
- If the hardware side of servers and storage are capable of the data transmission throughout the networks as called performance. While the total amount of data

packets in a specific time are called productivity.

### 7.4.8 Code of Conductance (CoC)

The code of conductance is an action of stimulating data centre operators to reduce their energy consumption. The code of conduct is responsible for the following parameters:

- Environmental statement;
- Problem Statement;
- The scope of code of conductance (CoC);
- Aim and Objectives of code of conductance (CoC);

## 7.5 COMPUTATION OF POWER CONSUMPTION

In the said case study, the devices are installed and consumed more energy in comparison to the others because of high power requirement by the devices, as well as cooling infrastructures. In general, it is approximate 40 times more in comparison to other office equipment installed in the building. A server takes more energy consumption during the peak hours. Let us describe, the electric power consumed by the devices for which consumption of energy takes place.

### 7.5.1 Electric Power Consumption

In the university, numerous devices are installed which are represented in figure 7.4 However, in some equipment it has ranged from minimum to maximum like CISCO router 7609 consumes power consumption from 48 watts to 60 watts; hence the range of power consumption varies from one device to other devices. Since these devices perform the critical operation for which Uninterrupted Power Supply (UPS) equipment is designed to maintain the desire for electric supply.

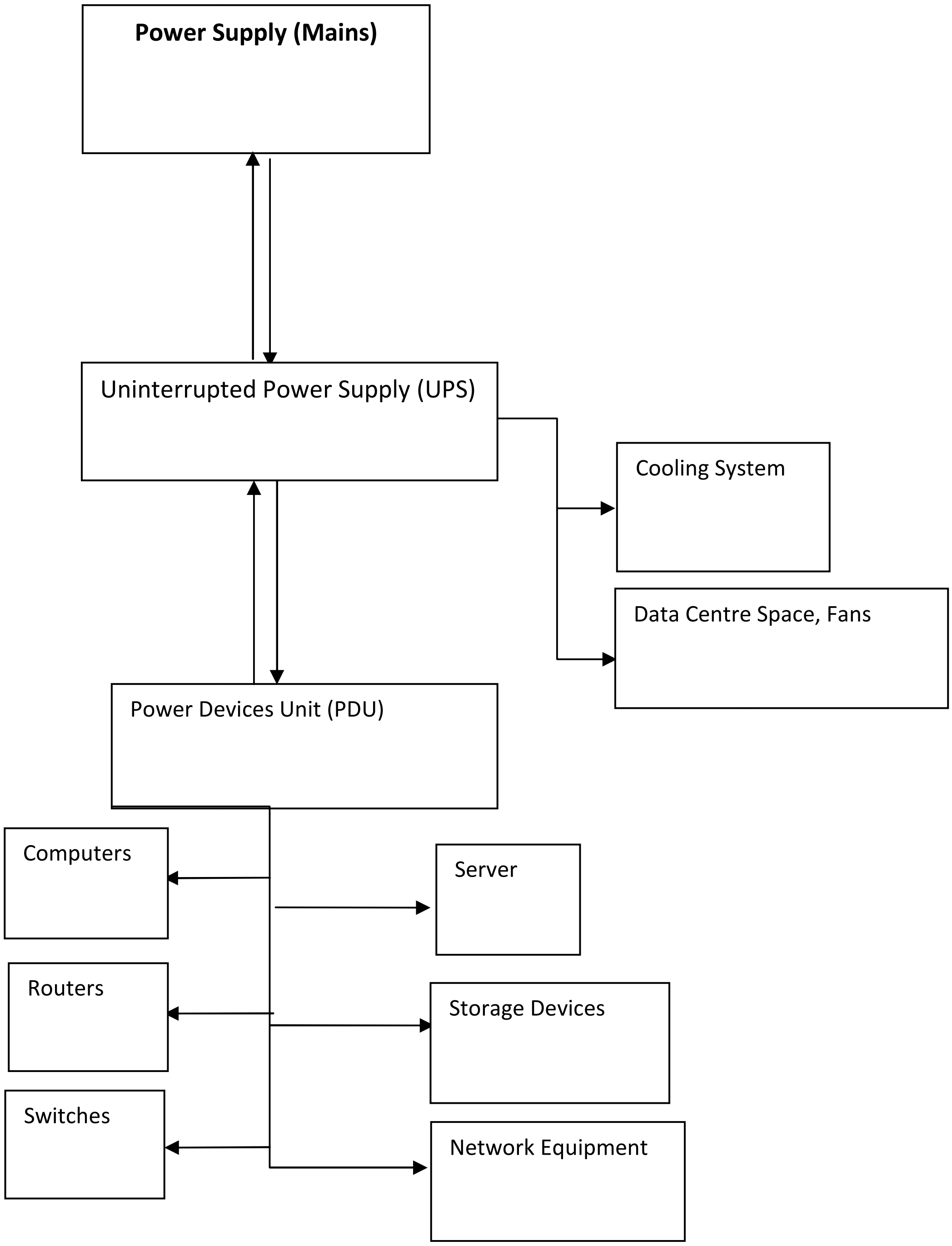



**Figure 7.4 Power Consumption Devices**

The equipment represented power as described in following table 7.2:

**Table 7.2 Peak Power Consumption Details**

| Component | Peak Power (kW) |
|---|---|
| CPU | 80 |
| Memory | 36 |
| Disks | 12 |
| Peripheral Slots | 52 |
| Motherboard | 25 |
| Fan | 10 |
| Power Loss Supply Unit | 38 |
| Total | 253 |

### 7.5.2 Thermal Heat Removal

Temperature, varies from day to day temperature varies, therefore, cooling equipment is necessary for maintaining the temperature in the computer centre, generally, air conditioning systems are used for maintaining temperatures in the computer centre where devices are installed.

### 7.5.3 Measurement Techniques

Various authors here designed measurement techniques for finding the consumption cost of the services related to the computer centre. The steps are given below,

To determine the rate of energy delivery from the source to the devices;

- To determine how many units are delivered by the devices;
- To determine how many units are used for the work;

Some of the measurement techniques in the computer centre are described below:

*7.5.3.1 Power Usage (PU)*

This is a technique for measurement of the amount of power to perform effective computation in a data centre. The formula is expressed of power usage and is given below. Power allocations in IT equipment are distributed. The power is distributed in the entire devices like UPS, generators, batteries, IT devices. The power uses the distribution air cooling system and network nodes.

*7.5.3.2 Data Centre Infrastructure Efficiency*

Let us consider a power management for the router (CISCO 7609) modelled in the computer centre the router power management is given by,

$$RPM = Static\ Power\ Supply + \alpha\ (Dynamic\ Power\ Supply) \tag{7.1}$$

$$RPM = SPS + \alpha (DPS)$$

Where α is constant, RPM is the Router Power Management, SPS is Static Power Supply, DPS is the Dynamic Power Supply. Let us apply a least square method to optimize the power consumption and normal equation are given below,

$$\sum RPM = SPS + \alpha \sum DPS \tag{7.2}$$

$$\sum RPM \times DPS = SPS \sum DPS + \alpha \sum DPS^2 \tag{7.3}$$

Let us consider computation current supply i.e. I=30 amp. and voltage is varying from minimum value 48 to maximum value 60, and then power consumption is resolved in the following table 7.3:

From the below table 7.3, it is observed that power is directly dependent on the voltage for management of this power, let us consider RPM is taken as P while DPS dependent on the voltage V, hence RPM depends on the V on solving (2) and (3) on the said data,

**Table 7. 3 Computation of Power Consumption in Data Centre**

| V (Volt) | I (Amp) | P =V*I (In Watt) |
|---|---|---|
| 48 | 30 | 1440 |
| 49 | 30 | 1470 |
| 50 | 30 | 1500 |
| 51 | 30 | 1530 |
| 52 | 30 | 1560 |
| 53 | 30 | 1590 |
| 54 | 30 | 1620 |
| 55 | 30 | 1650 |
| 56 | 30 | 1680 |
| 57 | 30 | 1710 |
| 58 | 30 | 1740 |
| 59 | 30 | 1770 |
| 60 | 30 | 1800 |

It is computed as SPS = 0, $\alpha$ = 30 and RPM = 30×V, This is true as per observations.

## 7.6 NUMERICAL RESULTS AND DISCUSSION

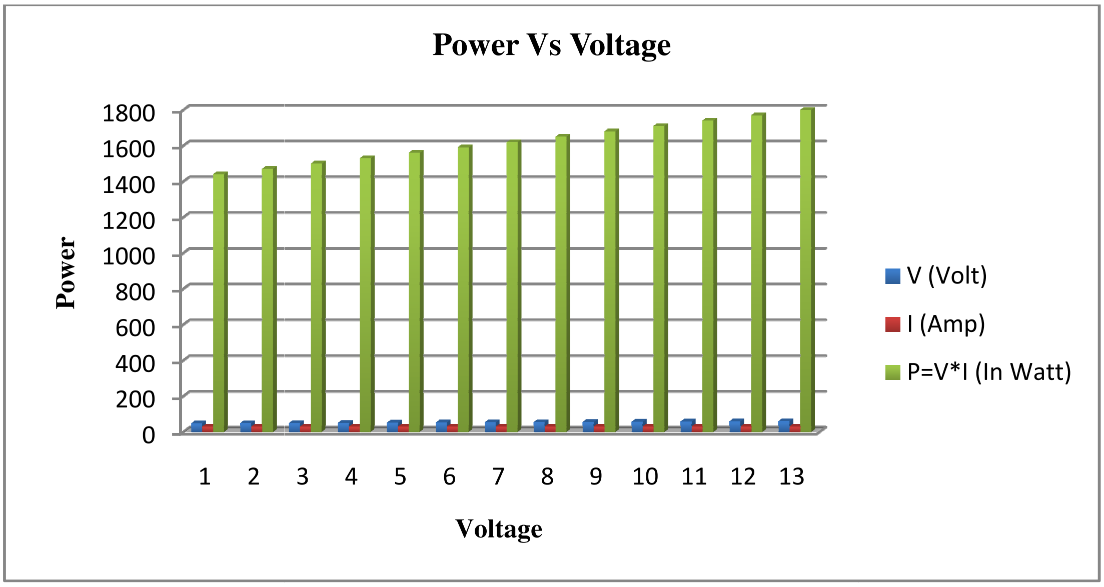



**Figure 7.5 Representation of Power v/s Voltage**

The above graph has shown the result of the relation between the power consumption and input voltage for the Router Power Management (RPM). The input voltage applied range from $V_{Min}$ = 48 Volt to $V_{Max}$ = 60 Volt and applied input current is 30 ampere. So the router power management and power measurement have described the power which is increased as the voltage is increased and when the current is constantly taken as 30 Amp.

## 7.7 MAJOR FINDINGS

From the above research work, it is concluded that the UML is powerful modeling language which is used to represent the dynamic behavior of the research issue. In the above work, a studied is done for the minimizing the power consumption in the computer centre which contains various devices emitting the energy. The data centre is a big infrastructure of network supply management. In the network, flow in pipelining is sequentially series. But in some situation that may be parallel distribution and flow of network is series. This chapter contains various types of devices are connected series or some of parallel. They have all devices are consumption energy in carbon form or carbon dioxide ($CO_2$). So in the data centre must have the connected quality wise instrument or resource devices? All input values have taken accurately for calculation of energy in a distributed data centre. A least square method is used for providing the optimized results represented by a graph. The same study can be extended to the other computer centre. A power-aware sensor node model essentially describes the power consumption in different levels of node sleep state. Every component device in the node can have different power modes. If distance between the adjacent nodes is minimum than the average distance between the nodes and the client transmission power can be minimization. Further, it’s likely that nodes in local data centre share highly correlated data. Some of the nodes elect themselves as server and the remaining nodes join one of the servers based on minimum transmission power criteria. Such application-specific network protocols for wire networks have been developed.

# Chapter VIII

## *Conclusions and Future Scope*

# CHAPTER- VIII

## CONCLUSIONS AND FUTURE SCOPE

The aim of the present thesis is to provide analytical frameworks for the evaluation of the network performance through optimization of the power consumption under different scheduling processes and based on the distributed computing approach:

Different problems have been solved namely energy optimization with Uni-Processor in distributed computing networks, energy optimization with multiprocessor in distributed systems, energy consumption on hardware devices in university data centre, survey of energy optimization in distributed computing systems, energy interpretative in consolidated computers devices network performance with extensive numerical results and representations of results in the form of performance through graphs.

On the basis of presented results the followings important findings are concluded:

1. The thesis is a backbone for the organization using the distributed computing approach since many of the computer centre have been shifted the approach of computing from the central computing to the distributed computing approach.
2. The entire work is based on the distributed approach. A model is proposed for distribution of the resources with three different levels across the distributed networks in which users are connected across step network. The admission control works with input users application request for data processed in networks. The Mathematical technique for energy performance calculation is preferred for the proposed framework. The transmission time is optimized by the Hungarian technique by considering the limited nodes but it can be extended up to the finite numbers of nodes connected across the step topological network.

3. A shortest path problem has been solved through the algorithm for the perfect result oriented scheme for energy performance in the network region. The Bellman-ford algorithm gives better optimized results to find the result for network reliability, costs, scalability and robustness. By the use of this algorithm the results have been optimized from 10% to 15% reducing over the network.
4. The end to end delay energy consumption in step network has been presented with assumption of time estimation and data frames used during transmit time and produced important results. The node wise explanation and percentage is also presented.
5. Further, a model for energy optimization for step network has been presented for the power measurement in a distributed computing environment. When information is transferred from one device to another device there are two cases arises one for uni-processor and another for multiprocessor. It is concluded that the power measurement of the uni-processor reduces the power with the use of different power allocation by components. It is further observed that energy is optimized in case of multiprocessor in comparison of uni-processor.
6. Some problems have also been solved through the modelling language and observed that the UML is powerful modeling language which is used to represent the dynamic behavior of the research problem. It is used for computation of the optimized the power consumption in the computer centre which contains various devices emitting the energy.
7. Before solving the above problems, extensive literature has been reported in the thesis.
8. The various fundamentals used for solving the above problems have also been specified in the work.

9. The results presented in the thesis are optimized results and also compared in some cases with the existing results in the literature.
10. The optimized results have been presented through tables and graphs.
11. The presented results shall also be very useful to carry out further research in the same direction.
12. The Mathematical problems formulated for the different models have been solved very efficiently.

From the presented work it is also observed that the work can be extended in many directions and some of the prominent directions are given below:

1. This research work supports from small to large scale wired network or distributed computing network. Hence the work can be extended for the large computer network for enhancing further scalability and energy performance for the large growing network.
2. The other power optimization models can also be proposed on the basis of the presented work.
3. The work is completely focused on enhanced energy efficiency considering of energy model and algorithms in the distributed network. But the presented work can be applied for the other complex network topological structure for optimizing the power consumption.
4. The future direction of the work may be carried out to check the applicability of the proposed system in distributed computing and parallel computing network.
5. The presented work can be extended for consideration of the various features of the algorithms based optimization and routing based scheduling techniques in the step network topology and for the other topological structures.
6. The work can be extended for the large database stored on the server having the arrangement of the various multiprocessors emitting the energy.

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# *APPENDIX*

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# Power Management in the Computer Centre Under Distributed Environment

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***Abstract:*** In the current scenario, many of the computer centres across worldwide are following the approach of distributed systems in which multiprocessors are arranged for timely run of tasks through task scheduling by means of effective networks topology. The centres contain many electrical devices which emit energy hence there is a big challenge to optimize the power consumption in the computer centre. In the present paper, a case study of computer centre is considered in which devices are arranged under distributed environment for providing better facilities to the users. Each device is examined properly along with specifications and methods are proposed for optimization of power consumption. Results are represented in the form of tables and graphs.

***Keywords:*** Distributed Computing; Energy Optimization; Power Consumption; Step Network Topology

## I. BACKGROUND

Since last few years, centralized computing is almost obsolete due to evolution of the distributed technology in which heterogeneous devices which have different configurations are well connected across the network. These devices may provide services on either on fibre optics or wireless technology both of the technology needs either Local Area Network (LAN) card or wireless LAN card. In this approach, control is not a centralized but users may access or run tasks on the server as well as on its own machine. In the present work, a well known National Knowledge Network (NKN) was established by Government of India in the computer centre located at Babasaheb Bhimrao Ambedkar University, Lucknow, India. In this network the devices are arranged according to the following figure.

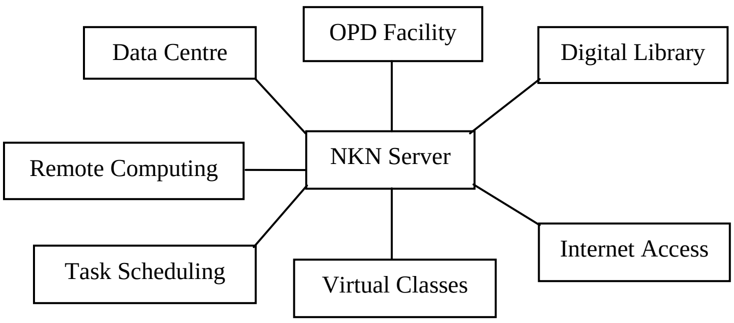


**Figure1.** Distributed Features of Computing

In the above technology, a router model CISCO 7609 is used to provide access to the server and through this server, users may get the services like OPD facility, online medicine treatment facility, online Examination, video conferencing, online report generation, digital library, remote computing, virtual classes, tasks computing through data centres, internet access and many more. For optimizing the performance of the above devices used for providing the said facilities to the users, a number of processors are used by means of the static step network technology as shown in the figure 2.

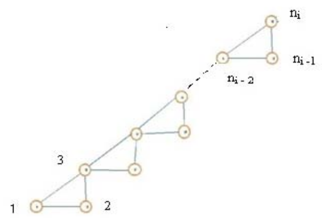


**Figure 2.** A Static Step Network

In the reference of figures 1 and 2, different network devices are well interconnected in the computer centre as shown below in the figure 3.

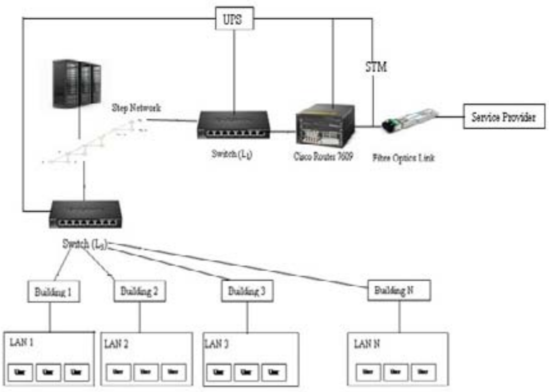


**Figure 3.** Interconnection of Devices in the Computer Centre of the University

The above setup has been established in Babasaheb Bhimrao Ambedkar University (BBAU), Lucknow and represented in figure 2. It is self explanatory; service provider provides the fibre connectivity to (STM). A link from STM is given to the CISCO router 7609, and then different processors are arranged through step network connected through L1 switch for distribution to the various buildings, link from servers is given to L3 switch which is used for NKN servers to the different buildings located in the BBAU campus of the University. The specifications of devices used in the computer centre are summarized below in following table 1.

**Table1** Specifications of Devices used in the Computer Centre

| Name of Device | Specification | Power Consumption |
|---|---|---|
| Router Cisco 7609 | **1. Dimensions** (H x W x D) 36.75 x 17.2 x 20.7 in. (93.3 x 43.1 x 53.3 cm) **2. Power requirements:** (a)– 208 to 240 VAC (b)– 48 to -60 VDC **3. Input Current** - 30A **4.-Environmental Features**: (a) Operating temperature: 32 to 104°F (0 to 40°C) (b)Storage Temperature: -4 to 149°F (-20 to 65°C) | Power Consumption: 1300W Max (100-120 VAC).2500W Max (200-240 VAC or -48 to -60 VDC). |
| L1 Switch - Coriant (switchgear)7090 Series 7090-92M | **1. Dimension**: 442 x 220 x 180. **2. Model :** Coriant , hiT 7090 92G **3.Fabric Capacity**: 92Gbps **4. Hardware Protection**: Control, timing and fabric module protection for hiT 7090 240G and hiT 7090 92G. | Maximum Power Consumption = 400w |
| L3Switch D Link DGS-3120 , 24PC | **1.Dimensions** (W x D x H) = (440 x 310 x 44 mm) **2. Model:** DGS-3120-24PC: 24-Port Gigabit , L2 Stackable Managed, PoE Switch including 4 x Combo 1000BASE-T/SFP ports and 2 x 10 Gbps stacking ports (24 x PoE ports, smart fans), **3. Switching Capacity** -88 Gbps, | PoE = Power Over Ethernet Load (Min): 482.7 Watts (with 70W ) PoE = Power Over Ethernet Load (Max): 935.1 Watts (with 740W ) |
| Firewall Proxy HP Proliant DL580G7 (Endian Firewall Community) | **1.Dimensions:** 4u Rack, 6.94 X 19 X 27.55 Inches (17.6 X 48.3 X 70 Cm) 100lbs Max **2.Rail Kit:** Rack Rail Kit 50/60 Hz **3**. Hewlett-Packard Company, Model No. HSTNS- 2131, Server / Storage - HSTNS-2131 (HP Proliant DL580 G7) **3. Cache Memory**- 24mb (1 X 24mb) Level 3 Cache Ports: 6 Usb 2.0 Ports. **4. Processors:** 2 X Intel Xeon 10 Core Processor E7-4860 2.26ghz 24mb Smart Cache 6.4 Gt/S Qpi Tdp 130w | Maximum Power Consumption HP 1200W ,100/110-120/200- 240 Volt Current supply at per 9/9/5 amp |

By the use of Table 1, different parameters are considered which are variable form time to time and a mathematical method is proposed to optimized the power consumption used in the above devices, since the power consumption is directly dependent on time hence is varied as per time variation for scheduling of the various tasks given by the users. In this work, power consumption is optimized by the mathematical technique and results are depicted in the form of table and graphs.

## II. RELATED WORK

Let us describe some of the important work on the said topic from which authors are motivated to describe the power consumption methods on the computer centre of the University. Vasudevan et al. [1] have given an algorithm for theoretical based framework a penalty based Profile Matching Algorithm (PMA). This algorithm is mainly used for scaling the energy consumption during data work load in profile based application in the data centre. Mäsker et al. [2] described the smart grid–aware scheduling in data centres. An algorithm introduced for better balance energy effect in multi queue batch system and improved the scheduling algorithms for energy utilization. Shen et al. [3] have developed a stochastic model on querying theory BFGS based algorithm to optimize the trade off by searching for the data centre operators to right–size. The Stochastic Right Sizing Model (SRM) implements the algorithm on data workload in data centre. Rossi et al. [4] have used various methods for energy saving techniques. One of the methods Energy-Efficient Cloud Orchestrator e-eco is a data management system that connected with the cloud load balance during execution. The power aware approaches the e-eco the best way for finding the energy performance. Arianyan et al. [5] have developed a Dynamic Voltage and Frequency Scaling (DVFS) method for consolidation resources to propose a novel fuzzy and objective resource management solution.

Nada et al. [6] have described a scaling physical model for energy consumption. In this model, there are three different stages (i) rack inlet temperature at the time of aisle partition and aisle containment configuration. (ii) Temperature reduction increase with increase power density (iii) using aisle partitioned with raised floor improvement. Gu et al. [7] have developed a green scheduling algorithm for cloud data centre and focused on two optimization, (1) Reducing the total energy cost through scheduling of servers, and the usage of different energy sources, (2) minimizing total carbon emissions within the budget of energy cost. Shoukourian et al. [8] have given a toolset, called Power Data Aggregation Monitor (PDAM). It collects and evaluates data from all resources like information technology systems, resource management systems and applications. The goal of power DAM improves the energy efficiency of High Performance Computing (HPC). Baccarelli et al. [9] have given a queuing theory for data work load in data centre. This theory has two features (i) maximize the average workload admitted by the data cente (ii) minimize the resulting networking-plus-computing average energy Consumption. The optimization method is implemented to the resource management framework uses in admission control. Zapater et al. [10] have given a technique for energy consumption in data centre called Grammatical Evolution Techniques (GET) used as generation as a temperature model. The temperature model is used for prediction of CPU and inlet temperatures for runtime data center temperature prediction using GET. Basmadjian et al. [11] have proposed a mechanism theory to find the demand supply electricity in data centres. In this proposed mechanism, they described the power supply policies to reduction the energy consumption. Lei et al. [12] have given an algorithm for energy efficient scheduling in data centre. In this proposed algorithm, there are two types of scheduling (i) Green-Oriented scheduling (ii) Time – Oriented Scheduling. They described a multi objective energy efficiency task scheduling on a green data centre by Dynamic Voltage Frequency Scaling (DVFS) technology. Hammadi et al. [13] have explained the survey methods of architectures and energy efficiency in Data Centre Networks and proposed the Data Centre Networks (DCN) techniques as switch-centric and server centric topologies. Xu et al. [14] have described a novel energy efficient flow scheduling and routing algorithms in Software Defined Networking (SDN). In this approach, the networks link and switch works as scheduling algorithms for energy consumption are explained. Vitali et al. [15] have given a model approach for finding the energy consumption of data centre. By the use of the model efficiency of data center has increased the energy efficiency and quality of service (QoS). Brown et al. [16] have discussed the current trend of energy and energy costs of data centres and servers and given various methods, techniques, and algorithms for finding the energy consumption in data centres. Ghazisaeed et al. [17] have proposed a method of energy embedding of Map Reduce based virtual networks in data center and formulated a mixed integer disciplined convex program (MIDCP) for applying this method. This method used for solving the NP-hard problems. Cupertino et al. [18] have proposed the energy efficiency through thermal modelling in data centre and used the CoolEm All approach for evaluation and measurement. They also described resource management scheduling for workload process. Asghari et al. [19] proposed proposed the three main approaches used to modify of Bcube topology as a topology for vitualized data centre. Khani et al. [20] proposed a Mathematical analysis for distributed consolidated virtual machines for pewer efficiency in cloud data centres. Jiang et al. [21] have proposed a Mathematical model for the network flow over the network device through Integer Linear Programming (ILP). In the complex networks the heuristic approach solving the Integer Linear Programming is explained. Myoung et al. [22] have proposed an algorithm for controlling the server speed and routing scheduling. They have proposed time distribution G/G/1/PS queue and load balancing algorithm. Castro et al. [23] have given two new methods for energy consumption (i) dynamic consolidation of virtual machines for CPU in data centres (ii) dynamic consolidation of virtual machines for RAM in data centres. Arianyan et al. [24] have proposed a multi-criteria decision making method for determination of energy consumption. In this method they have applied service level agreement (SLA) efficiency in resource management. Paul et al. [25] have described a method for controlling the electricity cost during load distribution for the reduction of energy consumption. Huu et al. [26] have proposed a power scaling algorithm and energy efficiency model for data centre networks. The energy analysis model is proposed to calculate the energy saving cost in low and high transmission data packets throughput in networks. Kulshrestha et al. [27] have explained a receiver contention based mixed transmission scheme for energy consumption .the residual energy of the receivers. It considers link reliability and the numbers of neighboring nodes, the proposed approach have given energy of efficient data transmission. Zhang et al. [28] proposed optical switching technology energy consumption for data centre networks. Collins et al. [29] proposed here as energy consumption case study an examination of the abandonment of applications for energy efficiency retrofit grants in Ireland. Freire- González et al. [30] have described input-output methodologies in data centre and direct and indirect rebound effects have been mathematical analysis efficiency improvements of energy efficiency. Zhang et al. [31] have proposed design principles and architecture. They have described two methods for energy reduction (i) Open Scale Network (ii) Workload Allocation. The analysis and experimental classification of an optical switching scalable data center network architecture.

## III. MATERIALS AND METHODS

In data centre, there are many devices, when are connected in series and every device consumes power itself called Local Power Management (LPM). The LPM is derived of each and every hardware configuration. The configurated devices are integrated of many embedded system, and the embedded system is connected through integrative circuits. The integrative circuits are depending on the power consumption. The different devices are represented by different formulas or (Energy) like Central Processing Unit (CPU) which varies the energy consumption represented by $P \alpha CV^2$, there are two types of energy consumption of the devices (a) dynamic energy consumption (b) static energy consumption. The dynamic energy consumption is depending over the full connectivity devices on voltage and conductance or consolidated devices. The static energy consumption is fixed over the devices. The server energy consumption is proportional to the CPU utilization. The dynamic energy consumption also depends on NP completeness problem. The energy consumption of the data centres also depends on the server and different types of servers are used to optimize the work load of the power optimization.

On the basis of above concept, a National Knowledge Network (NKN) is established by Government of India, which is a capable for providing secure and reliable connectivity. The NKN provides the research, innovation and multidisciplinary area and collaborative communication for the research area. The NKN has certain features in research area and other services as given below. It is a high-speed backbone connectivity which will enable knowledge and information sharing amongst NKN connected institutes. The services provided by NKN are shown in figure 1.

**a.** It is enabling collaborative research, development and innovation amongst NKN connected institutes;
**b.** It is facilitating advanced distance education in specialized fields like engineering, science, medicine etc;
**c.** It is facilitating an ultra-high speed e-governance backbone;
**d.** It is providing connection between different sectoral networks in the field of research;
**e.** It is providing OPD facility, video conferencing facility, remote computing, and digital library facility and many more.

### A. *UML Activity Diagram*

The process classification in data centre is represented through Unified Modeling Language (UML) activity diagram.

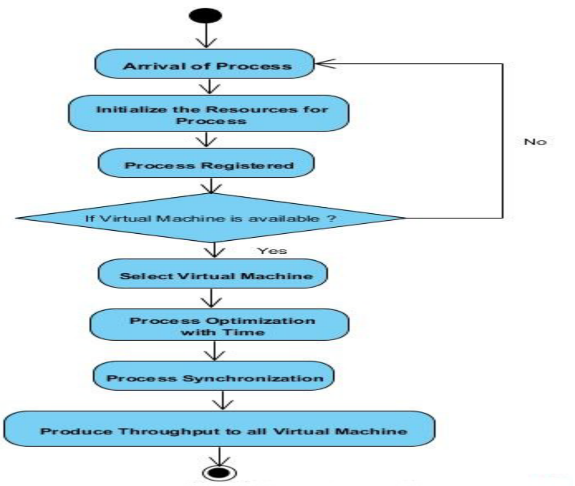


**Figure 4. UML Activity for Process Classification**

It is shown in the figure 4 in which flow of the information in data centre is a method of transmission. Firstly, the process of initializes incoming process at a specific time and go through for the resource analysis and process is registered in process block. Now the process entered in virtual machine and proceeded with the minimum energy cost and power utility chamber, Now then process flows in hard disks, memory, and CPU with specific time interval. Now that the same process in all virtual machine and process synchronizes throughput to all devices. Now the final process get energy cost measured with the data flow in data centre.

### *B. Methods of Energy Efficiency in Data Centre*

Data centre uses the energy consumption major components. Suitable methods for efficient energy consumption are described below:

*1) Information Technology for Equipments*

The energy consumption of data delivery packets in IT components is very vast. During the period of execution process, the energy consumption of all IT equipment is consolidated consumption and individual components. These approaches are working on IT equipment with working load on CPU, hard disk, motherboard, and other electromechanical devices components.

*2) Cooling*

The cooling in data centres is mostly provided by Computer Room Air Conditioning (CRAC) units. The CRAC units works in data centre, for minimizing the energy consumption in the equipments. The air handling units is covered the distributing the air throughout the data centre using the devices like fans, filters, and cooling coils. The fans works with the server's pulls are cold air and reduce their heat. At this time the warmed air toward the ceiling and receive the CRAC unit.

*3) Electric Power Delivery*

The power delivery is performed in data centre to storage devices and network IT equipments to facilitate the storage and transmission of data. The power delivery systems provide voltage regulation, backup power, and AC/DC convertors. The power delivery of electricity is first supplied to UPS, and then Power Distribution Unit (PDU). The PDU units convert the AC voltage in to the DC voltage. The DC voltage performs as work all internal hardware devices like, CPU, memory, disk drives, chipset, and fans.

*4) Heat Removal*

The maintaining and controlling of temperature or humidity is the main feature of air conditioning systems in data centres. The all electronic devices are consumed the energy as heat delivery. The rack of blade servers requires the power up to 20-25 kilowatts.

*5) Energy efficiency*

The energy efficiency of data reliability in data centres depends on the designers and operators. The power and cooling systems in data centres must be efficient for the energy efficiency. Many software programs and hardware devices consume the power allocation and released the carbon footprint. The energy efficiency is increased by the design of device architectural and software applications.

*6) Power Vs Energy*

- The power and energy are different. Power is measured in a particular point in respect of time but the energy consumption is measured in over a period of time.
- Power is measured in kilowatts (kw) but the energy is measured in kilowatts hours (kwh).
- The highest power approached is very important aspect at any point of time for power based design, while energy consumption over a period of time is important aspect for energy based design.

*7) Performance Vs Productivity*

- The performance and productivity are distinct of the data centre. The performance of the data centre is measured as (QoS) of the networks availability and their design, while the productivity is measured as the throughput data packets in amount of quality assurance.
- If the hardware side of servers and storage are capable of the data transmission throughout the networks as called performance. While the total amount of data packets in specific time is called productivity.

*8) Code of Conduct (COC)*

The code of conduct is a action of stimulate data centre operators to reduce their energy consumption. The code of conduct is responsible for the following parameters:

- Environmental statement;
- Problem Statement;
- Scope of CoC;
- Aim and Objectives of CoC;

## IV. COMPUTAION OF POWER CONSUMPTION

In the said case study, the devices are installed and consumed more energy in comparison of the others because of high power requirement by the devices, as well as cooling infrastructures. In general, it is approximate 40 times more in comparison of other office equipments installed in the building. A server takes more energy consumption during the peak hours. Let us describe, the electric power consume by the devices for which consumption of energy takes place.

### *A. Electric Power Consumption*

In the university numerous devices are installed which are represented in figure 5.

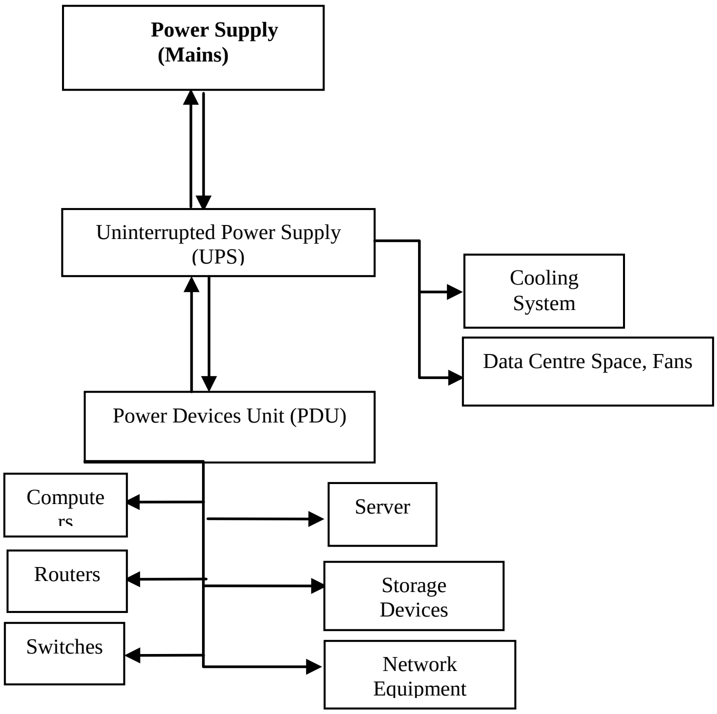


**Figure 5.** Power Consumption Devices

Since, these devices perform critical operation for which Uninterrupted Power Supply (UPS) equipment is designed to maintain desire electric supply. The equipment represented power as described in following table 2.

**Table2. Details of Peak Power Consumption**

| Component | Peak Power (kW) |
|---|---|
| CPU | 80 |
| Memory | 36 |
| Disks | 12 |
| Peripheral Slots | 52 |
| Motherboard | 25 |
| Fan | 10 |
| Power Loss Supply Unit | 38 |
| Total | 253 |

However, in some equipment it has range from minimum to maximum like CISCO router 7609 consumes power consumption from 48 watt to 60 watt, hence the range of power consumption varies from one device to other device.

### B. *Heat Removal*

Temperature, varies from day to day temperature varies therefore cooling equipment are necessary for maintaining the temperature in the computer centre, generally air conditioning systems are used for maintaining temperatures in the computer centre where devices are installed.

### C. *Measurement Techniques*

Various authors here designed measurement techniques for finding the consumption cost of the services related to the computer centre. The steps are given below,

- To determine the rate of energy delivery from the source to the devices;
- To determine how many units are delivered by the devices;
- To determine how many units are used for the work;

Some of the measurement techniques in the computer centre are described below:

*1) Power Usage (PU)*

This is a technique for measurement of the amount of power to perform effective computation in a data centre. The formula is expressed of power usage and is given below. Power allocations in IT equipments are distributed. The power is distributed in the entire devices like UPS, generators, batteries, IT devices. The power uses the distribution air cooling system and network nodes.

*2) Data Centre Infrastructure Efficiency*

Let us consider a power management for the router (CISCO 7609) modelled in the computer centre the router power management is given by,

$$RPM = Static\ Power\ Supply + \alpha\,(Dynamic\ Power\ Supply)$$

$$RPM = SPS + \alpha\,(DPS) \qquad (1)$$

Where $\alpha$ is constant, RPM is the Router Power Management, SPS is Static Power Supply, DPS is the Dynamic Power Supply. Let us apply least square method to optimize the power consumption and normal equation are given below,

$$\sum RPM = SPS + \alpha \sum DPS \qquad (2)$$

$$\sum RPM \times DPS = SPS \sum DPS + \alpha \sum DPS^2 \qquad (3)$$

Let us consider computation current supply i.e. I=30 amp. and voltage is varying from minimum value 48 to maximum value 60, and then power consumption is resolved in the following table 3.

**Table 3 Computation of Power Consumption**

| V (Volt) | I (Amp) | P=V*I (In Watt) |
|---|---|---|
| 48 | 30 | 1440 |
| 49 | 30 | 1470 |
| 50 | 30 | 1500 |
| 51 | 30 | 1530 |
| 52 | 30 | 1560 |
| 53 | 30 | 1590 |
| 54 | 30 | 1620 |
| 55 | 30 | 1650 |
| 56 | 30 | 1680 |
| 57 | 30 | 1710 |
| 58 | 30 | 1740 |
| 59 | 30 | 1770 |
| 60 | 30 | 1800 |

From the above it is observed that power is directly dependent on the voltage for management of this power, let us consider RPM is taken as P while DPS dependent on the voltage V, hence RPM depends on the V on solving (2) and (3) on the said data, it is computed as

SPS = 0, $\alpha$ = 30 and RPM = 30*V

This is true as per observations.

## V. RESULTS AND DISCUSSIONS

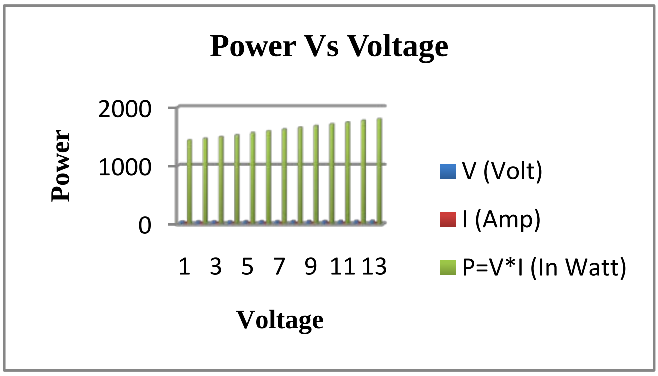


**Figure 6. Representation of Power V/s Voltage**

The above graph has shown the result of the relation between the power consumption and input voltage for the Router Power Management (RPM). The input voltage applied range from $V_{Min}$ = 48 Volt to $V_{Max}$ = 60 Volt and applied input Current is 30 Ampere. So the router power management and power measurement have described the power which is increased as voltage is increased and when the current is constant taken as 30 amp.

## VI. CONCLUSIONS

From the above work, it is concluded that the UML is a powerful modeling language which is used to represent the dynamic behavior of the research problem. In the above work, a studied is done for the minimizing the power consumption in the computer centre which contains various devices emitting the energy. A least square method is used for providing the optimized results represented through graph. The same study can be extended for the other computer centre.

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# Optimization of Energy Consumption for Task Scheduling on Uni-Processor and Multiprocessor for Step Topology under Distributed Environment

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## ABSTRACT

Distributed computer networking plays a very crucial role in the Business, Industries, Education, Research and Development areas. Many users work on the heterogeneous devices which have different configurations. In distributed network communication takes place from one to one machine, one to many machines or many to one machine. Hence, tasks are migrated from one device to another device which is the important property of the distributed system. Due to rapid increase of the users on the devices connected across the distributed network, the management of the computer networks is a very big and challenging area of research. In the present work, different devices are connected across the step topological networks and an attempt is made to reduce the overall energy consumption when data is flowing from one device to another device. Optimization of energy consumption reduces the overall cost of transfer of data. Multiprocessor and Uni-processor cases are considered in special cases and computed results are represented in the form of tables. A well known Hungarian methodology is used for optimization of the overall energy.

## Keywords

Distributed Network, Step Topology, Lagrangian Method, Hungarian Method, Uni-Processor, Multiprocessor, Energy Optimization.

## 1. INTRODUCTION

In the current scenario, distributed computing plays a vital role in computing. It takes an edge over the centralized computing system due to the low cost and higher efficiency. Multiple windows under the excellent operating system environment may appear on the computer screen for the multiple computing purposes. Nowadays personal computers may have more than one processor due to exhaustive research available for dual core processors or even multiprocessors when arranged via a static network topology which should be efficient and low cost involvement. Further, a task is defined a piece of macro, process, subroutine, subprogram, etc. and for multiple tasks scheduling algorithms are applicable for completion of tasks within minimum time. Since all the tasks are executed on the processor taking either uni-processor or multi-processor, therefore, energy optimization is a big challenge for the resources. One can say that the energy can be consumed when task is executed on the uni-processor or multi-processors connected across the step network. Electrical energy may be consumed by the hard disk, processors, motherboard, power supply etc. which is further categorized as a fixed energy and variable energy. Due to several advantages of distributed computing over the centralized computing, slowly-slowly, many organizations are shifting their computing labs from centralized system to distributed system. In this computing is a collection of various computer networks incorporated with a single server or computers. The computers are retrieving information with each other related computers. In this computing all computers are connected in common component computer devices, for the operation of various computing operation. All the computer components are initially worked as purely on scheduling basis as synchronize and asynchronies. The process may be FCFS (First come first serve), other job scheduling algorithm and Round-Robin is one of the most popular approach of the scheduling of the tasks. The computing component consumes the electric energy component wise, like chipset mother board, central processing unit, electromechanical devices (i.e. Fan), Hard disk. All the component devices consume more energy during action performance. The electric energy increases by the work load and it is a continuous process of synchronization if all components are busy. The electric energy reduces the cost which may be lack of workload during sleep mode and due to absence of data packets. There are two methods used for the reduction of the energy consumption. Firstly the component in sleep mode operation and secondly the rate of network operation to be applied through workload. In this work, authors have attempted to optimize consumed energy on the Uni-processor as well as the multiprocessors for the task scheduling. Standard specification of Uni-processor and multiprocessors are considered consumed energy is computed. Energy of a system is computed for Uni-processor and multi-processor using Lagrangian multipliers with resource tasks and processes. For optimizing the energy consumption, a well known Hungarian method is used.

## 2. RELATED WORK

Pecero S´anchez et al. [1] have given a scheduling algorithm for reducing energy consumption by dynamic voltage scaling (DVS). In this algorithm, authors found minimum time to finish complete process in scheduling. Wang et al [2] have described an algorithm for energy optimization method. Authors used dynamic reconfiguration in real time scheduling for multitasking systems. Authors used flexible parameter based on dynamic reconfiguration for completion of processes in multitasking system. Wang et al [3] have focused for solving the energy optimization problem for real time multiprocessor systems in streaming pipelining with dynamic voltage scaling and dynamic power management in complete transition process. A scheduling genetic algorithm is proposed for best scheduling process. By the result of proposed technique, 24.4% reduction in energy consumption was observed. Chen et al. [4] have used a mix integer linear programming technique. In this method, they have used the combined Dynamic Voltage Frequency Scaling (DVFS) and Dynamic Power Management (DPM) for the reduction of energy consumption in Uni-processor systems. The DVFS is constraints with voltage and frequency scaling at the time of processes scheduling and DPM is defined as the power constraints of various hardware equipments. Anne et al. [5] have invented a classical scheduling algorithm for unified scheduling process. This scheduling process is depends on probability, offline for energy consumption. Zhang et al. [6] have predicted a scheme based packet scheduling in Ethernet passive optical network, authors used an algorithm and discussed sleep based model for energy saving approaches. Authors have also interpreted the energy consumption on sleeping and low loaded networks unit. Anbazhagan et al. [7] have investigated power management mechanisms for power saving in heterogeneous traffic based on Combined Cyclic Exponent (CCE), Combined Anti-Cyclic Binary Exponent (CABE) and Combined Truncated Binary Exponent (CTBE) algorithms based in different time interval. Kiani et al [8] have given a theory of real time tasks scheduling. This scheduling process is based on CPU and read write tasks of hard disk. The execution time of the process of the CPU and read write time of hard disk without tasks missing. Yan et al. [9] have explained a numerical study of energy consumption which depends on time efficiency with five structural topologies and four different routing methods i.e. (i) ER Random Graph Model (ii) Kleinberg Small World Model (iii) Scale Free Model (iv) Grid Model. Although different devices have a range of power consumption but due to heavy load across the network, overall time of execution increases and power is directly related to the time, therefore energy consumption increases. Various authors have used the Mathematical techniques to optimize the energy consumptions and some of the important references are described.. Zhang et al. [10] have given a green task scheduling algorithms for heterogeneous computer networks. In these algorithms, the process scheduling with continuous speeds and discrete speeds for the energy consumption are described. Authors have considered two cases (i) Heuristically Assigning Tasks (ii) Minimum Optimal Speeds for all tasks assigned to each computer. The algorithm is used for energy efficient equipment as mobile devices, sensor networks; data centre, and distributed computing networks. Rehaiem et al. [11] have discovered a scheduling priority based algorithms of real time scheduling for embedded systems. In this method, authors used embedded systems with neural networks for low power consumption optimization. The combination of the DVS and neural Feedback scheduling process are used for energy optimization. Boiardi et al. [12] have described the joint Mathematical planning and energy management operation for energy consumption. They have discussed a Mathematical framework and designing the network for optimizing the power consumption. Zhang et al. [13] have given an algorithm named as Shuffled Frog Leaping Algorithm for real time tasks scheduling in heterogeneous networks. This algorithm is used in multiprocessor systems in the time of process scheduling. Rituraj et al.[14] have described three schemes for Orthogonal Frequency Division Multiple Access (OFDMA) named as Hungarian method, Game Theory and Gale-Shapley matching scheme for finding the energy performance. Li et al. [15] have described the power allocation and task scheduling process on multiprocessor computers with energy and time relations. In their work, authors discussed how the energy in multiprocessor affects with the time relation constraints. Jena et al. [16] have focused a theory on task scheduling using a multi objective optimization method for energy consumption with the related of processing time. Da-Ren et al. [17] have invented a model of variable voltage depend processor with the discrete time voltage/speed. The DVFS scheduling can be defined in two steps (i) inter-task DVFS (ii) intra-task DVFS. The DVFS scheduling technique is a most effective for reducing the power consumption. Bharti et al. [18] have given a Task Requirements Aware Pre-processing and Scheduling (TRAPS) for CPU. The scheduling of processor is measured by the incoming tasks. Proposed energy monitoring system works on reducing message process and energy consumption. Sousa et al. [19] have given an algorithm based on Meta heuristic technique for energy resource scheduling in smart grids. Zhao et al. [20] have discovered a task scheduling method for datasets and tasks. In this method there are two conditions (i) datasets of task scheduling (ii) tree to tree task scheduling. Ismail et al. [21] have given a model based technique named as Energy Aware Tasks Scheduling for the tasks scheduling. The application of Energy Aware Tasks Scheduling model increases the efficiency and reduces the energy consumption. The consumption of energy is depending on work load of data servers. C. Douligeris and G. Feng [25] have proposed a theory "guided trial-and-error" method for energy optimization. Authors have solved the technique by computer simulation on the assignment problem and N-Queen problem of different aspects.

# 3. BACKGROUND

## 3.1 Distributed Computing Networks

The distributed computing network is an interconnected network over various resources like laptop, printers, mobile, desktop, and other peripheral devices connected through a server. The devices may communicate from one to one and many to one device for applications. The network peripheral devices may send the process application for retrieving the information via server application as per instruction sequencing process.

## 3.2 Step Distributed Networks

In this network, there are at least three nodes linking on the network and communicated in distributed manner. When it is extended towards step network, there are many computers connected through a server for various application operations. In this network beneficial as resource sharing, scalability, robustness, performance speed and cost are important factors of study. It is challenging task for step network like as latency, synchronization process and failure data transmission, security, transparency and scalability. A view of step network is shown below in figure 1.

## 3.3 Energy Optimization Methods

### *3.3.1 Dynamic Voltage Frequency Scaling (DVFS) Method*

It is a very crucial technique used for reducing the energy consumption. If the voltage V decreases to the system then energy and frequency will also getting low. If the voltage increases of power supply then the system increases the frequency and generating power. The dynamic voltage scaling technique is used for reducing the energy efficiency. In the computer architecture, the voltage used in a device wise component is increased or decreased, depending upon conditions. So it is beneficial for voltage balancing to the networks system. Voltage measurement is important for energy reducing very low values when operating at low speeds. The computation of voltage is done by [3-4]

$$V = \sqrt{\frac{P}{C.f}} \quad (1)$$

Where, P, C and f are power, capacitance and frequency respectively. DFS can be used for energy conservation for lowering the heat produced by a processor by lowering frequency. The low frequency will increase the amount of time and a processing element needs to complete a task. Energy is conserved with DFS because the Peripheral Equipment (PE) like Motherboard, Hard disk, CPU and other electromechanical components (i.e. fan) consumes less power when running at low frequency. The frequency is given by.

$$f = \frac{P}{CV^2} \quad (2)$$

### 3.3.2 Clock Gating

Clock gating is a third technique of energy optimization methodology commonly used to conserve energy on the processing element level. Clock gating adds additional logic to the processing elements. This certain parts of the switching action from changing states. This method reduces the power of processing elements from constantly switching which accounts for a large fraction of the processing elements. Clock gating reduces the unwanted switching on the parts of clock net by disabling the clock.

### 3.3.3 Routing Techniques

#### 3.3.3.1 Link State Routing

The link state routing is a state description routing as the data transmission flow in one node to other neighbour node. In this method, routing for computation of shortest path is done by Dijkstra's Algorithm from a node to all other nodes. The Dijkstra's algorithm computes the end to end routes, and finds the shortest path of the routing store to the next node address. This method is also used for reducing the energy consumption. This routing technique defines states of node and used as linking state according to the process time scheduling in network topology. Routing used in this is as the scheduling constraints, which is minimum shortest task scheduling.

#### 3.3.3.2 Distance Vector Routing

Another method is a distance-vector routing which defines the length of the shortest-path from each of its neighbour's node to every destination in the network, and uses information status to measure its own distance and next successor router (r) to each destination. Each update message sent by a router to its neighbours contains a vector with one or more, each of which specifies as a minimum, the distance to a given destination's, each router sends only described information data flow. In this routing, the process scheduling is based on spanning distance. The spanning distance defines as the minimum shortest distance covered by the node vector.

## 4. RESEARCH METHODOLOGY

In the proposed model, different nodes which are arranged through the step topological structure as shown in figure1 make service requests which keep in the service queues. Let us consider each node is evaluated with the Uni-processor, computer with time constraint T and energy Constraint E. The transmission time for n nodes is represented by matrix Ti,j since all nodes are autonomous collection to form distributed system then ri ( i=1…. n) represents of task scheduling i & sum of all ri is R, pi represents power allocated to each task scheduling i in terms of supply voltage, clock frequency, etc. Then execution speed of task i, si = pi (1/α), where α = 1+2/φ ≥ 3, 0< φ ≤ 1, and φ is the linear change in supply voltage, and the energy consumption of a particular resource is given by [26].

$$Energy \ \alpha \ Power \ input \times Amount \ of \ workdone \ for \ Task(i)$$

$$E = r_i \ (p_i)^{1-\frac{1}{\alpha}} \quad (3)$$

Then total energy consumption of resources is given by [26],

$$E \ (p_1, p_2 \ldots\ldots\ldots\ldots p_n) = r_1 p_1^{1-\frac{1}{\alpha}} + r_2 p_2^{1-\frac{1}{\alpha}} + \ldots\ldots\ldots\ldots r_n p_n^{1-\frac{1}{\alpha}}$$

$$= \sum_{i=1}^{n} r_n \ p_n^{1-\frac{1}{\alpha}} \quad (4)$$

We should minimize E (p1, p2 .............pn) but subject to time constraints and let schedule length t1 , t2..........tn does not exceed T then , let a function is considered on variables( p1, p2 .............pn) and is given as F(p1, p2 .............pn), which are less than of total time scheduling T given by [26].

$$F(p_1, p_2 \ldots\ldots\ldots\ldots p_n) = \frac{r_1}{p_1^{1/\alpha}} + \frac{r_2}{p_2^{1/\alpha}} \ldots\ldots\ldots\ldots\ldots \frac{r_n}{p_n^{1/\alpha}} \leq T$$

$$\sum_{i=1}^{n} \frac{r_n}{p_n^{1/\alpha}} \leq T \quad (5)$$

Now, Let  i is Lagrangian multiplier formulated and then it is given by [26]

$$\lambda_i = \frac{\nabla E}{\nabla F}$$

$$\nabla E = \lambda_i \nabla F \quad (6)$$

$$\frac{\partial E}{\partial p_i} = \lambda_i \frac{\partial F}{\partial p_i} \quad (7)$$

From equation (3) and equation (5) given by [26], where $\lambda_i$ = $p_i$ (1- α) , for all 1≤ i ≤ n.

$$r_i \ (1 - \frac{1}{\alpha}) \frac{1}{p_i^{1/\alpha}} = \lambda_i \ r_i \ (-\frac{1}{\alpha}) \frac{1}{p_i^{1+1/\alpha}}$$

$$1 - \frac{1}{\alpha} = -\frac{\lambda_i}{\alpha \ p_i}$$

$$p_i = \frac{\lambda_i}{(1-\alpha)} \quad (8)$$

$$E_i = \frac{R_i^{\alpha}}{T^{(\alpha-1)}}$$

$$R_i^{\alpha} = E_i \, T^{(\alpha-1)}$$

$$R_i = E_i^{\frac{1}{\alpha}} \, T^{\frac{(\alpha-1)}{\alpha}}$$

$$E_i = \frac{R_i^{\alpha}}{T^{(\alpha-1)}}$$

$$R_i = (E_i)^{\frac{1}{\alpha}} \, T^{(1-\frac{1}{\alpha})}$$

$$E = \sum_{i=1}^{n} r_i \left(\frac{\lambda_i}{1-\alpha}\right)^{1-1/\alpha} \quad (9)$$

$$R = r_1 + r_2 + \dots\dots\dots + r_n$$

$$R = \sum_{i}^{n} r_i$$

$$T = (p_i)^{1/\alpha} \,/\, R \quad (10)$$

Where R is the total Task scheduling of requirement of the n tasks for resources, In the case of multiprocessor, the energy consumption is given by,

$$R = E_i^{\frac{1}{\alpha}} \times T^{(1-1/\alpha)} \quad (11)$$

The above formula used for multiprocessor for finding the energy for different resources.

## 5. PROPOSED WORK

In the present work, the following cases are described below based on the above formulae

### 5.1 Uni-processor Case

A Uni-processor system has a single computer processor, which is used to execute many tasks. All the tasks are related to a single processor and also to various operations controlled by the single processor computer. The power supply of the Uni-processor does not change and remains at fixed time by the component peripherals. The physical limitations of single processor are limiting controlling tasks. Let the coefficient $\alpha$ = 3,4,5 then Lagrangian multiplier $\lambda_I$ is calculated by the equation 7, for the uni-processor as given by [26]

$$\lambda_i = p_i(1-\alpha) \quad (12)$$

Where $\lambda_i$ is the Lagrangian Multiplier and processes $p_i$ are different tasks scheduling and power supply is taken as uniform by the equation 8.

$$E = \sum r_i \left(\frac{\lambda_i}{1-\alpha}\right)^{1-\frac{1}{\alpha}} \quad (13)$$

The energy consumption of the Uni-processor can be obtained by putting the value of Lagrangian multiplier and coefficient $\alpha$ in above formula. The energy consumption is calculated by Lagrangian values in different task scheduling with the varying $\alpha$ values, simultaneously. The energy consumption of the Uni-processor with the Lagrangian multiplier and coefficient $\lambda$ are demonstrated based on Lagrangian values through different resource tasks scheduling with $\alpha$ = 3, 4, 5.

**Table 1.Uni-processor related with various component wise Specification.**

Table 1. Uni-processor related with various component wise Specification

| Sr. No. | Hardware | Specification Supply | Max Power (in Watt) |
|---|---|---|---|
| 1. | HDD | 1 TB, Seagate | 9 watt |
| 2. | Motherboard | ASUS, i5,3.5 GHz | 80 watt |
| 3. | RAM | DDR2,DIMM,Clock Speed 200. | 5.5 watt |
| 4. | CPU | Intel core i5, 6402P,Size of cache 6.0 MB, Clock Speed 30 watt, 3.40 GHz. | 95 watt |
| 5. | DVD | Time Read Single layer 28.3, Time read double layer 25.7, speed 0.8x | 30 watt |
| 6. | Electro-Mechanical (i.e. Fan) | Blade 120mm, 2000 rpm | 6 watt |
| 7. | Graphic Video Card | ---- | 258 watt |
| 8. | Battery | ---- | 300 watt |

**Table 2. Computation of energy consumption for Uni-processor ($\alpha$ = 3, 4, 5)**

| Sl. No. | Power ($p_i$) | Tasks | Lagrangian Multiplier for ($\alpha$=3) | Energy ($e_i$) Consumption for ($\alpha$=3) | Lagrangian Multiplier for ($\alpha$=4) | Energy ($e_i$) Consumption ($\alpha$=4) | Lagrangian Multiplier for ($\alpha$=5) | Energy ($e_i$) Consumption for ($\alpha$=5) |
|---|---|---|---|---|---|---|---|---|
| 1. | $p_1$ | 100 | 0.0052 | 1.80 | 0.0030 | 0.560 | 0.0025 | 0.270 |
| 2. | $p_2$ | 105 | 0.0047 | 1.81 | 0.0031 | 0.588 | 0.0023 | 1.680 |
| 3. | $p_3$ | 110 | 0.0045 | 1.76 | 0.0030 | 0.616 | 0.0027 | 0.220 |
| 4. | $p_4$ | 115 | 0.0043 | 1.84 | 0.0031 | 0.644 | 0.0021 | 0.260 |
| 5. | $p_5$ | 120 | 0.0041 | 1.86 | 0.0027 | 3.480 | 0.0020 | 2.640 |
| 6. | $p_6$ | 125 | 0.0046 | 1.93 | 0.0026 | 0.587 | 0.0019 | 2.610 |
| 7. | $p_7$ | 130 | 0.0038 | 2.07 | 0.0025 | 0.611 | 0.0019 | 0.247 |
| 8. | $p_8$ | 135 | 0.0037 | 2.02 | 0.0024 | 3.51 | 0.0018 | 0.0675 |

For the Uni-processor, the following devices are considered with standard specification configuration. Now the energy computation with the different resource scheduling $r_i$ is considered with power supply and standard specification of component wise, the standard power supply max values is taken. Let $r_1$, $r_2$, $r_3$, $r_4$, $r_5$, $r_6$, $r_7$ and $r_8$ are the various tasks scheduling for the multiprocessor component devices. Let $r_1$ =100, $r_2$=105, $r_3$= 110, $r_4$ = 115, $r_5$ =120, $r_6$ = 125, $r_7$ =130 and $r_8$ =135 at different state when information flow from on multi-core shared memory. The formula used for finding energy for each component based with different task is given by equation (7). The following matrix represented in the form of table is designed for the eight resources by taking combinations in the form of 8x8 (Ei X Ri) [26].

$$E = \sum p_i^{1-\frac{1}{\alpha}} \times r_i \quad (14)$$

To compute the optimal result, a well-known Hungarian method is used and final matrix is given below by the following steps, Draw lines through appropriate rows and columns so that all the zero entries of the cost matrix are Covered and the minimum number of such lines is used and optimize the above matrix, a well-known Hungarian method [14] is used and final matrix is given below, The formula is used for finding the energy , where pi is power of hardware device E= $(9)^{2/3} \times$ 100= 426.3 Joule and so on,

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 426 | 652 | **544** | 567 | 610 | 763 | 697 | 479 |
| 1851 | 2824 | 2353 | 2447 | **2636** | 3314 | 3012 | 2071 |
| 2075 | **3169** | 2641 | 2746 | 2958 | 3698 | 3381 | 2354 |
| **313** | 470 | 392 | 417 | 439 | 548 | 501 | 345 |
| 4128 | 3192 | 5160 | 5366 | 5779 | 7224 | **6605** | 4541 |
| 976 | 1464 | 1220 | **1268** | 1366 | 1708 | 1562 | 1074 |
| 136 | 498 | 415 | 431 | 465 | 581 | 531 | **365** |
| 927 | 6850 | 5708 | 5937 | 6394 | **7992** | 7307 | 5024 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36 | 201 | **0** | 0 | 55 | 921 | 368 | 15 |
| 582 | 0 | 162 | 91 | **0** | 341 | 24 | 394 |
| 703 | **0** | 219 | 137 | 23 | 302 | 0 | 456 |
| **0** | 234 | 3 | 1 | 77 | 987 | 415 | 0 |
| 1874 | 3201 | 924 | 741 | 426 | 0 | **0** | 1493 |
| 187 | 90 | 25 | **0** | 0 | 677 | 204 | 121 |
| 197 | 226 | 0 | 7 | 71 | 974 | 405 | **0** |
| 5843 | 311 | 1144 | 938 | 579 | **0** | 66 | 1778 |

The optimal values of Uni-processor represented as underlined, measured by the Hungarian Method, and the optimized value of energy consumption is given by [14]

$E_{Min}$ = [313 3169 544 1268 2636 7992 6605 365]

$$E_{Min} = 22892 \text{ KJ.} \quad (15)$$

The relationship between energy and resource is also shown below in figure 2.

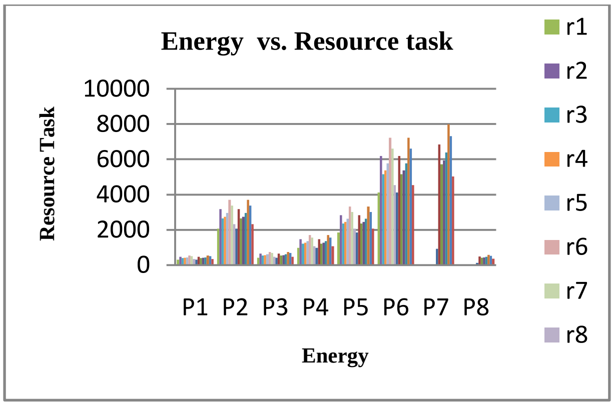


**Figure 2. Relationship between Energy and Resource Task in a Uni-Processor**

In Uni-processor, there is different component-wise power supply; the power supply is fixed with maximum value in unit emitted by each component. The different resource aspect task scheduling is computed for finding the energy consumption with different tasks; energy is computed at different task scheduling. One by one, each component has been computed by the estimation process with different interval task scheduling. The energy optimal paths are computed above and overall energy is optimized by Hungarian optimization method i.e. 22892 KJ.

## 5.2 Multiprocessor Case

In the multiprocessor system, the use of two or more central processing units (CPU's) within a single computer system is available. The multiprocessor system has better performance in terms of cost and tasks scheduling. It's also called multi core system with each one is sharing the common main memory as well as the peripherals. It has better throughput, hardware sharing within processors. Energy consumption parameters for multiprocessor system are Task Time Scheduling (ms), Input Power Supplying and Energy-Delay (ED). Let us consider the execution time of each process as T=10 milliseconds in multiprocessor and the execution on different task R is to be computed by the equation 11 and computed resources for eight processes are also demonstrated column-wise results as given below:

$$R_1 = \begin{bmatrix}36\\33\\62\\34\\51\\65\\89\\92\end{bmatrix} \quad R_2 = \begin{bmatrix}32\\34\\75\\98\\41\\56\\78\\102\end{bmatrix} \quad R_3 = \begin{bmatrix}41\\70\\73\\37\\35\\100\\98\\60\end{bmatrix} \quad R_4 = \begin{bmatrix}37\\81\\45\\79\\109\\40\\59\\106\end{bmatrix}$$

$$R_5 = \begin{bmatrix}66\\65\\39\\47\\84\\88\\118\\119\end{bmatrix} \quad R_6 = \begin{bmatrix}52\\77\\74\\65\\58\\46\\101\\48\end{bmatrix} \quad R_7 = \begin{bmatrix}84\\51\\55\\71\\107\\100\\89\\52\end{bmatrix} \quad R_8 = \begin{bmatrix}46\\82\\71\\53\\85\\99\\48\\57\end{bmatrix}$$

The relationship matrix with different resources allocation R power supply and energy between each component wise $E_i$ with same time for multiprocessor across the step distribution network is given below in 8x8 ($E_i$ x $R_i$).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36 | 33 | 62 | **34** | 51 | 65 | 89 | 92 |
| 32 | **3 4** | 75 | 98 | 41 | 56 | 78 | 102 |
| 41 | **70** | 73 | 37 | **35** | 100 | 98 | 60 |
| **37** | 81 | 45 | 79 | 109 | 40 | 59 | 106 |
| 66 | 65 | **39** | 47 | 84 | 88 | 118 | 119 |
| 52 | 77 | 74 | 65 | 58 | **46** | 101 | 48 |
| 84 | 51 | 55 | 71 | 107 | 100 | 89 | **52** |
| 46 | 82 | 71 | 53 | 85 | 99 | **48** | 57 |

The above matrix is further optimized by the use of Hungarian Method and 0 values represent the optimized cell.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 0 | 29 | **0** | 18 | 32 | 54 | 58 |
| 0 | **0** | 41 | 63 | 7 | 22 | 42 | 67 |
| 8 | 35 | 38 | 1 | **0** | 65 | 61 | 24 |
| **0** | 42 | 6 | 39 | 70 | 1 | 18 | 66 |
| 29 | 26 | **0** | 7 | 45 | 49 | 77 | 79 |
| 8 | 31 | 28 | 18 | 12 | **0** | 53 | 1 |
| 35 | 0 | 4 | 19 | 56 | 49 | 36 | **0** |
| 2 | 36 | 25 | 6 | 39 | 53 | **0** | 10 |

The optimal values of the above matrix are recorded below:

$$E_{Min} = [37 \quad 34 \quad 39 \quad 34 \quad 35 \quad 46 \quad 48 \quad 52]$$
$$E_{Min} = 325 \text{ J}$$

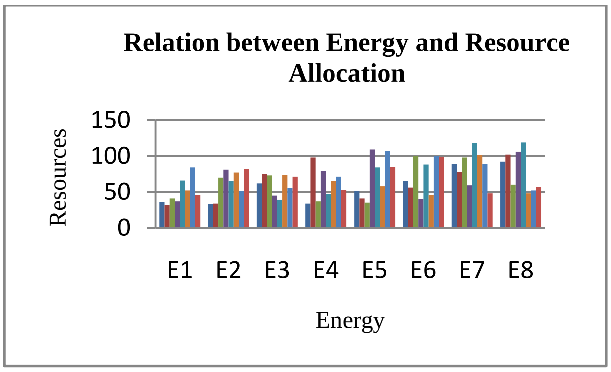


**Figure 3. Energy optimization based on various resources components in multiprocessor**

A relationship between resource and energy is also shown above in figure 3. In multiprocessor, there is low energy consumption used for step topology network in comparison of Uni-processor case. There are three nodes and energy is calculated for each node. The local power management has each and every component; the local maximum power supply by the component is stable and does not change. The comparison for energy consumption between Uni-processor and multiprocessor is shown below in figure 4.

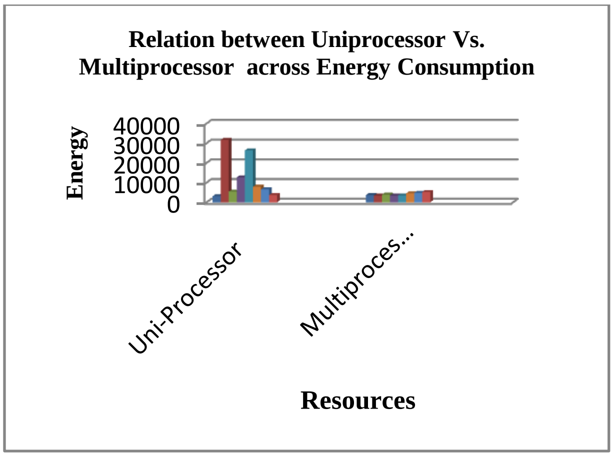


**Figure 4. Comparison of Uni-processor and Multiprocessor with Energy Consumption Matrices**

## 6. CONCLUSION

In this paper,a model for energy optimization for step network defines the power measurement in distribution computing environment. When information is transferred from one device to another device there are two cases arises one for Uni-processor and another for multiprocessor. The power measurement of the Uni-processor reduces the power with the use of different power allocation by components. The optimal values are given by Hungarian and Lagrangian methods. The power measurement in multiprocessor is also computed with different resource allocations at same time and also for different time interval further the optimal values are observed which are measured through Hungarian Method. If one compares the energy consumption between Uni-processor and multiprocessor. It is further observed that energy is optimized in case of multiprocessor in comparison of Uni-processor.

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# Energy and End to End Delay Computation across Step Network under Distributed Environment

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## ABSTRACT
Distributed computing is widely used by many researchers due to several advantages in terms of low cost with high efficiency. In the present paper, a step topological structure is explained and process model is designed through Markov chain. The energy is computed when information is transmitted from one node to another node. End to End delay is also computed in terms of the transmitted rate. Transmission time is also computed and results are represented in terms of table and graph. Since, it is newly developed topological structure under distributed environment, hence comparison on the said topological structure is not possible however it can be converted in the form of bus topology.

## Keywords
Distributed Computing, Step Network, Energy Computation, Transmission Rate, Processing Time.

## 1. INTRODUCTION
Distributed computing system is well known computing system and it has several advantages over the centralized computing system in terms of cost and efficiency. A lots of research work is available on the distributed computing systems however less number of research papers are available for the step network which is a recently designed topological structure. Let us describe some of the important research papers related to the present work. Chunlin, et al. [1] have described an algorithm to find the quality of service (QoS) and also described energy aware scheduling algorithm (QESA) for Joint optimization of network (i.e. QoS and energy conservation in grid and distribution network). Behere et al. [2] have given some technology based theory depended on cooling devices like as variable frequency drives (VFD's), blanking panels, high efficiency plug fans, and other electro mechanically devices. Authors have given control strategy wireless and wired sensors, optimization of temperature set points, through put sequence, VFD speeds, and air reheat and humidification controls. Limmer et al. [3] have proposed the use of OptiNum-Grid element method through simulations, Analog circuit simulations and e-beam simulations for energy optimization. Ding et al. [4] have described the method of the developments of distributed state estimation and distributed H filtering which are systematically reviewed. As the latest results on the distributed over sensor networks are discussed in details and some challenges are highlighted. Li et al. [5]have describedthe coordination of the energy resources for decentralized system. Energy resources are coordinated with each other system for efficient autonomous system and demand in large power the distributed networks, information exchange is indirect communications between the agents. The coordination mechanism is asynchronously scalable and robust. Chaudahri et al. [6] have found the performance of latency, bandwidth, through the experiment on Distributed Shared Memory (DSM) in multiprocessor system. The performance of the system described as distributed the performance parameter are latency of the process (l), occupancy (o), and node to network bandwidth (g). Ball et al. [7] have given a strategy for the optimization of design of Bayesian Network. Authors used a distributed network and the decomposition is formulated as a non linear network optimization. Bayesian network which is used by authors decomposed sensor networks in to a sectioned Bayesian networks. Islam et al. [8] have described an algorithm for a set S1 S2 S3 .........SN. of non trivial connecting sets based on maximize $\alpha = m/k$, connected devices are based on frequencies and maximize α to reduce the frequencies. Dhanalakshmi et al. [9] have described the energy consumption of the node by the using the Energy Conserving Advanced Optimized Link State Routing (ECAO) methodology. This methodology used MANET routing scheme. The routing scheme is based on data communication of the nodes. Chen et al. [10] have described a new type of sensor called cable sensor, this type of sensor has a rectangular shape sensing area with a processor. Authors have given the energy efficient communication algorithms for wireless cable sensor network. There are two cases for proposed algorithm, one is the reducing power via transmission power of processors during connectivity of network and another is scheduling cable sensor during network connectivity. There are two approaches which are reported to develop the distributed algorithm called DTRNG based on neighbour node connectivity graph. The second approach is the cable mode based transition algorithm which has evaluated the minimum number of active sensor to maintain K-coverage and connectivity.

## 2. MARKOV CHAIN DECISION PROCESS MODEL
Markov decision process model is used for discrete sequential data interpretation. This is a stochastic model for finding the process sequential definition. In this model, the probability distribution works on the next state which depends on the current state. A simple Markov process is, in which states can be observed directly. It may be autonomous or controlled process model by process sequencing. When the controlled processes are in actions for a distributed system then results affect on the outcomes process output. The Markov chain process model is shown below in figure 1.

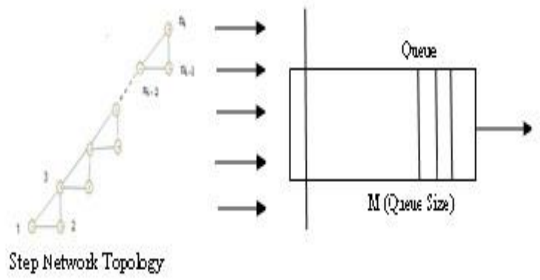


**Figure 1. Markov Chain Process Model used in Step Network Topology**

Markov Decision Process (MDP) [11] as shown in figure. 2 provide a mathematical platform for modelling of the research problems which are based upon the decision making. It is a powerful analytical tools used for sequential decision under uncertainty. It is widely used in industrial and manufacturing applications. It is based upon the numbers of states in which outcomes are partly random and partly under the control of a decision results based on the decision variables. Markov Decision Process is also useful for major optimization problems solved via dynamic programming. Markov Decision Process was discovered on the 1950. Dynamic programming is used by Markov Process. Markov process are used in different disciplines like, robotics, automated control, economics, and manufacturing. A Markov Decision Process is a discrete time stochastic control process. A Markov process is a stochastic process that operates on random sequences and outcome states according to certain probabilities condition.

Markov chains are integer time process $\lambda n$, $n \geq 0$ for which each random variable □ nis integer valued and depends on the past only through most recent random variable $\lambda n$-1 for all integer $n \geq 1$. $\lambda n$, $n \in N$ is a discrete Markov chain on state space S=1…...M, At each time instant t, The system changes state, and transition. The Markov chains follow stationary property. A first order Markov chain, the Markov property states that the process state of the system at time increases t+1 depends only on the state of the system time t. The step topology is queued based on Markov decision process and used the node wise probability to check the process sequentially. The process outcomes are node as first priority, and then next node process waits until the first process is completed. The process outcomes are depended on the time and data frames. The process is based on FCFS (first come first serve), and time priority bases.

Probability $(\lambda t+1=xt+1|\lambda t=\lambda 1\ldots\lambda t$=Probability$(\lambda t+1=xt+1|\lambda t = \lambda t)$

A stationary equation implement with Markov property is independent of time. Then,

Probability $(\lambda t+1=\lambda i|\lambda t=\lambda j)$ = Pi, j, Where for $\forall$ t and $\forall$ i, $j \in 0\ldots N$

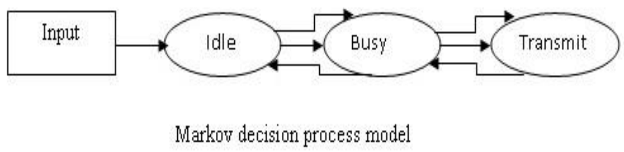


**Figure 2. Markov Decision Process Model**

Thus we are testing at processes whose functions are sequence of integers between 1…M. Thus Markov process is covered by transition fraction Pij and initial probability Pi , Markov chains can be represented by graphs where, each state is represented by a node and directed edge represents a non zero transition probability. If a Markov chain has M states then transition probability can be represented by an M x M matrix. The matrix T is stochastic matrix 1.

The Markov model processes are based on

**1. Service Type**
The service types are the independent and identical.

**2. Service Time**
(i) It can be deterministic or exponentially distributed.

(ii) It‘s dependent on the queue length.

**3. Service Discipline**
The service disciplines are as the following:

**(i) FCFS**
The first come first serve process is based on time, frequency bandwidth and data packets. The service process time is minimum in FCFS and the process which comes first is automatically processed first by server.

**(ii) Random Order**
The random number is used by network scheduling in network topology. This random number is based on time slot. The random time slot number is defined as Ti → Δt. So the time dependency depends on the random number.

**(iii) Priorities Scheduling**
The all real time systems usually used the pre-emptive priority scheduling systems. A process tasks must specify the time needed, then system can be complete the task.

**(iv) Processor Sharing**
The processor sharing is based on the dividing the total amount of time into an equal number of process used in sharing. The total time is divided into equal slots of time to complete with each other and every process. The process sharing scheduling works as entry scheme for control policy systems.

**4. Service capacity**
The service capacity may be based on single server or a group of servers.

**5. Waiting Room**
In data transmission network finitely many cells can buffered in a switch. The determination of good buffer sizes is important factor in the design communication networks.

# 3. WIRE LINE CABLE TRANSITION IN DISTRIBUTED NETWORK SYSTEMS

The various formulae used in the work are given below:

## 3.1 The Packet Delivery Ratio (PDR

The Packet Delivery Ratio is the packet frames per millisecond. It depends on the process stateinitial state to another state) and this is a relation between received packet and packet transmission in all system component such as CPU on system hardware component and given below.

$$Packet\ Delivery\ Ratio = \frac{No.of\ \text{Re}ceived\ Packtes}{No.of\ Packets Transmitted} \quad (1)$$

## 3.2 The transmission control messages

The transmission control messages are the method of controlling unit which is based on connection establishment and maintain a network conversation during. Which application programs can exchange data, the Transmission Control Protocol works with the Internet Protocol (IP), which defines how computers send packets of data to each other. The TCP and IP are the operation on the distributed network. TCP is a connection-oriented protocol, which works on a connection is established and maintained until the application programs at each end finished exchanging messages. It breaks the data packets of the networks which can deliver, sends packets to network and accepts packets from the network and manages the data flow, to provide error-free data transmission for handling retransmission of dropped packets. In the Open SystemsInterconnection (OSI) Communication model, TCP covers layer 4 the Transport Layer, and parts of Layer 5, the Session Layer.

## 3.3 Average Transmission Time

The average transmission time is defined as the process coordinated over the packets transmission of sending and receiving data per unit time in milliseconds.

## 3.4 End to End Delay

End to End delay = Processing Time + Queuing Time + transmission Time + Propagation Time.

# 4. RESULTS AND DISCUSSION

On the basis of above problem, a calculation of processing time is shown in the table 1. This is computed for seven nodes which are connected across step network. The links between nodes are N1N2, N2N3, N1N3, N3N4, N4N5, N3N5, N5N6, N6N7 and N5N7. The end to end delay is also recorded in the table by considering the packet size which is transmitted on the said links.

**Table1.1 Computation of Processing Time and End to End Delay**

| Sr. No. | Nodes | Processing Time (ms) | E2E Delay (kbps) | Data Packets (kbps) | Transmission time (ms) |
|---|---|---|---|---|---|
| 1. | $N_1N_2$ | 0.6 | 379.42 | 62 | 5.11 |
| 2. | $N_2N_3$ | 0.8 | 602.9 | 72 | 5.89 |
| 3. | $N_1N_3$ | 0.4 | 1040.4 | 64 | 6.10 |
| 4. | $N_3N_4$ | 0.6 | 16747.27 | 1280 | 7.25 |
| 5. | $N_4N_5$ | 0.4 | 990.4 | 72 | 5.10 |
| 6. | $N_3N_5$ | 0.7 | 626.07 | 64 | 6.14 |
| 7. | $N_5N_6$ | 0.9 | 525.7 | 64 | 6.48 |
| 8. | $N_6N_7$ | 0.7 | 14318.4 | 1280 | 7.13 |
| 9. | $N_5N_7$ | 0.5 | 20480.5 | 1280 | 7.50 |

above table, authors have taken various nodes related to the processing assumption time and data packets. The end to end Delay finding results and transmission times. The time is varying for the data packets and data packets in the transmission network layer. The network layer accepts the request then the data is flowed through the transport layer. The transmission data flow is buffered in the given time duration and process synchronization occurs at process sequences and the end to end delay of data are affected with the operation process. This is shown below in following graph.

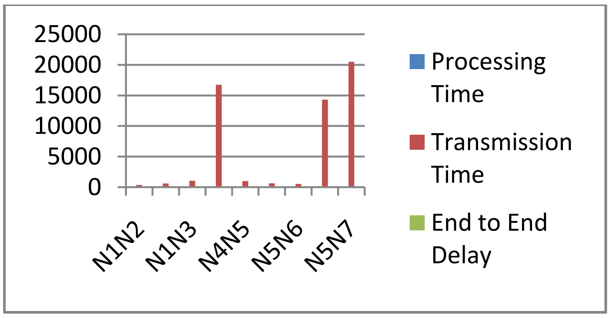


**Figure 3. Relation between Processing Time, Transmission Time and End To End Delay**

Let assume that,

Number of Nodes - 200

Area Size - 600 × 600

MAC- 802.3

Simulation Time – 50 sec.

Traffic source – CBR (Constant Bit Rate)

Packet Size -512 Mbps

Transmit Power – 0395 w

Receiving Power – 0.395 w

Idle Power – 0.335 w

Initial Energy – 3.1 J

No. of Sources – 1,3,7,9.......................... $N_i$

Transmission Rates – 250, 500,750, and 1000 kbps.

On the basis of above, let us generate the Cost function of the model In this model ϕt are the real numbers, and Xt are the correlated random variables

$$f(y) = x_t[\text{variable dependent for static or dynamic}]$$

$f(y) = x_t[\phi_s \; or \; \phi_d]$ × Stationary Equation during data flow on component

$$f(y) = \sum [(\phi_1 x_{t-1} + \phi_2 x_{t-2} + .............\phi_p x_{t-p} + \in_t) \times \lambda_s \; or \; \lambda_d]^{\alpha t} \quad (2)$$

$$f(y) = \sum x_t .[(\lambda_s \; or \; \lambda_d)]^{\alpha t} \quad (3)$$

$$f(y) = \sum x_t .[(\lambda_s (t)^{\alpha t} \; or \; \lambda_d (t)^{\alpha t}] + f(w) \quad (4)$$

Where f(w) is a fix power consumption

$$f(y) = \int \sum x_t . \lambda_s^{\alpha t} \; or \; \lambda_d^{\alpha t} + \int f(w)$$

$$f(y) = \int_{t_1}^{t_{n_i}} \sum x_t + \int_{t_{n_i}}^{t_T} f(w)$$

Total Power of the whole system,

$$P_T = \int f(y) \Rightarrow \int_{t_1}^{t_{n_i}} \sum x_t + \int_{t_{n_i}}^{t_T} f(w_i) \quad (5)$$

Pr(x) = pr ($x_{ni}$ ,$x_n$)

$$pr(x) = pr(x_{n_i}, x_{n_{i-1}} \ldots\ldots\ldots\ldots\ldots\ldots x_{n_1}) \quad (6)$$

$$pr(x) = pr(x_{n_i}, x_{n_{i-1}} \ldots\ldots\ldots\ldots\ldots\ldots x_{n_1}).\, pr(x_{n_{i-1}} / x_{n_{i-2}} \ldots\ldots\ldots\ldots x_{n_1})$$

$$Pr(N_1 N_2 N_3) = pr(N_1)\, pr(\frac{N_2}{N_1})\, pr(\frac{N_3}{N_1})\, pr(\frac{N_3}{N_3}) \quad \textbf{(7)}$$

$$Pr(N_3 N_4 N_5) = pr(N_3)\, pr(\frac{N_4}{N_3})\, pr(\frac{N_5}{N_3})\, pr(\frac{N_5}{N_4})\, pr(\frac{N_5}{N_5}) \quad (8)$$

$$Pr(N_5 N_6 N_7) = pr(N_5)\, pr(\frac{N_6}{N_5})\, pr(\frac{N_7}{N_6})\, pr(\frac{N_5}{N_4})\, pr(\frac{N_7}{N_7}) \quad (9)$$

$$Pr(N_{i-2} N_{i-1} N_i) = pr(N_{i-2})\, pr(\frac{N_{i-1}}{N_{i-2}})\, pr(\frac{N_i}{N_{i-1}})\, pr(\frac{N_i}{N_i}) \quad (10)$$

Node Wise Probability Distribution, Energy is given below:

## 5. NODE DISTRIBUTION ENERGY

The node wise distribution of energy is given by table 2.

**Table 2. Node Wise Distribution of Energy**

| Sr No. | Probability Distribution(Node) | Estimated Nodes | Node Values | Distributed Energy | Percentage Nodes Wise Energy ( % ) |
|---|---|---|---|---|---|
| 1. | $Pr(x_i = N_1 / N_{i-1})$ | $N_1$ | 0.6 | 120.4 kw | 30.89 % |
| 2. | $Pr(x_i = N_2 / N_{i-1})$ | $N_2$ | 0.8 | 796.48 kw | 47.84 % |
| 3. | $Pr(x_i = N_3 / N_{i-1})$ | $N_3$ | 0.7 | 640.00 kw | 21.26 % |
| 4. | $Pr(x_i = N_4 / N_{i-1})$ | $N_4$ | 0.6 | 700.48 kw | 96.42 % |
| 5. | $Pr(x_i = N_5 / N_{i-1})$ | $N_5$ | 0.9 | 768.0 kw | .361 % |
| 6. | $Pr(x_i = N_5 / N_{i-1})$ | $N_6$ | 0.4 | 120.4 kW | 8.22 % |
| 7. | $Pr(x_i = N_6 / N_{i-1})$ | $N_7$ | 0.9 | 700.41 kW | 91.36 % |
| 8. | $Pr(x_i = N_i / N_{i-1})$ | $N_i$ | $\phi$ | Null | ---- |

$$Pr(N_5 N_6 N_7) = a_{n_5} \times e_1(\text{packet frame}) + a_{n_6} \times e_2(\text{packet frame}) + a_{n_7} \times e_3(\text{packet frame})$$

$$Pr(N_3 N_4 N_5) = a_{n_3} \times e_1(\text{packet frame}) + a_{n_4} \times e_2(\text{packet frame}) + a_{n_5} \times e_3(\text{packet frame})$$

$$Pr(N_5 N_6 N_7) = a_{n_5} \times e_1(\text{packet frame}) + a_{n_6} \times e_2(\text{packet frame}) + a_{n_7} \times e_3(\text{packet frame})$$

We find that, every node power utilization in networks

$$Pr(N_1 N_2 N_3) = 120.4\, kw$$

$$Pr(N_3 N_4 N_5) = 796.48\, kw$$

$$Pr(N_5 N_6 N_7) = 700.48\, kw$$

$$Pr(N_1) = \frac{Pr(N_1)}{Pr(N_1 N_2 N_3)} \times 100$$

$$Pr(N_2) = \frac{Pr(N_2)}{Pr(N_1 N_2 N_3)} \times 100$$

$$Pr(N_3) = \frac{Pr(N_3)}{Pr(N_1 N_2 N_3)} \times 100$$

$$Pr(N_4) = \frac{Pr(N_4)}{Pr(N_3 N_4 N_5)} \times 100$$

$$Pr(N_5) = \frac{Pr(N_5)}{Pr(N_3 N_4 N_5)} \times 100$$

$$Pr(N_6) = \frac{Pr(N_5)}{Pr(N_3 N_4 N_5)} \times 100$$

$$Pr(N_7) = \frac{Pr(N_5)}{Pr(N_3 N_4 N_5)} \times 100$$

**Table 3. Energy Table per Node Consumption in Topology**

| | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | $E_7$ |
|---|---|---|---|---|---|---|---|
| $N_1$ | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| $N_2$ | 0 | 47 | 0 | 0 | 0 | 0 | 0 |
| $N_3$ | 0 | 0 | 3.2 | 0 | 0 | 0 | 0 |
| $N_4$ | 0 | 0 | 0 | 96 | 0 | 0 | 0 |
| $N_5$ | 0 | 0 | 0 | 0 | .36 | 0 | 0 |
| $N_6$ | 0 | 0 | 0 | 0 | 0 | 8.2 | 0 |
| $N_7$ | 0 | 0 | 0 | 0 | 0 | 0 | 91 |

Total power consumption in step networkis 30 + 47 +3.2+ 96+ 0.36 + 8.2 +91= 275.76 kW.

## 6. CONCLUSION

The end to end delay energy consumption in step networks which used Markov Chain is very crucial. The calculation of time estimation and data frames used during transmit time is important results. The node wise explanation and percentage is also calculated. In the present work, the input time and data frames, which are used are limited, however one can increase the number of nodes across the step network. The sequence of processes is varied with time and optimization of energy is computed through cost function.

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# An Energy Computation in Distributed Computing Environment through Bellman-Ford Algorithm

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## ABSTRACT
In the current scenario, energy optimization for the electrical components used in the hand-held devices is a broad area of research. Energy principle for information technology contains its own specific energy behavior. The energy costs in server centre are now compatibility to the cost of hardware devices and other compare devices. In the processor device system, heat existing is a major cause of limiting changes in the performance evaluation. In laptop, scanners, computers, cell phones, printers, i-pods, and other digital devices, which are portable, reduced the power consumption converts into the battery long life manner. The energy consumption is now presenting challenges as a performance measure in computers, processing the task execution time. The energy is linked with the execution time capacity, where comparable patterns have been recognized by a combination of hardware devices, software devices, and algorithms. In this paper, the design of energy-efficient computer systems is proposed by the use of Bellman-ford algorithmic approach. A model is proposed for finding the performance of the system. Computed results are depicted in the form of tables and graphs.

## Keywords
Energy Optimization, Wired Networks Topology, Packet Routing, QoS, Bellman-ford Algorithm Optimization Techniques.

## 1. INTRODUCTION
Today's networks energy saving techniques is very challenging area in the Information and Communication Technology (ICT) world. The energy consumption is very costly in the network for the system's parameters like CPU, motherboard, hard disk and the power level systems. There are three important factors for the energy consumptions namely (a) data forwarding or data transmitting from source to destination. (a) Speed to the flow of data. (b) Transmission of data packets. There are three types of methods for finding the energy consumptions (a) dynamic voltage scaling (b) dynamic frequency scaling (c) clock gating. These methods are very precious for network energy consumptions. At the dynamic voltage scaling, all devices are working with the voltage dependent component. In voltage scaling, the voltage varies with the network performance as if network's flow in high, then data transmission is capturing high energy over the system configuration. If the networks gain, the voltage is low then the data speed is low and energy consumption will be getting low. So frequency works, whereas the same as working with voltage if frequency and voltage with high, then energy is high consumption. But either frequency or voltage are related with reciprocal with each other. In electrically.

$$\text{Voltage} = \text{Charge}/\text{Capacitance Volt}, \quad (1)$$

Where, the charge is $Q = i \times t$ Coulomb.

Now consider frequency scaling which explains to the technique that reduces the energy consumption by lower the processor's frequency. If high frequency enables high energy and lower frequency makes low energy consumption. If constraint occurs for the reduce voltage, energy to the workload balance will be reduced. These methods can be applied to other energy-consuming devices, as hard disk drives, motherboard, processor, and electromechanical devices. There are algorithms to find the minimal speed of data throughput and schedules for transmission packet scaling and finding the speed scaling. The power performance varies the main challenges for device system architecture and CPU temperature. In high temperatures performance varies according to reliability and cooling systems. The temperatures increase the energy consumption. The power optimization performance has been done for optimizing energy required for data storage and access data transmission.

## 2. RELATED WORK
The goal of the present work is to reduce the energy consumption in network environment. Let us briefly explain the literature review on the present work. Lange et al. [1] have predicted for energy consumption in broadband network and the highest energy consumption growth rates are foreseen in the data centers and IP backbone networks. They proposed a load factor networking and energy aware system. Bolla et al. [2] have given two features of green networking, firstly power consumption for next generation networking and secondly provided a detail survey for energy performance design mechanism issues. Tseng et al. [3] have described a compression algorithm, which is designed to solve the problem of link on/off and weight assignment problem issues to minimize a network's energy consumption. Ballga et al. [4] have described analysis and technology for energy consumption of data throughput in network's like DSL, HFC networks, passive optical networks, point to point optical systems, W-CDMA, WiMAX. Gaona et al. [5] have given the design of energy-efficient in hardware transactional memory systems. Chiaraviglio et al. [6] have given the model based energy consumption mechanism such as device architecture and load for networks. They have proposed also algorithm for energy saving capabilities in sleep mode and active mode. Castene et al. [7] have proposed a framework formula, $E=mc^2$ for energy performance modelling in distributing computing. They have used Icancloud for simulations. Schien et al. [8] have proposed a model to analyze and assessing variability for the energy consumption at the during downloading multimedia applications. Lin et al. [9] 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. [10] have proposed the model for routing and scheduling for energy saving in power mode scheduling. Anbazhagan et al. [11] 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. [12] have proposed to develop a system wide energy consumption model for servers, in hardware performance and experimental results. Bilal et al. [13] 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.[14] have described two level control framework for reducing the power consumption in computer networks, (i) local control mechanism for network device , (ii) network wide control framework technique for reducing power consumption. Galinina et al. [15] have given the optimization of optimal power control scheme for reducing energy in 4G networks. Fang et al. [16] 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. [17] have proposed a profiling system architecture which used for energy consumption, in cloud computing. Bianzino et al. [18] have investigated full system based architecture in computer networks for energy efficient wired networks. Niewiadomska et al. [19] have described a Control system for reducing energy consumption in backbone computer network. Sivaraman et al. [20] have given three new contributions for energy efficiency (i) The three performance switches like ports counts, traffic loads, packets size, and traffic burstiness. (ii) Powerful model for reducing the energy consumptions (iii) Energy saving via experimental based. Tekbiyik et al. [21] have proposed the shortest-path-based energy – efficient routing algorithms for wireless and sensor network. Bolla et al. [22] have described Burst2save mechanism for energy efficient network dynamics. This technique gave results the Quality of Service for data throughput. Jiang et al. [23] have proposed a multicast routing algorithm for reducing energy consumption in topology network design. Hashimoto et al. [24] have given TCP congestion control mechanisms in three manner (a) active mode (b) sleep mode (c) sleep mode with burst transmission. Vardalis et al. [25] have proposed Delay Tolerant Network (DTN) architecture facilitates the reducing energy conservation. Coroama et al. [26] have given some method for reducing energy consumption firstly the top down analyses secondly model based approaches and thirdly bottom based approaches for finding the reducing energy consumption. Coiro et al. [27] have described a Genetic Algorithms for reducing power consumption in IP backbone Networks. Bonetto et al. [28] have investigated the energy to traffic proportional and resource utilization for the PoP, while sleeping modes. They have proposed the energy efficiency in access and aggregation networks. Tuysuz et al. [29] have proposed energy efficient QoS based network selection scheme over heterogeneous WLAN in 3G networks. Ahmed et al. [30] have proposed a framework for the energy efficient, the effect of network centric parameters depending on the application over the WLAN. David et al. [31] have evaluated memory by DVFS techniques in real system.

## 3. METHODOLOGY

The collection of data for the data transmission in data centre server is like as packet flow, if the data packets pass through the routing protocols algorithm. In the routing algorithm namely Bellman-ford algorithm developed by C. Perkins and P. Bhagat, in 1994 for distributed computing network in routing scheme under Destination Sequenced Distance Vector Routing (DSDV) protocols for the shortest path. The graph is denoted by $\mathcal{G}$, and the vertices, v and edges, e are representing. The graph is $(\mathcal{v}, \mathcal{e})$ and link is $\mathcal{L}$, then the cost of function for the algorithm, $\mathcal{F}$ is given by

$$\mathcal{F} = \mathcal{L}_T + (\mathcal{V}_n, e_n - 1)\,\phi; \quad (2)$$

$$Energy = \frac{q^2}{c} \times frequency \quad (3)$$

Where, $\mathcal{L}_T$ is total cost of links, $\mathcal{F}$ is a cost function, $\phi$ is workload. The algorithm consists of a set of operations that followed step by step for the solutions of the problem. It has two main features for efficiency of an algorithm which are the (a) memory (b) computational time requirement for input size. Algorithm has two linear arrays F and H, fi ∈ F hi∈ H , where i th edge in G, if the graph has any self loop then process may be discarded. It is given in as,

**INPUT**: Directed Graph G= (v, e)

Edge lengths $\{l_{edge}: e \in E\}$ with no negative cycles, Vertex S∈V,

Bellman-Ford- BGL (G,w, s)

for each vertex v 2 V [G] do

d[v] = 1

end for

d[s] = 0

for i = 1 to |V [G]| do

Rest False

for each edge (u, v) 2 E [G] do

if d[v] > d[u] + w (u, v) then call Relaxation

d[v] = d[u] + w (u, v) Relaxation step

Rest True

end if

end for

if Rest = False then

exit the loop

end if

end for

for each edge (u, v) 2 E[G] do

if d[v] > d[u] + w(u, v) then

return False

end if

end for

return True

## 4. PROPOSED MODEL

In the proposed model, the devices has consolidated attach in distributed computing manner.the parameter have motheboard, HDD, memory and processor to reducing energy. They all parameter's have own generalized features like volatge , frequency, current , and capacitor etc. so the above algorithm applied in parameter devices affect in action for transmission data.

Server energy is given by the following formula

$$E_{eff} = \frac{W(workload)}{E_{Total}} \quad (4)$$

where , Eeff. Is a server efficiency, and W is a workload , ETotal is a energy used in whole system.

Energy of processor is given by

$$E_{Proc.} = C_{eff} .V^2 . f \quad (5)$$

Where $C_{eff}$ , is the total capacitance, V is supply voltage and f is the frequency.

The energy for motherboard is given by

$$\Sigma E_{MB}=V*I, \quad (6)$$

Where V is voltage, Vmin =5 volt, Vmax=12 volt, I is current in ampere, $I_{min}$ = 1A, $I_{max}$ = 8 A.

The energy parameter for hard disk is given by

$$E_{Hdd} = \frac{\mu}{(J+\gamma)(L+R)} \quad (7)$$

The standard values are recorded in the following table 1

Total Energy Consumption over the System,

$E_{Total}$ = 96 + 3.2 ×$10^{-11}$ + 11.904 + 150 + 29.895

=287.799Watt (8)

The variations in energy consumptions are depicted in the following figure 2.

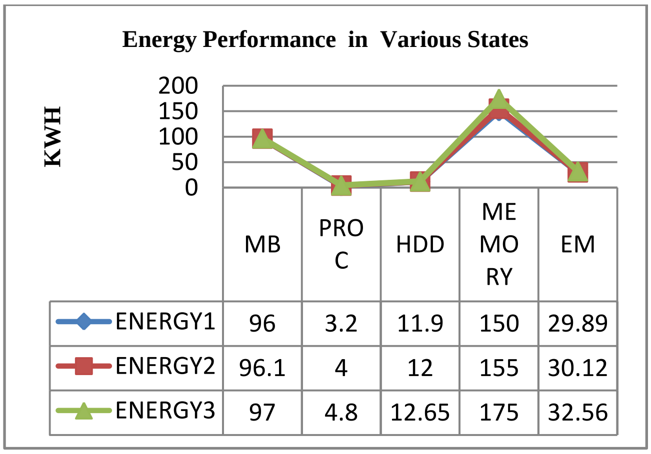


**Figure 2. Energy Performance in Various States**

On the above aspects, let us now implementing the Bellman-ford algorithm for optimizing the energy consumption which is recorded below in table 2.

Now the total energy consumption over the system is given below:

$E_{Total}$ = 80 + 1.72×$10^{-8}$ + 11.904 + 150 + 28.395

= 270.299 Watt. (9)

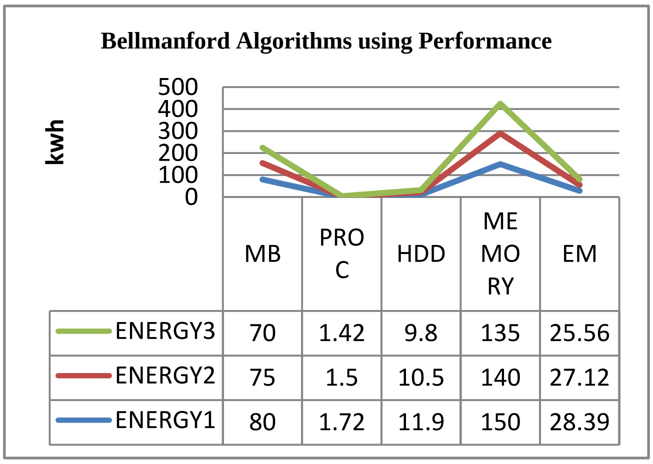


**Figure3. Energy Performance using Bellman ford Algorithm**

After comparing equations (8) and (9), it is observed that energy consumption is optimized through the Bellman-ford algorithm and some features related to shortest path routing algorithm are given below:

**a.** Carrier sense delay: The Carrier sense delay, is introduced when the sender packet performs carrier sense. It's determined by the contention. Its happens when carrier sense failed.

**b**. Transmission delay: The transmission delay is determined by channel bandwidth, packet length and the coding scheme for transmission.

**c.** Propagation delay: It is determined by the distance between the sending and receiving nodes. In distributed networks, the node distance is normally very small, and the propagation delay can normally.

**d.** Processing delay. It is the receiver needs to process the packet before forwarding it to the next node. So due to the deployment mainly depends on the computing power of the node and the capacity of the network data processing.

**e.** Queuing delay: It depends on the traffic workload. In the heavy traffic load, queuing delay.

There are some parameters belongs for finding energy performance.

i. Utilization

ii. Response time

iii. Throughput

iv. Room temperature

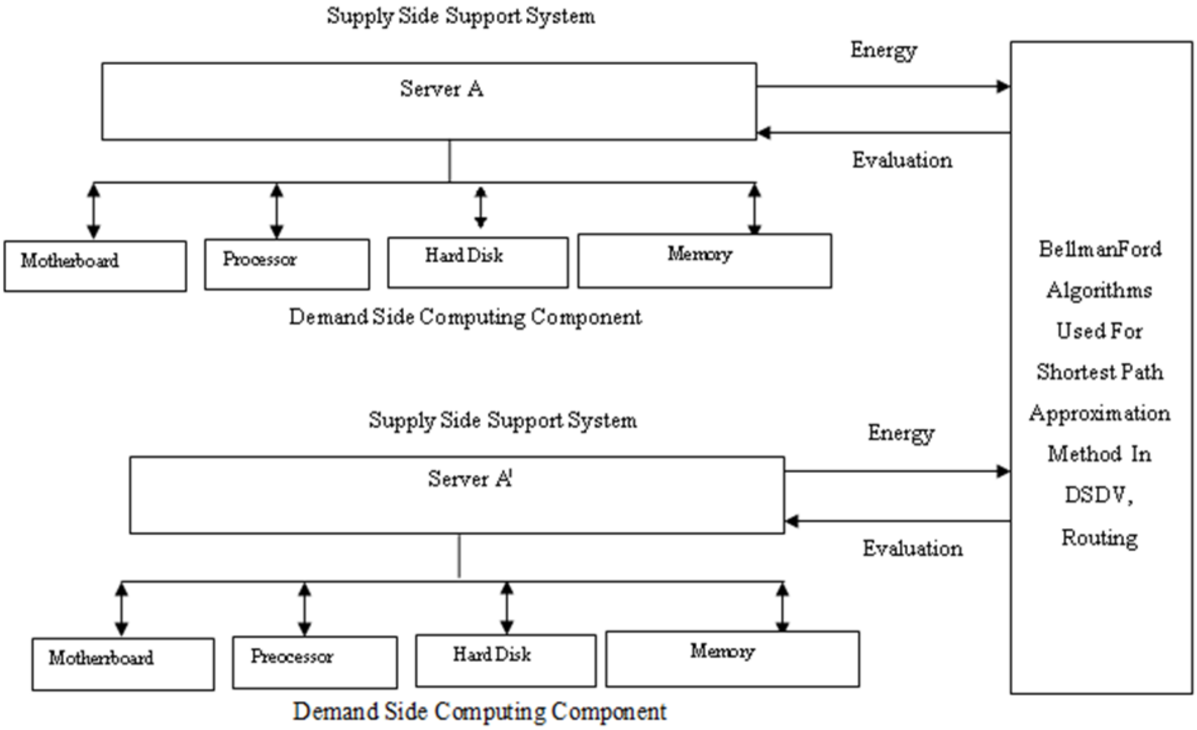


**Figure 1. Proposed Model for Energy Saving under Distributed Environment**

**Table 1. Standard Values of Various Electrical Components**

| Sr.No. | Computing Component | Capa_ (C) | Voltage | Freq_(f) | Temp_T | Curr._(I) | Energy_E Evaluated |
|---|---|---|---|---|---|---|---|
| 1. | Motherboard [31] | Input Depended | 5v(min) , 12v (max) | Input Depended | $30^{0C}$ | 1A(min) 8A(max) | $E_{min}$=5 Watt. $E_{max}$=96 Watt. |
| 2. | Processor [31] | $0.43\times 10^{-9}$ | -30V min to 30 V max | min(96mhz) max(6000mhz) | $44^{0C}$ | Input Depended | $3.2\times10^{-11}$MJ |
| 3. | HDD [31] | Input Depended | 5v(min), 12v (max) | 500Mhz (min) 1100Mhz(max | $40^{0C}$ | Input Dependent | From Equation 6. 11.904 J |
| 4. | Memory [31] | Input Depended | Input Depended | Input Depended | $30^{0C}$ | Input Depended | $E_{min}$=30 Watt. $E_{max}$=150Watt |
| 5. | Electromechanical | Input Depended | Fan=1.5 V | Input Depended | $30^{0C}$ | 19.93 Amp | P=VI, P=29.895 Watt |

**Table 2. Computed Values through Bellman-ford Algorithm**

| Serial No. | Computing Component | Capacitance(C) | Voltage_V | Frequency (f) | Current(I) | Temp_(T) | Energy_E Evaluated |
|---|---|---|---|---|---|---|---|
| 1. | Motherboard | Input Depended | 5v (min) 12v (max) | Input Depended | 1 A(min) 8 A(max) | $30^{0C}$ | $E_{min}$=5 W $E_{max}$=80 W |
| 2. | Processor | $0.43\times 10^{-9}$ | -30Vmin to30 V max | Min(96mhz) Max(6000mhz) | Input Depended | $44^{0C}$ | $1.72\times10^{-8}$ MJ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3. | HDD | Input Depended | 5v (min) 12v (max) | 500Mhz (min) 1100Mhz(max | Input Depended | $40^{0C}$ | By above formula 11.904 J |
| 4. | Memory | Input Depended | Input Depended | Input Depended | Input Depended | $30^{0C}$ | $E_{min}$=30 watt $E_{max}$=150 watt |
| 5. | Electromechanical | Input Depended | fan=1.5 V | Input Depended | 18.93Amp. | $30^{0C}$ | P = VI, P=28.395 Watt |

## 6. CONCLUSION

In future, the shortest path problem can be solved by the algorithm as it gives the perfect result oriented scheme for energy performance in the network region. Whereas the major issue for network measurement are the Quality of Service, data flow and throughput performance. The Bellman-ford algorithms can be applied for the shortest path routing in a better way to find the result for network reliability, costs, scalability and robustness. The input values are taken according to computing components. From the above paper it is concluded that energy is saved approximately from 10% to 15% reducing over the network.

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# A Framework for Dynamic Power Management at Network Level

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## ABSTRACT
In the current scenario of computing, distributing is gaining popularity as many of users are connected with their handheld device across the globe. The connected device generally emits the energy which is of different categories and it is major challenge to optimize the entire energy of the system. The present paper proposes a frame work for the dynamic power management for completion of tasks in minimum time frame which are routed from one node to another node across the network. For this purpose, a step topological network is selected at the application level of the model. Computed results are depicted for the dynamic power management in the forms of graphs.

## Keywords
Step Network System, Energy Consumption, Dynamic Power Management, Application Level, System Level, Hardware Component Level. Distributed Computing.

## 1. INTRODUCTION
In the recent years, energy efficient computing is a major challenging area of research. It is mainly depending on hardware or software computing components. The hardware components are as processors, storages, and picture display devices. The performance and power management of the distributed network system are very effective. It is depending on the contributions of networks nodes. In distributed computing systems, the data stores on networks, the nodes must be switched on and connected to each computer. If the participating nodes are wireless then it is more challenging. On network level, the dynamic power management classifies into two types of components i.e. sleep modes or slow down and idle modes. It is a way of reducing power consumption. The dynamic power management has been proposed by the heuristic method for stochastic optimization technique. The heuristic dynamic power management technique is used for time out transmission. The stochastic theory is based on stochastic model of service request. The service requests are of three types. Firstly, each time, a new job process is generated and then searches for procedure to find the minimum power execution sequence, the sequence has also be repeated. Secondly, this strategy does not effective of reducing the system energy by changing the working stage of devices with multi level stage. Thirdly, the exact knowledge of the device uses a process before the job is scheduled. A power management has attached to device components,
system architectures, system resources that are shared among these device components. The application level scheduling is requiring the power management for system. The numbers of power saving techniques have been related into many types of standards and protocol eg. Power management in network topology and the power mode in IEEE 802.3 wire network. The network topology is on network break down. Then a local area network (LAN) card is working in power saving mode and depends on data flow. The dynamic power management is depending on software also.

This paper proposes for network level dynamic power management architecture. It is decomposed into the system level, application level, and component level. This division is integrating of various power management techniques. Application level supports the administrative level handling which is contributing to the users for share system level, and the flow control depends on part level. This paper presents the design, implementation, and network evaluation, wire network device architecture that enables full device functionality, availability, and extended device life. Wire line networks are unique, they have finite times. In large scale distributed network devices such as desktop, the power management is used to extend device.

## 2. RELATED WORK
Let us briefly explain some of the important references related to the work. Hwang and Wu **[1]** have described a system level power management technique for power saving. There was a new method for system shutdown developed by authors. Authors had introduced two mechanisms, (i) prediction-miss correction (ii) pre-wakeup. Benini et al. **[2]** have explained the dynamic power management technique for reducing the power consumption of complex network systems. It is performance and power consumption depended on workload. Qiu and Pedram **[3]** have invented a theory for Stochastic Modelling of a Power-Management System. Rodoplu and Volkan **[4]** have discovered a distributed theory for position-based network protocol optimization for minimum energy consumption in wireless networks. They have supported end to end communications. Simunic et al. **[5]** have described the algorithms for reducing energy consumption at the system-levels in low-power states. There are two classes of defining algorithms and proposed for performance measurement (i) timeout and (ii) predictive. They have categorized the algorithms based on stochastic for Performance Measurement and Time Indexed Semi Markov decision process (TISMDP) model in performance. Irani and Gupta **[6]** have found the strategies for "online" Dynamic Power Management (DPM). In this paper, they have two contributions (1) a theoretical basis for the analysis of DPM for systems with multiple powers (2) the competitive algorithm based on probabilistically generated inputs that improve the competitive ratio over deterministic strategies. Sorber et al. **[7]** have described the design, implementation, and evaluation of Hierarchical Power Management Architecture (HPMA) for mobile systems. Fernando et al. **[8]** described the cost optimization method in digital learning region. The method is based on maximum estimation in heterogeneous networks of

Information Communication Technology (ICTs) like as resource utilisation for educational environments. Ren and Marculescu **[9]** have discussed a hierarchical technique for DPM under non stationary service requests. The dynamic power management has targeted at extending battery life by low power modes when there is a reduced demand for service. Static power management strategies can effect to poor performance or unwanted power. Jun et al. **[10]** has found the Disruption Tolerant Networks (DTNs) technique in mobile computing. The DTN's are useful for wireless mobile networks in end to end communication. They evaluated the energy consumed by wireless communication. The energy can be using the low-power radio and high-power radio. Chelius and Mignon **[11]** have explained the minimization of the power consumption to the nodes of wireless sensor networks for lower and upper bound broadcasting. The theory is based on mathematical programming problem in sensor networks. Huang et al. **[12]** have described the topology for optimized link state routing in mobile ad hoc network MANET routing protocols. Cao et al. **[13]** have discussed, the green computing which explores the potential energy savings for the direct parallel implementation, and this is used with a large-scale computational biology application. There are two power approaches for direct for the CPU speed power saving. The parallel workload of the effective application is needed for power management. Gouvy et al. **[14]** have invented an energy aware routing algorithm for minimizing the energy consumption through mobile with connectivity in sensor networks. Elavarasan. R et al. **[15]** have invented an algorithm for delay aware network structure for WSN's with consecutive data collection and reduction of energy consumption without data losses from peer to peer data transmission has been proposed. Limmer et al. **[16]** have found a numerical method for simulations and optimizations performance in grid computing. Sharma and Nitin **[17]** have described a simulation method in real time distributed system for finding the entropy. Balachennaiah et al. **[18]** have described an algorithm based technique for optimization the control of power loss and voltage stability in transmission time. Quwaider et al. **[19]** have invented the theory for the mobile cloud computing and mobile cloud resources. Lyu et al. **[20]** have defined high performance scheduling model with a cloud sensor system. In cloud system, scheduling has performed optimization by Zero One programming method by task models. Han et al. **[21]** have invented a algorithm for distributed hierarchical game based algorithm for power allocation in Orthogonal Frequency Division Multiple Access (OFDMA) networks system. Moety et al. **[22]** have described the optimization models for power delay minimization theorem in green wireless networks. Huang et al. **[23]** have invented the cloud data redundancy for high reliable cloud storage systems and also demonstrate the improvement of saving of data redundancy computation in networks system. Hassan, et al. **[24]** has discovered the evaluation the scalability and performance of High Performance Cloud Computing (HPCC) on Microsoft Azure Cloud Systems (MACS). Agostini et al. **[25]** have found the management of strategic multi partner SME small and medium enterprises networks introduce the concepts of heavy weight, lightweight and internal or external network. Alonso et al. **[26]** have described the management for power consumption in fat tree communication networks. It is depended on network bandwidth in transport requirement. Zdraveski et al. **[27]** have described an algorithm for the load balancing in power distribution networks in cloud system. Walkowiak et al. **[28]** have discussed two methods Popular Wavelength Division Multiplexing (WDM) and a new emerging approach of Elastic Optical Network (EON). Ayyoub et al. **[29]** have invented the theory for the optimizing techniques for ultra scale cloud computing data centres. Jiang et al. **[30]** have discussed a probabilistic challenge for the users files which are available and stored specified cloud server. the cloud infrastructure with some reasonable as (i) Rational Economic Security Model, (ii) Semi Security Model of cloud servers. Mershad et al. **[31]** have given a mathematical model for evaluation and the utilization of a big data in cloud data centre. Nabiel et al **[32]** have described the cost optimization approaches for scientific workflow in cloud and grid computing. He and Li **[33]** described a fast diagnosis algorithm for communication network in high performance computers. Banditwattanawong et al. **[34]** have invented i-cloud (intelligent cloud) performances which were stable and close to those of infinite cache size. Damian et al. **[35]** have given a theory (i) quality of service (ii) a general control theoretic approach for cloud service (iii) the proposed language and control.

## 3. PROPOSED MODEL

Network system level dynamic power management architecture is represented in the following figure. The model is divided into three parts which are described in Figure 1.

### 3.1 Application Level

In the application level, many users work with server system. The server is working as distributed computing system as a data core network. All others send the application for processing with server interaction with the network. The server permits to all users for synchronize process. The synchronized process is controlled by the administrator such types of user operation by sequence. The users are interconnected across the step network as shown below:

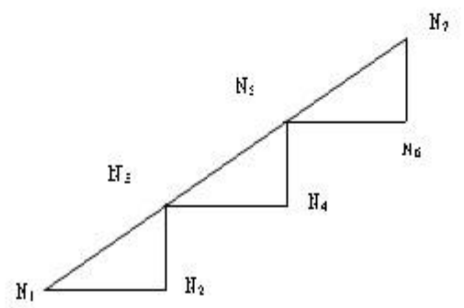

**Figure2.** A **Step Network System**

### 3.2 System Level

At the system level, the application server works on system level component. There are many services which request to organize by the computing as first come first serve. Afterthat, the service request is becoming complete then the next step is going to service flow control. The Service Flow Control also works with service request in minimum duration of time interval with related to request. It is working with data process and depends on throughput process and latency. The latency must be minimized in duration of such process operations.

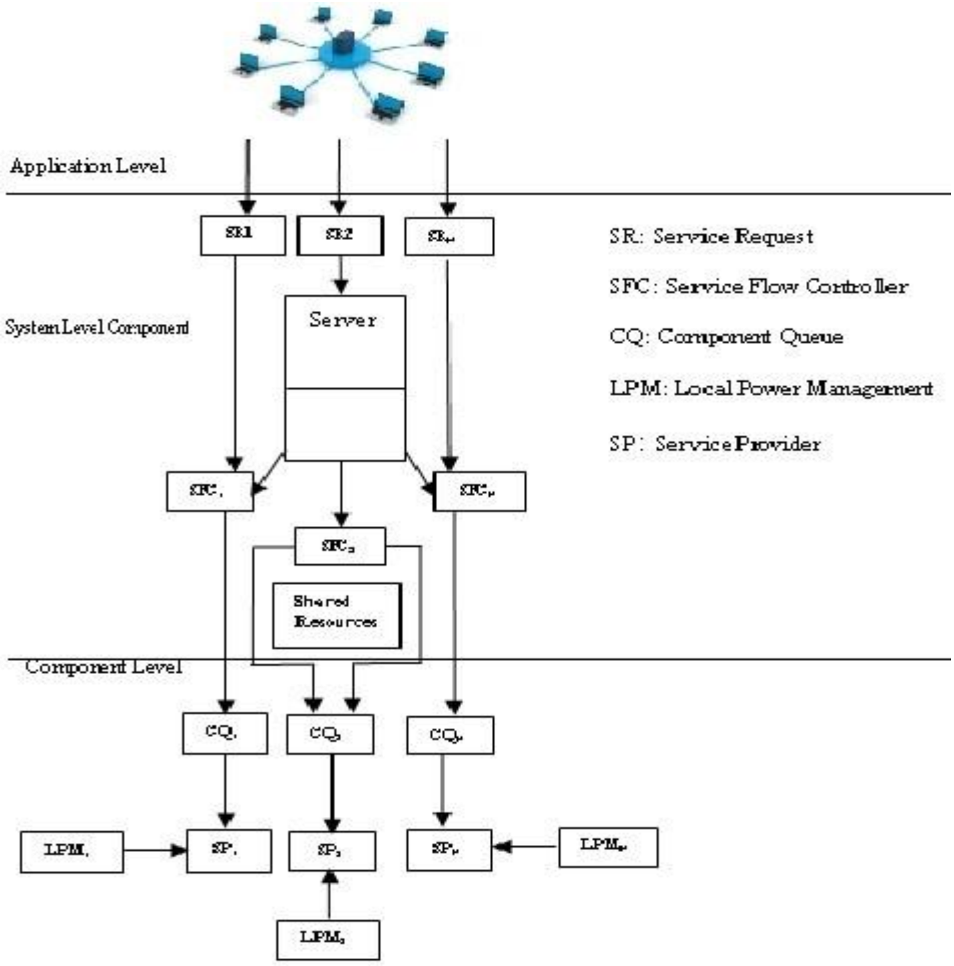


**Figure 1. A Network System Level Dynamic Power Management Architecture**

## 3.3 Hardware Component Level

The hardware component level is attached to the computers. The every computer has own power management system known as local power management. Every service provider has own request related to control queue request in the synchronization process. All service providers interact with common resources and control on all components which request as the throughput process. In the above diagram, if the set of states (S) for all servers is S = {$s_1$, $s_{2\ldots}$…………..$s_n$} for all possible states with A= {$a_1$, $a_2$……………..$a_n$} for all possible actions, then the relation model is given below.

$R: S \times A \rightarrow R$ Specifies for taking action in state S (1)

Now let us define the transition model for the process. The transition model specifies probability of transmission from state i to state j on taking action a and the specified matrix

$T_{ij}^{a}$ is given below:

$$\begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14}\text{.......}T_{1n} \\ T_{21} & T_{22} & T_{23} & T_{24}\text{.......}T_{2n} \\ T_{31} & T_{32} & T_{33} & T_{34}\text{.......}T_{3n} \\ T_{41} & T_{42} & T_{43} & T_{44}\text{.......}T_{4n} \\ \text{::::::::::::::::::::::::::::::} \\ T_{n1} & T_{n2} & T_{n3} & T_{n4}\text{.......}T_{nn} \end{bmatrix}$$

**Figure 3**. **Transition Matrix**

The above matrix indicates the process states $T_{11}$, $T_{22,}$ $T_{33}$, $T_{44}$...... $T_{nn}$ , is diagonal which shows the process is ideal for next state and data throughput. If the transmission state i to j on taking action a and defines the specified matrix $T_{ij}^{a}$ = $T_{11}$,$T_{22,}$$T_{33}$,$T_{44}$......$T_{nn}$ is ideal. In the transmission matrix $T_{11}$, $T_{22,}$ $T_{33}$, $T_{44}$......$T_{nn}$ are ideal, and all remaining may be in the waiting state for next state or failed transmission.

## 4. NUMERICAL RESULTS AND DISCUSSIONS

One can compute extensive numerical values as the size of step network grows. Authors have computed for five nodes as shown in the figure 2 by considering the file size of 0.6 MB which is to be transmitted across the network. The transition time is computed for all possible combinations from $n_1$ node to $n_5$ node by using the following:

$$T_{ij}^{a} = k\,(Arrival\,Time + Generation\;Time)$$

Where $T_{ij}^{a}$ is the transmission time in state action a and k is the Load Factor. The minimum transition time is also computed by the use of Hungarian Method [35] and it is computed as 3.014 milliseconds when the file is to be routed from $T_{14}$, $T_{22}$, $T_{31}$, $T_{33}$ and $T_{55}$. On the basis of above, the transition table is given below:

$$\begin{bmatrix} 0.540 & 0.594 & 0.570 & 0.564 & 0.710 \\ 0.560 & 0.588 & 0.564 & 0.688 & 0.656 \\ 0.510 & 0.582 & 0.540 & 0.578 & 0.662 \\ 0.630 & 0.606 & 0.570 & 0.698 & 0.652 \\ 0.688 & 0.735 & 0.757 & 0.751 & 0.782 \end{bmatrix}$$

**Figure 4. Transition Table**

The transmission in between of the network is considered as a minimum time for example if two routes exist between n1→n4 i.e. n1→n2→n4 or n1→n3→n4 then that route is selected which consumes minimum transmission time. In such a manner, the data can be transmitted across the step network. Now the DPM is constructed to the point of view of whole System Power Management (SPM). This is utilized to derive a system level policy and component level policy. The above model contains Application Level (AL), Service Queue (SQ), Service Control Flow (SCF) and Analysis Service Provider (ASP). The working functionality of entire system is shown below:

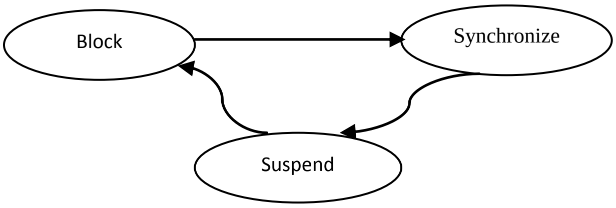


**Figure 5. Functions during DPM**

The SFC is modeled as a stationary. The state set of the SFC as SSFC= {Block, Suspend, Synchronize} and action flow of SFC is the set of action, ASFC = {Goto_Synchronize, Goto_Suspend, Goto_Block}.The details of state and transition of the SFC are explained.

**(a) Synchronize:** In this state, the SFC generates a run state process and classified two types of synchronized process in whole Universal Power Management (UPM) (i) Synchronized Service Queue (SSQ) (ii) None Synchronized Service Queue (NSSQ). The SSQ requests to the Service Provider (SP) on response time for next process zone. SP is decided in the process of that of fixed time. If fixed time for process is not completed, then Goto NSSQ and vice versa.

**(b) Suspend:** In this state, the SFC continuously moves from SSQ to the SP. The SP will take up and provide requested services. Now a new component is added in that time Component Queue (CQ). The CQ is available on component level policy. The process is in SSQ by the acknowledged from SP at service request on the queue (SRQ). The SRQ moves towards a head for throughput one by one and burst it.

**(c) Block**: In this state the SFC blocks all incoming SRQ from the entering the CQ of the SP. The main objective of the blocking various non synchronized processes is reduced and wake up times of SP and extend time utility the SP, synchronized process during sleep mode. Therefore,

The operation of request for service (SR) = Waiting Time + Service Operations.

It is clear from the above that non synchronization process over the network gives increase in the transmission process with heavy load on system. The packet delivery fraction in service flow provider is based on the ratio of data packets transmission to those generated by sources. During the routing, load depends on routing packets sent per transmitted packets at the destination. Let us consider the SP with the fixed time out policy and hard disk drive consists of two power states. (i.e. Active = 2.1 watt, Low power = 0.65 watt) and the transition power and time between the two states are 1.4 milliseconds and 0.4 milliseconds; the local power manager has two states as shown below in figure 4.

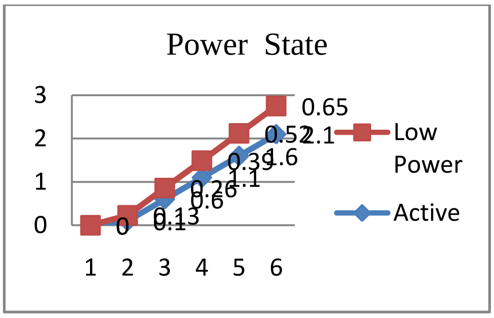


**Figure 6. Power State Process from User to Server**

The transmission processes from user have local power management and the initial time depends on the user performance related to time and energy from time interval. If the initial time is 0.7 second and the power consumption is 0.2 watt, then transmission process is shown below:

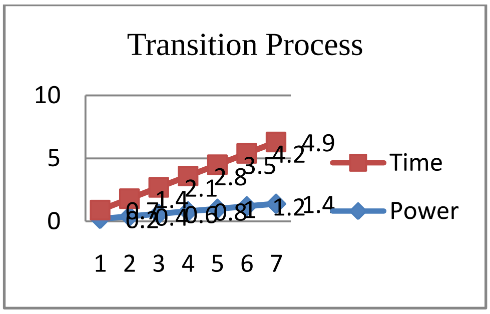


**Figure 7. Transmission Process across Step Network**

## 5. CONCLUDING REMARKS

In this paper, a model is proposed for distribution of the resources with three different levels across the distributed networks in which users are connected across the newly developed step network. The transmission time is optimized by the Hungarian technique by considering the limited nodes but it can be extended up to the finite numbers of nodes connected across the step topological network. In the proposed approach, the model is decomposed into three parts namely application level system, component level and system level. Dynamic power management technique is used for optimization of the transmission of the processes. In above table has taken as per each system. The experimental results has evaluated on five system connected over network server.

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RESEARCH PAPER

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# A SURVEY OF RECENT TECHNIQUES FOR ENERGY COMPUTATION IN DISTRIBUTED COMPUTING NETWORKS

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***Abstract:*** In recent years many techniques have been computed for energy consumption. The Energy Consumption is a very big challenging area for research in networks. There are various techniques for computing energy consumption in distributed computing as described in this paper. There is a different device attached to the distribution system for different electrical operation. They are Dynamic Power Management Techniques (DPMT) like as Dynamic Voltage Scaling (DVS), Dynamic Frequency Scaling (DFC), and Routing algorithm. In these techniques, Clock Gating technique is also a methodology but it is very expensive and effective. They consume very highly electricity working in operations. There are two major metrics for reducing energy consumption in networks as, power and time. So any reliable networks the performance must be less energy during throughput packet and transmission delivery. Energy Consumption is a valuable cost of any networks over the lifetime. In this paper the recent techniques used for energy optimization in distributed computing.

***Keywords:*** Energy Consumption; Routing Algorithm; Dynamic Voltage Frequency Scaling (DVFS); Dynamic Power Management.

## I. INTRODUCTION

Distributed Computing is an emerging area of research. The application of distributed computing devices power consumption is increasing day by day in all areas of network application throughout the world. The broadband wired communication network including the home personal computers and number of popular devices are based on the electrical application that gathered information from the surrounding. These devices are highly Energy Efficiency proposed due to their uses like Motherboard, processor, electromechanical devices and HDD in the computer for throughput the information processing. The proposed constraint makes energy consumption one of the most predicted areas among researcher and scientists. In these computing networks, there have been various techniques for reducing energy Consumption in previous and depend basically to traffic Load. The networks consume the largest amount of energy consumption which is observed to fix and variable in wired networks with a huge number of distributed networks. The highest energy consumption has seen in Dataware center and IP backbone networks. The method for reducing energy consumption is various types and matrices found for energy-related of networks. It's divided into main categories (1) Network workload. (2) The sleep mode approach. These two solutions can find the energy to save extra energy. Therefore, a technique to find for energy minimization or reducing is the research region in networks. The current work is focussed on computational techniques, which minimization the extra energy due to traffic load. The energy performance formulates as,

$$\text{Power} \propto CV^2 \times f \quad (1)$$

or

$$\text{Power} = k\, CV^2 \times f \quad (2)$$

Where C is the capacitance, V is voltage, f is frequency and k is the load factor.

Performance-driven computer development has lasted decades. Computers have been developed higher performance. Three supercomputers have achieved Tera or Peta flops speed such as supercomputer: Cray Jaguar, Dawning Nebulae, and IBM Roadrunner

In the computing hardware characteristics as processing speed, memory/storage capacity, and network capacity. the power consumption an exponential speed, and the increased energy consumption in areas, Industry Impact, Environmental Impact, Research & Development organization and Science and Technological Impact.

## II. METHODOLOGY

Hammadi et al. [1] have described a survey on architectures and energy efficiency in data center networks. The survey of existing techniques approaches for energy saving and green data centers. Orgerie et al [2] have described the techniques to improve the energy performance of Computing and Networks devices in wired or wireless networks. They had described the solution to improve such as resource allocation, network traffic, and scheduling. Han Song et al. [3] have proposed an algorithm for macro-base stations and Femto-access points station for distributed computing. Moety Farah et al. [4] have proposed the multiple objective optimization methods is used in network power consumption. The minimization of transmission delay in wireless access networks used two techniques (i) IEEE 802.11 (ii) LTE network technology. Huang et al. [5] have given a model for minimizing the data redundancy for reliability to the distributed computing or cloud storage. Hassan A. et al. [6] have proposed a method for finding the scaling, communication, and performance for cloud datacenter. In this experiments, they found the point to point communication performance between nodes and network size. Agostini et al. [7] have proposed a method for the management of network and network performance technique for strategic multiplier networks. Alonso et al [8] have given a novel methodology for reducing power consumption in fat tree networks types. They have given a latency, routing algorithms methods. Zdraveski et al. [9] have proposed an algorithm for power saving by dynamic intelligent load balancing technique in distributed networks. Walkowiak [10] have developed the methodology for power saving. They have proposed for power saving two methods (i) elastic optical network (ii) operating expenditures for finding cost and power consumption in big data. Al-Ayyoub et al [11] have developed a model for power reducing in data centers. In this model, they have described the model in service like as (i) operational cost and (ii) service level agreement. Bilal et al [12] have described the various methods for finding the energy saving in the data center. Rengarajan et al. [13] have investigated the sleep modes technique for wireless access networks to the finding energy optimization. The fixed computing component in network utilization for finding the energy reduction. O'Neill et al. [14] have described the role of energy consumption for gaming system during the time of playing the game of the networking. The gaming architecture and designed in large-scale distribution networks. Qiu et al. [15] have given a greedy model-based algorithm for improving the network robustness and energy reduction technique in networks. Cholda et al. [16] have described a solution to the find a state of art between energy efficiency and resilience in communication networks. A numerical algorithm is designed for finding the energy performance by iterative methods. Tang et al. [17] have given a particle swarm based optimization algorithm for finding the energy optimization. Jiang et al [18] have described a probability method for designing a reliable cloud data. In this method the securing the data and reliable to storage and re-outsourcing. Mershad et al [19] have given a mathematical model for analyzing the best result of power reducing in cloud data. They have good explained for power consumption in various computers hardware devices like CPU, Memory, and bandwidth. Alkhanak et al. [20] have described a review and classifications of t Cost optimization scheme for scheduling in the cloud and distributed computing. He Li et al. [21] have discussed an algorithm for an interconnection network of high-performance computers. They have experimented algorithm through folded hypercube. Banditwattanawong et al. [22] have proposed a method for power optimization of intelligent cloud data centers networks. A. Lynch et al. [23] are designed to solve different kinds of distributed algorithms covered in this book. The algorithms that arise, the problems that telecommunications, information distribution, scientific computing and real-time process distribution. Elavarasan et al. [24] have proposed an algorithm for energy consumption in network infrastructure of the distributed data center. Lange et al [25] have discovered the method for reducing energy consumption in backbone networks data server. They have studied the improvements methods for the energy consumptions of all network operators. Bolla et al. [26] have studied the energy efficiency in future networks and energy aware of stable network architecture. Tseng and Chung et al. [27] have given the methods for energy consumption in IP network the energy consumption of mixed integer non-linear network optimization problem. Baliga et al [28] have analyzed of network distribution. They have described the energy consumption in wired, wireless, HFC networks, passive optical networks, WiMAX, and optical access networks. Gaona et al. [29] have proposed a model energy optimization on the design of hardware transactional memory systems. They have described the lazy-lazy network systems energy consumption. Chiaraviglio et al [30] have given a mathematical model for energy consumption in distributed networks. They have described the methodology in sleep mode, wake up and active mode. Castane et al. [31] have examined the experimental formula i.e. E-mc2 the framework model for energy modeling in cloud networks. Schien et al [32] have developed a mathematical model for energy consumption of online multimedia services at the time of variability. Lin et al. [33] have described mathematical model and algorithms for NP complete problem. They have solved NP problem by the method of Dijkstra's algorithm and Yen's k-shortest paths algorithm.

### *A. Energy Saving Measurement*

- Simulator based power estimation likes NS2, OMNET++, OPNET, GloMoSim etc.
- Direct Measurement i.e. consolidated hardware devices.
- Event based estimation i.e. discrete time interval.

### *B. Energy Computation in Hardware Devices of Distributed Networks*

The energy consumption consolidated hardware devices in data centre is shown figure 1.

- Hard Disk: depend on different speed.
- Internet Card: it's depending on different speed.
- CPU: it's depending on different frequency and voltage.
- Motherboard: It's depending on voltage.
- RAM: It's depending on voltage
- Fan: It's depending on voltage.
- Processor Controller Board (PCB): It controls all process over voltage and power regulation.

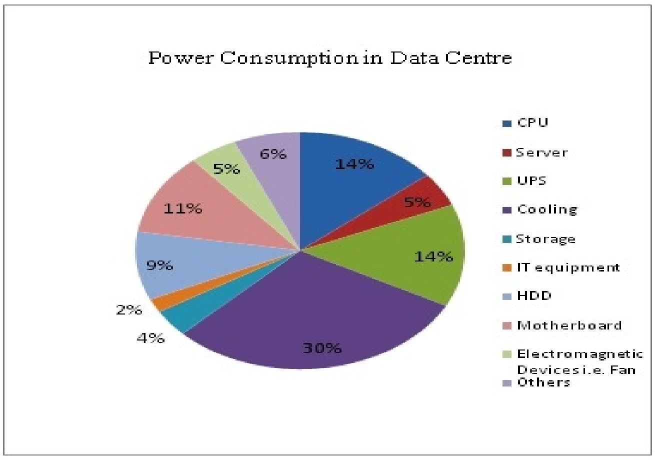


Figure1. Hardware Devices wise Energy Consumption in Data Centres.

## III. Mode of Energy Consumption in Distributed Networks

### *A.* A Fixed Part or Static Mode Energy Consumption

In this part depends on system size and computing type such as data storage, computing, and supporting networks elements. In that part the energy consumption occurs in leakage currents.

### *B.* A Variable or Dynamic Mode Energy Consumption

In this part the works defining the results from the usage of computing, storage and network devices caused by system action. The energy consumption of a large scale distributed networks is a big challenge.

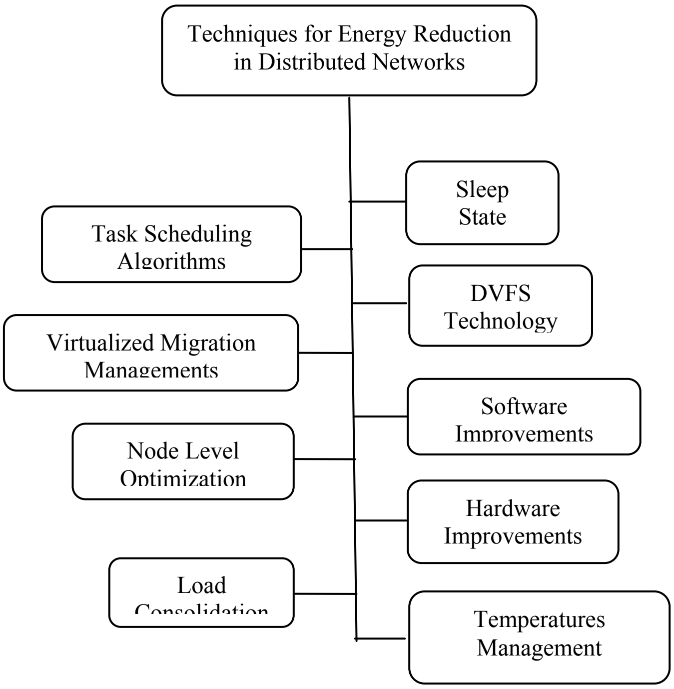


Figure 2. Energy Reduction Methodology in Distributed Computing.

### 3.1 Computing Devices for Energy Efficiency

Energy is defined as the rate of distributed system consumes electrical power during operation, Energy computations of the large scale distributed systems are as following techniques.

### *C.* DVS (Dynamic Voltage Scaling )

Its method is used to conserve energy in a data centre that each processing elements like as,

Processing Peripheral Devices

$$\sum PD_i = PD_1 + PD_2 \ldots\ldots\ldots\ldots\ldots PD_m \qquad (3)$$

Where peripheral devices like Motherboard, CPU, Hard Disk Drives (HDD). In that given all devices computes the formula. Like CPU energy consumption by Equation 2, here, supply voltage V can be scaled to a discrete number of voltage levels. Frequency reducing power consumption will increase the execution time of a task on a processing element. There are more useful for energy computation technique because the DVS approaches are (1) approximately solution of real problems (2) it has no switching (3) it has close relationship among voltage, power, and energy.

### *D.* DFS (Dynamic Frequency Scaling)

DFS can be used for energy conservation by lowering the heat produced in a processor by the low frequency. The low frequency will increase the amount of time a PE needs to complete a task. Energy is conserved with DFS because the PE consumes less power when running at low frequency.

### 3.2 Energy for Traffic Signal or Flow Data Packets

The packet throughput of the transportation data for processing occurs energy signal exhibits. The energy of the signal in data transmission. The energy equation of every packet frames in data transmission is given below:

$$E \int_{N_0}^{N_n} \left| x(t) \right| dt \qquad (4)$$

the stationary equation of the data forwarding as given Equation 5.

$$y = x(\mathrm{t}) = a\ (\sin \omega t\ +\ \phi) \qquad (5)$$

Where x (t) is linear time with distance node from vertices or destination point. a is the amplitude of the transmission time, ω is an angular frequency which depends on cycle per second ω = 2πf , $f = \frac{1}{T}$, and during data sending , φ is the phase difference between from the packet source to destination packet. If x (t) is the voltage applied across a load Ω resistor, then x (t) is the power estimation. The integration of power over time is total energy of the signal is called energy E that can be extracted from the signal continuous time T and the total energy depending on the time interval.

## IV. Power Computation Techniques

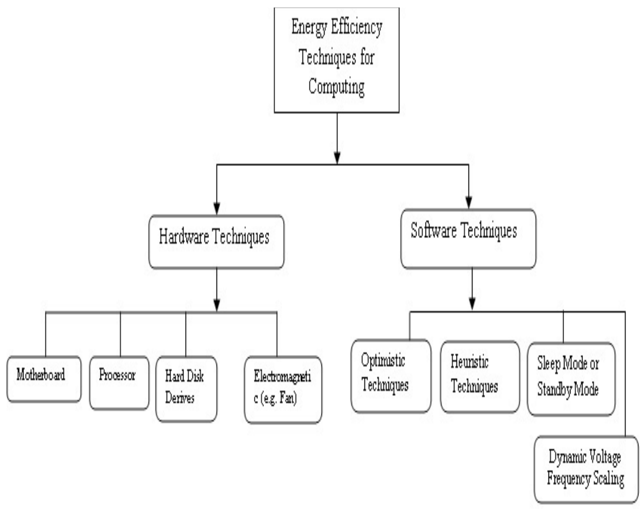


Figure 3: Energy Efficiency Computing Model

### *A.* Distributed and Data Centre Power Mnagement

The Following diagram represented in given below:

 

- Temperature Control by Data Centre Air Condition (DCAC)
- Energy aware of task scheduling.
- Load estimation.
- System configuration energy
- Energy emits with $CO_2$.
- Load balancing through data centres.

## V. ENERGY COMPUTATION BY ROUTING A LGORITHMS

There are various methods for finding the energy consumption by the method of routing algorithms.

### *A.* Bellman- Ford Algorithm.

Its algorithms solve the single source shortest paths problem. The graphs where the edge-weights may be negative, but no negative weight cycle exists in dynamic programming. The Bellman-ford equation is

$$d_x(y) = \min_v \{c(x,v) + d_v(y)\} \qquad (6)$$

$d_x(y)$, be the cost of the least-cost path from node x to node y. where the min v, in the equation, is taken over all of x is the neighbors traveling from x to v, if we take the least-cost path from v to y, the path cost will be $c(x,v) + d_v(y)$ . It begin by traveling to some adjacent v, the minimum cost from x to y is of $c(x,v)+ d_v(y)$ across whole near vertices v.

### *B.* Optimization Scheduling Algorithms for Energy

Efficient Networks The optimization algorithms are used to find solutions for the energy consumption through task scheduling allocation problem in the following figure 4. is represented:

Optimization Scheduling Algorithms –

The routing algorithms in scheduling as

*(1) Link sates routing*
*(2) Distance vector routing*
*(3) Minimum, Maximum and Mini-Max Scheduling*

### *C. Dijkstra's Algorithm*

In this algorithm shortest path from a single source to all destinations i.e. vertices on a graph with non-negative weights. The algorithm is used for single source shortest path but no negative cycles. In this algorithms divide the nodes into two sets (a) Provisional Method (b) Permanent Method. It finds the neighbors of a current node makes them provisinal and examines if they pass the criteria makes them permanent. Dijkstra's algorithm requires processing time proportional to the number of links in the graph i.e. n * k links and describes by the log of the number of nodes in the net, it defines the originated term as O (n * k log n).

## VI. CONCLUSIONS

Energy consumption is one of the most important roles in the wired and wireless sensor networks. The main objective of energy consumption computing is two types (i) Software-based energy consumption techniques (ii) Hardware-based energy consumption techniques. The DVFS techniques to reduce power consumption of CPU during communication, The routing scheduling techniques and algorithms are methods of finding energy consumption as an important computational method in networks. The Energy saving in wire or distributed networks having a lot of challenges across the world. In this paper, the energy consumption not only for energy consumption but it is also used for energy balance to increase and lifetime for futuristic.

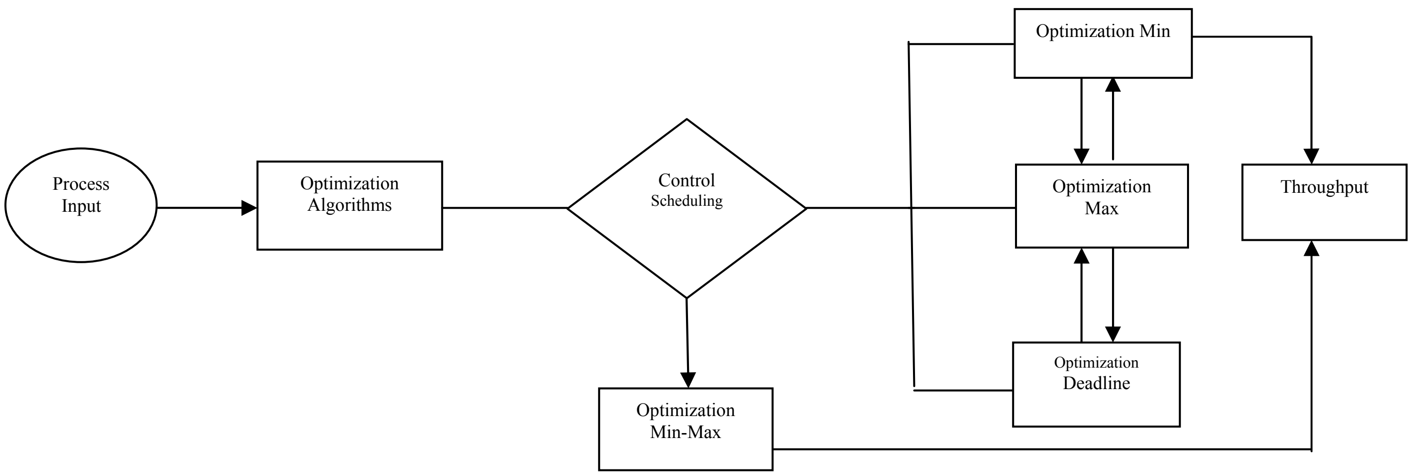


Figure 4. Flowchart of Optimization Scheduling Algorithms in Networks

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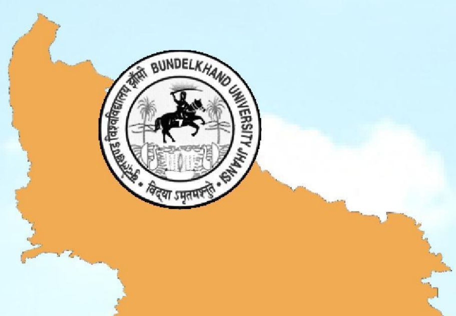

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