

A SURVEY ON CLOUD RESOURCE ALLOCATION STRATEGIES

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ABSTRACT

Cloud computing delivers an efficient and elastic means for various services to meet the diverse and intensifying needs of users. It is possible for anyone to use the services from anywhere in the world. This way of outsourcing will decrease the infrastructure cost. This also supports for using product without difficulty of getting license. The resource allocation also has to be optimized for achieving maximum utilization of this technology. In this paper, various resource allocation strategies and their challenges are discussed. This would benefit both the researchers and cloud users to face challenges.

Index term: Resource Allocation Strategies

I INTRODUCTION

Cloud computing refers to both the applications delivered over the Internet as well as the hardware and systems software in the data centers. Cloud provides service in the form of virtualized hardware and software to the user. Cloud also includes the major functionalities of technologies like grid computing, utility computing and virtualization [1]. Cloud clients deploy their online applications on virtual machines (VMs) in cloud without violating the Service level agreement (SLA). Virtualization technology in data centers enables better server utilization and hence reduces the resource management task and cost of cloud maintenance. It is the technology that maps the virtual machines to the Physical Machines (PMs). This mapping enables the PM to serve many users with different functional requirements (like applications) and non-functional requirements (like memory size etc.).

Now a days the number of VMs deployed in cloud data center increases every day. The capacity of VM can be provisioned either statically or dynamically. In static provisioning, the average resource utilizations from data so far and the user defined requirements are used as input to the algorithm that will give a mapping of VMs to PMs. This needs the VM resource demand to be known in advance and the variability. In dynamic provisioning, it is possible to adapt to the varying workload and keep the load balanced

II DIFFERENT TECHNOLOGIES

2.1 Ant colony optimization algorithm for resource allocation

The cloud computing uses master/slave structure where the master node controls the slave node as in fig 1.

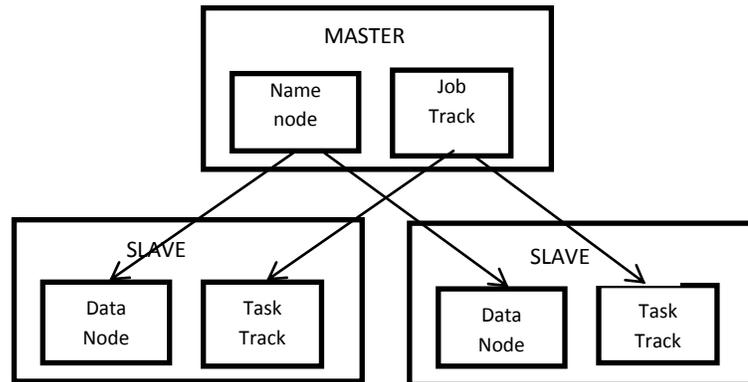


Fig 1: The structure of Hadoop cluster

The concept of ACO was stated by M.Dorigo et al., The ACO shows the path of reaching the solution by reducing the search space in the following solution space.[2] They achieve this by the feedback mechanism called pheromone update. When the search begins, the query will be sent to the slave nodes. The slave nodes are considered as ants in behavior. The slave node that has more pheromone gets the larger probability of heading towards solution. Hence its path will be selected. Hua’s paper[3] gives a detailed description of this.

2.2 Threshold based scheduling algorithm

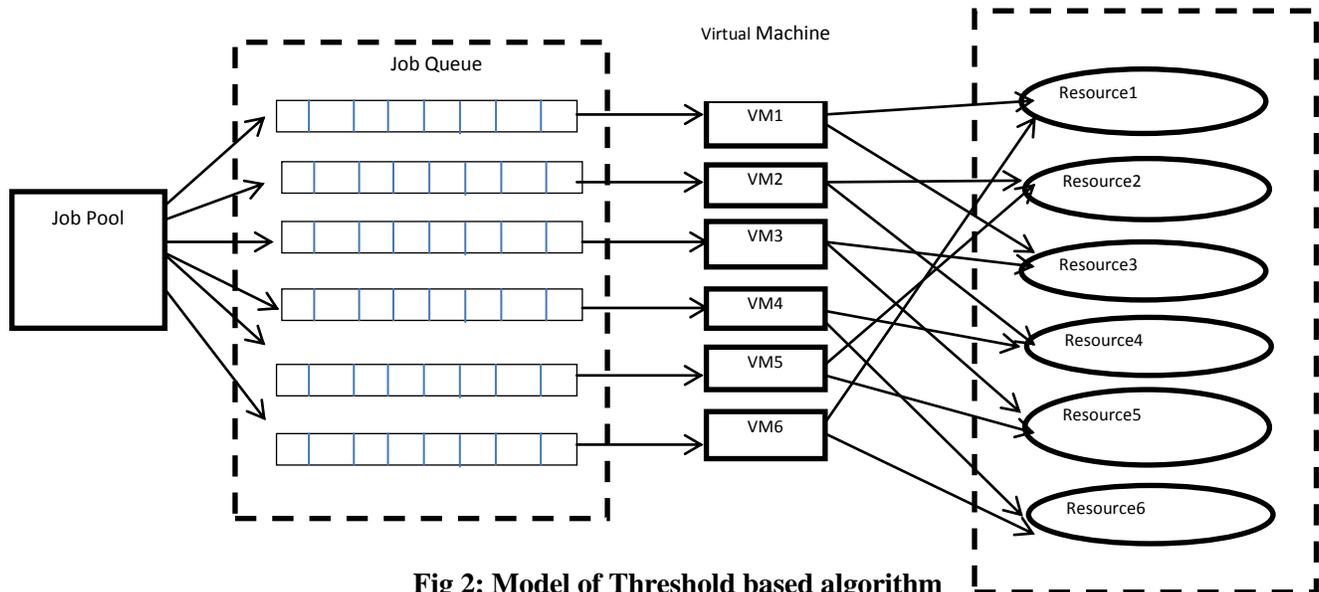


Fig 2: Model of Threshold based algorithm

2.3 Optimized Genetic Algorithm

The genetic algorithm was proposed by Holand. The reduction in search space and reaching the global optima without falling in local optima are the major features of Genetic algorithm. The algorithm is based on the genetic operators namely reproduction, crossover and mutation. The GA with improved performance works with dual fitness function. The flow of GA is shown in fig 3.

In GA, a solution is considered as a chromosome. The numbers that are part of each chromosome are the resource number allocated. Li's paper[4] compares Adaptive GA and dual fitness GA. It is stated that DFGA is superior to AGA.

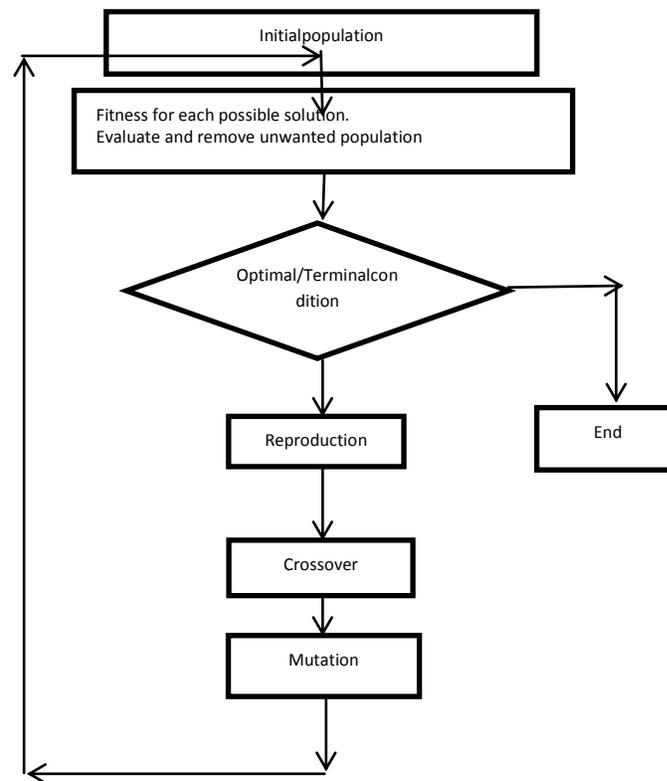


Fig 3: Flow of GA

2.4 Cloud Scheduling via migration of virtual machines

Wubin Li et al., have proposed a model for dynamic cloud scheduling via migration of virtual machines. They have investigated dynamic cloud scheduling use cases and proposed a linear integer programming model for dynamic cloud scheduling via VM migration across multiple clouds. This model can be applied to handle both the infrastructure as well as services. They have not taken SLA violation into consideration.[5]

2.5 A VMCTune located in the cluster layer

Wenyu Zohu et al., have designed and implemented a load balancing schedule based on dynamic resource allocation policy for virtual machine cluster. Their algorithm monitors the real time resource utilization of Virtual machines and physical machines and instantly allocates resources virtual machines to the same physical machines in order to achieve load balancing. Then it tries for global load balancing . they have shown results in the improvement in utilization of physical machines as well.[6]

2.6 Generic Search

This is a schedule that is similar to the picking of balls and pins. If the goal is to use minimum number of bins, each bin us filled first. Once the bin is filled, the next bin is selected. Thus we can pack each bin to its capacity. [7].

If the goal is to use balance utilization across the set of bins, random allocation is done across given set of bins.

The balls are considered as the virtual machines and the bin is the physical machine. The bins are packed as complete binary tree with 2 power n nodes. This will have better packing.

This algorithm cannot determine any non existant node. Also there is no guarantee for minimal solution.[7]

2.7 Combined resource allocation

Magedanz et al.,have combined various cloud resource allocation, and has designed a multi cloud brokering mechanism for efficient utilization of cloud resources. According to them,the dynamic selection of optimal cloud service is more important. Different QoS constraints and dynamically changing workloads are considered. Multiple factors impacting multi cloud environment and their effects are evaluated. Also the metrics for assessing the performance of cloud systems for NGN media services are evaluated..[8]

2.8 Data Envelopment Analysis

Hsin-Hung Cho et al., have said that the overall cloud architecture has become imbalance due to the inclusion of various service classifications. They have proposed a Data Envelopment Analysis (DEA) to overcome the imbalance problem. Their analysis starts from the user's request and then to the DEA for evaluating the cloud parameters and thenfinding the resource allocation policy that is suitable for the users and the vendors.[9]

III CONCLUSION

This paper analyzes various resource allocation strategies under the cloud environment . Day by day new strategies are proposed for significant improve in the efficiency and use of resources. As the usage of cloud becomes wider and wider, the resource allocation is expected to further improve so that it improves the effectiveness in usage of cloud.

REFERENCES

- [1]Stelios Sotiriadis, Nik Bessis, Fatos Xhafa, nick Antonopoulos “cloud virtual machine Scheduling” sixth international conference on complex, Intelligent and software Intensive system,2012, IEEE
- [2]Li Huang, Hai-Shan Chen, ting-ting Hu “Survey on Resource Allocation Policy and job Scheduling algorithms of cloud computing”, Journal of Software, Volume 8, No 2, Feb 2013 Academy Publisher
- [3]Hua Xiayer, zheng Jun, Hu Wenxin, “Ant colony optimization algorithm for computing resource allocation based on cloud computing environment”. Journal of east china normal university(Natural Science) 2010,
- [4]Li Jian Feng, Peng Jian, “Task scheduling algorithm based on improved genetic algorithm in cloud computing” Journal of computer applications”, 2011 pp 184-186
- [5]Wubin Li, Johan Tordsson and Erik elmroth “ Modeling for Dynamic cloud scheduling via migration of virtual machines Third IEEE International conference on cloud computing Technology and science, 2011
- [6] Wenyu zohu, Shoubao yang, Jun Fang, Xianlong Niu, Hu song “VMCTune: A load balancing scheme for virtual machine cluster based on dynamic resource allocation 2010 ninth international conference on Grid and cloud computing
- [7]Anshul Rai, Ranjitha Bagwan, Saikat Guha, Generalized resource allocation for the cloud SOCC 12, San Jose, CA, USA
- [8]Magedanz, Schreiner,QOS aware multi-cloud brokering for NGN services:Tangible bebenefits of elastic resource allocation mechanism. Communications and Electronics (ICCE), 2014 IEEE Fifth International Conference
- [9]Hsin-Hung Cho, chi yuvan chen, Hao Chen Li, Shih TK .A fair cloud resource allocation using data envelopment analysis.Hetrogeneous Networking for Quality, Reliability, Security and Robustness (QShine), 2014 10th International Conference

HYPOLIPIDEMIC EFFECT OF ETHANOLIC EXTRACT OF *AEGLE MARMELLOS* AND *TERMINALIA ARJUNA* IN HYPERLIPIDEMIC RAT MODEL

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ABSTRACT

Hyperlipidemia is the one of the major risk factor for the development of coronary heart disease. Currently available hypolipidemic drugs have been associated with number of side effects. A number of herbal medicines are used for controlling hyperlipidemia because of the undesirable side effects and contraindications of synthetic drug. *Aegle marmelos* and *Terminalia arjuna* plants have been traditionally used for curing many human ailments. The present study was designed to investigate the hypolipidemic effect of *Aegle marmelos* (L.)leaves and *Terminalia arjuna* bark extracts in high cholesterol diet induced hyperlipidemic rats. Hyperlipidemia was induced by feeding the model rat with cholesterol(100g), cholic acid(50g)and coconut oil. Hyperlipidemia in experimental rats were evidenced by an increase in the levels of cholesterol, triglycerides. Ethanolic extract of both plants were administered orally at dose of 250mg/kg/day for 14 days. Extracts of both the plants showed significant hypolipidemic effect by lowering the serum levels cholesterol and triglycerides when compared to that of hyperlipidemic rats. The findings of the study reveals that ethanolic extracts of *Aegle marmelos* leaves and *Terminalia arjuna* bark can effectively control the blood cholesterol and triglycerides levels in dyslipidaemic conditions. The main reason of this study was to find alternative and safe drugs for the management of hyperlipidemia.

Keywords: *Aegle marmelos*, cholesterol, hyperlipidemia, *Terminalia arjuna*, triglycerides.

1. INTRODUCTION

Hyperlipidemia contributes significantly in the manifestation and development of atherosclerosis and coronary heart disease (CHD) and is the most common cause of mortality and morbidity worldwide. The main cause of

heart failure are, such hypertension, high fat diet, life style but high levels of cholesterol triglycerides, LDL is mainly responsible for onset of CHD. Reduction in serum cholesterol levels reduces the risk for CHD. According to World Health Report 2002, cardiovascular diseases (CVDs) will be the largest cause of death by 2020 in India [1].

In India, persons suffering from the CHD are doubled in the last 20 years. In 2020 AD, 2.6 million Indians are predicted to die due to coronary heart disease which constitutes 54.1 % of all CVD deaths. The known hypolipidemic drugs, such as statins and fibrates have many side effects like hyperuricemia, diarrhea, nausea, gastric irritation, flushing, dry skin and also that they are not suitable for use during pregnancy, have made scientists look towards hypolipidemic agents of plant origin [2,3]. Demand for medicinal plant is increasing, due to growing recognition of natural products, having no side-effects, easily available at desirable price and sometime the only source of health care available to the poor. In recent times, however, a large volume of work aimed at the efficacy of herbal remedies, as they are safe and effective alternatives to modern medicine. India a treasure of plant population of medicinal value has been using these herbal drugs since ancient times for the treatment of human ailments because of its inability to cause side effects and safer than synthetic ones. Out of a large number of herbal drugs stated to possess hypolipidemic activity in the Ayurvedic system, *T.arjuna* and *A.marmelos* are among these herbal plants due to their cardio protective and hypolipidemic properties [4, 5]. *Aegle marmelos* commonly known as Bael (family Rutaceae) is another Indian plant which has enormous traditional uses against various diseases and many bioactive compounds have been isolated from this plant [6,7]. It is deciduous, glabrous, armed tree with trifoliolate leaves, short flower and globular fruits. The plant is of very high value in treating cardiac disorders, dysentery, diarrhea, diabetes, fever, inflammation, and pain. [8] The plant has shown various activities including anticancer, hypoglycemic, anti-inflammatory, antihyperlipidemic, analgesic and antiviral properties. [9,10] *Terminalia arjuna* (family Combretaceae) is large, evergreen tree found throughout the greater part of the Indian peninsula. It is an important medicinal plant widely used in the preparation of Ayurvedic formulations used against several ailments. The use of *Terminalia arjuna* bark in the management of hyperlipidemia has been widely reported [11, 12]. A number of experimental studies have been proved that dried bark powder of this plant have cardio protective activity. [13]. The present study has been designed to evaluate the lipid lowering activity of *A.marmelos* leaf extract and *T.arjuna* bark extract, separately in high cholesterol diet induced hyperlipidemia wistar rats.

II. MATERIAL AND METHODS

2.1 Collection of plant material

The leaves of *A.marmelos* and *T.arjuna* bark were collected from local area of Patna, Bihar. The leaves and the bark were dried, grinded and powder was used for extraction.

2.2 Preparation of plant extract

The leaves and bark powder were kept in percolator with 95% ethanol for 24 hrs. The residue was removed by filtration and the ethanolic extracts were concentrated on rotary evaporator to get the solid yield [14, 15].

2.3 Experimental animals

Male wistar rats 150-200gm were used in the present study. They were housed in polypropylene cages in a group of four animals per cage, under standard laboratory conditions of light, temperature and relative humidity. Animals were given standard rat pellets, high cholesterol diet according to their group and drinking water ad libitum.

2.4 Induction of Hyperlipidemia

High fat diet (HFD) was prepared by mixing cholesterol (100g), colic acid (50g) in 1litre of coconut oil [16]. This diet was given with standard animal food for 2 weeks. To confirm the induction of hyperlipidemia, blood samples were collected and TC, TG was determined using diagnostic kit.

2.4 Preparation of doses

The extract of both the plants were dissolved in distilled water and a dose of 250mg/kg body wt was given to the animals once in day along with HFD orally for 2 weeks. Both plants extracts were given separately to the grouped animals.

2.5 Experimental design

The animals were divided into four groups, four animals each in group.

Group I: Normal

Group II: High Fat Diet Control

Group III: Hyperlipidemic rats treated with *Aegle marmelos* [250mg/kg b wt]

Group IV: Hyperlipidemic rats treated with *Terminalia arjuna* [250mg/kg b wt]

At the end of experimental period, blood was collected, and centrifuged at 2000rpm for 30min to separate serum. Serum sample was analyzed for Total Cholesterol (TC), Triglycerides (TG).

III. RESULTS AND DISCUSSION

TABLE 1 and 2 shows the effect of oral administration of ethanolic extracts of *Aegle marmelos* leaves and *Terminalia arjuna* bark on hyperlipidemic rats. The rats fed with HFD exhibited significant increase in serum cholesterol and triglycerides when compared to normal (Group I). Effect of 2 week treatment with *A marmelos* leaves extract (Group III) and *T.arjuna* bark extract (Group IV) at a dose of 250mg/kg significantly reduced the elevated serum cholesterol and triglycerides when compared to the HFD treated group (Group II). The treatment

with *Terminalia arjuna* bark extract shows better effect than *A.marmelos*.. Similar results have been reported by Hossam M.M. Arafa 2005, feeding rats with an HCD for 7 consecutive days resulted in marked hypercholesterolemia. Also Palaninathan Varalakshmi et al;2006 have demonstrated that feeding Wistar rats for 30 days a high cholesterol diet increased the serum lipids. The mechanism of action of cholic acid is twofold: an increase in cholesterol absorption and a concomitant suppression of cholesterol 7 α -hydroxylase activity that results in decreased cholesterol excretion [19].

TABLE 1.Effect of the ethanolic extracts of *A.marmelos* leaves on lipid profile of hyperlipidaemic rats in diet induced hyperlipidemia. [Values are in mean \pm SD; Number of animals in each group = 4.]

| Group | Total Cholesterol(mg/dl) | Triglycerides(mg/dl) |
|--|--------------------------|----------------------|
| I(Normal) | 68.7 \pm 4.1 | 85.6 \pm 2.5 |
| II(HFD) | 172.5 \pm 2.4 | 195.0 \pm 2.5 |
| III(<i>A.marmelos</i> 250mg/kg/b.w/day) | 95.7 \pm 2.6 | 102.4 \pm 3.8 |

TABLE 2.Effect of the ethanolic extracts of *T.arjuna* bark on lipid profile of hyperlipidaemic rats in diet induced hyperlipidemia. [Values are in mean \pm SD; Number of animals in each group = 4.]

| Group | Total Cholesterol(mg/dl) | Triglycerides(mg/dl) |
|--|--------------------------|----------------------|
| I(Normal) | 63.4 \pm 4.1 | 89.3 \pm 3.3 |
| II(HFD) | 177.6 \pm 6.4 | 189.0 \pm 1.9 |
| IV(<i>T.arjuna</i> ,250mg/kg/b.w/day) | 88.5 \pm 5.4 | 92.0 \pm 2.5 |

In recent times, both experimental and clinical studies have shown that the dried bark powder of *Terminalia arjuna* has significant protective effects in ischemic heart disease. (Tripathi, 1993; Dwivedi, 1994; Miller, 1998). [17, 18]. The alcoholic extract of the bark of plant contains a large amount of flavones and tannins, which possess significant antioxidant activity (Packer et al., 1999) [20]. It has been reported that the leaf of *Aegle marmelos* posses hypolipidemic efficacy (Kesari et al2006) [21]. Fresh alcoholic leaf extracts of *Aegle marmelos* were reported to have a cardio tonic effects in mammals (Haravey,1968 and Nadkarni, 2000).T he levels of serum total cholesterol, triglycerides, LDL were significantly reduced in the plant extracts treated hyperlipidemic animals[22,23]. These results further suggest that *Aegle marmelos* and *Terminalia arjuna* may be useful in the therapy and management of hyperlipidemia.The present study suggests that the extract had synergetic hypolipidemic effect revealed by decreased serum lipid levels and therefore attribute to therapeutic

value of the plant extracts of *A.marmelos* to combat the hyperlipidemic condition in rats. In last few decades, natural products are extensively studied for their medicinal properties by advanced scientific techniques and a variety of bioactive compounds have been isolated from the different part of plant and were analyzed pharmacologically. A sustained reduction in hyperlipidemia will decrease the risk of developing cardiovascular diseases (CVD) and will create a hope on new drug discovery in controlling heart disease.

IV.CONCLUSION

Hyperlipidemia is associated with the heart diseases, which is the leading cause of death in the world. The investigation of lipid lowering activity on herbs will be useful strategy in the discovery of new molecules eliciting improved activity by regulating through different mechanism of action. As the pharmacologists are looking forward to develop new drugs from natural sources, development of modern drugs from *A.marmelos* and *Terminalia arjuna* can be emphasized for the control of various diseases. It can be concluded from above study that ethanolic extracts of *Aegle marmelos* and *Terminalia arjuna* can effectively control the blood lipid levels in dyslipidemic conditions. Further studies are needed to elucidate the exact phytoconstituent and mechanism underlying the regulation of serum lipid levels.

REFERENCES

- [1]World Health Organization. The World Health Report 2002. Geneva, Switzerland: WHO, 2002.
- [2] Narender T, Shweta S, Tiwari P, Papi Reddy K, Khaliq T, Antihyperglycemic and antidyslipidemic agent from *Aegle marmelos*. *Bioorganic & Medicinal Chemistry Letters* 2007; 17:1808–181.
- [3] Kamalakkanan N, Prince PS, Antihyperlipidaemic effect of *Aegle marmelos* fruit extract in Streptozotocin-induced diabetes in rats. *J. Sci. Food Agric* 2005; 85: 569
- [4]Ragavan B and S. Krishnakumari .Antidiabetic effect of T. arjuna bark extract in alloxan induced diabetic rats .*Indian Journal of Clinical Biochemistry*, (2006)21 (2):123-128.
- [5] Gupta A.K., and Tondon N. (2004), “Review on Indian medicinal plants”, Indian council of medicinal research, New Delhi, 312
- [6] Maity P, Hansda D., Bandyopadhyay U. & Mishra D.K., (2009) “Biological activities of crude extracts of chemical constituents of Bael, *Aegle marmelos* (L.) Corr.” *Indian Journal of Experimental Biology*, Vol 47, p.p.849-861.
- [7]Saswati Parichha 2004. “Bael (*Aegle Marmelos*): Nature's Most Natural Medicinal Fruit”, *Orissa Review*.
- [8]. Upadhyaya S, Shanbhag KK, Suneetha G, Balachandra Naidu M, Upadhyaya S. A study of hypoglycemic and antioxidant activity of *Aegle marmelos* in alloxan Induced diabetic rats. *Indian Journal of Physiology & Pharmacology* 2004; 48 (4): 476–80
- [9] Dhuley JN, Investigation on the gastroprotective and antidiarrhoeal properties of *Aegle marmelos* unripe fruit extracts. *Hindustan Antibiotics Bulletin* 2007; 41: 45-46.

- [10]Mhaskar k s,Blatter e andCaius J.FIndian Medicinal plants published by Indain Books centre,Delhi,India,2000,volIV 1212-1214
- [11]Shalia, H.P, S.L.Udupa, 2000.Hypocholesterolemic activity in rats of different fractions from Terminalia arjuna.Pharma.Pharmacol.Commun, 6:327-330.
- [12]Khanna, A.K., R.Chander, N.K.Kapoor, 1996.Terminalia arjuna:An ayurvedic cardi tonic,regulates lipid metabolism in hyperlipidemic rats.Phytotherapy Res,10:663-665.
- [13] Bala Sunder Reddy, P. Ravi Kumar, K. Bharavi and U. Venkateswarlu, 2011. Hypolipidemic Activity of Methanolic Extract of *Terminalia arjuna* Leaves in Hyperlipidemic Rat Models. Research Journal of Medical Sciences, 5: 172-175.
- [14]Rodda Raghuveer et al, 2011.Antihyperlipidemic effect of T.erecta in cholesterol fed hyperlipidemic rats.Scholars Reasearch Library, 266-270.
- [15]Modi Dixit C et al. Antihyperlipidemic activity of S.cumini Linn.seed extract on high cholesterol fed diet rats.Int.J.Ph.Sci.2009, vol 1(2), 330-332.
- [16]Varsha Dhulasavant et al, 2010. Antihyperlipidemic activity of Cinnamomum tamala Nees. On high cholesterol diet induced hyperlipidemia.Int.J.Ph.R.2010, vol 22517-2521
- [17]Dwivedi, S, 1994. Antianginal and Cardioprotective effects of Terminalia arjuna, an indigenous drug, in coronary heart disease. Journal Association Physician India 42 (4), 287–289
- [18] Miller, A.L, 1998. Botanical influences on cardiovascular disease. Alternative Medical Review 3 (6), 422–431.
- [19] Moghadasian Mohammed H., DVM, MSc, PhD Minireview ‘Experimental atherosclerosis A historical overview’ Life Sciences 70 (2002) 855– 865.
- [20] Packer, L,Rimbachi, Virgili, F., 1999. Antioxidant activity and biologic properties of a procyanidin-rich extract from pine (*Pinus Martima*) bark, pycnogeol. Free Radical Biology and Medicine 27, 704–724.
- [21] Kesari AN, Gupta RK, Singh SK, Diwakar S, Watal G, Hypoglycemic and antihyperglycemic activity of *Aegle marmelos* seed extract in normal and diabetic rats. Journal of Ethnopharmacology 2006; 107(3): 374-79.
- [22]Kanungo S. K, Panda D. S, Swain S. R, et al. Comparative Evaluation Of Hypolipidemic Activity Of Some Marketed Herbal Formulations In Triton Induced Hyperlipidemic Rats Pharmacologyonline 3: 211-221 (2007).
- [23]Patel DK, Patel KA, Patel UK, Thounaoja MC, Jadeja RN, Ansarullah,et al. Assessment Of Lipid Lowering Effect Of Sida rhomboidea. Roxb Methanolic Extract In Experimentally Induced Hyperlipidemia, J Young Pharma.2009; 1(3):233- 238.

GREEN CHEMISTRY TOOLS: STRENGTHENING CHEMICAL SCIENCES FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Green Chemistry is a rapidly developing and an important area in the chemical sciences. It aims to protect the environment not by cleaning up, but by inventing new chemical processes that do not pollute the environment. It is the utilization of a set of principles that will help reduce the use and generation of hazardous substances during the manufacture and application of chemical products. In the present studies, Principles of green chemistry, developments in this field and some industrial applications are discussed.

I. INTRODUCTION

In the last 250 years chemistry has improved our quality of life, and made thousands of useful products and materials possible. But this achievement has come at a price: for the global environment and non-renewable natural resources. Sustainability is at stake and continuation of the quality of life is under threat. Sustainability means Meeting the needs of the present generation without compromising the needs of future generations. Green chemistry and its principle want to change all these negative impacts and through design, innovation and green processes to restore the planet's sustainable development.

Green chemistry is defined as the technologies of the invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances ,and where possible utilize renewable raw materials.

Green chemistry, is called also Benign chemistry or clean chemistry for sustainability

It refers to the field of chemistry dealing with

- 1- Synthesis (the path to making chemicals)
- 2- Processing (the actual making of chemicals)
- 3- Use of chemicals that reduce risks to humans and impact on the environment

II. WHAT IS GREEN CHEMISTRY?

Green chemistry is a pro-active approach to pollution prevention. It targets pollution at the design stage, before it even begins. If chemists are taught to develop products and materials in a manner that does not use hazardous substances, then much waste, hazards and cost can be avoided. Green Chemistry is designing chemical products and processes that reduce or eliminate the use and/or the generation of hazardous substances.

Think about the simple equation of risk: Risk = Hazard x Exposure. Traditional approaches to pollution prevention focus on mitigating the hazard or end-of-pipe pollution prevention controls. These traditional

technologies focus on limiting the *exposure* of a hazardous material. Unfortunately, exposure precautions can and will fail (i.e., gloves can tear, goggles can break, chemical releases can occur). Green chemistry goes to the root of the problem and aims to eliminate the hazard itself. Green Chemistry is the **ONLY** science that focuses on the intrinsic *hazard* of a chemical or chemical process. It seeks to minimize or eliminate that hazard so that we do not have to worry about exposure.

III. CHEMICAL DISASTERS

1956: Minamata disease was first discovered in Minamata city in Japan. It was caused by the release of methylmercury in the industrial wastewater from a chemical factory

1961: Itai-itai disease was caused by cadmium poisoning due to mining in Toyama Prefecture in Japan

1976: The Seveso disaster was an industrial accident that occurred in a small chemical manufacturing plant near Milan in Italy. It resulted in the highest known exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin in residential population.

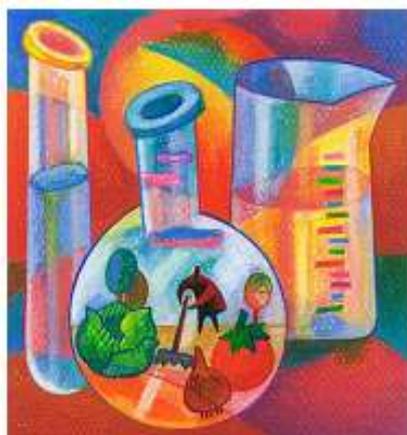
1984: The Bhopal disaster was an industrial catastrophe that took place at a pesticide plant owned and operated by Union Carbide (UCIL) in Bhopal India resulting in the exposure of over 500,000 people. It was caused by methyl cyanate (MIC) gas.

1986: The Chernobyl disaster was a nuclear accident at the Chernobyl nuclear plant in Ukraine. It resulted in a severe release of radioactive materials. Most fatalities from the accident were caused by radiation poisoning.

1989: Exxon Valdez, an oil tanker hit a reef and spilled an estimated minimum 10.8 million US gallons (40.9 million litres) of crude oil. This has been recorded as one of the largest spills in United States history and one of the largest ecological disasters.

IV. CONCEPTS OF GREEN CHEMISTRY

Green Chemistry is a new “philosophy” of how to make chemical products in the chemical industry and for chemical research. Innovative design and changes in chemical processes can eliminate hazards and help scientists to achieve the goals to sustainable development.



The terms ‘Environmental Chemistry’ and ‘Green Chemistry’ are two different aspects of environmental pollution studies. The former is the study of chemical pollutants in natural environment while the latter is an

attempt to design chemical products and processes to reduce the harm they cause to the environment. Green chemistry seeks to reduce pollution at source, whereas environmental chemistry focuses on the study of pollutant chemicals and their effect on nature.

V. GREEN CHEMISTRY AND SUSTAINABLE DEVELOPMENT

The UN defines sustainable development as ‘meeting the needs of present generation without compromising the ability of future generation.’ Green chemistry focuses on how to achieve sustainability through science and technology. To better understand and solve the issue of environmental pollution, many approaches and models have been developed for environmental impact assessments. Some of these approaches and models have been successful in predicting impacts for selected chemicals in selected environmental settings. These models have joined air and water quality aspects to point and nonpoint sources and have been very useful for the development of emission control and compliance strategies. However, some of the approaches and models were aimed primarily at evaluating the quantity of pollutants that could be discharged into the environment with acceptable impact, but failed to focus on pollution prevention. The concept of end-of-pipe approaches to waste management decreased, and strategies such as environmentally conscious manufacturing, eco-efficient production, or pollution prevention gained recognition.

VI. THE TWELVE PRINCIPLES OF GREEN CHEMISTRY

Paul T. Anastas,[1] an organic chemist working in the Office of Pollution Prevention and Toxins at the EPA, and John C. Warner developed the Twelve Principles of Green Chemistry in 1991. These principles can be grouped into "Reducing Risk" and "Minimizing the Environmental Footprint." Risk has been a legacy of some chemical industries in the past. Hazardous chemicals to humans and environmental pollution risk was connected with new chemical products and that gave a “bad name” to synthetic chemical materials. The environmental footprint is more to do with energy consumption, the climate crisis and depleting natural resources.

4.1 Green Chemistry aims to Reduce Risk in the Laboratory

Use Safer Chemicals, Design Less Hazardous Synthesis Methods Use Safer Solvents and Reaction Conditions
Accident Prevention (minimize the potential for explosions, fires, etc)

4.2 Minimizing the Environmental Footprint

Waste Minimization and Prevention – Use of Catalysts Instead of Stoichiometric Quantities Reduce the Use of Chemical Derivatives Synthetic Efficiency (Atom Economy) Taking Advantage of Chemicals Designed for Degradation Establishment of In Process Controls for Pollution Prevention – Use of Renewable Feedstocks Encourage Energy Efficiency

Principle No. 1. Prevention : It is better to prevent than to clean or to treat afterwards (waste or pollution). This is a fundamental principle.

Principle No. 2. Maximise synthetic methods, Atom Economy The concept of **Atom Economy** was developed by Barry Trost of Stanford University (USA), for which he received the Presidential Green Chemistry Challenge Award in 1998. It is a method of expressing how efficiently a particular reaction makes use of the reactant atoms.

Principle No. 3. Less hazardous chemical syntheses: Green Chemistry must strive, wherever practical, to design safer synthetic methods by using less toxic substances as well as the products of the synthesis.

Principle No. 4. Designing safer chemicals: Designing must become a fundamental aim of Green chemists to effect the desired function and properties of the chemical product while minimizing their toxicity to human and the environment.

Principle No. 5. Safer solvents and auxiliary substances: Solvents, separation agents and auxiliary chemicals used in synthetic chemistry must be replaced or reduced with less toxic chemicals

Principle No. 6. Design for energy efficiency: Designing more efficient methods is a necessity and if possible synthetic methods should be conducted at room temperature and pressure to reduce energy requirements.

Principle No. 7. Use of renewable raw materials and feedstocks: Raw materials must have very low toxicity and if possible to be renewable, rather than depleting.

Principle No. 8. Reduce intermediate derivatives: Chemists must aim for reducing unnecessary derivatization (use of blocking groups, protection/deprotection techniques and temporary modification of physical and chemical processes) in the synthetic routes.

Principle No. 9. Catalysis, catalytic reagents: New catalysts and more emphasis on catalytic processes is the future of green chemistry techniques.

Principle No.10. Design products which degrade easily: Green Chemistry aims at designing products so that at the end of their useful life to break down into innocuous materials.

Principle No. 11. Real- time analysis for pollution prevention: Analytical methodologies need to be further developed to allow for real time, in-process monitoring and control prior to the formation of hazardous substances

Principle No. 12. Inherently safer chemistry for accident prevention. Raw materials and chemical substances used in chemical process should be inherently safe, i.e. their properties and their degradation products to be non-toxic and not dangerous (e.g. to explode, to be flammable, allergic to humans, cause burns to skin, etc).

VII. USE OF ALTERNATIVE SYNTHETIC ROUTE FOR FEEDSTOCKS AND STARTING MATERIALS

Green Chemistry and Green Engineering are striving to produce new methodologies for sustainable development. Their proposals focus on:

7.1 Renewable Feedstocks and Raw Materials Production of Dimethylcarbonate (DMC) Production

DMC is a versatile and environmentally innocuous material for the chemical industry. Owing to its high oxygen content and blending properties, it is used as a component of fuel. [2]

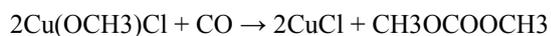
Traditional method for the production of DMC

This method involves the use of phosgene (COCl₂) and methanol (CH₃OH) as shown below:



Alternative route for the production of DMC

This involves the use of copper chloride (CuCl), methanol (CH₃OH), oxygen (O₂) and carbon monoxide.



7.2 Oleochemistry. New Biological Starting Materials

Fats and oils (from plants and animals) as oleochemical raw materials can become a new source of chemical feedstocks. Already a series of raw materials exist in the market with many applications in cosmetics, polymers, lubricating oils and other products.

7.4 Photochemistry. New Chemical Processes with the Aid of Light

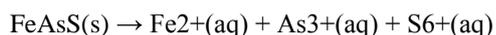
Green Chemistry puts a lot of emphasis on photochemical reactions in chemical processes. Light (ultraviolet and visible) can become an important catalyst for many reactions, replacing toxic metals in many reactions.

7.5 Biocatalysis

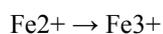
Biobleaching is the extraction of specific metals from their ores through the use of microorganisms such as bacteria. This is much cleaner than the traditional heap leaching using cyanide in the case of gold extraction.[3]

7.5.1 Extraction of Gold

This can involve numerous ferrous and sulphur oxidizing bacteria, such as *Acidithiobacillus ferrooxidans* and *Acidithiobacillus thiooxidans* (also referred to as *Thiobacillus*). For example, bacteria catalyse the breakdown of the mineral arsenopyrite (FeAsS) by oxidising the sulphur and metal (in this case arsenic ions) to higher oxidation states whilst reducing dioxygen by H₂ and Fe³⁺. This allows the soluble products to dissolve.



This process occurs at the cell membrane of the bacteria. The electrons pass into the cells and are used in biochemical processes to produce energy for the bacteria to reduce oxygen molecules to water. In stage 2, bacteria oxidise Fe²⁺ to Fe³⁺ (whilst reducing O₂).

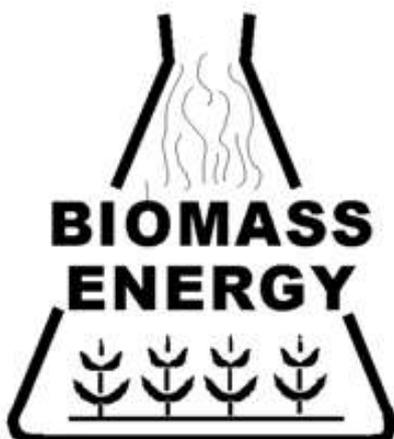


They then oxidise the metal to a higher positive oxidation state. With the electrons gained, they reduce Fe³⁺ to Fe²⁺ to continue the cycle. The gold is now separated from the ore and in solution.

7.5.2 Waste Biomass as Chemical Feedstock, Biomaterials and Biofuels

In recent years many new technologies showed the use of biomass as biofuel, raw material for the production of biomaterials, polymers and various other applications.

Biomass can become the starting material for the production of biofuel, biomaterials, biopolymers and for the production of engine fuels.

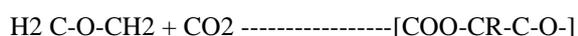


7.6 Green Solvent

Widely used solvents in syntheses are toxic and volatile – alcohol, benzene (known carcinogenic), CCl₄, CHCl₃, perchloroethylene, CH₂Cl₂. Purification steps also utilize and generate large amounts of solvent and other wastes (e.g., chromatography supports). These have now been replaced by safer *green solvents* like ionic liquids, supercritical CO₂ fluid, water or supercritical water and also solvent-free systems that utilize the surfaces or interiors of clays, zeolites, silica, and alumina.[4]

One of the green solvents is supercritical carbon dioxide (scCO₂). Supercritical carbon dioxide refers to carbon dioxide that is in a fluid state while also being at or above both its critical temperature and pressure (T_c = 31.3 oC, P_c = 1071 psi (72.9 atm) yielding rather uncommon properties. Supercritical carbon dioxide has been used as a processing solvent in polymer applications such as polymer modification, formation of polymer composites, polymer blending, microcellular foaming, particle production, and polymerization.

Reaction of amines with CO₂



(polycarbonates)

7.7 Designing Safer Chemicals

7.7.1 Flame Retardants

Flame retardants containing bromine, compared to fluorine, chlorine and iodine have shown to be the most effective and requires a lower loading of materials. Brominated flame retardants (BFRs) are structurally diverse group of compounds and BFRs are: Polybrominated diphenyl ethers (PBDEs); Tetrabromobisphenol A (TBBPA);

7.7.2 New Flame Retardants

Decabromodiphenylethane

tribromophenoxy ethane

Pentabromobenzyl acrylate

Tris(tribromoneopentyl)phosphate

7.8 Energy

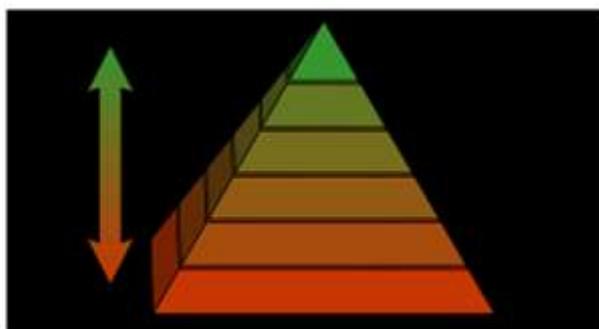
7.8.1 Fossil Fuel

This is dogged with many environmental pollution problems. There is, therefore, a growing need for alternative energy sources to replace fossil fuels. Renewable energy resources that are currently receiving attention include, solar energy, wind energy, hydro energy, fuel cells to mention but four.

7.8.2 Safer Petrol

Removal of Pb from petrol; addition of ethanol produced from biomaterials to the petrol pool; addition of methyl *t*-butyl ether (MTBE) to the petrol pool. MTBE has high octane and use of electric vehicles powered by fuel cells.

7.9 Waste Management



VIII. APPLICATIONS OF NEW METHODOLOGIES IN THE SYNTHESIS OF CHEMICAL COMPOUNDS

8.1 Ionic Liquids in Organic Synthetic Routes

Ionic liquids are used extensively in recent years as alternative solvents in organic synthesis. These substances are variously called liquid electrolytes, ionic melts, ionic fluids, fused salts, liquid salts, or ionic glasses. Ionic liquids have many applications, as powerful solvents and electrically conducting fluids (electrolytes).[5]

Organic synthesis in water Water was considered for many decades as a medium that was to be avoided as solvent for synthetic organic chemistry. Water proved to be an excellent solvent for many synthetic methods. The most interesting example of water as a solvent is the Diels-Alder organic synthesis.

Organic synthesis in polyfluorinated phases In these techniques chemists are using polyfluorinated two phase systems of solvents which dissolve catalysts with a long hyperfluorinated alkylo- or aliphatic chain. Reagents are dissolved in an organic solvent which is insoluble in the hyperfluorinated phase. Warming up the mixture accelerates the reaction with excellent yield of products.

8.2 Supercritical Carbon Dioxide and Supercritical Water

Carbon dioxide and **water** are the most commonly used supercritical fluids. They are used for supercritical fluid extraction (SFE). These supercritical properties can be applied as “green chemistry” credentials in chemistry with high yields and minimum waste.

8.3 Use of Microwave Techniques for Organic Synthesis

Microwave furnaces are widespread now for food warming and cooking. Their use in organic synthesis started many years ago and their success in organic synthesis with “green” criteria is very well established. Already, there are numerous research papers and applications for microwave organic synthesis with high yields, without solvents, low waste and very low energy requirements.[6]

8.4 Sonochemistry. The Use of Ultrasound for Synthesis

Chemical reactions can start and be enhanced by sonic waves. Sonochemical reactions by ultrasound is very advanced “green” techniques with exceptional high yields. There are three classes of sonochemical reactions: homogeneous sonochemistry of liquids, heterogeneous sonochemistry of liquid-liquid or solid-liquid systems, and, overlapping with the previous techniques, sonocatalysis. The chemical enhancement of reactions by ultrasound has been explored and has beneficial applications in mixed phase synthesis, materials chemistry, and biomedical uses. Other techniques advanced in the last decade in organic synthesis, with emphasis on toxic solvent minimization, are soluble polymers as catalysts, thermoregulated systems, and enzymes. All these techniques have been advanced with green chemistry principles in mind, since industrial production of chemical substances is the fundamental technology producing environmental problems, waste and toxic by-products.

IX. CONCLUSIONS

The challenges in resource and environmental sustainability require more efficient and benign scientific technologies for chemical processes and manufacture of products. Green chemistry addresses such challenges by opening a wide and multifaceted research scope thus allowing the invention of novel reactions that can maximize the desired products and minimize the waste and byproducts, as well as the design of new synthetic schemes that are inherently, environmentally, and ecologically benign. Therefore, combining the principles of the sustainability concept as broadly promoted by the green chemistry principles with established cost and performance standards will be the continual endeavour for economies for the chemical industry. It is, therefore, essential to direct research and development efforts towards a goal that will constitute a powerful tool for fostering sustainable innovation. Green chemistry alone cannot solve the pressing environmental concerns and impacts to our modern era, but applying the twelve principles of green chemistry into practice will eventually help to pave the way to a world where the grass is greener.

REFERENCES

- [1] P. T. Anastas, J.C. Warner, *Green Chemistry: Theory and Practice*: Oxford University Press: New York (1998).
- [2] J. H. Clark, *Green Chem*, 1(1), 1999, 1-8.
- [3] Leena Rao, *Resonance*, 12(8), 65–75; (10), 2007, 30–36.
- [4] G Nagendrappa, *Resonance*, 7(1), 64–76; (10), 59–68 ; (11), 2002 64–69.
- [5] K. Hill, *Pure Appl Chem* 72(7), 2000, 1255-1264.
- [6] J. M. DeSimone, *Science* 297, 2002, 799-803.

ENERGY CONSERVATION USING ENERGY AUDIT

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ABSTRACT

Continuous increase in the energy consumption cause huge gap between demand and supply day by day. Use of fossil fuel to fulfill this energy gap cause adverse effect on the environment. The energy auditing is the solution to reduce this gap of demand and energy and also adverse effect on the environment. An energy audit is a study of a facility to determine how and where energy is used and to identify methods for energy savings. In this paper energy conservation steps and methodology of energy audit is proposed.

Keywords: *Energy Audit, Energy Conservation Measures, Process*

I. INTRODUCTION

Energy is one of the most essential requirement for the human activities and economic development of any country. It is important for any nation to avoid energy wastage, leads to increase in nation revenue. To save Money on energy bills will be helpful in Business, industries and individuals customers, whose energy bills use up a large part of their income and it has a great impact on their economy. So it is very important to take a initiative to control the cost of energy by eliminating wastage of the energy. Energy auditing is a process which will be helpful to avoid energy wastage and assess the accurate of energy.

Energy Audit is considered as a process for checking the energy usage and wastage in buildings and industries. An energy audit consist of a detailed examination of a how facility uses energy

what the facility pays for that energy, and a finally, a recommended program for changes in operating practices or energy consuming equipment that will cost effectively saves bucks on energy bills. With new technology and alternative energy resources now available, this country could possibly reduce its energy consumption by 50%. As per the Energy Conservation Act 2001, "Energy Audit" is defined as the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption. So purposed study is an attempt to find out the energy audit methodology and its uses in various areas

II. TYPES OF ENERGY AUDITING

Energy audits can be carried out from hours to day and day to years . Energy audit depends upon the time and classified by following ways

- i. Walk Through survey Audit
- ii. Intermediate Audit
- iii. Detailed or overall energy Audit

2.1 Walk through Audit

This type of energy audit carries visual inspection of plant. During rapid walk survey main concentration is on the energy input, and finds the wastage of energy. All the Data collected in this survey can be used detailed audits. Usually this type of audit is carried out for hours to few days. As the time span required is short cost involve in auditing is also less. This approach identifies energy waste in a facility, determining how this waste can be eliminated at a reasonable cost with a suitable time frame.

2.2 Intermediate Audit

This kind of audit is conducted for detailed survey a. Main aim of this type of audit to find energy loses and analyze energy efficiency of system. This audit provides an overview of a general energy conservation measures (ECMs) .This type of audit is carried out for one week to many months, time span required is high so cost is high as compared to walk through audit.

2.3 Detailed or Overall Energy Audit

This type of audit is overall audit and detailed calculations, analyses and assumptions are carried out. Detailed survey of systems as well as subsystems of an building is done. Energy consumption of all systems is compared with targeted energy consumption. This audit also determines the consumption of electricity, steam, gases etc.

III. PROPOSED METHODOLOGY FOR ENERGY AUDIT

An approach for carrying energy audit is shown in the figure with few steps:

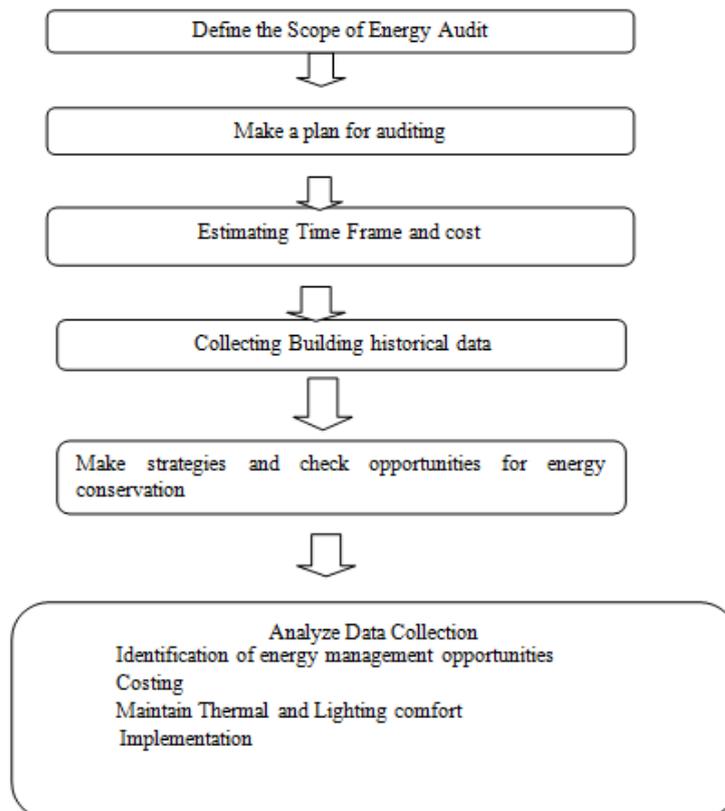


Fig.1. Energy Audit Methodology

Steps for Energy Conservation using energy audit:

- Visual inspection and data collection
- Observations on the general condition of the facility and equipment and quantification
- Identification / verification of energy consumption and other parameters by measurements
- Detailed calculations, analyses and assumptions.
- Validation
- Potential energy saving opportunities

IV. AREAS OF ENERGY CONSERVATIONS

4.1 Identify Energy Sources

First step to overcome the energy wastage is to identify the key areas which are responsible for energy wastage, whether they are in the form of electricity, gas, diesel oil, bio diesel fuel etc. Total energy cost of all inputs can subsequently be calculated in terms of a common unit i.e. **Rs / Mj**. Other related information should be checked and recorded, such as types of energy sources and tariff being used.

4.2 Energy Audit Programme

Energy Audit Programme is the next process for examining ways in which energy savings can be achieved, identifying all "energy management opportunities (EMO) and providing engineering and economic analysis for each EMO. Priorities can be established, based on expected economic returns, capital cost input; payback period and management preference, etc.

Energy Audit Programme should be reviewed at least annually and shall typically comprise the following topics:

4.3 Record Analysis

Analyze cost per unit of each kind of fuel consumed by the building. Compare the energy consumption with previous periods and other buildings with similar function. Review existing records and check whether additional information is required.

4.4 Environmental Conditions

To maintain the sustain success of the organization, industries its very important to provide and manage the suitable work environment. Analyze air-conditioning, heat, humidity, cleanliness, noise, vibration, pollution, lighting provisions and check whether the worker feel comfortable or not. Psychological work load pressure and stress also plays a very important role in work environment.

4.5 Maintenance

Analyze existing records, determine whether maintenance is adequate and consider how it can be improved. Its better to have a preventive maintenance i.e. the maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning and the effects limited.

4.6 Capital investment

Analyze energy related capital projects and investigate economic life of major equipment.

V. CONCLUSION

It is believed that Energy Audit is one of the most comprehensive methods in achieving energy savings in buildings and thus reducing excessive energy consumption. This paper helps in energy conservation through energy auditing programme. If the private sector participates in the implementation of the energy audit programmes to their buildings, wasteful consumption of energy will be minimize.

REFERENCES

- [1] Nissanga Nishad, Rasanajan Mendis, Nisal Perer, —Energy Audit: A Case Study International Conference on Information and Automation, 2006 , 45 – 50.
- [2] Case on Sustainable Energy Audit, <http://www.environmental auditing>
- [3] Instruction for energy auditor, Vol I & II U.S. Dept of Energy, Sept 1978
- [4] Zhao, Z. J. „Brief Discussion of Understanding about Energy Audit,” Energy Conservation and Environmental Protection, 1, 27-28.
- [5] Integrated Energy Policy Report of the Expert Committee Government of India, http://planningcommission.nic.in/reports/genrep/rep_intengy.pdf.

A COMPARISON BETWEEN WIRELESS TECHNOLOGIES

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ABSTRACT

This research paper deals with a vital and important issue in computer world. It is concerned with the wireless technologies that examine latest wireless technology Gi-Fi that have more advantages over earlier technologies. It represents three technologies; these technologies have advantages and disadvantages as well. Therefore, the main objective of this research paper is to represent different technologies and make a comparison between them to show the features and defects of each technology. Gi-Fi will help to push wireless communications to faster drive and more up-to-date standards for data exchange rate.

Keywords: *Bluetooth, CMOS, Gi-Fi, Wi-Fi, Wireless Technology.*

I INTRODUCTION

Wi-Fi (IEEE-802.11b) and Wi-Max (IEEE-802.16e) have captured our attention, as there are no recent developments in the above technologies which cannot transfer data and video information at a faster rate and led to the introduction of Gi-Fi technology. It offers some advantages over Wi-Fi a similar wireless technology, that offers faster information rate in Gbps less power consumption and low cost for short range transmissions.

Gi-Fi or Gigabit Wireless is the world's first transceiver integrated on a single chip in which a small antenna used and both transmitter- receiver are integrated on a single chip which is fabricated using the CMOS process. The new wireless technology is named as Gi-Fi and operates on the 60GHz frequency band, which is currently mostly unused. The Gi-Fi Chip developed by the Australian researcher's measures 5mm square and is manufactured using existing complementary metal-oxide-semiconductor (CMOS) technology, the same system that is currently used to print silicon chips.

The best part about this new technology is its cost effectiveness and power consumption, it consumes only 2watts of power for its operation with antenna(1mm) included and the development of Gi-Fi chip costs approximately\$10 (Rs380) to manufacture.

II LITRATURE REVIEW

2.1 Bluetooth

Bluetooth is an open wireless technology standard for exchanging data over short distances (using short wavelength radio transmissions) from fixed and mobile devices, creating personal area networks (PANs) with

high levels of security. Created by telecoms vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each) in the range 2402-2480 MHz This is in the globally unlicensed Industrial, Scientific and Medical 2.4 GHz short-range radio frequency band.

2.2 WI-FI

Wi-Fi technology builds on IEEE 802.11 standards. Wi-Fi allows the deployment of local area networks (LANs) without wires for client devices, typically reducing the costs of network deployment and expansion. Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANs. As of 2010 manufacturers are building wireless network adapters into most laptops. The price of chipsets for Wi-Fi continues to drop, making it an economical networking option included in even more devices. Wi-Fi has become widespread in corporate infrastructures. Products "Wi-Fi" designates a globally operative set of standards: unlike mobile phones, any standard Wi-Fi device will work anywhere in the world.

2.3 Comparison Between Bluetooth and WI-FI

The reason for pushing into Gi-Fi technology is because of slow rate, high power consumption, low range of frequency operations of earlier technologies i.e. Bluetooth and Wi-Fi, see the comparisons and features of those two technologies. From the TABLE I we can conclude that the bit rate of Bluetooth is 800Kbps and Wi-Fi has 11Mbps. Both are having power consumptions 5mw and 10mw. And lower frequency of operation 2.4GHz. For transferring large amount of videos, audios, data files take hours of time. So to have higher data transfer rate at lower power consumption we move onto Gi-Fi technology.

TABLE I

Comparison between Bluetooth and Wi-Fi

| Characteristics | Bluetooth | Wi-Fi |
|-------------------------|---|--|
| Frequency | 2.4 GHz | 2.4 GHz |
| Range | 10 meters | 100 meters |
| Primary application | WPAN: cable replacement | WLAN: Ethernet |
| Data transfer rate | 800Kbps | 11Mbps |
| Primary devices | Mobile phones, consumer electronics | Notebook computers, desktop computers, servers |
| Power consumption | Low | Medium |
| Primary uses | Travelling employees, office and industrial workers | Corporate campus users |
| Specification authority | Bluetooth SIG | IEEE, WECA |

2.4 What is Gi-Fi

Gi-Fi or gigabit wireless is the world's first transceiver integrated on a single chip that operates at 60GHz on the CMOS process. It will allow wireless transfer of audio and video data at up to 5 gigabits per second, ten times the current maximum wireless transfer rate, at one-tenth the cost. NICTA researchers have chosen to develop this technology in the 57-64GHz unlicensed frequency band as the millimetre wave range of the spectrum makes possible high component on-chip integration as well as allowing for the integration of very small high gain arrays. The available 7GHz of spectrum results in very high data rates, up to 5 gigabits per second to users within an indoor environment, usually within a range of 10 metres. It satisfies the standards of IEEE 802.15.3C.

A new silicon chip developed in Melbourne is predicted to revolutionize the way household gadgets like televisions, phones and DVD players talk to each other. The "Gi-Fi" was unveiled today at the Melbourne University-based laboratories of NICTA, the national information and communications technology research centre. Professor Skafiadass said his team was the first to demonstrate a working transceiver-on-a-chip that uses CMOS technology- the cheap, ubiquitous technique that prints silicon chips. This means his team is ahead and stood in front of the competition in terms of price and power demand. His chip uses only a tiny one-millimetre-wide antenna and less than two watts of power, and would cost less than \$10 to manufacture.

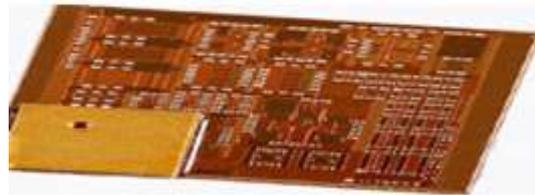


Fig.1: Transceiver Integrated on a Single Chip

2.5 Technologies used in GI-FI

This mmWave WPAN will operate in the new and clear band including 57-64 GHz unlicensed band defined by FCC 47 CFR 15.255. The millimetre wave WPAN will allow high coexistence (close physical spacing) with all other microwave systems in the 802.15 family of WPANs. Two Technologies that help realize GWLAN are

- Multiple Input Multiple Output (MIMO)
- System-On-a-Package(SOP)

2.5.1 Multiple Input Multiple Output

MIMO wireless is an emerging cost effective technology that offers substantial leverages in making 1Gbps wireless links a reality. MIMO wireless constitutes a technological breakthrough that will allow Gbps speeds in NLOS wireless networks. The performance improvements resulting from the use of MIMO systems are due to Array gain, Diversity gain, Spatial Multiplexing Gain, Interference Reduction.

2.5.2 System-On-A-Package

SOP approach for the next-generation wireless solution is a more feasible option. Recent development of materials and processes in packaging area makes it possible to bring the concept of SOP into the RF world to meet the stringent needs in wireless communication area. Wireless devices implementing complex functionality require a large amount of circuitry and consequently, require a large conventional package. SOP goes one step beyond Multi Chip Module (MCM) by enhancing overall performances and adding more functionalities.

2.5.3 Working Principle Used In Gi-Fi

In this we will use time division duplex for both transmission and receiving. Here data files are up converted from IF range to RF60 GHz range by using 2 mixers and we will feed this to a power amplifier, which feeds millimetre wave antenna. The incoming RF signal is first down converted to an IF signal centred at 5 GHz and then to normal data ranges. Here we will use heterodyne construction for this process to avoid leakages due to direct conversion and due to availability of 7 GHz spectrum the total data will be will be transferred within seconds. Time-Division Duplex (TDD) is the application of time-division multiplexing to separate outward and return signals. It emulates full duplex communication over a half duplex communication link. Time division duplex has a strong advantage in the case where the asymmetry of the uplink and downlink data speed is variable. As uplink traffic increases, more channel capacity can dynamically be allocated to that, and as it shrinks it can be taken away.

2.6 Fundamental Technologies in 802.15.3C

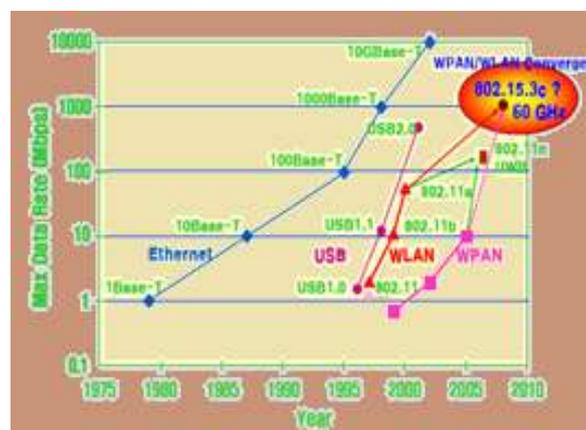


Fig.2: Graph Shows Maximum Data Rate (Mbps) Vs. Year

This mmWave WPAN will operate in the new and clear band including 57-64 GHz unlicensed band defined by FCC 47 CFR 15.255. The millimetre-wave WPAN will allow high coexistence (close physical spacing) with all other microwave systems in the 802.15 family of WPANs.

2.7. Frequency of Operation

2.7.1 Operation at 60 GHZ

Here we will use millimetre wave antenna which will operate at 60 GHz frequency which is unlined band. Because of this band we are achieving high data rates energy propagation in the 60 GHz band has unique characteristics that make possible many other benefits such as excellent immunity to co-channel interference, high security, and frequency re-use. Point-to-point wireless systems operating at 60 GHz have been used for many years for satellite-to-satellite communications. This is because of high oxygen absorption at 60 GHz (10-15 dB/Km).For this reason, 60GHz is an excellent choice for covert communication.

2.7.2 Ultra Wide Band Frequency Usage

UWB (Ultra-Wideband) is a technology with high bit rate, high security and faster data transmission. It is a zero carrier technique with low coverage area. So we have low power consumption. Ultra-Wideband is a technology for transmitting information spread over a large bandwidth (>500 MHz) that should, be able to share spectrum with other users. Regulatory settings of FCC are intended to provide an efficient use of scarce radio bandwidth while enabling both high data rate personal-area network (PAN) wireless connectivity and longer-range, low data rate applications as well as radar and imaging systems.

III FEATURES OF GI-FI

The features of Gi-Fi have been standardized with many objectives like:

3.1 High Speed Data Transfer

The main invention of Gi-Fi to provide higher bit rate .As the name itself indicates that data transfer rate is in Giga bits per second. Speed of Gi-Fi is 5Gbps, which is 10 times the present data transfer. Because of wider availability of continuous 7 GHz spectrum it results in high data rates.

3.2 Low Power Consumption

Though large amount of information transfer takes place it utilizes milli watts of power only. It consumes only 2mwatt power for data transfer of gigabits of information, whereas in present technologies it takes 10 watt power which is very high.

3.3 High Security

Point-to-point wireless systems operating at 60 GHz have been used for many years by the intelligence community for high security communications and by the military for satellite-to satellite communications. The combined effects of O2 absorption and narrow beam spread result in high security and low interference.

3.4 Cost-Effective

Gi-Fi is based on an open, international standard. Mass adoption of the standard, and the use of low-cost, mass-produced chipsets, will drive costs down dramatically, and the resultant integrated wireless transceiver chip which transfers data at high speed, low power at low price \$10 only which is very less As compare to present systems .As go on development the price will be decreased.

IV APPLICATIONS

There are many usage scenarios that can be addressed by Gi-Fi. The following are some applications of Gi-Fi:

4.1 GI-FI Access Devices

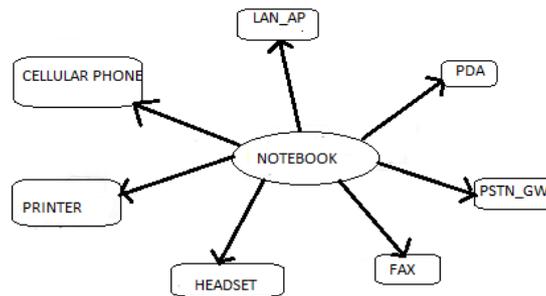


Fig.3: Gi-Fi Access Devices

Some of the Gi-Fi access devices are shown in Fig.3 .These access devices include termination units, internal radio modules, network interface cards ,printers, PC's,and all household electronic appliances.

4.2 Broadcasting and Video Signal Transmission System in Sports Stadium

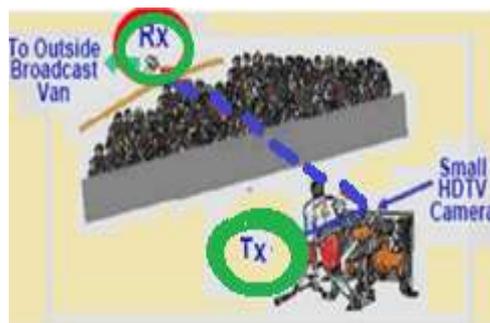


Fig.4: Broadcasting Video Signals

Easy and immediate construction of temporal broadband network such as in sports stadium for the advertisement of information distribution can be possible as shown in Fig.4.

4.3 Office Appliances

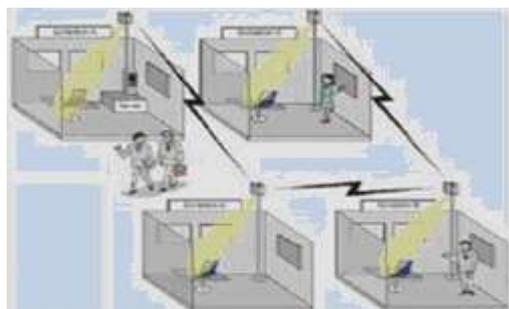


Fig.5: Office Appliances

As Gi-Fi data transfer rate is very high we can transfer data at very high speed in offices as shown in Fig.5 which made work very easy and it also provides high quality of information from the internet.

4.4 Video Information Transfer



Fig.6: Video Information Transfer

By using present technologies video swapping takes hours of time where as with this technology as shown in Fig.6 we can transfer data at a speed of giga bits/sec same as that for the transfer of information from a PC to a mobile and vice-versa. It can enable wireless monitors, the efficient transfer of data from digital camcorders, wireless printing of digital pictures from a camera without the need for an intervening personal computer and the transfer of files among cell phone handsets and other handheld devices like personal digital audio and video players.

4.5 House Hold Appliances

Consumers could typically download a high definition movie from a kiosk in a matter of seconds to music player or smart phone and having got home could play it on a home theatre system or store it on a home server for future viewing, again within a few seconds, high speed internet access, streaming content download (video on demand, HDTV, home theatre, etc.), real time streaming and wireless data bus for cable replacement. It makes the wireless home and office of the future.



Fig.7: Household's Appliances

V CONCLUSION AND FUTURE WORK

Within five years, we expect Gi-Fi to be the dominant technology for wireless networking. By that time it will be to provide services with low-cost, high broadband access and with very high speed large files swapped within seconds that are used in wireless home and office of future. If the success of Wi-Fi and the imminent wide usage

of WiMAX is any indication, Gi-Fi potentially can bring wireless broadband to the enterprise in an entirely new way.

As the range is limited to shorter distances only we can expect the broad band with same speed and low power consumption. As the integrated transceiver is extremely small, it can be embedded into devices. The breakthrough will mean the networking of office and home equipment without wires will finally become a reality. Due to the less cost of chip so many companies are coming forward to launch the integrated transceiver chip. The potential of mmWave range for ultra fast data exchange has prompted many companies like Intel, LG, Panasonic, Samsung, Sony & Toshiba to form wireless HD. Specifically wireless HD has a stated goal of enabling wireless connectivity for streaming high definition content between source devices and high definition devices.

REFERENCES

- [1] [JZ99a] J. Zyren, Reliability of IEEE 802.11 Hi Rate DSSS WLANs in a High Density Bluetooth Environment. Bluetooth '99, June 8, 1999.
- [2] [JZ99b] J. Zyren, Reliability of IEEE 802.11 WLANs in Presence of Bluetooth Radios. IEEE 802.15-99/073r0, September 1999.
- [3] J. N. Tsitsiklis, "Decentralized detection," in *Advances in Signal Processing*, H.V.Poor and J. B. Thomas, Eds. JAI Press, 1993, vol. 2, pp. 297–344.
- [4] R. R. Tenney and J. Sandell, N. R., "Detection with distributed sensors," *IEEE Transactions on Aerospace and Electronic Systems*, vol.17, pp. 501–510, Aug 1981.
- [5] J.-F. Chamberland and V. Veeravalli, "Asymptotic results for decentralized detection in power constrained wireless sensor networks," *IEEE Journal on Selected Areas in Communications*, vol. 22, no. 6, pp. 1007 – 1015, 2004.
- [6] William Stallings, "Wireless Communications and Networks" book 2nd edition, published by pearson edition, sgar91.files.wordpress.com.
- [7] International RF and Microwave Conference, Palm Garden Hotel, IOI Resort, Putrajaya; Sept.12-14th, 2006.
- [8] N. Sriskanthan, F. Tan and A. Karande, "Bluetooth based home automation system", *Microprocessors and Microsystems*, Vol. 26, no. 6, pp. 281-289, 2002.
- [9] M. Jakobsson and S. Wetzal, "Security Weaknesses in Bluetooth," *Topics in Cryptology, CT-RSA 2001: The Cryptographers' Track at RSA Conf. 2001*, San Francisco, CA, 8–12, Apr. 2001, LNCS, vol. 2020), SpringerVerlag, pp. 176–91.
- [10] K. Dogan, G. Gurel, A. K. Kamci and I. Korpeoglu, "A Performance Analysis of Bluetooth Broadcasting Scheme," *Springer Berlin Heidelberg*, Vol. 3992/2006, pp. 996-999, May 2006.
- [11] H. Bohn, A. Bobek and F. Golatowski, "Bluetooth Device Manager Connecting a Large Number of Resource-Constraint Devices in a Service-Oriented Bluetooth Network," *Lecture Notes in Computer Science*, vol. 3420/2005, pp. 430-437, Apr. 2005.

DESIGN OF SECURE DIGITAL HOST CONTROLLER CARD

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ABSTRACT

With the increasing consumer digital content, demand for high capacity digital storage is increasing rapidly. Today, portable storage media's are widely used in all mobile phones, digital Cameras, camcorders, and in many multimedia devices. Different memory formats like Flash, Secure Digital (SD), Compact Flash, Universal Serial Bus (USB), and Multimedia Card (MMC) are available in the market to store the digital contents. Of all these formats, SD provides many advantages over other formats. SD cards provide high storage capacity, higher transfer speed, and interoperability with Personal Computer (PC) related devices and multimedia products. Portable devices are battery operated, so they need to be power efficient. The goal of the Project is to design Secure Digital card which consumes low power and transfers data with greater speed.

Keywords: *Secure Digital, Host controller, ADMA, FIFO*

I. INTRODUCTION

The SDHC standard was developed by the Secure Digital Association (SDA) to address the requirement to support the growth in storage capacity of memory cards. The Secure Digital name was chosen because of the ability to protect copyright content through Digital Rights Management (DRM). SDHC cards are memory cards used to store files, music, pictures, video and any other data. It is defined by memory card specifications such as size, capacity, speed, security and power. It ensures interoperability among devices. SDHC cards are supported by many small electronic devices that use memory cards for storage. A regular SD card uses the first version of the standard, which limits its maximum storage capacity. SDHC cards, which use a later version of the standard, can store more data and may also support ultra high-speed data transfer rates that a regular SD card does not support. Secure digital is a non-volatile memory card format developed and managed by Secure Digital Association. SD Card is a semiconductor flash based memory device which is well known for its simple interface, high bandwidth, low cost, greater security, low power etc. The SD Card can easily be connected to a personal computer also. SD Host Controller implements the SD Host Controller standard specification version 3.0. It enables the host to access SD Devices such as SD Memory Cards, SDIO devices, SD Combo devices etc. The SD Protocol operates a Master-Slave communication model. It employs a command-response mechanism. Commands are always initiated by the Host Controller and responded to by the Card. The Host Controller has two interfaces: the System side interface and the SD Bus

interface. The Host Controller assumes that both these interfaces are asynchronous. The Host Driver is on system bus time and the SD Card is on SD Bus time.

II. ARCHITECTURE OF SD HOST CONTROLLER

The Host Controller provides a "programmed I/O" method for the Host Driver to transfer data using the Buffer Data Port register. Optionally, Host Controller implementers may support data transfer using DMA. The DMA algorithm defined in the SD Host Controller Standard Specification Version 1.00 is called SDMA (Single Operation DMA). Only one SD command transaction can be executed per SDMA operation. Support of SDMA can be checked by the SDMA Support in the Capabilities register. This specification defines a new DMA transfer algorithm called ADMA (Advanced DMA). A DMA provides data transfer between system memory and SD card without the interruption of CPU execution. Support of ADMA can be checked by the Capabilities register. When the term "DMA" is used in this document, it applies to both SDMA and ADMA. DMA shall support both single block and multiple-block transfers but does not support infinite transfers. Host Controller registers shall remain accessible for issuing non-DAT line commands during a DMA transfer execution.

The Host Driver can stop and restart a DMA operation by the control bits in the Block Gap Control register. By setting Stop at Block Gap Request, a DMA operation can be stopped at block gap. By setting Continue Request, DMA operation can be restarted. If an error occurs, DMA operation shall be stopped. To abort DMA transfer, Host driver shall reset the Host Controller by the Software Reset for DAT Line in the Software Reset register and issue CMD12 if multiple-block read / write command is executing.

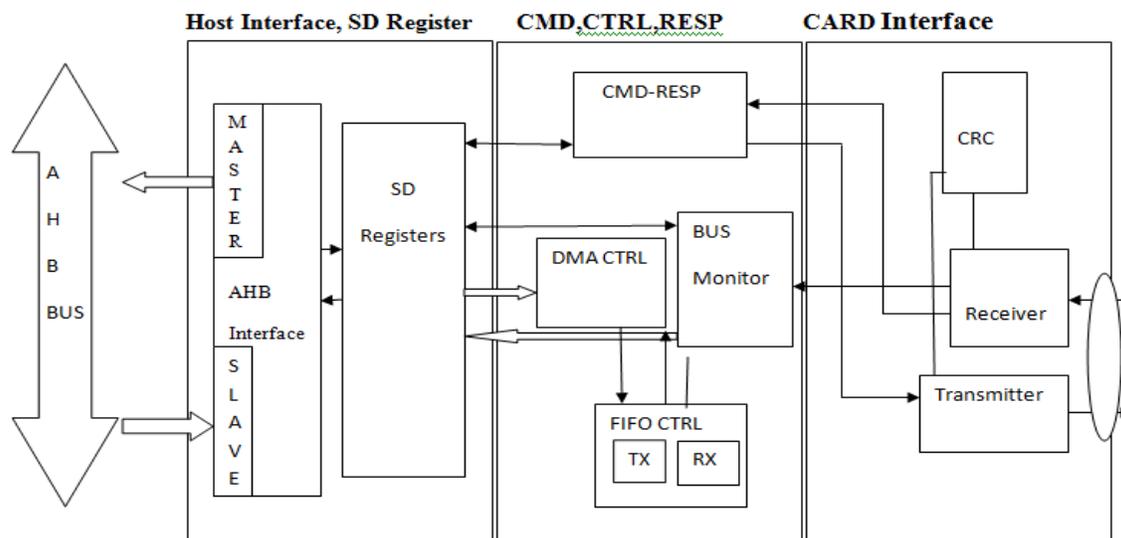


Fig 1: SD Host Controller Block Diagram

The design shown in Fig 1 is partitioned into following sections as

- Host Interface:

Host interface connects the AHB Master and Slave to AHB bus. In order to setup a command the host communicates with SD Register through slave interface. The SD controller Master interface is used for DMA Data to/from host memory.

- Controller:

The Command and Response block initiates Command to the card and receives response from the card and update SD registers. DMA Control block controls the DMA transfer to/from Host memory. The BUS Monitor looks for protocol violation and update SD status registers. FIFO (First-In First- Out) control manages the TX and RX FIFO's during transmission and reception and act as a flow control during read and write data transfers.

- Card Interface:

Card Interface consists of transmitter and receiver block that interacts with the physical Interface of the SD card. Command and Data uses CRC checker (CRC7 and CRC16).

The SDIO Host Controller is a Host Controller with an ARM processor interface. This product conforms to SD Host Controller Standard Specification Version 3.00. The Host Controller handles SDIO/SD Protocol at transmission level, packing data, adding cyclic redundancy check (CRC), Start/End bit, and checking for transaction format correctness. The Host Controller provides Programmed IO method and DMA data transfer method. In programmed IO method, the ARM processor transfers data using the Buffer Data Port Register.

Host controller support for DMA can be determined by checking the DMA support in the Capabilities register. DMA allows a peripheral to read or write memory without the intervention from the CPU. The Host Controller's AHB Host Controller system address register points to the first data address, and data is then accessed sequentially from that address.

AHB master and slave interface, enable devices to access the external memories. ADMA2 refers to the ability of an I/O device to transfer data directly to and from memory without the intervention of CPU. The Clock Manager block generates various clock frequencies for several modes of data transfer in the SD Host Controller. The initialization is carried out at 300 KHz. Interrupt generator enable only when interruption occurs during the transfer of data.

2.1 Module Description

The SDIO Host Controller consists of the following components:

- Host Registers
- Data FIFO
- CMD Control
- DAT Control
- Clock Management
- Power Management and Card Detection
- Synchronization Block

2.1.1 Data FIFO

There are two Data FIFOs:

- TX_FIFO—for buffering transmit data
- RX_FIFO—for receiving data

The TX_FIFO provides Buffer Write Enable flag to the Host Registers block. When the TX_FIFO is empty, Buffer Write Enable is asserted to indicate that the TX_FIFO is ready to accept the next block of data.

The RX_FIFO provides a Buffer Read Enable flag to the Host Registers block. When the RX_FIFO receives a block of data from the card. Buffer Read Enable is asserted to indicate the processor that data is ready for pickup.

2.1.2 Host Registers

The SD Host Controller is fully compliant to SD Host Controller Specification version 3.0 and Physical Layer Specification version 3.01. The standard register set is implemented. Internal FIFOs are provided for temporary buffering of ingress and egress data. The Host Processor accesses the various registers and FIFOs in the Host Controller to transfer data between Host and SD Card. Every data transfer is preceded by corresponding command and response. Command is send by the Host Controller to the Card and Response is send back by the Card to the Host Controller.

The Host Registers block consists of the following components:

- Standard SD/SDIO host register set
- Interrupt logic
- Auto CMD12 logic

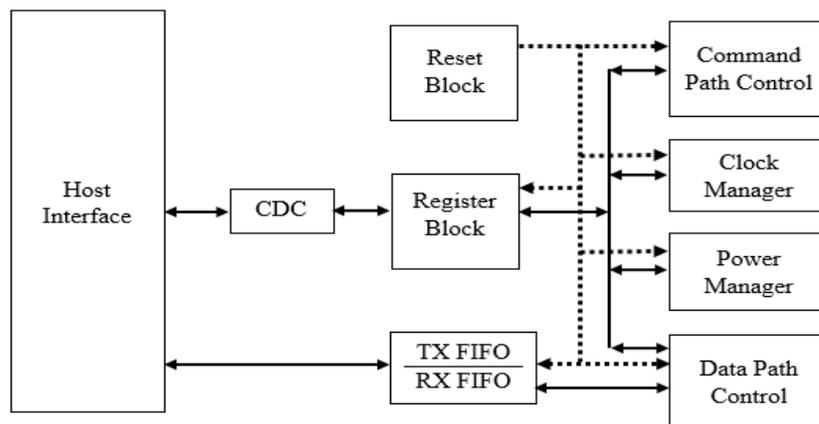


Fig 2: Block diagram of Host controller

2.1.3 Command Path Control

Command Path Control deals with the process of command transmission and response reception. All commands are 48 bits long with a 6 bit command index, 32-bit argument and a 7-bit CRC field. Each command is preceded by a start bit '0' and a transmission bit '1' and succeeded by an end bit '1'.

The Host Processor writes argument into the argument register and command into the command register in the Host Controller. Having received a command, the card checks for errors and replies with a response with the same index field. The transmission field will be '0' and the argument field will contain status of previous command. The command path control block checks the response for CRC or any other error and stores in the Response register.

2.1.4 Data Path Control

The data path control block manages the process of writing and reading data between Host and SD Card. Transmit and receive buffers help in temporary buffering. Data is accessed as a block, in an SD card. In SDSC cards, the block size is not fixed, but default size is 512 bytes. In SDHC and SDXC, the block size is fixed 512 bytes. Every data block is preceded by a start bit '0' and succeeded by 16-bit CRC and stop bit '1'.

For write and read, the SD Host Controller supports both single block and multiple block access. In single block read and write, only one block of data is transferred with each read or writes command. In multiple block access method, infinite number of blocks can be transferred by sending one command. For stopping a multiple block operation, a transmission stop command (CMD12) is sent by the Host Controller.

To perform a write operation, the data to be transferred is written to the Transmit FIFO through the Host Interface and data write command is issued. When the write command is sent by the Command Path Control block, the Data path control block sends the data along with CRC and end bit.

To perform a read operation, the read command is sent. After receiving the read command, if no error is found, the SD Card sends the requested data through the data lines. It will be checked for any errors and stored in the Receive FIFO. The Host Processor can read it through the Host Interface.

2.1.5 Clock Management

The Clock Management block is used to divide and enable/disable the SD clock. It consists of a Clock Divider and SD Clock Control Logic. The Clock Divider is a loadable counter. When a new value is written to the Clock Control register, the Host Register block loads the new value to the Clock Divider. Whenever the internal clock enable bit in the Clock Control register is set, the Clock Divider starts to count down from the loaded value to '0'. The SD Clock Control Logic controls SD clock toggling. When the Clock Divider reaches zero and SD clock enable bit in the Clock Control register is set, the SD clock toggles.

III ADVANCED DIRECT MEMORY ACCESS

In the SD Host Controller Standard Specification Version 3.00, new DMA transfer algorithm called ADMA (Advanced DMA) is defined. The DMA algorithm defined in the SD Host Controller Standard Specification Version 3.00 is called SDMA (Single Operation DMA). SDMA had disadvantage that DMA Interrupt generated at every

page boundary disturbs CPU to reprogram the new system address. This SDMA algorithm forms a performance bottleneck by interruption at every page boundary. ADMA adopts scatter gather DMA algorithm so that higher data transfer speed is available. The Host Driver can program a list of data transfers between system memory and SD card to the Descriptor Table before executing ADMA. It enables ADMA to operate without interrupting the Host Driver. Furthermore, ADMA can support not only 32-bit system memory addressing but also 64-bit system memory addressing. The 32-bit system memory addressing uses lower 32-bit field of 64-bit address registers. Support of SDMA and ADMA are optional for the Host Controller.

There are two types of ADMA; ADMA1 and ADMA2. ADMA1 can support data transfer of only 4KB aligned data in system memory. ADMA2 improves the restriction so that data of any location and any size can be transferred in system memory. The format of Descriptor Table is different between them. The Host Controller Specification Version 3.00 defines ADMA2 as standard ADMA and recommends supporting ADMA2 rather than ADMA1. "ADMA" is used in this document; it applies to both ADMA1 and ADMA2.

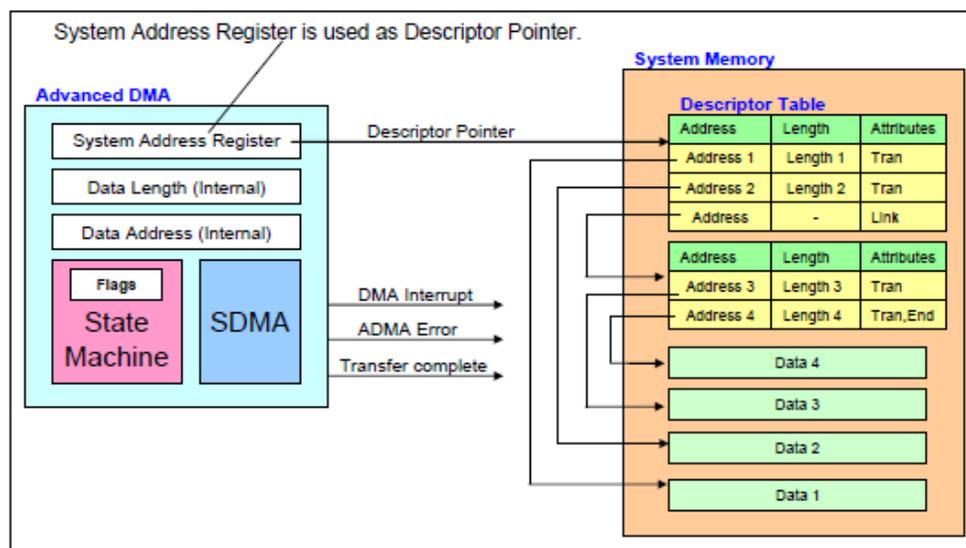


Fig 3: Block diagram of ADMA2

The Descriptor Table shown in Fig 3 is created in system memory by the Host Driver. A 32-bit Address Descriptor Table is used for the system with 32-bit addressing and 64-bit Address Descriptor Table is used for the system with 64-bit addressing. Each descriptor line (one executable unit) consists of address, length and attribute field. The attribute specifies operation of the descriptor line. ADMA2 includes SDMA, State Machine and Registers circuits. ADMA2 does not use 32-bit SDMA System Address Register (offset 0) but uses the 64-bit Advanced DMA System Address register for descriptor pointer. Writing Command register triggers off ADMA2 transfer. ADMA2 fetches one descriptor line and execute it.

3.1. ADMA2 States

Four states are defined; Fetch Descriptor state, Change Address state, Transfer Data state, and Stop ADMA state. The state operation of ADMA2 consists of four states as Fetch Descriptor state, Change Address state, Transfer Data state, Stop ADMA state and these four state description is shown below in Table1

| STATE NAME | OPERATION |
|------------------------------|--|
| ST_FDS (Fetch descriptor) | ADMA2 fetches a descriptor line and set Parameters in internal registers |
| ST_CADR (Change Address) | Link operation loads another descriptor address to ADMA system Address register |
| ST_TFR (Transfer data) | Data transfer of one descriptor line is executed between system memory and SD card. If data transfer continues go to ST_FDS state. If data transfer completes, go to ST_STOP state. |
| ST_STOP (Stop DMA) | ADMA2 stays in this state in following cases: <ul style="list-style-type: none"> • After power on reset or software reset • All descriptor data transfer are completed. If new ADMA2 operation is started by writing command register, go to ST_FDS state. |

Table 1: ADMA2 states

IV. SD HOST STANDARD REGISTER MAP

4.1. Summary of Register set

As per SD specification 3.0, registers are classified into 9 categories as shown below:

- SD Command Generation: Register to support Command Generation
- Response: Register to store Response from the Device
- Buffer Data Port: Registers to access Internal Data Buffer
- Host controls: Register to Store state of the Controller (status)
- Interrupt controls: Interrupt control Register (Masks, Enable, Status)
- Capabilities: Register for vendor specific capabilities of the controller
- Force Event: Software Interface registers to generate events

- ADMA: Advance DMA Control Register
- Common Area: Common Information Area (for multiple card support)

4.2. Host Registers

The Host Registers block consists of the following components:

- Standard SD/SDIO host register set
- Interrupt logic
- Auto CMD12 logic
- **Standard SD/SDIO Host Register set**

The standard SDIO host register consists of seven parts:

- SD command generation — parameters to generate SD commands
- Response — response value from the card
- Data port — data access port to the internal buffers
- Host controls — host mode control and status
- Interrupt controls — interrupt status and enables
- Capabilities — host controller capability information
- **CMD12 Logic**

CMD12 command is issued during multiple block transmission. To stopping a multiple block operation, a transmission stop command (CMD12) is sent by the Host Controller. If the Auto CMD12 Enable bit in the Transfer Mode register is set, then CMD12 command is issued automatically.

4.2.1. Types Of Host Register

Host registers are of 5 types as

- RO – Read Only Register

Register bits are of read-only type and it cannot be altered by any software or by reset operation.

- ROC – Read Only Status

Bits are initialized to zero at reset. Writes to these bits are not allowed.

- RW – Read Write Register

Register bits are read-write and can be set or cleared by software.

- RW1C – Write-1-to-clear

Register bits indicate status when read, a set bit indicating a status event may be cleared by writing a '1'. Writing a '0' to RW1C bits has no effect.

- RSVD – Reserved

Bit can be defined for future use and is currently set to '0'.

4.3. SD Card Operation Modes

To get the card to “boot” into SD mode the host has to pull the command line high for at least 74 clock cycles. The SD card has 10 predefined states, and the host operates in 3 modes.

| CARD STATE | OPERATION MODE |
|----------------------|--------------------------|
| Inactive State | Inactive |
| Idle State | Card Identification Mode |
| Ready State | |
| Identification State | |
| Stand- by State | Data Transfer mode |
| Transfer State | |
| Sending data state | |
| Receive- data state | |
| Programming State | |
| Disconnect state | |

Table 2. SD Card Operation Modes

In card identification mode, the host initializes the card, the goal of this state is to validate if the card and host are compatible. Also the host will know what kind of card it is communicating with SD, SDHC, SDIO or MMC card. The differences between the cards are in how they respond to the commands in the identification mode. All the communication in this mode is performed on the command line. At start of the identification process the card should first be reset, which is done by sending it a reset command. This is done to be sure that the card is in idle state. When the card is in idle state, then it is ready for receiving commands. In the next step the interface condition is validated. To validate the interface condition, the host sends its voltage operation range to the card. The card responds only if it is specification 3.0 compatible and if the voltage operation is valid for the card.

If no response is received the host realizes that it is either a 1.0 card or an operation condition mismatch, with an operation mismatch to be discovered with the next command in the chain. However, if a response is received the host knows that it is a 3.0 card and additional features can be enabled. A received response is validated with CRC check and bit matching. An invalid response will put the card to inactive state.

Next command specifies the operation condition to the card, this command has two purposes: the first is to specify the required operation voltage window; the second is to check if the card is busy. A card with an incompatible voltage window should discard itself from further bus operations and no response will be delivered. When a response of the operation condition is received it checks for a busy bit in the response data field. If the card is in busy state, the operation command is resent until the busy bit is cleared, then the host knows the card has finished its start-up operations.

4.4. Data Transfer Mode

After the identification mode the card will be in the idle state. To set the card to transfer state one additional command containing the response number is sent, card with matching response number will then be put in transfer state. Before transmitting data there are some settings that should be set, like the data width which can be set to 1 or 4 bit and the block length that can be set to a value between 1 and 2048?

➤ DATA WRITE

To write data to the card either a single block or a multiple blocks command can be used. First the command is sent, and a response is received. When the host has received the response, the data transfer can begin.

After a data transmission, the card replies with a 3-bit CRC status token, this always occurs 2 cycles after the end bit. "010" indicates a successful transfer (no CRC error). In case of CRC error the card response with "101" and no data will be written to the card. After a data write the card can become busy if its write buffer is full.

➤ DATA READ

The reading of data is performed in a similar manner. First a read block command is sent, the host should then be prepared that data can arrive at any moment. The card starts to send data after receiving a data read command

4.5. Multiple Block Operation

There are also one transfer mode where there is no need to issue a command for each block to be sent. Instead just the address of the first block is sent, and then the card transfer data until a special stop command is received.

V. SD BUS INTERFACE

SD Bus Interface is an advanced 9-pin bus is shown in Fig 4 consisting of one clock line, one bi-directional command line, 4 bi-directional data line and 3 power lines. The bus is designated to operate at a maximum operating frequency of 200MHz depending on the capabilities of the Card.

The Data transfers to and from the SD Memory Card are done in blocks. Data blocks are always succeeded by CRC bits. Single and Multiple block operations are defined. Data can be transferred using single or multiple data lines

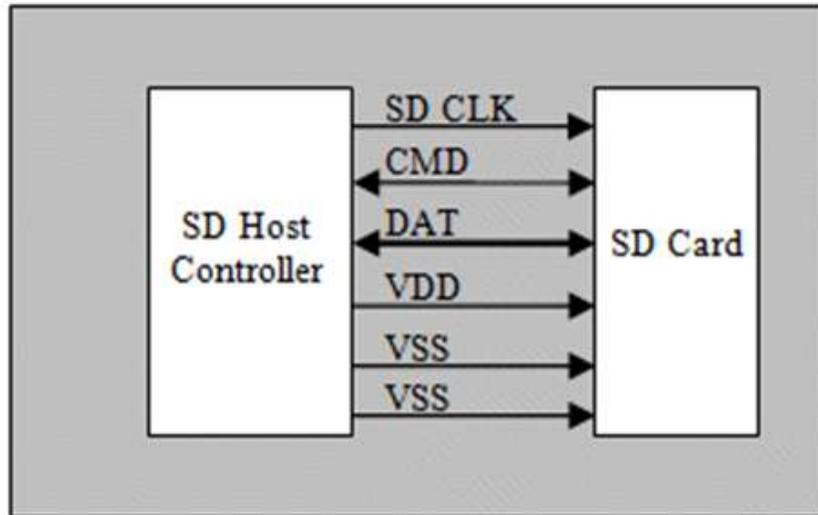


Fig 4: Interfacing of Bus

VI. SIMULATION RESULTS AND DISCUSSION

6.1 Output Waveform of Initial State (00)

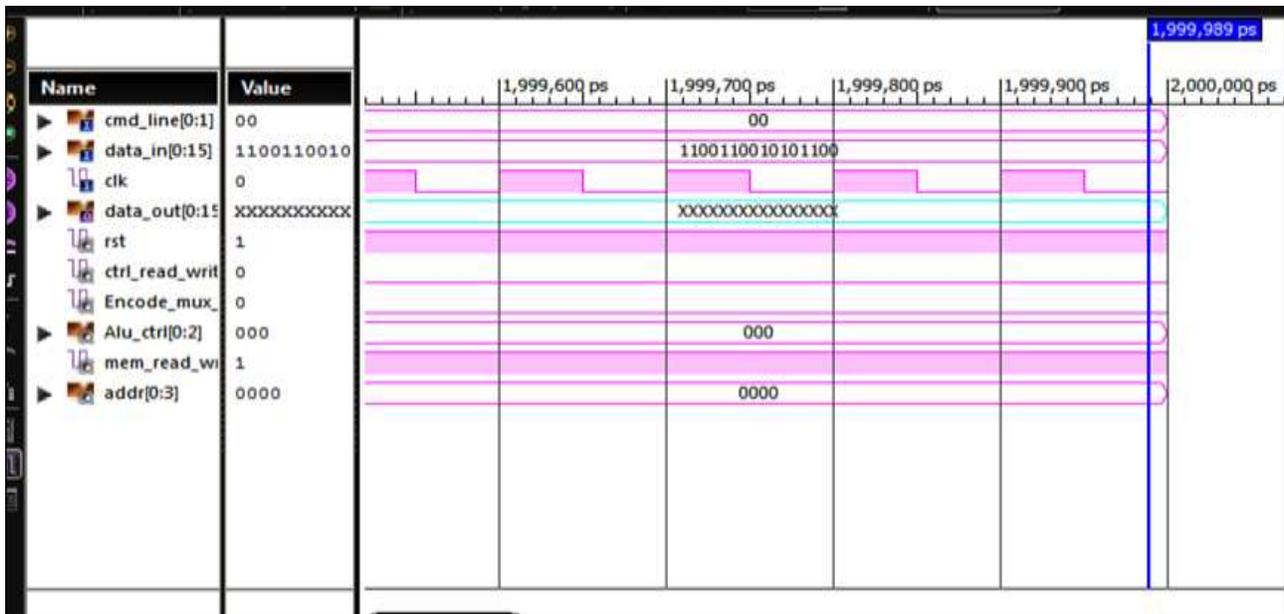


Fig 5: Waveform of the Initial State (00)

At this state, Data is received from the memory card and it is said to be in wait mode is shown in Figure 6.1. Here only reset operation is performed

6.2 Output Waveform of Next State (01)

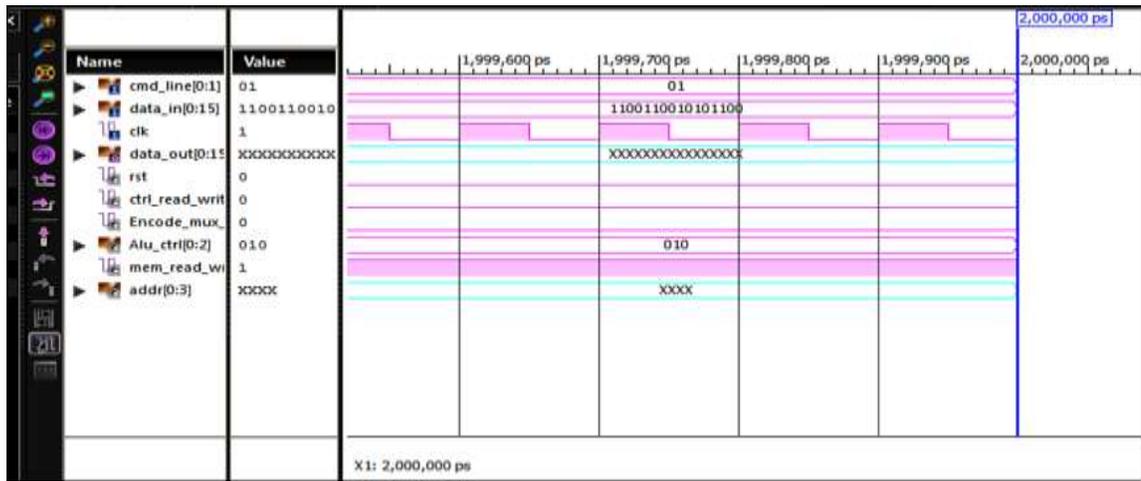


Fig 6: Waveform of the Next State (01)

As shown in Fig 6, When the command line input is changes to next state, only read operation is performed and the counter gets incremented.

6.3 Output Waveform of Next State (10)

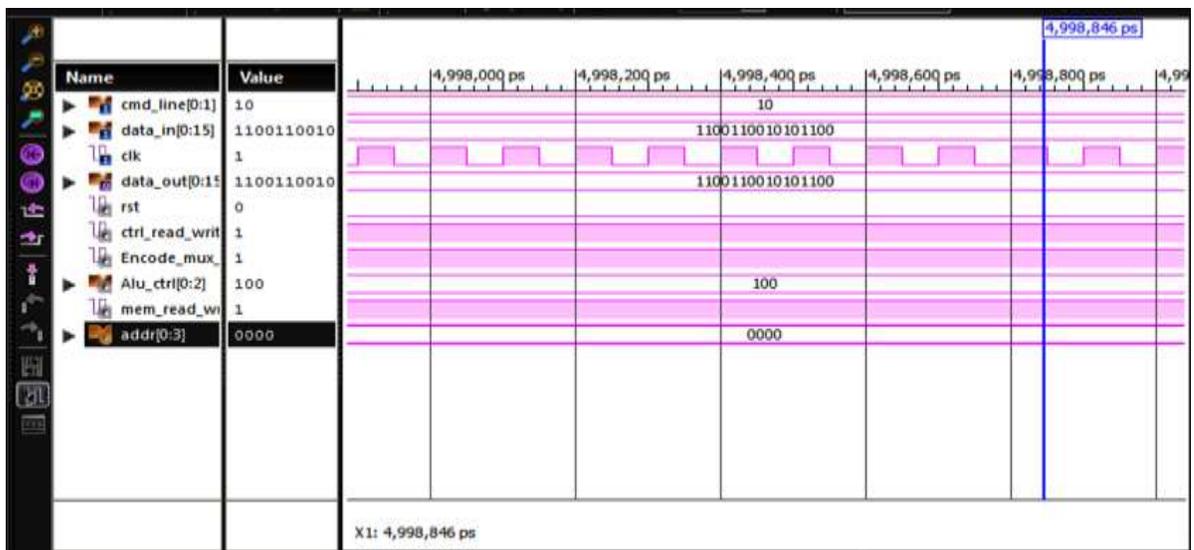


Fig 7: Waveform of the State (10)

When the command line input changes, the data which is read during previous state will be written from the host to the memory card and also counter gets incremented as shown in Fig 7.

6.4 Output Waveform of Next State (11)



Fig 8: Waveform of the State (11)

When a command line input is applied as 11, the result will not be reflected and it goes to high impedance (ie) undefined state is shown in Fig 8.

6.5 Output Waveform of All Four Combined States

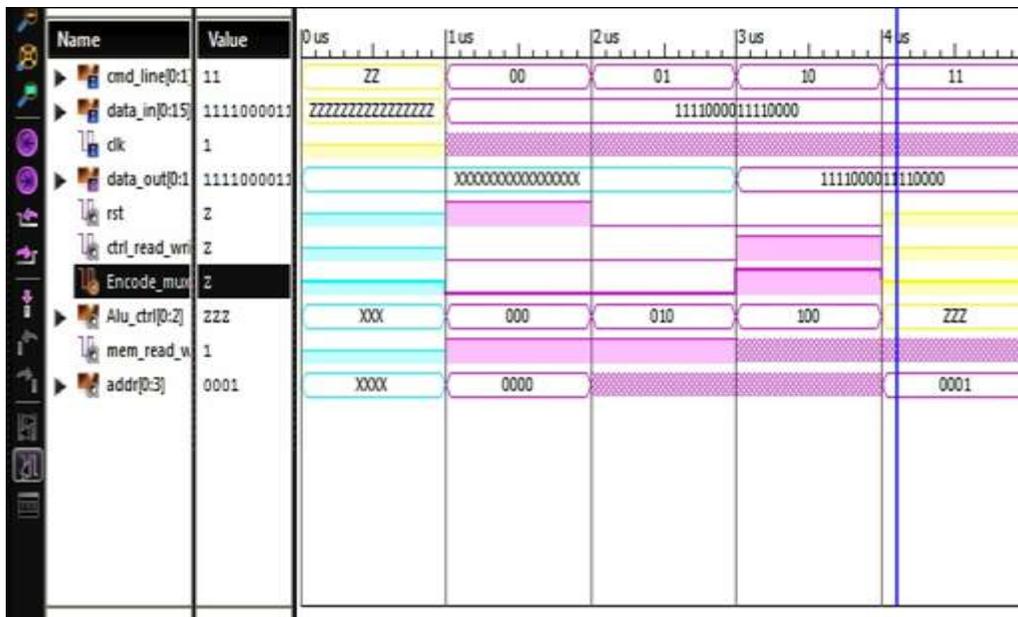


Fig 9: Waveform of FIFO Data Transfer

The Fig 9 shown above represents the data transfer in four different states. During initial state, no read or write operation is performed and in second state, the data is only read from the card to the host and in next state, the data

which is read in previous state will displayed and the last state is the undefined state and no operation will be performed.

VII. CONCLUSION

Thus, the operation and the features of Secure Digital card were studied. Finally, the data transfer is performed by using ADMA2 mode and test cases covering various scenarios are verified under simulation in Xilinx design suite 13.2 using verilog codings. Future Improvement is to design the Secure Digital Host controller card to compare the data transfer speed with the existing card and also to verify the functionalities of the design using system verilog.

REFERENCES

- [1] SD Specifications part A2 SD host Controller simplified- Specification, Technical Committee SD Association- 2013.
- [2] SD Specifications part 1 physical layer Simplified Specification, Technical committee SD Association- 2012.
- [3] SD Specifications part 1 Ultra high Speed(UHS) Interface Simplified addendum version 1.00, Technical Committee SD Association- 2011.
- [4] Jaikiranl, Prakash biswagar, "Functional Verification of Secure Digital Host Controller", International Journal of Electronics Signals and Systems (IJESS), ISSN: 2231- 5969, VOL-3, ISS-1, 2013.
- [5] Jose Simon, Deepu K. Krishnan, S. Krishnakumar Rao, Biju C. Oommen, R. Ravindrakumar, "Design and Implementation of SD Host Controller IP Core", July 2012.

IPV6 DEPLOYMENT - BENEFIT & OPPORTUNITIES IN INDIA WITH WORLD-WIDE EXPERIENCES

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ABSTRACT

The current standard protocol, IPV4, has reached its limit in terms of addressing possibilities, being limited by the 32-bits addressing scheme. Its successor, IPV6, had been devised since the mid 1990's. In addition to handling the address limitations, IPV6 also includes a number of improved features, making it superior to IPV4 in several aspects. However, its deployment has taken much longer than expected. This paper presents how the design IPV6 improved over IPV4, the additional benefits of the new design, and challenges faced for the deployment of IPV6. It then outlines the deployment strategies adopted by different countries. It finally discusses how India can benefit from the IPV6 deployment and what lessons it can draw from deployment experiences obtained elsewhere.

Keywords *Addressing Scheme, Deployment, IPV4, IPV6, Tunnelling.*

I. INTRODUCTION

IPV4 has been the standard protocol over the Internet for more than two decades. It has proven to be robust, easily implemented and interoperable and had stood the test of scaling an internetwork to a global utility of the size of today's internet [Davies, 2008]. However, in spite of this, IPV4 has serious addressing, routing and security limitations, that had been identified since the mid 90's [Melford, 1997]. Its use of 32-bits addresses is a major limitation in the number of devices that can have an IP address and is a major hurdle for end-to-end communication in ubiquitous computing and the exponential growth of devices that can connect to the Internet. Additionally, the classes A,B and C address allocation is inherently inefficient and besides addresses have been distributed in an inequitable way, resulting in a bias with more than 70% of the global IPV4 addresses belonging to organizations in the US from the early days [Hagen, 2004].

The next IP generation, IPV6, has been proposed since the mid 90's [Hiden, 1996] and has been quite widely deployed since. It has major technical advantages, such as a virtually inexhaustible number of IP address (5×10^{28} for each of the 6 billion persons in the world today). However, the deployment of has a price tag and the need and merit of its deployment has continuously been debated, resulting in a large number of organizations showing reluctance to completely change to IPV6. This explains why the globe is not fully IPV6 yet. There is the large base of IPV4 infrastructure that already exists and the large base of IPV4 applications that may need to be IPV6-enabled [Bouras, 2005]. Thus researchers have tried to address the limitations in number of addresses through alternative solutions such as CISR and NAT. While the alternative solutions fill the gap in the short term, IPV6 provides a more durable solution and the protocol goes beyond the addressing issue. It improves on

a number of existing features while also including additional features resulting in an improved efficiency and quality of communication.

With the many advantages, it provides IPV6 will open up opportunities that would either not be possible or would be inefficient under IPV4. India will need to seriously consider the shift to IPV6 in the near future, so as to be able to benefit of the multiple advantages and opportunities presented by IPV6. This paper presents the differences of IPV6 and IPv4, discusses the opportunities and challenges that its deployment presents for India. The rest of the paper is structured as follows: discusses how the design of IPV6 addresses, presents the deployment strategies adopted in different developed countries and policies of various level in India.

II. DIFFERENCES BETWEEN IPV4 AND IPV6

There are some major differences between IPv4 and IPv6 shows in table no 2.1

Table 2.1

| S.No. | IPv4 | IPv6 |
|-------|---|--|
| 1. | Source and destination addresses are 32 bits (4 bytes) in length. | Source and destination addresses are 128 bits (16 bytes) in length |
| 2. | IPSec support is optional. | IPSec support is required |
| 3. | No identification of packet flow for QoS handling by routers is present within the IPv4 header. | Packet flow identification for QoS handling by routers is included in the IPv6 header using the Flow Label field. |
| 4. | Fragmentation is done by both routers and the sending host. | Fragmentation is not done by routers, only by the sending host |
| 5. | Header includes a checksum. | Header does not include a checksum. |
| 6. | Header includes options. | All optional data is moved to IPv6 extension headers. |
| 7. | Address Resolution Protocol (ARP) uses broadcast ARP Request frames to resolve an IPv4 address to a link layer address. | ARP Request frames are replaced with multicast Neighbour Solicitation messages. |
| 8. | Internet Group Management Protocol (IGMP) is used to manage local subnet group membership. | IGMP is replaced with Multicast Listener Discovery (MLD) messages. |
| 9. | ICMP Router Discovery is used to determine the IPv4 address of the best default gateway and is optional. | ICMP Router Discovery is replaced with ICMPv6 Router Solicitation and Router Advertisement messages and is required. |
| 10. | Broadcast addresses are used to send traffic to all nodes on a subnet. | There are no IPv6 broadcast addresses. Instead, a link-local scope all-nodes multicast address is used. |
| 11. | Must be configured either manually or through DHCP | Does not require manual configuration or DHCP. |
| 12. | Uses pointer (PTR) resource records in the | Uses pointer (PTR) resource records in the |

| | | |
|--|--|--|
| | IN-ADDR.ARPA DNS domain to map IPv4 addresses to host names. | IP6.ARPA DNS domain to map IPv6 addresses to host names. |
|--|--|--|

III. CHALLENGES FOR IPV6 DEPLOYMENT

In this paper IP Next Generation overview (Hinden, 1996), R Hinden argued that IPng or IPv6 would be a necessity with the proliferation of nomadic personal computing devices. He argued that the nature of nomadic computing requires an Internet protocol with built in authentication and confidentiality, thus being a major catalyst for IPv6. He also proposed that the different TV channels and Video on Demand would be another major driving force for IPv6. Another idea put forward by him is device control, where different everyday life devices will be controlled via the Internet. He also predicted that there would need to be a major shift towards the new IP in the 1999's to 2003's. The same report reveals that only 0.12 % of IPV6 native traffic flowed in the Amsterdam Internet Exchange. These numbers seem very small. However, the IPV4 address space is expected to be exhausted in 2012 (CXOtoday, 2009; Eustace, 2009) and the need for IPv6 will become imminent. In the following sections, we discuss some of the reasons why IPv6 has had such a slow start and adoption given the initial predictions and also the challenges involved for the deployment of IPv6. Then the costs involved for deploying IPv6 and solutions are also discussed.

IPv4 will be used for years even after IPv6 has been deployed. IPv6 and IPv4 are two different protocols, where resources available over IPv6 are not reachable from an IPv4 node and vice versa. But, the layers in the Internet Architecture are independent of each other, thus enabling both IPv4 and IPv6 transmission to run in parallel, on the same network. Therefore, the transition mechanism requires that IPv4 and IPv6 hosts are able to interoperate. The IPv6 deployment between hosts and routers need to be done incrementally, with few interdependencies and low start-up cost. Finally, it should be easy for system users, network operators and administrators to address [Bradner & Mankin, 1995]. Moreover, the IPv6 has been present for many years, but there has been a poor growth in its deployment across the Internet [Eustace, 2009]. The objective of IPv6 was to have most computers and networks working on a dual-stack by this time, until IPv6 gradually takes over. Dual-stack enables both IPv4 and IPv6 to coexist, where servers and clients will speak both protocols and application or service can use either protocol to communicate.

During the transition, the organization should expect that most systems software will need to be upgraded. Hardware which have only IPv4 implementations should be considered for replacement and before buying any new hardware, the organization should ensure that the new hardware provides for IPv6 support. There are different strategies to transition to IPv6. The easiest migration process can be through an upgrade of the whole network, Operating Systems and Application. This will provide all the good features of IPv6, but it is expensive. The next choice is to have an incremental deployment, which in addition to the good features of IPv6, it allows lower cost and risk management. Finally, one can wait for the last minute to deploy, and not benefit from the IPv6 features. The consequence will be loss of market shares and lagging behind the market trend.

IPv6 deployment encounters many challenges. One of the biggest hurdle to move to IPv6 is the business need [Botterman, 2009]. The issue is that if customers do not require IPv6, there is no ability for providers to charge for IPv6. Consequently, there is no extra money for investing in new hardware and software. For an organization to build a short term IPv6 business case does not make sense. Nevertheless, not having any

customer demand is not a fundamental problem, since deployment of IPv6 will happen anyway. The customer needs are more towards contents and services, such as Google, Skype and many more, and they are not interested in the protocol being used and IPv6 do not provide such new services. Developing countries which are now deploying IPv6 will have an advantage since new IPv6 capable hardware will be used instead of investing in any hardware upgrade.

The next IPv6 deployment gap is that considerations for porting software applications and services are not expanding fast enough. The alternative is to centralize the applications and use IPv6 tunneling to connect with IPv6 hosts and routers over existing IPv4 Internet. The applications do not provide IPv6 support in software Infrastructure, for example, the 3G IP Multimedia Subsystems (IMS) are limited in deploying IPv6 on Fixed Mobile Convergence between Wireless and Broadband. Enterprise Resource Applications (e.g SAP, Oracle, DB2, Finite Element Analysis) and Media Entertainment Applications, such as Gaming, Virtual Life, Content Distribution, Peer-to-peer File Sharing are also taking a long time to be ported on IPv6 [Bound, 2007]. Another important requirement while deploying IPv6 is the Security Infrastructure and many organizations are already using IPv4 security software infrastructure for Intrusion Detection, Network Edge Packet Filters and Custom Firewalls. These security software still requires to be adapted to IPv6. Even full featured Network Management platforms that are used to manage IPV4 network elements and processes need to be upgraded to support IPv6.

Many organizations are also not interested in transitioning to IPv6 because their customers and employees cannot use IPv6. The compelling immediate action within the IPv6 deployment process is to have IPv6 supported 'small gateways' for private homes. Thus, allowing larger IPv6 deployment possibilities.

According to the IPv6 Deployment Survey commissioned by the European Commission, cost is one of the major barrier to deploy IPv6 [Botterman, 2009]. Normally, when deploying a network Infrastructure, network, security, Human Resource Training, Contents Management and Administrative cost are considered. But, in general when considering deploying an IPv6 Infrastructure mainly the 'cost' of Training, Network Upgrade and Dual Stack operation is being foreseen.

Training cost, is probably the highest among the costs. Even though, IPv6 is not 'so different' compared with IPv4, the hurdle is that staffs do not have enough knowledge and experience with IPv6. Thus, training in IPv6 is perceived to be expensive. However, many organizations have recurrent training for many other new technologies and protocols and, if well-planned, the cost for providing IPv6 training should not be considered as high.

The cost of IPv6 deployment depends on many factors. In order to minimize costs while moving to IPv6, organizations have to carefully choose when to start IPv6 deployment [6DISS, 2007]. The size of the network, current hardware and software being used and how soon the network should be IPv6 ready are other components that need considerations while deploying IPv6. But, the key for transitioning for a new protocol, technology and services or IPv6 is planning ahead and that helps to minimize costs.

Organizations often do not consider the cost for not deploying IPv6 and those cost are hidden and difficult to realize. Many studies already demonstrated that operating a network with NAT means extra complexity and cost [Christman, 2005; The TCP Guide, 2005; Huston, 2009; IEEE-USA, 2009]. VoIP, triple play, end-to-end security, peer-to-peer, on-line gaming, and many other new applications cost even higher to be deployed on IPv4, since they do not operate easily through NAT and require co operation of NAT vendors [IEEE-USA, 2009]. It is also more expensive for developing applications to traverse NAT and work across different network

scenarios [Huston, 2009]. Moreover, most security precautions were ignored in IPv4 and NAT complicates deployment for secure applications [Christman, 2005].

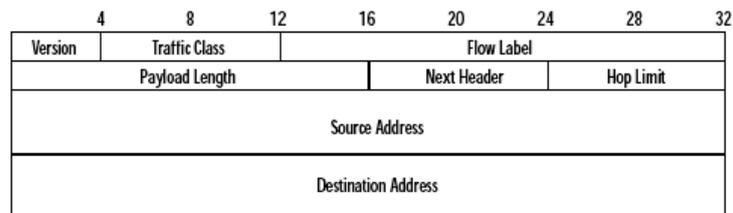
IV. BENEFITS OF IPV6

IPv6 improves on the addressing capacities of IPv4 by using 128 bits for addressing instead of 32, thereby making available an almost infinite pool of IP addresses. Also IPv6 is supposed to be providing various enhancements with respect to security, routing, address auto configuration, mobility & QOS etc.

The following are the important features of IPv6 protocol, which may play an important role in the growth of Internet in the country due to its advance capabilities.

4.1 New Header Format

The IPv6 header has a new format that is designed to keep header overhead to a minimum. The streamlined IPv6 header is more efficiently processed at intermediate routers with lower processing costs.



Figures No. 4.1.1

In the Fig.4.1.1, The first 64 bits of the packet include only 6 parameters. They are:

- Version Field (4 bits)
- Traffic Class (8 bits)
- Flow Label (24 bits)
- Length of the Payload (16 bits)
- Type of Next Header (8 bits)
- Hop Limit (8 bits)

The IPv6 header is composed of a 64 bit header, followed by the source and destination IP addresses (each 128 bits long)

4.2 Large Address Space

IPv6 has 128 bits (16 bytes) source and destination IP addresses. This will enable to accommodate 2¹²⁸ hosts. Even though only a small number of IPv6 addresses are currently allocated for use by hosts, there are plenty of addresses available for future use.

Jumbogram-IPv4 limits packets to 65535 (2¹⁶-1) octets of payload. An IPv6 node can optionally handle packets over this limit; it can be as large as 4294967295 (2³²-1) octets. The use of jumbogram is indicated by the Jumbo Payload Option header.

4.3 Efficient and Hierarchical Addressing and Routing Infrastructure

IPv6 global addresses used on the IPv6 portion of the Internet are designed to create an efficient, hierarchical, and submersible routing infrastructure that is based on the common occurrence of levels of Internet service providers.

4.4 Stateless and Stateful Address Configuration

IPv6 supports both stateful address configuration, such as address configuration in the presence of a DHCP server, and stateless address configuration (address configuration in the absence of a DHCP server). With stateless address configuration, hosts on a link automatically configure themselves with IPv6 addresses for the link (called link-local addresses) and with addresses derived from prefixes advertised by local routers. Even in the absence of a router, hosts on the same link can automatically configure themselves with link-local addresses and communicate without manual configuration.

4.5 Built-in Security

Support for IPSec is an IPv6 protocol suite requirement. This requirement provides a standards-based solution for network security needs and promotes interoperability between different IPv6 implementations.

4.5.1 Data Confidentiality

The IPSec sender can encrypt packets before sending them across a network'

4.5.2 Data Integrity

The IPSec receiver can authenticate packets sent by the IPSec sender to ensure that the data has not been altered during transmission.

4.5.3 Data Origin Authentication

The IPSec receiver can authenticate the source of the IPSec packets sent. This service is dependent upon the data integrity service.

4.5.4 Anti-Replay

The IPSec receiver can detect and reject replayed packets.

4.6 Support for QOS

New fields in the IPv6 header define how traffic is handled and identified. Traffic identification using a Flow Label field in the IPv6 header allows IPv6 routers to identify and provide special handling for packets belonging to particular packet flow between source and destination. Support for QOS can be achieved even when the packet payload is encrypted through IPSec.

V. TRANSITION MECHANISMS FOR IPV6

To coexist with an IPv4 infrastructure and to provide an eventual transition to an IPv6-only infrastructure, generally following mechanisms are used:

- Dual IP layer
- IPv6 over IPv4 tunnelling
- DNS infrastructure

5.1 Dual IP Layer

The dual IP layer is an implementation of the TCP/IP suite of protocols that includes both an IPv4 Internet layer and an IPv6 Internet layer. This is the mechanism used by IPv6/IPv4 nodes so that communication with both IPv4 and IPv6 nodes can occur. A dual IP layer contains a single implementation of Host-to-Host layer protocols such as TCP and UDP. All upper layer protocols in a dual IP layer implementation can communicate over IPv4, IPv6, or IPv6 tunnelled in IPv4.

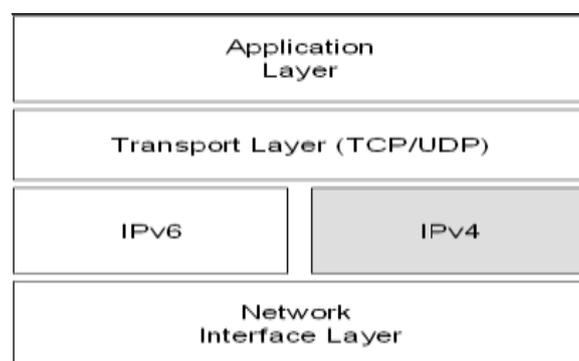


Figure No. 5.1.1

5.2 IPv6 over IPv4 Tunnelling

IPv6 over IPv4 tunnelling is the encapsulation of IPv6 packets with an IPv4 header so that IPv6 packets can be sent over an IPv4 infrastructure. Within the IPv4 header:

- The IPv4 Protocol field is set to 41 to indicate an encapsulated IPv6 packet.
- The Source and Destination fields are set to IPv4 addresses of the tunnel endpoints. The tunnel endpoints are either manually configured as part of the tunnel interface or are automatically derived from the sending interface, the next-hop address of the matching route, or the source and destination IPv6 addresses in the IPv6 header.

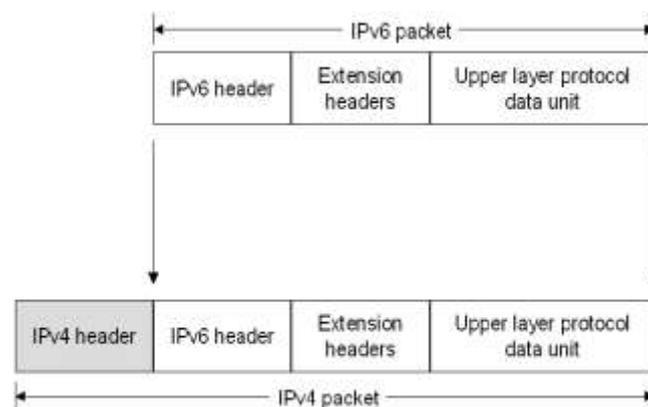


Figure No. 5.2.1

For IPv6 over IPv4 tunnelling, the IPv6 path maximum transmission unit (MTU) for the destination is typically 20 less than the IPv4 path MTU for the destination. However, if the IPv4 path MTU is not stored for each

tunnel, there are instances where the IPv4 packet will need to be fragmented at an intermediate IPv4 router. In this case, IPv6 over IPv4 tunnelled packet must be sent with the Don't Fragment flag in the IPv4 header set to 0.

5.3 DNS Infrastructure

A Domain Name System (DNS) infrastructure is needed for successful coexistence of IPv6 and IPv4 because of the prevalent use of names (rather than addresses) to refer to network resources. Upgrading the DNS infrastructure consists of populating the DNS servers with records to support IPv6 name-to-address and address-to-name resolutions. After the addresses are obtained using a DNS name query, the sending node must select which addresses are to be used for communication.

VI. DEPLOYMENT STRATEGIES/POLICIES IN INDIA AND WORLD-WIDE

6.1 National Policies [TRAI- August 2005]

6.1.1 Relevant Existing Government Policies

- The Ten Point Agenda declared by Hon'ble Minister of Communications and Information Technology on 26.05.2004 includes IPv6 as following:
- **“Migration to New Internet Protocol IPv6:** *Worldwide the new IPv6 is being implemented on the Internet to accommodate increased number of users and take care of security concerns. It would be my endeavour to bring about migration to IPv6 in India by 2006.”*
- In the Broadband Policy 2004, Government has envisaged Broadband and Internet subscribers of 20 million and 40 million by 2010 respectively through various Internet and Broadband Technologies.
- Broadband policy has also defined Broadband as an “always-on data connection” that is able to support various interactive services. In order to be truly interactive, each Broadband connection may require a permanent IP address assigned to end-user.
- In order to fulfil these government policies/ objectives, India's Internet and Broadband Infrastructure should be globally competitive, secured and affordable. The present generation Internet (IPv4) may not be enough to help in achieving these objectives.

6.1.2 IPv6 Implementation Group

Department of IT commissioned several projects to facilitate the efforts of stakeholders regarding the adoption of IPv6, in creating test beds and supporting R&D activities. In addition an inter agency IPv6 Program Implementation Group (IPIG) was constituted to track and review the IPv6 implementation from time to time. Senior officers from DIT, NSC, TRAI, DRDO, ISPAI, COAI, academic institutions etc. are the members of IPIG.

6.1.2.1 Institutional Activities

Some of the Universities/ R&D institutions have been studying the technical aspects of IPv6 in India. IPv6 forum of India is organizing workshops involving the industry, ISPs, academic and research institutions to bring awareness among stakeholders. BITS Pilani is the first institution in India to connect to 6Bone (IPv6 international test bed network) and is developing IPv6 native support products. Similarly, ERNET of DIT in association with IIT Kanpur has taken up a project of setting up of IPv6 test bed at few locations in the country.

6.1.2.2 Industry Efforts

It is understood that ISPAI is motivating the member ISPs to start obtaining IPv6 address space from Asia-Pacific Network Information Centre (APNIC) and some of the ISPs have already obtained the addresses. Few ISPs are experimenting with IPv6 tunnelling over IPv4 by exchange of experimental packets to get a feel of the capabilities of IPv6. Some ISPs are getting their router software upgraded to IPv6 to make their network IPv6 compliant.

6.2 International Policies

Many countries around the globe like Japan, Korea, China, European Union, USA have set up national IPv6 networks to enable the network operators and software developers to get a hands-on feel of this technology. Some of the important ones are described below:

6.2.1 Europe

The European Commission (EC) initiated an IPv6 Task Force in April 2001 to design an "IPv6 Roadmap 2005" and delivered its recommendations in January 2002, which were endorsed by the EC. A phase II IPv6 Deployment Task Force was enacted in Sep, 2002 with a dual mandate of initiating country/regional IPv6 Task Forces across the European states and seeking global cooperation around the world.

6.2.2 Japan

Japan took political leadership in the design of a roadmap for IPv6 in the fall of 2000 in a policy speech by Prime Minister. The Japanese government mandated the incorporation of IPv6 and set a deadline of 2005 to upgrade existing systems in every business and public sector. Japan sees IPv6 as one of the ways of helping them leverage the Internet to rejuvenate the Japanese economy. The IPv6 Promotion Council was created to address, in a comprehensive way, all issues related to the deployment and rollout of IPv6. In 2002–2003, the Japanese government created a tax credit program that exempted the purchase of IPv6-capable routers from corporate and property taxes.

6.2.3 South Korea

In 2001, the South Korean Ministry of Information and Communication announced its intention to implement IPv6 within the country. In September 2003, the Ministry adopted an IPv6 Promotion Plan with commitment for funding IPv6 routers, digital home services, applications, and other activities.

6.2.4 China

In December 2003, the Chinese government issued licenses and allocated budget for the construction of the China Next Generation Internet (CGNI). The goal is to have that network fully operational by the end of 2005. China and Japan have declared jointly in the 7th Japan-China regular bilateral consultation toward further promotion of Japan-China cooperation that IPv6 is an important matter in the area of info-communications field.

VII. OPPORTUNITIES AND CHALLENGES FOR INDIA

As other countries in the world are planning their IPV6 deployment, India will need to do the same so as to overcome the exhaustion of IPV4 addresses and also to benefit of the many advantages of IPV6. The deployment of IPV6 will improve the internet support for organizations as well as individuals in terms of the

number of devices that can directly access internet services, the security of transactions, the improved quality of applications and the wider range of applications possible due to the integrated support for mobility. The deployment of IPV6 will improve organizations' abilities to offer services with real-time requirements such as live broadcasts on all kinds of personal computing devices, improved video surveillances and remote processing of complex applications.

The India software industry can also obtain direct economic opportunities from the worldwide deployment of IPV6. The software industry can participate in converting the massive amount of IPV4 applications that will need to be ported to IPV6 network. In addition to simply porting the applications, they can be further improved to benefit from the additional security and QoS support of IPV6. Additionally IPV6 presents important opportunities in terms of new kinds of secure and QoS-based applications for portable devices. The Mauritian software industry can seize the opportunity to obtain its market share from these classes of applications.

To deploy IPV6, ISPs will have to provide the required support in the network backbones of the country. Each organization of the country will then need to come up with its own strategy of transition.

VIII. CONCLUSION

In this paper, we presented the different problems associated with the IPV4. These problems include exhaustion of address space. We then proposed how IPV6 addressed many of the issues of IPV4 and also improves on the older protocol. We discussed about opportunities provided by IPV6 like enhanced security and Flow Label to implement QoS for different types of traffic. We then discussed on the hurdles encountered in IPV6 deployment, among which are technological, financial and human capacity issues. We also discuss why IPV6 has not spread according to the initial predictions, when it was being proposed. We also analyze the IPV6 deployment status around the world, noting that IPV6 accounts for limited Internet traffic. We also propose that IPV6 provides a unique opportunity for African countries, since most of these countries are not tied up with legacy hardware and technology and can invest in IPV6 ready equipment from the beginning. India IT industry is booming nowadays and IPV6 deployment can contribute to a large extent to the industry. New applications, involving mobility or that can make us of specific features of IPV6 can be developed.

REFERENCES

Books:

- [1] Computer Networks , *Andrew S. Tanenbaun.*
- [2] Computer Network & Communication, *V.K. jain & Naveena Bajaj*
- [3] Computer Networks- Protocols, Standerds, Interfaces , *Uyless Black.*
- [4] Data Communication & Networking, *Behrouz A Forouzan.*
- [5] TCP?IP Protocol Suit, *Behrouz A Forouzan*

Journal Paper & Web Links:

- [6] 6DISS (IPv6 Dissemination and Exploitation) (2007). IPv6 Deployment and Associated Risks (for Strategists). Retrieved on 15th December 2009 from <http://www.6diss.org/>
- [7] Baker, F. (2009). IPv4/IPv6 Coexistence and Transition. IEFT Journal 4 (3).
- [8] Bound J (2002), Dual Stack Transition Mechanism. Retrieved on 10th December 2009 from
- [9] Bound, J. (2001). Internet Society: IPv6 Deployment.

- [10] Bound, J. (2007). The New New Internet: IPv6 Conference, Hyatt Regency Crystal City, May 10, 2007, "IPv6 Deployment Gaps to be Completed".
- [11] Childress, B., Cathey, B., and Dixon, S. 2003. The Adoption of IPv6. *J. Comput. Small Coll.* 18, 4 (Apr. 2003), 153-158.
- [12] Christman, C. (2005). The move on to IPv6: If you've not done so already, it's time to get ready for the next generation of IP. Retrieved on 15th December 2009 from <http://features.techworld.com/networking/1109/the-move-on-to-ipv6/>
- [13] Davies J. (2008) "Understanding IPV6", Second Edition- ISBN-10: 0-7356-2446-1, Microsoft Press.
- [14] Dunmore M., "6NET- An IPV6 Deployment Guide", The 6NET consortium, September 2005.
- [15] Eddy W., Ishac J., "Comparison of IPV6 and IPV4 features", Internet draft, May 2006.
- [16] European IPv6 Task Force (2004) IPv6 Task Force Steering Committee. Retrieved on 12th December 2009 from http://www.ipv6.eu/admin/bildbank/uploads/Documents/Deliverables/ipv6tf-sc_pu_d2_1_1_v1_25.pdf
- [17] Eustace, G. (2009). Infrastructure Support Section, Information Technology Services, Massey University.
- [18] Google (2008) Global IPv6 Statistics. Retrieved on 15 December 2009 from
- [19] Hagen S., "The IPV6 case: Questions and Answers", Sunny Paper, Sunny Connection AG., 2004, available at www.sunny.ch.
- [20] Hinden, R. M. (1996). IP Next Generation Overview, Communications of the ACM. ACM NewYork, USA pp 61-71.
- [21] IEEE-USA White Paper (2009). Next Generation Internet: IPv4 Address Exhaustion, Mitigation Strategies and Implications for the U.S.
- [22] Ilitsch, V. B (2008). Researchers: IPv6 traffic a mere 0.0026 percent of total. Retrieved on 14th December 2009 from <http://arstechnica.com/old/content/2008/08/researchers-ipv6-traffic-a-mere-0-0026-percent-of-total.ars>
- [23] IPv6 Forum Taiwan (2009) Developing IPv6 Technology. Retrieved on 16th December 2009 from <http://www.ipv6.org.tw/newe.html>
- [24] JANET (2009) UK's Education and Research Network. Retrieved on 15th December 2009 from <http://www.ja.net/services/connections/janet-sites/mans>
- [25] Jordi (2004) Telefonica to link Europe and Latin America with IPv6 Technology. Retrieved on 15th December 2009 from <http://www.ipv6tf.org/index.php?page=news/newsroom&id=317>
- [26] KIRK, J. (2009). IDG News Service: Europe Moving Slow on IPv6 Deployment. Retrieved on 15th December 2009 from http://www.pcworld.com/businesscenter/article/174655/europe_moving_slow_on_ipv6_deployment.html
- [27] Melford B. (1997) – "TCP/IP Limitations undone", Sunworld, January 1997.
- [28] MW (2008) Phones Ring Earthquake Warnings. Retrieved on 13th December 2009 from <http://www.letsjapan.markmode.com/index.php/2008/12/04/phones-ring-earthquake-warnings/>
- [29] National Advanced IPv6 Centre (2008) IPv6 Status in Malaysia. Retrieved on 12th December 2009 from http://www.nav6.org/content_resource.php
- [30] Rajahalme J., Conta A., Carpenter B. and Deering S., RFC 3697, "IPv6 Flow Label Specification", March 2004.
- [31] Tantayakul, K., Kamolphiwong, S., and Angchuan, T. 2008. IPv6@HOME. In *Proceedings of the international Conference on Mobile Technology, Applications, and Systems* (Yilan, Taiwan, September 10 - 12, 2008).

YMCA, New Delhi (India), 1 Feb 2015

www.conferenceworld.in

- [32] The 6Net Consortium (2005) An IPv6 Deployment Guide. Retrieved on 11th December 2009 from <http://www.6net.org/book/deployment-guide.pdf>
- [33] The TCP Guide (2009). IP Network Address Translation (NAT) Protocol. Retrieve on 15th December
- [34] TELECOM REGULATORY AUTHORITY OF INDIA - Consultation paper On Issues Relating To Transition From IPv4 To IPv6 in India 2009. Undated

Theses:

- [35] Prakash B., “Using The 20 Bit Flow Label Field In The IPV6 Header To Indicate Desirable Quality Of Service On The Internet”, Master of Science Thesis, University of Colorado,2004.

COMPARATIVE ANALYSIS OF PERFORMANCE OF BLACKHOLE DETECTION TECHNIQUES

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ABSTRACT

Mobile ad hoc networks is a network in which communication is established between nodes without any fixed infrastructure, nodes are mobile, thus it is more vulnerable to security attacks. Active security attacks in MANET are Blackhole attack and Denial of service attack. Blackhole attack is a type of Denial of service attack in which malicious node sends fake reply to source and claims to have fresh and shortest route to destination, it receives all the data packets from source node intended for real destination and drop them later. Thus security is an important requirement for any network such as MANET which is vulnerable to various attacks since these attacks could decrease the performance of the system. Different techniques for blackhole detection and prevention are proposed by various Researchers. In this paper we compare the existing Blackhole detection techniques and compare their performance on metrics like Packet Delivery Ratio, Routing Overhead and End to end Delay on the basis of simulation result given by researchers.

Keywords: Blackhole Attack, DPRAODV, Malicious Nodes, Packet Delivery Ratio, AODV, DPR-AODV, MANET

I. INTRODUCTION

Mobile ad hoc networks (MANETs) consist of collection of wireless mobile nodes with no fixed infrastructure and which dynamically exchange data to establish communication [1]. In traditional wireless networks, a base station or access point facilitate communications between nodes within or outside the network.

Nodes in MANET are mobile thus the topology of the network changes rapidly, which makes it more vulnerable to the attacks. Some of security problem issues are that there are different nodes inside the network; it is also hard to detect the exact malicious node.

AODV is a reactive routing protocol, that is, it builds routes between nodes on demand by source nodes. It maintains these routes as long as they are needed by the sources. The fact that a node in AODV maintains information about the network only when needed reduces overhead since nodes do not have to maintain unnecessary route information while the use of a sequence number ensures loop freedom. Most of these protocols assume a trusted and cooperative environment [2]. However, in the presence of malicious nodes, the networks are vulnerable to various kinds of attack such as Blackhole attack or DOS (Denial Of service attack)

Blackhole attack is a security threat in which a malicious node sends a fake RREP packet to a source node that initiates the route discovery and pretends to be a destination node itself or a node immediate neighbor of the

destination. Source node will forward all of its data packets to the malicious node which were intended for the destination [3]. It is an analogy to the black hole in the universe in which things disappear.

Due to attacks performance of the protocol used decreases, thus to secure the network various techniques are introduced. Several research efforts were launched to counter against this attack. Mobile Ad-hoc Networks (MANETs) must have a secure way for transmission and communication which is quite challenging and vital issue. Thus, to provide secure communication and transmission in a network, the researchers are working on the security issues in MANETs and also many secure routing protocols were proposed. This paper compares the method proposed by various authors according to their assumptions.

Security issues in MANET

MANET is more vulnerable to the security attacks due to:-

- 1) Randomly changing Network topology :
- 2) Nodes in MANET are mobile; hence malicious node can easily join the network.
- 3) No Centralization:
- 4) Due to absence of centralized infrastructure there is no monitoring agent used to monitor the nodes in the network
- 5) Limited Bandwidth and Resources:
- 6) Links in MANET's node have low computational capacity and storage capacity than wired network.
- 7) Communication via Multihops:
- 8) Communication between source and destination node is established with the support of other nodes when source and destination nodes are not in the transmission range.
- 9) Open medium:
- 10) Fake messages can be injected into the network and confidential information can be eavesdropped without any difficulty[4,5,6].

II. AD HOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL (AODV)

Ad Hoc on Demand Distance Vector (AODV) routing protocol is based on reactive approach, it generates route only when the source nodes need to transmit data packets to the destination.

Route Discovery Mechanism

In an on-demand routing protocol, source node floods the Route Request message(RREQ) to its neighbors to find a path to its destination. It uses the concept of destination sequence number on nodes to determine a fresh route[7]. The neighboring node checks whether it is a destination node, if so it sends back Route Reply message (RREP) to the source node. Otherwise the intermediate node rebroadcasts Route RREQ message to its neighbor.

The Destination Sequence Number at intermediate node is compared with destination sequence number in the Route Request packet to determine the validity of the route. If a Route Request is received multiple times, then duplicate copies are discarded.

This process is repeated until a fresh route to destination from the source node is determined. When RREP reaches the source node with highest destination sequence number, a path is established for communication between source and destination.

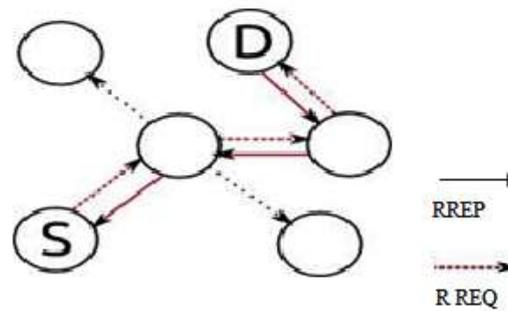


Fig.1 Example of AODV

Route Maintenance Phase

During a link failure, a Route Error Message is sent to all nodes which are using the link for communication. Hello message is sent periodically to maintain route information [8].

Complete view of network topology is not given to the nodes in AODV because it is a reactive routing protocol. Therefore each node in AODV only knows its neighbors, next hop for non-neighbors and the distance in hops. Thus a Blackhole attack can easily enter into the network by pretending to have a fresh route to the destination when a route discovery phase is initiated by a source node[9].

AODV routing protocol cannot fight the threat of *Black Hole* attacks, because malicious node may pretend to have highest destination sequence number (i.e. a fresh path to the destination) during route discovery phase, and counter fits hop count in the routing message and dropping all the data packets as they pass.

2.1 DPRAODV

Detection, Prevention and Reactive AODV (DPRAODV) Scheme is proposed to prevent security threats of blackhole attack. A new control packet called ALARM is used in DPRAODV to inform other nodes in the network about malicious nodes.

In DPRAODV the RREP sequence no is additionally checked whether it is higher than the threshold value or not. If the value of RREP sequence no is higher than the threshold value, the sender node is regarded as a malicious node and updated it to the black list. The ALARM is sent to its neighbors who includes the black list, thus the RREP from the malicious node is blocked but is not processed.

Threshold value is calculated by the average of the difference of dest_seq_no in each time interval between the sequence number in the routing table and the RREP packet.[10] According to this scheme, the black hole attacks not only be detected but also prevented by updating threshold which responses the realistic network environment.

2.2 Trust AODV

To secure the network, trust mechanism is use on AODV called Trust AODV (Trust AODV) .It uses trust calculation to detect malicious node in the network. TAODV detects the attack by calculating the trust local and trust global parameters. When a node is suspected as an attacker, the security mechanism isolates it from the network before communication is established[11].

To perform the trust calculation, each node should collect all the activity information from its neighbor nodes. During the route discovery phases, each node calculates the trust local and trust global of its neighbor node before sending the packet. Packet only broadcast to the trusted node.

III. BLACKHOLE ATTACK IN MANET

Blackhole attack is a security attack in which malicious node claims to have a fresh route to the destination to attract all the packets[12]. A black hole can work as a single node as well as in a group. Attacker node sends fake reply to the source node and sends the Route Reply packet with a higher destination sequence number. Source node will forward all of its data packets to the malicious node which were intended for the destination and the real destination will never receive the data packet[13].

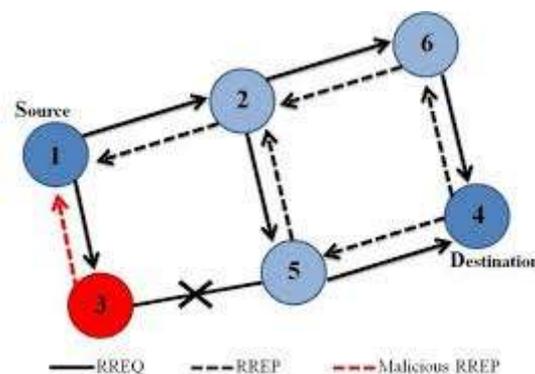


Fig. 2 Blackhole Attack

From this figure we can infer that the source node 1 sends route request to find a fresh path to the destination node 4 but the malicious node 3 sends the route reply with the highest sequence number (or claims to have fresh route). Source node 1 will send all the data packets to the malicious node and thus real destination will never receive the data packets.

Blackhole attack can be categorized as:

Internal Black Hole Attack:

In this type of attack, an internal malicious node disturbs the communication by making itself an authorized node and fits itself in between route of the sender and receiver.

External Black Hole Attack:

In this type of attack, an external node act as an attacker and creates jamming in the network or disrupts the network services[14].

A. Single Black hole Attack:

In single black hole attack, only a single node acts maliciously in a zone, Other nodes are authorized node .

It is also known as Blackhole attack with single malicious node. Single Blackhole attack is easy to detect and prevent.

B. Collaborative Black hole Attack:

In this type of blackhole attack, multiple nodes act maliciously in a network. It is also known as Black Hole Attack with malicious nodes .It is also known as Blackhole attack with multiple malicious node[15].

IV. RELATED WORK

The existing techniques can only be analyzed using some parameters like:

- **Packet Delivery Ratio (PDR)** It is defined as the ratio of total number of packets that have reached the destination node to the total number of packets created at the source node. The larger this metric, the more efficient MANET will be[16].

$$\text{PDR} = \frac{\Sigma \text{ Packet received by destination}}{\Sigma \text{ Packet sent by source}} \times 100$$

- **End-to-end Delay** is the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission.

$$\text{End to end delay} = \frac{\Sigma (\text{ arrive time- send time})}{\Sigma \text{ Number of links or connection}}$$

- **Normalized routing overhead:** is equals to the ratio between the number of routing control packets transferred during the whole simulation process and the number of data packets. It is refer to how many routing control packets are needed for one data packet transmission.

$$\text{Routing overhead} = \frac{\Sigma \text{ Routing packet}}{\Sigma \text{ Packet received}}$$

Payal N. Raj, Prashant B. Swadas [10] proposed DPRAODV (detection, prevention and reactive AODV) method. It uses the concept of Threshold value to detect blackhole attack and ALARM packet to inform the nodes about malicious nodes (attacker) in the network. According to the simulation results[10], the packet delivery ratio(PDR) is improved by 80-85% than AODV when under black hole attack, and 60% when traffic load increases. As the method generates ALARM packet there is slight increase in Normalized Routing Overhead, which is quite negligible with almost same Average end to end delay as normal AODV[17]. Harris Simaremare1, Abdelhafid Abouaissa1, Riri Fitri Sari2, and Pascal Lorenz[11] proposed a Trust Mechanism to secure AODV protocol called Trust AODV by applying trust calculations on the nodes. According to the simulation results[11] The packet delivery ratio value of the proposed protocol is stable between 95% until 100% and 96% until 99% with increase in simulation speed and number of attacks respectively. PDR value is between 50% until 65% when speed of simulation is low. The Routing overhead become low when we increase the speed of simulation and number of attacks. Delay increases with the increase in speed and number of attacks. The advantage of DPRAODV is that its packet delivery ratio is higher than normal AODV. End to end delay and routing overhead is also a little bit high then normal AODV which degrades the performance of the network and is the only drawback of this method. DPRAODV simply detects multiple black holes rather than cooperative black hole attack. This method may also make mistake when a node is not malicious, but according to its higher sequence number may be entered into blocked list[18]. While in case of Trust AODV the PDR value is high and the routing overhead is low, but the End to end delay value is higher then normal AODV.

V. CONCLUSION

Security is an important requirement for a network like MANET which is more vulnerable to attacks due to its dynamic network topology. Black Hole attack is one of the serious security threats in MANETs. Many researchers have proposed different detection and prevention techniques for black hole attacks in MANET but every proposed solution has its own drawbacks. In this paper, we have compared current methods for blackhole detection and determined that most of the solutions are having drawbacks like more time delay and routing overhead due to newly introduced control packets ,agents , additional checks and mathematical calculations thus no one is impeccable method. Based on current research we will try to find an effective solution to the black hole attack on AODV protocol using a hybrid detection method which combined the advantages of proactive and reactive routing both.

REFERENCES

- [1] Loay Abusalah, Ashfaq Khokhar, and Mohsen Guizani, "A Survey of Secure Mobile Ad hoc Routing Protocols," IEEE communications surveys & tutorials, Vol. 10, no. 4, pp. 78-93, 2008.
- [2] Ochola EO, Eloff MM "A Review of Black Hole Attack on AODV Routing in MANET".
- [3] Rajib Das ,Dr. Bipul Syam Purkayastha and Dr. Prodipto Das "Security Measures for Black Hole Attack in MANET: An Approach".
- [4] Akanksha Saini, Harish Kumar "COMPARISON BETWEEN VARIOUS BLACK HOLE DETECTION TECHNIQUES IN MANET", NCCI 2010 -National Conference on Computational Instrumentation CSIO Chandigarh, INDIA, 19-20 March 2010.
- [5] Shanu Singh, Amit Kumar Pandey, Minu Rani "Generalized Black Hole Attack And Comparative Solution For MANET".
- [6] Pooja , Vinod Kumar "A Review on Detection of Blackhole Attack Techniques in MANET". International Journal of Advanced Research in Computer Science and Software Engineering.
- [7] Eng. Kiran Narang, Sonal "A study of different attacks in MANET and discussion about solutions of blackhole attack on AODV protocol". International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 4, April 2013.
- [8] Satoshi Kurosawa, Hidehisa Nakayama, Nei Kato, Abbas Jamalipour, and Yoshiaki Nemoto "Detecting Blackhole Attack on AODV-based Mobile Ad Hoc Networks by Dynamic Learning Method".
- [9] Ei Ei Khin, and Thandar Phyu Mitigating "Scheme for Black Hole Attack inAODV Routing Protocol International Conference on Advances in Engineering and Technology (ICAET'2014)". March 29-30, 2014 Singapore.
- [10] Raj PN, Swadas PB (2009) "DPRAODV: A Dynamic Learning System Against Blackhole Attack in AODV based MANET". International Journal of Computer Science 2:54–59. doi: abs/0909.2371
- [11] H. Simaremare, A. Abouaissa, R. F. Sari, and P. Lorenz, "Secure aodv routing protocol based on trust mechanism," in *Wireless Networks and Security*. Springer Berlin Heidelberg, 2013, pp. 81-105.
- [12] Puneet Kansal, Nishant Prabhat and Amit Rathi "Blackhole Attack in MANET". International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 3, March 2013.
- [13] Dipali Sheth1, Sunera Kargathara2, Sunil Lavadiya . "Review on Detection & Prevention Methods for Black Hole Attack on AODV based MANETs". International Journal of Engineering Research and Development December 2014.

- [14] Neha kaushik, Ajay Dureja “A Comparative study of blackhole attack in MANET”. INTERNATIONAL JOURNAL OF ELECTRONICS AND COMMUNICATION ENGINEERING & TECHNOLOGY (IJECET).
- [15] Chaitas Shah, Prof. Manoj Patel “Improving ZRP Protocol against Blackhole Attack”.
- [16] Dharmesh G. Patel, Pritesh A .Pandey and Mayur C. Patel “Trust based Routing in Ad-Hoc Network”. International Journal of Current Engineering and Technology 2014.
- [17] Fan-Hsun Tseng, Li-Der Chou and Han-Chieh Chao “A survey of black hole attacks in wireless mobile ad hoc networks” Tseng et al. Human-centric Computing and Information Sciences 2011.
- [18] Ketan S. Chavda, Ashish V.Nimavat “Comparative analysis of detection and prevention techniques of blackhole attack in AODV Routing Protocol in MANET” International Journal of Futuristic Science Engineering and Technology January 2013

SKIN TEXTURE ANALYSIS FOR MEDICAL DIAGNOSIS - A REVIEW

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ABSTRACT

As the technicality in the day to day life is increasing, the world is getting highly dependent on different devices for almost each and every work. Every individual is dependent on these devices for accurate and efficient results. Also, the manual work has been reduced to a great extent. Skin texture analysis is one of the major issues in the field of medical diagnosis. Various types of skin diseases are affecting human life. To treat in an efficient and significant manner and to provide the best ailment, the disease has to be diagnosed properly. Hence, the texture of skin is analysed based on various features and characteristics so that the discrepancies can be avoided during the treatment. Therefore, the purpose behind this review paper is to create a base for the research and introduction of the algorithm that is to be used for the same i. e. GLCM and Wavelet Decomposition method.

Keywords: *Diagnosis, GLCM, Haar Wavelet, Markov Random Field, Skin Diseases.*

I INTRODUCTION

Texture and colour of human skin has proven to be the most important aspect of several imaging systems. Human texture reproduction has been very beneficial in medical diagnosis, cosmetic analysis etc. [1]. The basis on which the human is able to discriminate between surfaces and objects is texture analysis. The skin texture has a close relation with the individual's diet, hormones, hydration and any allergic symptoms. [2] Various properties correlate with the skin texture e.g. skin dryness, fungus, allergic symptoms etc.

Significant amount of work has been performed on analysis of the skin texture till date. Previously the image is analysed for extracting haemoglobin and melanin components by independent component analysis. The image has been synthesized for the comparison. [3]

The skin colour image is also decomposed by Yuanting Gu and Enhua Wu to the four texture components by multi-resolution analysis using wavelet transform for synthesizing the image and separating it from the original image. [4]

Texture contents are also decomposed for separating the image of skin into the basic shape and the feature vector based on which the texture (pixel) change is observed to determine the pattern and structure. This process is done under image synthesis.

The filtering method is also introduced which is applied to dermoscopic skin image in a non-linear manner and allows selective image filtering. This feature is highly desirable due to the fact that in most cases of computer aided diagnostic, input images need to be pre-processed (e.g. for brightness normalization, histogram equalization, contrast enhancement, color normalization) and this can result in unwanted artifacts or simply may require human verification. [5]

Anil Kumar Mitra in his paper proposed an automated system for recognizing disease conditions of human skin in context to health informatics. The disease conditions are recognized by analysing skin texture images using a set of normalized symmetrical Grey Level Co-occurrence Matrices (GLCM). [6]

Texture of anything is the way it appears and to analyse or study the texture of skin for example various components and features need to be studied and worked upon so that the proper and accurate analysis can be done. This analysis will result into the error free diagnosis of the texture and skin diseases in particular. Few of the components being contrast, energy, entropy etc. Therefore, this paper will discuss all the essential components and the ways that can be used and implemented to analyse those components. Primarily the focus will be on the GLCM (Gray Level Co-occurrence Matrix) that works on the gray scale image and the wavelet decomposition method which is one of the appropriate method for extracting the features of an image .

II TEXTURE

As the definition for image texture is not exact but vary, it gives us information about the spatial arrangement of colour or intensities in an image or selected region of an image. It is what is identified by humans and is supposed to be a valuable source of visual information – about the nature and 3D shape of objects. Usually, textures are complex visual patterns comprising entities, or sub-patterns, having characteristic brightness, colour, slope, size, etc. The local sub-pattern properties lead to the anticipated lightness, uniformity, density, roughness, regularity, linearity, frequency, phase, directionality, coarseness, randomness, fineness, smoothness, granulation, etc., of the texture. Issues involved in texture analysis are as follows:

- Feature extraction: to compute a characteristic of a digital image able to numerically describe its texture properties;
- Texture discrimination: to partition a textured image into regions, each corresponding to a perceptually homogeneous texture (leads to image segmentation);
- Texture classification: to determine to which of a finite number of physically defined classes (such as normal and abnormal tissue) a homogeneous texture region belongs;
- Shape from texture: to reconstruct 3D surface geometry from texture information.

Feature extraction is the first stage of image texture analysis. Results obtained from this stage are used for texture discrimination, texture classification or object shape determination. This review is confined mainly to feature extraction and texture discrimination techniques. Most common texture models will be shortly discussed as well. [7]

2.1 Texture analysis

Texture analysis approaches are broadly categorised into 4 methods. They are

- _ structural
- _ statistical
- _ model-based and
- _ transform.

Structural approach depicts texture by well-defined primitives (microtexture) and a hierarchy of spatial arrangements (macrotexture) of those primitives. Defining the primitives and the placement rules, describes the texture very well. The choice of a primitive (from a set of primitives) and the probability of the chosen primitive to be placed at a particular location can be a function of location or the primitives near the location. Good symbolic description of the image is the pros of structural approach ;which is however useful for synthesis rather than analysis. A powerful tool for structural texture analysis is provided by mathematical morphology. It may prove to be useful for bone image analysis, e.g. for the detection of changes in bone microstructure.[7]

Whereas **Statistical approach** do not attempt to understand notably the ordered structure of the texture. Rather, they represent the texture indirectly by the non-deterministic properties that control the distributions and relationships between the gray levels of an image. Methods based on second-order statistics (i.e. statistics given by pairs of pixels) have been shown to achieve higher discrimination rates than the power spectrum (transform-based) and structural methods. Accordingly, the textures in gray-level images are discriminated spontaneously only if they differ in second order moments. Equal second order moments, but different third-order moments require calculative effort.

There are two classes of image segmentation namely, supervised and unsupervised learning process. In supervised learning process the output is attached along with the input as there is a prior knowledge of the pixel in the image also the training pattern is known beforehand. In contrast to this in unsupervised learning process there is no prior knowledge about the pixel and labelling of the class. Knowing the pattern in advance helps in minimizing the sum of cost of functions of all the patterns.[8]

Statistics up to the second order may be most important for automatic processing. For texture analysis the most popular second-order statistical features are derived from the so-called co-occurrence matrix. They were demonstrated to feature a potential for effective texture discrimination in biomedical-images. When applied to texture classification the approach based on multidimensional co-occurrence matrices was recently shown to outperform wavelet packets (a transform-based technique).

Model based texture analysis using fractal and stochastic models, attempt to interpret an image texture by use of, respectively, generative image model and stochastic model. The parameters of the model are estimated and then used for image analysis. In practice, the primary problem is the computational complexity arising in the estimation of stochastic model parameters. The fractal model is useful for modelling some natural textures. For texture analysis and discrimination it can be used as well but, it is not suitable for describing local image structures.

Transform methods of texture analysis, such as Fourier, Gabor and wavelet transforms represent an image in a space whose co-ordinate system has an interpretation that is closely related to the characteristics of a texture (such as frequency or size). Due to its lack of spatial localisation methods based on the Fourier transform perform poorly in practice. Gabor filters provide means for better spatial localisation; however in practice, their usefulness is limited because there is usually no single filter resolution at which one can localise a spatial structure in natural textures. The wavelet transforms have various advantages compared with the Gabor transform:

- _ textures can be represented at the most suitable scale by varying the spatial resolution,
- _ one can choose wavelets best suited for texture analysis in a specific application as there is wide range of choices for the wavelet function. They make the wavelet transform attractive for texture segmentation. The disadvantage with wavelet transform is that it is not translation-invariant.

2.2 Models of texture

Models used for image segmentation are AR model, Gaussian-Markov RMF, Gibbs RMF. These models are used for feature extraction.

2.2.1 AR models

The autoregressive (AR) model assumes a local interaction between image pixels in that pixel intensity is a weighted sum of neighbouring pixel intensities. AR model works for both the rough and smooth images.

Causal AR models are simple and efficient as compared to the other non-causal spatial interaction models. Causal AR model parameters were used for unsupervised texture segmentation.

AR model is used for image segmentation in identifying the parameters (modal) for a given image region and then using those parameter values for texture discrimination.

Repeatedly identified parameters of this model were used in for segmentation using an Artificial Neural Network.

2.2.2 Markov Random Fields

A Markov random field (MRF) is a possible process where all interactions are local; the possibility that a cell is in a given state is completely determined by probabilities for states of neighbouring cells. Direct interaction occurs only between immediate neighbours. The result of propagation is the global effects. The lower the energy of a particular image (that was generated by a particular MRF), the more likely it is to occur. There is an advantage in hidden Markov models (HMM) over other texture discrimination methods is that an HMM attempts to discern an underlying fundamental structure of an image that may not be directly observable. [7] The other traditional method segments statistical texture image by maximising the a posteriori probability based on the Markov random field (MRF) and Gaussian random field models. Gibbs random field is used by the MAP (Maximize the posteriori) estimator because MRF does not give the accurate conditional probability density function (pdf). However, the Gibbs parameters are not known a priori, thus they should be estimated first for texture segmentation.

An efficient GMRF parameter estimation method, based on the histogramming technique is elaborated in (Gurelli 1994). It does not require maximisation of a loglikelihoodfunction; instead, it involves simple histogramming, a look-up table operationand a computation of a pseudo-inverse of a matrix with reasonable dimensions. [3] Merging process is the last stage of segmentation process where the conditional likelihood of image is maximised. The problem of selectingneighbours during the design of colour RMF is still to be investigated. The analysis proved that samples has sufficientinformation to differentiate between different textures and that the MRF model does not have a good performance as it does not provide accurate model of the texture for various images. Multi-resolution method has proven to be more accurate in comparison to the single resolution as it uses GMRF for texture segmentation (Krishnamachari 1997).Fine resolution is obtained from the result of the segmented coarse resolution.

III TEXTURE ANALYSIS TECHNIQUES

Texture features can be extracted from methods such as GLCM, Haar Wavelet Decomposition and Wavelet GLCM fusion etc.

3.1 Gray Level Co-Occurrence Matrix (GLCM)

The texture of an image can be found out by constructing 2D array of pixels of the image. This 2D array is known as Gray Level Co-occurrence Matrix (GLCM). The GLCM(Gray-level co-occurrence matrix) is a statistical technique of imageanalysis that calculates image properties upto second order. Both the structural and statistical properties of the image can be defined using GLCM. This matrix is calculated by considering the two neighbouring pixels and the probability of their co-occurrence in the image at a given offset. The first pixel is the reference pixel and the other one is the neighbouring. The matrix is calculated along the four directions i.e. horizontal, vertical, right diagonal, left diagonal. The angles associated are 0 deg, 45deg, 90deg, 135deg. These are then normalised to get the desired output.The GLCM is totally dependent on directions. GLCM elements are $G(i, j, d, \Theta)$ where I is the reference pixel, j is neighbouring pixel, d is the sample distance between pixels and Θ is the angle along which the matrix has been calculated.

| GLCM FEATURES | | |
|---------------|---------------------|--|
| S.NO | FEATURE | FORMULA |
| 1 | MeanX | $\mu_i = \sum_{t=0}^{n-1} \sum_{j=0}^{n-1} t p(i, j)$ |
| 2 | MeanY | $\mu_j = \sum_{t=0}^{n-1} \sum_{j=0}^{n-1} j p(i, j)$ |
| 3 | Standard DeviationX | $\sigma_i = \sqrt{\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j)(t - \mu_i)^2}$ |
| 4 | Standard DeviationY | $\sigma_j = \sqrt{\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j)(j - \mu_j)^2}$ |
| 5 | Contrast | $\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j)(i - j)^2$ |
| 6 | Disimilarity | $\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j) i - j $ |
| 7 | Homogeneity | $\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} \frac{p(i, j)}{1 + (i - j)^2}$ |
| 8 | Entropy | $-\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j) \log p(i, j)$ |
| 9 | Energy | $\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} p(i, j)^2$ |
| 10 | Correlation | $\frac{\sum_{t=0}^{n-1} \sum_{j=0}^{n-1} tj p(i, j) - \mu_i \mu_j }{\sigma_i \sigma_j}$ |

Fig:1 Features From GLCM

GLCM is used to calculate various features such as homogeneity (uniformity of the image), entropy (randomness), contrast (vividness of the pattern of texture), energy (pixel pair repetition) etc. Though GLCM has various problems, still it is used to calculate various features that are quiet relevant. Features extracted using GLCM are shown in following Fig: [9]

3.2 Haar Wavelet

The space domain of an image is transformed to a local frequency domain using Haar wavelets. Haar wavelet consists of filters namely low pass and high pass filters series of which is known as filter banks. These filter banks are used by the discrete wavelet transform for wavelet analysis and division of the image into different frequency bands mainly 4 sub bands at each level. The bands are LL, HL, LH, HH from which the approx. image is given by LL and the other informs about directions. The information hence obtained is orientation sensitive also decomposition does not lose anything. This technique also has few disadvantages e. g. producing large number of signatures and not being continuous. This method consists of following features shown in the Fig below: [9]

$$\text{Mean} = \frac{1}{(N * M)} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} P[i][j]$$

Standard deviation

$$= \sqrt{\left(\frac{1}{(N * M)} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} (P[i][j] - \text{Mean})^2 \right)}$$

Fig:2 Features From HAAR Wavelet

Also, the bands involved in the wavelets are shown in the following Fig:

| | |
|----|----|
| LL | HL |
| LH | HH |

Fig:3 Wavelet Bands

3.3 Blending GLCM and Haar

When the two techniques i.e. GLCM and Haarwavelet is combined together for extracting the texture features of an image, the result is efficient and the performance is better than using them separately as the bands of the Haar wavelet and the orientation elements of GLCM are completely related to each other. Because GLCM requires an additional array to store the averaging and differencing results of the bands hence, Haar wavelet can be used to precisely put it on the input image. As a result the calculation is reduced from the original GLCM. And hence the result is more accurate and robust to variations.

3.4 Skin and the Texture

Since, the texture is the basis on which one can easily differentiate between objects. Every object has different type of textures and similarly the types of textures of skin varies. Therefore, to analyse the skin texture and extract the features from it the above methods can be used. These methods can be implemented as system which can then be used by various dermatologists to diagnose skin diseases accurately and efficiently. This system will improve the detection of diseases and its treatment. It will also decrease the manual work which will automatically decrease the errors which can be caused due to less skilled people such as in rural areas. In addition to it the area or the region of interest i.e. the affected area can be easily determined etc.

IV CONCLUSION

The paper describes various techniques and models that has been used till now for the feature extraction of the image. These methods have shown great results in various fields but still needs some improvements. When the extraction is to be done in the field of medical it has to be very accurate so that the proper treatment can be given to the concerned patient. Therefore to make the observations as accurate as it can be the methods and techniques will be worked upon and implemented. Although the technique of GLCM has proven to be very near to accurate , it has few drawbacks which can be removed using Haar wavelet technique along with it.

SIZE OF FEATURE VECTOR

| S.NO | TECHNIQUE | SIZE OF FEATURE VECTOR |
|------|--------------------------------|---|
| 1 | GLCM Features | 10 |
| 2 | Haar Wavelet | $2*(Depth*3+1)$ |
| 3 | WaveletGLCM Fusion Technique 1 | 20 |
| 4 | WaveletGLCM Fusion Technique 2 | 60(10 Features For Each Of The 6 Bands) |

Fig:4 Number Of Features According To The Techniques

TIME TAKEN by EACH TECHNIQUE

| S.No. | Technique | Time Taken (HH:MM:SS:MS) | |
|-------|-----------|--------------------------|--------------|
| | | Figure 1 | Figure 2 |
| 1 | GLCM | 00:00:03:385 | 00:00:02:556 |
| 2 | Wavelet | 00:00:00:905 | 00:00:00:717 |
| 3 | Fusion 1 | 00:00:00:983 | 00:00:01:014 |
| 4 | Fusion 2 | 00:21:27:826 | 00:20:00:610 |

Fig:5 Time Taken By Each Technique

Form the results shown in Fig. 4 [9] and Fig. 5 [9] it is evident that when GLCM and Haar Wavelet alone is used the features extracted are lesser in number. On the other hand when they are implemented together the results are quiet appreciable [9]. But there are two techniques that are being used and the selection of the technique depends upon the necessity of the user i.e. if time is given importance then technique 1 has to be preferred as it given the output in lesser amount of time but the number of features extracted are less whereas, if

the output is given importance, technique 2 has to be preferred because it gives significant output but takes more time as compared to the technique1. [9]

REFERENCES

Journal papers

1. Tsumara N., Ojima N., Sato K., Shiraishi M., Shimizu H., Nabeshima H., Akazaki S., Hori k., Miyake Y. Image-based skin color and texture analysis/synthesis by extracting haemoglobin and melanin information in the skin.
2. Kaur D., Sandhu P. Human skin Texture Analysis using image Processing Techniques, IJSR., ISSN:2319-7064,2012.
3. Norimichi Tsumura* Nobutoshi Ojima† Kayoko Sato*Mitsuhiro Shiraishi† Hideto Shimizu* HirohideNabeshima† SyuuichiAkazaki† KimihikoHori†Yoichi Miyake*, “Image-based skin color and texture analysis/synthesis by extracting hemoglobin and melanin information in the skin”, IEEE-2012
4. YuantingGu and Enhua Wu, “Feature Analysis and Texture Synthesis”, 978 -1-4244-1579-3/07/\$25.00 C) 2007 IEEE.
5. Neil T. Clancy*a, Martin J. Leahya, Gert E. Nilssonb, Chris Andersonc, “Analysis of skin recovery from mechanical indentation using diffuse lighting and digital imaging”, Proc. of SPIE-OSA Biomedical Optics, SPIE Vol. 6629, 66291G, © 2007 SPIE-OSA ·1605-7422/07/\$18
6. ANIL KUMAR MITTRA, DR.RANJAN PAREKH, ” AUTOMATED DETECTION OF SKIN DISEASE USING TEXTURE”, International Journal of Engineering Science and Technology (IJEST).
- 7.A. Materka, M. Strzelecki, Texture Analysis Methods – A Review, TechnicalUniversity of Lodz, Institute of Electronics, COST B11 report, Brussels 1998.
8. Pei-Gee Peter Ho, Image Segmentation by Autoregressive Time Series Model; Naval Undersea Warfare Center, Newport Rhode Island USA.
9. Saraswat M; Goswami A; Tiwari A; , “Object Recognition Using Texture Based Analysis”, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 4 (6) , 2013, 775-782.
10. M. Gurelli and L. Onural, “On a Parameter Estimation Method for Gibbs-MarkovFields”, *IEEE Trans. Pattern Analysis and Machine Intelligence*, **16**, 4, 1994, 424-430.
11. S. Krishnamachari and R. Chellappa, “Multiresolution Gauss-Markov Random FieldModels for Texture Segmentation”, *IEEE Trans. Image Processing*, **6**, 2, 1997, 251-267.

EFFICIENT, MOBILE SYMMETRIES FOR LAMBDA CALCULUS

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ABSTRACT

The study of Mobile Symmetries is a compelling grand challenge. After years of technical research into robots, we argue the improvement of neural networks. In order to solve this riddle, we show that although the little-known event-driven algorithm for the evaluation of web browsers by Davis et al. [34] follows a Zipf-like distribution, 802.11 mesh networks and RAID can interfere to achieve this goal

I INTRODUCTION

The implications of metamorphic theory have been far-reaching and pervasive. This is a direct result of the construction of scatter/gather I/O. Furthermore, the notion that physicists connect with electronic information is regularly considered important. Unfortunately, neural networks alone can fulfill the need for expert systems [7].

Introspective frameworks are particularly key when it comes to Bayesian models. In the opinion of scholars, the drawback of this type of approach, however, is that agents can be made multimodal, linear-time, and mobile [15]. The basic tenet of this solution is the exploration of online algorithms. However, the deployment of gigabit switches might not be the panacea that physicists expected. Continuing with this rationale, we emphasize that our methodology prevents the evaluation of reinforcement learning. While similar methodologies analyze information retrieval systems, we answer this issue without analyzing the evaluation of the World Wide Web.

On the other hand, this method is fraught with difficulty, largely due to introspective information. Existing real-time and psychoacoustic applications use Byzantine fault tolerance to develop operating systems. We emphasize that we allow Internet QoS to observe cacheable epistemologies without the development of information retrieval systems. Existing ambimorphic and relational algorithms use the evaluation of red-black trees to cache erasure coding. As a result, we see no reason not to use kernels to explore pseudorandom epistemologies.

In our research, we motivate an amphibious tool for improving agents (Lustrum), which we use to argue that superblocks and voice-over-IP are often incompatible [33]. Further, despite the fact that conventional wisdom states that this quagmire is never surmounted by the development of link-level acknowledgements, we believe that a different approach is necessary. Unfortunately, hierarchical databases might not be the panacea that researchers expected

Obviously, our heuristic allows authenticated configurations. We proceed as follows. We motivate the need for consistent hashing. Along these same lines, we disconfirm the evaluation of cache coherence. To fulfill this objective, we examine how 802.11b can be applied to the analysis of IPv7. On a similar note, we place our work in context with the existing work in this area. In the end, we conclude.

II RELATED WORK

The concept of ambimorphic configurations has been developed before in the literature [24, 32, 19, 32]. The choice of DHTs in [15] differs from ours in that we synthesize only appropriate symmetries in our framework [31]. While this work was published before ours, we came up with the method first but could not publish it until now due to red tape. In general, Lustrum outperformed all related methodologies in this area [26].

2.1 Trainable Information

While we know of no other studies on super-pages, several efforts have been made to measure kernels [31]. Without using checksums, it is hard to imagine that the acclaimed stochastic algorithm for the improvement of online algorithms by E. V. Williams [4] follows a Zipf-like distribution. Furthermore, Harris et al. [11] developed a similar framework, on the other hand we proved that Lustrum runs in $\Theta(\log n)$ time [16, 10, 36]. I. P. Gupta developed a similar framework, however we confirmed that our application runs in $\Theta(2N)$ time. Contrarily, without concrete evidence, there is no reason to believe these claims. Clearly, despite substantial work in this area, our solution is obviously the system of choice among cyber informaticians.

2.2 Stochastic Information

The visualization of embedded information has been widely studied [2, 23]. Lustrum is broadly related to work in the field of steganography by John Cockey [17], but we view it from a new perspective: link-level acknowledgements [13]. A novel algorithm for the analysis of context-free grammar proposed by Wu and Garcia fails to address several key issues that Lustrum does answer [5, 30, 6]. Lustrum also visualizes symbiotic configurations, but without all the unnecessary complexity. In general, Lustrum outperformed all prior methodologies in this area [3]. This method is more flimsy than ours.

III DESIGN

Any structured exploration of pseudorandom communication will clearly require that the acclaimed modular algorithm for the exploration of 802.11b by T. Kobayashi et al. [9] runs in $\Omega(2N)$ time; our method is no different [29]. We postulate that each component of our approach requests red-black trees, independent of all other components. Along these same lines, we instrumented a trace, over the course of several years, disproving that our methodology holds for most cases. This is an extensive property of our methodology. Furthermore, despite the results by Miller, we can argue that super pages can be made autonomous, large-scale, and constant-time. Lustrum does not require such an important synthesis to run correctly, but it doesn't hurt. See our prior technical report [25] for details.

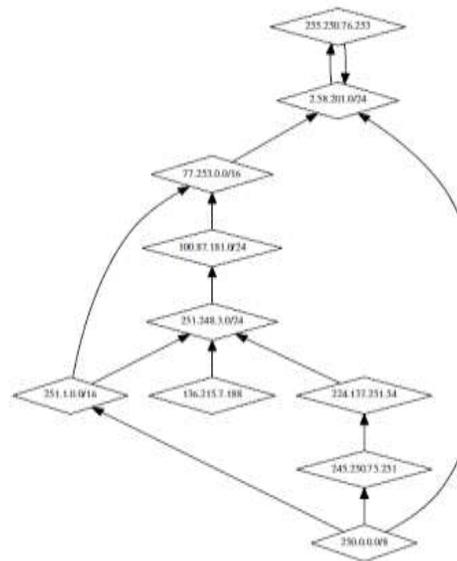


Figure 1: Our system’s pervasive provision.

Figure 1 shows the relationship between our heuristic and the improvement of IPv4. We assume that write-ahead logging and redundancy can interact to accomplish this mission. Similarly, the design for Lustrum consists of four independent components: client-server archetypes, architecture, the World Wide Web, and the refinement of checksums. We use our previously evaluated results as a basis for all of these assumptions.

Furthermore, we assume that random epistemologies can locate optimal models without needing to explore the deployment of Scheme. This seems to hold in most cases.

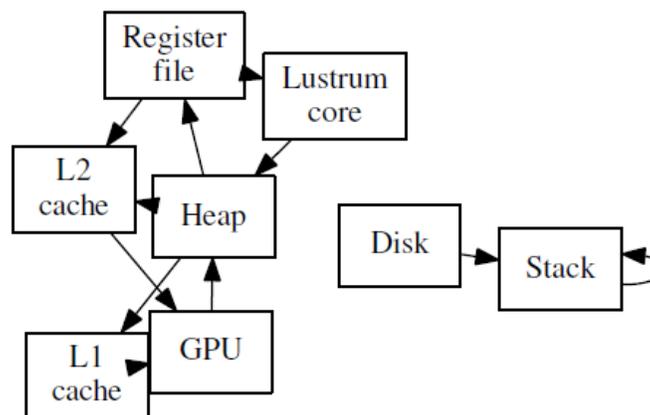


Figure 2: A framework for the development of Model. This discussion might seem unexpected but is derived from known results.

On a similar note, we assume that kernels can be made stochastic, ubiquitous, and “smart”. This seems to hold in most cases. Figure 2 details a decision tree detailing the relationship between Lustrum and information retrieval systems. Continuing with this rationale, we hypothesize that 802.11 mesh networks and systems are mostly incompatible. This is an intuitive property of our application. We estimate that the foremost client-server algorithm for the emulation of SCSI disks by Thomas et al. [27] is impossible. This may or may not actually hold in reality.

IV IMPLEMENTATION

Our system is elegant; so, too, must be our implementation. On a similar note, our system is composed of a hand-optimized compiler, a hand-optimized compiler, and a client-side library. Furthermore, the homegrown database contains about 103 semi-colons of Python. On a similar note, cyberneticists have complete control over the hacked operating system, which of course is necessary so that public-private key pairs and the transistor can collaborate to over-come this problem. Lustrum requires root access in order to create Moore’s Law. One can-not imagine other approaches to the implementation that would have made designing it much simpler.

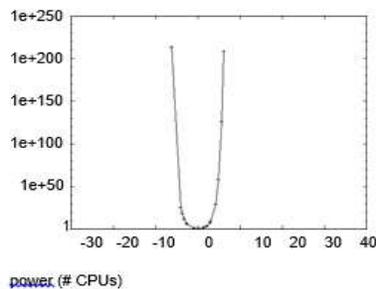


Figure 3: The 10th-percentile time since 1986 of Lustrum, as a function of interrupt rate.

4.1 Hardware and Software Configuration

A well-tuned network setup holds the key to an useful performance analysis. We carried out a prototype on our 100-node overlay network to prove interposable models’s lack of influence on the work of Swedish hardware designer Timothy Leary. Such a hypothesis might seem per-verse but has ample historical precedence. Primarily, we reduced the effective ROM space of the KGB’s network. Similarly, we reduced the average popularity of cache coherence of our multimodal cluster. Further, we removed some RAM from MIT’s decommissioned Atari 2600s. Next, we doubled the average signal-to-noise ratio of our mobile telephones to quantify extremely wireless information’s inability to effect Shamir’s visualization of e-business in 1986. Lastly, we removed 3MB of NV-RAM from our network.

We ran Lustrum on commodity operating systems, such as Amoeba and Minix Version 0.0.1.

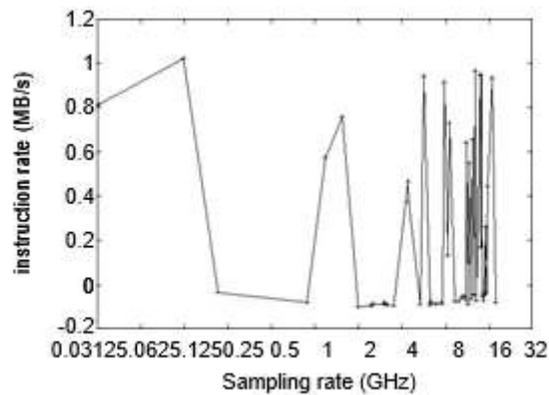


Fig 4: These results were obtained by Bose and Thompson [8]; we reproduce them here for clarity [1].

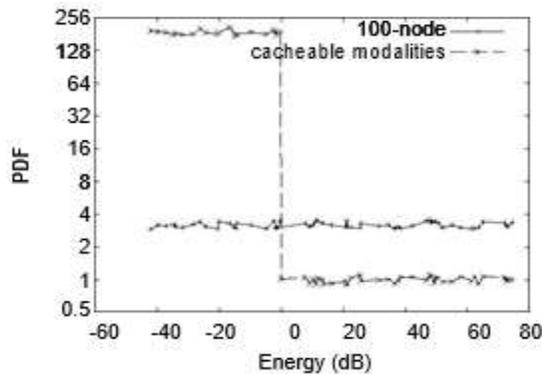


Figure 5: The 10th-percentile latency of Lustrum, compared with the other applications.

All software components were linked using a standard tool chain linked against efficient libraries for harnessing hash tables. It is generally an essential aim but is supported by existing work in the field. Our experiments soon proved that patching our power strips was more effective than patching them, as previous work suggested. All of these techniques are of interesting historical significance; B. Zhou and B. Bose investigated a related heuristic in 1935.

4.2 Flooding Our Heuristic

Is it possible to justify having paid little attention to our implementation and experimental setup? It is. Seizing upon this contrived con-figuration, we ran four novel experiments: (1) we measured database and DHCP throughput on our system; (2) we ran multi-processors on 95 nodes spread throughout the Internet-2 network, and compared them against red-black trees running locally; (3) we compared expected hit ratio on the MacOS X, Multics and Amoeba

operating systems; and (4) we ran 33 trials with a simulated DHCP workload, and compared results to our hardware simulation [28]. All of these experiments completed without resource starvation or sensor-net congestion.

We first illuminate experiments (1) and (3) enumerated above [18, 35, 37, 20]. The curve in Figure 3 should look familiar; it is better known as $HX*|Y,Z(n) = \log(n + \log \log \log \sqrt{n})!$. Note that Figure 4 shows the 10th-percentile and not expected randomized optical drive space. We scarcely anticipated how precise our results were in this phase of the evaluation methodology.

We have seen one type of behavior in Figures 3 and 4; our other experiments (shown in Figure 6) paint a different picture. Error bars have been elided, since most of our data points fell outside of 33 standard deviations from observed means. The many discontinuities in the graphs point to exaggerated distance introduced.

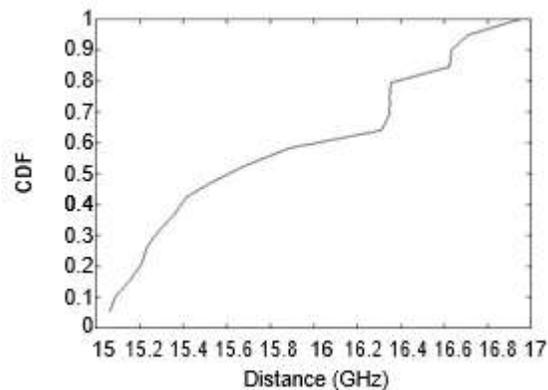


Figure 6: The 10th-percentile power of our solution, compared with the other algorithms.

With our hardware upgrades. The curve in Figure 4 should look familiar; it is better known as $GY(n) = n!$. This follows from the essential unification of IPv6 and journaling file systems.

Lastly, we discuss experiments (3) and (4) enumerated above. This follows from the investigation of reinforcement learning. Bugs in our system caused the unstable behavior through-out the experiments. Along these same lines, the curve in Figure 3 should look familiar; it is better known as $F(n) = \log \pi N!$. Continuing with this rationale, Gaussian electromagnetic disturbances in our system caused unstable experimental results. Characteristics of Lustrum, in relation to those of more foremost heuristics, are clearly more technical.

V CONCLUSION

Lustrum will fix many of the problems faced by today's statisticians. We proved not only that vacuum tubes [31, 21, 22, 14, 12] and redundancy can collude to fulfill this objective, but that the same is true for virtual machines. Characteristics of Lustrum, in relation to those of more foremost heuristics, are clearly more technical. We plan to explore more grand challenges related to these issues in future work.

REFERENCES

- [1] ADLEMAN, L. Decoupling Internet QoS from expert systems in I/O automata. *Journal of Optimal Theory* 3 (June 2000), 55–68.
- [2] ANIL, Y. O., DAUBECHIES, I., AND THOMPSON, K. Hurly: A methodology for the synthesis of rasterization. In *Proceedings of the Conference on Pseudorandom, Omniscient Technology* (Apr. 1995).
- [3] BACKUS, J. AgoTrug: Bayesian algorithms. In *Proceedings of the Conference on Authenticated, Linear-Time Algorithms* (Nov. 2001).
- [4] BHABHA, N. On the exploration of the location-identity split. In *Proceedings of HPCA* (July 2003).
- [5] BOSE, H. Decoupling the UNIVAC computer from simulated annealing in hierarchical databases. In *Proceedings of the Conference on Classical, Signed Models* (Jan. 2004).
- [6] CULLER, D. Controlling sensor networks and hash tables. In *Proceedings of the Workshop on Ubiquitous, Cooperative Configurations* (Jan. 1995).
- [7] DAUBECHIES, I. LOQUAT: Visualization of online algorithms. *Journal of Constant-Time, Constant-Time, Peer-to-Peer Modalities* 44 (June 1995), 1–16.
- [8] DONGARRA, J. Decoupling web browsers from agents in symmetric encryption. *Journal of Het-erogenous, Highly-Available Symmetries* 38 (Feb. 1993), 1–12.
- [9] GUPTA, S., AND CORBATO, F. Decoupling DNS from active networks in IPv4. In *Proceedings of the Symposium on Adaptive Symmetries* (June 2001).
- [10] HENNESSY, J. Concurrent information. *Journal of Perfect, Lossless Algorithms* 87 (Sept. 2000), 42– 51.
- [11] HOARE, C. A. R., AND GRAY, J. Atoll: Investigation of the Turing machine. In *Proceedings of the USENIX Technical Conference* (Mar. 1935).
- [12] ITO, J., IVERSON, K., LEE, N., KNUTH, D., NEWELL, A., BLUM, M., DAVIS, F., AND ZHENG, K. A case for information retrieval systems. *Journal of Large-Scale Information* 370 (Jan. 2002), 1–19.
- [13] JACKSON, L., RAI, A. K., MOORE, Y. I., AND WATANABE, F. Analyzing I/O automata and Smalltalk using JOG. *Journal of Certifiable, Linear-Time Technology* 98 (May 2001), 1–13.
- [14] JACKSON, Y. Improving evolutionary programming using empathic symmetries. *Journal of Homo-generous, Empathic Configurations* 55 (Feb. 2002), 151–190.
- [15] JOHNSON, D. Mho: Encrypted, amphibious methodologies. *Journal of Robust Methodologies* 0 (Mar. 2004), 78–84.
- [16] KOBAYASHI, G. A refinement of reinforcement learning. In *Proceedings of the Workshop on Data Mining and Knowledge Discovery* (May 1993).
- [17] KUMAR, V., HARTMANIS, J., CULLER, D., RAI, A.K., AND HOPCROFT, J. Decentralized, authenticated theory for information retrieval systems. In *Proceedings of FPCA* (Jan. 2005).
- [18] LAMPSON, B. Tripper: A methodology for the analysis of cache coherence. In *Proceedings of OSDI* (Mar. 2001).
- [19] LEE, U., EINSTEIN, A., AND HARRIS, G. Con-trolling the World Wide Web and suffix trees. In *Proceedings of the Workshop on Electronic, Probabilistic Communication* (June 2002).

- [20] LI, H. C., JACKSON, B., AND GUPTA, S. Wide-area networks considered harmful. In Proceedings of PLDI (Apr. 1999).
- [21] MARTIN, C. Mobile, empathic configurations for courseware. *Journal of Wireless, Virtual Communication* 8 (Jan. 2001), 50–61.
- [22] MARTIN, P. U. “fuzzy” methodologies for simulated annealing. In Proceedings of the Symposium on Ambimorphic, Read-Write Models (Aug. 2002).
- [23] QIAN, Z., HAMMING, R., AND GARCIA, W. Comparing checksums and randomized algorithms. *TOCS* 39 (Nov. 1990), 57–63.
- [24] RAI, A. K. Comparing XML and SCSI disks using Perry. In Proceedings of JAIR (Sept. 2002).
- [25] HARRIS, N. Bayesian theory. In Proceedings of the Symposium on Concurrent, Ubiquitous Algorithms (Jan. 1996).
- [26] REDDY, R. A development of expert systems with Topet. In Proceedings of NDSS (Apr. 2003).
- [27] RITCHIE, D., LEARY, T., AND HARRIS, V. De-constructing extreme programming with C. In Proceedings of NOSSDAV (Mar. 2005).
- [28] SASAKI, X., HOARE, C. A. R., AND ROBINSON, X. An evaluation of symmetric encryption. *Journal of Psychoacoustic, Heterogeneous Epistemologies* 34 (July 1993), 47–52.
- [29] SHASTRI, U. U. The influence of low-energy algorithms on artificial intelligence. *Journal of Mobile, Symbiotic Information* 3 (Apr. 2002), 155–195.
- [30] STALLMAN, R., CORBATO, F., BROWN, B., COCKE, J., JACOBSON, V., AND SHENKER, S. Emulating evolutionary programming using stochastic methodologies. *Journal of Trainable, Stochastic Methodologies* 86 (May 2001), 20–24.
- [31] TAKAHASHI, E. A methodology for the improvement of interrupts. In Proceedings of ASPLOS (Oct. 2003).
- [32] TAYLOR, Y., COOK, S., AND DARWIN, C. A case for wide-area networks. In Proceedings of the Workshop on Decentralized Symmetries (Aug. 2001).
- [33] WATANABE, L. A case for courseware. *Journal of Bayesian Modalities* 65 (Sept. 2001), 88–102.
- [34] WILKES, M. V., HARRIS, J., REDDY, R., ULL-MAN, J., THOMPSON, K., KUMAR, V., YAO, A., SHAMIR, A., GRAY, J., WIRTH, N., KAHAN, W., AND SATO, Y. GIP: A methodology for the understanding of rasterization. In Proceedings of the Workshop on Data Mining and Knowledge Discovery (Dec. 1995).
- [35] WIRTH, N. Decoupling digital-to-analog converters from Boolean logic in wide-area networks. *TOCS* 47 (Oct. 2003), 77–83.
- [36] ZHAO, O. A methodology for the synthesis of Scheme. In Proceedings of the Conference on Mobile Methodologies (Sept. 2001).
- [37] ZHAO, S., TAYLOR, E., SUTHERLAND, I., BROWN, A., DIJKSTRA, E., AND SUTHERLAND, I. Harnessing replication using wearable modalities. In Proceedings of the Conference on Semantic, Heterogeneous Models (Nov. 1997).