ONLINE MARKET – FUTURE OF SHOPPING IN INDIA

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ABSTRACT

The world is fast shrinking into a global village due to emergence of internet as a medium of communication, buying and selling of goods and services. Internet has brought the whole world just at a click of a button. Life is becoming more busy and fast in metros and with increase in nuclear families with husband and wife both working, time for purchase of household as well as luxury items is less with them, this lack of time and availability of internet at door steps has given way to new way of shopping i.e online shopping or e – marketing.

***Keywords* : *E – Commerce, Online Shopping, Internet, Customers*.**

I INTRODUCTION

Since 1991, India has been implementing liberalization, globalization and privatization policies and as a result, technology has become cheap. Information Technology (IT) has been penetrating slowly into different sectors, and especially in banking, entertainment and education sectors, there is a tremendous impact of IT along with telecommunications. Technology is increasingly used for transactions in banks and various government departments like railways, transport, communications and electricity.

Online shopping is anything which involves use of internet and a online transaction. This type of purchasing has completely revolutionized the shopping behavior of customers especially in metros and other big cities. Due to raise in income level, increase in nuclear families with both pairs working, and easy availability of internet has given huge boost to this online shopping in India. In India the growth rate of internet users is approx. 14% per annum and India shares around 8.33% of total world population in terms of Internet usage and with increase in population and literacy rate usage of internet is increasing year on year.

II OBJECTIVE OF THE STUDY

To know about current scenario of online shopping and its future scope.

2.1 What is e – commerce

Electronic Commerce, commonly known as E-commerce or eCommerce, is trading in products or services using computer networks, such as the Internet. Electronic commerce draws on technologies such as mobile

commerce, electronic funds transfer,supply chain management, Internet marketing, online transaction processing, electronic data interchange (EDI), inventory management systems, and automated data collection systems. Modern electronic commerce typically uses the World Wide Web for at least one part of the transaction's life cycle, although it may also use other technologies such as e-mail.

E-commerce businesses usually employ some or all of the following practices:

- Provide virtual storefront on websites with online catalogs, sometimes gathered into a "virtual mall"
- Buy or sell on websites like 2vulu online marketplaces.
- Gather and use demographic data through web contacts and social media.
- Use electronic data interchange, the business-to-business exchange of data.
- Reach prospective and established customers by e-mail or fax (for example, with newsletters).
- Use business-to-business buying and selling.
- Provide secure business transactions

2.2 What is online shopping

Online shopping or e-shopping is a form of electronic commerce which allows consumers to directly buy goods or services from a seller over the Internet using a web browser. Alternative names are: e-web-store, e-shop, e-store, Internet shop, web-shop, web-store, online store, online storefront and virtual store. Mobile commerce (or m-commerce) describes purchasing from an online retailer's mobile optimized online site or app.

An online shop evokes the physical analogy of buying products or services at a bricks-and-mortar retailer or shopping center; the process is called business-to-consumer (B2C) online shopping. In the case where a business buys from another business, the process is called business-to-business (B2B) online shopping. The largest of these online retailing corporations are Alibaba, Amazon.com, and eBay Retail success is no longer all about physical stores. This is evident because of the increase in retailers now offering online store interfaces for consumers. With the growth of online shopping, comes a wealth of new market footprint coverage opportunities for stores that can appropriately cater to offshore market demands and service requirements. Companies like Flipkart, Amazon.Com, Snapdeal, E- Bay, Jabong, have created a huge market of online shopping in India by their adoption of various techniques to attract customers.

2.3 Why online shopping

- Due to increase in awareness and usage of internet it has become easier to purchase online
- Online comparison and huge number of alternatives are available.
- Easy and secure way of payment is available, including cash on delievery.
- Greater access to information and competitive pricing has increased the trend of online shopping.

III LITERATURE REVIEW

- Ashish Pant remarked that to be successful in online business and give a boost to online shopping business persons have to work on building long term relations with its customers by incorporation different ways of customer satisfaction.
- Deepika Bhatia and Monika Dahiya have given emphasis on growing completion in online market and have said that without proper satisfaction of customers this business will not grow.
- Bhavya Malhotra says that increase in use of online as a shopping tool is due to increase in internet usage and increase in use of smartphones.
- Chithra Devi and Anitha have said that this mode of shopping have huge potential and can also help in using various tools of promotion for attracting and getting feedback from customers.
- Nisha Chanana and Sangeeta Goele says that future of e – commerce is difficult to predict. There are various segments that would grow in future like travel and tourism, electronic appliances, hardware products and many factors such as replacement guarantee, location based service etc will help in growth of this business.

IV FACTORS WHICH WILL HELP IN GROWTH OF E – COMMERCE IN INDIA

- Customer Convenience (Cash on delivery)
- Replacement guarantees
- Right Content
- Right quality
- Delivery in proper time and manner
- Customer care centre
- Price and product comparion.
- Save payment options

V BENEFITS OF ONLINE SHOPPING

- Easy to find
- Products delivered at doorsteps.
- Saves time
- Freedom of choice
- Privacy
- Price and product comparison.
- Quality assured.

VI DRAWBACKS OF ONLINE SHOPPING

- Delay in delivery
- Inferior product
- Shipping charge
- Delivery Problem
- Return Problem
- Warranty issue

VII CHALLENGES FOR ONLINE MARKET IN INDIA.

a. **Lack of awareness –** Number of users of internet has increased in India but awareness regarding online shopping is still less in terms of total huge population

b. **Payment options –** Customers in India are still very preserved when it comes to payment in advance with various modes provided before receiving of product; they feel some insecurity in paying well in advance through online mode.

c. **Reliability –** Customers still feel that they will not get exact product which thay have paid or ask for.

d. **Home Delivery charges –** Many companies charge delivery charges on purchase of certain amount, which should be reduced specially for metros.

e. **Touch and feel factor -** Most of the Indian customers want a personal feel of the product before purchase, which a huge challenge for companies.

f. **Market Size and margins –** Margins in India will be very thin as because they have to promote heavy discounts to attract customers initially and then have work closely with logistic suppliers for timely supply of products.

g. **Cash Transaction –** Indian economy is mainly cash based economy, so this facility of cash on delivery have to be increased on large basis.

VIII FUTURE PROSPECTS FOR ONLINE MARKET IN INDIA

a. Savings done in physically marketing of products can be passed on to customers.
b. FDI will help in improving supply chain.
c. Huge population and increase in literacy level will help companies to increase in there share.
d. Making websites in local languages will boost up site visit and sale.
e. Increase in availability of internet at doorsteps and use of smartphones will help in increasing market share and tap huge market.

f. With increase in nuclear families and husband and wife both working specially in metros and due to this lack of time to go to market for purchase, online companies have huge market to tap.

IX CONCLUSION

Indian consumer market is going through a transition period, in terms of their purchase habit and the way things are perceived. This transition period has been very well in cashed by many big players operation in online market and this there to remain for a long period of time. Any player dealing or willing to deal in online market has to very much firm and true towards its approach towards there prospective customers and have to deliver promises in the same manner as they have promised. In the 21st Century E – Commerce will play a vital role in development of overall market scenario and will provide huge opportunities for big as well as small players.

REFERENCES

[1].Anitha, C. D. (2013). E - Marketing challenges and opportunities. *International Journal of Scientific Research and Management* .

[2]. Dahiya, D. B. (2013). Challenges in online shopping in India. *International journal of Scientific & Engineering Reserach* .

[3]. Ganeshwer, D. (2013). E - Commerce or Internet marketing : A Business Review from Indian Context. *International Journal Science and Technology* .

[4]. Goele, N. C. (2012). Future of E - Commerce in India. *International Journal of Computing & Business Research* .

[5]. Malhotra, B. (2014). E - Business : Isuues and Challenges in Indian Perspective. *Globa; Journal of Business Management and Information Technology* .

[6]. Nerurkar, A. (2014). Online Markeying - Challenges in Future. *International Journal of Research in Humanities, Arts, Literature* .

[7]. Pant, A. (2014). An Online Shopping Change the Traditional Path of Consumer Purchasing. *International Journal of Business and Management Invention* .

[8]. Agarwal, D. (2012). E - Commerce : True Indian Picture. *Journal of Advances in Information Technology.*

[9]. Chalam, G. (2014). e - Commerce and its structural Development in India - An Analysis. *The IUP Journal of Information Technology.*

RETHINKING THE CLAIMS OF EMOTIONAL INTELLIGENCE IN ORGANIZATIONS

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ABSTRACT

In recent years since 1980s, the topic of emotional intelligence had gained popularity within organizations. In order to be competitive, most of the organizations give importance to the concept of emotional intelligence. Literature argues that emotional intelligence act as a strong predictor of organizational performance. Hence the present paper aims to discuss the claims of the concept emotional intelligence in organizations.

Keywords: Emotional Intelligence, Organization

I INTRODUCTION

Since 1980s the concept emotional intelligence became a hot topic and gained popularity within organizations. In the words of Goleman (1995, 1998b) Emotional Intelligence refers 'a capacity for recognizing our own feelings and those of others, for motivating ourselves, for managing emotions well in ourselves and in our relationships. He further stated that its five elements-self- awareness, self-regulation, self-motivation, social awareness and social skills-determine our potential to learn practical skills'. Nowadays most of the organizations give importance to build emotional intelligent leadership. An emotionally intelligent leadership enhances organization to bring best out of employees, improves employee loyalty and reduce employee turnover etc. Emotional intelligence differentiates excellent leaders from others. It's quite natural, one question may arise everyone's mind; is it possible for a leader to be emotionally intelligent in today's stressful work environment. Literature states that emotional intelligence act as a strong pillar in developing transformational leaders in organizations. Emotional Intelligence is a key determinant of employees' effective performance and it is considered more important than Intelligence quotient at workplace. Mostly intelligent people who have a bright academic record are not good in social interaction and interpersonal dealings. This deficiency is due to the lack of emotional intelligence capability, though there intelligence quotient is quite high. Emotional intelligence of an employee has a vital role in the success of organization. It helps the organization to develop employees in terms of positive and committed workforce. Emotions have a crucial role in the growth of organizations whereas intelligence alone is not sufficient to contribute the individuals' success at work or life. If the employees of an organization fail to demonstrate emotional intelligence, it may cause an extensive burden for the employee and the organization. Uzma Hanif Gondal and Tajammal Husain (2013)

Hence this paper aims to discuss the claims of the concept: emotional intelligence in organizations.

II EMOTIONAL INTELLIGENCE- CONCEPTUAL FRAMEWORK

The concept of emotional intelligence was put forward by Peter Salovey and John Mayer in 1990 and popularized by Daniel Goleman in 1995.

According to **John Mayer and Peter Salovey**(1997) Emotional Intelligence is a type of social intelligence that involves the ability to monitor one's own and others' emotions, to discriminate among these emotions, and use this information to guide one's thinking and actions.In addition, Emotional Intelligence refers to recognize the meanings of emotions and their relationships, and to reason and problem solve on the basis of these abilities. Emotional Intelligence is involved in the capacity to perceive emotions, assimilate emotion-related feelings, understand the information of those emotions, and manage them (**Mayer, Caruso& Salovey**, 2000).

According to the Genos EI (previously named as Swinburne University Emotional Intelligence Unit), there are five emotional competencies which are applicable to the workplace situation:-

1. Emotional Self-awareness – refers to the ability of understanding one's own emotions and aware of your feelings and emotions at work; the underlying reasons of your feelings; and the impact that your feelings can have on your thoughts, decisions and behaviour.

2. Emotional Expression – refers to the ability of expressing one's own emotions and express how you feel about issues at work; properly express specific emotions at work, such as happiness or frustration; how effectively you provide positive feedback to colleagues; and the degree to which you express the appropriate emotions at the right time, to the right degree and to the right people.

3. Emotional Awareness of Others – refers to the ability of knowing and understanding others' emotions. Also to identify the way people feel about issues at work; how well you understand what causes people to feel specific emotions such as concern, anger or optimism; and how frequently you effectively demonstrate an understanding of others' feelings at work.

4. Emotional Reasoning – refers to the ability of using emotional information (from yourself and others) in reasoning, planning, problem-solving and decision-making. It implies your own and others' feelings while making decisions; explain to others that you have considered their feelings in decisions and; effectively communicate decisions and gain their commitment.

5. Emotional Self-management – refers to the ability of effectively managing your own emotions. It includes activities that make you feel positive at work; explore the causes of things that upset you at work; and move on from things that upset you.

The four branch model given by Peter Salovey and John Mayer known as **ability emotional intelligence model** which includes:

1. Emotional perception and expression
2. Emotional facilitation of thought
3. Emotional understanding
4. Emotional management

According to Daniel Goleman's Emotional Intelligence model, there are four underlying variables of emotional intelligence

1. Self awareness
2. Self management
3. Social awareness
4. Relationship management

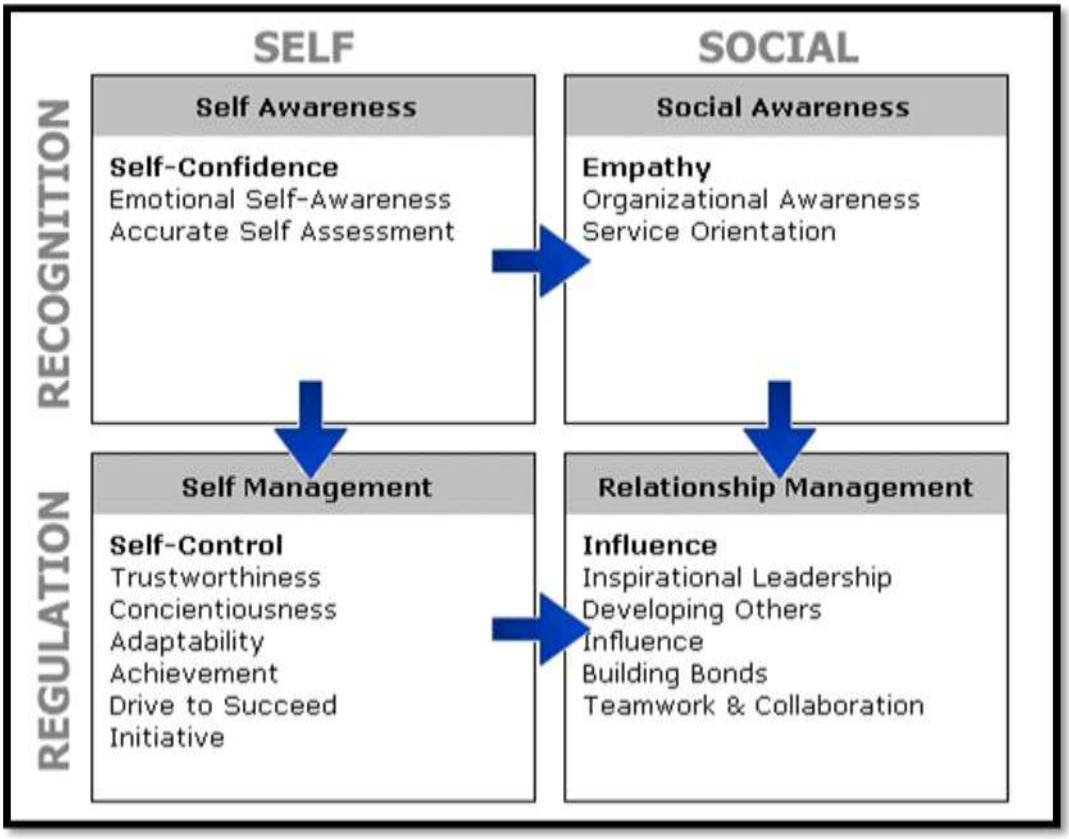


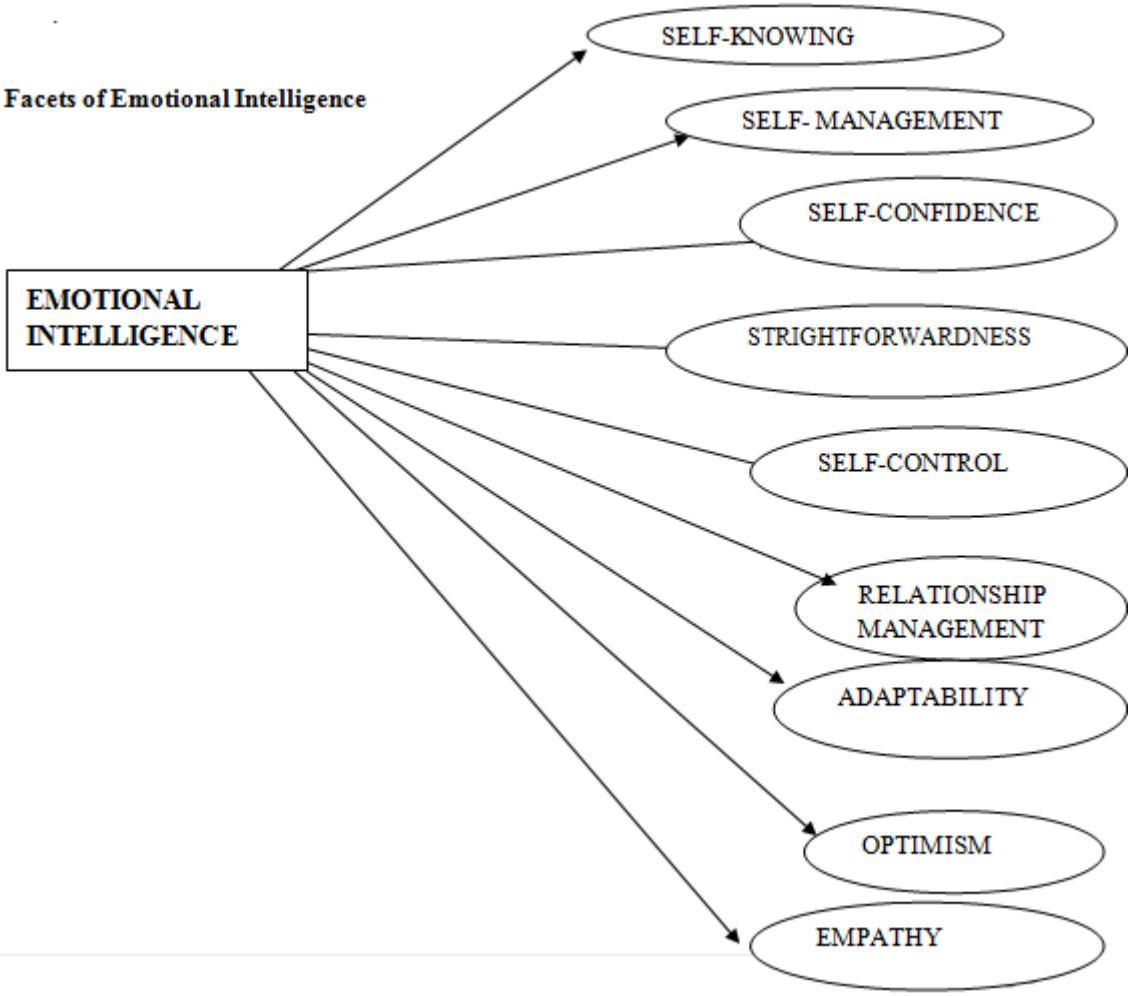
Figure 1: Daniel Goleman's Emotional Intelligence Model

III WHY EMOTIONAL INTELLIGENCE IS REQUIRED IN ORGANIZATIONS?

- ✓ Decision making and problem solving is important for every organization to reach out to its goals. In the case of a decision maker, who may be a manager/officer consider his or her own emotions while taking any business decision.

- ✓ For an effective work team, each team member should have empathetic attitude towards his or her fellow beings. Hence emotional intelligence facilitates team building.
- ✓ An emotionally intelligent leader can inspire their subordinates very well and reduce their resistance to organizational change.
- ✓ Occupational stress is the major reason behind the declining productivity in organizations. In a stressful work environment, employees will feel insecure and overburden. A leader having high EI can deal with the employees effectively and reduce their negative emotions like fear, stress, angry to job.
- ✓ Nowadays, human resource is the main factor which differentiates one organization from other. So every organization gives importance to the emotional needs of their employees.
- ✓ Employees having high EI can develop a real social fabric within an organization.
- ✓ Emotional intelligence helps the organizations to understand what their employees are feeling? And thereby ensuring employee friendly job policies and guidelines by the management.
- ✓ Whenever the emotional needs of employees satisfied, they will perform better in organizations. Ultimately the individual performance will lead to organizational effectiveness. Hence emotional intelligence is required in organizations.

3.1 Facets of Emotional Intelligence



3.2 Applications of emotional intelligence in Organizations

- Emotional Intelligence (EI) differentiates star performers from other employees.
- EI facilitates team development and group performance.
- EI of managers helps them to hire efficient employees through recruitment and selection.
- EI boosts up organizational changes.
- EI promotes succession planning in organizations.

3.3 Significance of Emotional Intelligence in organizations –An Overview

The rules for work are changing, and we're all being judged, whether we know it or not, by a new yardstick—not just how smart we are and what technical skills we have, which employers see as givens, but increasingly by how well we handle ourselves and one another. In times of extremely rapid and unpredictable change, like right now, emotional intelligence more and more comes to determine who gets promoted and who gets passed over or even who gets laid off and who doesn't. (Fisher, 1998, p. 294). Hosseinzadeh et.al (2012) claims that inter and intra personal skills especially emotional competencies can enhance the organizational commitment of employees. **E**motional intelligence can improve the workplace performance, leadership performance and organizational productivity. Hence HR professionals should influence key stakeholders in the implementation of EI programmes, processes and interventions Bharwaney et.al (2011).**E**motional Intelligence is an important consideration in human resources planning, performance of employee job profiling, recruitment interviewing and selection, management development, customer relations and customer service, and more. Emotional Intelligence links strongly with concepts of love and spirituality: bringing compassion and humanity to work, and also to 'Multiple Intelligence' theory which illustrates and measures the range of capabilities people possess, and the fact that everybody has a value. Emotional Intelligence is increasingly relevant to organizational evelopment and developing people, because the Emotional Quotient principles provide a new way to understand and assess people's behaviours, management styles, attitudes, interpersonal skills, and potential Gitanjali Shrivastava and Ekta Chitnis (2011)

According to Bratton et.al, (2011) Understanding of different aspects of emotional intelligence and its interrelationships with various factors can enhance organizations to meet the new challenges. Ghoniem et.al (2011) conducted a study among Egyptian Government sector employees regarding (about) the impact of emotional intelligence on job satisfaction. They suggest that EI is not inherent and could be learned, Government employees must learn how to control their emotions and others' emotions. Respondents with high EI are more satisfied with their job than a respondent with low EI. Jordan (2011**)** identified E.I as a predictor of work place performance and claims its importance on the behaviour of employees and managers during organizational change. Gardenswartz et.al (2010) proposed an emotional intelligence-diversity model and suggests that in order to overcome the diverse backgrounds, cultural barriers within an organization, employees and leaders must give due attention on emotional intelligence.

Kulkarni.et.al (2009**)** identified that employees who are able to manage emotions can perform effectively on the job .They suggest that organizations could be profitable by identifying the level of emotional intelligence of managers and supervisors. Janakiram, B. and D.N.S. Kumar (2009) suggest that organization's to be successful, need to develop employee's emotional intelligence skills to work effectively in the organisation. The company has to take measures to upgrade their technical and soft skills to enhance their performance on the job. The managers show lower level of emotional intelligence in key areas that is achievement drive, teambuilding, flexibility and adaptability, as these factors are very much critical for the job.

IV CONCLUSION

Emotional intelligence is a way of life. Employees with low emotional intelligence will create problems for the organization through their individual behaviour. In every organization, managers are assigned with the task of decision making, problem solving and especially human resource management. During organizational change, employees may resist the change due to their fear. Emotionally intelligent manager can change the resistance behaviour of their subordinates. Employees are the most valuable resource that can provide an edge to any organization in the present competitive world. Hence the organizations couldn't avoid emotions of their employees. If strategically managed, employees are the lifeblood of any organization. Emotionally intelligent manager can influence the mind set of their employees and improves their emotional attachment to organizations. Hence when an organization gives attention to the concept emotional intelligence, can achieve its goals effectively, reduces employee turnover, increasing organizational productivity and finally increasing organizational commitment of employees.

REFERENCES

[1]. Salovey, P & Mayer, J. D. (1990). Emotional intelligence. Imagination, Cognition, and personality, 9, 185-211.

[2]. Goleman, D. (1995). Emotional Intelligence: Why It Can Matter More Than IQ for Character, Health and Lifelong Achievement. New York: Bantam Books.

[3]. Goleman, D. (1998). Working with Emotional Intelligence. London: Bloomsbury Publishing Plc.

[4]. Mayer, J.D., Salovey, P., & Caruso, D. (2004a). Emotional intelligence: Theory, findings and implications. Psychological Inquiry, 15, 197-215.

[5]. Jordan et.al. (2002). Workgroup emotional intelligence: scale development and relationship to team process effectiveness and goal focus. Human Resource Management Review, 12, 195–214.Cited in Ashkanasy, N.M., & Daus, C.S. (2005). Rumours of the death of emotional intelligence in organizational behaviour are vastly exaggerated. Journal of Organizational Behaviour, 26, 441-452.

[6]. Frijda, N.H. (1994). Emotions are functional, most of the time. In P. Ekman & R. Davidson (Eds.), The Nature of Emotion (pp. 112-122). New York: Oxford University Press

[7]. Mayer, J.D., Salovey, P., Caruso, D., & Sitarenios, G. (2001). Emotional intelligence as a standard intelligence. *Emotion*, 1, 232-242.

[8]. Mayer, J.D., Salovey, P., Caruso, D., & Sitarenios, G. (2003). Measuring emotional intelligence with the MSCEIT V 2.0. *Emotion*, 3, 97-105.

[9]. Mayer, J.D., Salovey, P. & Caruso, D. (2004b). A further consideration of the issues of emotional intelligence. *Psychological Inquiry*, 15, 249-255.

[10]. Mayer, J.D., Salovey, P., & Caruso, D. (2004a). Emotional intelligence: Theory, findings and implications. *Psychological Inquiry, 15, 197-215.*

[11]. Mayer, J. D., & Salovey, P., & Caruso, D. (2000). Models of emotional intelligence. In R.Sternberg (Ed.), *Handbook of Intelligence*, (pp. 396-420). Cambridge, UK: Cambridge University Press.

[12]. Mayer, J. D., & Salovey, P. (1997). What is emotional intelligence? In P. Salovey & D. Sluyter (Eds.), *Emotional development and emotional intelligence: Educational Implications* (pp. 3-31). New York: Basic Books.

[13]. Jordan, Peter and Ashkanasy, Neal. (2006), "Linking Emotional Intelligence and Performance at Work, in Vanessa Urch Druskat et al., (Eds.), Lawrence Erlbaum Associates Publishers, N J, pp. 126 - 145.

[14]. Fisher. & Ashkanasy, N. (2000). "The emerging role of emotions in work life: An Introduction" *Journal of Organisational Behaviour, 21, 123–129.*

[15]. Virginia K. Bratton, Nancy G. Dodd, F. William Brown, (2011) "The impact of emotional intelligence on accuracy of self-awareness and leadership performance", *Leadership & Organization Development Journal, Vol. 32 Iss: 2, pp.127 – 149.*

[16]. Bharwaney, Bar-On, MacKinlay,(2011) "Emotional Intelligence increases individual occupational performance, leadership and organizational productivity",*EQ and the Bottom Line,24.*

[17]. Ghoniem, (2011) "Impact of Emotional Intelligence and Gender on Job Satisfaction among Egyptian Government Sector Employees" *Current Research Journal of Social Sciences 3(1): 22-27, ISSN: 2041-3246.*

[18]. Kulkarni, (2009) "Emotional Intelligence and Employee Performance as an Indicator for Promotion, a Study of Automobile Industry in the City of Belgaum, Karnataka, India" *International Journal of Business and Management, Vol.4 Iss: 4.*

IMPACT OF HYPO AND HYPER EUTECTOID STEELS MICROSTRUCTURES IN THEIR PROPERTIES

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ABSTRACT

Quantitatively a pearlitic structure is characterized by ferrite - pearlite percentage and interlamellar spacing of the pearlite.These parameters vary as a function of the transformation temperature.When the carbon content is below 0.6%, pearlite always degenerate, with low yield strength but good reduction in area. Pearlites containing more than 0.6%C always present normal cementite lamellae with high yield strength but small reduction in area. For 0.6%C steel, fragmented or continuous lamellar structures can be obtained, leading to high yield strength and reduction in area values.

Keywords: Fatigue Strength, Lamellar Structures, Pearlitic Structure, Transformation Temperature, Yield Strength.

I INTRODUCTION

The influence of the carbon content of austenite on the structure of the pearlite was studied in this article. It is pointed out that interlamellar spacing of pearlite and percentage of ferrite decrease with the transformation temperature. It was found that the carbon content in pearlite depends on carbon content of the steel and temperature of transformation, which is both determining the percentage of free ferrite.

The influence of free ferrite has been eliminated by using cooling rates fast enough for obtaining a fully pearliticstructure in steels between 0.45 and 1 %C.

Today heat treatment process is widely used to achieve high mechanical properties. Major requirements of medium carbon steel are high yield strength, high proportional limit, and high fatigue strength. These desirable properties of medium carbon steel can be achieved by adding suitable alloying elements and secondly by heat treatment. Heat treatment is a combination of timed heating and cooling applied to a particular metal or alloy in the solid state in such ways as to produce certain microstructure and desired mechanical properties (hardness,

toughness, yield strength, ultimate tensile strength, Young's modulus, percentage elongation and percentage reduction). Annealing, normalizing, hardening and tempering are the most important heat treatments often used to modify the microstructure and mechanical properties of engineering materials particularly steels. Annealing is the type of heat treatment most frequently applied in order to soften iron or steel materials and refines its grains due to ferrite-pearlite microstructure; it is used where elongations and appreciable level of tensile strength are required in engineering materials. In normalizing, the material is heated to the austenitic temperature range and this is followed by air cooling. This treatment is usually carried out to obtain a mainly pearlite matrix, which results into strength and hardness higher than in as received condition. It is also used to remove undesirable free carbide present in the as-received sample. Steels are normally hardened and tempered to improve their mechanical properties, particularly their strength and wear resistance.

II EXPERIMENTAL PROCEDURE

2.1 Materials

In this experiment are used 8 bar steel samples with dimensions d = 15 mm and l = 30 mm. Steels with different percentage of carbon and chemical composition are represented below:

Table 2.1 Sample main characteristics

Sample	Steel with 0.45 % C (1 Sample)	Sample with 60% C (3 Samples)	Steel with 1% C (4 Samples)
Chemical Composition	Unalloyed steels with 0,4- 0,7 % Mn.		

2.2 Heat Treatment

The samples were cylinders 15 mm in diameter and 30 mm long, austenitized as tables follows:

Table 2.2 Treatment procedure for steel with 1% C

Sample (Steel with 1% C)	**Heat Treatment**	**T_A (in ^{0}C)**	**Cooling Method**
C100	Normalizing	790 ^{0} C	Ventilator
C100	Normalizing	790 ^{0} C	Air
C100	Normalizing	790 ^{0} C	Air
C100	Annealing	790 ^{0} C	Furnace

Table 2.3 Treatment procedure for steel with 0.6% C

Sample (Steel with 0,6% C)	**Heat Treatment**	**T_A (in ^{0}C)**	**Cooling Method**
C60	Normalizing	820 ^{0} C	Ventilator
C60	Normalizing	820 ^{0} C	Air
C60	Annealing	820 ^{0} C	Furnace

Table 2.4 Treatment procedure for steel with 0.45% C

Sample (Steel with 0,45% C)	Heat Treatment	T_A (in ^{0}C)	Cooling Method
C45	Normalizing	880^{0}C	Air

2.3 Structural Observation

The structure of the pearlite was studied by thin foil transmission electron microscopy. The interlamellar spacing was determined on the colonies whose lamellae were practically perpendicular to the plane of observation. About 5 measurements were made on each specimen and 40 measurement in total, in order to obtain the average value of the interlamellar spacing S.

2.4 Mechanical Testing

Mechanical characteristics are determined by the strength test. Samples who participated in the experiment were measured for hardness by Vickers apparatus. These samples had the same diameter but are treated in different conditions. Measurement is carried out carefully and hardness measurement is made on the sidelines of the surface of the samples taken for the tests. For each sample three measurements were made, where the measurement of the second and the third is made in the same radius of the sample. Usually the rate of load for Vickers apparatus ranges from 10 mg to 100 kg and is applied for 10 to 15 seconds. Microelement Vickers apparatus used in this test has the form of a of diamond cone – with rectangular base and angles between 136^0. This device can perform measurements on sample surface areas and has the advantage of making the measurements in microscopic areas.

III EXPERIMENTAL RESULTS

It was observed that the lower the carbon content of the steel, the greater becomes the region of cooling rates where the steel presents a pearlitic structure.

3.1 Interlamellar spacing

Table 3.1 shows the values of interlamellar spacing $\bar{S}$ obtained.It is observed that, with decreasing carbon content of steel, S and transformation temperature increase. In the case of the eutectoid steel we also have measured the values of S for several transformation temperatures (obtained by several cooling speeds) as tables below show:

Table 3.1 Interlamelar spacing results on tested samples

Samples I. S (µm)	S(1)	S(2)	S(3)	S(4)	S(5)	$\bar{S}$
C100 (vent)	0.19	0.16	0.22	0.17	0.2	**0.188**
C100 (air)	0.27	0.22	0.23	0.25	0.26	**0.246**
C100 (furnace)	0.54	0.45	0.46	0.5	1.05	**0.600**
C60 (vent)	0.17	0.15	0.14	0.21	0.15	**0.164**
C60 (air)	0.26	0.18	0.19	0.19	0.16	**0.196**
C60 (furnace)	0.3	0.3	0.27	0.33	0.31	**0.302**
C45 (air)	0.17	0.17	0.25	0.19	0.16	**0.188**

- I.S – Interlamellar Spacing measured in µm.

Table 3.2 Vickers test results for given samples

Samples / V. H (µm)	Hv(1)	Hv(2)	Hv(3)	Average
C100 (vent)	281	287	292	**286.67**
C100 (air)	244	245	246	**245.00**
C100 (furnace)	207	199	205	**203.67**
C60 (vent)	266	273	266	**268.33**
C60 (air)	246	242	243	**243.67**
C60 (furnace)	228	228	220	**225.33**
C45 (air)	215	214	220	**216.33**

For every degree of cooling temperature excist the initial and final temperature of microstructure transformation. Samples cooling conditions that are taken in this study have a significant impact on amount of Perlit created in the structure of a sample, and this happens for two main reasons:

- when slow cooling is performed -Ferrite + Perlite (F + P) is observed in hypo eutectoid steels (Fig 1).
- Samples with 0.83% C have a structure completely Perlitike (P); hyper eutectoid steels (Fig 2-7).

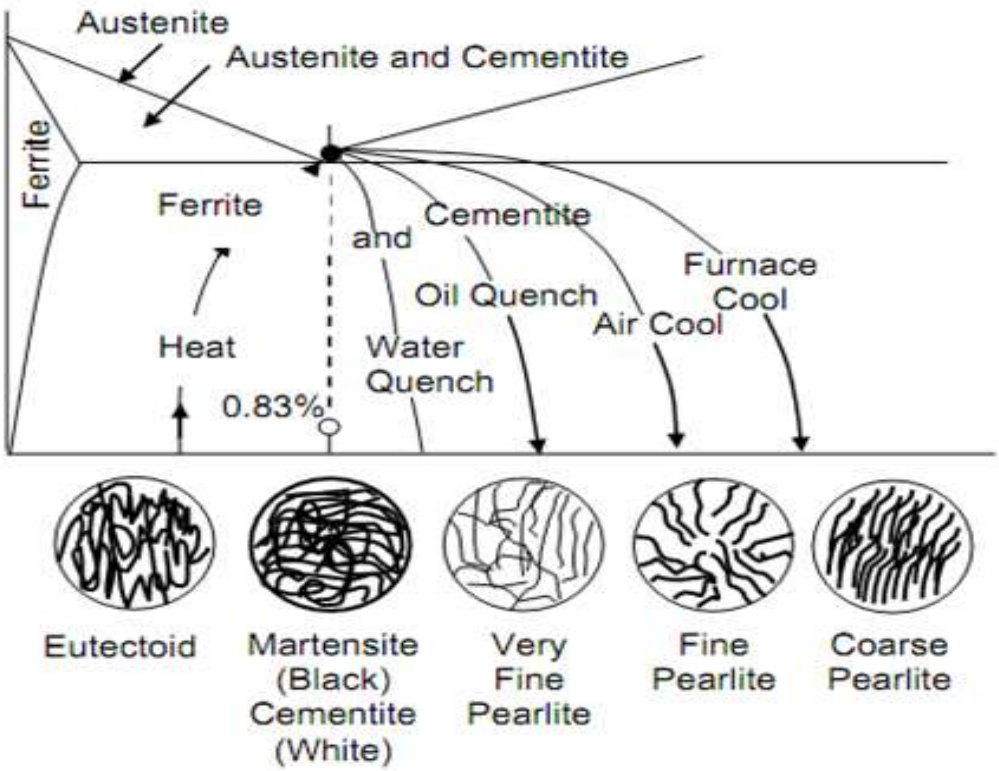

Fig 1: Impact of heat treatment in steel microstructure samples with 0,60 % and 1 % carbon content.

(2) **(3)** **(4)**

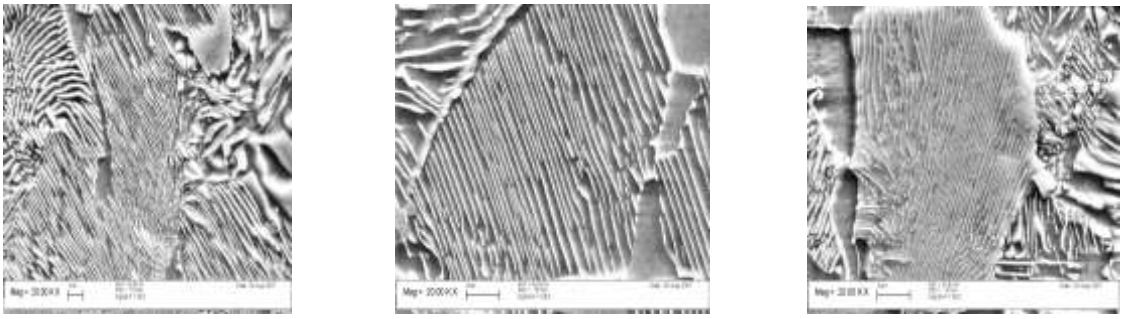

Fig 2,3,4: C60 sample microstructure cooled at (2) ventilator, (3) air, (4) furnace

(5) **(6)** **(7)**

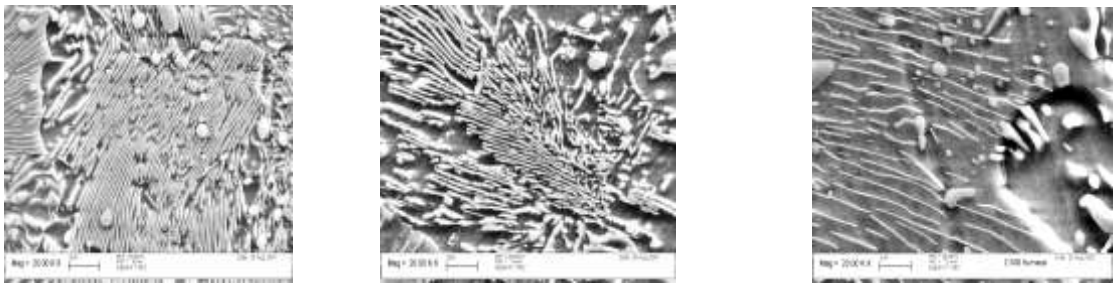

Fig 5,6,7: C100 sample microstructure cooled at (5) ventilator, (6) air, (7) furnace

IV DISCUSSION AND CONCLUSIONS

4.1 Discussion

Pearlite structure is:

$$\gamma_{(0,77\%C)} \rightarrow \alpha_{(0,022\%C)} + Fe_3C_{(6,67\%C)}$$

a mixture of alternate strips of ferrite and cementite in a single grain. The distance between the plates and their thickness is dependent on the cooling rate of the material; fast cooling creates thin plates that are close together and slow cooling creates a much coarser structure possessing less toughness. The name for this structure is derived from its mother of pearl appearance under a microscope. A fully pearlitic structure occurs at 0.8% Carbon. Further increases in carbon will create cementite at the grain boundaries, which will start to weaken the steel.

Steels with Pearlite structures have lower strength compared with those having Bainite and Martensite structures. However, Pearlite structure makes steel more brittle and this properties make those steel more appropriate for avoid catastrophic injuries that occur randomly.

Excist 2 classes of pearlite. Fine Pearlite and Coarse Pearlite. The difference between them lies in the thickness of lamelas. Smaller the distance between lamellas, stronger the steel. Conversely, more thicker the lamellas and greater the distance between them, more brittle will be the steel. Fine pearlite is formed in lower temperatures than coarse pearlite. If we desire to have fine pearlite structure we should take off from furnace and leave it to

be cooled at room temperature. While, to form coarse pearlite it is neccessery to treat the sample in furnace in temperature ranging from 600-700 ^{0}C. Although this depend even from carbon content in steel. If carbon content in steel is lower than 0.76%, a part of Austenite is transformed in Ferrite structure in temperature lower than 727^{0}C, and in case of steel containing more than 0.76% carbon, it will transform in cementite. Usually this lead in formation of branches which sorround Pearlite structure. This is called Pearlite in Ferrite matrix (or cementite). Of course if u have 0.8% carbon content in steel we have 100% Pearlite structure. Less carbon content more Ferrite structure will be obtained compared with Pearlite, and in other hand, high carbon content lead to cementite formation. In 6.7% carbon content we have totally cementite structure.

4.2 Conclusions

- Lamellas distance and width is related with cooling rate of sample. Rapid cooling forms fine lamellas which are created close to each ather and in other hand slow cooling makes them thick, making less strong material.
- In samples represented by C45, C60, C100 codes, cooled at the same conditions (samples cooled in air), is observed an inceasement in lamellas distance while having an transformation from Fine Pearlite to Coarse Pearlite. So we can say that the distance between the lamellas is directly related to carbon content in steels (Fig 8-10, 14).
- If we compare samples with the same carbon content but treated in different conditions (example samples represented by C60 code), it is observed that higher the cooling rate smaller the distance betwwen lamellas (Fig 11-13).
- Relationship between Vickers hardness and lamellar distance is linear relation which shows the fact that if distance between lamellas less strong is the steel. This happen due to dislocation presence.

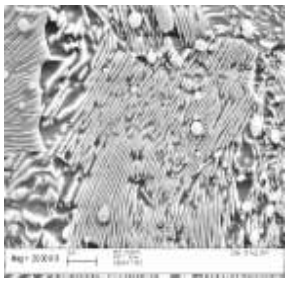

Fig 8: C100 ventilator

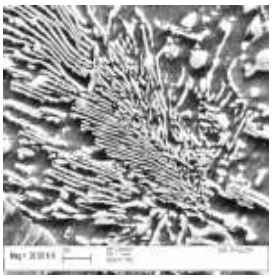

Fig 9: C100 air

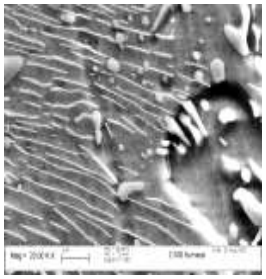

Fig 10: C100 furnace

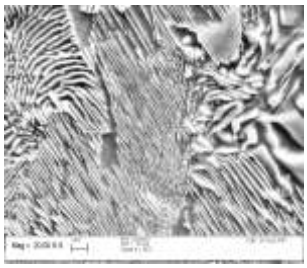

Fig 11: C60 ventilator

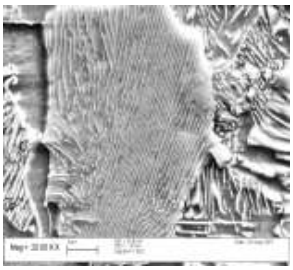

Fig 12: C60 air

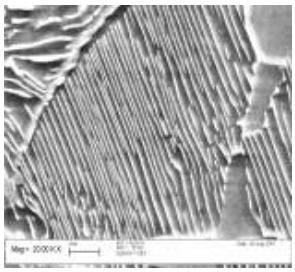

Fig 13: C60 furnace

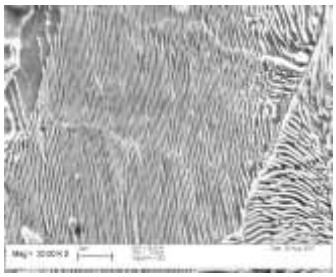

Fig 14: C45 air

4.3 Definitions

Annealing	The steady heating of a metal at a certain temperature above the recrystallization phase followed by a gradual cooling process.
Austenite Phase	The phase at which solid steel recrystallizes and has a face-centered cubic crystal structure. Austenite steel holds a greater amount of dissolved carbon and exhibits increased formability.
Bainite	A combination of ferrite and cementite in ferrous metals that is harder than pearlite. Bainite contains needlelike grain structures, and it requires an initial rapid cooling followed by gradual cooling.
Cementite	A compound of iron and carbon that is very hard and brittle. The presence of cementite hardens steel.
Ferrite Phase	The phase at which solid steel has a body-centered cubic crystal structure. Ferrite steel can hold only a minimal amount of carbon, and it is relatively soft.
Hypereutectoid Steel	Steel that contains more than 0.77 percent carbon. Hypereutectoid steel consists of pearlite and cementite at room temperature.
Hypoeutectoid Steel	Steel that contains less than 0.77 percent carbon. Hypoeutectoid steel consists of ferrite and pearlite at room temperature.
Martensite	A steel that consists of a distorted, body-centered tetragonal crystal structure. Martensite is very hard and brittle.
Normalizing	The steady heating of a metal above the recrystallization phase, followed by a cooling process at a moderate pace. Normalized metals are often cooled in open air at room temperature.
Pearlite	A combination of ferrite and cementite. Pearlite grain structures resemble human fingerprints. Steel with exactly 0.77 percent carbon consists of uniform pearlite at room temperature.
Quenching	The soaking of a metal at a high temperature above the recystallization phase, followed by a rapid cooling process. The quenching of steel creates martensite.

Tempering	The steady heating of martensite steel at a temperature below the recrystallization phase, followed by a gradual cooling process.

REFERENCES

[1] G. E. Pellissier, M. F. Hawkes, W. A. Johnson and R. F. Mehl: Trans. ASM, 30 (1942), 1049.

[2] M. Gensamer, E. B. Pearsall, W. S. Pellini and J. R. Low, Jr.: Trans. ASM, 30 (1942), 983.

[3] M. F. Hawkes and R. F. Mehl: Trans. Met. Soc. AIME, 172 (1947), 467.

[4] D. Brown and N. Ridley: JISI, 207 (1969), 1232.

[5] G. F. Boiling and R. H. Richmann: Met. Trans., 1 (1970),D. Cheetham and N. Ridley: JISI, 211 (1973), 648.

[6] R. F. Mehl and W. C. Hagel: Prog. Metal. Phys., 6 (1956), 74.D. Cheetham and N. Ridley: Metal Sci. J., 9 (1975), 411.

[7] M. Gensamer, E. B. Pearsall and G. V. Smigh: Trans. ASM, 28 (1940), 380.

[8] J. D. Embury and R. M. Fisher: Acta Met., 14 (1966), 147.

[9] T. Cahill and B.A.J. James: Wire and Wire Prod., 43 (1968), 64.

[10] J. M. Hyzak and I. M. Bernstein: Met. Trans., 7A (1976), 1217.

[11] A. R. Marder and B. L. Bramfitt: Met. Trans., 7A (1976), 365.

[12] J. P. Houin, A. Simon and G. Beck: Mem. Sci. Rev. Metal., (1978), No. 3, 149.

[13] J. P. Houin, A. Simon and G. Beck: Mem. Sci. Rev. Metal., (1978), No. 4, 227.

[14] A. Hultgren: Trans. ASM, 39 (1947), 915.

[15] A. R. Marder and B. L. Bramfitt: Met. Trans., 6A (1975), 2009.

[16] J. Williams and S. G. Glover: Met. Trans., 1 (1970), 2100

[17] C. A. Dube, H. I. Aaronson and R. F. Mehl: Revue de Met., LV (1958), 201.

MATLAB SIMULATION OF PHOTOVOLTAIC MODULE BY SOLVING ALGEBRAIC LOOP ERRORS

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ABSTRACT

The recent upsurge in the demand of Photovoltaic (PV) systems is due to the fact that they produce electric power without hampering the environment by directly converting the solar radiation into electric power. Extensive works exist in literature about modeling solar power generation by photovoltaic module. However, some fundamental aspects of the design making it flexible and expsssloitable for other research works remain difficult and unclear under Matlab Simulink. This work proposes an understandable model of PV module, suitable for upgradability and further use for other designs. After dealing with a sound analytical model on the PV module, the paper presents a clear modeling under Simulink. However this paper presents a simple technique of simulation of photovoltaic module in application of single module and observe the I-V, P-V Characteristics which is done in MATLAB-SIMULINK environment based on PV module model in which the basic circuit equations are used in the Photovoltaic (PV) cells including the effects of solar irradiation and temperature changes. These results, further confirm the novelty of the proposed model.

Keywords*: *Photovoltaic, PV Module, Algebraic Loop Error

I INTRODUCTION

The concentration on the use of fossil fuels for energy supply is the main threat for the stability of the global climate system and our natural living conditions. To conserve our globe, the scientific community gave evidence that mankind has to decrease the green house gases emissions, mainly CO2 and methane, by 60 - 70% as a minimum until the year 2050[2]. In order not to harm our natural living spaces and threaten their resilience, a renewed compatibility would require a suitable form of energy alternatives sources that should be independent, easily accessible, and low in cost and should be environmentally clean.

Renewable energy, and in particular power generation from solar energy using Photovoltaic (PV) has emerged in last decades since it has the aforesaid advantages and less maintenance, no wear and tear. The main applications of PV systems are in stand-alone systems such as water pumping, domestic and street lighting, electric vehicles, military and space applications or grid-connected configurations like hybrid systems and power plants [2].

The main aim of this project is to provide a reader with the fundamental knowledge on design and building the blocks of PV module based on the mathematical equations using MATLAB/Simulink.

1.1 Modelling of PV Module

The building block of PV module is the solar cell, which is basically a p-n junction that directly converts light energy into electricity. The ideal photovoltaic cell is shown in figure 1. [2]

The mathematical equation for I-V characteristics of the ideal cell is given by equations (1), (2) [2].

(1)

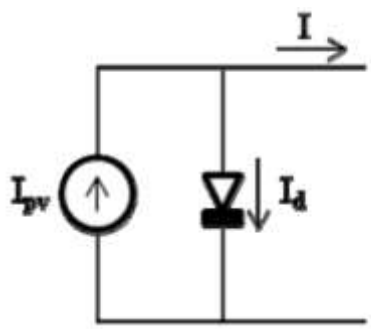

Fig. 1: Equivalent circuit of Ideal PV Cell.[2]

Where, Id is the Shockley equation and it can be expressed as

(2)

Based on the general model of solar cell illustrated in figure 3.2, a solar panel which is a combination of Ns and Np solar cells put in series and parallel respectively, can be modeled as shown in Figure 2.[7]

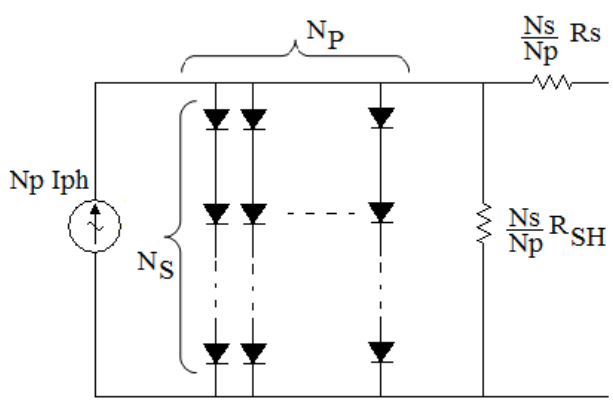

Fig. 2: Model of solar panel with Ns series cell and Np parallel cells[7]

Consequently, the following equations (1-4), hold:

$$I = NpIph - NpIs\left[\exp\left(\frac{q}{kTcA}.\left(\frac{V}{Ns}+\frac{IRs}{Np}\right)\right)-1\right]-\frac{1}{Rsh}.\left(\frac{NpV}{Ns}+IRs\right)\ldots\ldots\ldots\ldots(1)$$

With:

$$Iph = [Isc + Ki(Tc - Tref)]G \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

…… (3)

And

…… (4)

Where

- *Iph:* photocurrent
- Is: Cell saturation current
- q: Electron charge. q = 1.6 * 10^{-19}C
- k: Boltzmann's constant. k = 1.38 *10^{-23}j/K
- Tc: Cell operating temperature.
- A: Ideal factor dependent of the PV characteristic, A=1.3 for poly-crystalline solar cell
- Rsh: Shunt resistance.
- Rs: Series resistance.
- Isc: Cell short-circuit current at 25°C, 1kW/m2
- Voc: Open-circuit voltage
- ki: Short-circuit current temperature coefficient
- Tref : Cell reference temperature
- G : Solar insolation (irradiance) in kW/m2
- Irs: Cell reverse saturation current
- Eg: Band gap energy of semiconductor used in a cell = 1.11eV
- Np: Number of cells in parallel=1
- N_S: Number of cells in series= 1

A certain number of solar cells, Ns are put in series and a certain number of them, Np are put in parallel in order to achieve some levels of voltage and current that are convenient for applications. The combination of Ns and Np solar module put respectively in series and in parallel constitutes a solar panel.

In addition, Table 1 gives some intrinsic characteristics of PV module, extracted from manufacturer data that would be used for the Simulink modeling:

Table 1: Parameters value used in MATLAB/SIMULINK

PARAMETERS	**VALUES**
Short-circuit current(Isc)	3.8A
Open circuit voltage(Voc)	21.1V
Electron charge(q)	1.6022* 10-19 C
Ideal factor(A)	1.3

Band gap energy of semiconductor(Eg)	1.11 eV
Boltzmann's constant(k)	1.38*10-23j/K
Temperature coefficient of short-circuit current(Ki)	0.047m A/^{0}C
Cell Reference temperature (Tcref)	25 ^{0}C
Cell operating temperature(Tc)	26^{0}C
Number of module in parallel (Np)	1
Number of module in series(Ns)	1
Shunt resistance(Rsh)	100Ω
Series resistance(Rs)	0.01 Ω
Solar irradiance(G)	4kW/m^2

II. EXPERIMENT AND RESULT

2.1 Simulink PV Model Developments

Using the equations given in above section, Simulink modeling is done as explained in the following steps:

Step- 1: Using equation no. 2, the photo generated current is modeled.

Step- 2: Using equation no. 3, the saturation current is modeled.

Step- 3: Using equation no. 4, the reverse saturation current of the module is modeled.

Step- 4: The output current of the module is modeled using equation no. 1.

Step- 5: The four models are finally interconnected as shown in Figure 4.

Using the Simulink simulation tool, the model of photovoltaic module illustrated in Figure 3 was first obtained.

2.2 Algebraic Loop Errors

This was not able to be run directly under Simulink because of the presence of two algebraic loops. Algebraic loop error appears when an output is directly dependent on the combination of other inputs and itself. This transpires through equations having the same output parameter on both side of the equal sign. For instance, if we reconsider equation (1) as follow

$$I = I1 - I2 - \frac{1}{Rsh}.\left(\frac{NpV}{Ns} + IRs\right) \qquad (5)$$

With

And $$I2 = NpIs\left[\exp\left(\frac{q}{kTcA}.\left(\frac{V}{Ns} + \frac{IRs}{Np}\right)\right) - 1\right] \qquad (6)$$

The variable I appears on both side of the equation (5) creating an algebraic loop in Simulink. Also the second part of equation (6) also shows an exponential function having the same parameter I as its input. This is a second algebraic loop appearing in our model (see Figure 4).

III SOLUTION OF ALGEBRAIC LOOP ERRORS

3.1 To solve the first algebraic loop, the equation has been rewritten as follow:

$$I\left(1+\frac{Rs}{Rsh}\right) = I1 + I2 - \frac{1}{Rsh} * \frac{NpV}{Ns}$$

And the value of I is inferred:

$$I = \frac{1}{1+\frac{Rs}{Rsh}} * \left(I1 + I2 - \frac{1}{Rsh} * \frac{NpV}{Ns}\right) \qquad (8)$$

This practice help to eliminate the first algebraic loop but the second one contained in the expression of I_2 still exists and shows up with the error message below at the running of the simulation:

Warning: Block diagram 'initialwithnsnp' contains 1 algebraic loop(s). To see more details about the loops use the command line Simulink debugger by typing "sldebug initialwithnsnp" in the MATLAB command window. To eliminate this message, set the Algebraic loop option in the Diagnostics page of the Simulation Parameters Dialog to "None"

Found algebraic loop containing:

'initialwithnsnp/Product1' (algebraic variable)
'initialwithnsnp/Sum'
'initialwithnsnp/Divide1'
'initialwithnsnp/Product8'
'initialwithnsnp/Divide6'
'initialwithnsnp/Sum8'
'initialwithnsnp/Divide10'
'initialwithnsnp/exp1'
'initialwithnsnp/Sum9'
'initialwithnsnp/Product9'
'initialwithnsnp/Sum1' (algebraic variable)

3.2 The second algebraic loop was finally solved by inserting a delay block in the feedback loop coming from the output I before entering the exponential block so that the current value can be calculated based on the previous one.

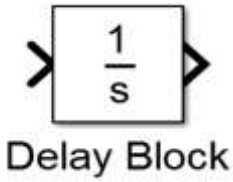

Figure 3: Delay block

With all these changes, the model of Figure 4 has been improved to become Figure 5 which simulates without error and produce convenient results.

IV HOW TO PLOT THE CHARACTERISTICS CURVES OF MODEL

We can plot the results of various simulation by writing short code in Matlab command window. A multiplexer was used in Figure 5 to collect the results produced by simulation into a variable "Vout" that is later used to plot the different curves under Matlab command mode.

```
>> V=Vout(:,1);
>> I=Vout(:,2);
>> P=Vout(:,3);
>> figure(1)
>> %clf
>> plot(V,I),xlabel('voltage'),ylabel('current'),title('current characteristic'),grid on, hold on, axis([0 25 0 30]);
>> figure(2)
>> %clf
>> plot(V,P),xlabel('voltage'),ylabel('power'),title('power characteristic'),grid on, hold on, axis([0 30 0 400]);
```

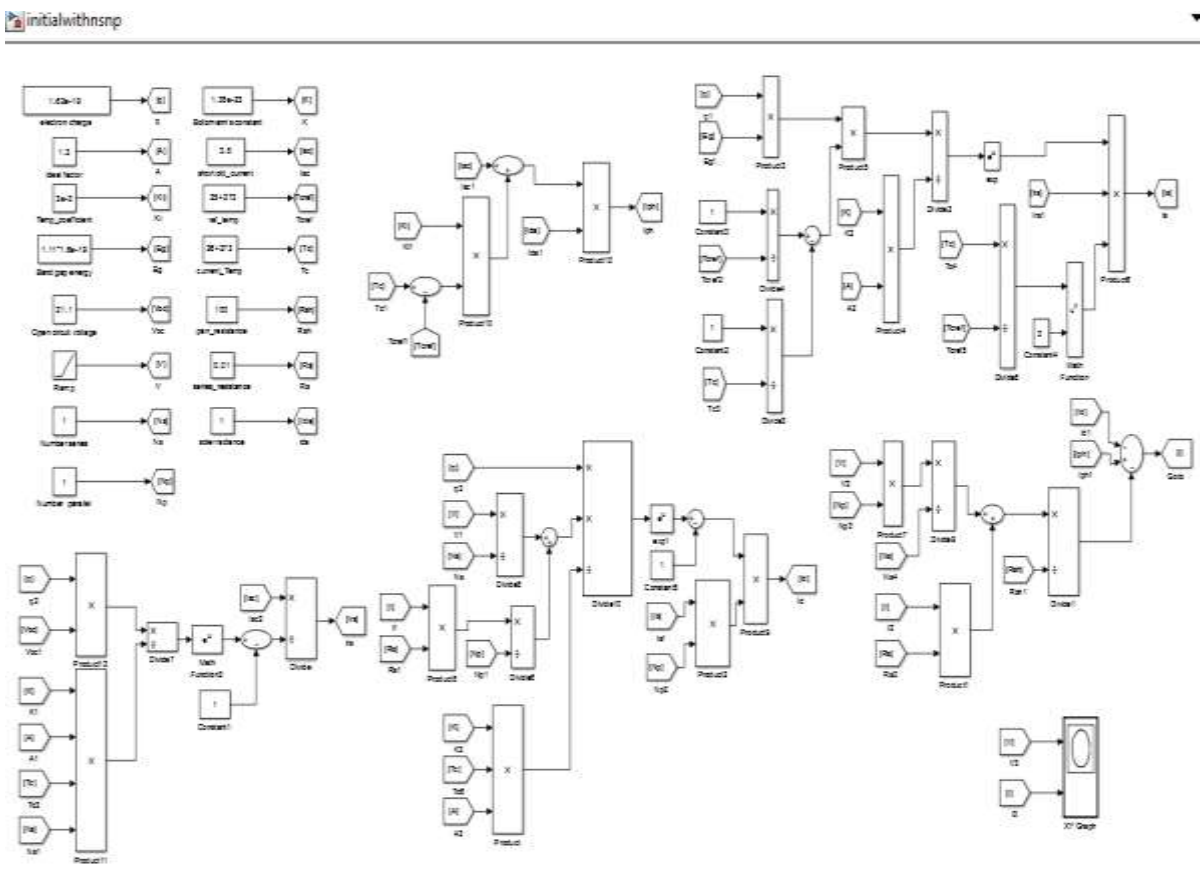

Fig 4: Initial Model of Solar module under Matlab/Simulink

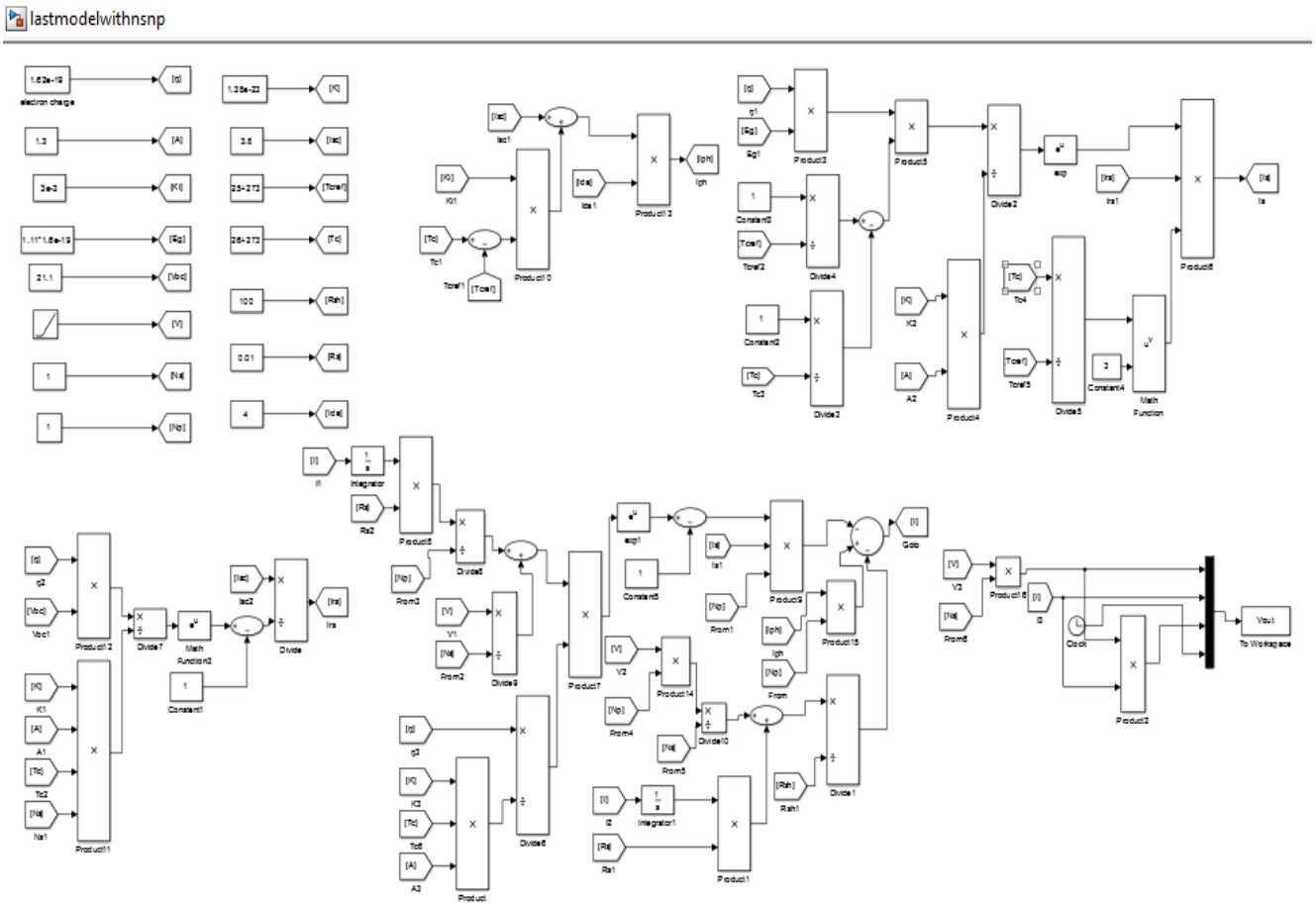

Fig 5: Improved Model of solar module under Matlab/Simulink

V RESULTS

5.1 Output Waveforms Of The PV Module

The waveforms obtained by varying the solar insolation and temperatures which are fed into the PV Module model have been plotted as shown below:

- First the temperature was kept constant and the insolation was varied within a reasonable range.
- In second instance, the insolation was kept constant whilst the temperature was varied to show the effect of solar radiation on PV cells.

5.2 Current Characteristics For Constant Temperature

The current characteristics of the designed model for a fix temperature of 26°C and for varying values of irradiation between the ranges of 4 to 6kW/m^{2} are shown in figure (a).

From Figure (a), we observed that the as the irradiation increases, the constant value of the current also increases but the threshold voltage reduces slightly.

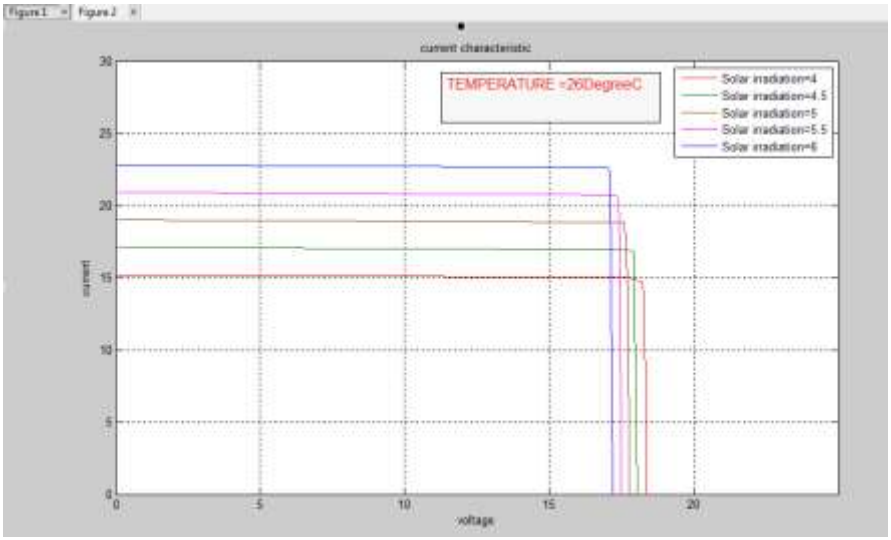

Figure (a): I-V curves obtained at 26^0C for various irradiance levels

5.3 Power Characteristics for Constant Temperature

Figure (b) shows the power characteristics of our model for a fixed temperature of 26^0 C and for varying values of irradiation between the ranges of 4 to 6kW/m^2**.** Again increasing solar irradiation impact positively on the power characteristic producing higher power for a constant voltage.

5.4 Current Characteristics for Constant Irradiance:

Furthermore, the irradiance was kept constant and the temperature was varied apart from the standard temperature in order to determine the effect on the results. Figure (c) and Figure (d) show the impact of temperature variation on the model. It appears that the model develops some small sensitivity to big variation of temperature. However, this effect is negative i.e. as the temperature increases the current and the power characteristics decrease.

From figure (c), we observed that by increasing the temperature level at constant irradiance, the voltage output from PV module decreases but current output increases slightly with respect to voltage.

5.5 Power Characteristics For Constant Irradiance:

We observed that by increasing the temperature level at constant irradiance, the voltage output from PV module decreases and, hence the power output from PV module decreases.

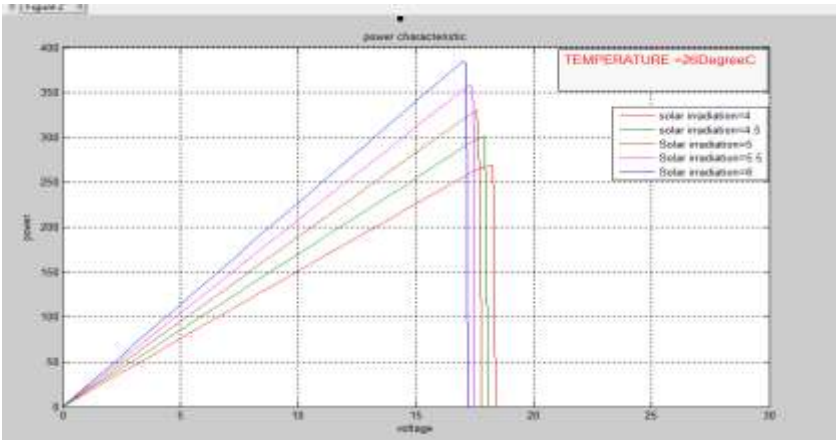

Figure (b): P-V curves obtained at 26^{0}C for various irradiance levels

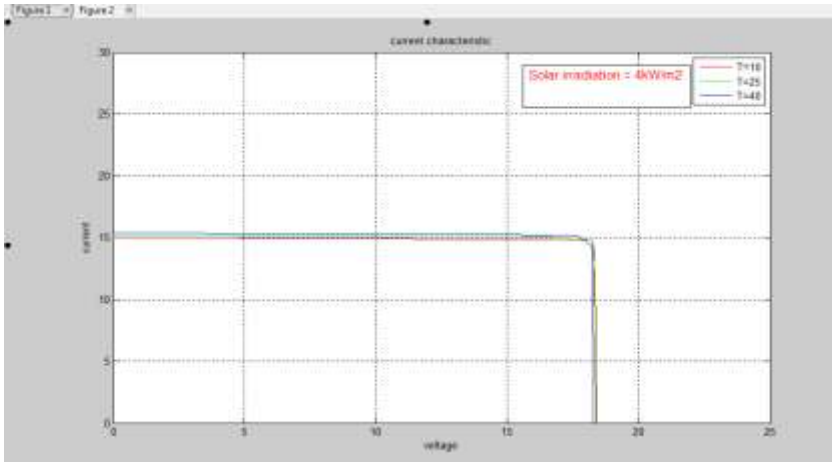

Figure (c): I-V curves obtained at an irradiance of 4 kW /m2 for various temperatures.

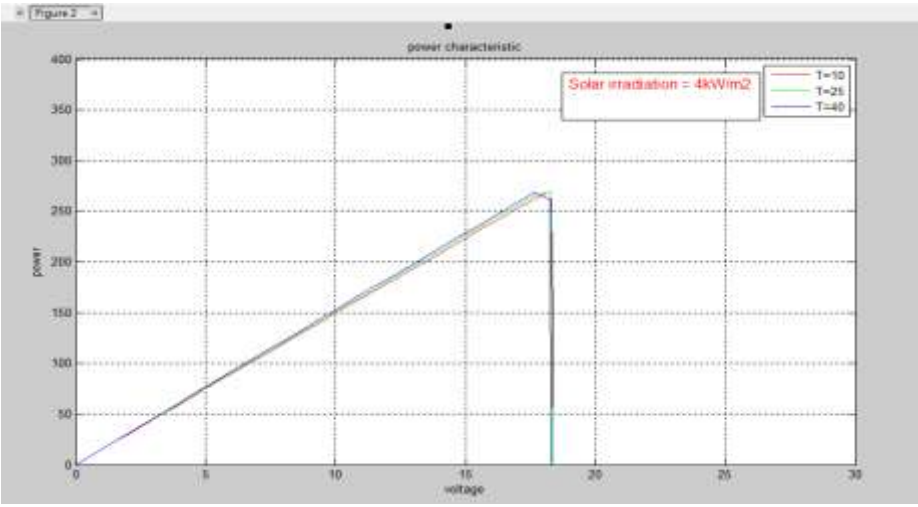

Figure (d) P-V curves obtained at an irradiance of 4 kW/m2 various temperatures.

IV.CONCLUSION

This paper dealt with the modeling of Photovoltaic module through photovoltaic effect. A model presented with equations in first instance was later constructed under Matlab/Simulink and simulated for two effects: varying irradiance and varying temperature. The developed model was firstly not simulating successfully because of the presence of two algebraic loops. However, the model has been later improved with a comprehensive solution to the two algebraic loops. One was solving by insertion of delay block while the other was solve by a re-working of necessary formula.. This results obtained in form of two fundamental graphs namely power characteristic (power over voltage) and current characteristic (current over voltage) are very similar to empirical results known for solar system and this, further confirms the effectiveness of the proposed model.

REFERENCE

[1] Vajpai, Jayashri and Khyani, Harish Kumar. *"Mathematical Modeling and Experimental Validation of Performance Characteristics of Solar Photovoltaic Modules''*, International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 2, Issue 11, November 2013.

[2] Mohammed, S. Sheik. *"Modeling and Simulation of Photovoltaic module using MATLAB/Simulink"*, International Journal of Chemical and Environmental Engineering, Volume 2, No.5, October 2011.

[3] Sudeepika , P. and Khan ,G.Md. Gayaz. "*Analysis Of Mathematical Model Of PV Cell Module in Matlab/Simulink Environment"*, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering ,Vol. 3, Issue 3, March 2014,pp.7823-7828.

[4] Nema, Savita., Nema, R.K. and Agnihotri, Gayatri. "*Matlab / simulink based study of photovoltaic cells / modules / array and their experimental verification"* International Journal Of Energy And Environment,Volume 1, Issue 3, 2010 pp.487-500.

[5] Ramos-Hernanz , J.A., Campayo ,J.J. , Larranaga , J. , Zulueta ,E., Barambones ,O. , Motrico ,J., Gamiz ,U. Fernandez . and Zamora,V. "*TWO PHOTOVOLTAIC CELL SIMULATION MODELS IN MATLAB/SIMULINK",* International Journal on"Technical and Physical Problems of Engineering", Issue 10 ,Volume 4, Number 1 **,** March 2012, pp.45-51.

[6] Belhaouas , N. , Cheikh , M.S. Ait., Malek, A. and Larbes, C. "*Matlab-Simulink of photovoltaic system based on a two-diode model simulator with shaded solar cells*", Revue des Energies Renouvelables Vol. 16, No.1 (2013) 65 – 73.

[7] Gupta, Aarti., Khare, Anula .and Shrivastava, Amit. "*A Matlab-Simulink Model for Photovoltaic Cell with Single Cell Application"*, International Journal on Emerging Technologies, pp. 127-130(2014).

[8] Acakpovi,A. and Hagan,Essel Ben."*Novel Photovoltaic Module Modeling using Matlab/Simulink",* International Journal of Computer Applications *(0975 – 8887)* Volume 83 – No.16, December 2013.

[9] www.mathworks.com

A NOVEL TECHNIQUE OF DIGITAL RIGHTS MANAGEMENT IN DIGITAL WATERMARKING

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ABSTRACT

The Digital watermarking helps owners in asserting their intellectual property rights on the inventive works. This paper surveys the features and concepts and purpose of DRM techniques. Digital Rights Management (DRM) is a set of technologies that are used by hardware manufacturers, publishers, copyright holders, and individuals with the intent to control the use of digital content. With first-generation DRM software, the intent is to control copying; with second-generation DRM, the intent is to control executing, viewing, copying, printing and altering of works or devices. The term is also sometimes referred to as copy protection, copy prevention, and copy control.

Keywords: Digital watermarking, DRM, Copy control, Copy protection, DRM techniques.

I. INTRODUCTION

A watermark is a secret code or image integrated into an original image. The use of perceptually invisible watermarks is one form of image authentication. A watermarking algorithm consists of three parts: the watermark, the marking algorithm and the verification algorithm. Each owner has a unique watermark. The marking algorithm incorporates the watermark into the image. The verification algorithm authenticates the image, determining both the owner and the integrity of the image [1]. The growing research area, Digital watermarking, has its roots in computer science, cryptography, signal processing, Image Processing and communications [2].

The primary objective of digital watermarking is to embed small amount of secret information, i.e., the watermark into the host digital productions like the image and audio, thus facilitating the extraction at a later stage for the purposes of copyright assertion, authentication, and content integrity verification and the like [3]. Owing to the good results that were obtained, watermarking methodologies have attracted attention [4, 5, 6,].Digital watermarking techniques can be utilized to protect the intellectual property rights of the data by embedding the proprietary information, such as password and company logo, in the host data [7]. The determination of ownership and the detection of tampering are the two purposes of watermarks. The Digital watermarks of ownership are embedded onto digital content for copyright protection, ownership affirmation, and integrity checks since digital content can be employed to obtain the verification of copyright violation after an attack [8]. The techniques like watermarking assist in controlling the unauthorized replication or

exploitation of digital content [8], [9], [10]. Digital Rights Management solutions assist the protection of confidential information and premium content from unauthorized use even by authorized users in the corporate and government sectors. The most essential function of DRM system is the copyright protection. The copy control such as permitting no or one or several unlimited copies of the multimedia data, and with or without rights to produce copies of these copies can be enforced by the DRM system [11]. Thus the use of digital watermarking techniques that embed information recognizing the copyright owner's identity within the content is regarded as a promising copyright protection technique [12]. DRM consists of certain techniques which includes encryption, copy control, digital watermarking, fingerprinting, traitor tracing, authentication, integrity checking, access control, tamper-resistant hard- and software, key management and revocations as well as risk management architectures [13].

Although watermarking is used in many applications, still there is a risk to security for the embedded watermark against possible malicious attacks. Digital watermarking embeds some information regarding the rights into the digital data, hence guaranteeing copyright protection. Planned for variety of purposes like copyright protection, access control, and broadcast monitoring, the extraction of the embedded data in the future is possible [14]. The information about ownership can be any privacy information that completely identifies the owner during ownership controversies, such as password, logo. The aforesaid information can possibly be hacked by the hackers. There is an opportunity of the owner losing or forgetting the same as well. The hackers may at times brute-force the information and maintain the ownership finally. In addition, the solution for the problem of rightful ownership has not been properly solved. Therefore the design of DRM system needs to address the above mentioned security issues and also solve the ownership dispute. In this paper, we have focused on the prevention of disputes that begin out of ownership claims on digital images and a novel and efficient scheme of DRM technique to deal with it has been developed.

II. DIGITAL RIGHTS MANAGEMENT

The DRM Digital Right Management has been broadly applied in the protection of video/audio medias over the internet [15]. In broadcasting system, the broadly applied content protection is CA (Condition Access) [16].Compared with DRM, CA has many disadvantages in security, service model, Value-added Service, etc. The application of DRM technique in broadcasting system is becoming a trend [17] [18].Digital Rights Management (DRM) is a scheme by which content owners use scientific mechanisms to enforce and protect copyrights over the authored digital work. The objective of a DRM system is to restrict the use of content to its rightful user in order to facilitate rightful payment to artists for their work. Depending on usage scenarios and operating environments, DRM systems architecture [19] and implementation differ from vendor to vendor but the basic functionality provided by each system is equivalent, to facilitate publishing of digital content in a manner such that the usage of this content can be controlled. Figure 1 illustrates the various DRM systems types along with the respective functionality achieved by the type of implementation

A typical DRM solution [20] is implemented through software and involves proprietary formats and generally operates in a client-server context. The technologies used for digital management of rights include cryptography and watermarking. Cryptography is used for license management. User rights are

expressed in the licenses which are typically implemented as digital certificates. User rights specify the number of usages, temporary or partial use, duration of access, lending rights, and number of devices on which the content can be used. Licenses generally contain an identifier of a user who has purchased the content, or an identifier of a device on which the license may be used.

Watermarking is a data embedding technology used mostly for tracing purposes. It is used to identify the source of illegal distribution by analysing the user-specific identifier embedded in the digital content prior to its distribution. DRM systems can also be realized in hardware through integrated circuits [21]. DRM is the system for protecting the copyrights of data circulated via the Internet or other digital media by enabling secure distribution and/or disabling illegal distribution of the data Some DRM Goals are: - (i) Protection of digital content (ii) Secure distribution (iii) Content authenticity (iv) Transaction non-repudiation (digital signature) (v) Market participant identification (digital certificates). & DRM Techniques are:- (i)Encryption (ii) Public/private keys (iii) Digital certificates (iv) Watermarking (v) Access control (vi)Secure communications protocols (vii) Fingerprinting (viii) Rights specification language (ix) Trust infrastructure (x) Hashing

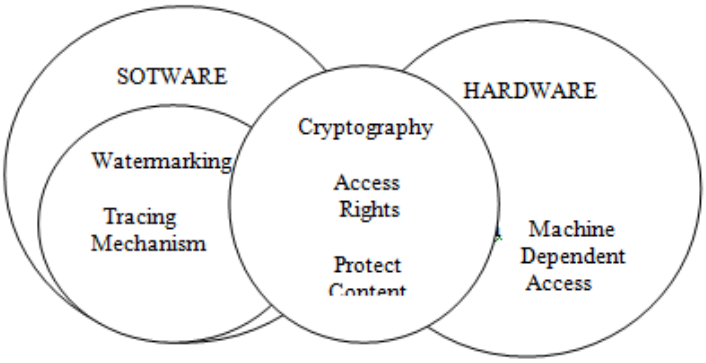

Fig. 1 DRM System Types

The term Digital Rights Management - DRM - has its origins in the combined efforts of some vendors, their marketing staff and some other industry analysts in the late 1990s [22]. It is a breakthrough in the progress of Conditional Access Systems (CAS). CP, for Copy Protection, often completes the DRM acronym although CP should be part of a DRM system for Rights Enforcement. DRM spans a broad array of technological and business concepts. It includes relatively specialized technologies such as watermarking, Public Key Infrastructure (PKI) and encryption, as well as other business areas such as pricing, terms, and conditions for use [22]. A main matter for DRM is the lack of a standardized definition for the process and for the key concepts involved [23]. Different interpretations of the term abound, including: "Digital Rights Management refers to controlling and managing rights to digital intellectual property."[22] "Digital Rights Management is "the description, identification, trading, protection, monitoring and tracking of all forms of rights usages over both tangible and intangible resources including management of rights holders relationships it is the "digital management of rights" not the "management of digital rights."[24] Digital Rights Management (DRM) involves the description, layering, analysis, valuation, trading and monitoring of the rights over an individual or organization's assets; both in physical and digital form; and of tangible and intangible value [25]. DRM

covers the digital management of rights - being them rights in a physical form of a work (e.g. a book), or being them rights in a digital form of a work (e.g. an e-book). Current methods of managing, trading and protecting such assets are inefficient, proprietary, or else often require the information to be wrapped or embedded in a physical format [25].The copyright environment consists of three main aspects: rights (what can be protected by copyright) and exceptions (e.g. copies for private use or for public libraries); enforcement of rights (sanctions for making illegal copies and for trading in circumvention devices); and management of rights (exploiting the rights). In the online world, management of rights may be facilitated by the use of technical systems called Digital Rights Management (DRM) systems [26] [7]. DRM consists broadly of 2 elements: the identification of intellectual property and associated rights and the enforcement of usage restrictions. The identification consists in the attribution of an (standard) identifier (such as the ISBN numbers for books) and the marking of the property with a sign (such as a watermark). The description of the rights relies on Rights Expression Languages (REL). The enforcement is based on encryption and key management, by i.e. ensuring that the digital content is only used for purposes agreed by the right holder. DRM is the chain of hardware and software services and technologies leading the authorized use of digital content and managing any consequences of that use throughout the complete life cycle of the content [7].

III. PROPOSED METHOD

The choice of an's and bn's are governed by texture sensitivity of Human Visual System (HVS). The following factors are considered to develop mathematical model. The edge blocks should be least altered to avoid significant distortion of the image. So we can add only small amount of watermark gray value in the edge block of host image. This means that scaling factor an should be close to amax, (the maximum value of the scaling factor) and embedding factor bn should be close to bmin (the minimum value of the embedding factor).

- So, we assume a_n to be directly proportional to variance s n and b n to be inversely proportional to variance s_n. The blocks with mid-intensity are more sensitive to noise than that of low intensity blocks as well as high intensity blocks.
- This means that the an should increase with local mean gray value up to mid gray value and again decrease with local mean gray value. The variation of a_n with mean block gray value is assumed to be Gaussian in nature. The variation b_n with mean gray value is reverse to that of an. Based on the above discussion we propose the following mathematical model.

$$\alpha_n = \alpha_{max}, \quad \text{(For edge blocks)}$$

$$\alpha_{min} + (\sigma_n (\alpha_{max} - \alpha_{min})/\sigma_{max}) \exp.(-(\mu_n - \mu)^2/2), \quad \text{(For other blocks)} \qquad (1)$$

$$\beta_n = \beta_{min}, \quad \text{(For edge blocks)}$$

$$\beta_{min} + (\sigma_{min} (\beta_{max} - \beta_{min}) / \sigma_n)[1 - \exp(-(\mu_n - \mu)^2 / 2)], \quad \text{(For other blocks)} \qquad (2)$$

Where,

- α min and a max are respectively minimum and maximum values of scaling factor,

- β min and b max are respectively minimum and maximum values of embedding factor,
- μ n is normalized mean of each block,
- σ n are normalized variances of each DCT blocks,
- σ min and s max are respectively minimum and maximum values of DCT block variances,
- μ is the normalized image mean.

IV. DRM ARCHITECTURE

The DRM architecture is composed of a standardized set of different building blocks.

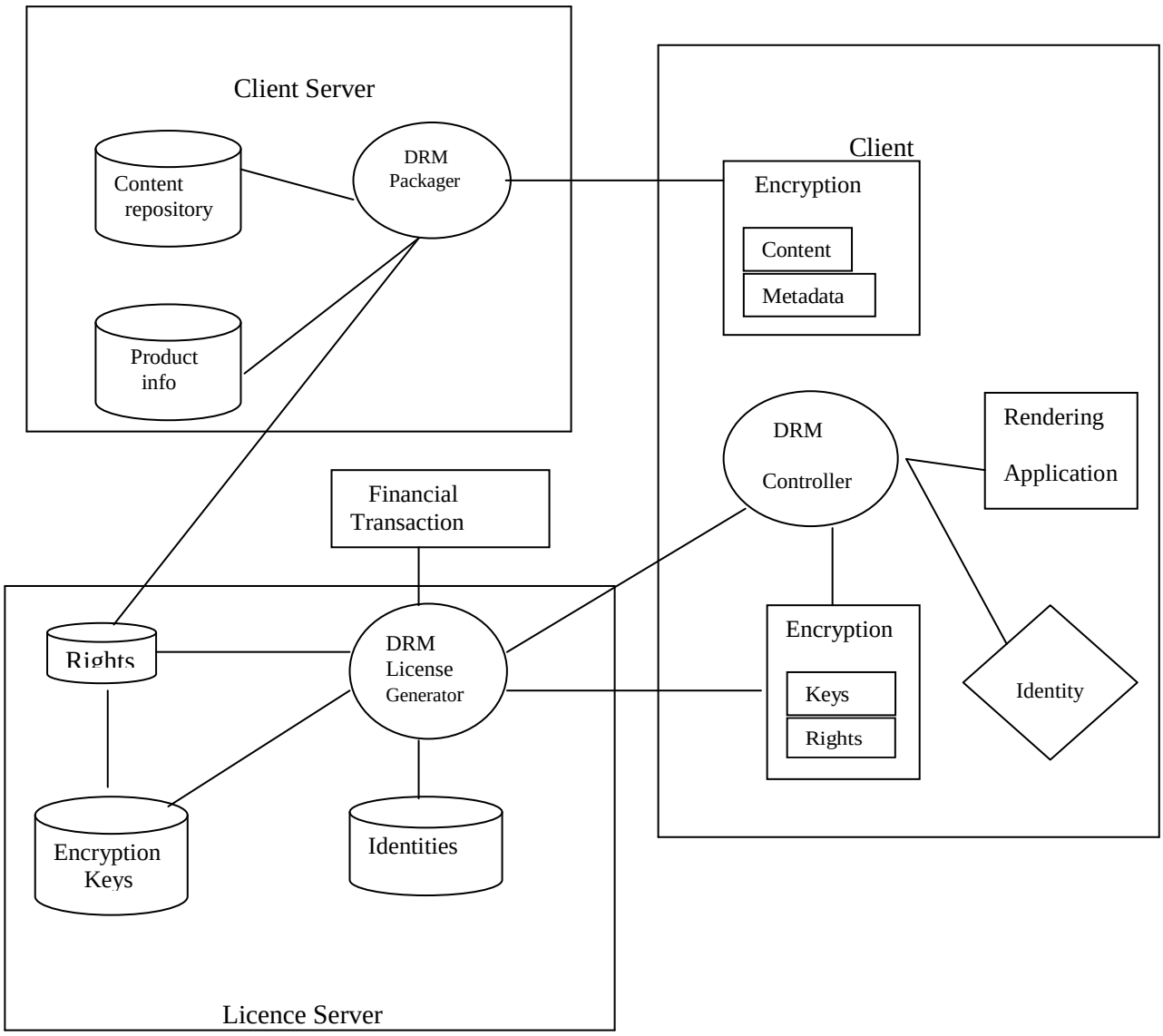

Fig. 2 DRM Architecture [22]

Two different visions from DRM can be presented: an architectural view and a functional view. From an architectural view, three major components can be identified: the content server, the license server, and the client [7] as shown in Figure 2. The content server is a server component on the DRM architecture that consists

of the actual content, information about products (services) that the content provider wants to distribute, and functionality to prepare content for a DRM-based distribution.

The license server is responsible for managing licensing information. Licenses contain information about the identity of the user or device that wants to exercise rights concerning the content, identification of the content to which the rights apply, and specifications of those rights.

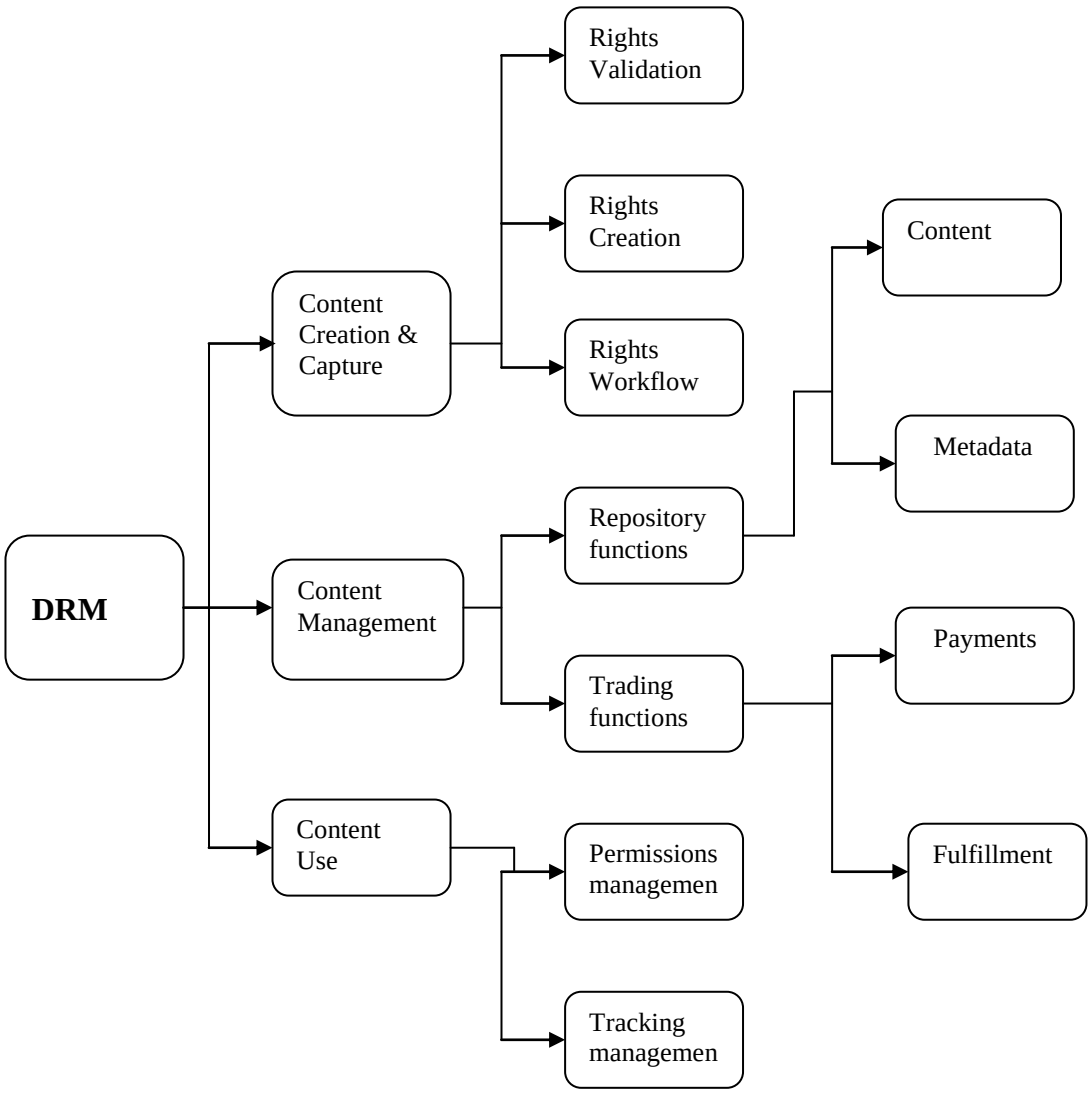

Fig.3 Generic DRM Functional Architecture

The client resides on the user's side and supplies the following functionalities: DRM controller, the rendering application and the user's authentication mechanism [27].

From a functional point of view, the Figure 3 can continue the most important functions of DRM architecture:

1) Content Creation and Capture
2) Content Management
3) Content Use

4.1 Content creation and capture: Managing the creation of content to facilitate trading, including asserting rights when content is first created (or reused and extended with appropriate rights to do so) by various content creators or providers. This module supports:

a. Rights validation - to ensure that content being created from existing content includes the rights to do so and that the rights are consistent.

b. Rights creation -to assign rights to new content, such as specifying the rights owners and allowable use (permissions).

c. Rights workflow - to process content for a series of workflow steps for review and/or approval of rights.

4.2 Content management: Managing and enabling the trade of content, including accepting content from creators into an asset management system. This module supports:

a. Repository functions - to access content and the "metadata" that describes the content and the rights specifications (see Information Architecture) or enabling the access/retrieval of content in potentially distributed databases and the access/retrieval of metadata. The metadata covers Parties, Rights and descriptions of the Works.

b. Trading functions – to enable the issue of licenses to parties who have done deals for rights over content, including, for example, royalty payments.

4.3 Content use: Managing the use of content once it has been traded. This module supports:

a. Permissions management - to enforce the rights associated with the content. For example, if the user has only the right to view the document, then printing will be prohibited.

b. Tracking management - to monitor the use of content where such tracking is a requirement of the user's agreement. This module may need to interoperate with the trading functions to track use or to record transactions for "per use" payments [7]. e.g., the user has a license to play a video ten times.

V. CONCLUSION

The extreme advancements in the area of digital technology have created the need to offer security for copyright protection of digital contents. A DRM system needs to be capable of providing persistent content protection against illegal access to the digital content, restricting access to only those with suitable authorization. Watermarking techniques are being used for this purpose these days. Digital rights management systems enable robust e-commerce, copyright protection, secure distribution and protection of digital data by means of encryption, watermarking, fingerprints, secure communication protocols, trust infrastructures, etc. Digital watermarks as a way of preserving the digital data value are designed to permanently reside in the host data (images, audio data, and video). However the embedded watermark data can be easily hacked by the hackers and thus result as a threat to protection of digital content. To solve the security issues in protecting the rights of digital content, in this paper, we have presented a novel scheme, which uses watermarking and DRM techniques.

REFERENCES

[1] Raymond B. Wolfgang and Edward J. Delp, "A Watermarking Technique for Digital Imagery: Further Studies", Video and Image Processing Laboratory (VIPER), School of Electrical and Computer Engineering, Purdue University, Indiana, 47907-1285, USA.

[2] Saraju. P. Mohanty. "Digital Watermarking:- A Tutorial Review", Dept of Computer Science and Engineering, University of South Florida 1999.

[3] Huayin Si, Chang-Tsun Li, "Copyright Protection in Virtual Communities through Digital Watermarking", Idea Group Publishing, 2005.

[4] N. K. Ratha, J. H. Connell, and R. M. Bolle, "Secure data hiding in wavelet compressed fingerprint images," In Proceedings of the ACM Multimedia Workshops , pp. 127– 130, USA, 2000.

[5] A. K. Jain and U. Uludag, "Hiding biometric data," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 25, no. 11, pp. 1494–1498, 2003.

[6] K. Zebbiche, L. Ghouti, F. Khelifi, and A. Bouridane, "Protecting fingerprint data using watermarking," In Proceedings of the 1st NASA/ESA Conference on Adaptive Hardware and Systems , 2006,pp. 451–456

[7] B. Surekha and G. N. Swami "Sensitive Digital Image Watermarking for Copyright Protection" International Journal of Network Security, vol.15, no.1, Jan 2013.

[8] Memon, N. and Wong, P.W., "Protecting digital media content," Communications of the ACM, Vol: 41, pp.35–43, 1998.

[9] G. Voyatzis, I. Pitas, "The use of watermarks in the protection of digital multimedia products," IEEE Proceedings, July 1999, vol. 87, No. 7, pp 1197-1207.

[10] A.B. Kahng, J. Lach, W.H. M-Smith, S. Mantik, I.L. Markov, M. Potkonjak, P. Tucker, H. Wang, and G. Wolfe, "Constraint-based watermarking techniques for design IP protection," IEEE Trans Comput.-Aided Des. Integrated Circuits Syst., vol.20, no.10, pp.1236–1252, Oct. 2001.

[11] E. T. Lin, A. M. Eskicioglu, R. L. Lagendijk, and E. J. Delp., "Advances in digital video content protection." IEEE: Special Issue on Advances in Video Coding and Delivery, pp: 171–183, 2005.

[12] Scott Craver, Stefan Katzenbeisser, "Copyright protection protocols based on asymmetric watermarking: The ticket concept", In Communications and Multimedia Security Issues of the New Century, pp 159–170, 2001.

[13] Ian Kerr, "Hacking privacy: Why We Need Protection from the Technologies That Protect Copyright", in proc. of Conference on privacy and identity, 2007.

[14] Xu, S. Dexter, A. M. Eskicioglu, "A Hybrid Scheme of Encryption and Watermarking," IS&T/SPIE Symposium on Electronic Imaging 2004, Security, Steaganography, and Watermarking of Multimedia Contents VI Conference, 2004,Vol. 5306, pp. 725-736..

[15] Shaojun Zhu, "The comparison and study of DRM standard", East China Normal University Master's Dissertations, 2004, pp.7-20

[16] Jun Chen, "The realization of CA on DTV", Chinese Academy of Sciences Doctor's Dissertations, 2004.

[17] Rosenblatt B., Trippe B., Mooney S., "Digital Rights Management - Business and Technology", M&T Books, 2003.

[18] Martin M., Agnew G., Boyle J., McNair J., Page M., Rhodes W., "DRM Requirements for Research and Education - Discussion Paper", The NSF Middleware Initiative and Digital Rights Management Workshop, 2002.

[19] Susanne Guth. "A sample drm system", Springer-Verlag Berlin, Heidelberg, 2003, vol 2770, pp 150-161

[20] Laurent Michaud, Mathieu Massot, and Alain Puissochet. "Digital rights management (drm) - drm and virtual content distribution." Technical report, IDATE Digiworld, 2005.

[21] W. Shi, H. Lee, R. Yoo, and A. Boldyreva. "A Digital right enabled graphics processing system." In Proceedings of the 21st ACM SIG-GRAPH/EUROGRAPHICS Symposium on Graphics Hardware, 2006, pp 17-26

[22] Rosenblatt B., Trippe B., Mooney S., "Digital Rights Management - Business and Technology", M&T Books, 2003.

[23] Martin M., Agnew G., Boyle J., McNair J., Page M., Rhodes W., "DRM Requirements for Research and Education-Discussion Paper", The NSF Middleware Initiative and Digital Rights Management Workshop, 2002.

[24] Iannella R., "Digital Rights Management (DRM) Architectures."D-Lib Magazine, vol.7, no.6, http://www.dlib.org/dlib/june01/iannella/06iannella.html, 2001.

[25] Rosenblatt B., "Integrating DRM with P2P networks - Enabling the future of Online Content Business Models", Giant Steps Media Technology Strategies, November 2003.

[26] Commission Staff Working Paper - "Digital Rights Background, Systems, Assessment", European Commission, February 2002.

[27] Rosenblatt B., Tripp B., Mooney S., "Digital Rights Management: Business and Technology", John Wiley & Sons, 2001.

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IDENTIFICATION OF PROKARYOTIC PATHOGENS AND THEIR ANTIBIOGRAM STATUS ASSOCIATED WITH URT INFECTIONS IN PATIENTS WITH ENDOTRACHEAL INTUBATION

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ABSTRACT

A total of 160 Endotracheal aspirates from tracheitis patients with Endotracheal Intubation were screened for the qualitative and quantitative incidence of bacterial infections in a defined-period case study. The results of the study revealed that 83% of the analysed samples were infected with bacterial pathogens. Bacterial members belonging to 5 different genera namely Streptococcus, Staphylococcus, Pseudomonas, Klebsiella and E. coli, were encountered. Among this Pseudomonas sp. had the highest rate of incidence (30.0%). The Genera with the lowest rate of incidence was Staphylococcus (6.0%). The rate of incidence of the other members were Streptococcus (15.7%), Klebsiella (24%) and E. coli (24%). Antibiogram analysis revealed that among the isolated members of the Pseudomonas sp., most strains (73.33%) were highly sensitivity to Ampicillin while 100% resistance was exhibited against Amoxyclav, Cephaloridine, Penicillin and Vancomycin.

***Keywords: Antibiogram, Endotracheal Intubation, Prokaryotic pathogens, Tracheitis, URT Infections*.**

I INTRODUCTION

The term tracheitis refers to microbial inflammation of the trachea or the wind pipe. Although trachea is part of the lower respiratory tract, WHO has classified tracheitis under acute Upper Respiratory Infections (URTI), in its 10th revision of the International Statistical Classification of Diseases and related health problems (ICD-10). Bacterial tracheitis is an invasive exudative bacterial infection of the soft tissues of the trachea. The larynx of healthy individuals is often colonized with bacterial species common to the upper respiratory tract, some of which are potential pathogens. Such colonization can extend at least transiently into the trachea [1]. When a patient with acute laryngotracheobronchitis undergoes tracheal intubation, the secretions are usually copious and appear "dirty" since the endotracheal tube has had to pass through the contaminated oropharynx. Hence, bacteria are frequently cultured from the secretions obtained through the tube [2].

The present study was a limit-time case study carried out in a period of three months from June-September 2014 in a tertiary care referral hospital in Madurai, Tamil Nadu, India. The objectives of the study were to find out the most frequently incident bacterial genera in Upper Respiratory Tract Infections in patients under endotracheal

Intubation and to report the antibiotics to which the isolated members were most sensitive and most resistant, from among a defined set.

II MATERIALS AND METHODS

2.1 Samples for microbiological analysis

The samples used for the study were the residual samples of endotracheal aspirates of tracheitis patients under intubation. The samples were procured from the Microbiology department of the hospital and were used for the study. The samples were either plated immediately or refrigerated for not more than 1 hour prior to plating.

2.2 Isolation and identification of bacterial pathogens

A volume of two loops full of the sample were quadrant-streak seeded on nutrient agar (HiMedia) plates and blood agar base (HiMedia) plates supplemented with 5% defibrinated sheep's blood. The plates were incubated under standard conditions and the bacterial colonies that appeared after 24 hours of incubation were identified to the generic level using phenotypic tests as per standard protocol [3]. Plates that showed no growth or had fungal growth were unaccounted. The isolated strains were subcultured in peptone broth (HiMedia) for antibiogram study.

2.3 Antibiogram assay

The antibiotics (Himedia) used were Ampicillin (10µgm), Amikacin (30µgm), Amoxyclav (30/40µgm), Ceftazidime(30µgm), Cefdinir(5µgm), Clindamycin (2µgm), Cefotaxime (30µgm), Ceftriaxone (30µgm), Co-trimoxazole (0.016/256µgm),Doxycycline (30µgm), Cephaloridine (10µgm), Cefoperazone (75µgm), Cephadroxil (30µgm), Erythromycin (15µgm), Kanamycin (5µgm), Netillin (10µgm), Penicillin (10µgm), Piperacillin-Tazobactum (100/10µgm) and Vancomycin (30µgm). The broth cultures were adjusted to 0.5 McFarland standards by standard procedure and used to seed Muller Hinton agar (HiMedia) plates. In order to meet the objective of the study, antibiotics that showed 'intermediately sensitive' as per CLSI standards were included in the resistant category. [4 modified].

III RESULTS AND DISCUSSION

Of the 160 samples plated, 133 plates (83%) showed bacterial growth. Biochemical analysis of the isolates revealed that 21 (15.7%) of the isolates belonged to the genera *Streptococcus*, 40 (30%) of the isolates belonged to the genera *Pseudomonas*, 32 (24%) of the isolates were of the genera *Klebsiella*, 32 (24%) of the isolates were *E. coli* and 8 (6%) were of the genus *Staphylococcus*.

Antibiogram assay revealed that the *Streptococcus* strains were 100% sensitive to the antibiotics Amikacin, Amoxyclav, Cefoperazone, Penicillin, Piperacillin-Tazobactam and Vancomycin and were 100% resistant to the antibiotics Doxycycline and Kanamycin (Table.I). Among the *Pseudomonas*

genera, maximum number of strains were sensitive to Ampicillin while all the isolates were resistant to Amoxyclav, Cephaloridine, Penicillin and Vancomycin (Table.II). While 66.66% of the isolated *Klebsiella* strains were sensitive to Ceftriaxone, 100% resistance was observed against Amikacin, Erythromycin, Piperacillin-Tazobactum and Vancomycin (Table. III). Regarding *E. coli*, 91.66% was the maximum rate of sensitivity against the antibiotic Ampicillin whereas 100% resistance were against the antibiotics Amoxyclac, Cefdinir, Cephaloridine, Cephadroxyl, Erythromycin, Penicillin and Vancomycin (Table.IV).

Within the isolated genera *Staphylococcus*, while ampicillin was the only antibiotic to which all of the isolates were sensitive, all the isolates were resistant to the antibiotics Amikacin, Amoxyclav, Clindamycin, Cefotaxime, Ceftriaxone, Doxycycline, Cephadroxil, Erythromycin, Kanamycin, Penicillin, Piperacillin-tazobactam and Vancomycin(Table.V). This finding revealed that among the isolated members, Staphylococcus genera had members that had a very narrow spectrum of sensitivity and were resistant to 63% of the drugs tested. This result is further justified by that of Deng et al., (2012), who had commented that antibiotic resistance has become a surging problem for the treatment of *Staphylococcus* infections and resistance can be gained via drug target modification, drug inactivation, or drug export by efflux pumps. *Staphylococcus* sp. encodes several multidrug resistance (MDR) efflux pumps that export a variety of structurally unrelated drugs [5]. The results showed that though *Staphylococcus* recorded the least percentage of isolates in number, the genera recorded isolates with maximum Multi Drug Resistance.

IV CONCLUSION

The outcome of the study is that among the total of 160 endotracheal aspirates tested, a total of 83% had bacterial infections. The encountered bacterial genera were of the order *Pseudomonas* (30.0%), *Klebsiella* (24.0%), *E. coli* (24.0%), *Streptococcus* (15.7%) and *Staphylococcus* (6.0%). Ampicillin was the drug that showed good antibacterial activity against the isolated *Pseudomonas* strains. The drugs that were completely ineffective against *Pseudomonas* strains were Amoxyclav, Cephaloridine, Penicillin and Vancomycin. Ceftriaxone was the drug that showed fair inhibitory effect against the isolated *Klebsiella* members and the drugs that were ineffective on the genera were Amikacin, Erythromycin, Piperacillin-Tzobactam and Vancomycin. While Ampicillin was the best effective drug against the *E. coli* isolates, Amoxyclac, Cefdinir, Cephaloridine, Cephadroxyl, Erythromycin, Penicillin and Vancomycin were completely ineffective. The drugs Amikacin, Amoxyclav, Cefoperazone, Penicillin, Piperacillin-Tazobactam and Vancomycin were the best against the members of *Streptococcus* while the ineffective drugs were Doxycycline and Kanamycin. The only drug that was best against the members of the *Staphylococcus* genera was ampicillin and the ineffective drugs were Amikacin, Amoxyclav, Clindamycin, Cefotaxime, Ceftriaxone, Doxycycline,

Cephadroxil, Erythromycin, Kanamycin, Penicillin, Piperacillin-Tazobactum and Vancomycin, with a record high of 100% of the strains resistant to 63% of the drugs tested.

Table. I: Percentage Sensitivity and Resistance Pattern of the Isolated Genera *Streptococcus*:

S. No	Antibiotics	Sensitive (%)	Resistant (%)
1	Ampicillin	37.5	62.5
2	Amikacin	100	0
3	Amoxyclav	100	0
4	Ceftazidime	25	75
5	Clindamycin	87.5	12.5
6	Cefdinir	37.5	62.5
7	Cefotaxime	87.5	12.5
8	Ceftriaxone	87.5	12.5
9	Co-trimoxazole	12.5	87.5
10	Doxycycline	0	100
11	Cephaloridine	25	75
12	Cefoperazone	100	0
13	Cephadroxil	25	75
14	Erythromycin	25	75
15	Kanamycin	0	100
16	Netillin	25	75
17	Penicillin	100	0
18	Piperacillin-Tazobactum	100	0
19	Vancomycin	100	0

Table II: Percentage Sensitivity and Resistance Pattern of the Isolated Genera *Pseudomonas*:

S. No	Antibiotics	Sensitive	Resistant
1	Ampicillin	73.33	26.6
2	Amikacin	6.66	93.33
3	Amoxyclav	0	100
4	Ceftazidime	53.33	46.66
5	Clindamycin	33.33	66.66
6	Cefdinir	6.66	93.33
7	Cefotaxime	40	60
8	Ceftriaxone	46.66	53.33
9	Co-trimoxazole	6.66	93.33
10	Doxycycline	13.33	86.66
11	Cephaloridine	0	100
12	Cefoperazone	20	80
13	Cephadroxil	6.66	93.33
14	Erythromycin	6.66	93.33
15	Kanamycin	13.33	86.66
16	Netillin	40	60
17	Penicillin	0	100
18	Piperacillin-Tazobactum	33.33	66.66
19	Vancomycin	0	100

Table III: Percentage Sensitivity and Resistance Pattern of the Isolated Genera *Klebsiella*:

S. No	Antibiotics	Sensitive	Resistant
1	Ampicillin	58.33	41.66

2	Amikacin	0	100
3	Amoxyclav	8.33	91.66
4	Ceftazidime	41.66	58.33
5	Clindamycin	16.66	83.33
6	Cefdinir	8.33	91.66
7	Cefotaxime	33.33	66.66
8	Ceftriaxone	66.66	33.33
9	Co-trimoxazole	33.33	66.66
10	Doxycycline	41.66	58.33
11	Cephaloridine	8.33	91.66
12	Cefoperazone	33.33	66.66
13	Cephadroxil	25	75
14	Erythromycin	0	100
15	Kanamycin	41.66	58.33
16	Netillin	50	50
17	Penicillin	8.33	91.66
18	Piperacillin-Tazobactum	0	100
19	Vancomycin	0	100

Table IV: Percentage Sensitivity and Resistance Pattern of the *E. coli* Isolate:

S. No	Antibiotics	Sensitive (%)	Resistant (%)
1	Ampicillin	91.66	8.33
2	Amikacin	8.33	91.66
3	Amoxyclav	0	100

4	Ceftazidime	58.33	41.66
5	Clindamycin	33.33	66.66
6	Cefdinir	0	100
7	Cefotaxime	8.33	91.66
8	Ceftriaxone	16.66	83.33
9	Co-trimoxazole	8.33	91.66
10	Doxycycline	8.33	91.66
11	Cephaloridine	0	100
12	Cefoperazone	8.33	91.66
13	Cephadroxil	0	100
14	Erythromycin	0	100
15	Kanamycin	8.33	91.66
16	Netillin	41.66	58.33
17	Penicillin	0	100
18	Piperacillin-Tazobactum	8.33	91.66
19	Vancomycin	0	100

Table V: Percentage Sensitivity and Resistance Pattern of the Isolated Genera *Staphylococcus*:

S. No	Antibiotics	Sensitive	Resistant
1	Ampicillin	100	0 0
2	Amikacin	0	100
3	Amoxyclav	0	100
4	Ceftazidime	66.6	33.33
5	Clindamycin	0	100

6	Cefdinir	66.6	33.33
7	Cefotaxime	0	100
8	Ceftriaxone	0	100
9	Co-trimoxazole	0	100
10	Doxycycline	0	100
11	Cephaloridine	33.33	66.6
12	Cefoperazone	33.33	66.6
13	Cephadroxil	0	100
14	Erythromycin	0	100
15	Kanamycin	0	100
16	Netillin	33.33	66.6
17	Penicillin	0	100
18	Piperacillin-Tazobactum	0	100
19	Vancomycin	0	100

REFERENCES

[1]. IM. Hjuler, MB. Hansen and B. Olsen, J. Renneberg, Bacterial colonization of the larynx and trachea in healthy children, *Acta Paediatrica, 84*, 1995, 566-570.

[2]. F. Alan Isles and J. Christopher Newth, *Journal of Canadian Medical Association, 129*, 1983, 532–533.

[3]. J. G. Holt, N. R. Kreig, P. H. A. Sneath, J. T Staley, and S. T. Williams, *Bergey's manual of determinative bacteriology* (Williams and Wilkins, Maryland, 1994).

[4]. Azar Dokht Khosravi, Najmeh Parhizgari, Effat Abbasi Montazeri, Alireza Mozaffari and Fariba Abbasi, The Prevalence of Bacteria Isolated From Endotracheal Tubes of Patients in Golestan Hospital, Ahvaz, Iran, and Determination of Their Antibiotic Susceptibility Patterns, *Journal of Microbiology, 6(1)*, 2013, 67-71.

[5]. Deng Xing, Fei Sun, Quanjiang Ji, Haihua Liang, Dominique Missiakas, Lefu Lan and Chuan He, Expression of Multidrug Resistance Efflux Pump Gene norA Is Iron Responsive in *Staphylococcus*, *Journal of Bacteriology, 194(7)*, 2012, 1753–1762.

A SURVEY ON VARIOUS POWER MANAGEMENT TECHNIQUES FOR DATA CENTERS

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ABSTRACT

With growing use of internet and exponential growth in amount of data to be stored and processed (known as "big data"), the size of data centers has greatly increased. This, however, has resulted in significant increase in the power consumption of the data centers. For this reason, managing power consumption of data centers has become essential. In this paper, we highlight the need of achieving energy efficiency in data centers and survey several recent architectural techniques designed for power management of data centers. We also present a classification of these techniques based on their characteristics. This paper aims to provide insights into the techniques for improving energy efficiency of data centers and encourage the designers to invent novel solutions for managing the large power dissipation of data centers.

Keywords: Data Centers, Power Management, Low-ower Design, Energy Efficiency, Green Computing, DVFS, Server Consolidation

I INTRODUCTION

As we move to the exascale era, the requirements of data storage have grown exponentially and hence, the power consumption of data-centers has also increased [1, 2]. It has been reported that in year 2006 alone, the datacenters and servers in U.S. consumed 61 billion kilowatt hours of electricity, which is 1.5% of all US electricity consumption and has a monetary cost of $4.5 billion [3]. Many data centers which support cloud services employ tens of thousands of servers which draw tens of Mega-Watts of power at peak [4]. It has been estimated that such data centers draw power worth $9.3 million per year [4]. Moreover, the worldwide expenditure on enterprise power supply and cooling has been estimated to be more than $30 billion [5]. Hence, achieving energy efficiency in data centers has become an issue of paramount importance.

Recently, several techniques have been proposed for managing power consumption of data centers (e.g. [6–10]). Due to large power consumption levels of data centers, use of these techniques has become essential to maintain both energy efficiency and cost efficiency. In this paper, we highlight the need of

achieving energy efficiency in data centers and survey several techniques which have been proposed for ensuring green operation of data centers. Since it is not possible to include detailed discussion of a large Technical Report, 2014. number of techniques, we take the following approach to limit the scope of this paper. We focus on architectural-level and operation-level techniques for improving energy efficiency and not on circuit-level (device-level) techniques. Moreover, we only discuss the key design principles of different techniques and do not discuss the quantitative results, since different techniques have been tested using different evaluation platforms. We only include those techniques which have been evaluated for improving energy efficiency, and do not include the techniques aimed at improving performance, although they are also expected to improve energy efficiency.

The rest of the paper is organized as follows. In the next section, we present the factors which lead to increased power consumption. We also discuss their impact along with the need of managing data center power consumption. We then present a classification of power management techniques based on their characteristics, and then discuss some of these power management techniques in detail. Finally, we provide a discussion of future research directions and concluding remarks.

II. BACKGROUND

2.1 Reasons behind Increase in Power Consumption

Due to recent growth in use of internet, the demand placed on data-centers has increased. Modern data centers typically contain up to tens of thousands of servers and provide 24×7 services to hundreds or thousands of users. As an example, YouTube serves as much as 100 million videos a day, while Facebook has nearly 400 million active users and 3 billion photos uploaded every month [11]. These images, videos and text data are processed using computation-intensive software programs; and stored and accessed from data centers [12, 13]. Further, in recent years, use of high-performance computing techniques has also increased, which require trading off energy consumption for obtaining increased performance. For this reason, data centers have grown in sizes; which has led to increase in their power consumption.

2.2 Power Consumption Levels

Recent years have witnessed a huge increase in the power consumption of servers, data centers and supercomputers [14–16] . The total energy consumption of data centers as a percentage of total US energy consumption has doubled between 2000 and 2007 [2]. As an example, peak power consumption of the most powerful supercomputers in the TOP500 list of supercomputers ranges in tens of megawatts [17, 18]. This amount of power is sufficient to fulfill the demands of a city of 40,000 residents. Research has also shown that the buildings with data centers can be as much as 40 times more energy intensive than the conventional office buildings [19].

The high levels of power consumption demand a costly cooling infrastructure [20]. For example, a 30,000 square feet data center with 10 megawatts power consumption consumes on the order of $5 million for

cooling in a year [21]. Moreover, for every watt of power consumed in the computing equipment, an additional 0.5 to 1W of power is required to operate the cooling system itself [21], which further adds to the cost.

2.3 Need of Power Management

It has been shown that most of the time, the modern servers operate between 10% to 50% of maximum possible utilization [22, 23]. Further, at these utilization levels, the server energy efficiency also becomes very low [24]. Thus, despite the fact that the average utilization remains low; there exist frequent, brief bursts of activity, and to meet the requirements of service-level-agreements (SLAs), operators are forced to allocate high amount of resources, which leads to poor energy efficiency [25].

Power management is also important from an economic point of view, since effective power management also improves operational efficiencies and increases compaction. Electricity costs for powering servers forms a major cost of operation in data centers and it has been estimated that in near future, energy costs may contribute even more than the cost of IT ([26, 27]). Further, a high ratio of cooling power to computing power restricts the compaction and consolidation possible in data centers, which results in increased operation costs. For example, the high power density poses significant challenges in routing the large amounts of power needed per rack. Currently the power delivery in typical data centers is near 60 Amps per rack and it is expected to reach the limit of power delivery, which will severely affect the operation of servers [23].

The large power consumption and high concentration of nodes in data centers leads to increased node failures. It has been observed that a 15 degree Celsius rise increases the failure rates in hard-disks by a factor of two [28]. Hence, maintaining the computer systems at proper temperature is important for ensuring maximum reliability, longevity, and large return on investment. Finally, large power consumption also has adverse environmental impact, e.g. large carbon emission [29–33]. For these reasons, the design of green solutions for modern data centers has become a topic of paramount importance. Hence, in this paper, we survey techniques for managing power consumption in data centers.

III OVERVIEW OF POWER MANAGEMENT TECHNIQUES

In recent years, researchers have proposed several techniques for managing power consumption in data centers. While it is very difficult to draw sharp boundaries of classification; for the purpose of study, we broadly classify the techniques in the following four types.

1) DVFS (dynamic voltage/frequency scaling) based techniques [34–43].

2) Techniques which transition the server/node to low-power or turned-off state; or use server- consolidation based approach to allocate only required amount of server resources [23, 43–55].

3) Workload management or task scheduling based techniques [56–63].

4) Thermal-aware or thermal-management techniques which take into account the thermal properties [56, 59, 61, 64–70]. Further, some techniques address the issues related to cooling in data centers [21, 59, 71].

Based on other characteristics/parameters, the techniques can be further classified. While most techniques aim to reduce average power (energy), a few techniques aim to reduce peak power consumption [72], or limit power (called power capping) [73, 74]. A few techniques aim to save energy while keeping the performance degradation bounded or maintaining QoS (quality-of-service) guarantee [39, 41, 43, 50, 75–79].

Several techniques use analytical approach and offer control-theoretical algorithms with provable guarantees [38, 74, 79–84], while most other techniques use system approach and focus only on implementation. Some researchers propose use of renewable energy sources [85, 86]. Some researchers aim to reduce disk energy [87–89], while others focus on saving main memory energy [35, 90–93] in data centers.

IV POWER MANAGEMENT TECHNIQUES

4.1 DVFS Based Techniques

Dynamic voltage and frequency scaling (DVFS) is a widely-used power-management technique where the clock frequency of a processor is dynamically adjusted to allow a corresponding reduction in the supply voltage to achieve power saving [94]. DVFS is especially useful for memory-bound workloads. The power consumption of a CMOS (Complementary metal oxide semiconductor) circuit is given by

$$P = P_{static} + CFV^2 \quad (1)$$

Here C shows the capacitance of the transistor gates, F shows the operating frequency and V shows the supply voltage. The frequency at which circuit is clocked determines the voltage required for stable operation; and hence, by intelligently reducing the frequency, the supply voltage can also be reduced; which leads to significant power savings due to V^2 relationship shown above. The limitation of DVFS, however, is that a reduction in frequency also reduces the performance of the circuit and hence, DVFS may adversely affect the performance of the processor. For this reason, DVFS needs to be intelligently applied, to maintain high performance. In data centers, DVFS technique is applied to manage the power consumption of multicore processors, DRAM memories and other components.

Sharma et al. [41] propose adaptive algorithms for dynamic voltage scaling in QoS-enabled web servers.

Their algorithms aim to minimize energy consumption subject to service level agreements (SLAs). The algorithms are implemented inside the Linux kernel. Their algorithms minimize the energy consumption using a feedback loop which regulates the frequency and voltage levels to keep the instantaneous utilization bounded.

Hsu and Feng [39] propose an algorithm for the dynamically varying voltage and frequency of the

processor to realize energy saving while keeping the performance loss bounded. The algorithm takes decisions at the end of fixed time period. Their algorithm uses an estimation model to relate the intensity level of off-chip accesses to total execution time. Using this, the algorithm computes the lowest CPU frequency which keeps the performance loss bounded, while saving largest possible amount of energy. For multiprocessor environment, the same algorithm is repeated for each processor to set the frequency of the processor individually.

Xu et al. [43] propose a technique for saving energy in embedded clusters. Their technique adjusts the number of active nodes based on the system load. In their technique, each node in the cluster performs dynamic voltage scaling independently and runs at the lowest frequency at which it can keep up with the request arrival rate. To prevent the system from reacting to short-term changes in workload, at a time, their technique changes only one node from active to inactive and vice-versa in each interval.

Horvath et al. [38] present methods to dynamically adjust the server voltages to minimize the total system power consumption, while also meeting end-to-end delay constraints in a multi-tier web service environment. In their architecture, server machines use DVS-capable processors. They propose coordinated distributed voltage scaling policy, where decisions on frequency adjustments are made on each locally while minimizing overall power consumption. Compared to other methods such as server on/off, use of dynamic voltage scaling incurs less overhead which facilitates aggressive energy saving.

Deng et al. [91] use DVFS mechanism to save memory energy. Their technique lowers the frequency of DRAM devices, memory channels and memory controllers at the time of low memory activity. This reduces the memory power consumption. They have also extended their technique for coordinating DVFS across multiple memory controllers, memory devices and channels to reduce the overall system power consumption [35].

4.2 Server Consolidation and Power State Transitioning Based Techniques

As discussed before, modern servers typically operate at low utilization levels. Moreover, to cater to the peak demand and service-level-agreements and ensure reliability, high amount of server resources needs to be allocated which leads to poor energy efficiency [24]. To address this challenge, many approaches have been proposed. Server consolidation is one such approach aimed to ensure efficient usage of server resources by reducing the total number of servers required by a data center, while still delivering same throughput. In this approach, the existing applications are consolidated onto fewer servers, such that unused servers can be transitioned into low-power (or turned-off) state and the used servers can be operated at full utilization levels. Another approach is transitioning the server resources into low-power mode during periods of low activity. These approaches have been widely used to improve energy efficiency of data centers.

Chun et al. [95] propose a hybrid data center design which uses heterogeneous platforms to save power. Under low utilization levels, their technique transfers the running tasks from a high-power, high performance system to a low-power, low-performance system and turns off the higher power servers. Thus, server virtualization

along with task migration reduces the number of active servers by consolidating many servers with low-average utilization to a few servers operating at high utilization. The limitation of sever consolidation, however, is that it may lead to slow response times and high transition costs.

For ensuring energy-efficient operation of data centers, Chase et al. [46] discuss a system resource management based approach. Their method controls server allocation and routing of requests to selected servers using a dynamically reconfigurable switch; and thus enables achieving a trade-off between service quality and cost. For optimizing energy consumption, incoming request traffic is continuously monitored and only desired amount of server resources are allocated such that the service level agreements can be fulfilled. Since internet sites observe highly varying usage patterns (e.g. as much as 11:1 peak-to-trough ratio of usage), their method enables intelligent adaptive resource provisioning.

Ranganathan et al. [23] propose a technique for managing server power at the ensemble (i.e. collection of systems) level instead of individual server level. Their design observes the resource-usage trends across multiple systems. By taking advantage of inter-server variations, their technique allows active server to steal power from the inactive servers. Their technique facilitates reductions in the requirements for power delivery, power consumption, and cooling in the data centers.

To leverage the variation in workload for saving energy, Anagnostopoulou et al. [44] propose a “barely- alive” server design. Their design transitions the servers to a barely-alive power state, where the server can be still accessed, even if many of its other components are turned off. Their design uses a small embedded processor to only keep the memory of idle servers active so that in-memory application code/data remain unaffected, and the free memory space can be used for cooperative application data caching.

To reduce the energy consumption of servers during periods of reduced load, Rusu et al. [77] discuss a cluster-wide QoS-aware technique which uses dynamic reconfiguration based approach. For a given workload, their algorithm dynamically decides the servers which need to remain turned on/off to minimize global power consumption. To minimize the time penalty of server on/off, the algorithm accounts for the booting time of the server and turns on a server before it is actually needed. The authors also use dynamic voltage scaling (DVS) to conduct QoS-aware power management. The authors show the use of their technique in the context of a web server.

Ghosh et al. [49] propose a technique to save energy in data centers by using out-of-band management processors which are typically used for remotely managing a server, to satisfy the I/O requests from a remote server. By transferring the load from the primary server to the management processor, their technique allows the primary server to stay in low-power state for longer time, which improves the energy efficiency.

To utilize the opportunity of energy saving at multiple levels, Da Costa et al. [48] present an integrated framework, called GREEN-NET. GREEN-NET provides a multi-faceted approach for saving energy in clouds and grids. Their approach has three levels. At first level, it increases the awareness of users of their energy consumption. At second level, it involves the users in decisions to trade-off performance for saving energy.

Finally, at third level, it conducts adaptive management of grids by techniques such as server turn-off to save energy.

L. Liu et al. [50] use virtual-machine migration approach where a virtual machine (VM) is transferred across physical computers to enable server consolidation and allow more computers to be turned-off. Their technique dynamically decides the time to trigger VM migration, and the alternative physical machines to achieve optimal VM placement. Their technique enables live migration of VMs, such that the users can hardly notice that their applications are being or have been migrated.

Leverich et al. [55] use per-core power-gating (PCPG) approach to manage power consumption of multicore processors. Their technique works by selectively turning on/off the power supply to individual cores of a multicore processor based on the utilization and quality-of-service requirements. The authors have also shown that by syngersitically combining their technique with DVFS technique, additional power savings can be obtained.

4.3 Workload Scheduling Based Techniques

Modern data centers typically have a large number of servers and hence, the decision about placement of workloads on specific servers significantly affects the heat-dissipation and power-consumption. A poor placement may greatly increase the temperature of the building which will further increase the heat-dissipation of the servers and also increase the cooling requirements. Hence, workload-scheduling techniques have been proposed which intelligently place the workloads on available servers with the goal of saving power, reducing the temperature and the cooling requirements.

Nathuji and Schwan [96] propose a dynamic power management technique to support the isolated and independent operation of VMs running on a virtualized platform, while globally coordinating the diverse power management strategies applied by the VMs to the virtualized resource. Their technique uses a set of virtualized power states to permit guest VMs to run their own, independent power management methods. Further, guest VM-level power management policies act upon these states to minimize power consumption, while meeting application requirements.

A thermal-aware technique for spatial workload placement in data centers is presented by Banerjee et al. [56]. One of their techniques uses the information about dynamic behavior of computer room air conditioned (CRAC) to place the jobs in a manner which reduces the cooling demands from the CRACs. By integrating this technique with a temporal scheduling technique, the decision about when and on which server to execute a job can be taken, leading to a spatio-temporal scheduling technique.

Bradley et al. [57] present a predictive power management technique for saving power in parallel computer systems. In web-based applications where the load on a system varies a lot, minimizing power consumption while meeting the demands of the workload is challenging. For such systems, their technique projects workload ahead of time to allow adequate resources to be powered on and kept ready for work when required to execute the workload.

Their algorithm uses CPU utilization data to estimate the workload demand. When the utilization becomes larger than a predefined threshold, additional servers are powered on to reduce utilization on all servers to below that threshold. Conversely, when utilization at all servers is below that threshold and there is adequate capacity in the resulting server group to absorb the load of at least one server without any resource on any server being over-utilized, one or more server are powered off.

4.4 Thermal-aware Power Management Techniques

Several power management techniques work in thermal-unaware manner, i.e. they do not take the temperature-dependence of server power consumption into account. However, the heat-dissipation of processor components has strong temperature dependency and hence, an increase in operating temperature leads to increased heat-dissipation, which further increases the temperature and so on. This may drastically increase the component failure rates. To address this, several techniques have been proposed which manage the power consumption of the data centers while taking into account the thermal properties.

To minimize the total energy costs of data-center operation while providing a reliable thermal environment, Tang et al. [63] propose a thermal-aware task-scheduling technique. In a blade server, multiple blades are integrated into each chassis, in which blades share a common supply and cooling fan. Each blade may itself have many processors. Operation of a chassis incurs chassis startup power consumption, along with actual power consumption of the blades. Hence, the power consumption cost of adding a task to one chassis may be different depending upon whether it involves waking up an idle chassis or an idle blade. Based on this observation, they evaluate several thermal-aware task-scheduling techniques, which exercise the trade-off between cost of start-up and power saving coming from turning off the blade servers.

Moore et al. [59] present techniques to control the heat generation in servers using temperature-aware workload placement. Their techniques take into account the fact that since the heat may travel a large distance inside the data center before arriving at a temperature sensor, cooling inefficiencies can often arise in locations which are spatially uncorrelated from the place where the heat originates. Based on this, their technique uses the information about steady-state hot-spots and cold-spots in the data center to develop scheduling algorithms.

As discussed above, in data centers, work-scheduling algorithms have a significant influence on temperature distribution. Li et al. [97] present a thermal forecasting model to predict the temperatures near the servers in a data center. Their model is based on continuous streams of temperature and airflow measurements. Their model integrates both physical laws and sensor observations in the data center. It uses the data obtained from the sensors to learn the parameters of the cyber-physical system of the data center.

4.5 Other Techniques

While most techniques aim to reduce energy consumption, a few techniques have also been proposed which aim

to control peak power consumption. Lefurgy et al. [74] present a technique for controlling the peak power consumption of a high-density server. Their technique uses a feedback controller to periodically select the highest performance state while keeping the system within a fixed power constraint. The control loop is designed using the control theoretic methodology which helps in obtaining analytical guarantee on system stability and controller performance, despite variation in workloads. Their technique allows controlling power at different time-granularity, e.g. one second, eight seconds etc. The authors have shown that their technique performs better than the ad-hoc and open-loop techniques.

To fulfill the needs of several performance-critical and data-intensive applications that execute on many data center platforms [98–101], a large amount of main memory resources need to be provisioned. Hence, improving the energy efficiency of main memories is important to achieving data center energy efficiency. Yoon et al. [92] propose a technique for saving memory power consumption in data centers by intelligently utilizing low power mobile DRAM components. By using buffering mechanism to aggregate the data outputs from multiple ranks of low frequency mobile DRAM devices (such as 400MHz LPDDR2), their technique enables achieving high bandwidth and high storage capacity equal to server-class DRAM devices (such as 1600MHz DDR3).

Chatterjee et al. [90] propose a technique to take advantage of heterogeneity in DRAM memories to accelerate critical word access. In recent years, processors use DRAM chips with vastly differing latency and energy characteristics. Their technique recognizes the critical word in a cache line which is placed in a low-latency region of the main memory. The remaining non-critical words of the cache line are placed in a low-energy consuming region. Thus, their approach enables achieving high performance while reducing memory energy.

A technique to save the energy spent in unbeneficial refreshes in DRAM is proposed by J. Liu et al. [93]. In a DRAM, only a small number of cells need to be refreshed at the minimum conservative refresh rate and the remaining cells can be refreshed at a much higher rate, while still maintaining their charge. Using this observation, their technique groups DRAM rows in multiple bins and uses different refresh interval for different bins. Further, by refreshing most of the cells with lower frequency than the leaky cells, they achieve reduction in the number of refresh operations required which leads to reduction in memory power consumption.

Keys et al. [102] characterize a wide variety of clusters to find energy-efficient data center building blocks which are useful for data-intensive applications. The authors build homogeneous clusters using embedded, mobile and server systems and execute DryadLINQ applications on these clusters in order to study their energy efficiency for different application types. The authors have observed that their cluster was significantly more energy-efficient than ones with low-power server processors or embedded processors.

To maximize the benefits from the provided quality of computational services, while maintaining energy efficiency, Parolini et al. [82] present an energy saving technique for data centers. They model the data center in terms of mutually coupled cyber and physical systems. Here cyber component refers to the computational network representing the distribution and flow of computational tasks. The physical network refers to the thermal network which characterizes the distribution of thermal energy. The authors have shown that compared to the

traditional approach in which the cyber and physical resources are controlled independently, their coordinated control strategy achieves more effective management of power consumption.

V. FUTURE RESEARCH DIRECTIONS

With CMOS scaling, the leakage energy consumption is increasing and hence the dynamic range of energy consumption that DVFS can utilize has reduced. Further, the design complexity of multicore processors also hinders straightforward use of DVFS for saving energy. For this reason, the effectiveness of DVFS based techniques has been reducing. Instead, the state-of-the-art in power management in data centers has focused on achieving energy-proportional computing by addressing hardware-platform heterogeneity [103]. Since modern data centers use tens to hundreds of servers with possibly different configurations, there exists significant heterogeneity in the computing servers. This heterogeneity is likely to increase further with increasing sizes of the data centers. Since workloads are sensitive to hardware platforms, a heterogeneity-oblivious scheduling of workloads on servers may lead to significant performance degradation. Thus, novel techniques have been proposed which take heterogeneity into account for scheduling workloads. Also, as discussed above, research efforts are also being directed towards utilizing renewable energy sources and dynamic power-state transitioning techniques. Also, researchers are exploring low-leakage high-density technologies such as non-volatile memory for reducing the energy consumption of computing systems [104]. These techniques reduce the carbon footprint of data centers, while also improving their energy efficiency.

It is expected that in the near future, several of the above mentioned solutions will be deployed in a synergistic manner for providing even larger savings. A key challenge for this is designing a coordination framework which is flexible and allows seamless integration of different techniques.

VI. CONCLUSION

With the growing use of internet and requirement of data-storage and processing, the size of modern data centers has greatly increased. This has led to significant increase in the power consumption levels of the data centers. Moreover, the power consumption of data centers is approaching the limit imposed by thermal limitations of cooling solutions and power delivery. Also, since data centers are already consuming tens of Mega Watts, they are also stressing the capabilities of power generation facilities.

As the complexity of operation of data centers increases, power management techniques which also ensure high-performance and low-costs are expected to become a crucial part of future enterprise architectures. In this paper, we highlighted the need for power management in data centers. We reviewed several techniques which have been proposed for reducing power consumption of data centers and classified them based on their characteristics. We believe that our survey will enable the researchers to gain insights into the state-of-the-art in power management of data centers and motivate them to propose innovative solutions for architecting future green data centers.

REFERENCES

[1] J. Baliga, R. W. Ayre, K. Hinton, and R. Tucker, "Green cloud computing: Balancing energy in processing, storage, and transport," Proceedings of the IEEE, vol. 99, no. 1, pp. 149–167, 2011.

[2] K. Kant, "Data center evolution: A tutorial on state of the art, issues, and challenges," Computer Networks, vol. 53, no. 17, pp. 2939–2965, 2009.

[3] R. Brown et al., "Report to congress on server and data center energy efficiency: Public law 109-431," 2008

[4] A. Greenberg, J. Hamilton, D. A. Maltz, and P. Patel, "The cost of a cloud: research problems in data center networks," ACM SIGCOMM Computer Communication Review, vol. 39, no. 1, pp.68–73, 2008.

[5] C. Patel and P. Ranganathan, "Enterprise power and cooling," ASPLOS Tutorial, 2006.

[6] R. A. Bergamaschi, L. Piga, S. Rigo, R. Azevedo, and G. Araújo, "Data center power and performance optimization through global selection of p-states and utilization rates," Sustainable Computing: Informatics and Systems, vol. 2, no. 4, pp. 198–208, 2012.

[7] G. Cabusao, M. Mochizuki, K. Mashiko, T. Kobayashi, R. Singh, T. Nguyen, and X. P. Wu, "Data center energy conservation utilizing a heat pipe based ice storage system," in CPMT Symposium Japan, 2010 IEEE, 2010, pp. 1–4.

[8] J. Chang, J. Meza, P. Ranganathan, A. Shah, R. Shih, and C. Bash, "Totally green: evaluating and designing servers for lifecycle environmental impact," in ACM SIGARCH Computer Architecture News, vol. 40, no. 1, 2012, pp. 25–36.

[9] H. Chen, Y. Li, and W. Shi, "Fine-grained power management using process-level profiling,"Sustainable Computing: Informatics and Systems, vol. 2, no. 1, pp. 33–42, 2012

[10] G. L. T. Chetsa, L. Lefevre, J. Pierson, P. Stolf, and G. Da Costa, "Beyond cpu frequency scaling for a fine-grained energy control of hpc systems," in Computer Architecture and High Performance Computing (SBAC-PAD), 2012 IEEE 24th International Symposium on. IEEE, 2012, pp. 132–138.

[11] A. Hepburn, "Facebook statistics, stats & facts for 2011," Digital Buzz, 2011.

[12] S. Mittal, S. Gupta, and A. Mittal, "BioinQA: metadata–based multi–document QA system for addressing the issues in biomedical domain," International Journal of Data Mining, Modelling and Management, vol. 5, no. 1, pp. 37–56, 2013.

[13] S. Mittal and A. Mittal, "Versatile question answering systems: seeing in synthesis," International Journal of Intelligent Information and Database Systems, vol. 5, no. 2, pp. 119–142, 2011.

[14] S. Mittal, "A survey of architectural techniques for dram power management," International Journal of High Performance Systems Architecture, vol. 4, no. 2, pp. 110–119, 2012.

[15] Y. Zhang and N. Ansari, "Green data centers," Handbook of Green Information and Communication

Systems, p. 331, 2012.

[16] S. Mittal, Z. Zhang, and Y. Cao, "CASHIER: A Cache Energy Saving Technique for QoS Systems," 26th International Conference on VLSI Design(VLSID), pp. 43–48, 2013.

[17] W.-c. Feng and K. W. Cameron, "The green500 list: Encouraging sustainable supercomputing,"Computer, vol. 40, no. 12, pp. 50–55, 2007.

[18] [18] www.top500.org.

[19] S. Greenberg, E. Mills, B. Tschudi, P. Rumsey, and B. Myatt, "Best practices for data centers: Lessons learned from benchmarking 22 data centers," Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings in Asilomar, CA. ACEEE, vol. 3, pp. 76–87, 2006.

[20] S. Mittal, "A survey of techniques for improving energy efficiency in embedded computing systems," International Journal of Computer Aided Engineering and Technology (IJCAET), 2014.

[21] C. D. Patel, C. E. Bash, R. Sharma, M. Beitelmal, and R. Friedrich, "Smart cooling of data centers," Pacific RIM/ASME International Electronics Packaging Technical Conference and Exhibition (IPACK03), 2003.

[22] L. A. Barroso and U. Hölzle, "The datacenter as a computer: An introduction to the design of warehouse-scale machines," Synthesis lectures on computer architecture, vol. 4, no. 1, pp. 1–108,2009.

[23] P. Ranganathan, P. Leech, D. Irwin, and J. Chase, "Ensemble-level power management for dense blade servers," in ACM SIGARCH Computer Architecture News, vol. 34, no. 2, 2006, pp. 66–77.

[24] L. A. Barroso and U. Hölzle, "The case for energy-proportional computing," IEEE computer, vol. 40, no. 12, pp. 33–37, 2007.

[25] S. Mittal and Z. Zhang, "EnCache: Improving cache energy efficiency using a software-controlled profiling cache," in IEEE International Conference On Electro/Information Technology, Indianapo- lis, USA, May 2012.

[26] L. A. Barroso, J. Dean, and U. Holzle, "Web search for a planet: The Google cluster architecture,"Micro, vol. 23, no. 2, pp. 22–28, 2003.

[27] R. Bianchini and R. Rajamony, "Power and energy management for server systems," IEEE Computer, vol. 37, no. 11, pp. 68–74, 2004

[28] D. Anderson, J. Dykes, and E. Riedel, "More than an interface-scsi vs. ata." in FAST, vol. 2, no. 00,2003, p. 3.

[29] T. Daim, J. Justice, M. Krampits, M. Letts, G. Subramanian, and M. Thirumalai, "Data center metrics: An energy efficiency model for information technology managers," Management of Environmental Quality: An International Journal, vol. 20, no. 6, pp. 712–731, 2009

[30] "Energy star program," www.energystar.gov/.

[31] W.-C. Feng, "Making a case for efficient supercomputing," Queue, vol. 1, no. 7, p. 54, 2003.

[32] M. Mazzucco and I. Mitrani, "Empirical evaluation of power saving policies for data centers," ACM

SIGMETRICS Performance Evaluation Review, vol. 40, no. 3, pp. 18–22, 2012.

[33] L. H. Sego, A. Márquez, A. Rawson, T. Cader, K. Fox, W. I. Gustafson Jr, and C. J. Mundy, "Implementing the data center energy productivity metric," ACM Journal on Emerging Technologies in Computing Systems (JETC), vol. 8, no. 4, p. 30, 2012.

[34] P. Bohrer, E. N. Elnozahy, T. Keller, M. Kistler, C. Lefurgy, C. McDowell, and R. Rajamony, "The case for power management in web servers," in Power aware computing. Springer, 2002, pp.261–289.

[35] Q. Deng, D. Meisner, A. Bhattacharjee, T. F. Wenisch, and R. Bianchini, "Multiscale: memory system dvfs with multiple memory controllers," in international symposium on Low power electronics and design, 2012, pp. 297–302.

[36] V. W. Freeh, D. K. Lowenthal, F. Pan, N. Kappiah, R. Springer, B. L. Rountree, and M. E. Femal, "Analyzing the energy-time trade-off in high-performance computing applications," Parallel and Distributed Systems, IEEE Transactions on, vol. 18, no. 6, pp. 835–848, 2007.

[37] A. Gandhi, M. Harchol-Balter, R. Das, and C. Lefurgy, "Optimal power allocation in server farms,"in ACM SIGMETRICS Performance Evaluation Review, vol. 37, no. 1, 2009, pp. 157–168.

[38] T. Horvath, T. Abdelzaher, K. Skadron, and X. Liu, "Dynamic voltage scaling in multitier web servers with end-to-end delay control," Computers, IEEE Transactions on, vol. 56, no. 4, pp. 444–458, 2007.

[39] C.-h. Hsu and W.-c. Feng, "A power-aware run-time system for high-performance computing," in Proceedings of the 2005 ACM/IEEE conference on Supercomputing. IEEE Computer Society,2005, p. 1.

[40] L. Rao, X. Liu, L. Xie, and W. Liu, "Minimizing electricity cost: optimization of distributed internet data centers in a multi-electricity-market environment," in IEEE INFOCOM, 2010, pp. 1–9.

[41] V. Sharma, A. Thomas, T. Abdelzaher, K. Skadron, and Z. Lu, "Power-aware QoS management in web servers," in 24th IEEE Real-Time Systems Symposium (RTSS), 2003, pp. 63–72.

[42] B. Shi and A. Srivastava, "Unified datacenter power management considering on-chip and air temperature constraints," Sustainable Computing: Informatics and Systems, vol. 1, no. 2, pp. 91–98, 2011.

[43] R. Xu, D. Zhu, C. Rusu, R. Melhem, and D. Mossé, "Energy-efficient policies for embedded clusters," in ACM SIGPLAN Notices, vol. 40, no. 7, 2005, pp. 1–10.

[44] V. Anagnostopoulou, S. Biswas, A. Savage, R. Bianchini, T. Yang, and F. T. Chong, "Energy conservation in datacenters through cluster memory management and barely-alive memory servers," in Proceedings of the 2009 Workshop on Energy Efficient Design, 2009.

[45] P. Bohrer, D. Cohn, E. Elnozahy, T. Keller, M. Kistler, C. Lefurgy, R. Rajamony, F. Rawson, and E. Hensbergen, "Energy conservation for servers," in IEEE Workshop on Power Management for Real-time and Embedded Systems, 2001.

[46] J. S. Chase, D. C. Anderson, P. N. Thakar, A. M. Vahdat, and R. P. Doyle, "Managing energy and server resources in hosting centers," in ACM SIGOPS Operating Systems Review, vol. 35, no. 5. ACM, 2001, pp. 103–116.

[47] H. Chen, M. Kesavan, K. Schwan, A. Gavrilovska, P. Kumar, and Y. Joshi, "Spatially-aware optimization of energy consumption in consolidated data center systems," in ASME 2011 Pacific Rim Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Systems. American Society of Mechanical Engineers, 2011, pp. 461–470.

[48] G. Da Costa, M. D. De Assuncao, J.-P. Gelas, Y. Georgiou, L. Lefèvre, A.-C. Orgerie, J.-M. Pierson, O. Richard, and A. Sayah, "Multi-facet approach to reduce energy consumption in clouds and grids: the green-net framework," in Proceedings of the 1st international conference on energy-efficient computing and networking. ACM, 2010, pp. 95–104.

[49] S. Ghosh, M. Redekopp, and M. Annavaram, "Knightshift: shifting the i/o burden in datacenters to management processor for energy efficiency," in Computer Architecture. Springer, 2012, pp.183–197.

[50] L. Liu, H. Wang, X. Liu, X. Jin, W. B. He, Q. B. Wang, and Y. Chen, "GreenCloud: a new architecture for green data center," in 6th international conference industry session on Autonomic computing and communications industry session. ACM, 2009, pp. 29–38.

[51] E. Pinheiro, R. Bianchini, E. V. Carrera, and T. Heath, "Dynamic cluster reconfiguration for power and performance," in Compilers and operating systems for low power. Springer, 2003, pp. 75–93.

[52] K. Rajamani and C. Lefurgy, "On evaluating request-distribution schemes for saving energy in server clusters," in Performance Analysis of Systems and Software, 2003. ISPASS. 2003 IEEE International Symposium on. IEEE, 2003, pp. 111–122.

[53] A. Verma, G. Dasgupta, T. K. Nayak, P. De, and R. Kothari, "Server workload analysis for power minimization using consolidation," in Proceedings of the 2009 conference on USENIX Annual technical conference. USENIX Association, 2009, pp. 28–28.

[54] W. Zheng, R. Bianchini, G. J. Janakiraman, J. R. Santos, and Y. Turner, "JustRunIt: Experiment- based management of virtualized data centers," in Proc. USENIX Annual Technical Conference, 2009.

[55] J. Leverich, M. Monchiero, V. Talwar, P. Ranganathan, and C. Kozyrakis, "Power management of datacenter workloads using per-core power gating," Computer Architecture Letters, vol. 8, no. 2,pp. 48–51, 2009.

[56] A. Banerjee, T. Mukherjee, G. Varsamopoulos, and S. K. Gupta, "Integrating cooling awareness with thermal aware workload placement for hpc data centers," Sustainable Computing: Informatics and Systems, vol. 1, no. 2, pp. 134–150, 2011.

[57] D. J. Bradley, R. E. Harper, and S. W. Hunter, "Workload-based power management for parallel computer systems," IBM Journal of Research and Development, vol. 47, no. 5.6, pp. 703–718, 2003.

[58] K. Le, R. Bianchini, M. Martonosi, and T. D. Nguyen, "Cost-and energy-aware load distribution across

data centers," Proceedings of HotPower, pp. 1–5, 2009.

[59] J. D. Moore, J. S. Chase, P. Ranganathan, and R. K. Sharma, "Making scheduling cool: Temperature-aware workload placement in data centers." in USENIX annual technical conference, General Track,2005, pp. 61–75.

[60] R. Nathuji, C. Isci, and E. Gorbatov, "Exploiting platform heterogeneity for power efficient data centers," in Fourth International Conference on Autonomic Computing (ICAC). IEEE, 2007, pp.5–5.

[61] L. Wang, G. Von Laszewski, J. Dayal, X. He, A. J. Younge, and T. R. Furlani, "Towards thermal aware workload scheduling in a data center," in 10th International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN). IEEE, 2009, pp. 116–122.

[62] M. Zapater, J. L. Ayala, and J. M. Moya, "Leveraging heterogeneity for energy minimization in data centers," in Cluster, Cloud and Grid Computing (CCGrid), 2012 12th IEEE/ACM International Symposium on, 2012, pp. 752–757.

[63] Q. Tang, S. K. Gupta, D. Stanzione, and P. Cayton, "Thermal-aware task scheduling to minimize energy usage of blade server based datacenters," in Dependable, Autonomic and Secure Computing,2nd IEEE International Symposium on. IEEE, 2006, pp. 195–202.

[64] C. E. Bash, C. D. Patel, and R. K. Sharma, "Dynamic thermal management of air cooled data centers," in Thermal and Thermomechanical Phenomena in Electronics Systems, 2006. ITHERM'06. The Tenth Intersociety Conference on. IEEE, 2006, pp. 8–pp.

[65] W. Huang, M. Allen-Ware, J. B. Carter, E. Elnozahy, H. Hamann, T. Keller, C. Lefurgy, J. Li, K. Rajamani, and J. Rubio, "TAPO: Thermal-aware power optimization techniques for servers and data centers," in Green Computing Conference and Workshops (IGCC), 2011 International. IEEE,2011, pp. 1–8.

[66] D. Kudithipudi, Q. Qu, and A. K. Coskun, "Thermal management in many core systems," in Evolutionary Based Solutions for Green Computing. Springer, 2013, pp. 161–185.

[67] A. Mirtar, S. Dey, and A. Raghunathan, "Adaptation of video encoding to address dynamic thermal management effects," in Green Computing Conference (IGCC). IEEE, 2012, pp. 1–10.

[68] J. Moore, R. Sharma, R. Shih, J. Chase, C. Patel, P. Ranganathan et al., "Going beyond CPUs: The potential of temperature-aware solutions for the data center," in Proc. 2004 First Workshop Temperature-Aware Computer Systems (TACS-1) Held in Conjunction with ISCA-31, 2004.

[69] E. Pakbaznia, M. Ghasemazar, and M. Pedram, "Temperature-aware dynamic resource provisioning in a power-optimized datacenter," in Proceedings of the Conference on Design, Automation and Test in Europe. European Design and Automation Association, 2010, pp. 124–129.

[70] L. Ramos and R. Bianchini, "C-Oracle: Predictive thermal management for data centers," in IEEE 14th International Symposium on High Performance Computer Architecture (HPCA), 2008, pp.111–122.

[71] J. Kim, M. Ruggiero, and D. Atienza, "Free cooling-aware dynamic power management for

green datacenters," in High Performance Computing and Simulation (HPCS), 2012 International Conference on. IEEE, 2012, pp. 140–146.

[72] W. Felter, K. Rajamani, T. Keller, and C. Rusu, "A performance-conserving approach for reducing peak power consumption in server systems," in 19th annual international conference on Supercom- puting, 2005, pp. 293–302.

[73] J. Choi, S. Govindan, B. Urgaonkar, and A. Sivasubramaniam, "Profiling, prediction, and capping of power consumption in consolidated environments," in Modeling, Analysis and Simulation of Computers and Telecommunication Systems, 2008. MASCOTS 2008. IEEE International Symposium on. IEEE, 2008, pp. 1–10.

[74] C. Lefurgy, X. Wang, and M. Ware, "Server-level power control," in Autonomic Computing, 2007.ICAC'07. Fourth International Conference on. IEEE, 2007, pp. 4–4.

[75] J. O. Kephart, H. Chan, R. Das, D. W. Levine, G. Tesauro, F. L. Rawson III, and C. Lefurgy, "Coordinating multiple autonomic managers to achieve specified power-performance tradeoffs." in ICAC, vol. 7, 2007, p. 24.

[76] D. Kusic, J. O. Kephart, J. E. Hanson, N. Kandasamy, and G. Jiang, "Power and performance management of virtualized computing environments via lookahead control," Cluster computing, vol. 12, no. 1, pp. 1–15, 2009.

[77] C. Rusu, A. Ferreira, C. Scordino, and A. Watson, "Energy-efficient real-time heterogeneous server clusters," in Proceedings of the 12th IEEE Real-Time and Embedded Technology and Applications Symposium, 2006, pp. 418–428.

[78] K. Sudan, S. Srinivasan, R. Balasubramonian, and R. Iyer, "Optimizing datacenter power with memory system levers for guaranteed quality-of-service," in Proceedings of the 21st international conference on Parallel architectures and compilation techniques. ACM, 2012, pp. 117–126.

[79] X. Wang and Y. Wang, "Co-con: Coordinated control of power and application performance for virtualized server clusters," in Quality of Service, 2009. IWQoS. 17th International Workshop on. IEEE, 2009, pp. 1–9.

[80] Y. Chen, A. Das, W. Qin, A. Sivasubramaniam, Q. Wang, and N. Gautam, "Managing server energy and operational costs in hosting centers," in ACM SIGMETRICS Performance Evaluation Review, vol. 33, no. 1, 2005, pp. 303–314.

[81] T. Horvath and K. Skadron, "Multi-mode energy management for multi-tier server clusters," in 17th international conference on Parallel architectures and compilation techniques. ACM, 2008, pp.270–279

[82] L. Parolini, N. Tolia, B. Sinopoli, and B. H. Krogh, "A cyber-physical systems approach to energy management in data centers," in Proceedings of the 1st ACM/IEEE International Conference on Cyber-Physical Systems. ACM, 2010, pp. 168–177.

[83] R. Urgaonkar, U. C. Kozat, K. Igarashi, and M. J. Neely, "Dynamic resource allocation and power management in virtualized data centers," in Network Operations and Management Symposium (NOMS). IEEE, 2010, pp. 479–486.

[84] X. Wang and M. Chen, "Cluster-level feedback power control for performance optimization," in IEEE 14th International Symposium on High Performance Computer Architecture (HPCA), 2008, pp. 101–110.

[85] I. Goiri, R. Beauchea, K. Le, T. D. Nguyen, M. E. Haque, J. Guitart, J. Torres, and R. Bianchini, "Greenslot: scheduling energy consumption in green datacenters," in International Conference for High Performance Computing, Networking, Storage and Analysis. ACM, 2011, p. 20.

[86] K.-K. Nguyen, M. Cheriet, M. Lemay, M. Savoie, and B. Ho, "Powering a data center network via renewable energy: A green testbed," Internet Computing, IEEE, vol. 17, no. 1, pp. 40–49, 2013.

[87] S. Gurumurthi, A. Sivasubramaniam, M. Kandemir, and H. Franke, "DRPM: dynamic speed control for power management in server class disks," in 30th Annual International Symposium on Computer Architecture. IEEE, 2003, pp. 169–179.

[88] D. Narayanan, A. Donnelly, and A. Rowstron, "Write off-loading: Practical power management for enterprise storage," ACM Transactions on Storage (TOS), vol. 4, no. 3, p. 10, 2008.

[89] E. Pinheiro, R. Bianchini, and C. Dubnicki, "Exploiting redundancy to conserve energy in storage systems," in ACM SIGMETRICS Performance Evaluation Review, vol. 34, no. 1, 2006, pp. 15–26.

[90] N. Chatterjee, M. Shevgoor, R. Balasubramonian, A. Davis, Z. Fang, R. Illikkal, and R. Iyer, "Lever- aging heterogeneity in dram main memories to accelerate critical word access," in Microarchitecture (MICRO), 2012 45th Annual IEEE/ACM International Symposium on. IEEE, 2012, pp. 13–24.

[91] Q. Deng, D. Meisner, L. Ramos, T. F. Wenisch, and R. Bianchini, "Memscale: active low-power modes for main memory," ACM SIGPLAN Notices, vol. 46, no. 3, pp. 225–238, 2011.

[92] D. H. Yoon, J. Chang, N. Muralimanohar, and P. Ranganathan, "BOOM: enabling mobile memory based low-power server DIMMs," in ACM SIGARCH Computer Architecture News, vol. 40, no. 3. IEEE Computer Society, 2012, pp. 25–36.

[93] J. Liu, B. Jaiyen, R. Veras, and O. Mutlu, "RAIDR: Retention-aware intelligent DRAM refresh," in Computer Architecture (ISCA), 2012 39th Annual International Symposium on. IEEE, 2012, pp. 1–12.

[94] S. Mittal, "A survey of architectural techniques for improving cache power efficiency," Sustainable Computing: Informatics and Systems, 2013.

[95] B.-G. Chun, G. Iannaccone, G. Iannaccone, R. Katz, G. Lee, and L. Niccolini, "An energy case for hybrid datacenters," ACM SIGOPS Operating Systems Review, vol. 44, no. 1, pp. 76–80, 2010.

[96] R. Nathuji and K. Schwan, "VirtualPower: coordinated power management in virtualized enterprise systems," in ACM SIGOPS Operating Systems Review, vol. 41, no. 6, 2007, pp. 265–278.

[97] L. Li, C.-J. M. Liang, J. Liu, S. Nath, A. Terzis, and C. Faloutsos, "Thermocast: a cyber-physical forecasting model for datacenters," in 17th ACM SIGKDD international conference on Knowledge discovery and data mining. ACM, 2011, pp. 1370–1378.

[98] S. Gupta, S. Mittal, and S. Dasgupta, "Guaranteed QoS with MIMO Systems for Scalable Low Motion Video Streaming Over Scarce Resource Wireless Channels," in Proceedings Second International Conference On Information Processing, 2008, pp. 452–466.

[99] S. Gupta, S. Mittal, S. Dasgupta, and A. Mittal, "MIMO Systems For Ensuring Multimedia QoS Over Scarce Resource Wireless Networks," in ACM International Conference On Advance Computing, India, 2008.

[100] S. Mittal et al., "Design exploration and implementation of simplex algorithm over reconfigurable computing platforms," in IEEE International Conference on Digital Convergence, 2011, pp. 204–209.

[101] A. Pande and S. Mittal, "BayWave: BAYesian WAVElet-based image estimation," International Journal of Signal and Imaging Systems Engineering, vol. 2, no. 4, pp. 155–162, 2009.

[102] L. Keys, S. Rivoire, and J. D. Davis, "The search for energy-efficient building blocks for the data center," in Computer Architecture. Springer, 2012, pp. 172–182.

[103] C. Delimitrou and C. Kozyrakis, "Paragon: QoS-aware scheduling for heterogeneous datacenters,"in ASPLOS. ACM, 2013, pp. 77–88

[104] S. Mittal, Architectural Techniques For Managing Non-volatile Caches. Lambert Academic Publishing (LAP), 2013.

DATA TRANSFER USING BIPARTITE GRAPHS

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ABSTRACT

Transfer of data is and its safety is an issue in current world. Methods are developed and used for data encryption. Graph theory is growing as a promising field for this purpose. In this paper we propose a method of message encryption as a graph.

Keywords: Decryption, Encryption, Graph.

I INTRODUCTION

In cryptography, encryption is the process of encoding messages or information in such a way that only authorized parties can read it. Encryption does not of itself prevent interception, but denies the message content to the interceptor. In an encryption scheme, the message or information, referred to as plaintext, is encrypted using an encryption algorithm, generating cipher text that can only be read if decrypted. For technical reasons, an encryption scheme usually uses a pseudo-random encryption key generated by an algorithm. It is in principle possible to decrypt the message without possessing the key, but, for a well designed encryption scheme, large computational resources and skill are required. An authorized recipient can easily decrypt the message with the key provided by the originator to recipients, but not to un authorized interceptors [1].

Graph theory is extensively used in encryption. In [2], M. Yamuna et al have provided a new genetic code for amino acids and by using this any details regarding amino acids can be encrypted. In [3], Wael Mahmoud Al Etaiwi has provided an encryption algorithm to encrypt and decrypt data securely with the benefits of graph theory properties. They have used the concepts of cycle graph, complete graph and minimum spanning tree to generate a complex cipher text using a shared key.

II PRELIMINARY NOTE

In this section we provide the basic results of graph theory which are required for proposed encryption scheme.

Graph

In the most common sense of the term, a graph is an ordered pair G = (V, E) comprising a set V of vertices or nodes together with a set E of edges or links, which are 2 – element subsets of V (that is an edge is related with two vertices, and the relation is represented as an unordered pair of the vertices with respect to the particular edge).

Weighted Graph

A graph is a weighted graph if a number (weight) is assigned to each edge. Such weights might represent, for example, costs, lengths or capacities, etc. depending on the problem at hand. Some authors call such a graph a network [4].

Multigraph

A multigraph is a graph which is permitted to have multiple edges (also called parallel edges), that is, edges that have the same end nodes. Thus two vertices may be connected by more than one edge [5].

Independent Set

An independent set is a set of vertices in a graph, no two of which are adjacent [6].

Bipartite Graph

A bipartite graph (or bigraph) is a graph whose vertices can be divided into two disjoint sets U and V (that is, U and V are each independent sets) such that every edge connects a vertex in U to one in V [7].

III RESULTS AND DISCUSSIONS

In this paper we proposed the encryption scheme for transfer the data into a graph. For that we have given a encryption table and graph construction in this section.

3.1. Construction of Encryption Table

First we decide the number of characters (S) required for the message encryption. We can randomly fix the number of rows and columns of the table, taking care that the number of cells available in the table is atleast of length of S. Assign numbers 1, 2, 3…. k, to the columns and numbers k + 1, k + 2, ... m, to the rows, where k = number of columns $k \leq 9$, m = number of rows. Distribute the characters in S randomly in the table.

For normal message we use the 26 alphabets and blank space. A model table for the same is seen is Table 1.

	1	2	3
4	A	B	C
5	D	E	F
6	G	H	I
7	J	K	L
8	M	N	O
9	P	Q	R
10	S	T	U
11	V	W	X
12	Y	Z	Space

Table 1

Now each character in the cell receives a number value. The first character represents the column number, remaining the row number. For example using Table 1 A receives value 14, U receives value 310.

3.2. Graph Construction from Number Sequence

Let M be message to be encrypted of length k. Convert each character in M into its corresponding number value using Table 1. Let the resulting sequence be M1. We know that each character will receive a two place value, one representing the row number and other the column number. So M1 will be a sequence of numbers. Let us represent them as c_1r_1, c_2r_2,…, c_kr_k. Note that c_1, c_2 ….c_k, r_1, r_2, …, r_k are numbers. We construct a graph G as follows

Vertices Set of G Number of vertices in G = number of distinct row numbers + column numbers used to generate M1.

Each vertex receives its corresponding row and column value as its label.

Edge Set of G Draw edges between the vertex pairs (c_1, r_1), (c_2, r_2),… (c_k, r_k). Let us label these edges as e_1, e_2, …, e_k.

Number of edges in G = length of M.

Note that c_1, c_2, …, c_k and r_1, r_2, …r_k are always independent sets. So, the graph G is always a bipartite graph.

Edge Weight Assign random numbers n_1, n_2, n_3,…, n_k as the edge weights to the edges e_1, e_2,…, e_k so that $n_1 > n_2 >\ldots> n_k$.

3. 3. Encryption Algorithm

Let M**: GRAPH** be the message to be encrypted.

Step 1 Convert each character in M into its corresponding number value using Table 1 to generate M1.

For the message M, M1: 16 39 14 19 26

Step 2 Construct the graph corresponding to the sequence M1 as explained in Section 3. 2 to generate a graph G.

For M1

Vertex Set = { 1, 2, 3, 4, 6, 9 }

Edge Set = { (1 6), (3, 9), (1, 4), (1, 9), (2, 6) } = { e_1, e_2, e_3, e_4, e_5 }

Edge weights = { 24, 32, 42, 44, 86 } assigned to the edges e_1, e_2, e_3, e_4, e_5 respectively.

The resulting graph is as seen in Fig. 1

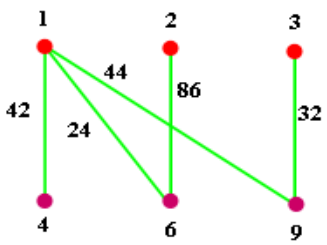

Fig. 1

Step 3 Send G to the receiver.

For decrypting the message we reverse the procedure.

Suppose the received graph is as seen in Fig. 2

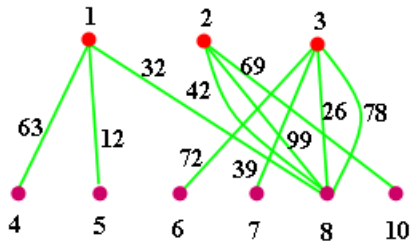

Fig. 2

Arranging the edge weights in increasing order we generate the sequence

12 26 32 39 42 63 69 72 78 99

Picking the corresponding vertex labels from the graph we generate the sequence

15 38 18 37 28 14 210 36 38 28

From Table 1 the message is decrypted as **DOMINATION**.

IV CONCLUSION

The number of columns can be decided as per. We can construct a graph with 1 or 2 or….or 9 columns. So the number of possible ways of constructing any table 1! + 2! + … + 9! = 409113 (this value is only for columns, similarly we can arrange for rows also)

For each of these 409113 ways we can arrange the characters in any message M of length k in k! ways. So we can construct atleast 409113 (k!) distinct tables .

Numerous weighted graphs are available in public domain for various reasons. It is difficult to find the difference between a fake graph and the encrypted one. So the proposed method is safe for encryption of any message.

REFERENCES

[1]. http://en.wikipedia.org/wiki/Encryption.

[2]. M. Yamuna, B. Joseph Sasikanth Reddy, Nithin Kumar Reddy, Paladugula Raghuram, Genetic Code for Amino Acids using Huffman Trees, International Journal of ChemTech Research, 6(1), 2014, 53 – 63.

[3]. Wael Mahmoud Al Etaiwi, Encryption Algorithm using Graph Theory, Journal of Scientific Research & Reports, 3(19), 2014, 2519 – 2527.

[4]. http://en.wikipedia.org/wiki/Graph_%28mathematics%29.

[5]. http://en.wikipedia.org/wiki/Multigraph.

[6]. http://en.wikipedia.org/wiki/Independent_set_%28graph_theory%29.

[7]. http://en.wikipedia.org/wiki/Bipartite_graph.

WEB BASED GEOPROCESSING USING OPEN SOURCE TOOLS

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ABSTRACT

As web services has been developed, GIS i.e. Geographical Information System plays a very important role in web based Geoprocessing which is useful for many geospatial projects. An efficient and time saving web based geospatial application compared to earlier application has always been a very big challenge for developers. In this article, aim is to develop such web based Geoprocessing technology which facilitates clients to extract or retrieve any needed information from the map and enables the capability to perform functions like addition, overlay, intersection, spatial analysis etc. in very easier and effective manner from anywhere over the network. In the present implementation, web based Geoprocessing technology has been developed to perform the supporting capability of all GRASS-GIS like overlay, addition and non GRASS-GIS functions in PyWPS which can be Access by clients from anywhere on the network. It is basically developed on Python language, so it is known as a PyWPS (Python web processing service), the service which provides a time saving and fast application compared to PHP WPS application and native support of GRASS-GIS functions. PyWPS has been followed by many steps to develop like request acceptance from web application, run scripts via OpenLayers and provides the user efficient and fast geospatial calculations with no server dependencies. Here the focus is on developing a web based application performing overlay analysis function which makes features of all data set into one dataset and any user can access these computations anywhere over the network.

Keywords :*Apache Server, Grass-GIS 7, Open Layers, QGIS, UBUNTU 10.04 and WPS-Grass-Bridge.*

I. INTRODUCTION

Rapidly increase in use of mapping application over the web developing popular services based on Google maps, facilities and accessibility of data over the network have been increased. All Scientists or researchers are showing their interest in WEBGIS development. A variety of geospatial data and information can be gathered from anywhere. Online Geoprocessing is one of the parts of WEBGIS by which we are not only gathering data but also to extract the information by applying all Grass-GIS functions from anywhere over the network. Geoprocessing means processing of earth information. Geoprocessing is used to create map layer by applying all Grass-GIS and non-Grass-GIS functions. Previously Online Geoprocessing was available on workstations

with high performance used for quantitative and qualitative functionalities. But nowadays it is available for desktop application. Online Geoprocessing offers a variety of calculations, computations and transformations e.g. thematic and temporal information in computation, coordinate transformation etc and all geospatial calculation from large scale to simple calculation e.g. r.add, r.buffer, r.mapcalc etc. This document provides Overlay analysis on PyWPS (Python web processing service) server which is geographic patterns. Open source map layers in a GIS are used to discover relationship among the layers. Overlay analysis is used to search geographic patterns and to determine locations that meet specific criteria. Here we are using Open source tools for online Geoprocessing such as Grass-GIS (The Geographic Resources Analysis Support System), QGIS (Quantum GIS), and WPS (Web Processing Service), Open Layers. In open source software, source code is made available over the web and needs to modify according to new design. Geoprocessing provides Geo-processes in standard way in order to standardize input and output or request and response. It is also called deployment of Geo-processes by implementing some procedure on all Geospatial services like add, multiply, intersect, polygon overlay. Open source is free licensed and any programmers may modify their source code and share within the network. It is standards of OGC (open geospatial consortium) that is non-profit standards organization that is standards for geospatial and location based services. WPS is one of the OGC standards. WPS stands for Web Processing Service. It also makes easy for a client to request the execution of a process and handle output. It provides facilities to encode and decode all process and newly designed process. This implementation focuses on the current OPENGIS specification. The main advantages of using web services that are based on an industry standard framework are a wide variety of implementation support on various platforms, adaptively to document based processing and request-based processing, relative ease to consume other web services, unlimited Geoprocessing functionality supportable and efficient to perform processing the data remotely. WPS defines an interface that facilitates the publishing of geospatial processes and clients discovery of and binding to those processes. This article focused on development of PyWPS (Python Web processing service) server and implementation of it to provide overlay operation over the network without Grass-GIS and build real life based WEBGIS application, which is able to perform for example interpolation of raster data or various digital elevation model analyses. PyWPS is relatively new project (its development started in April 2006). Here PyWPS 3.2.1 has been used. PyWPS as interlayer, which translates requests from the WEBGIS application, runs web server scripts, provides calculation progress and returns the calculation results back to the web browser. PyWPS server provides a framework that makes online Geoprocessing services and calculations over the network faster and easier compared to existing previous methods.

II. LITERATURE REVIEW

Many earlier implementations have been done to acquire better and better performance in the field of online Geoprocessing. This paper introduces one of its implementation in the field of online Geoprocessing named PyWPS. PyWPS was aimed for accessibility of all Grass-GIS modules by all users but this paper introduces PyWPS which would be able to work with the modules of Grass-GIS and non Grass-GIS over the network. PyWPS results in the less time in geospatial calculations than other WPS. Quantitative based availability check and testing for the long running process enables the effective use of web services which is termed as reality

check of web servers [1]. A web based multi-tiered distributed geospatial information system has been developed on the platform of GeoBrain web service which is termed as Grass Web application Software system (GWASS) for reducing the cost of access in the client side [2]. A total object oriented mechanisms, principles and work flow for developing real time web based Geoprocessing service has been covered and explained on the term of automation [3]. The demand of light weight protocols and real time crowd-sourcing capability based Geoprocessing over the web is increasing day by day. These increasing developments have been provided by architecture [4]. Interactive GUI application based on Quality of service aware of Geoprocessing service over the web has been delivered in the form of GeoQOS for standardization and monitoring attributes [5]. Transfer of internet information consisting of temperature of Malaysia into GIS platform has been performed using four modules consisting Google connection, HTML parameters, temperature extraction and Shapefile update module [6].

A Technological Implementation of the new Open Geospatial Consortium Web Processing Service "WPS PHP Server" which provides Web based generalization services and techniques on the real time application that provides a overall accessibility, the Geographic Resources Analysis Support System (GRASS) to generalize roads on the fly [7]. Geospatial calculation and computation on spatial referenced data for overall accessibility has been offered [8] e.g. subtracting one set of spatially referenced numbers from another, or as a global climate change model over the remote servers. US-Geological Survey's provide a user-centered design of many portable web-mapping clients for online Geoprocessing [9]. Geospatial data has been accessed explicitly for data access standards from the OGC [10]. An investigation about the availability of standard Geoprocessing services and its use in the geosciences domain has been done to find the servers available conforming to the Web Processing [11].The research goals were (i) Web processing services has been checked whether it is accessible or not, (ii) For long running Geoprocessing processes and web accessible response, this research goal provide quantitative data for extracting different features and (iii) to test the capability for finding Web services in the Domain[12]. The ZOO Project, which is a new open source implementation of the Open Geospatial Consortium's (OGC) Web Processing Service (WPS), released under the term of the MIT/X-11 license based on a robust server-side C language Kernel (named ZOO Kernel), ZOO Project has been proposed a new way to develop, handle and standardized GIS-based Web services focusing on its assets and limitations, foremost to highlight the new Opportunities provided by such a platform [14]. Plymouth Marine Laboratory (PML)has been developed python WPS implementation (PyWPS) and it has actively supported new developments (SOAP/WSDL) contained in a separated project branch for improvement of WPS-WSDL interface after converting conversion of WPS processes into WSDL integrated easily with Taverna-workbench [19].

III. IMPLEMENTATION

3.1 Presentation

Several implementations were done on the Web Processing Services. Our challenges are to make web processing services more efficient and easy to implement compare with previous implementations. Grass-GIS supported nature of PyWPS (Python enabled web processing service) provides some significant challenges for

geospatial calculations. Our initial implementations of PyWPS used overlay function to represent relationships across map layers in GIS. PyWPS may be run in Windows and Linux, but the Windows implementation of PyWPS lacks asynchronous capabilities in get Capabilities due to problems forking all Python processes. Here it has been efficiently implemented on Ubuntu 10.04. Prerequirements used are Python 2.5, 2.6 and python-xml. A couple of dependencies such as libapache2-mod-python, python-htmltmpl, and python-magic have been installed. Packages has been used which is essential for the development. Packages used are Apache Web Server, GRASS (Geographic Resources Analysis Support System), PROJ.4 (Cartographic Projection Library), and GDAL/OGR (Geospatial Data Abstraction Library). Latest PyWPS has been downloaded [PyWPS-3.2.1].Connection between apache server and PyWPS has been established. It provides a server-side C kernel that makes creation and management of web services by loading dynamic libraries possible. It also connects to geospatial libraries from which geospatial calculation possible. Here web services have been programmed in python Web-scripting language but it could be possible with C, Python, Java, FORTRAN, PHP and JavaScript. It updates existing code to create new web services. PyWPS distribution does not include any default processes. For any other process, client has to create a custom process and add this process to PyWPS GetCapabilities.

3.2 Architecture

In this section architecture has been explained in Fig 1. Service provider is the key concept of this architecture that has been explained in this section.

This architecture run on Apache web server which handles all traffic related to network and write script on python. This Python script includes HTTP request and response to any input POST data.

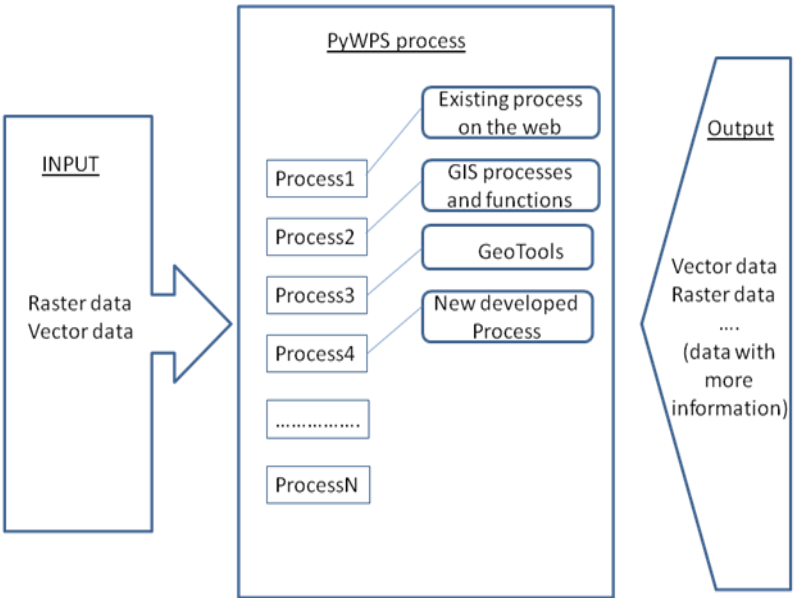

Figure 1 Basic PyWPS process

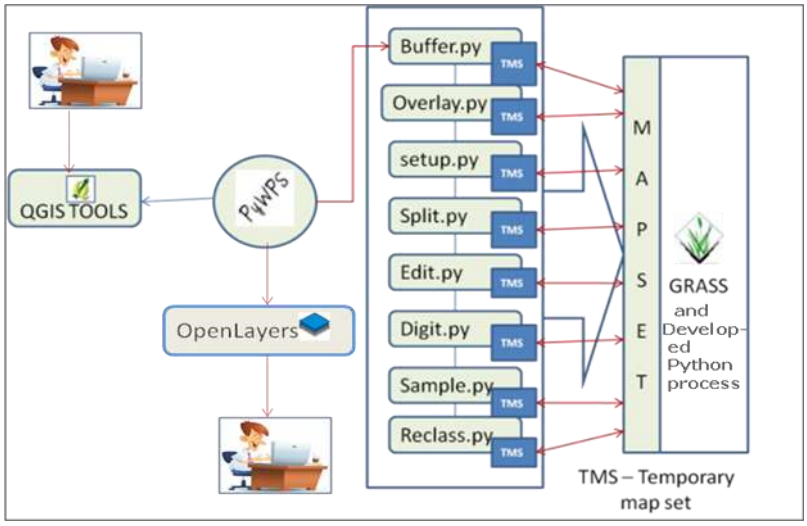

Figure 2 Architecture of Online Geoprocessing using PyWPS

Our implementation is based on architecture given in Fig. 1. In Fig. 2, a complete Grass-GIS process has been described on PyWPS. PyWPS includes following steps: 1) Import custom process created on python from PyWPS into Grass-GIS function e.g. v.in.ogr in vector region.2) Region should be set raster e.g. r.in.gdal in raster region 3) Export that process back to PyWPS to execute that process and to provide the response e.g. v.out.ogr in vector or r.out.gdal in raster.

After going through this architecture, we need to initialize each incoming request separate, since HTTP requests are stateless. First, XML file should be located and parsed. Here configuration.xml files are located and parsed at the beginning of the initialization. XML (Extensible Markup Language) is used for providing information about the working directory i.e. from where it can find and somewhat Grass-GIS set up also.WPS services are accessible via two HTTP methods (GET and POST). Fig. 3 shows the HTTP methods and their work flow.

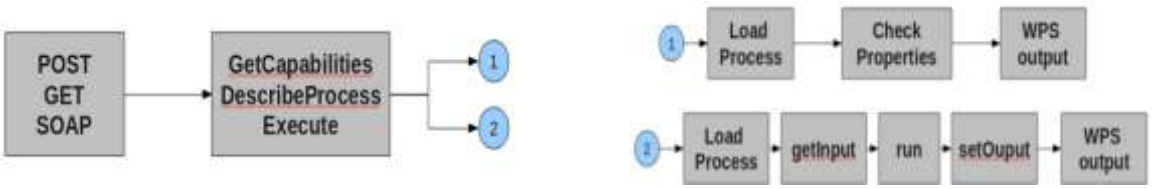

Figure 3 Description of HTTP Methods

To parse the input, handler class is necessary like GET handler, for Get Parser which makes available all the function key and value pairs that provides variables. The Post Parser parses the request written in XML.

3.3 PyWPS as a Framework Provider

A PyWPS service provider is defined as a group of Services Shared Objects and one common gateway interface file that is wrapper file (pywps.cgi). PyWPS is normally run as a CGI script (pywps.cgi) but it can also be run using mod_python and support for mod_wsgi (Web Server Gateway Interface) is being finalized. Checking of

all the possibilities of CGI script integration in python shell play an important role in WEBGIS clients. A WebGIS interface can improve better understanding for area information for both before and after data processing and analysis. Since the code is written in standard Python it can also be ported as a Java let (using Jython) and run from Tomcat application server. PyWPS is lightweight, with only 5000 lines of code, which makes it a good candidate for testing new concepts This CGI file provides all the metadata configuration of all processes, description and their execution. Service provider facilitates the Get Capabilities and Describe Process Requests. Pywps.cgi file defines the configuration files which checks whether all required inputs were provided in the request. Here we have been implemented two kinds of Processes in the PyWPS Server: GRASS and native processes. Grass Processes uses GRASS GIS functions to do the implementation. Native processes do not use GRASS GIS functions for implementation. It builds one module to develop geospatial functions without using GRASS GIS functions. Module is a set of processes. Initialization of PyWPS Server helps in defining each module by XML file. There are two additional steps needed to make a Grass-GIS process run because the Grass-GIS processes are separated. These two extra steps are listed below:-

- The transferred (or referenced) data sets needs to be imported to form a GRASS GIS database.
- The results have to be exported after processing and querying has been done in a proper way. The care should be taken that only Geographic Markup language is supported.

No programming is needed for adding the process. The only requirement is to connect a process written in XML to a Grass-GIS module. Suppose a more complex process is needed, then the requirement is to write a script for chaining multiple Grass-GIS modules. There is no any restriction for programming language used. Execution of process or sequence diagram can be represented by Fig. 4.

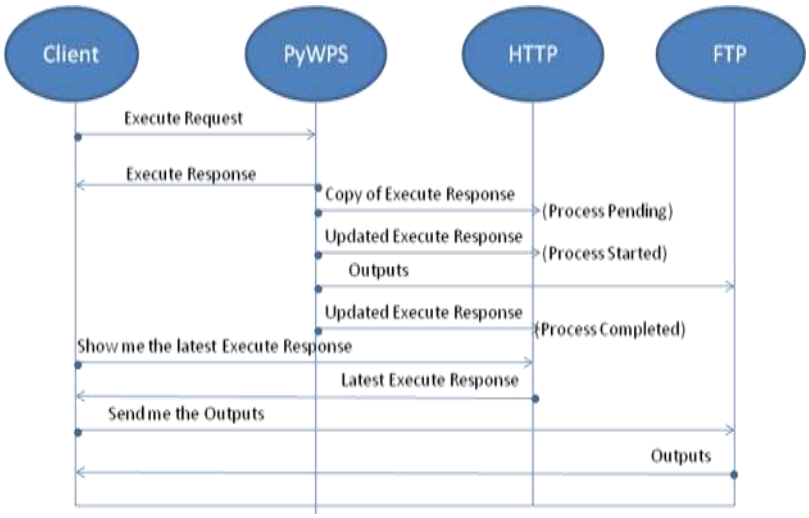

Figure 4 Execution of process through request and response.

3.4 OSGeo libraries for PyWPS server

It is basically used in a form of platform for numerous and effective libraries for connecting together and able to make easy access for all web services. The GDAL/OGR library is used to perform almost all raster and vector functions written in python with supported libraries.

GDAL/OGR

GDAL (Geospatial Data Abstraction Library) is basically supported for various functions in projects e.g. importing, exporting, convert reproject for all data in raster and vector format. This library is used in set up of very efficient web services by using both single and multiple geometries spatial operations. Gdalgrid and gdaltranslate capabilities in WPS implementation is also possible .In case of Map Server, GDAL and OGR are also needed.

GRASS GIS 7

It refers to Geographical Resources Analysis Support system. It is one of the efficient Open Source GIS software that export process description of WPS processes returning Grass-GIS functions with XML scripting. PyWPS is written in native support of GRASS and its functions. All Grass-GIS function with python scripting are termed as PyWPS Service Provider. Several successful examples have been carried out using the r.add, r.mapcalc, r.div, r.mult and r.sub functions.

PROJ.4 (Cartographic Projection Library)

This library is basically used for almost all open source projects for data transformation from one coordinate to another coordinate. Proj4 is especially beneficial for integration of Map Server as well, in python-pyproj package.

QGIS (Quantum Geographic Information System)

It refers as an open source desktop application that runs on different platforms and freely available providing all capabilities of data viewing, editing and analysis functions. Its function is similar to other software like Grass-GIS. It allows users to create maps with different raster or vector layers in different map projections. It supports different kind of raster images and vector images. Vector image is stored as point, line or polygon and raster image needs to be georeferenced by the software. To illustrate a workflow sequence that triggers a PyWPS-based model, a PyWPS instance is created and a set of computational geometries is to be simplified with the help of this instance. All request and response depends upon XML messages generated by a web client application. For this, user should know the entry point of PyWPS instance. Such entry point can be retrieved from the web services but can get more and more information by using queries on service metadata via GetCapabilities request. Retrieving the metadata such as entry point is important for further communication called Operations Metadata. By these services, Individual information can also get about the provider called Service Provider and many models are offered called Process Offerings. Fig. 5 shows the overlay process of helloworld example.

http://localhost/cgi-bin/wps.py?Service=WPS&request=execute&version=3.2.1&identifier=helloWorld&DataInputs=[message=Tim]

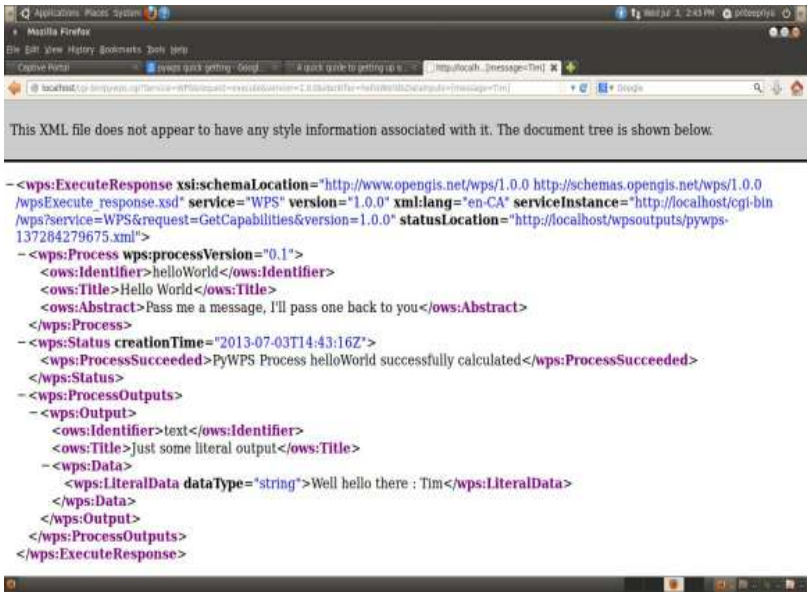

Figure 5 Execution of helloworld.py process

Open Layers

Open Layers (OL) is an open source JavaScript API that represents a map dynamically in any web page displaying map tiles and markers loaded from any source.

The API is extensive and offers the following functionalities:

- Availability and usage of mostly web based GIS application e.g. Google maps, Open street etc;
- Support of map servers like GeoServer or Map Server;
- Easily Support for both Web Map Service and WFS specification with common Image formats (in PNG, GIF or JPEG format);
- Support for all raster as well as vector formats: GML, GeoTIFF, KML, OGC, img etc.

PyWPS supports future developments concerning WPS integration and OL (Open Layers) should use the API's native functionalities. Earlier Plymouth Marine Laboratory has developed some examples based on the PyWPS JavaScript client that provides support for the WPS operations, HTTP request and response and XML processing.

WPS implementation via OL has two strategies:

- Toolbox, were user uses Get Capabilities / describe Process to determine which process to run;
- Pre-defined process that will be run when necessary (e.g. an event that triggers a JavaScript call to WPS).

Finally, a new WPS-Grass-Bridge has been focused that makes easily importing of Grass-GIS modules into PyWPS in a convenient way and allows easy integration into QGIS-WPS Plug-in.

The WPS-Grass-Bridge depends on Grass-GIS 7 trunk, PyWPS trunk and PyXB 1.1.2. So, we have been used the latest versions of PyWPS and GRASS GIS 7.

The general principle is

- Install GRASS GIS trunk version 7 and PyWPS 3.2.1 trunk via svn.
- Install PyXB, which facilitates to generate the PyWPS processes.
- Download the Latest WPS-Grass-Bridge.
- Modify the GlobalGrassSettings.py script and check PyWPSGrassModuleStarter.py.
- Create the XML process description of all processes for each Grass-GIS module which need to be attached.
- Based on the XML files generate the PyWPS processes with GrassXMLtoPyWPS.py.
- Provide the WPS-Grass-Bridge and the generated processes into a PyWPS process directory.

IV. RESULTS

The use of libraries like GDAL/OGR, PROJ4 in a standard way on the basis small changes in original codes and the native support for GRASS GIS makes PyWPS more effective than other web processing services. Fig. 6 shows an overlay process on PyWPS server. Vector operations on a single geometry can also be performed e.g. boundary, centroid. After Get Capabilities and describe Process, Execute operation on a given processes has been performed and the final response will be displayed via XML scripting and graphically displayed on map simultaneously.

http://localhost/cgi-bin/grass.cgi?request=Execute&service=WPS&version=1.0.0&identifier=overlay1&datainputs=[data=http://localhost/landuse.gml;mask=http://localhost/file2.gml;atype=line]

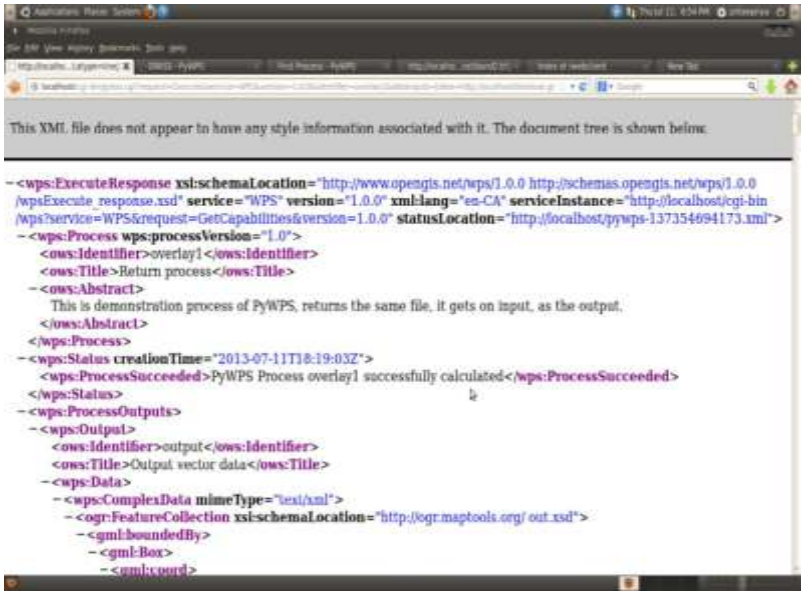

Figure 6 Execution of Overlay.py operation on PyWPS

Now the way such PyWPS Web services called have been explained and make easily access from a client-side Web mapping application based on Open Layer. Fig. 7 shows the web mapping application of overlay operation

on the client side.

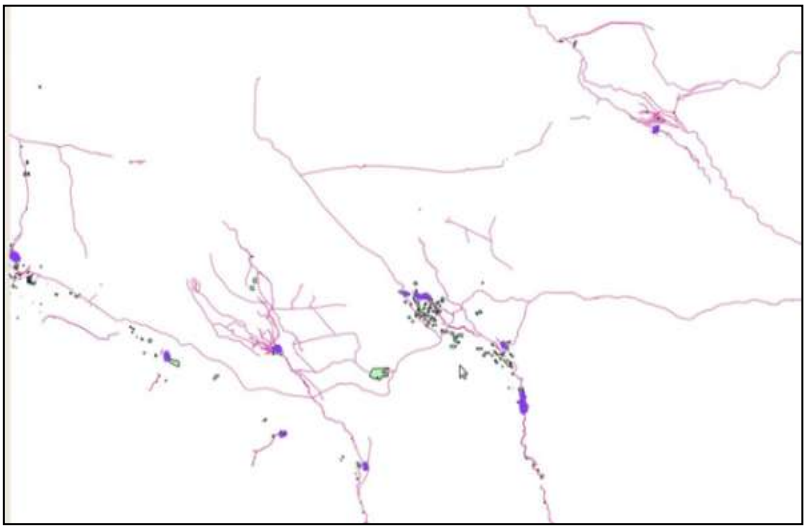

Figure 7 Client-side web mapping application of Overlay Operation

The user can also select another polygon to perform a multi-geometry operation after overlaying of maps is shown in the output. Future developments also depend upon the integration of all open source GIS and non-GIS libraries.

REFERENCES

Journal Papers:

[1] F. J. Lopez-Pellicer, W. Renteria-Agualimpia, R. Bejar, P. R. Muro-Medrano and F. J. Zarazaga-Soria, Availability of the OGC Geoprocessing standard: March 2011 reality check, Computers & Geosciences 47, Elsevier Ltd (copyright), 2012, pp. 13–19.

[2] F. Qiu, F. Ni, B. Chastain, H. Huang, P. Zhao, W. Han and L. Di, GWASS : GRASS web application software system based on the GeoBrain web service, Computers &Geosciences 47, 2012, pp. 143–150.

[3] S. Shi and N. Walford, Automated Geoprocessing Mechanism, Processes and Workflow for Seamless Online Integration of Geodata Services and Creating Geoprocessing Services, IEEE Journal Of Selected Topics In Applied Earth Observations And Remote Sensing, VOL. 5, NO. 6, 2012, pp. 1659-1664.

[4] P. Zhao, T. Forester and P. Yue, The Geoprocessing Web, Computers&Geosciences47, Elsevier Ltd (copyright), 2012, pp. 3–12.

[5] P. Yue, Z. Tan and M. Zhang, GeoQOS : Delivering Quality of Services on the Geoprocessing Web, Proceedings Template - WORD - FOSS4G, 2014, pp. 59-70.

[6] M. I. Sameen, A. A. Ali, N. O. A. Wahid and M. A. A. Kubaisy, An Approach to Develop a

Geographic Information Database Using Dot Spatial Open Source Platform and Google Search Engine, Computer Science Systems Biology vol. 7, 2014, pp. 217-220.

Proceedings Papers:

[7] J. Cepicky, P. Gnip, S. Kafka, I. Koskova, Geospatial data management and integration of geospatial web services, World Conference on Agriculture Information and IT, 2008, PP. 1-16.

[8] B. Schaeffer, Towards a Transactional Web Processing Service (WPS-T), Proc 6th GI Days, Institute for Geoinformatics, Muenster, 2008, pp 91–117.

[9] W. Bergenheim, L. T. Sarjakoski, T. Sarjakoski, A Web Processing Service for GRASS GIS to provide on-line Generalization, 12th AGILE International Conference on Geographic Information Science, Germany, 2009, pp. 1-10.

[10] G. Percivalla, L. Menardb, L. K. Chungc, S. Nativi and J. Pearlmane, Geoprocessing in cyber infrastructure making the web an easy to use Geospatial computational platform, 34th International Symposium on Remote Sensing of Environment, Australia, 2011, pp. USBkey.

[11] F. J.Lopez-Pellicer, W. Renteria-Agualimpia, R. Bejar, J. Valino, F. J. Zarazaga-Soria, P. R. Muro-Medrano, Implantation of OGC Geoprocessing services for Geoscience, Proceedings of the II Iberian Conference of Spatial Data Infrastructures, 2011, pp. 1-12.

[12] E. B.Wolf and K. Howe, Web client Based Distributed Generalization and Geoprocessing, International Conference on Advanced Geographic Information Systems & Web Services, 2012, pp. 123-128.

Web References:

[13] http://www.zooproject.org. Gerald Fenoy, ZOO-Project: the open WPS platform, Applied Geomatics, 2012.

[14] http://wpsint.tigris.org. OGC Web Processing Service (WPS) interface, 2012.

[15] http://2010.foss4g.org/presentations_gensel.php. Open Geospatial Consortium Inc. OpenGIS ® (FOSS4G 2010) Presentations about WPS at Source Geospatial Foundation (OSGeo), 2010.

[16] http://pywps.wald.intevation.org. Conference on Advanced Geographic Information Systems and Web Services, PyWPS, 2012.

[17] http://wiki.ieee-earth.org/Documents/GEOSS_Tutorials. Steps for Plymouth Marine Laboratory implementation of Python WPS.

[18] www.osgeo.org.

OPTIMAL LOAD BALANCING IN CLOUD COMPUTING BY EFFICIENT UTILIZATION OF VIRTUAL MACHINES

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ABSTRACT

Load balancing is the major concern in the cloud computing environment. Cloud comprises of many hardware and software resources and managing these will play an important role in executing a client's request. Now a day's clients from different parts of the world are demanding for the various services in a rapid rate. In this present situation the load balancing algorithms built should be very efficient in allocating the request and also ensuring the usage of the resources in an intelligent way so that under utilization of the resources will not occur in the cloud environment. In the present work, a novel VM-assign load balance algorithm is proposed which allocates the incoming requests to the all available virtual machines in an efficient manner. Further, the performance is analyzed using Cloudsim simulator and compared with existing Active- VM load balance algorithm Simulation results demonstrate that the proposed algorithm distributes the load on all available virtual machines without under/over utilization.

Keywords: Load Balancing, Resource Utilization, Cloud Computing, Virtual Machine, Cloud Analyst.

I. INTRODUCTION

Distributed computing leads to a new technology called Cloud computing used by both academia and industry to store and retrieve the files and necessary documents. The main issue is to schedule the incoming requests in an efficient way with minimum response time and at the same time resources should not underutilized. Many algorithms like FCFS, Round Robin, Active-VM monitoring and Throttled are used for executing clients request with a minimum response time and also assigning the requests to the virtual machines [1]. But the constraints such as high communication delays, underutilization of the resources are not addressed clearly and efficiently, which leads to many of the resources does not participate in executing the requests and hence leads to imbalance of cloud system.

Load balancing is very much essential because every virtual machine in the cloud system does the same amount of work throughout, therefore increasing the throughput and minimizing the response time. We can balance the load of a machine by dynamically shifting the workload local to the machine to remote nodes or machines which are less utilized. This maximizes the user satisfaction, minimizing response time, increasing resource utilization, reducing the number of job rejections and raising the performance ratio of the

system . Management of the dynamic resources in cloud platform can be efficiently given by virtualization technology. It provides a new way to improve the power efficiency of the datacenters i.e., (server) consolidation, which enables the assignment of multiple virtual machines (VMs) to a single physical server [2]. Consequently, some of the servers can be turned off or put into sleep state, thereby, lowering power consumption of the cloud computing system.

In this paper, we present a novel VM-assign algorithm which allocates incoming jobs to available virtual machines. Here the virtual machine assigned depending on its load i.e. VM with least request is found and then new request is allotted. With this algorithm underutilization of the virtual machine is improved significantly and later it is compared with existing Active-VM algorithm.

The rest of the paper is outlined as follows: The background and related work is discussed in Section II, in Section III proposed algorithm is given, Section IV gives details about experimental setup, Section V gives the results and analysis; finally the conclusion is given in Section VI.

II. BACKGROUND AND RELATED WORK

In this section, we briefly summarize the load balancing algorithms used in the cloud computing environment. The main focus is on the efficient utilization of the virtual machines and balancing the virtual machines with the incoming request. Load balancing is defined as a process of making effective resource utilization by reassigning the total load to the individual nodes of the collective system and thereby minimizing under or over utilization of the available resources or virtual machines.

Hemant S. Mahalle, Parag R.Kaveri and Vinay Chavan.[3] have developed Active monitoring load balancer algorithm which maintains information about each VMs and the number of requests currently allocated to which VM. When a request to allocate a new VM arrives, it identifies the least loaded VM. If there are more than one, the first identified is selected. Active VM Load Balancer returns the VM id to the Data Center Controller the data Center Controller sends the request to the VM identified by that id. Data Center Controller notifies the Active VM Load Balancer of the new allocation.

Shridhar G. Domanal and G. Ram Mohana Reddy [4] have developed Modified Throttled algorithm which maintains an index table of virtual machines and also the state of VMs similar to the Throttled algorithm [5]. There has been an attempt made to improve the response time and achieve efficient usage of available virtual machines. Proposed algorithm employs a method for selecting a VM for processing client's request where, VM at first index is initially selected depending upon the state of the VM. If the VM is available, it is assigned with the request and id of VM is returned to Data Center, else -1 is returned. When the next request arrives, the VM at index next to already assigned VM is chosen depending on the state of VM and follows the above step, unlikely of the Throttled algorithm, where the index table is parsed from the first index every time the Data Center queries Load Balancer for allocation of VM.

B.Wickremasinghe, R.N. Calheiros and Rajkumar Buyya have developed Throttled algorithm which is completely based on virtual machine. Here the client first requests the load balancer to check the right virtual machine which access that load easily and perform the operations which is given by the client [6]. In

this algorithm the client first requests the load balancer to find a suitable Virtual Machine to perform the required operation

In the present work we are considering Active-VM load balancer and proposed VM-assign algorithm for comparison. Our main focus is to distribute the load efficiently on the available virtual machines and ensuring that under or over utilization of the resources/ virtual machines will not occur in the cloud system.

Algorithm: VM-Assign Load Balancer

Input: No of incoming jobs x], X2 ..... xn

Available VM y], Y2··· ..... yn

Output: All incoming jobs x], X2 ..... Xn are allocated least loaded virtual machine among the available Yh y2····· .yn

1: Initially all the VM's have 0 allocations.

2: VM-assign load balancer maintains the index / assign table of VMs which has no.of requests currently allocated to each VM.

3: When requests arrive at the data center it passes to the load balancer.

4: Index table is parsed and least loaded VM is selected for execution.

Case I: if found

a. Check whether the chosen least loaded VM is used immediately in the last iteration.

if YES

goto step 4 to find next least VM

if NO

Least loaded VM is chosen

5: VM-assign load balancer returns the VM id to the data center.

6: Request is assigned to the VM. Data center notifies the VM-assign load balancer about the allocation.

7: VM-assign load balancer updates the requests hold by each VM.

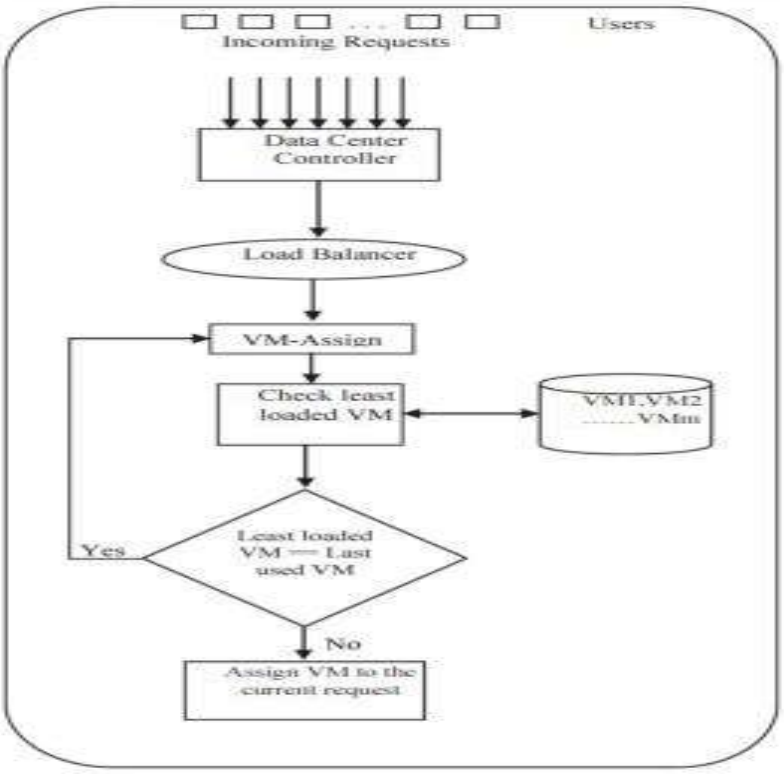
8: When the VM finishes the processing the request, data center receives the response.

9: data center notifies the VM-assign load balancer for the VM de-allocation and VM-assign load balancer updates the table.

10: Repeat from step 2 for the next request.

III. PROPOSED VM-ASSIGN LOAD BALANCE ALGORITHM

This algorithm focuses mainly on fmding out the least loaded virtual machine and how incoming jobs are allocated intelligently. The basic methodology of the proposed VM assign algorithm is given in the following Fig. I.



Figl: Flow of the Proposed VM-assign Algorithm

The Fig.l. Shows the complete flow of the proposed algorithm. There are "n" users are present who request for services in the cloud. The data center which receives the incoming requests and pass to the load balancer. There are "y" virtual machines for processing the requests. VM-assign load balancer algorithm maintains an indexl assign table of virtual machines and also the load of VMs. There has been attempt made to efficient usage of available virtual machines depending on its load. Proposed algorithm employs a method for selecting a VM for processing client's request. It checks for least loaded VM. Initially all VM are free so it follows Round Robin. Then if next request comes then it checks for VM table, if the VM is available and it is not used in the previous assignment then, it is assigned with the request and id of VM is returned to Data Center, else we find the next least loaded VM and it continues and follows the above step, unlikely of the Active load balancer, where the least loaded VM is chosen but it will not check for the previous assignments.

IV. EXPERIMENTAL SETUP

Experiment is carried out in the simulator. For the experimentation Cloudsim based CloudAnalyst simulator has been used [6]. As cloud infrastructure is distributed in nature requests will be coming from all geographical locations and should be handled intelligently.

CloudAnalyst simulator gives the real time scenario with six different geographical locations. i.e depending on the specific application no of users from particular locations can be identified, e.g Twitter users from Asia, Africa etc. The simulator is very flexible and it provides, virtual machines, data centers, band width and many more for experimentation [7]. A snapshot of the CloudAnalyst architecture is shown in Fig. 2 [5].

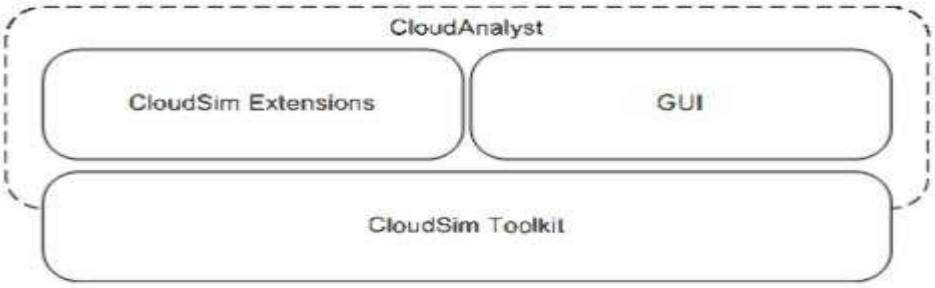


Fig.2: Architecture of Cloud Analyst simulator

Hypothetical applications like Facebook users, Twitter users, Internet users are considered for experimentation. Six different geographical locations (six different continents of the world) are considered [3]. A single time zone is considered for all user locations. For simplicity one hundredth of the total users from each continent is considered and it is assumed that only 5% of total users are online during peak hours and in off peak hours, users are one tenth of the peak hours.

For experimentation internet users at six different continents are considered i.e. six user bases and peak and non peak users are given in the Table 1.

User Base	Region	Simultaneous online Users during peak Hours	Simultaneous online users during off peak hours
North America	0	135000	13500
South America	1	125000	12500
Europe	2	255000	25500
Asia	3	535000	53500
Africa	4	30000	3000
Oceania	5	10000	1000

TABLE I. Simulation Configuration

We have considered internet users at different continents from the month of June 2012. The same data is experimented with three different scheduling algorithms and response time of each algorithm is also considered for the result analyses.Each Data Center has a capacity to host a no of virtual machines which are needed for particular application. Machines have 100 GB of storage space, 4 GB of RAM, each machine has 4 CPU and a power of 10k MIPS.

V. RESULTS AND ANALYSIS

Results are analyzed W.r.t efficient utilization of the virtual machines by avoiding the under or over loading conditions. And then comparing with the existing active VM load balancer.

5.1 Load Balancing a/VMs

As mentioned in section III the proposed algorithm will not allow the VM which was allocated in its previous step. But this is not the same case with Active load balancing algorithm in which it assigns the least loaded VM depending on the current load. So with this in Active load balancer algorithm few VMs are overloaded with many requests and remaining VMs will handle only few requests with this under utilization of the VMs takes place. This results in imbalance of the load on the VMs. But if we use the proposed VM-assign load balance algorithm all the VMs are utilized completely and properly. Our algorithm proves that there is no under utilization of the resources in the cloud. The algorithm is tested for initially with five VM and later 25 VM. In both cases our proposed algorithm balances the load on all available VMs in an efficient way. Hence we can say that our algorithm will overcome the underlover utilization of resources usage problem. The following Table 2 gives the information about how many times each VM has been used efficiently.

SI. No	Active Load Balancer	Load VM-assign Load Balancer
VMO	1178	258
VM1	78	252
VM2	10	253
VM3	4	251
VM4	2	254

Table 2: VMs Usage with 5 VMs

From the Table 2 we can observe that using VM-assign load balancer distributes the incoming requests to all VM's in an intelligent way compared to Active load balancer. In the proposed algorithm we can see, utilization of the resources is neither underutilized nor over utilized but where as in Active load balancer VM 0 is over utilized and VM 4 is never utilized and other VM's are underutilized. We have repeated the experiment with the 25, 50 and 100 virtual machines. The following Table 3 gives the information about the usage of the 25 virtual machines.

SI. No	Active Load Balancer	VM-assign Load Balancer
VM0	18609	3693
VM1	20078	4376
VM2	6569	4330
VM3	5845	4312
VM4	4973	4350
VM5	4568	4318
VM6	4164	3818
VM7	4907	4588
VM8	4337	4565
VM9	3886	4610
VM10	3267	4615
VM11	3321	4582
VM12	2966	4065
VM13	3869	4890
VM14	2988	4863
VM15	2948	4828
VM16	2332	4852
VM17	2425	4971
VM18	2047	5053
VM19	2467	4440
VM20	2249	5098
VM21	2564	5278
VM22	1883	5309
VM23	1984	5472
VM24	1648	5618

Table 3: VMs usage with 25 VM

From Table 2 and 3 we can analyze that Active-VM load balancer algorithm is over utilizing the initial VM's and under utilizing the later ones. But our proposed algorithm distributes the incoming requests to all VM's intelligent way and hence all the resources are used efficiently. We have also verified response time of both algorithms and the values are same in both algorithms. Further, the results for 50 and 100 virtual machines follow the same pattern of allocation as shown in Tables 2 and 3.

VI. CONCLUSION

In this paper, an efficient algorithm is designed which manages the load at the server by considering the current status of the all available VMs for assigning the incoming requests intelligently. The VM-assign load balancer mainly focuses on the efficient utilization of the resourcesNMs. We proved that our proposed algorithm optimally distributes the load and hence under / over utilization (VMs) situations will not arise. When compared to existing Active-VM load balance algorithm, the load was not properly distributed on the VMs and from able 3 we can say that VM 0 is used almost ten times more than the VM 24. [t proves that initial VMs are over tilized and later VMs are underutilized. Our proposed algorithm solves the problem of inefficient utilization of the VMs / resources compared to existing algorithm. As a future scope the proposed algorithm can still be improved by taking some more dynamic situations of the incoming requests and how the algorithm responses if we mix both static and dynamic loads.

REFERENCES

[1] Klaithem Al Nuaimi, Nader Mohamed, Mariam Al Nuaimi and Jameela AI-Jaroodi, "A Survey of Load Balancing in Cloud Computing: Challenges and Algorithms", in Second Symposium on Network Cloud Computing and Applications, 978-0-7695-4943-9/12, IEEE 2012.

[2] Zhen Xiao, Weijia Song and Qi Chen, "Dynamic Resource Allocation Using Virtual Machines for Cloud Computing Environment" IEEE transactions on parallel and distributed systems, vol. 24, no. 6, june 2013.

[3] Hemant S. Mahalle, Parag R. Kaveri and Vinay Chavan, "Load Balancing On Cloud Data Centres" in International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, issue 1, January 2013.

[4] Shridhar G. Domanal and G. Ram Mohana Reddy," Load Balancing in Cloud Computing Using Modified Throttled Algorithm" IEEE, International conference. CCEM 2013. In press.

[5] Brototi Mondal, Kousik Dasgupta and Paramartha Dutta, "Load balancing in cloud computing using stochastic hill climbing-a soft computing approach" in Procedia Te chnology 4 (2012) 783 - 789, ELSEVIER C3IT-2012.

[6] B. Wickremasinghe, R.N.Calheiros,R.Buyya, Cloudanalyst: A cloudsim-based visual modeller for analysing cloud computing in: Proceedings of the 24th International Conference on Advanced

Information Networking and Applications (AINA 2010), Perth, Australia" 2010.

[7] Mr.Manan D. Shah, "Allocation Of Virtual Machines In Cloud Computing Using Load Balancing Algorithm" in International Journal of Computer Science and Information Technology & Security (lJCSlTS), ISSN: 2249-9555 Vol. 3, No.1, February 2013.

[8] Ms.Nitika, Ms.Shaveta, Mr. Gaurav Raj, "Comparative Analysis of Load Balancing Algorithms in Cloud Computing" in International Journal of Advanced Research in Computer Engineering & Technology Volume 1, Issue 3, May 2012.

[9] M. Armbrust et aI., "Above the Clouds: A Berkeley View of CloudComputing," technical report, Univ. of California, Berkeley, Feb. 2009.

[10] Hung-Chang Hsiao, Hsueh-Yi Chung, Haiying Shen, and Yu- Chang Chao, "Load Rebalancing for Distributed File Systems in Clouds" IEEE transactions on parallel and distributed systems, vol. 24, no. 5, may 2013.