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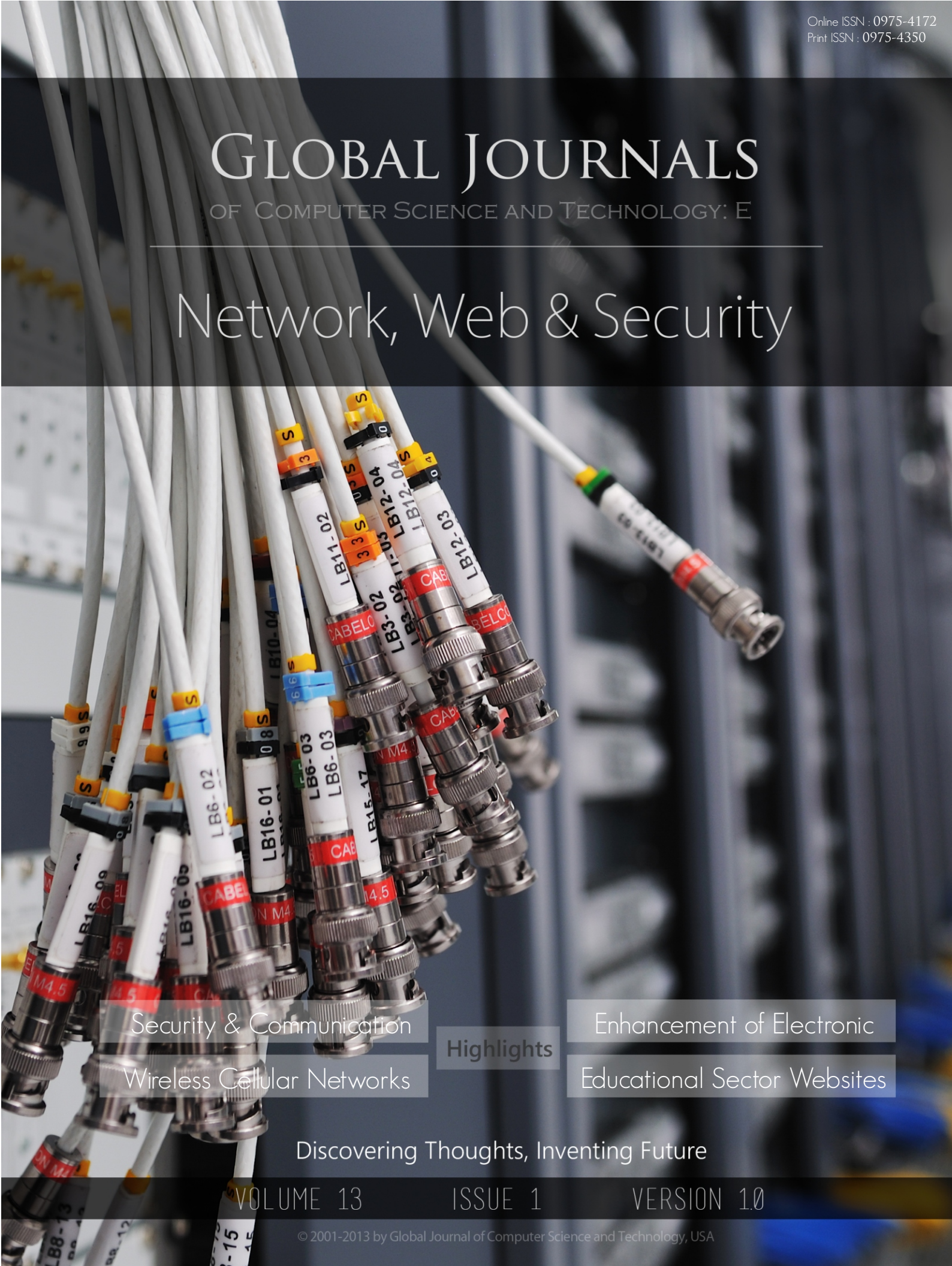

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Wireless Cellular Networks

Highlights

Enhancement of Electronic

Educational Sector Websites

Discovering Thoughts, Inventing Future

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Provides Unbreakable Security & Communication to the Users on VPN through Multiprotocol Label Switching Technology

By Ravi Yadav, Mrs. Laxmi Prasanna & Mukesh Kumari

Shekawati College of Engineering Dundlod Rajasthan

Abstract - Our main contribution in this paper is to provide users with everywhere communication capacity and information access regardless of location. The world is moving towards packet based transport network. Primarily because all of the applications and services that use these networks are packet based and packet based network is best for suited for carrying packets. For above purpose the Multiprotocol Label Switching is Use. Multiprotocol Label Switching is a technology for delivery of packet on a high speed backbone network that incorporates some of advantages of circuit-Switched communication system and packet –switched so as to produce a better performance than the normal IP routing.

Keywords : *virtual routing, switching, VPN, LSP, LDP, LSR.*

GJCST-E Classification : *D.4.6*

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Ravi Yadav [α], Mrs. Laxmi Prasanna [σ] & Mukesh Kumari [ρ]

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I. Introduction

Increasing demand of the Internet to carry more traffic in reliable manner and provide support for bandwidth guarantee, Quality of Services (QoS), it is important to have a high level of performance mechanism. Traffic Engineering is a process of mapping traffic demand on to the network by minimizing the resource utilization. Multi-Protocol Label Switching (MPLS) is a tool for network traffic engineering and hence is becoming the technology of choice for Internet backbone.

To forward packets MPLS employ labels, for each individual packet an independent and unique label is assigned as the packet passes through the network so that switching of packets can be performed. With these labels routing and switching of the packets is done in the network. Label is a short fixed length packet identifier which is used to identify the particular path. The basic idea of MPLS was developed long before and exits in the form of networking technologies like X.25, frame relay and ATM. As they are first one to be using the label switching technology in the networking world. Label switching technology was developed in mid 90's to enhance the quality of service and performance of network. This technology was used earlier by Lpsilon / Nokia (IP switching). Then IETF (Internet Engineering Task Force) standardized label switching technology and from here MPLS was emerged as a standardized label switching technology.

In MPLS label are used to make forwarding decisions i.e. labels are used to identify the particular path. So process switching is not in use. When the packet enters in MPLS network, layer-3 analysis is done and on the basis of layer 3 destination address label is assigned to each incoming packet. In MPLS network intermediate nodes are called Label Switched Router (LSRs), while other nodes that connect with IP routers or ATM switches are called Label Edge Router (LERs). Those router within MPLS domain that connects with the outside world, thorough which a packet enters the network are called ingress routes and the one through which the packets leaves the MPLS domain is called egress route. In MPLS the basic idea is to bind a label to a packet at the ingress router within the MPLS network and afterward can be applied to make forwarding decisions instead of looking up for the destination address at each point because the label define the fast and effective label switch path (LSP) to direct the traffic all the way to the destination.

Objectives of the MPLS:

- MPLS is a standardized network based technology, which uses labels to make forwarding decision with network layer routing in the control components.
- The objective is to provide a solution that MPLS provide integrated service model including RSVP and support operation, administration and maintenances facilities.
- MPLS must run over any link layer technology and support unicast and multicast forwarding.
- MPLS must be capable of dealing the ever growing demand of traffic onto the network and provide extending routing capabilities more than just destination based forwarding.
- Along with reduced cost and offers new revenue generating customer's services in addition with providing high quality of base services.

a) Architecture of MPLS

Multiprotocol Label Switching (MPLS) is a tunneling technology used in many service provider networks. The most popular MPLS-enabled application

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in use today is the MPLS virtual private network. MPLS VPNs were developed to operate over MPLS networks, but they can also run over native IP networks. This offers providers flexibility in network deployment choices, improved routing system scalability and greater reach to customers. The key element is the ability to encapsulate MPLS packets in IP tunnels. In an MPLS network, each LSP is created over the best path selected by the IGP, towards the destination network. An IGP (OSPF or IS-IS) is used to propagate routing information to all routers in an MPLS domain to determine the best path to specific destination networks. Each hop within the network core forwards packet based on the label, not IP information, until the final label switch is reached where the label is discarded and normal IP forwarding resumes.

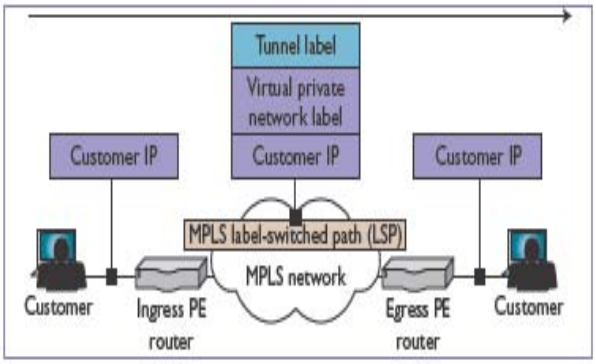

Fig.1 : MPLS Tunneling Architecture

b) Working of MPLS

In MPLS the transportation of data occurs on label switched path and protocols are used to establish LSPs in order to pass information among the LSRs. These LSRs are responsible for performing switching and routing of packets according to the label assigned to them. In MPLS header label is bind to a packet, altogether making a label stack. Packets are switched using label without looking into IP table. The route traversed by a packet within MPLS network between ingress and egress nodes while passing through the intermediate LSRs is called Label Switched Path (LSP).

A label-switched path (LSP) is a path through an MPLS network, set up by a signaling protocol such as LDP, RSVP-TE or CR-LDP. These LSPs form a logical network on a regular physical network and guarantee connection-oriented processing over the connection less IP networks. Each MPLS packets has a header that consist of 4 fields, a 20-bit label value field, 3-bit for class of service field,1-bit label stack (bottom of stack flag).if set will indicate that the current label is the last label in the stack and the 8-bit time to live field (TTL). Entry and exit point with in an MPLS networks are called label edge router where as label switch routers are within an MPLS networks. They Examines only the MPLS header containing the label and forward the packet no matter what ever the underline protocol is. Each LER maintain a special database for destination address to label the packet when a packet enters MPLS network.

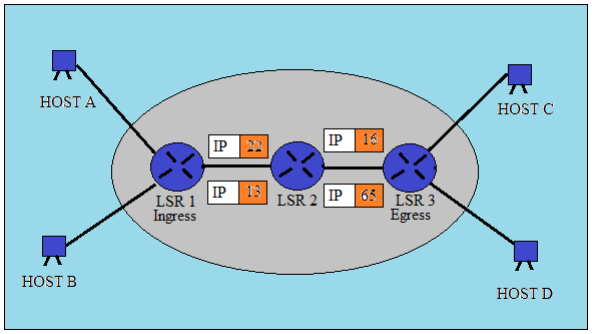

Figure 2.1 : Label Switched Path in an MPLS enabled network

When fault occurs in LSP, due to failure of link or node in the network, the carried traffic in failed LSP has to be transmitted through the backup LSP and the selection of backup LSP is based on the following criteria:

- Reducing the request blocking probability
- Minimizing cost of network
- Load balancing

i. *Reducing request blocking probability*

The major task of traffic engineering is to reduce the request blocking probability, to make sure that maximum numbers of requests are accepted in the network, in order to improve operator revenues and increase client satisfaction. Minimum Interference Routing Algorithm (MIRA) is one of the best algorithms for constraint based routing which reduces the request blocking probability. The basic concept of MIRA is based on the relationship between the maximum flow value between two nodes and the bandwidth (that can be routed between nodes). In MIRA critical links are the links, which cause a decrease in maximum flow values between pair of nodes. Therefore, weights are allocated to the links according to their criticality. In the end a shortest path- like algorithm is used to evaluate the path with minimum critical links. But MIRA suffers from computational complexity problem, as this algorithm frequently computes maximum flow.

ii. *Minimizing costs of network*

To accomplish a minimum cost of network, metrics like minimum hop count or link costs, have been conventionally included in routing algorithms. In order to minimize the cost of network many algorithms are proposed, for example Minimum hop algorithm. Moreover, many other algorithms are proposed to make improvement in Minimum hop algorithm. Minimum hop algorithms are easy and computationally proficient. But in case of heavily loaded network, they give worse result in terms of request refusal ratio. Link cost corresponds to the physical link length, so they are used in algorithms mainly for traffic engineering and they have no huge influence in networking architectures.

iii. *Load balancing*

In network, load balancing plays an important role to decrease congestion. The basic concept of load balancing is to distribute load in such a way that improves the overall performance of network. But in lightly loaded network load balancing shows bad performance, for example routing packets on longer paths.

iv. *MIRA, Minimizing cost of network and Load Balancing*

In this approach three criteria (Load Balancing, MIRA and Minimizing cost of network) are used to calculate the path for the affected traffic. But this approach suffers from the problem computational overhead, because this approach computes all the three criteria throughout the process of packet forwarding.

II. Proposed Solution

Our proposed solution closely relates the integrated solution In order to compute backup path by using above three criteria, the main challenge is to define the optimal weighting (W_1, W_2, W_3) for each element in the cost function given by (Eq. 1). Initially, the weight connected with MinHop should be increased, in order to show, its good performance under lightly loaded network. Therefore equation2 shows, weight (W_1) is inversely proportional to the total network load. So it can be that, weight (W_1) is predominant under lightly loaded network and it starts to decrease as the total network load increases to reach the total network capacity. Next, Minimum Interference Routing Algorithm (MIRA) comes into play, when links criticality is changing (links are getting rapidly loaded). So we see in equation 2 weight (W_2) is directly proportional to the network load. Finally, in equation 3 a new parameter for the load metric element that will control load balancing influence in the overall cost function by limiting its undesirable effects under light load. Moreover, constants a, b and c are used in order to scale the numeric values to a comparable range.

$$Cost(e) = W_1 + W_2 \times criticality(e) + W_3 \times load(e) \quad (1)$$

$$W_1 = a \times \frac{total\_cap}{total\_load}\ ;\ W_2 = 16 \times b \times \frac{total\_load}{total\_cap}\ ;\ W_3 = c \quad (2)$$

$$load(e) = f(x) = \begin{cases} 0 & if\ load(e) < threshold = cap(e)/3 \\ \frac{reserved\ \ bandwidt\ \ h(e)}{cap\,(e)} & otherwise \end{cases} \quad (3)$$

In simulation, we can see that the performance of the method is good in overall situation. The request blocking probability of the proposed scheme is comparable with MIRA results. The load standard deviation values are comparable with values for load balancing under light load. Under high load, the proposed scheme achieves performance bounded by load balancing (upper standard deviation) and MIRA (lower standard deviation) due to the equally combined effect of these algorithms. Finally, we see the influence of the MinHop element under light load; the integrating solution has good performance compared to MinHop. Therefore, these results justify our weighting approach. Even with a set of intuitive weights, we show the relevancy of the three objectives, and the benefit of their combination.

In our proposed solution, we use three criteria (Load Balancing, MIRA and Minimizing cost of network) to compute the backup path based on the below conditions but not all at a time since this increases the complexity of the algorithm as done in main heading Simulation model in 3:

- We compute backup path on the basis of Minhop algorithm, only if the total load is less than or equal to 25% of the total network capacity, because Minhop algorithm gives good result under light load.
- We are using MIRA algorithm to compute the backup path only if total load is greater than 25% and less than 75% of the of total network capacity.
- Load balancing is used to compute the backup path for the affected traffic if total load is greater than 75% of the of total network capacity.

III. Simulation Model

Model:

G = (V,E) is a directed graph representing the network with:

V is the set of vertices (MPLS router)

E is the set of edges

Action

Determine the optimal set of binary variable x(e) and y(e) that:

$$Minimize\colon \sum_{e\epsilon E} cost(e) * [x(e) + y(e)] \quad (4)$$

$$\text{Subject to: } \sum_{e\epsilon out\,(v)}[x(e) - y(e)] - \sum_{e\epsilon In\,(v)}[x(e) - y(e)] = \varepsilon(v) \quad for\ v\epsilon V \quad (5)$$

$$[x(e) + y(e)] \times [load(e) + b] \leq cap(e)\ for\ e\epsilon E \quad (6)$$

With:

$$\varepsilon(v) = \begin{cases} +1 & v = O \\ -1 & v = D \\ 0 & v \neq \{O, D\} \end{cases}$$

$$\text{cost(e)} = \begin{cases} 1 & Min-hop \\ len\,(e) & Minlen \\ \frac{load\,(e)}{cap\,(e)} & load\ balancing \\ criticalty(e) & MIRA \end{cases} \quad (7)$$

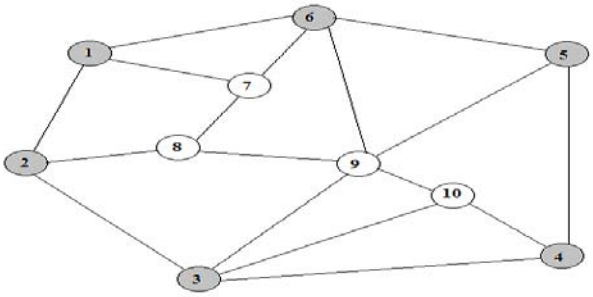

Figure 3 : Network Topology

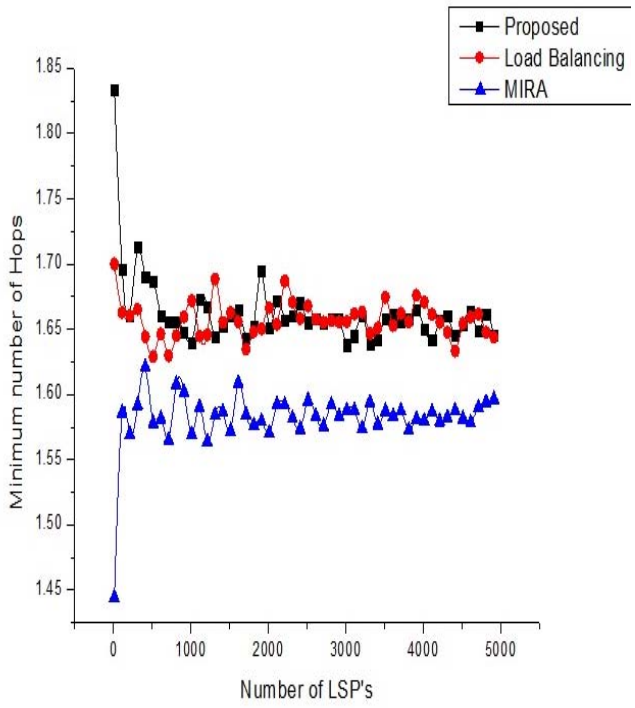

Fig. 3.1 : Blocking Probability

In figures 2.1, we can see that the performance of our proposed method is good in overall situation. The blocking probability (Fig. 3.1) of the proposed scheme is comparable with MIRA results. The load standard deviation (Fig. 3.2) values are comparable with values for load balancing under light load. Under high load, the proposed scheme achieves performance bounded by load balancing (upper standard deviation) and MIRA (lower standard deviation) due to the equally combined effect of these algorithms.

IV. Conclusion

In this paper, we examine that Multiprotocol Label Switching Technology is used for : request reducing blocking probability, minimizing cost of network, and load balancing.

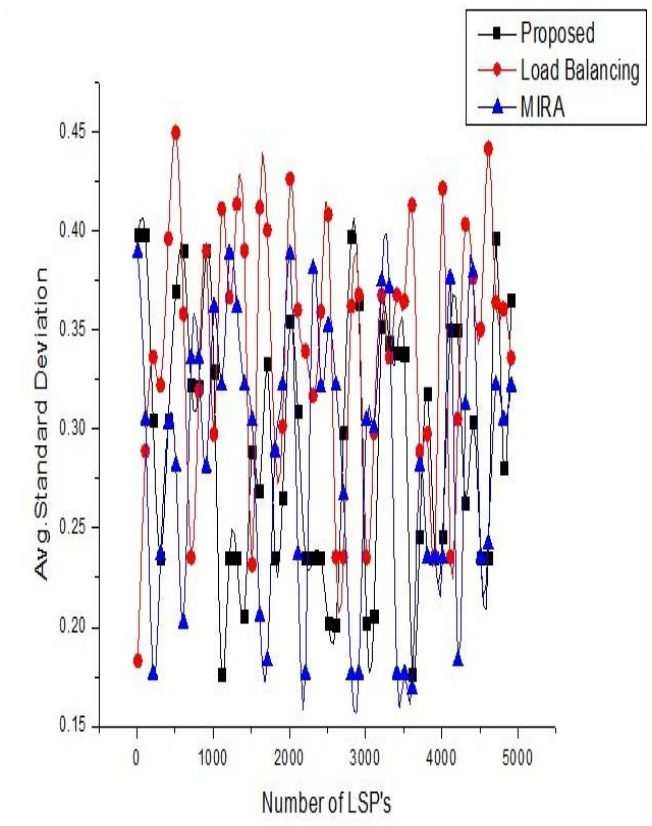

Figure 3.2 : Load Standard Deviation

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Enhancement of Electronic Payments for Hyper Market System

By Akram Saleh Almansoub, TAN Guan-Zheng & Abdullah Alqwbani

Central South University, Changsha 410083, China

Abstract - The purpose of this system is to enhance the online shopping sites by creating a new method with different services that allow the client to browser, search, compare, decide and purchase product with flexibility and high efficiency. When the customer browse the market website he can get all shopping steps and functions very simple passing the search, compare and payment three main functions in the site, it has a new flexible methods to help the user to search and compare very quick and let him/her to choose the way of payment he want or dividing it to several parts and use more than one method to pay the price. In this way we can achieve a more users and searchers which can promise a high percentage of sales. The convenience is important for online shopping, and the good designed and structured site will take more users and lead to a good business. ASP.NET is the implementation tool for this website, Microsoft SQL server is used for database management.

Keywords : *ecommerce, friend payment, online markets, flexible online shopping.*

GJCST-E Classification : *K.4.4*

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I. Introduction

The internet and the World Wide Web have become a part of our daily life. Since 1997, the web has progress into a true economy and a new frontier for business [1], It has changed life and the way of business. Therefore, many businesses have changed to online business. However, not all e-commerce websites can success as there are many competitors out there. As e-commerce website is all about attracting and retaining customer, it is crucial to guarantee that users are having a good experience throughout the whole process [2].

EC is the use of computer networks to improve organizational performance as well as increasing the profitability ratio. Moreover, it helps to get a share in the market and improve customer service by creating a Web page and supporting the investors' relations or communicating electronically with customers [3].

Now a day many sites have a good business and become well known ecommerce sites, such as ebay.com, Amazon.com, taobao.com and others. Business is evenhanded to the process of shopping on the web site. It becomes the way of shopping spread widely for different purposes. Including personal need, house need or business need. Online shopping with its 24-hour availability, a global reach, the ability to interact and provide custom information and ordering, and multimedia prospects, the Web is rapidly becoming a multibillion dollar source of revenue for the world's businesses.

Along with EC areas, Business to Business (B2B) is being spotlighted as an interesting research area considering its size and the potential impact it has overall. Now various B2B systems are being used in seller-centric E-marketplaces, intermediary-centric E-marketplaces, and buyer-centric E- Marketplaces etc [4].

Internet commerce brings new technologies and new capabilities to business, but the fundamental business problems are those that merchants have faced for hundreds or even thousands of years: you must have something to sell, make it known to potential buyers, accept payment, deliver the goods or services, and provide appropriate service after the sale. Most of the time, you want to build a relationship with the customer that will bring repeat business [5]. From this we believe the good designed site and the optional services provided in the shopping site is the promise of good business.

In this paper, we have created some enhancements in electronic commerce. From the basic functions of the shopping sites and the development stage of this market we analyzed the enhancement of some cases:

The first case is multi-payment services, a payment system and method for electronic commerce transactions is disclosed. In an exemplary embodiment, a payment Administrator receives a request for payment notice for an electronic commerce transaction, such as a purchase on a merchant website. In response, the payment administrator creates a payment notice comprising a transaction amount (which may be converted between different currencies), an age restriction for the purchased product (if applicable), and a unique identifier for the electronic commerce transaction. Preferably, the unique identifier is presented in both human-readable form and machine-readable form (such as a barcode) on the payment notice [6].

The second case is the convenience of searching and comparing products with new way to challenge other shopping sites and save more time and effort during all customers' visits.

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II. Enhancements

The tremendous growth of the Internet has led millions of companies to set up shop on the Internet and over 100 million consumers worldwide are eagerly participating in the global online marketplace [7]. From the beginning of electronic commerce to its current status has received a quantum leap of development and progress in many aspects.

From this development of electronic sites we start to get destruct with the payment systems methods and security to meet users and customers' expectations. The enhancements of this website are designed to meet such needs including the payment features and site features.

The payment features are designed to make the users have the ability to choose multi-able payment methods by himself or his partners or other companies when the payment was by percentage between them. Which mean the system supports the payment from different methods or different parties.

Site features include the compare part which allow user to compare products according his choice or according his search and displayed results even if he does not choose them to compare. The compare feature also allows him to choose one property as default compare.

The second part of site features also include very advanced way for search which allows the user beside the normal search and advanced search of all available sites to search by his phrased description of his desired product. That's because the advanced search method only have limited properties for search which the users may have and it is not available in the basic advanced search.

Using data mining search the user will have his desired search fast and easy.

The user or customer can find his desired search very easy and compare it with others to help him decide the payment process.

He can find the product in any small shop site in the main shopping site.

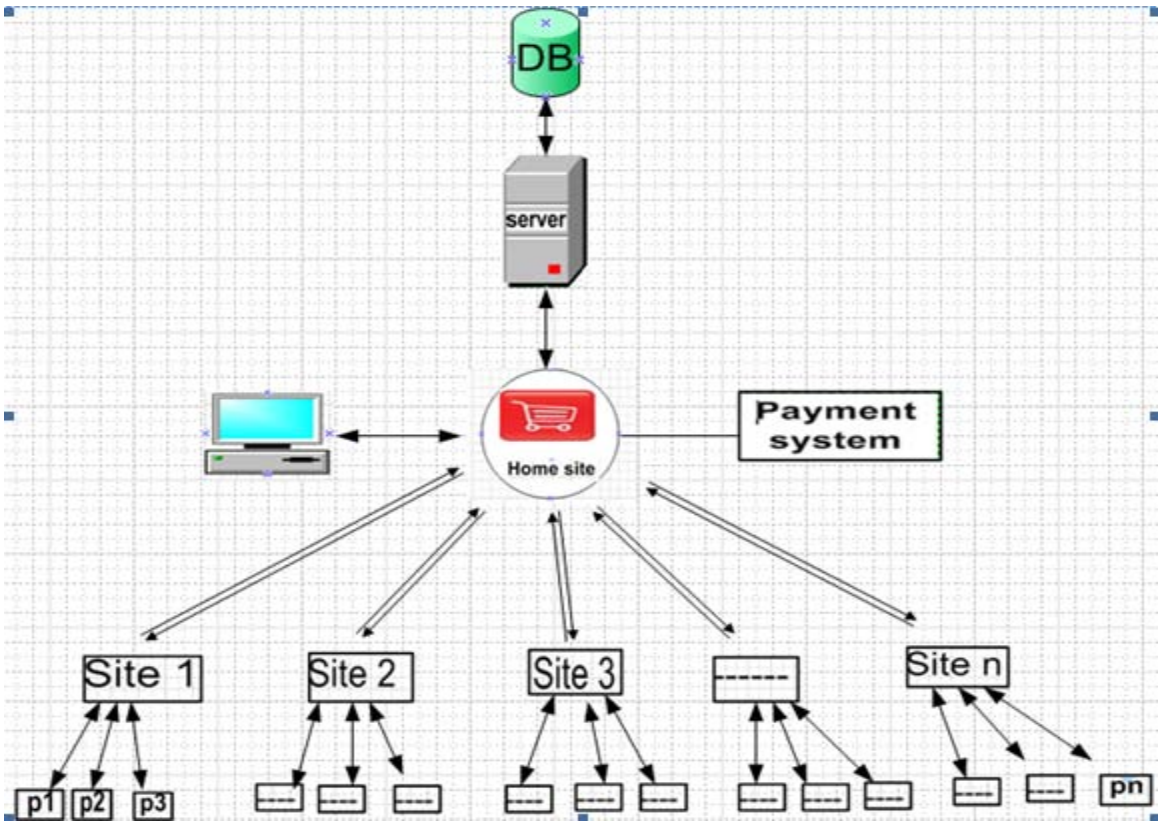

Figure 1 : Architecture of E – Hyper Market System

a) Enhance of Payment

Electronic Payment System (EPS) always uses transactions between three kinds of entities: A client (payers), electronic shops (payees) and the bank (Trusted Third Party). The Architecture of system is Shown in Figure (2) [8].

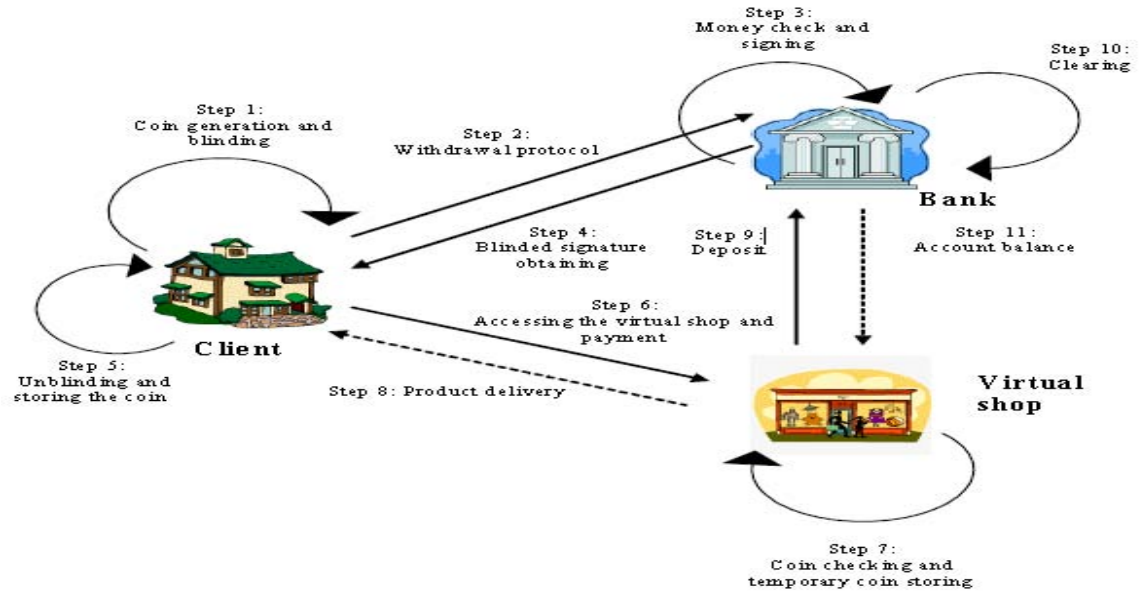

Figure 2 : Architecture of on- line EPS

In general, EPS is classified into two categories, the systems with on-line verification and the systems with off- line verification [9].

In the every E market when you use the market payment the system will show you the total price of the product you're willing to pay and you need to pay it from one machine at once, as a customer this way may be an inconvenient one for different reasons and may cause you loss lot of customers. From different corner coincide with the developing of the e market and Procurement partnership or company discounts for employees that what we can see is, this way of payment cannot face all these requires and development.

b) Compare Products

Online shopping is often conducted to compare products, or processes to select the one which has the highest reliability. For some products, a failure is said to have occurred when a performance characteristic reaches a specified threshold.

For these products, reliability is defined by the performance characteristic.

Then comparing the reliabilities of two products can be turned into comparison of their performance characteristics.

During testing, it is possible to measure the performance characteristics at different times. Measurement data can be employed to predict whether or not the performance characteristics of the two products will be significantly different at the time of interest, when there are sufficient data to make such a prediction with a high degree of confidence, the test can be terminated as a result[10].

Shopping over the net and facing the difficulty of searching for the appropriate item you want to purchase, the standard way for that is the key search by typing the related word of item and goes searching, but with the huge data over the net and sites also the growth of the manufacturers and suppliers you will face the problem of choosing the suite item for your need.

And now by using the compare function according items properties you can see the differences between items and choose the suitable one for you before going payment.

And the different site will provide a different item or even the same but with different properties that will make the customer need to go through a different sites and compare the items manually to choose the right one for him. This will cause the customer more time and may lead him to another site to buy the appropriate item for him.

c) Described Search

One of the main obstacles in e- commerce is that it is not easy for customers to search for relevant information about the products they want [11].

As we know the most sites already have the When button called (Properties- based Search) which allow the customer to enter the specific characteristics. He can search using a specific value for the property he wants. But, according to the users interface of the site, the advanced search may not contain the property which the user want to search by even if it very available in the product properties, in this website the user can use the function of described search to type down the phrased description of his desired product and hit search which will compare all product properties with this phrased description and give the match result to the user by 100% accurate and post all related product by very quick and correct way,beside this function the user also can use the normal search or advanced search which also available in this site.

III. Architecture Design

The Figure3 shows the architectural structure of the database of this site which represents the logical schema. SQL server is used for this database.

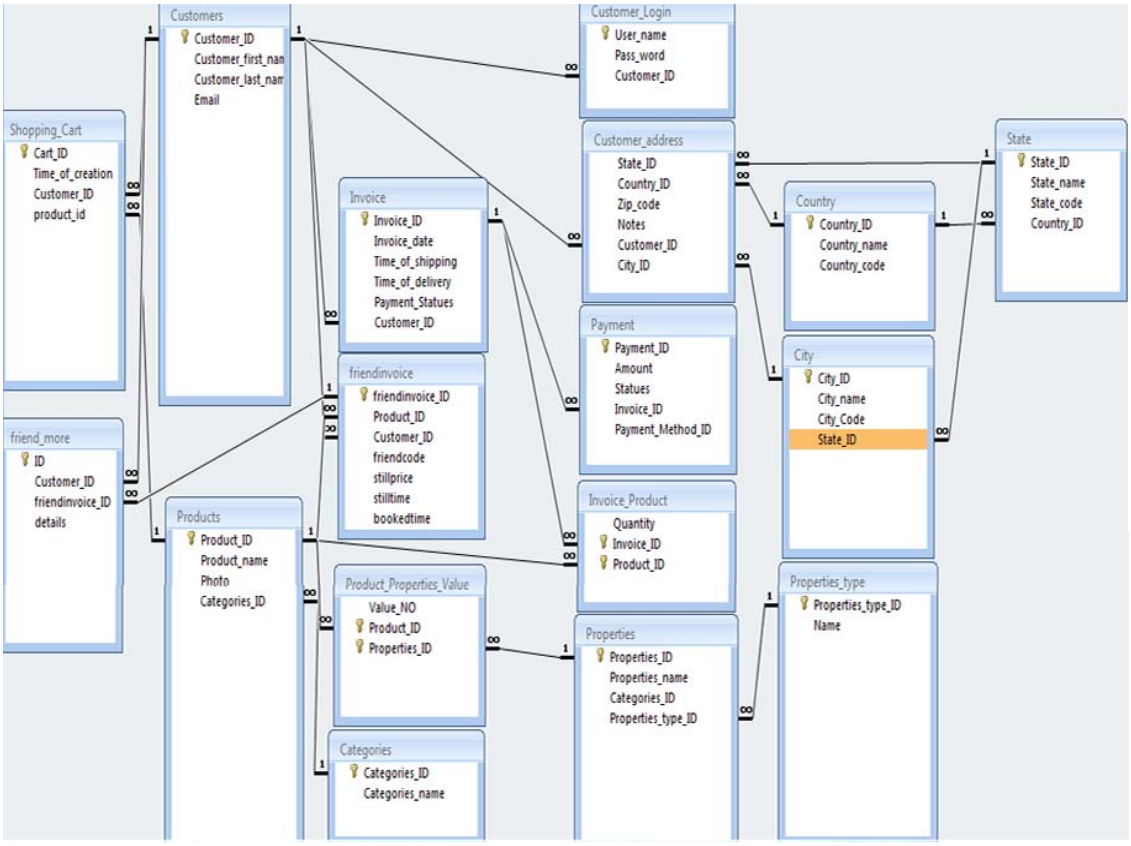

Figure 3 : Logical Schema

From this figure we can deal with the all enhancements feature that mentioned in this paper.

a) Enhance of Payment

There are various proposals for EPS the vast majority have been failed to achieve, rely on a large scale. Reasons for non-success of some of the proposals and others fail remains unclear [12]. But as a customer and market manager we can see the development of the payment systems, online market, manufactures, trusted sides and Procurement partnerships is a way to make us feel the optional way for the payment is the most success way for the payment system. This way can be implemented by giving different options while the item been selected to face the customer plan of payment. This options need to include the most famous ways available to the customer and face his actual plan of payments. Payment options will include the internet bank and visa card, by friend, partner, and delivery, etc.

Using these options after selecting items will face the most desirable plan of payment of customer. This what we have seen in the recent research, in this paper we are providing a more optional way for the payment: which will allow more than user to make the payment, which mean I can pay part of the payment price and can let my friend or company to pay the second part the same as the third part and so on. This function is great way for banks percentage buyers or big company which can buy the discount percentage for its employees and the employee can buy and pay the rest of the price of the product.

It means that enhancement of the payment feature allows the product to be paid by two payers and the both of them can use multiple options of payment methods. This will face a certain demands of customer specially for friends and partners, when the customer choose the item and goes for payment options he will see the by friend option he can choose the appropriate way for himself to pay and after that by clicking the by friend option will allow him to copy a special code he can send this code to his friend or partner to complete the payment, in the other side customer's friend can also see the name of his friend and the original price of the item and how much his friend is already paid for the item and complete the payment using the same options available in the system.

And also the customer can make the payment separated or not he can choose pay at once and pay the total price of the item using one option of the system and complete the buying process.

The tables below and their relationship tables cover the main function of payment enhancements:

Table 1 : Payment Options

S.no	Name	Type	Description
1	Product_ID	Number(int)	Primary Key For Product
2	Product Name	Varchar	
3	Category ID	Number	Foreign key from Category
4	Photo	Blob	
5	Site ID	Number	Foreign key from Sites

Table 2 : Friendinvoice Method

S.no	Name	Type	Description
1	FriendinvoiceID	Number (int)	Primary key for friend invoice
2	Product_ID	Number	Foreign key from product
3	Customer_ID	Number	Foreign key from customers
4	friendcode	Number	Special code for the friend
5	bookedtime	Date	Date to complete by friend
6	stilldate	Date	The date of starting by customer

b) Compare Products

Electronic commerce is the area that requires ontology mapping on product comparison over different product classification taxonomies of various shopping malls [13]. The customer need to compare the item he wants to buy with different items which has the same use or different brands in the same web store or the same item form different sites web stores to see all properties and differences and choose the appropriate one to buy. This function will allow the customer to view different items from different sites and select some of these items and compare them by their all properties and see the best for his/her choice.

Not only this but the system will allow him to choose what properties his considering more and the system will provide him the comparison according his chosen properties. And with most exited part of the compare function, the system will also allow him to choose whether he want to compare with the selected items only or to also search and compare according his chosen properties from other unselected products which has related properties and not chosen by him and display the result in one page easily and smartly, after displaying the result in the default view it also allow you to display the result in different view according to your sort option provided in the system (numeric ranking, standard ranking, site ranking) The following tables and relations cover the enhancement of compare:

Table 3 : Product Table

S.No	Name	Type	Description
1	Product_ID	Number (int)	Foreign key from Product
2	Describtion	Varchar	
3	_ID Value	Number (int)	Foreign key from Properties

Table 4 : Product description

S.no	Name	Type	Description
1	Properties_ describe_ID	Number	Primary key for Properties type
2	Name	Varchar	

c) Described Search

As we know the most site already have the When button called (Properties- based Search) which allow the customer to enter the specific characteristics. He can search using a specific value for the property he wants. But according to site entry by user, the advanced search may not contain the property which the user want to search by even if it very available in the product properties, in this website the user can use the function of described search to type down the phrased description of his desired product and hit search which will compare all product properties with this phrased description and give the match result to the user by 100% accurate and post all related product by very quick and correct way.

Beside this function the user also can use the normal search or advanced search which is also available in this site.

The following tables with other related tables cover the described search on the database schema:

Table 5 : Category Table

S.no	Name	Type	Description
1	Categories_ID	Number	Primary key for Categories
2	Categories_name	Varchar	

Table 6 : Description Table

S.no	Name	Type	Description
1	Describtion _ID	Number	Primary key for description table
2	Name	Varchar	
3	Categories_ID	NUMBER	FK
4	Properties_describe_ID	NUMBER	FK

IV. Implementation

ASP.NET is a multi-language of the .NET, we used c# to code this website pages .By entering the main page of this site the user can see the recommended products, features, new, etc. user can be one of three types: admin, shop owner, customer , the admin can manage and grant the most function of the site including shop owner, news, notes etc.

Shop owner can register and log in, after being granted he can add, modify, and delete his own product in the site.

Customer can browse search buy and make the payment using all available functions of the site.

Here we will focus on the Enhancements functions we discussed in this paper.

a) The enhancement of payment

Figure 4 : Payment Page

After completing shopping process and deciding the payment step the page of payment (Figure 4) will appear to the customer and as we see in this page the customer can decide the amount he is willing to pay and confirm that which will direct him to the payment plan by choosing full or divided payment full payment which will direct him to choose the payment methods and pay the all price at once, or by choosing divided payment which allow him to choose the multiple methods of Payment (Credit Card, Internet Bank, so on) [14].

Before finishing his payment process he will be asked to fill the address of shipping for the product delivery, and the email address for the payment details,

this email will contain the code of completing payment to give it to other payment parties to complete the payment of the product.

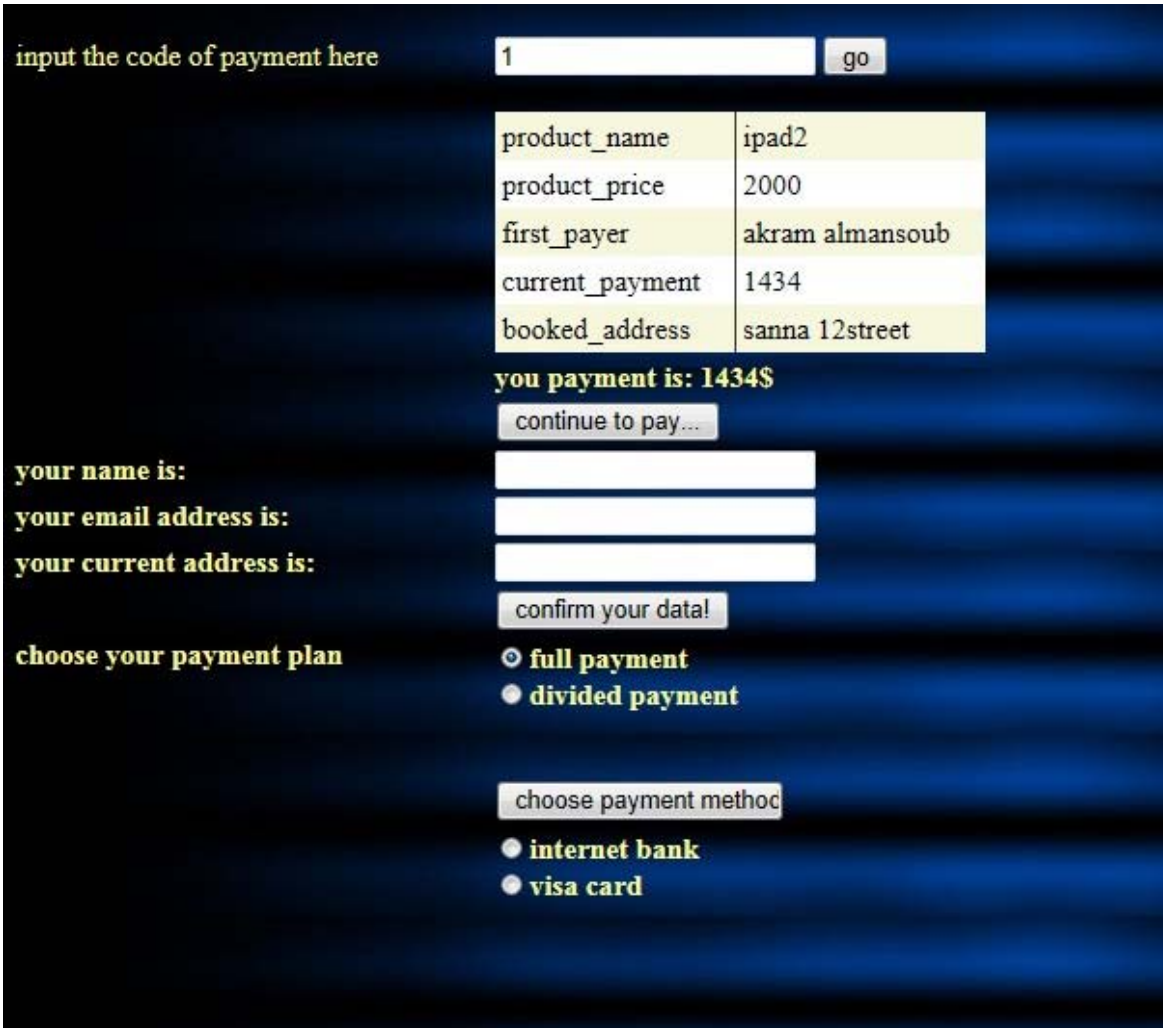

Figure 5 : Payment Page

As we see in the figure(5) above when the other parties get the code of payment he can go through the main page completing payments button to the code payment page Figure 4. In this page he can put the code of the payment and see the all details of the payment and previous payment and by clicking the continue the payment he can fill his information and choose his payment plan from full payment or divided payment the same as the first payer except on delivery option, also the same if the payment is not finished yet he will be sent an email contains code of completing payment to other parties till the minimum payment which will ask the last payer to pay the all payment to finish the payment process.

b) Compare Products

The compare function is very good way to let the customer know the different between products and making a sound decision for his product use, as we see in Figure7, when the user search and browse products he can easily compare between them. By selecting items from the browse page and he can directly compare the product without configuring any of the product properties; also he can specify a one property for his compare by selecting one of the product properties shown in figure (6) below:

Figure 6 : Payment Page

After selecting this property small window will pop up to let the use know he can choose to compare the selected items only or to choose the selected and related items and go compare, by choosing the related items the result will include all related items side by side according to the selected property.

c) Described Search

From the main page of the site every user can see the recommended product according best sales or recent sales, he can see also the search input to search the product he wants very easy and by using the advanced search he can refine his search for example the price range. The third enhancement of search is the described search after clicking (described search button) the user can type the phrased description about his desired product, for example he can type (red, 200$, apple, iPod) this will give him his desired search very accurate and desired from the market availability. Figure (7), shows the main search function of search.

Figure 7 : Described Search

Then click on the search button to obtain the search results as accurate as shown in the following Figure 7.

V. Conclusions

The goal of this paper is to enhance the online market sites by providing developed and useful functions to meet the user and customer expectations and needs, taking the full consideration of online commercial developments from this following:

1. Enhancing payment service by dividing the total price to be optional for more than one payer and each of these payers has the ability to choose multiple methods to make his payment.
2. Enhancing the comparison of product by providing the function of compare by property and function of compare the selected items or selected and related items to show more valuable data to the user and help him to make his payment decision.
3. Enhancing the search service by providing the function of described search which will allow him to write down his desired item description and get the result very quick and easy. This function will save the user time of browsing and searching by keywords.

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Comparative Analysis of MAC Protocols in Wireless Cellular Networks

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Abstract - This paper seeks with the comparative analysis of MAC protocols in wireless cellular networks. Theory begins with a short overview of basic cellular networks. Then special MAC algorithms for world of wireless are discussed according to the particular type of wireless networks like wireless cellular networks. A description of these algorithms and protocols together with their issues and comparison is given in this paper. Finally, the comparison of different forms of wireless network systems with respect to the MAC algorithms belong to them is presented.

Keywords : *internet, networks, mobile switching center, public telephone.*

GJCST-E Classification : *C.2.1*

Strictly as per the compliance and regulations of:

Comparative Analysis of MAC Protocols in Wireless Cellular Networks

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I. Introduction

A cellular network is a radio network distributed over land through cells where each cell includes a fixed location transceiver known as base station. These cells together provide radio coverage over large geographical areas. User equipment such as mobile phones is therefore able to communicate even if the equipment is moving through cells during transmission.

The term cellular refers that the certain geographical area is divided into small areas called **cells**. Each cell contains a **base station** (BS). The BS transmits and receives the signals to and from the **mobile stations** (MS) in its cell. The coverage area of a cell depends on transmitting power of BS, the transmitting power of MS, buildings and mountains in a cell etc. Each base station is connected to **mobile switching center** (MSC) as shown in the Figure 1.1. The MSC is then connected to Public Switched Telephone Network (PSTN) which serves the functionalities as done by conventional telephone switching center.

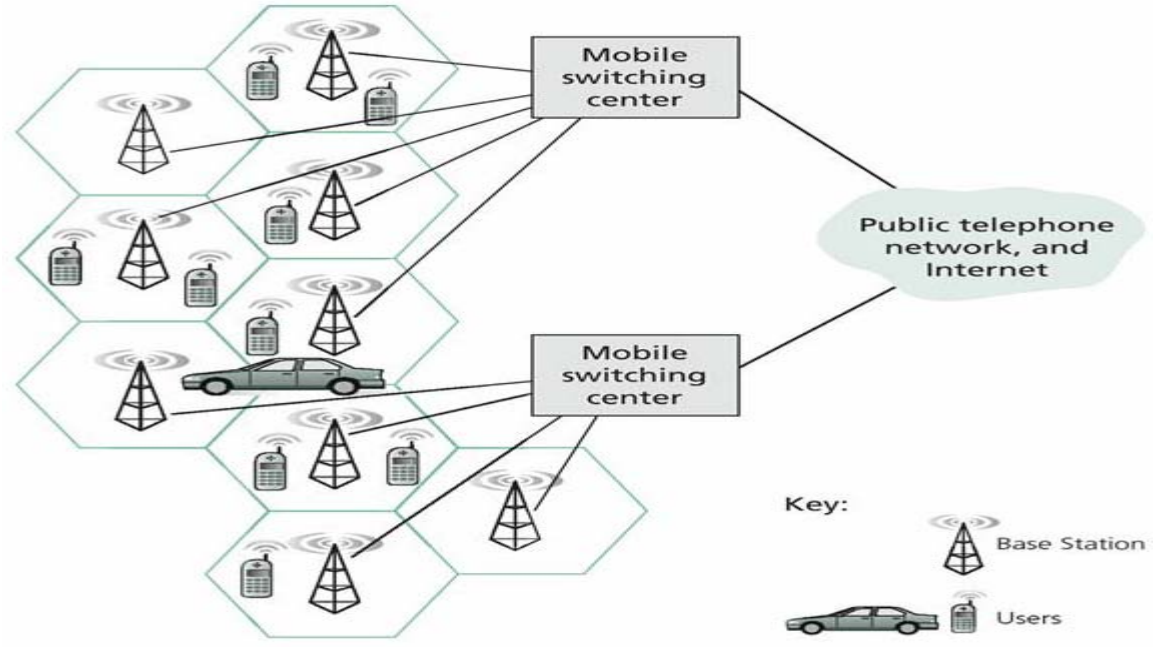

Figure 1.1 : Cellular Network Architecture

As cellular network is a type of telecommunication network, so it requires the communication like in ordinary telephone system; talking and listening simultaneously. This mechanism is called Duplexing. In cellular network the Duplexing can be done by using either frequency or time division duplexing.

- *Frequency Division Duplexing (FDD): FDD* provides two different frequencies bands to each user; one is for uplink channel and other for downlink. The uplink channel is responsible for data flow from mobile station to base station, and downlink channel is from base to mobile station. In FDD, actually a

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duplex channel is consists of two simplex channels (forward and reverse) at the same time.

- *Time Division Duplexing (TDD):* TDD uses time in order to provide uplink and downlink. In TDD, multiple users utilize a single radio channel by taking turns in different time-slots. Each duplex channel has both uplink time-slot and a downlink timeslot for bidirectional communication. Thus, TDD provides two simplex time-slots on same frequency.

II. MAC Protocols In Cellular Networks

The cellular network has different requirements for sharing a common medium. Its network and users are spread over the cities, a country or even more than one country. The users must be allowed to use their mobile phones calls at their own will. It should not be case that they remain busy in sensing the carries or exchanging the control packets like in WLANs. Thus, the sharing of medium access in cellular network can be achieved by allocating each user a different frequency or time-slot in order to access the channel at any time as same as in conventional telephone system. Particularly in cellular networks, sharing a common medium by several users is dependent to four basic dimensions: space, time, frequency and code.

a) FDMA

The frequency division multiple access (FDMA) divides the whole frequency available into several frequency bands or channels depends on the number of users. These bands are non-overlapping and unique in nature. A user is assigned a unique frequency band as soon as new mobile phone connection is established. Sender can use a certain frequency continuously at any time. Each channel in FDMA is a pair of frequencies by using FDD; one frequency is for uplink, while other is used for downlink. Since it uses duplexing, so both caller and receiver can communicate at the same time. Overall it is a less complex system. The Figure 1.2 is describing the protocol clearly if there are six users than whole frequency available is sub-divided into six sub-channels each having different frequency. They are unlikely to interference each other.

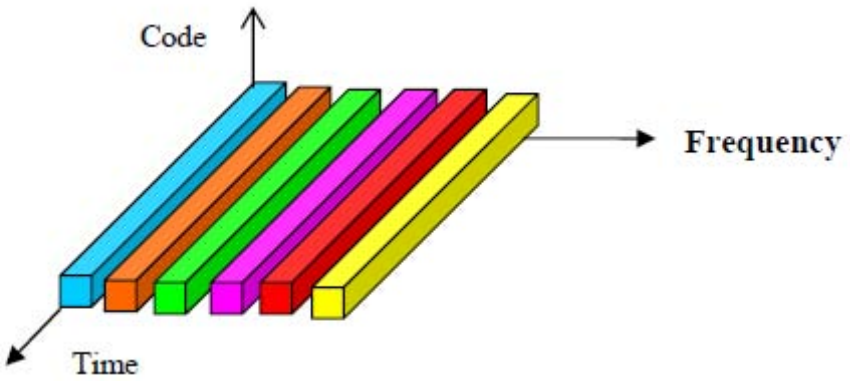


Figure 1.2 : Frequency Division

b) TDMA

It is much more flexible scheme as compared to FDMA. In time division multiple accesses (TDMA) the channel is divided into time-slots. Each time slot allows one user to either transmit or receive data. The frequency remains same for all users but separation is achieved through division of time i.e. time-slots, as in the Figure 1.3 the frequency is same for all 6 channels but total time is divided into 6 slots.

Two or more time periods can interfere each other, and to avoid this precise synchronization is necessary. This is done by base station which reserves the time slot at right moment for different callers. In TDMA system the data is transmitted in a buffer and burst method. During one time-slot only the part of whole data is buffered and burst to destination and remaining data is buffered in the next time-slots accordingly. Thus, the transmission is not continuous for all users. But time difference between two time-slots is so small (in micro-seconds) that it is not felt by a user e.g., GSM system based on TDMA and a caller using GSM, does not feel any delay due to time-slots. The data of different users is buffered into repeating frames. The frame consists of number of slots. The receivers are also required to be synchronized for each data burst. TDMA/TDD separates the time-slots for uplink and downlink procedure by using different frames. But if TDMA/FDD is the system, then similar frame would be used for uplink/downlink transmission, but carrier frequency would be different for both links.

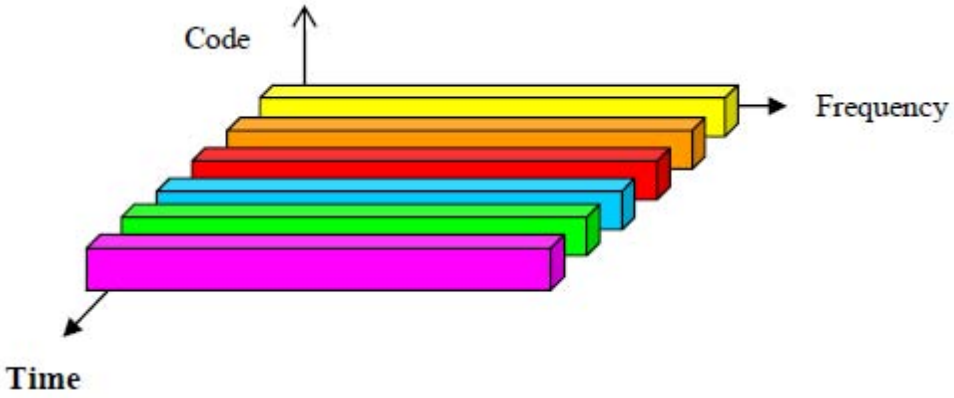


Figure 1.3 : Time Division

c) SDMA

The task of space division multiple accesses (SDMA) is to allocate a separate space to each user for wireless communication with a minimum of interference and a maximum of channel utilization. SDMA assigns space, time, frequency and code to each communication channel. Actually, it is never used alone but always works together with any other technique like time, frequency or code division etc. The space division implies the interference range of each channel. For example, the range of FM radio station is limited to certain region. The FM 100 channel is running in both Sweden and Pakistan with same frequency but different spaces which are limited to their respective countries.

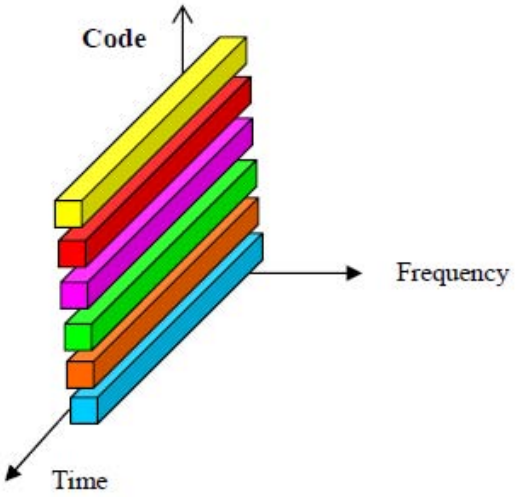
In cellular networks using SDMA, each mobile phone is assigned an appropriate base station. The Mobile phone may receive signals from several base stations. But the (SDMA) MAC algorithm chooses the required one among all signals considering the time, frequency or code. The down link procedure is strong as base station has entire control over the power of all transmitted signals. In case of uplink, the transmitted power is dynamically controlled to avoid interference with other signals. The transmitted power is limited in mobile phones due to the use of small batteries.

d) DSMA

The digital sense multiple access (DSMA) algorithm is used for packet data transmission service: Cellular Digital packet Data (CDPD). It is a type of slotted p-persistent CSMA mechanism. There is only one Uplink/Downlink pair available per slot for data transmission in each CDPD cell. The downlink channel is easy to manage because base station is the only sender per cell. On the contrary, the uplink channel is critical as there are number of mobile stations (MSs) trying to send data at same time. When MS wants to send packet it senses the downlink for a flag bit indicating whether the uplink is busy or idle at the moment. If it is free then data is sent and acknowledgment from base station is received. But if uplink is busy then MS does not wait for next slot rather it skips the random number of slots and tries again.

e) CDMA

Code division multiple access (CDMA) is relatively the new and advance medium access algorithm for wireless networks. Initially it has been used in military applications, now this system is a part of commercial cellular networks as well. In CDMA transmission all channels use same frequency at the same time, but separation is achieved by assigning each channel a unique '**code**' e.g., orthogonal codes. These unique codes provide better security against interference and tapping. The critical tasks like how to find suitable codes, performing encoding and decoding are all done by **spread spectrum** technique shall be explained after issues.



III. Spread Spectrum

The narrowband signal of CDMA is multiplied by a very large bandwidth signal; resulting signal is called the spread spectrum. The spread spectrum is a pseudo-noise or pseudorandom code sequence. Each user has its own pseudorandom code which is orthogonal to all other codes. These codes are basically random binary sequence. There are two ways of spreading the spectrum;

a) Direct Sequence Spread Spectrum

The Direct Sequence Spread Spectrum (DSSS) system uses chipping sequence for spreading the spectrum. The chipping sequence is a binary code which is usually called pseudo-noise sequence; generated as a unique code each time when user has to send the signal. While using DSSS, the user data (bit stream) is taken and then performed an XOR with the chipping sequence. Each bit of user is XOR with whole sequence code periodically. For example the user data is 01, and the chipping sequence is 0110101. The result of XOR (resulting signal/spread spectrum) would be: 0110101 1001010. The resulting signal is then modulated and finally transmitted to the receiver. The receiver side is more complex than sender particularly in spread spectrum systems. The receiver has to perform demodulation first in order to get original spread spectrum signal. Next is the critical part to know the original chipping sequence to perform XOR with receiving spread spectrum signal. Actually the transmitter and the receiver are synchronized with the same chipping code. The receiver calculates the code from receiving signal. After having the required code, the XOR is performed and got the original message. The spreading signal was 0110101 1001010, code is 0110101 and the result of XOR = 0000000 1111111. Each seven resulting bits representing the one original bit, hence the data is 01. In this way, the DSSS works nicely depending on the codes.

b) Frequency Hopping Spread Spectrum

The Frequency Hopping Spread Spectrum (FHSS) system splits the total available bandwidth into several sub-channels with smaller bandwidth each. While communication the transmitter and the receiver stay on one of these sub-channels with a certain frequency for small amount of time and then hop to another sub-channel. This implies that, the signal hops from sub-channel to sub-channel and transmitting short bursts of data on each channel for a certain period of time. The pattern of changing the channels is called the **hopping sequence**, and time spent on each channel is called **dwell time**. The system has implemented both FDM and TDM. The sender and the receiver must be synchronized to the hopping sequence. FHSS can work in either of two ways; slow hopping and fast hopping. In slow hopping the transmitter uses one frequency (one sub-channel) for several bits, e.g., the transmitter sends first three bits of data by using frequency f2. For fast hopping the transmitter changes the frequency several times to transmit a single bit, e.g., the transmitter uses three frequencies f1, f2, f3 (hops three sub channels) during one bit. Fast hopping has been implemented in Bluetooth, whereas slow hopping in GSM.

IV. Comparison of MAC Protocols

The different techniques and mechanisms have been deployed in domain of cellular network. The protocols used here are more versatile in nature. There is no one basic mechanism that belongs to all protocols, rather all have distinct features. TDMA makes time-slots for better sharing of medium, FDMA splits the total bandwidth into sub-channels of different frequency each, CDMA produces unique codes for each user with help of spread spectrum technique, SDMA is applied in separate spaces and DSMA senses the carrier before transmitting the uplink data etc. Furthermore, the protocols are most famous GSM network, and both SDMA and DSMA are the combination of two or more

schemes as well. The CDMA has an edge that it can add number of users without any upper limit, because it uses single channel (same frequency and time) but with different codes which has abundant capacity. On the other hand, TDMA and FDMA divide total available time and frequency respectively. The number of users is confined to either total number of time-slots or number of sub-channels with different frequencies each. If all time-slots or sub-channels are allocated to users then a new user cannot be added in the network. The table below is representing some more comparisons of protocols.

Table 1.2 : Comparison of MAC protocols in Wireless Cellular Networks

Algorithms	Basic concept	Multiple sub-channels	Single channel	Combination with more schemes	Limited no. of users	Network system
TDMA	Total time of channel divided into time-slots	Yes , multiple sub-channels as many as time-slots	No	No	Yes, limited to no. of time-slots	GSM
FDMA	Total frequency of channel divided into sub-bands	Yes, multiple sub-channels as many as sub-frequency bands	No	No	Yes, limited to no. of sub-frequency bands	AMPS
SDMA	Separate space is allocated to each user	No	Yes	Yes, with TDMA/FDMA or CDMA	No	----
DSMA	Type of slotted p-persistent CSMA	Yes , multiple channels as many as time-slots	No	Yes, with TDMA / CSMA	Yes	CDPD
CDMA	Orthogonal codes using spread spectrum	No	Yes	No	No limit	IS-95
WCDMA	CDMA technique with larger bandwidth	No	Yes	No	No limit	UMTS (3 G)

V. Conclusion

We have gone through a detailed explanation with many comparisons of MAC protocols in wireless sensor networks. Each network type has its own demand for its medium access control technique. It has been superb learning and exposure of different types of wireless networks as well as their requirements particularly for MAC schemes. So, it was nice opportunity to learn in-depth about various MAC schemes or mechanisms. In addition to all, the upcoming feature is integration of technologies. Hence, different types of wireless technologies are going to communicate with each other in near future. The newly proposed MAC schemes are mostly focusing on CDMA and spread spectrum technologies.

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A Study on Implementation of Privacy Policy in Educational Sector Websites in Saudi Arabia

By Dr. Sami Alhomod & Mohd Mudasir Shafi

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Abstract - In the past few year's privacy over websites have received significant amount of attention all around the world. Privacy policy in websites describes the collection of information and its use by the website. Users consult websites privacy policy to know what information is collected by the website and how this information can be used by the website. This paper is concerned with the implementation of privacy policy in the educational sector of Saudi Arabia. In the course this study, we looked at the privacy of all the educational sector websites in Saudi Arabia. The results of this study provide an insight about the application of privacy policy in Saudi Arabia. This study can help to inform governing bodies, Administration and IT managers of educational institutions about their application of privacy policy in Saudi Arabia.

Keywords : *websites, privacy policy, data privacy, web privacy, universities, educational collages, data privacy laws, internet laws, platform for privacy preferences project(P3P), Saudi Arabia.*

GJCST-E Classification : *D.4.6*

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I. Introduction

Privacy is one of the most important issue concerning websites over the internet these days. Every website tries to implement an understandable privacy policy. Providing links to privacy policy is absolute necessary today because a lot of people try to disclose personal information over the websites. A privacy policy is a document which defines the rules and regulations governing the user's interaction with websites. There are no standards or requirements for a privacy policy statement but a privacy policy statement must be understandable to the users who visit the website. A privacy policy must also define the information it collects from user. If the privacy policy takes information from the user it must also define why it needs the information. Most users understand if they provide some information it must not be shared with anyone else without their consent. According to a survey conducted by Graphics, Visualization and Usability center of the Georgia Institute of Technology, 69.95% of the users were concerned about disclosing information to the websites to access the requested information [7]. Organizations that publish privacy policies online are considered trustworthy. A survey conducted by *TRUST* showed that 78% of users will provide information to website if they are provided with some kind of privacy assurance [8]. Thus having a privacy policy statement in a website is a straightforward approach of ensuring privacy in the website which boosts the users confidence on the website and reduces the chances of receiving false information from the user.

Considering the importance of the private information over the internet, we conducted a study on implementation of privacy policy in the Educational sector websites in Kingdom of Saudi Arabia. The aim of the study was to check how concerned are the educational sector organizations in Saudi Arabia regarding the use of information and the implementation of the privacy policy. The data privacy in Saudi Arabia is governed by "The Internet laws" passed in 2001. The "Internet laws" define the rules for publishing of data and ensuring privacy over the internet [9].

The Paper is organized as follows. First, we will describe the background to the study. Next, we will discuss the approach undertaken in the research. Further we will provide the results of the study. Finally, in the last section we will provide our conclusion to the study.

II. Background of the Study

The Information practices of any website are described by its privacy policy. The privacy policy of any website must be easily accessible and understandable [4].The presence of privacy policy page describing how organizations handle data can have a broad impact on how websites are used. From the organizations point of view, the way in which it will conduct business will depend upon the way it handles the privacy issues [11].

Implementing privacy policies is absolutely necessary in today's electronic world. There are a number of nations which are creating their own privacy laws. Saudi Arabia has its own data privacy law passed in 2001 called as "The Internet law"[9]. There are also international laws which are enforcing privacy in websites. The most obvious reason of implementing privacy policy is that it keeps the organization out of trouble and keeps them away from the claws of the domestic and foreign data privacy laws. In United States and some other nations the disclosure of the private information of the user may result in sanctions and fines of up to $1 million [12, 13].

There are some other privacy enforcing alternatives like cookie buster, website filters and popup killers. These methods can only protect some aspects of web privacy. These mechanisms are based on user preferences and may vary in different websites [5]. Some more solutions for enforcing privacy are Platform for Privacy Preferences Project (P3P) and various privacy seal programs. The P3P is a framework

established by The World Wide Web Consortium. The presence of P3P allows users to configure their browser to implement web privacy policy [4, 5]. There are also some companies like TRUSTe, BBBOnline and WebTrust that provide privacy seal to the websites [4,8].The presence of TRUSTe seal ensures that TRUSTe has reviewed the privacy policy for the disclosure of user information[4, 10]. BBB Online also ensures privacy in the same way [4, 14].

Information is continuously collected by websites from users. Previous studies [15, 17] have shown that privacy concerns on websites are seriously taken by the users. The conclusions drawn by the studies can have very serious consequences. The main privacy concerns and the regulation of the internet are the areas that need to be thoroughly researched [16]. Our study is concerned with privacy policy implementation in educational sector websites in Saudi Arabia. The aim of the study is to measure the status of privacy policy implementation in educational sector websites in Saudi Arabia.

III. Research Methodology

a) Selecting E government Websites

In this step all the websites concerning the Saudi Arabian government and services were selected and a list was created. There were a total of 54 E government websites in Saudi Arabia.

b) Content Analysis

This step was concerned with the presence of privacy page in the website. The presence of the privacy page asked for the content analysis of the privacy statement to be done. Content analysis is a research tool to derive valid inferences and concepts from the text [12]. The privacy statement of each website was studied line by line to understand the level of privacy implemented by the websites. The evaluation of the privacy statement was done on the basis of the United States Federal Trade Commission's Fair Information Practice Principles (FIPs). The Fair Information Practice Principles (FIPs) are widely accepted guidelines for ensuring fair practices and is based on following core principles[2,13]:

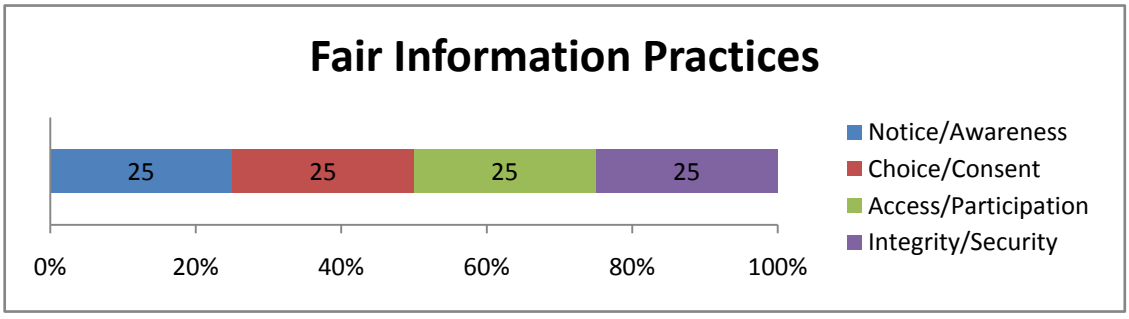
i. *Notice/Awareness:* It should be clearly stated to the user what information is collected from him and how this information is used [2, 13, and 14].
ii. *Choice/Consent:* Users should be clearly informed about the disclosure of the information by the website [2, 13, and 14].
iii. *Access/Participation:* Users must be able to access the information provided to the website [2, 13, and 14].
iv. *Integrity/Security:* Websites should prevent any unauthorised access to the user data. Websites must also ensure that data remains accurate all the time [2, 13, 14].

c) Classification

The last part of our research methodology was classifying the websites. Once the websites were checked for presence of privacy policy, each website was classified as:

i. *Privacy policy Present:* A link to a separate page stating the privacy policy of website is present i.e. privacy policy is present.
ii. *Privacy Policy Not Present:* No page or link dedicated to privacy policy of website present i.e. privacy policy not Present.

The second part of the study was to check whether the privacy policy comply to the Fair information practice principles of Notice/Awareness, choice/ Consent, Access/Participation and Integrity/Security.

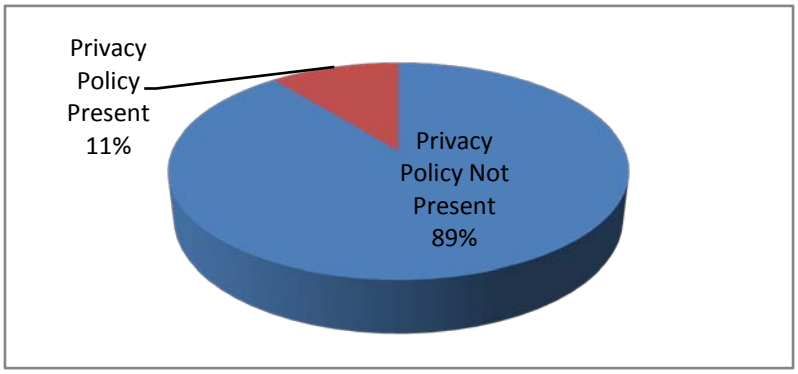


The FIP principles were given an equal weight age and on the basis of the presence of these principles the websites privacy policy was rated as:

1) **Strong:** The privacy policy of website complying with any three FIP principles was classified as Strong.
2) **Weak:** The privacy policy of website complying with two or less than two of the four FIP principles was classified as Weak.

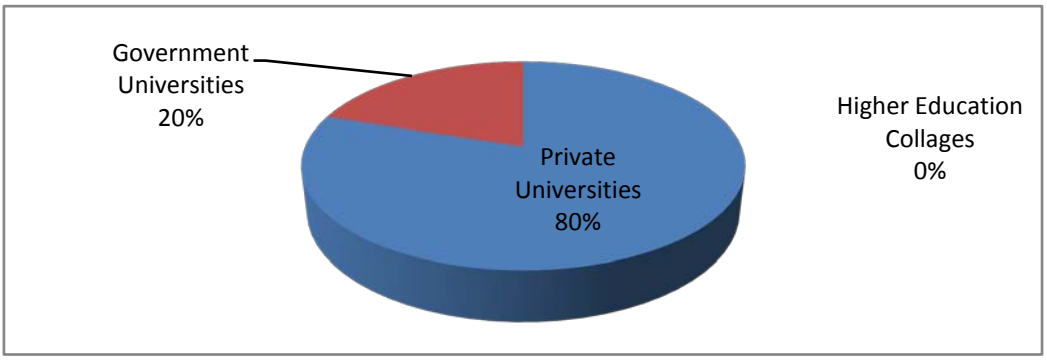
IV. Results

The results of our study were quite shocking considering the amount of attention that is given to data privacy these days. It was found that only 11% of the total educational sector websites in Saudi Arabia have some sort of privacy policy implemented. The rest of 89% of websites don't have any privacy policy implemented.



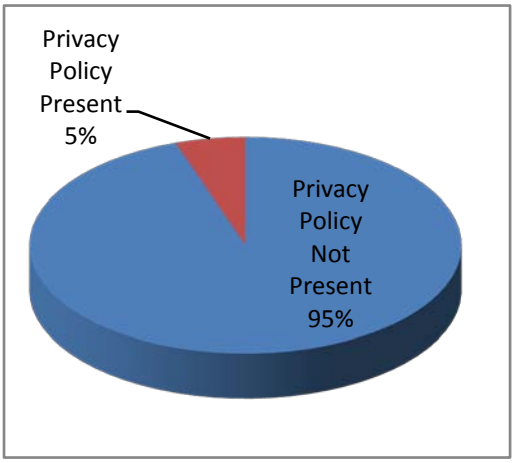
Privacy policy in overall Educational Sector

The private universities seemed to be more concerned about the implementation of privacy policy in Saudi Arabia. Out of the total 11% of the websites where privacy policy was present, 80% of this data belonged Private universities while as 20% of the privacy policy belonged to government universities. The higher education collages seemed to be less concerned about the privacy policy with 0% of websites having privacy policy implemented. None of the higher education collage websites have privacy policy implemented.

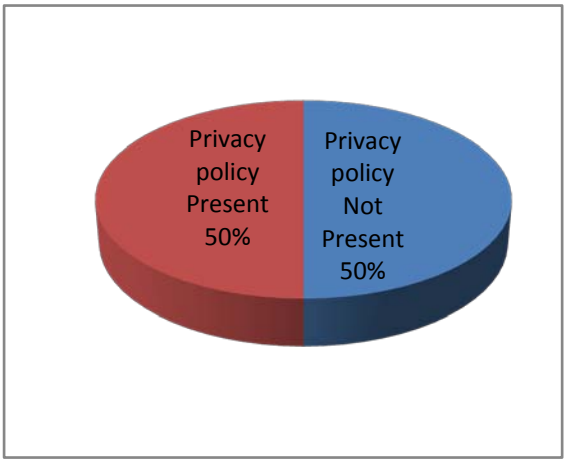


Percentage of total privacy policy implemented

Another interesting observation was that, Out of the 19 government universities in Saudi Arabia only 5% of the university websites have privacy policy present while as the ratio is slightly better with private universities with 50% of the websites having privacy policy present. This observation shows that private universities are 10 times more concerned about the privacy policy as compared to the government universities in Saudi Arabia.

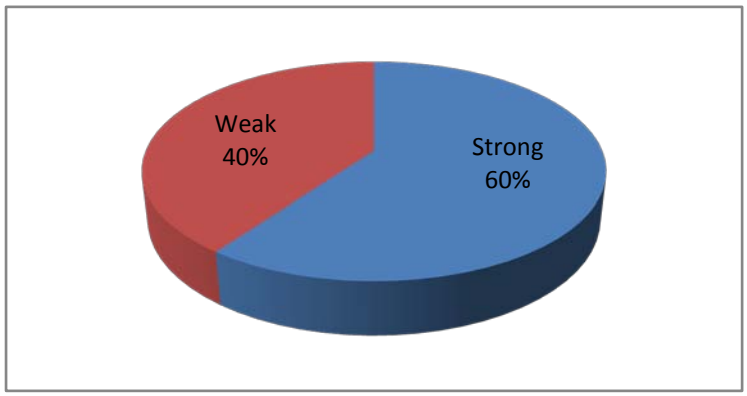


Privacy Policy in Government Universities



Privacy Policy in Private Universities

Another Part of our study was concerned with the status of the privacy policy statement based on the four information practices points discussed under content analysis part of our research. It was found that 60% of the websites where privacy policy was present have a strong privacy policy statement in place while as 40% of the websites have a weak privacy policy statement implemented.



Status of Privacy Statement

There were also a couple of websites where a link to privacy statement was provided but there was nothing in the privacy policy page. The privacy policy page in these websites showed a message of "Page under Establishment" or "Page under Construction". We have categorised these websites as "Privacy Policy Not Present".

V. Conclusion and Future Work

The amount of attention that is given to information privacy and its use is tremendous these days. Keeping this fact in mind we conducted a study on implementation of privacy policy in educational sector of Saudi Arabia. The results of the study were very surprising as well as shocking. A large number of the educational sector websites don't have any privacy policy in place. It was found that a majority of educational sector organisations in Saudi Arabia are not aware about the importance of the privacy policy in websites.

Our study was concerned only to educational sector in Saudi Arabia. Further work can be extended to other fields and sectors in Saudi Arabia. We also recommend a comparative study between Saudi Arabia and some other country in the world.

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BER Performance Evaluation of a Cooperative Wireless Communication System with CDMA Implementation of Fixed Relaying Protocols

By Muntasir Ahmed, Md. Anwar Hossain, A F M Zainul Abadin & Purno Mohon Ghosh

Pabna Science and Technology University, Pabna, Bangladesh

Abstract - In this paper, we investigate a comprehensive study on a simulated cooperative wireless communication system with implementation of code division multiple access (CDMA) technique under Decode-and-Forward (DAF) and Amplify-and- Forward (AAF) relaying protocols. The system under investigation incorporates two digital modulations (BPSK and QPSK) with five major types of signal combining schemes as Equal Ratio Combining (ERC), Fixed Ratio Combining (FRC), Signal-to-Noise Ratio Combining (SNRC), Maximum Ratio Combining (MRC) and Enhanced Signal-to-Noise Combining (ESNRC). Results of BER simulation in AWGN and Raleigh fading channels show that the system provides better performance in AAF relaying protocol as compared to DAF whatever the signal combining scheme is used. In DAF relaying protocol, the system shows most satisfactory performance in SNRC and QPSK digital modulation in comparison with worst case in ERC. In AAF relaying protocol, a much better system performance is achieved in FRC and QPSK digital modulation as finding worst performance in ERC. Information about the average quality shows performance benefits, and a rough approximation about the variation of the channel quality increases the performance even more. The best system performance is achieved when the relay is at equal distance from the sender and the destination or slightly closer to the former.

Keywords : *cooperative wireless communication system; code division multiple access (CDMA); amplifyandforward (AAF); decode-and-forward (DAF); equal ratio combining (ERC); fixed ratio combining (FRC); signal-to-noise ratio combining (SNRC); maximum ratio combining (MRC); enhanced signal-to-noise combining (ESNRC).*

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I. Introduction

Wireless communications technologies have seen a remarkably fast evolution in the past two decades. Each new generation of wireless devices has brought notable improvements in terms of communication reliability, data rates, device sizes, battery life, and network connectivity. In addition, the increase homogenization of traffic transports using Internet Protocols is translating into network topologies that are less and less centralized. In recent years, ad-hoc and sensor networks have emerged with many new applications, where a source has to rely on the assistance from other nodes to forward or relay information to a desired destination. This implies that many nodes or users can "hear" and receive transmissions from a source and can help relay information if needed. A cooperating node can act as a relay node for a source node. As such, cooperative communications can generate independent MIMO-like channel links between a source and a destination via the introduction of relay channels. In the soon-to-be-deployed fourth-generation (4G) wireless networks, very high data rates can only be expected for full-rank MIMO users. More specifically, full-rank MIMO users must be equipped multiple transceiver antennas. In practice, most users either do not have multiple antennas installed on small-size devices, or the propagation environment cannot support MIMO requirements. To overcome the limitations of achieving MIMO gains in future wireless networks, one must think of new techniques beyond traditional point-to-point communications.

Indeed, cooperative communications can be thought of as a generalized MIMO concept with different reliabilities in antenna array elements. It is a new paradigm that draws from the ideas of using the broadcast nature of the wireless channels to make communicating nodes help each other, of implementing the communication process in a distribution fashion, and of gaining the same advantages as those found in MIMO systems. Such a new viewpoint has brought various new communication techniques that improve communication capacity, speed, and performance; reduce battery consumption and extend network lifetime; increase the throughput and stability region for multiple access schemes; expand the transmission coverage area; and provide cooperation trade-off beyond source–channel coding for multimedia communications.

II. System Model and Description

The simulated model shown in Fig. 1 consists of three sections such as Source (Transmitting), Relay and Destination (Receiving). In transmitting section, the synthetically generated binary bit stream is passed through channel (FEC) Encoder and subsequently

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multiplied with Walsh Hadamard code. The multiplied binary bit stream is converted into NRZ format data and fed into digital modulator. The digitally modulated signal is transmitted through antenna. The transmitted signal is ultimately received by the receiving antenna in two ways: one is directly transmitted and the other is via Relay. In relaying section, two relaying protocols are used. In Amplify and Forward (AAF), protocol, the received signal is merely amplified and forwarded to the Destination (not shown in the block diagram). In Decode and Forward (DAF) protocol, the received signal is processed through various sections to recover the transmitted bits. The recovered bits are further processed with implementation of CDMA technology. The CDMA signal is ultimately sent up from the Relaying section. In Destination, the two signals are combined using various combining methods and the output of the combiner is multiplied with Walsh Hadamard code. The multiplied data are fed into digital demodulator and subsequently sent to FEC encoder and ultimately, the transmitted bit stream is retrieved.

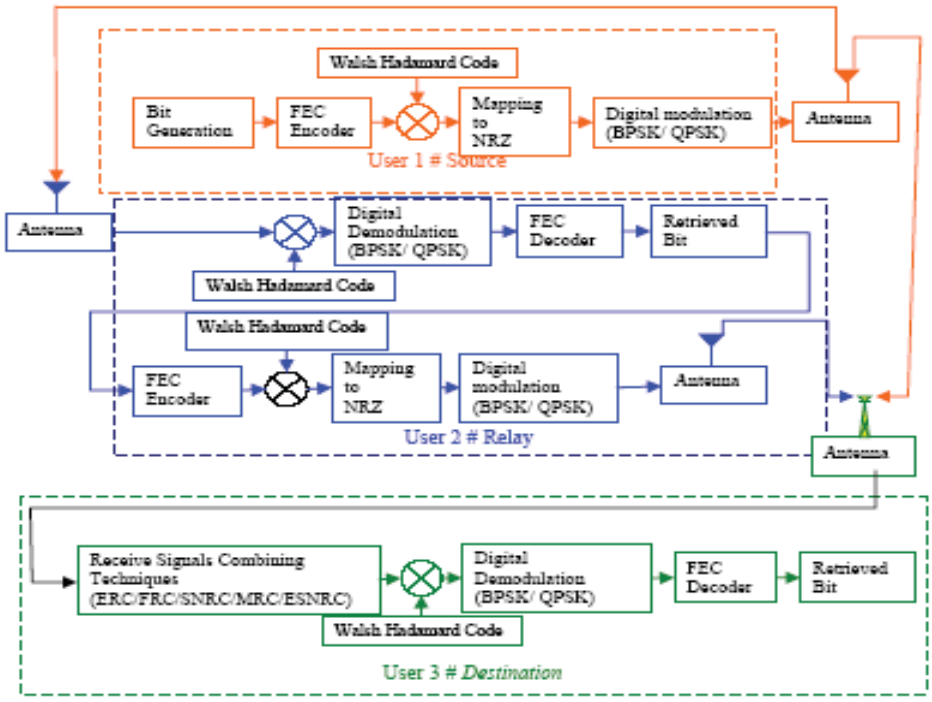

Figure 1 : Block diagram of the cooperative system with channel coding and decoding, modulation and demodulation and fading channel effects considered

The transferred data is a random bipolar bit sequence which is either modulated with Binary Phase Shift Keying (BPSK) or Quadrature Phase Shift Keying (QPSK). QPSK consists of two independent (orthogonal) BPSK systems and therefore has double the data rate compared to BPSK. This fact can be used to compare the performance of a single link channel compared to the one using diversity. While the single link channel uses BPSK the diversity channel, which has to send the data twice, modulates the channel with QPSK which results in the same overall bandwidth for both systems. The channel is modeled considering thermal noise $z_{s,d}[n]$ (additive complex Gaussian noise), path loss and Rayleigh (block-) fading. For the amplitude path loss $d_{s,d} \propto 1/R^2$ is assumed which is modeled by the plane-earth model. The fading coefficient $a_{s,d}[n]$ is modeled as a zero mean, complex Gaussian random variable with variances $\sigma^2_{s,d}$.

$$y_d[n] = \underbrace{d_{s,d}}_{\text{path loss}} \cdot \underbrace{a_{s,d}[n]}_{\text{fading}} \cdot x_s[n] + \underbrace{z_{s,d}[n]}_{\text{noise}} \quad (1)$$

$$\text{or } y_d[n] = \underbrace{h_{s,d}[n]}_{\text{attenuation}} \cdot x_s[n] + \underbrace{z_{s,d}[n]}_{\text{noise}} = \underbrace{d_{s,d}}_{\text{path loss}} \cdot \underbrace{a_{s,d}[n]}_{\text{fading}} \cdot x_s[n] + \underbrace{z_{s,d}[n]}_{\text{noise}}$$

In (1) s, d denote the sender and the destination, $x_s[n]$ is the transmitted symbol and $y_d[n]$ the received symbol. The scalar $h_{s,d}[n] = d_{s,d} \cdot a_{s,d}[n]$ represents the overall attenuation.

There are two popular implementations to transmit over a wireless network. One is the simple direct link which sends the data only once. The other is the two sender arrangement which sends the data twice

over different antennas. These two standard implementations put the performance of the arrangements used in this work into perspective.

The error probability of a single link transmission is as shown in [1].

$$P_b = \frac{1}{2}\left(1 - \sqrt{\frac{\bar{\gamma}_b}{1+\bar{\gamma}_b}}\right) \quad (2)$$

Where $\bar{\gamma}_b$ denotes the average signal-to-noise ratio, defined as $\bar{\gamma}_b = \frac{\varepsilon}{2\sigma^2} E(a^2)$ where $E(a^2) = a^2$.

The performance of a two sender transmission with MRC at the receiver can be expressed [1] as

$$P_b = \frac{1}{4}(1-\mu)^2(2+\mu) \quad and \quad \mu = \sqrt{\frac{\bar{\gamma}_b}{1+\bar{\gamma}_b}} \quad (3)$$

III. Diversity Protocols

The cooperative transmission protocols used in the relay station are either Amplify and Forward (AAF) or Decode and Forward (DAF). These protocols describe the processing of the received data at the relay station before the data is sent to the destination.

a) Amplify-and-Forward (AAF)

This method is often used when the relay has only limited computing time and or power available or the time delay, caused by the relay to decode and encode the message, has to be minimized. The signal received by the relay was attenuated and needs to be amplified before it can be sent again. In doing so the noise in the signal is amplified as well, this is the main drawback of this protocol.

The incoming signal is amplified block wise. Assuming that the channel characteristic can be estimated perfectly, the gain for the amplification can be calculated as follows:

The power of the incoming signal (1) is given by

$$E\left[\left|y_r^2\right|\right] = E\left[\left|h_{s,r}\right|^2\right] \cdot E\left[\left|x_s\right|^2\right] + E\left[\left|z_{s,r}\right|^2\right] = \left|h_{s,r}\right|^2 \xi + 2\sigma_{s,r}^2 \quad (4)$$

Where s denotes the sender, r the relay and $\xi = E\left[\left|x_s\right|^2\right]$ denotes the energy of the transmitted signal. To send the data with the same power the sender did, the relay has to use a gain β of

$$\beta = \sqrt{\frac{\xi}{\left|h_{s,r}\right|^2 \xi + 2\sigma_{s,r}^2}} \quad (5)$$

This term has to be calculated for every block and therefore the channel characteristic of every single block needs to be estimated.

b) Decode-and-Forward (DAF)

A wireless transmission typically uses digital modulation and the relay has enough computing power, as DAF is most often the preferred method to process the data in the relay. The received signal is first decoded and then re-encoded. So there is no amplified noise in the sent signal, as in the case using an AAF protocol. There are two main implementations of such a system.

The relay can decode the original message completely. This requires a lot of computing time, but has the advantage that an error correcting code could be processed in the relay. If the relay station has not the computer power or is not allowed to fully decode the message, the incoming signal can just be decoded and re-encoded symbol by symbol. So there is no amplified noise in the sent signal, as it is the case using a AAF protocol. Whining this work this second approach is used to get an idea about the raw performance of the DAF protocol.

c) Combining Methods

As soon as there is more than one incoming transmission with the same burst of data, the incoming signals have to be combined. In this work the signals are combined only with the current information of the signal and channel. The four used combing methods differ in the knowledge about the channel quality the need to work.

i. *Equal Ratio Combining (ERC)*

This is the simplest combining method, which should only be used if there is no information about the channel quality available or the computing capacity is extremely limited. The incoming signals are just added up before the symbols are detected. Note that you don't need information about the quality of the channel but about the phase shift of the signal which occurs due to fading.

$$y_d[n] = y_{s,d}[n] \cdot e^{-\angle h_{s,d}[n]} + y_{r,d}[n] \cdot e^{-\angle h_{r,d}[n]} \quad (6)$$

The parameters $y_{s,d}[n]$ and $y_{r,d}[n]$ denote the incoming signal from the sender and the relay.

ii. *Fixed Ratio Combining (FRC)*

A much better performance can be achieved when the incoming signals are weighted with a constant ratio, which will not change a lot during the whole transmission. The ration which is described with the parameters $d_{s,d}$ and $d_{r,d}$ should represent the average channel quality and therefore should not take account of temporary influences on the channel due to fading or other effects. In this work no algorithm is used to

estimate the optimal ratio. Instead, the best ratio is approximated by simulating different values to get an idea about the potential of this combining method.

$$y_d[n] = d_{s,d} \cdot y_{s,d}[n] \cdot e^{-\angle h_{s,d}[n]} + d_{r,d} \cdot y_{r,d}[n] \cdot e^{-\angle h_{r,d}[n]} \quad (7)$$

iii. *Signal to Noise Ratio Combining (SNRC)*

An even better performance can be achieved when precise information about the current state of different channels is known. An often used value to characterize the quality of a link is the SNR, which is used to weight the received signals.

$$y_d[n] = SNR_{s,d} \cdot y_{s,d}[n] \cdot e^{-\angle h_{s,d}[n]} + SNR_{r,d} \cdot y_{r,d}[n] \cdot e^{-\angle h_{r,d}[n]} \quad (8)$$

The estimation of the SNR of a multi-hop link using AAF or a direct link can be performed by sending a known symbol sequence in every block. This sequence is used to estimate the phase shift as well. If the multi-hop link is using a DAF protocol the receiver can only see the channel quality of the last hop. It is assumed that the relay sends some additional information about the quality of the unseen hops to the destination, so the SNR of the multi-hop link can be estimated. Whatever protocol is used, an additional sequence needs to be sent to estimate the channel quality. This results in a certain loss of bandwidth. In the Appendix A it is shown how the SNR is estimated in the simulation.

iv. *Enhanced Signal to Noise Ratio Combining (ESNRC)*

Another plausible combining method is to ignore an incoming signal when the data from the other incoming channels have a much better quality. If the channels have more or less the same channel quality the incoming signals are rationed equally. In a system where just one relay is used this can be expressed as

$$y_d[n] = \begin{cases} y_{s,d}[n] \cdot e^{-\angle h_{s,d}[n]} & \text{when } \left(SNR_{s,d} / SNR_{s,r,d}\right) > 10 \\ y_{s,d}[n] \cdot e^{-\angle h_{s,d}[n]} + y_{s,r,d}[n] \cdot e^{-\angle h_{s,r,d}[n]} & \text{when } 0.1 \le \left(SNR_{s,d} / SNR_{s,r,d}\right) \le 10 \\ y_{s,r,d}[n] \cdot e^{-\angle h_{s,r,d}[n]} & \text{when } \left(SNR_{s,d} / SNR_{s,r,d}\right) < 0.1 \end{cases} \quad (9)$$

Using this combining method, the receiver doesn't have to know the channel characteristic exactly. An approximation of the channel quality is enough to combine the signals. Notice that the estimation of the phase shift still needs to be as exact as possible.

IV. Key Results

In this section a combination of different combining methods and diversity protocols are analyzed to illustrate their potential benefits. In a first part, it is assumed that the three stations (sender, relay and destination) have an equal distance from each other. In a second part, the location of the relay station is varied to see the effect on the performance for different location of the relay. In the following table the abbreviations used in the illustrations are described.

Table 1 : Abbreviations used in the following figures

Abbreviations	Description
ERC	Equal Ratio Combining
FRC	Fixed Ratio Combining
$FRC_{x:y}$	Fixed Ratio Combining
	x: Weight of the direct link
	y: Weight of the multi-hop link
SNRC	Signal-to-Noise Ratio Combining
ESNRC	Enhanced Signal-to-Noise Ratio Combining
AAF	Amplify and Forward
DAF	Decode and Forward
$Distance_{x,y,z}$	x: Distance between sender and destination
	y: Distance between sender and relay
	z: Distance between relay and destination

a) Equidistant Arrangement

The three stations are arranged at the edges of a triangle with a relative length of one. Hence all the channels will have the same path loss and therefore the same average signal-to-noise ratio.

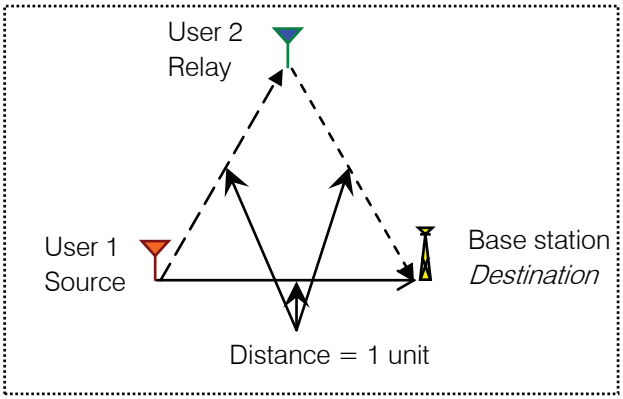

Figure 2 : Equidistant Arrangement - the three stations are arranged at the edges of a triangle with a length of unity

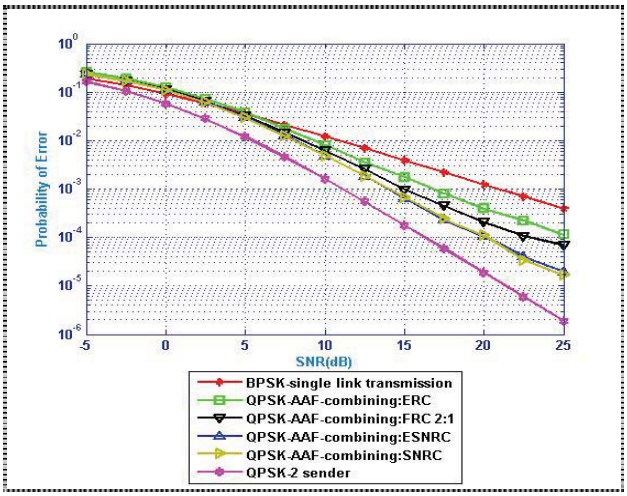

Figure 3 : Comparison of system performance under different combining methods under AAF relaying protocol

In Fig. 1 the effect on the performance of the different combining types using an AAF protocol can be seen. The BPSK single link transmission (2) should demonstrate if there is any benefit at all using diversity, while the QPSK two senders link (3) indicates a lower bound for the transmission.

The first result is that whatever combining type is used, the AAF diversity protocol achieves a benefit compared to direct link. Even the equal ratio combining shows advantages. But compared to fixed ratio combining, the performance looks quite poor. In addition if an intelligent algorithm to calculate the ratio is used, no bandwidth is wasted, in other words the bandwidth is the same than using ERC.

The signal-to-noise ratio combining and the enhanced signal-to-noise ratio combining show roughly the same performance. Remember that for the ESNRC a roughly estimated channel quality for every single block is sufficient in contrast to the SNRC, which needs exact information of the channel quality for every single block, this is a surprising result. It means that the transferred signal in an AAF system contains some information that allows correcting a small difference in the channel quality.

The performance of the combining methods, which have precise information about every single block, is just about one decibel better in SNR than the one using FRC which has just average knowledge of the channel quality. Hence using the AAF protocol, there is no point in wasting lot of computing power and bandwidth to get exact channel information.

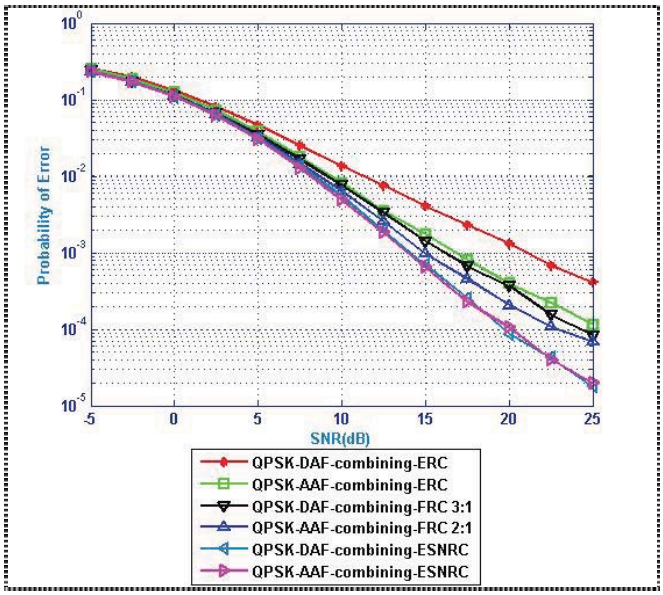

Figure 4 : Comparison of system performance under AAF and DAF relaying protocols with different combining methods

Fig. 2 illustrates the performance of the AAF diversity protocol compared with the DAF protocol. The surprising result is that the AAF diversity protocol always results in a better performance than the DAF protocol whatever combining type is used.

Using equal ratio combining results in a big difference between the two protocols. While the one using AAF shows a quite good performance already, the one using DAF does not have any benefits compared to the BPSK single link. The reason is that a wrong detected symbol at the relay station is relay difficult to correct at the destination, where the two incoming signals are combined. Hence an incorrectly detected symbol at the relay station will have a fifty percent probability of also being incorrectly detected at the destination.

This stands in contrast with the equal ration combing in a system using AAF. Instead of detecting the symbol at the relay, it is amplified and transmitted to the sender. Normally a symbol that would have been detected wrongly is just “a little bit” wrong. When this symbol is amplified before sent to the destination, it has on average much less energy than the correct symbol coming directly from the sender. There is now a high probability that the incorrect symbol will be corrected by the signal from the direct link, when combined at the destination.

It is now obvious now, why the fixed ration combining shows such a good performance. The direct link has on average the better quality than the multi-hop link, so it is sensible to weight the direct link more by assuming that the multi-hop link is more susceptible to errors than the direct link. It also explains why the optimal ratio in the system using DAF is higher than the one using AAF. The DAF relay sends the wrongly detected symbols with the full power, so it takes much more to correct this wrong powerful symbol.

The ESNRC shows roughly the same performance in an AAF or DAF system. The DAF using system benefits a lot by analyzing every single block. Using this combining method the big disadvantage of the wrongly detected symbol at the relay can be reduced. In the majority of the cases, when a symbol is wrongly detected by the relay, the multi-hop has a much poorer channel quality than the direct link, and therefore will not be considered at all.

It might be sensible to ask now, what the purpose is of making the effort at the relay station to decode and re-encode the data when there is no benefit at all doing that. As mentioned in Sec. III-B an error correcting code can be added to correct wrongly detected symbols at the receiver. This is, as seen before, crucial to get a good performance in a DAF system.

b) Moving the Relay

So far, the three stations were positioned were positioned equidistantly and therefore the three channels had all the same average signal-to-noise ratio. In this section the effect is shown when the relay station

is moved. Notice, in the following figurers the x-axis denotes always the SNR of the direct link, which can be assumed (without any loss of generality) to have a length of one.

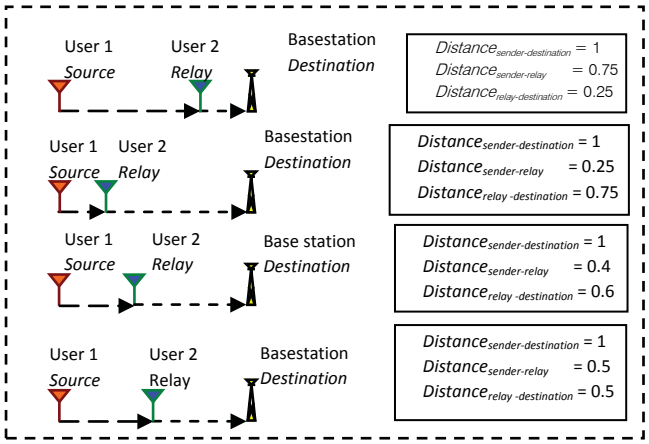

Figure 5 : Illustration of the respective position of the relay and destination whose simulation results are presented

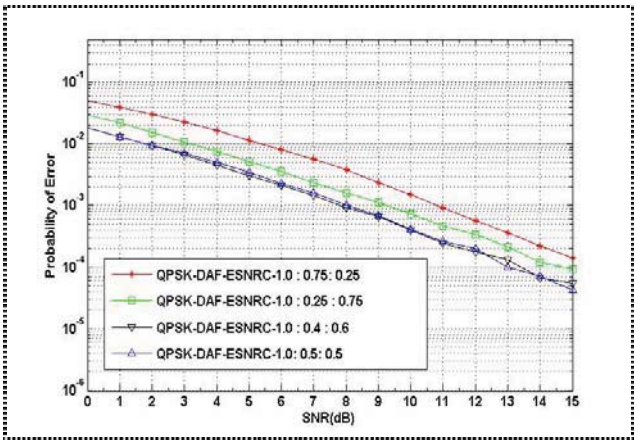

Figure 6 : A significant benefit results when the relay is located between the sender and the destination

The optimal arrangement is shown in Fig. 3 where the relay is placed right between the other stations. This shows the full potential of the used diversity arrangement. The performance is as good as the two sender arrangement. It is a little bit surprising that the resulting performance is not symmetric. The optimal position for the relay is right in the middle or slightly closer to the base station. This tendency to the base station is due to the fact that the noise received at the relay is amplified and therefore should be minimized. Another point that should be paid attention to is the huge benefit compared to the BPSK direct link. To achieve a BER of about 10-2 the SNR is up to eight decibels less than using only a direct link transmission.

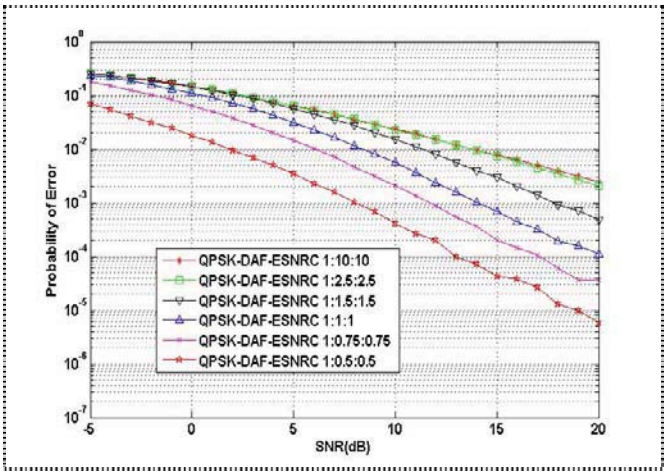

Figure 7 : Illustration of the effect of increasing the distance of the relay from the sender and the destination

Normally there is no relay station available just between the sender and the destination. But how close a mobile station has to be to act as a valuable candidate as a relay station? This is shown in Fig. 4.

The first thing that attracts attenuation is how fast the performance degrades when the distance of the relay increases. By increasing the distance by fifty percent, the resulting performance is roughly the same as the one for a two sender system, which is about three decibels less than the one of the optimal position. The position of the relay, where all three stations are equidistant, results in another 2.5 decibel loss in system performance. This equidistant arrangement still shows an advantage compared to the BPSK single link transmission. This performance degradation continues, when the distance of the relay is increased further. Another fifty percent, results in a situation where there is no useful advantage anymore using the relay link. Notice that the higher diversity level can still be recognized.

V. Conclusions

This work has shown the possible benefits of a wireless transmission using cooperative diversity to increase the performance. The diversity is realized by building an ad-hoc network using a third station as a relay. The AAF protocol has shown a better performance than the DAF protocol whatever combining method was used at the receiver. But it must be considered that no error correcting code was added to the transferred signal.

The choice of combining method has a big effect on the error rate at the receiver. When AAF is used at the relay station the easy to implement Equal Ratio Combining (ERC) shows some benefits compared to the single link transmission. If possible the Fixed Ratio Combining (FRC) should be used. This only needs knowledge of the average channel quality, and shows a much better performance than ERC. If knowledge of the

current state of the channel quality is available more sophisticated combining methods can be used. The enhanced signal-to-noise ratio combining (ESNRC) has shown a very good performance considering that a rough approximation of the current channel quality is sufficient.

The location of the relay is crucial to the performance. The best performance was achieved when the relay is at equal distance from the sender and the destination or slightly closer to the former. In general the relay should not be to far from the line between the two stations.

VI. Appendix A: Estimation of the SNR

a) Estimate SNR Using AAF

Using AAF, the received signal from the relay is

$$y_{r,d} = h_{r,d}x_r + z_{r,d} = h_{r,d}\beta(h_{s,r}x_s + z_{s,r}) \quad (1)$$

The received power will then be

$$E\left[\left|y_{r,d}\right|^2\right] = \beta^2\left|h_{r,d}\right|^2\left(\left|h_{s,r}\right|^2\xi + 2\sigma_{s,r}^2\right) + 2\sigma_{r,d}^2 \quad (2)$$

So the SNR of the one relay multi-hop link can be estimated as

$$SNR = \frac{\beta^2\left|h_{s,r}\right|^2\left|h_{r,d}\right|^2\xi}{\beta^2\left|h_{r,d}\right|^2 2\sigma_{s,r}^2 + 2\sigma_{r,d}^2} \quad (3)$$

b) Estimate SNR Using DAF

To calculate the SNR of a multi-hop link using DAF, first the BER of the link is calculated which can then be translated to an equivalent SNR.

The BER of a single link is given in (2). The BER over a one relay multi-hop link can then be calculated as

$$BER_{s,r,d} = BER_{s,r}(1 - BER_{r,d}) + (1 - BER_{s,r})BER_{r,d}. \quad (4)$$

To calculate the SNR, the inverse functions of (2) are used.

For a BSPK modulated Rayleigh faded signal this will be

$$SNR = \frac{1}{2}\left[Q^{-1}(BER)\right]^2 \quad (5)$$

For a QPSK modulated signal this will change to

$$SNR = \left[Q^{-1}(BER)\right]^2 \quad (6)$$

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Route Stability in WiMAX (802.16)

By Dr. Sheik Subani A.F

CMJ University, Shillong

Abstract - Thesis is devoted to network with WiMAX. It is claimed that WiMAX provides a perfect opportunity for an alternative network development. Discussion is based on five main aspects of WiMAX network implementation. Establishment and development of Base Stations (BS), Access Service Network Gateway (ASNG), and Connectivity Service Network (CSN), Base Station Controllers (BSC) and an Analogous Option (AO) to the GSM model are taken into account. The above mentioned entities are considered as integrative parts of WiMAX network establishment and implementation. Starting from 2011 the system was updated and rate was up to 1 Gigabits for fixed stations. The main emphasis in thesis is made on alternative nature of WiMAX.

GJCST-E Classification : C.2.1

Strictly as per the compliance and regulations of:

Route Stability in WiMAX (802.16)

Dr. Sheik Subani A.F

Abstract - Thesis is devoted to network with WiMAX. It is claimed that WiMAX provides a perfect opportunity for an alternative network development. Discussion is based on five main aspects of WiMAX network implementation. Establishment and development of Base Stations (BS), Access Service Network Gateway (ASNG), and Connectivity Service Network (CSN), Base Station Controllers (BSC) and an Analogous Option (AO) to the GSM model are taken into account. The above mentioned entities are considered as integrative parts of WiMAX network establishment and implementation. Starting from 2011 the system was updated and rate was up to 1 Gigabits for fixed stations. The main emphasis in thesis is made on alternative nature of WiMAX.

I. Importance of the Study

It is relevant to study WiMAX network to solve numerous problems of its integrative parts, of the network development. WiMAX network is an optimal network developed as an alternative for wireless connections and data transfer.

II. Statement of the Problem

WiMAX (Worldwide Interoperability for Microwave Access) is of special interest for the modern scientists and researchers, because it is a wireless communications standard established to provide 30 to 40 megabit-per-second data transfer rates. The main emphasis is made on data transfer speed and it is relevant to know that WiMAX can serve as an optimal gateway in the field of modern Internet technologies.

III. Objectives

Basically, the whole network should be studied with respect to the following issues: Mobile Stations (MS) is used by the end user to get to the network. The access service network (ASN) is based on several stations and several ASN gateways establish the radio access network at the edge. Connectivity service network (CSN) is responsible for IP connections development.

a) Hypothesis

WiMAX data transfer rates is a perfect alternative for speedy data transfer without any wires.

IV. Literature Review

WiMAX is a perfect opportunity to develop an alternative network. The WiMAX Forum's NWG is focused on improvement of interoperability among various WiMAX equipment and operators. Concerning the network reference model, it can be said that WiMAX is focused on an integrative network architecture development. Moreover, it is possible to provide a simplified illustration of IP-based WiMAX network architecture.

WiMAX Forum NWG developed the network reference model and defined numerous functional integrative parts and connections/interfaces between them (Information Security Tops CPA Tech Issues in 2005). WiMAX equipment can be found in two main forms – in the form of base stations, implemented by service providers to involve the innovative technology in a certain area, and receivers, installed in clients. Several networking usage models can be correlated with WiMAX (Mumtaz, Tham Tu, Sadeghi, Gameiro 193).

V. Research Methodology

Qualitative research methodology is applied. This can be explained by a processing of current materials in this field. To trace current trends in WiMAX network development and implementation, it is relevant to consider modern researches and studies in this field. Qualitative research methodology is justified in terms of this research.

VI. Results and Discussion

The WiMAX Forum's Network Working Group (NWG) is responsible for improvement of end-to-end network requirements, development of architecture, and protocols advancement for WiMAX. IEEE 802.16-2009 can be used as air interface. The WiMAX NWG has been conceptualized as a network reference model which can serve as a model of an architecture framework for WiMAX deployments. The main emphasis of WiMAX implementations is made on interoperability among various WiMAX equipment and operators (Cortada).

VII. Findings

It is possible to differentiate between base stations (BS) as the alternative for providing the air interface to the MS. One can argue that it is relevant to focus on additional functions of BS, such as changes in management functions of micro mobility, radio resources management, intensification of QoS policy, traffic classification of data transfer, proxy issues of Dynamic Host Control Protocol and many other steps of management. BS should be developed with respect to these requirements.

Access service network gateway (ASN-GW) is suggested as an agent. It can speed up gateway and a

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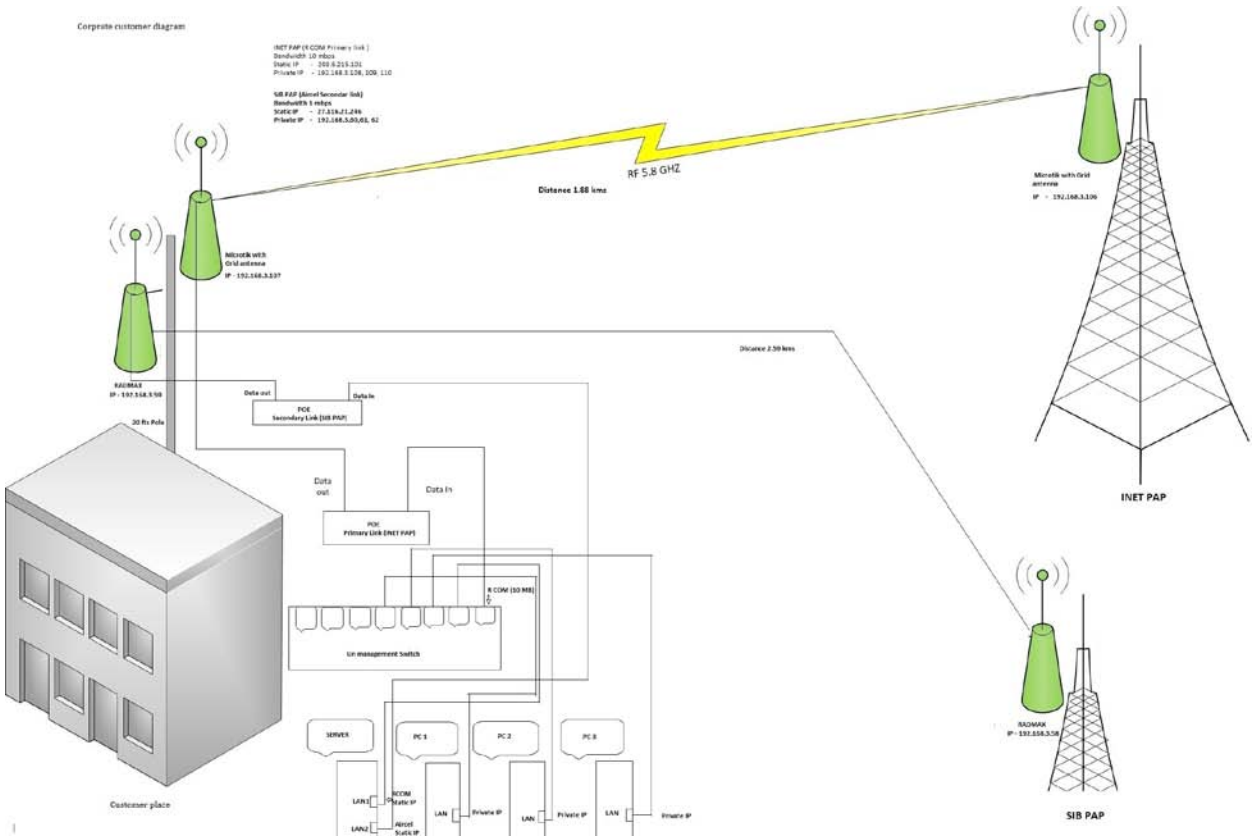
layer 2 traffic aggregation point (Dyck, Gordon, Kung 4). Moreover, it should be mentioned that ASN gateway includes intra-ASN location management and paging, radio deals with management issues and admission control. ASN gateway is focused on subscriber profiles' caching etc.

CSN enables Internet connection and can connect to numerous public and corporate networks (Godwin-Jones 8). Therefore, it is relevant to consider WiMAX architecture as a framework for the flexible remodeling of functional integrative parts in the process of physical entities creation. We can surely claim that the ASN can be remodeled in the main station transceivers (BST) and base station controllers (BSC). Moreover, further process of remodeling is based on the following issues: ASNGW analogous connection to the GSM model of BTS, BSC, and SGSN) (The Change Function: Why Some Technologies Take off and Others Crash and Burn 61).



VIII. Conclusion

Initially the name "WiMAX" was invented to promote conformity and interoperability of the standard. WiMAX was at first described as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL". From the perspective given above, WiMAX can be positioned as "Wi-Fi on steroids" and numerous applications can be supported by this network. A portable mobile connection occurs in the result of five integrative entities of WiMAX implementation (Blau 4).

Therefore, the main conclusion can be made as follows: WiMAX network is a relevant means for data transfer across an Internet service provider network (also known as backhaul). It is appropriate to mention that satellite Internet service can be replaced by this network. WiMAX is established by an industry consortium, considered by a group called the WiMAX Forum. The Forum is focused on certification issues and this technology should meet its standards. Actually, WiMAX occupies the niche of Internet communications model. Moreover, in the modern dynamical context there is a great need for a wireless alternative to cable and digital subscriber line (DSL). Of course, the main emphasis is made on the Internet access. At-home or mobile Internet access should be studied as a relevant option providing last-mile broadband Internet access in distant locations.

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