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Highlights

Designing and Analysis

Digital Radio Technologies

Discovering Thoughts, Inventing Future

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Secured Localized Broadcasting in Wireless Ad-Hoc Networks

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SECURED LOCALIZED BROADCASTING IN WIRELESS AD-HOC NETWORKS

Strictly as per the compliance and regulations of:

Secured Localized Broadcasting in Wireless Ad-Hoc Networks

Geethu Chandran [α] & Jenopaul.P [σ]

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I. Introduction

Wireless ad hoc networks are now being used to support wireless networks that can be established without the help of any fixed infrastructure. Wireless devices in ad hoc networks are usually termed as nodes. One of their important characteristic is their limited transmission ranges. Therefore, each node can directly communicate with only those within its transmission range (i.e., its neighbors) and requires other nodes to act as routers in order to communicate with out-of range destinations. One of the fundamental operations in wireless ad hoc networks is broadcasting, where a node transmits a message to all other where each node on receiving a message transmits nodes in the network. This can be achieved through the traditional where a node on receiving a message sends it to all its neighbors only for once. However, flooding can entail a large number of redundant transmissions, which can lead to significant waste of constrained resources such as bandwidth and power. In general, it is not necessary for every node to forward/transmit the message in order to process of flooding,

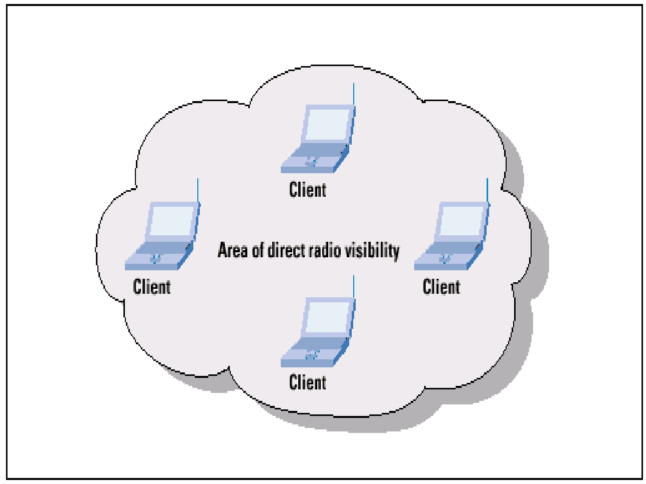

Figure 1 : A mobile ad-hoc network

deliver it to all nodes in the network. A set of nodes form a Dominating Set (DS) if every node in the network is either in the set or has a neighbor in the set. If the nodes in the DS form a connected sub graph then it is called a Connected Dominating Set (CDS). A CDS is hence formed by a source node along with its forwarding nodes. By using only the nodes in the set to forward the message CDS can be used for broadcasting. Therefore, the problems of finding the minimum number of required transmissions (or forwarding nodes) and finding a Minimum Connected Dominating Set (MCDS) can be reduced to each other. Unfortunately, finding a MCDS (and hence minimum number of forwarding nodes) was proven to be NP hard even when the whole network topology is known. A desired objective of many efficient broadcast algorithms is to reduce the total number of transmissions to preferably within a constant factor of its optimum. For local algorithms and in the absence of global network topology information, this is commonly believed to be very difficult or impossible. The existing local broadcast algorithms can be classified based on whether the forwarding nodes are determined statically (based on only local topology information) or dynamically

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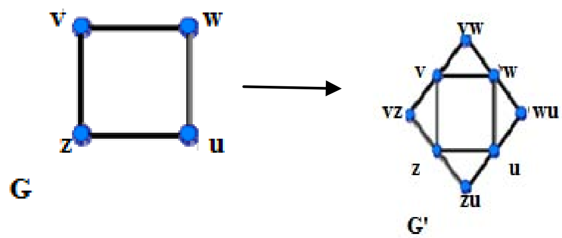

Figure 2 : Construction of connected dominating set G' from unidirectional graph G

(based on both local topology and broadcast state information). In the static approach, the distinctive feature of local algorithms over other broadcast algorithms is that using local algorithms any local topology changes can affect only the status of those nodes in the neighborhood. Hence, local algorithms can provide scalability as the constructed CDS can be efficiently updated. The existing local algorithms in this category use a priority function known by all nodes in order to determine the status of each node. Using only local topology information and a globally known priority function, based on the static approach the local broadcast algorithms cannot guarantee a good approximation factor to the optimum solution (i.e., MCDS). On the other hand, in the dynamic approach, the status of each node (hence the CDS) is determined "on-the-fly" during the broadcast progress. Using the dynamic approach, the constructed CDS may vary from one broadcast instance to another even when the whole network topology and the source node remain unchanged. As a result, the broadcast algorithms based on the dynamic approach typically have small maintenance cost and are expected to be robust against node failures and changes in network topology.

II. Security in Wireless Ad-Hoc Networks

The wireless ad-hoc networks are easily prone to attacks from malicious nodes that can result in loss of information. The expected and the perceived packet delivery ratios can be compared and in case of abnormalities we can check for the presence of malicious nodes. If the perceived packet delivery ratio is lesser than the expected ratio then we can assume that the packets are being lost. Selfish nodes are those nodes which do not broadcast the received packets thus leading to the failure of communication. By comparing Fig 3: Minimum Connected Dominating Set the expected and the perceived PDFs the selfish nodes can be easily detected and isolated. By preventing the selfish nodes from assuming forwarding status, the communication process can be preserved.

III. Model of the Network

We assume that the network consists of a set of nodes V, |V| = N. Each node is equipped with omni directional antennas. Every node u 2 V has a unique id, denoted id(u), and every packet is stamped by the id of its source node and a nonce, a randomly generated number by the source node. We can assume that all nodes are located in two-dimensional space. However, all the results presented in this paper can be readily extended to three dimensional ad hoc networks. To model the network, we assume two different nodes u ε V and v ε V are connected by an edge if and only if |uv| ≤ R, where |uv| denotes the Euclidean distance between nodes u and v and R is the transmission range of the nodes. Thus, we can represent the communication graph by G (V, R), where V is the set of nodes and R is the transmission range. This model is, up to scaling, identical to the unit disk graph model, which is a typical model for two dimensional ad hoc networks. Practically speaking, however, the transmission range can be of arbitrary shape as the wireless signal propagation can be affected by many unpredictable factors. Finally, we assume that the network is connected and static during the broadcast and that there is no loss at the MAC/PHY layer. These assumptions are necessary in order to prove whether or not a broadcast algorithm can guarantee full delivery. Note that without these assumptions even flooding cannot guarantee full delivery.

IV. Broadcasting in the Dynamic Approach

Using the dynamic approach, the status (forwarding/ non forwarding) of each node is determined "on-the-fly" as the broadcasting message propagates in the network. Usually in neighbor-designating broadcast algorithms, each forwarding node selects its own subset of its neighbors to forward the packet and in self-pruning algorithms each node determines its own status based on a self-pruning condition after receiving the first or several copies of the message. It was proved that self-pruning broadcast algorithms are able to guarantee both full delivery and a constant approximation factor to the optimum solution (MCDS). However, the proposed algorithm in uses position information in order to design a strong self-pruning condition. In the last section, it was observed that position information can simplify the problem of reducing the total number of broadcasting nodes. Moreover, acquiring position information may not be possible in some applications. In this section, we design a hybrid (i.e., both neighbor-designating and self-pruning) broadcast algorithm and show that the algorithm can achieve both full delivery and constant approximation using only the connectivity information.

V. The Proposed Localized Broadcast Algorithm

Suppose each node has a list of its 2-hop neighbors (i.e., nodes that are at most 2 hops away). This can be achieved in two rounds of information

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exchange. In the first round, each node broadcasts its id to its 1-hop neighbors (simply called neighbors). Thus, at the end of the first round, each node has a list of its neighbors. During the second round, each node transmits its id together with the list of its neighbors. The proposed broadcast algorithm is a hybrid algorithm, combining both neighbor designating and self-pruning algorithms and so every node that broadcasts the message may select some of its neighbors to forward the message. In the proposed broadcast algorithm, each broadcasting node selects at most one of its neighbors. A node should broadcast the message if it is selected for forwarding. Other nodes which are not selected have to decide whether or not to broadcast by themselves. This decision is made based on a self-pruning condition called the coverage condition. To evaluate the coverage condition, every node u maintains a list $List^{cov}_u$ (m) for every unique message m. Upon receiving a message m for the first time, $List^{cov}_u$ (m) is created and filled with the ids of all neighbors of u and then updated as follows: Suppose u receives m from its neighbor v and assume that v selects $w \neq u$ to forward the message. Note that w may not be a neighbor of u. However, since w is a neighbor of v, it is at a maximum of 2 hops away from u. Having id's of v and w (included in the message), node u updates $List^{cov}_u$ (m) by removing all nodes in $List^{cov}_u$ (m) that are a neighbor of either v or w. This update can be done because u has a list of its 2-hop neighbors. Since w will eventually broadcast the message, by updating the list, u removes those neighbors that have received the message or will receive it, finally. Every time u receives a copy of message m it updates $List^{cov}_u$ (m) as already been explained. If w = u (i.e., u is selected by v to forward the message), node u updates $List^{cov}_u$ (m) by removing only neighbors of v from the list. Note that in this case, u must broadcast the message. However, u has to update $List^{cov}_u$ (m) as it needs to select one of its neighbors from the updated list (if it is not empty) to forward the message.

Definition 1 (coverage condition). We say the coverage condition for node u is satisfied at time t if $List^{cov}_u$ (m) $=\phi$ at time t.

Algorithm 1 shows our proposed hybrid broadcast algorithm. When a node u receives a message m, it creates a list $List^{cov}_u$ (m) if it is not created yet and updates the list as explained earlier. Then, based on whether u was selected to forward or whether the coverage condition is satisfied, u may schedule a broadcast by placing a copy of m in its MAC layer queue. The sources of delay in the MAC layer can be divided into two. Firstly, a message may not be at the head of the queue so it has to wait for other packets to be transmitted. Secondly in contention based channel access mechanisms such as CSMA/CA, to avoid collision, a packet at the head of the queue has to wait for a random amount of time before getting transmitted. In this paper, we assume that a packet can be removed from the MAC layer queue if it is no longer required to be transmitted. Therefore, the broadcast algorithm has access to two functions to manipulate the MAC layer queue. Among the two functions, the first function is the scheduling/placing function, which is used to place a message in the MAC layer queue. We assume that the scheduling function handles duplicate packets, i.e., it does not place the packet in the queue if a copy of it is already in the queue. The second function is used to remove a packet from the queue (it does not do anything if the packet is not in the queue).

Algorithm 1 : The proposed hybrid algorithm executed by u

1. Extract the ids of the broadcasting node and the selected node from the received message m
2. if u has already broadcast the message m then
3. Discard the message
4. Return
5. end if
6. if u is receiving m for the first time then
7. Create and fill the list $List^{cov}_u$ (m)
8. end if
9. Update the list $List^{cov}_u$ (m)
10. Remove the information the previous node had added to message
11. if $List^{cov}_u$ (m) ; then
12. Select an id from $List^{cov}_u$ (m) and add it to the message
13. Schedule the message {(*only update the selected id if m is already in the queue*)}
14. else {(_$List^{cov}_u$ (m) ; in this case*)}
15. if u was selected then
16. Schedule the message
17. else
18. Remove the message from the queue if u has not been selected by any node before
19. end if
20. end if

The proposed algorithm obeys the following statements:

1. u discards a received message m if it has broadcast m before.
2. If u is selected to forward the message, it schedules a broadcast (regardless of the coverage condition) and never removes the messages from the queue in future. However, u may change or remove the selected node's id from the scheduled message every time it receives a new copy of the message and updates $List^{cov}_u$ (m).
3. Suppose u has not been selected to forward the message by time t and the $List^{cov}_u$ (m) becomes empty at time t after an update. Then at time t, it removes the message from the MAC layer queue (if the message has been scheduled before and is still in the queue).

4. If $List^{cov}_u$ (m) $\neq \phi$ then u selects a node from $List^{cov}_u$ (m) $\neq \phi$ to forward the message and adds the id of the selected node in the message. The selection can be done randomly or based on a criteria. For example, u can select the node with the minimum id or the one with maximum battery life-time.
5. If u has been selected to forward and $List^{cov}_u$ (m) = ϕ it does not select any node to forward the message. This is the only case where a broadcasting node does not select any of its neighbors to forward the message.

VI. Analysis of the Proposed Broadcast Algorithm

In this section, it can be proved that the proposed broadcast algorithm guarantees full delivery as well as a constant approximation to the optimum solution irrespective of the forwarding node selection criteria and the random delay in the MAC layer. In order to prove these properties, assume that nodes are static during the broadcast that the network is connected and there is no loss at the MAC/PHY layer. Note that even flooding cannot guarantee full delivery without these assumptions.

Theorem 5 : Algorithm 1 guarantees full delivery

Proof :

Every node broadcasts a message at most once. Therefore, the broadcast process eventually terminates. By contradiction, assume that node d has not received the message by the broadcast termination. Since the network is connected, there is a path from the source nodes (the node that initiates the broadcast) to node d. Clearly, we can find two nodes u and v on this path such that u and v are neighbors, u has received the message and v has not received it. The node u did not broadcast the message since v has not received it. Therefore, u has not been selected to broadcast; thus, the coverage condition must have been satisfied for u. As the result, v must have a neighbor w, which has broadcast the message or was selected to broadcast. Note that all the selected nodes will ultimately broadcast the message. This is a contradiction because, based on the assumption, v should not have a broadcasting neighbor.

Lemma 2 :

Using Algorithm 1, the number of broadcasting nodes inside any disk $D_{O,R/2}$ centered at an arbitrary point O and with a radius R/2 is at most 32.

Proof :

All nodes inside $D_{O,R/2}$ are neighbors of each other, thus they receive each others messages. The broadcasting nodes can be divided into two types based on whether or not the coverage condition was satisfied for them just before they broadcast the message. Recall that the coverage condition may be satisfied for a broadcasting node if the node has been selected to forward the message. It is because a selected node has to broadcast the message irrespective of the coverage condition. Consider two disks centered at O with radii R/2 and 3R/2, respectively. Suppose k is the minimum number such that for every set of k nodes w_i ε $D_{O,3R/2}$, $1 \leq i \leq k$, we have

$$\exists i, j \neq i : |wiwj| \leq R \qquad (1)$$

Following, we find an upper bound on k. By the minimality of k, there must exist k - 1 nodes w_i ε $D_{O,3R/2}$, $1 \leq i \leq k-1$, such that

$$\forall i, j \neq i : |wiwj| > R \qquad (2)$$

Consider k -1 disks D_1; . . .;D_{k-1} with radius R/ 2 centered at wi, $1 \leq i \leq k-1$, respectively. By (2), $D_1,\ldots,D_{k-1}$ are non overlapping disks. Also, every disk D_i, $1 \leq i \leq k-1$, resides in $D_{O,2R}$ that is the disk centered at O with radius 2R.It is because, the center of every Disk D_i, $1 \leq i \leq k-1$, is inside $D_{O,3R/2}$. Thus, by an area argument, we get

$$(k-1)(\prod(R/2)^2) \leq \prod(2R)^2 \qquad (3)$$

Hence, $k \leq 17$

We first prove that the number of broadcasting nodes inside $D_{O,R/2}$ for which the coverage condition is not satisfied is at most k -1. We then prove the same upper bound for the number of broadcasting nodes inside $D_{O,R/2}$ for which the coverage condition is satisfied. Consequently, the total number of broadcasting nodes inside $D_{O;R/2}$ is bounded by $2k-2 \leq 32$. By contradiction, suppose that there are more than k _ 1 broadcasting nodes inside $D_{O;R2}$ for which the coverage condition is not satisfied. Consider the first k broadcasting nodes be u_1, . . . , u_k ordered chronologically based on their broadcast time, and a_1, . . . , a_k the corresponding selected neighbor. Thus, for every i, $1 \leq i \leq k$, we have a_i ε $List^{cov}_{ui}(m)$, where $List^{cov}_{ui}(m)$ is the list of node ui at the time it broadcasts the message. Since u_1, . . . , u_k are all in $D_{O,R/2}$ and for every i, $1 \leq i \leq k$, $|u_i a_i| \leq R$, we get

$$\forall i, 1 \leq i \leq k : a_i \in D_{O,3R/2} \qquad (4)$$

Thus, by the definition of k, there are two nodes a_i, a_j,i < j such that $|a_i a_j| \leq R$. The node u_i is broadcast before u_j and is a neighbor of it.Hence, u_j is aware of u_i's selected neighbor a_i and removes a_j from $List^{cov}_{uj}$ (m) as soon as it receives the message from u_i. This is a contradiction because a_j ε $List^{cov}_{uj}(m)$ at the time u_j broadcasts.

It remains to prove that the number of broadcasting nodes inside $D_{O,R/2}$ for which the coverage condition is satisfied is at most k _ 1. By contradiction, suppose that there are at least k broadcasting nodes inside DO;R2 for which the coverage condition is satisfied. Let $v_1, \ldots, v_k \in D_{O,R2}$ be the first k broadcasting nodes, arranged chronologically based on their broadcast time. Note that a broadcasting node must have been selected (by another node) to forward the message if its coverage condition is fulfilled. Let $b_1, b_2, \ldots, b_k$ be the nodes that selected $v_1, \ldots, v_k$ to forward the message. Therefore, for every i, $1 \leq i \leq k$, we have $b_i \in D_{O,3R/2}$. Also, for every i, $1 \leq i \leq k$ and every j, $1 \leq j \leq k$ and $j \neq i$, we get $b_i \neq b_j$, because each node can select a maximum of one other node to forward. By the definition of k, there must exist two nodes bi and bj, i < j such that $|b_ib_j| \leq R$. This is a contradiction because b_i and b_j are neighbors and b_j receives the b_j broadcast message, thus v_j $List^{cov}_{bj}(m)$ as v_i and v_j are neighbors.

Corollary 1 :

Let u be any node in the network. Using the proposed Algorithm, the number of broadcasting nodes within the transmission range of u is at most 224.

Proof :

Let S_{MCDS} be a MCDS and S_{Alg} be the set of broadcasting nodes using Algorithm 1. Let u be any node in Proof. All the nodes within the transmission range of u (including u) are inside a disk with radius R. A disk with radius R can be covered with at most seven disks with radius R/2 . Thus, by Lemma 2, the number of broadcasting nodes within the transmission range of u is at most $7 \times 32 = 224$.

Theorem 6 :

Algorithm 1 has a constant approximation factor to the optimal solution (MCDS). Moreover, the approximation factor is at most 224.

$$|S_{Alg}| \leq 224 \times |S_{MCDS} \qquad (5)$$

S_{MCDS}. By Corollary 1, the number of broadcasting nodes within the transmission range of u is at most 224. Note that every broadcasting node is within the transmission range of at least one node in S_{MCDS}, because S_{MCDS} is a dominating set.

VII. Implementing Strong Coverage Condition

As proven, the proposed broadcast algorithm guarantees that the total number of transmissions is always within a constant factor of the minimum number of required ones. However, the number of transmissions may be further reduced by slightly modifying the broadcast algorithm. As explained earlier, in the proposed algorithm, a selected node has to broadcast the message even if its coverage condition is satisfied. Nevertheless, in some cases, a selected node can avoid broadcasting. For example, a selected node u can abort transmission (by removing the message from the queue) at time t if by time t and based on its collected information, all its neighbors have received the message. This idea can be implemented as follows:

Suppose, for each unique message m, every node u maintains and updates an extra list $List^{str}_u$ (m). Similar to $List^{cov}_u$ (m), $List^{str}_u$ (m) is created and filled with the ids of u's neighbors upon the first reception of message m. Also, every time u receives m, it updates $List^{str}_u$ (m) as follows: Let v be the broadcasting node and $w \neq u$ the selected node by v. Node u first removes the nodes in $List^{str}_u$ (m) that are neighbors of v. If the priority of w (e.g., its id) is higher than u, it also removes the nodes in $List^{str}_u$ (m) that are neighbors of w. To further reduce the number of redundant transmissions, a selected node can abort broadcasting m under the following strong coverage condition.

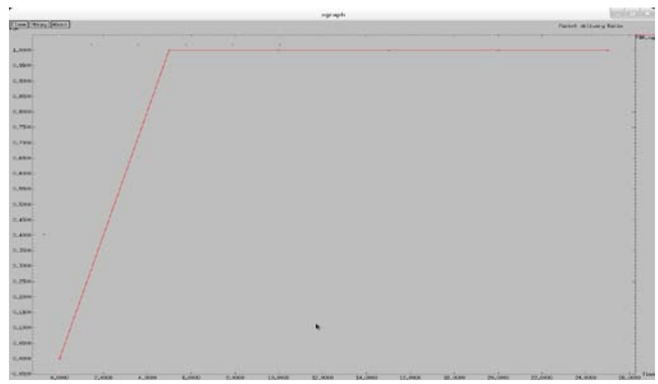

Figure 3 : Packet delivery ratio versus time

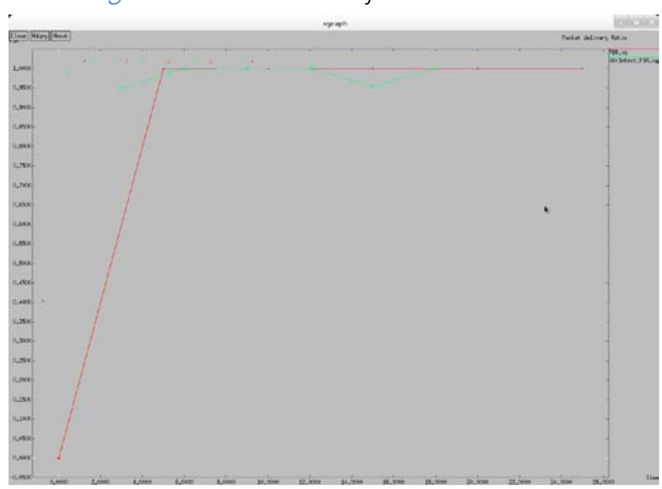

Figure 4 : PDRs of existing and modified systems

Definition 2 (strong coverage condition). It can be said that the strong coverage condition is satisfied for node u at time t if$List^{str}_u$ (m) $= \phi$ at time t.

Note that the strong coverage condition is only used by selected nodes to check whether they need to broadcast. Other nodes make a decision based on the previously defined coverage condition (a weaker condition). The following theorem states that the full delivery is guaranteed coverage condition is satisfied. Using a similar approach to g that used in the proof of Lemma 2, It can be proven that this extension of the algorithm also achieves a constant approximation factor.

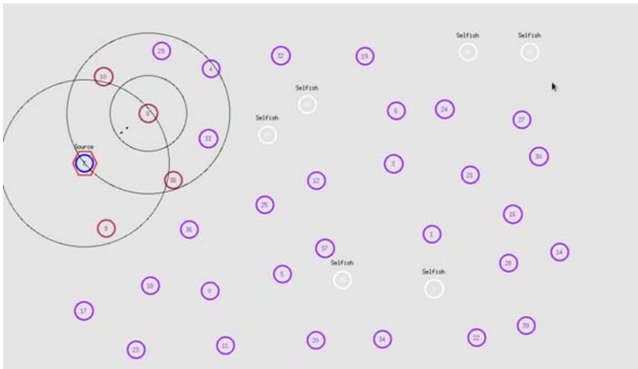

Figure 5 : A broadcasting instance from the proposed system

Theorem 7:

Suppose Alg-str is a modified version of Algorithm 1 in which each node maintains two lists $List^{cov}_{u}$ (m) and $List^{str}_{u}$ (m) and selected nodes can avoid broadcasting under the strong coverage condition. Full delivery can be guaranteed using Alg-str.

VIII. Experimental Results

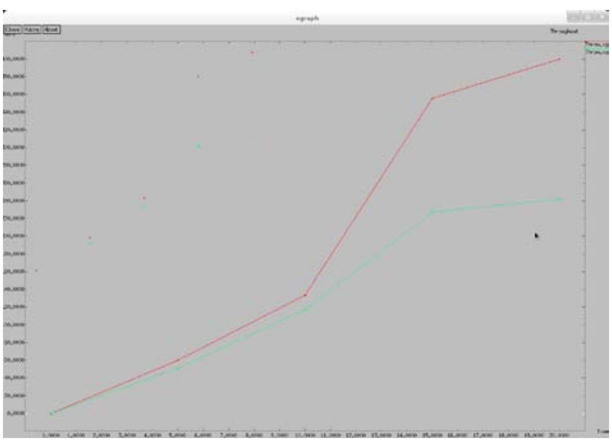

Figure 6 : Comparison of Throughput

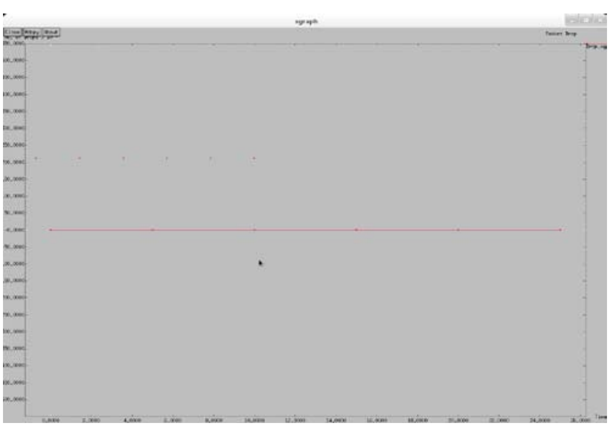

Figure 7 : Packet drop versus time

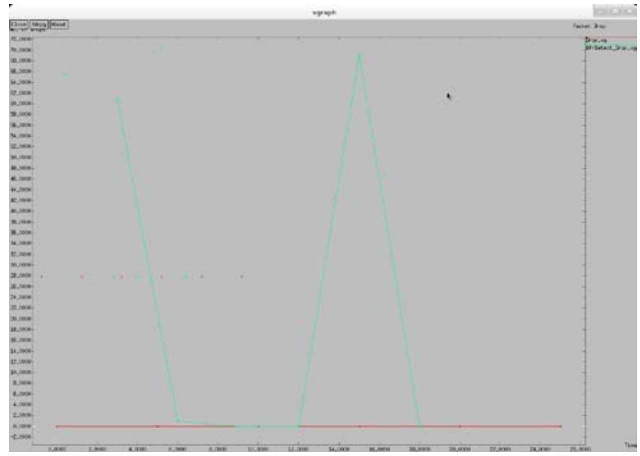

Figure 8 : Comparison of packet drop versus time

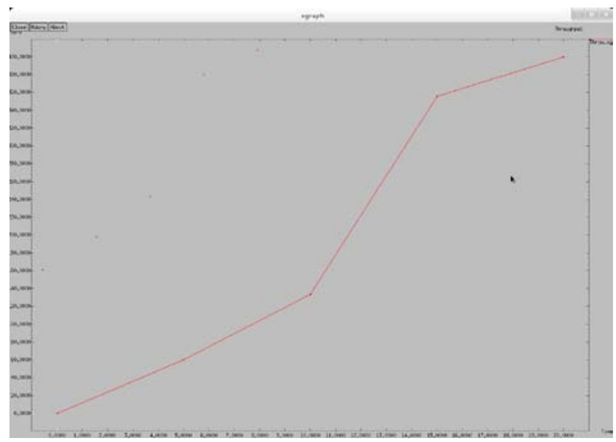

Figure 9 : Throughput versus time

This paper is aimed on implementing a secured broadcasting algorithm based on the dynamic approach. The existing system uses connectivity information to broadcast a message by forming a connected dominating set. But the disadvantage with the existing system is that it does not guarantee a secure means of broadcasting. The presence of selfish nodes in the network can disrupt smooth communication between the nodes. In this paper the existing algorithm is modified so as to identify the selfish Fig:3 A broadcast instance from the proposed system. nodes in the network and they are prevented from being a part of the connected dominating set.In this way, we can prevent the disruption of communication in the network.

In this system a 1150 x 800 m^2 sized rectangular network with 40 mobile nodes is used for carrying out the simulation purpose. Two ray ground propagation with a wireless channel is set up. A priority queue model is set up with a maximum queue size of 300 packets. Each node is assumed to have an initial energy of 100 joules which decreases with each transmission and reception of packets. Each node is equipped with an omnidirectional antenna. The simulation of the proposed system is done using NS-2.35 network simulator.

The figure illustrates a broadcasting instance from the proposed system. The source is broadcasting a message using the nodes in the connected dominating set namely, the nodes 8,9,10 and 38.The selfish nodes in the network had been identified as 2,13,15,26,31 and 35.These nodes are prevented from forming a part of the connected dominating set after their identification so as to improve the quality of communication.

In figure, the packet delivery ratio of the proposed system is shown. The x-axis shows the time, while the y-axis shows the packet delivery ratio. It can be shown from the figure that the packet delivery ratio increases linearly and attains a constant value at around 4000 unit of time. Around 1000 packets are delivered in a unit of time after the graph attains the constant value. The linearly increasing portion of the graph indicates the time taken for the formation of the connected dominating set. After the formation of the connected dominating set, the packet delivery ratio remains constant. Figure shows the comparison of the packet delivery ratio of the existing and proposed systems. In the existing system, the packet delivery ratio drops at certain instants due to the inclusion of selfish nodes in the network which is prevented in the proposed system.

The throughput of the proposed system is graphically shown in the figure. The time is plotted in the x-axis while throughput is plotted in the y-axis. The graph increases linearly for most of the parts but at certain points it increases rapidly. The graph attains a maximum value of 10,00,000. The figure shows the comparison for throughput of the two systems. In the existing system also, the graph follows the same pattern as that of the modified system but the maximum attained value is only 40,000.

The comparison of the packet drop values also show that the modified system is far more advantageous than the existing system. From the graph, it can be shown that the packet drop is almost negligible for the modified system throughout the broadcasting process. The graph is plotted with time on x-axis while packet drop on the y-axis. The comparison of the two systems show that the packet drop values increase and decrease alternatively in the existing systems.The packet drop reaches the zero value only at some instants.At some instants, it reaches the maximum value of upto 62,000 packets which adversely affects the broadcasting process.

IX. Conclusions

In this paper, the capabilities of local broadcast algorithms in reducing the total number of transmissions that are required to achieve full delivery was investigated. As proven, local broadcast algorithms based on the static approach cannot guarantee a small sized CDS if the position information is not available. It was shown that having relative position information can greatly simplify the problem of reducing the total number of selected nodes using the static approach. In fact, it can be shown that a constant approximation factor is achievable using position information. But by using the dynamic approach, it was shown that a constant approximation is possible using (approximate) position information. This paper shows that local broadcast algorithms that are based on the dynamic approach do not require position information to guarantee a constant approximation factor.

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Digital Radio Technologies for Better Mobile Services

By P. Venkata Maheswara & K. Bhaskar Naik
Sree Vidyanikethan Engg. College, India

Abstract - Digital mobile communications is one of the great success stories of recent years, offering people levels of mobility and services never available before. The new 3G services will push mobile even further, opening up opportunities for true broadband mobile services. This is not the end of the road for mobile, however. On the contrary, we are still only at the beginning of the mobile revolution. Already the requirements for the next generation of mobile and wireless communications technology are emerging. Future systems must put user needs centre stage - seamlessly integrating the many different communication systems we see emerging today so as to deliver personalised enhanced services to users. In addition, they will require open interfaces and architectures to allow different players to inter-work and offer new services. Such an open approach will be essential for players to compete in a market where users are increasingly mobile and their requirements continually changing. Digital rights management and content management will also be important considerations.

Keywords : digital mobile communication, 3G services, mobile and wireless networks, winner.

GJCST-E Classification : C.2.1

DIGITAL RADIO TECHNOLOGIES FOR BETTER MOBILE SERVICES

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Digital Radio Technologies for Better Mobile Services

P. Venkata Maheswara α & K. Bhaskar Naik σ

Abstract - Digital mobile communications is one of the great success stories of recent years, offering people levels of mobility and services never available before. The new 3G services will push mobile even further, opening up opportunities for true broadband mobile services. This is not the end of the road for mobile, however. On the contrary, we are still only at the beginning of the mobile revolution. Already the requirements for the next generation of mobile and wireless communications technology are emerging. Future systems must put user needs centre stage - seamlessly integrating the many different communication systems we see emerging today so as to deliver personalised enhanced services to users. In addition, they will require open interfaces and architectures to allow different players to inter-work and offer new services. Such an open approach will be essential for players to compete in a market where users are increasingly mobile and their requirements continually changing. Digital rights management and content management will also be important considerations.

Future mobile and wireless networks will need to combine different access networks and technologies - satellite as well as terrestrial – and get them to work together so as to optimize different services requirements and operational conditions. This brings many new research challenges: in particular solving interoperability issues across multiple networks and a variety of connected devices. Improvements in radio access technologies being explored by WINNER will be crucial for enabling new mobile services and applications anytime and anywhere.

Keywords : digital mobile communication, 3G services, mobile and wireless networks, winner.

I. Introduction

Analogue Private Mobile Radio (PMR) has enjoyed great success in Europe for many years, and serves a very broad community of users. Available for both licensed and unlicensed spectrum use, PMR applications extend from low-cost walkie-talkies aimed at the consumer market through to public safety and mission-critical systems. A comparable technology known as Specialized Mobile Radio (SMR) exists in the United States. Changes to the professional environment have meant that the operational requirements placed on communication equipment have evolved, and the traditional analogue service is no longer able to meet the users' needs completely. A demand for more sophisticated services has raised a need for a technology enhancement and inevitably this has led to a redefinition of PMR based on digital technology.

The concept will comprise the optimized combination of the best component technologies, based on an analysis of the most promising technologies and concepts available or proposed within the research community. The initial development of technologies and their combination in the system concept will be further advanced towards future system realization. Compared to current and evolving mobile and wireless systems, the WINNER system concept will provide significant improvements in peak data rate, latency, mobile speed, spectrum efficiency, coverage, cost per bit and supported environments taking into account specified Quality-of-Service requirements.

The success of future mobile and wireless communications systems depends on meeting, or exceeding, the needs, requirements and interests of users and society as a whole. It seems likely that this will require an increase in spectral efficiency to allow high data rates and high user capacities far beyond those of second or third generation systems. Moreover, flexible resource allocation will play a key role in future mobile radio networks. In recent years, much research has been carried out in increasing the performance and efficiency of various air interface components like coding or detection. Also new air interface concepts based on either single carrier or multi-carrier transmission have been proposed which show promising performance results. To design the next generation mobile radio systems, a clear understanding of the requirements on these systems is necessary and a comprehensive overview of new air interface technologies is required to really choose between the best available technologies. These new and integrated radio access technologies are being addressed as part of IST's research for Mobile and Wireless Systems and Platforms Beyond 3G.The work aims to arrive at a consolidated European approach to technology, systems and services, including location based services, and contributions to standards. It also aims towards a clear European understanding of spectrum requirements and novel ways of optimizing spectrum usage for "systems beyond 3G".

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II. Experimental Details

a) Requirements for Future Radio Systems

Future mobile radio systems will have to meet exacting requirements. Data rate per user is expected to increase significantly, but could also vary substantially between the peak vs typical. With data traffic dominating over voice transmissions, the demands in data rate between downlink and uplink are becoming asymmetric. Quality of service – a complex parameter which can be defined in several ways – is of particular interest to mobile users. And with many future services likely to be location based, mechanisms will be necessary to derive the user's location or other context.

Although hidden from the user, one of the most important issues is the integration of packet-switched and IP-based traffic. Network operators have made significant investments in building IP core networks based on internet system architectures. Further efforts are needed to optimize these and ease the integration of fixed and wireless networks.

Frequency spectrum and bandwidth allocation will be important considerations. Radio spectrum is scarce, and therefore expensive and hence future systems will have to be very efficient in how they use the limited spectrum available. Alternative methods of spectral allocation and use could also be considered. The system must be able to dynamically change the allocated resources as users' requirements and available capacities change.

Particular attention should be paid to how the air interface might affect terminal, base station and other infrastructure costs. Also regulatory authorities are specifying mandatory limits for the maximum power consumption and radiation for both the base station and the mobile terminal.

b) WINNER Overview

The key objective of the WINNER project is to develop an innovative concept in radio access in order to address high flexibility and scalability with respect to data rates and radio environments. The future converged wireless world requires in the long-term perspective a ubiquitous radio system instead of disparate systems for different purposes (cellular, WLAN, short-range access etc.).

The vision of a ubiquitous radio system concept is providing wireless access for a wide range of services and applications across all environments, from short range to wide-area, with one single adaptive system concept for all envisaged radio environments. It will efficiently adapt to multiple scenarios by using different modes of a common technology basis.

The concept will comprise the optimized combination of the best component technologies, based on an analysis of the most promising technologies and concepts available or proposed within the research community. The initial development of technologies and their combination in the system concept will be further advanced towards future system realization.

Compared to current and evolving mobile and wireless systems, the WINNER system concept will provide significant improvements in peak data rate, latency, mobile speed, spectrum efficiency, coverage, cost per bit and supported environments taking into account specified Quality-of-Service requirements.

III. Objectives of Winner i to iii in a Phased Approach

The WINNER vision results in the overall objectives for all the WINNER Phases as follows:

- To develop a ubiquitous scalable radio access system based on common radio access technologies that will adapt to and be driven by different user needs and scenarios, by utilizing advanced and flexible network topologies, physical layer technologies and frequency sharing methods.
- To base the design of the WINNER I and II radio system on a horizontal integration for different radio environments and spectrum conditions in terms of frequency range and carrier bandwidth with respect to spectrum availability.
- To make efficient use of the radio spectrum in order to minimize the cost-per-bit by utilizing and combining the technologies researched within WINNER I and II in an efficient way.
- In recent years tremendous advances have been made in radio technology research. The design of new radio systems provides the unique opportunity to combine the best of the recent advances in order to maximize their benefits from the perspective of defining new and improved radio interfaces using a systematic investigation and development approach and to feed the results into the international standardization and regulatory process.

The combination of new technologies, which are mutually optimized, is the key for significant performance leap. The ubiquitous WINNER radio system will be realized through a phased approach (Figure 2-2), each Phase is characterized by a major milestone and a basic objective. These are described below. The expected duration of all Phases is six years. Each of the three Phases with a specific focus will has a duration of two years to allow an adaptation to actual developments in technology, international standardization, regulation and the political environment. This Annex I is addressing Phase II.

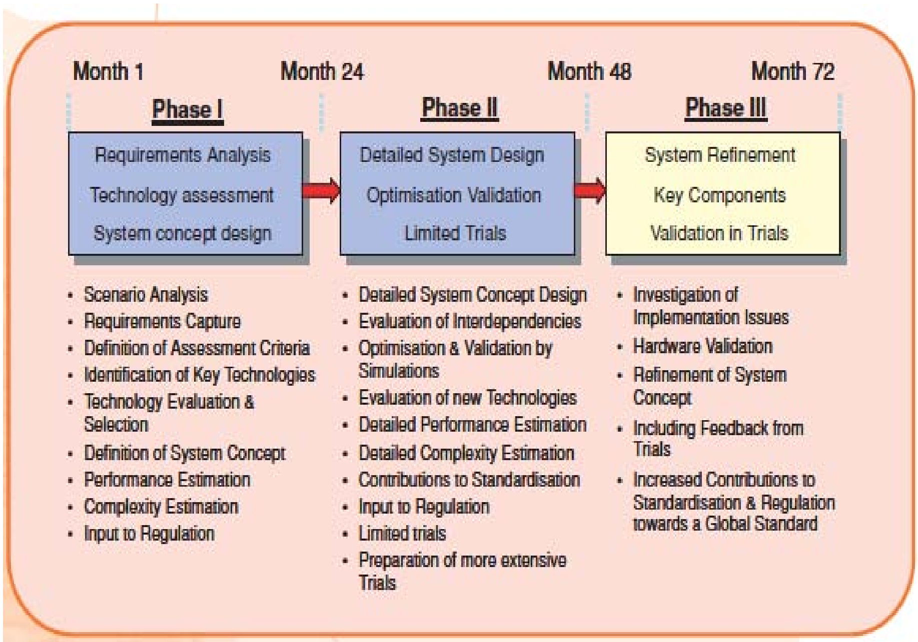

Figure 1 : Project Phases and major areas of activity

In Phase I a scenario analysis was performed to capture the user requirements. Additionally, a set of technical assessment criteria was defined, which will serve as a basis for the assessment of potential enabling technologies and the selection of the most promising ones, as well as the definition of suitable building blocks. From this assessment, a first concept for a ubiquitous system was defined with respect to the deployment and propagation conditions in the potential target frequency ranges, and its basic performance has been evaluated in Phase I.

Phase II is focused on the detailed system design, optimization, validation (through limited trials) and preparation of further trials in Phase III. This translates into the following WINNER II objectives:

G1- To design and optimize the new ubiquitous radio access system, whose parameters can be scaled or adapted to the requirements of a comprehensive range of mobile communication scenarios. From a coverage area point of view wide-area, metropolitan and short-range scenarios have to be supported. The radio access system should be capable of supporting variable bit rates, with peak data rates of up to approximately 100 Mb/s for medium to long-range heavy traffic areas with high mobility, and up to approximately 1 Gb/s for hot spots and short-range scenarios.

G2- To continue the identification and analysis of challenging user scenarios and corresponding usage scenarios in concordance with all WWI IPs based on WINNER I. To derive requirements for the WINNER II radio interface and to evaluate and refine the scenarios based on the evaluated radio interface performance and other external developments.

G3- To define the detailed radio interface technologies needed for the ubiquitous radio system concept, including the following items: adaptive transmission schemes, duplex schemes, multi antenna concepts, and enhanced radio protocols, including Medium Access Control (MAC)/ Radio Resource Management (RRM) protocols for multi antenna configurations in order to develop a system specification.

G4- To develop in detail radio network topologies and deployment concepts capable of providing a ubiquitous radio coverage area, for example by the use of fixed or mobile relays, feeder systems, ad-hoc networking. The definition includes the functionality and external interfaces of the different network elements, communication protocols for information exchange between them and Radio Resource Management (RRM) algorithms to assign the available radio resources to the corresponding elements. This will be part of the system specification.

G5- To define the detailed radio level cooperation mechanisms between different Radio Access Networks (RAN).The choice of mechanisms will include, but will not be limited to, handover between new RANs or between new and legacy ones, combined Radio Resource Management (RRM) and concurrent/ complementary use of different RANs. This will be part of the system specification.

G6- To investigate missing cases for the propagation conditions and to continue from WINNER I the development of related channel models including path loss, multipath propagation and direction of arrival models in the identified potential target frequency ranges.

G7- To define functionalities that implement efficient and flexible spectrum use and sharing as part of the system specification.

G8- To contribute to the international standardization and regulatory process – in particular to the development of the necessary reports and recommendations in ITU-R in the preparatory phase of WRC 2007 – and where appropriate to other international bodies, where WINNER II can provide technical input. One example might be the 3G evolution study item in 3GPP on special topics depending on the detailed work plan in 3GPP.

G9- To perform limited trials in Phase II in order to proof the concept of basic functionalities of the WINNER II system.

G10- To prepare the trial campaign in Phase III by the selection of the hardware and software platform of the trial system and preparatory activities towards the application of a frequency test license.

G11- To disseminate results via international conferences, reputable journals and the organization of workshops as part of a global harmonization process. WINNER III will be focused on system refinement, key components and validation in trials. Therefore, the following focus areas will be addressed in the following Phase III:

- Adaptation to external developments such as upcoming specification and standardization activities, e.g. after the potential identification of new spectrum in WRC 2007.
- Dissemination and external promotion of the WINNER II results and specifications in an international harmonization process as part of prestandardisation and standardization activities.
- Validation and proof of system in more extensive trials of key components in the intended Phase III.

IV. Achievements of Winner I

The overall objective of Phase I was to develop a system concept adaptable to meet a wide range of scenario requirements. This objective was achieved and a flexible system concept has been proposed based on the combined results from activities mainly conducted within the following five principal areas:

- Definition of Requirements: The WINNER I system concept is user centric. To reflect this system concept, requirements defining the overall design and performance goals of the WINNER II air interface and radio access network were defined based on both technical and user oriented system requirements. The former type of requirements were based on physical limitations and the anticipated state-of-the-art performance of systems beyond IMT-2000 whereas the latter type of requirements were derived based on fundamental results obtained from user scenario analysis.
- Significant contributions to the international regulatory process: WINNER I has contributed significantly to the work of ITU-R WP8F. It has covered the development of the ITU-R methodology for estimating the spectrum requirements for systems beyond IMT-2000 and significant work on Radio Aspects. For example during WINNER I the WP6 has prepared and submitted total over 60 regulatory contributions to ECC PT1, ECC TG3 and ITU-R WP8F meetings. All contributions submitted to PT1 were agreed with minor modifications by PT1 and they became agreed European contributions to ITU. The contributions to the ITU were very successful: a major25 part of the current ITU-R WP8F methodology working document and the Tool based on the methodology and intended for doing the actual calculations both originates from WINNER I. In the Draft ITU-R WP8F Radio Aspects report major content such as the list of required radio parameters, most of their values and the view about the preferred frequency range including it's justifications originate from WINNER I.
- Identification of key technologies and system concept design: The WINNER I system concept is based on state-of-the-art technologies and procedures. Such technologies and procedures have been identified within several key areas such as advanced radio-link technologies, duplex arrangements, multiple access schemes, advanced beam forming and MIMO technologies and methods for enhanced radio protocols. Based on the Modes Convergence Manager the Modes Convergence Reference Model has been established as a concept to represent any scenario specific WINNER I protocol stack and also to handle the problem how to switch between different stacks. A concept on how to mesh base stations and fixed relay stations into an existent cellular system in a plug and play manner has also been developed. Furthermore, a framework for cooperation architectures between WINNER I RAN and legacy RANs, including the cooperation architecture entities and the mapping of the cooperation functionalities (mobility management, admission control, location based handover, scheduling / load control and QoS management) in these new entities has been defined. As spin-off of the activities in this area, a large number of scientific papers has been prepared and submitted to international conferences and magazines.
- Assessment of key technologies and system concept proposals: The justification of identified and selected key technologies and system concept components was a central activity in Phase I. Such assessments were conducted both on the link and system levels as well as on the network levels. To

support those activities different channel models were developed. Initially channel models based on existing models were selected and adapted for early assessment use. In parallel, acquisition of measurement data for diverse outdoor and indoor environments at both 2 GHz and 5 GHz frequency ranges considering an RF bandwidth of 100 MHz were conducted in order to provide wide-band channel models for final assessment use.

- Feasibility studies: The implications of the technology concepts chosen for the WINNER I system concept have been studied in terms of feasibility and complexity. The feasibility of multiband width transmission was verified. It has also been established that fixed (L1/L2/L3) relays are useful in both, short-range/hot area and wide-area scenarios to increase the capacity of a radio cell substantially as well as to increase the range of coverage of a base station substantially. Moreover, sharing, co-existence and flexible spectrum use have also been studied and analyzed extensively and suitable ways how to employ by the WINNER I system concept to improve the overall spectrum efficiency, ease the possible spectrum identification and deployment of the networks has been proposed.

V. Conclusion

Future systems must put user needs centre stage - seamlessly integrating the many different communication systems we see emerging today so as to deliver personalized enhanced services to users. In addition, they will require open interfaces and architectures to allow different players to inter-work and offer new services. Such an open approach will be essential for players to compete in a market where users are increasingly mobile and their requirements continually changing. Digital rights management and content management will also be important considerations.

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Designing and Analysis of T-Shape Microstrip Antenna for the 4G Systems

By Amit Kumar & Sanjay Singh

Abstract - In this paper, the designing and analysis of T-shape microstrip patch antenna presented. The shape will provide the broad bandwidth which is required for the operation of fourth generation wireless systems. The operating frequency of antenna is 2.5 GHz, the dielectric constant and thickness of the antenna is 4.2, 1.6mm respectively. The simulation results of antenna are done by the help of IE3D Zeland Software (Version 12.0) and MATLAB programming. For the analysis of antenna we used the popular Finite difference time domain method (FDTD). This antenna is fed by a co-axial probe feeding. In this paper, the effects of different types of antenna parameters like return loss, voltage standing wave ratio (VSWR), impedance etc. are also studied.

Keywords : microstrip antenna, 4G system, FDTD, return loss, VSWR.

GJCST-E Classification : C.2.1

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Amit Kumar [α] & Sanjay Singh [σ]

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Keywords : microstrip antenna, 4G system, FDTD, return loss, VSWR.

I. Introduction

The MSA in 1953 [1] and practical antennas were developed by Munson [2, 3] and Howell [4] in the 1970s. The numerous advantages of MSA, such as its low weight, small volume, and ease of fabrication using printed-circuit technology, led to the design of several configurations for various applications [5–9]. With increasing requirements for personal and mobile communications, the demand for smaller and low-profile antennas has brought the MSA to the forefront. An MSA in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The T-shape of microstrip patch antenna as shown in Figure 1. However, other shapes, such as the square, circular, triangular, semicircular, and annular ring shapes etc. In this paper, we present a designing of T-shaped microstrip patch antenna and show the results for return losses operating at different frequencies. The dielectric constant (ε_r=4.2) of the dielectric substrate and thickness of the substrate h=1.6 mm.

II. Designing Of T-Shape Microstrip Patch Antenna

The Figure 1. Shows the T-shaped microstrip patch antenna. The T-shaped microstrip patch antenna is simpler in construction. The geometry is shown in figure 2.

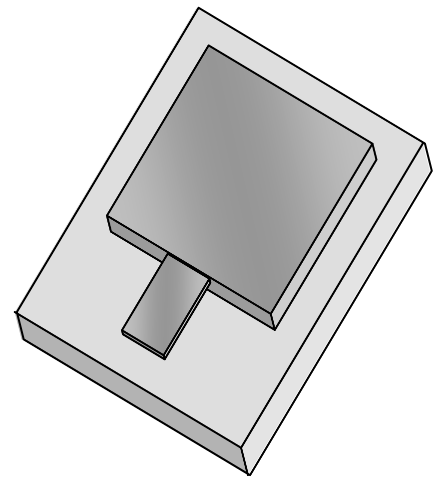

Figure 1 : T-shaped of microstrip antenna

The T-shaped microstrip patch antenna has width (w) and length (L). Outer patch strip width is w_1. The patch is fed at position p0 by a coaxial probe. The dielectric substrate materials are used for fabrication of antenna element. Designing of the T-shaped microstrip patch antenna as shown in Figure 2. The designing of T-shaped microstrip patch antenna the resonant frequency f_r 2.5 GHz and the dielectric substrate is used for the design the T-shaped of microstrip patch antenna. The dielectric constant of the substrate is ε_r = 4.2 and thickness (h) of the substrate h= 1.6 mm to design the T-shaped microstrip patch antenna.

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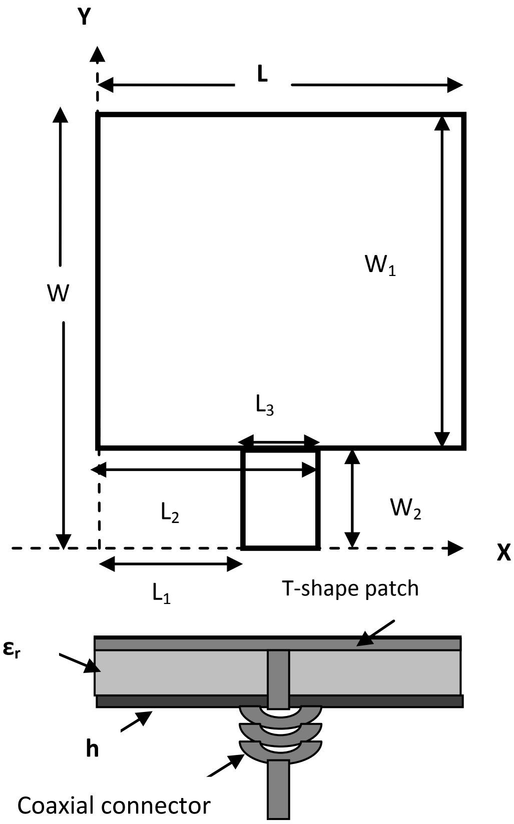

Figure 2 : Geometry of the T-shaped microstrip patch antenna

The width and length of the microstrip antenna are determine as follows

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r + 1}} = \frac{v_0}{2 f_r} \sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

Where v_o is the free-space velocity of light.

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[1 + 12 \frac{h}{W} \right]^{-1/2} \qquad (2)$$

Where the dimensions of the patch along its length have been extended on each end by a distance *ΔL*, which is a function of the effective dielectric constant ε_{reff} and the width-to-height ratio (*W/h*), and the normalized extension of the length, is

$$\Delta L = h\, 0.412 \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad (3)$$

The actual length of the patch (L) can be determine as

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \qquad (4)$$

The designing of the microstrip patch antenna by the used of IE3D electromagnetic three dimensional simulators and MATLAB programming. The dimensions of the T-shaped microstrip patch antenna parameters as shown in table 1.

Table 1 : Dimension of the optimization antenna parameters

Frequency fr	2.5 GHz
W	37.21
W_1	27.21
W_2	10
L	28.89
L_1	12
L_2	16.89
L_3	4.89
Dielectric constant ε_r	4.2
Thickness of the substrate h	1.6

III. Analysis of Antenna using FDTD Method

The basic FDTD space grid and time-stepping algorithm trace back to a seminal 1966 paper by Kane Yee in IEEE Transactions on Antennas and Propagation (Yee 1966). The descriptor "Finite-difference time domain" and its corresponding "FDTD" acronym were originated by Allen Taflove in a 1980 paper in IEEE Transactions on Electromagnetic Compatibility (Taflove 1980). The FDTD method has been used for the analysis for the probe-fed microstrip patch antennas and can indeed yield very accurate highly result. The FDTD method uses Maxwell's equations which define the propagation of an electromagnetic wave and the relationship between electric and magnetic field, these are

$$\mu \frac{\delta H}{\delta t} = -\nabla \times E \qquad (5)$$

$$\varepsilon \frac{\delta E}{\delta t} + J = \nabla \times H \qquad (6)$$

$$\nabla \cdot E = \frac{\rho}{\varepsilon} \qquad (7)$$

$$\nabla \cdot H = 0 \qquad (8)$$

By applying appropriate boundary conditions on sources, conductors and mesh walls an approximate solution of these educations can be find over a finite three-dimensional domain. The equation in the *i* direction gives:

$$\mu \frac{\Delta H_x}{\Delta t} = \frac{\Delta E_Y}{\Delta Z} - \frac{\Delta E_Z}{\Delta y} \qquad (9)$$

The maximum time step that may be used is limited by the stability restriction of the finite difference equations. This is given by

$$\Delta t \le \frac{1}{c}\left[\frac{1}{\Delta x^2}+\frac{1}{\Delta y^2}+\frac{1}{\Delta z^2}\right]^{\frac{1}{2}} \qquad (10)$$

Where c is the speed of light (300 000 000 $m.s^{-1}$) and Δx, Δy and Δz are the dimensions of the unit element.

IV. Results

The simulated results of the return loss, VSWR, and Radiation pattern of E and H plane as shown in fig 3 (a) (b) and (c).The return loss is -13.63 dB, VSWR 1.562, and the bandwidth of the antenna is 123 MHz at the 2.5 GHz resonant frequency. The result of the return loss (-16.78 dB) by using MATLAB programming as shown in Figure 4. The results of the T-shape microstrip patch antenna as shown in Table 2 Simulation results using IE3D and MATLAB programming.

Table 2 : Simulation results using IE3D and MATLAB programming

S.No.	Parameters	Results	Software
1	Return loss 1	-13.63 dB	IE3D
2	VSWR	1.562	IE3D
3	Return loss 2	-16.78	MATLAB
4	Bandwidth	123MHz	Theoretical

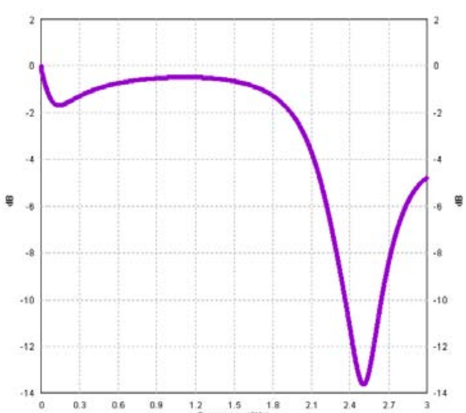

Figure 3(a)

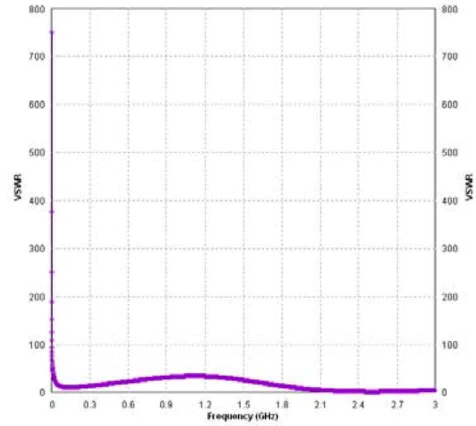

Figure 3(b)

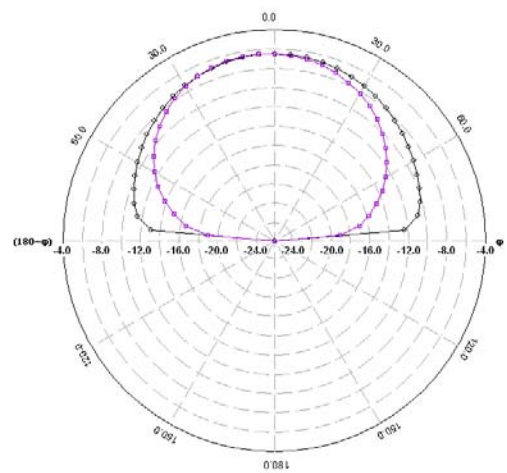

Figure 3(c)

Figure 3 : (a) & (b) Simulation results of return loss and VSWR using IE3D software & (c) Radiation pattern of E and H plane at operating frequency 2.5 GHz

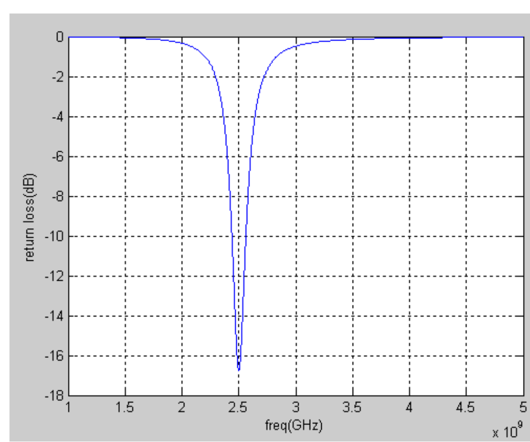

Figure 4 : Simulation results of return loss operating frequency 2.5 GHz using Matlab programming

In 4G systems, or any microstrip antenna the frequency range is 2.4-2.5 GHz and VSWR range is 1.2-1.7 required. Hence, this antenna is best suited for 4G systems.

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Cooperative Caching Framework for Mobile Cloud Computing

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Abstract - Due to the advancement in mobile devices and wireless networks mobile cloud computing, which combines mobile computing and cloud computing has gained momentum since 2009. The characteristics of mobile devices and wireless network makes the implementation of mobile cloud computing more complicated than for fixed clouds. This section lists some of the major issues in Mobile Cloud Computing. One of the key issues in mobile cloud computing is the end to end delay in servicing a request. Data caching is one of the techniques widely used in wired and wireless networks to improve data access efficiency. In this paper we explore the possibility of a cooperative caching approach to enhance data access efficiency in mobile cloud computing. The proposed approach is based on cloudlets, one of the architecture designed for mobile cloud computing.

Keywords : mobile cloud computing, cooperative cache, cloudlet.

GJCST-E Classification : C.2.4

COOPERATIVE CACHING FRAMEWORK FOR MOBILE CLOUD COMPUTING

Strictly as per the compliance and regulations of:

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I. Introduction

Mobile cloud computing has received large interest recently as it allows storage and processing of data outside the mobile device. It has a growing popularity due to the proliferation of smart phones which act as mini PCs. The limitations of the mobile device such as smaller size, low battery life and other features can be overcome by offloading the processing and storage to a cloud. The offloading can happen to a remote data center, nearby computer or cluster of computers, or even to nearby mobile devices. Cloud computing is a frame work for sharing resources, information and software capabilities to different mobile devices. The resources will be available on the cloud and can be shared by the devices on demand. In mobile cloud computing environment the client can use the cloud to back up data in the mobile devices. Generally, there are two approaches to realize mobile cloud computing namely General Purpose Mobile Cloud Computing (GPMCC) and an Application Specific Mobile Cloud Computing (ASMCC) [5]. GPMCC is utilizing the internet by the mobile devices to use the computing resources of remote computers without any applications specifically developed for this purpose. In ASMCC, specific applications are developed for mobile devices to use the cloud computing facility. Mobile Service Clouds proposed in [1] is a cloud service which uses ASMCC approach for the deployment of autonomic communication services. In [4], mobile cloud computing is broadly classified in into two, those which use mobile devices as thin clients, offloading computation to cloud resources on the internet and the one using mobile devices as computational and storage nodes as a part of cloud computing infrastructure.

Although mobile devices have improved much in processing speed, memory and operating systems, they still have some serious drawbacks. The major challenge for a mobile device in cloud computing is the data transfer bottle neck. Battery is the major source of energy for these devices and the development of battery technology has not been able to match the power requirements of increasing resource demand. The average time between charges for mobile phone users is likely to fall by 4.8% per year in the near future [2]. As the cloud grows in popularity and size, infrastructure scalability becomes an issue. Without scalability solution, the growth will result in excessively high network load and unacceptable service response time.

Data caching is widely used in wired and wireless networks to improve data access efficiency, by reducing the waiting time or latency experienced by the end users. A cache is a temporary storage of data likely to be used again. Caching succeeds in the area of computing because access patterns in typical computer applications exhibits locality of reference [3]. Caching is effective in reducing bandwidth demand and network latencies. In wireless mobile network, holding frequently accessed data items in a mobile node's local storage can reduce network traffic, response time and server load. To have the full benefits of caching, the neighbor nodes can cooperate and serve each other's misses, thus further reducing the wireless traffic. This process is called cooperative caching. Since the nodes can make use of the objects stored in another node's cache the effective cache size is increased. In this paper we discuss a cooperative cache based data access frame work for mobile cloud computing. The proposed approach uses the cloudlet architecture presented by M. Satyanarayanan [7].

The rest of the paper is organized as follows. Section 2 overviews the mobile cloud architecture, section 3 briefs the applications of mobile cloud computing , section 4 presents the limitations of mobile cloud computing, section 5 explains the cloudlet architecture, section 6 details the proposed cooperative cache architecture and section 7 discusses the

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possibility of exploring caches in other mobile cloud architecture, section 8 concludes the paper.

II. Mobile Cloud Architecture

The general architecture of MCC is shown in Fig 1. The mobile clients are connected to the internet via base stations, access points or by a satellite link. The shared pool of resources in mobile cloud computing are virtualized and assigned to a group of distributed servers managed by the cloud services. The cloud services are generally classified based on a layered concept [6].The frame work is divided in to three layers, Infrastructure as a Service (IaaS), Platform as Service (PaaS) and Software as a Service (SaaS).

Infrastructure as a Service (IaaS) : IaaS includes the resources of computing and storage. It provides storage, hardware, servers and networking components to the user. The examples of IaaS are Elastic Cloud of Amazon and S3 (Simple Storage Service).

Platform as a Service (PaaS): Paas provides an environment of parallel programming design, testing and deploying custom applications. The typical services are Google App engine and Amazon Map Reduce/Simple Storage Service.

Software as Service (SaaS): SaaS provides some software and applications which the users can access via Internet and is paid according to the usage. Google online office is an example for SaaS.

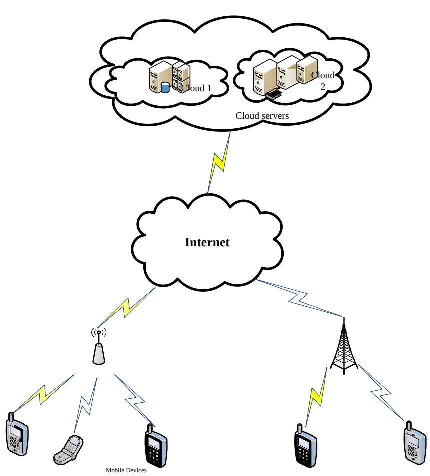

Figure 1 : Mobile Cloud Computing Architecture

III. Applications of Mobile Cloud Computing

Mobile cloud applications move the resource intensive applications and storage away from mobile phones so that the mobile applications are not constrained to certain kind of mobile devices. This helps to overcome the storage capacity and computing power constraints of mobile devices. Mobile cloud computing paradigm is an attractive option for many areas like business, mobile image processing and for computing intensive applications like speech recognition, machine learning augmented reality etc. The typical applications of mobile cloud computing includes Mobile Commerce, Mobile Learning, Mobile Healthcare, Mobile Gaming and other practical applications like social networking, showing maps, storing images and video[6].

IV. Major Issues in Mobile Cloud Computing

The key elements in a mobile cloud computing approach are: mobile devices, networks through which the devices communicate with the cloud and mobile applications. The major challenge in cloud computing comes from the characters of the first two elements, mobile devices and wireless network .This makes the implementation of mobile cloud computing more complicated than for fixed clouds. This section lists the major issues in Mobile Cloud Computing.

Limitations of the Mobile devices: Compared to personal computers mobile devices have limited storage capacity, poor display, less computational power and energy resource. Although smart phones have improved a lot, they still have battery power constraint.

Network Bandwidth and Latency: As the mobile cloud computing uses wireless networks for data transfer bandwidth is a major issue compared to wired networks which uses a physical connection to ensure bandwidth consistency. Furthermore, the cloud services may be located far away from mobile users, which in turn increase the network latency.

Heterogeneity: Heterogeneity in mobile cloud computing comes from two sources: mobile devices and mobile networks. There is a wide range of mobile devices used by the group of people sharing the network. The operating system and the application software used by these devices vary which cause a major issue in the interoperability of the devices. Another area is the different radio technologies used for accessing the cloud. This will lead to changes in bandwidth and network overlay.

Service Availability: Availability of service is an important issue in mobile cloud computing. Mobile clients may not be able to connect to the cloud due to traffic congestion, network failures and out of signal.

Privacy and Security: Offloading computation and storage to cloud pose security and trust issues. The cloud services are vulnerable and the mobile clients may lose their data if the services fail due to some technical issues.

V. Cloudlet Architecture

One of the key issues in mobile cloud computing is the end to end delay occurring in servicing a request. Since the cloud services and resources in Internet service provider is distant from the mobile clients network latency is increased. Satyanarayanan

(2009) proposed an architecture for mobile cloud computing called Cloudlet, to reduce the bandwidth induced delay between devices and cloud. A cloudlet is a set of computers connected to the internet and is accessed by the nearby mobile devices using a Wi-Fi or WLAN. In this architecture the mobile devices act as a thin client and all the computations occur in the cloudlet. Fig 2 shows cloudlet architecture. The basic idea of this approach is to reduce the distance between the mobile users and cloud services. By this architecture mobile users can access the cloudlet which is one hop away, thus reduces bandwidth utilization and efficiency.

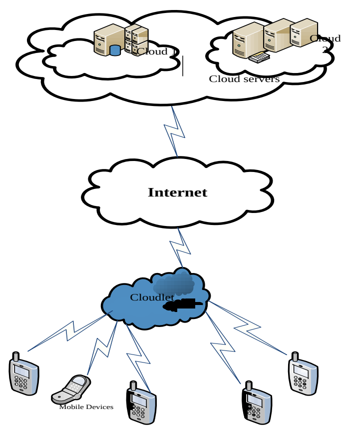

Figure 2 : Mobile Cloudlet Architecture

To overcome the challenges of mobile devices, parts of computation and data storage is migrated to resource providers outside the mobile device. Offloading transfers the information needed for processing and storage to a remote server which will complete the computation task and send the results back to the mobile client. The different offloading techniques currently available are client server communication, virtualization and mobile agents [20].

Cloudlet architecture reduces the gap between the mobile devices and remote servers by offloading its workload to a local cloudlet with connectivity to remote cloud servers. Offloading in cloudlet infrastructure is based on a Virtual Machine (VM) technology. To create a transient client software environment cloudlet uses dynamic VM synthesis. In this approach the mobile device transmits a small VM overlay to the cloudlet and applies it to a compatible base VM to generate the Launch VM. Launch VM is the virtual environment temporarily created for a mobile client to execute the task. After execution results are given back to the mobile client. The cloudlet infrastructure is restored to its previous state after each execution.

The performance of cloudlet depends mainly on two factors. Overlay transmission time and overlay synthesis. Overlay transmission time can be improved by using a higher bandwidth wireless network. The different techniques proposed in [7] includes partitioning the overlay in to different chunks that can be executed in parallel, caching and prefetching and pipelining i.e. pipelining the overlay execution with transmission. In this paper we discuss a cooperative cache design for the cloudlet architecture.

VI. Proposed Approach

Mobile cloud computing has found wide applications in many areas like speech synthesis, natural language processing, image processing, augmented reality, information sharing ,information searching , social networking, etc. While many applications like information sharing or social networking are not dependent on the speed of processing, some computation intensive applications like augmented reality, image processing demand high level of responsiveness. Cooperative caching tries to improve the response time by reducing VM synthesis time by caching previous states. If the users that use cloud services have similar interest, cooperative caching increases the response time considerably. A language translator is an interesting application, which we could look into. This is a useful tool for foreign travelers. Using mobile cloud computing, different words, sentences or paragraphs can be independently processed in the cloud. Commonly used words or sentences will be available in the local cache, which can be accessed faster during subsequent searches, thereby improving the responsiveness of the system.

Cooperative caching consists of multiple distributed caches to improve system response time. Having distributed caches permits a system to deal with concurrent client request as well as sharing contents. We can also reduce response time by concurrently retrieving objects from different cache sites. Concurrent retrieval of objects from different cache sites is beneficial as opposed to the remote cloud server which will result in latency and bandwidth issues.

In cloudlet, when a mobile client requests for a cloud service, the network searches for data in the local cloud. If the service is not available, the users should contact a distinct cloud which involves network transfers and latency. If we are able to cache different VM synthesis states, the users can get the service from cache. When the object is not present in the cache, request is given to the base layer to get the corresponding launch VM. If t the corresponding base h VM is not present, we have to contact distant cloud for the service. Thus data caching also increases battery life in mobile devices by reducing wireless communication.

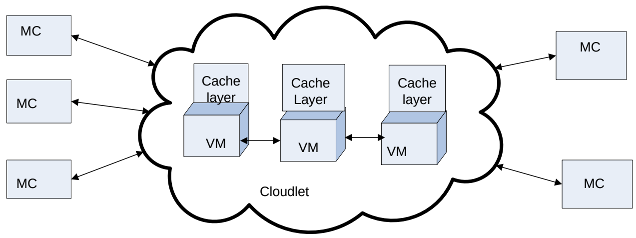

Figure 3 : Cooperative Cache Framework

VII. Cache Deployment Options

There are two main cache deployment options: those which are deployed in the strategic points in cloudlet based on user access pattern and those which are deployed between the cloudlets. In this paper we consider the first option, deploying cache in different points (virtual machines) in the cloudlet. Fig. 3 shows the cooperative cache frame work for cloudlet architecture. The cloudlet consists of virtual machines which are temporary customization of software environment for each client for their use. The virtual machines separate the transient client software environment from the permanent host software environment. A local cache can reduce virtual machine's synthesis delay by caching virtual machine states that are likely be used again. In a cloudlet we can have more than one virtual machine with a local cache. If we are able to share the cache states, availability and accessibility of different states can be improved. Fig.4 shows the different components of cache layer.

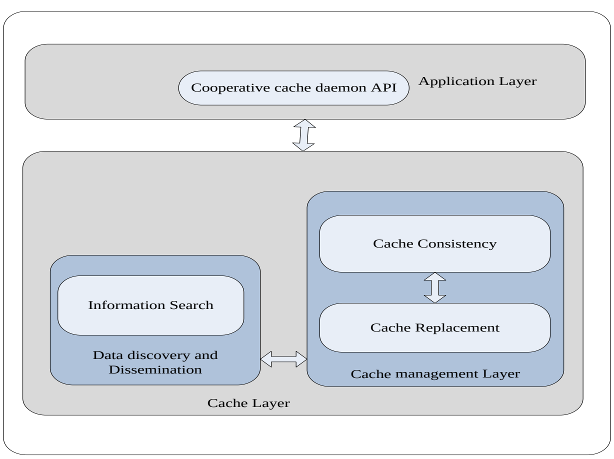

Figure 4 : Different components of cache layer

The cooperative cache daemon API acts as an interface between the application layer and the cache layer. The core system consists of two modules: data discovery and dissemination and the cache management. The information search module in the data discovery and dissemination layer locates and fetches the required object from the cache module. The cache management layer includes the cache replacement and consistency modules. Cache consistency module is designed to be configurable to maintain data synchronization with the original data. The cache replacement module handles the replacement of objects when the cache is full.

The efficiency of a distributed cache depends on three services, discovery, dissemination and delivery of objects. Discovery refers to how the clients locate the cached object. Dissemination is the process of selecting and storing objects in the cache i.e., deciding the objects to be cached, where they are cached and when they are cached. Delivery defines how the objects make their way from the server or cache site to the client. A query based or directory based approach can be used for information discovery. Dissemination may be either client initiated or server initiated. In client initiated dissemination, the client determines what, when and where to cache. The advantage of this scheme is that it automatically adapts to the rapidly changing request pattern. In server initiated dissemination the server chooses the object to be cached. Here the server can maintain a historical data to make the dissemination decision. This approach can provide strong consistency compared to client driven approach. For the proposed approach as the mobile devices act as thin client dissemination decision can be taken by the cloudlet. Another issue we must look into is how to replace the objects from the cache when it is full. A number of cache replacement policies are proposed in literature for wired and wireless networks. The important factors that can influence the replacement process are access probability, recency of request for a data item, number of requests to a data item, size, cost of fetching data from server, modification time, expiration time, distance etc. Based on these parameters we can propose different cache replacement policies suitable for mobile cloud computing. Cooperative caching achieves high hit rates and low response time only if caches are distributed, cache sharing is wide spread and discovery overhead is low.

VIII. Discussion

Compared with traditional cloud computing mobile cloud computing poses a challenge in the way mobile device access data stored in the cloud. This is due to the inherent challenges of mobile computing such as low bandwidth, mobility, limited storage and battery life. In mobile cloud, user's location is not fixed and the bandwidth provided will also vary for same data access. Having caches closer in proximity to certain group of users is an effective way to reduce average network latencies since there is a correlation between the location of the user and the object requested.

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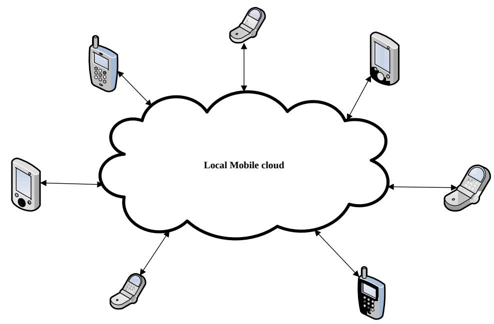

Figure 5 : Virtual resource cloud of mobile devices

In this paper we have presented a cooperative caching framework for a cloudlet based mobile cloud computing architecture. The purpose of cloudlet is to reduce the distance between cloud services and mobile devices because when the distance is increased the end to end user delay is also increased, which may not be feasible for some applications. Cloudlet is a middle tier introduced in between the mobile devices and distant cloud services to reduce network latency for the mobile users. By incorporating distributed caches which cooperates each other, we can reduce data traffic and latency considerably. Apart from the caching model discussed for cloudlet architecture, distributed caches can be used in other mobile cloud computing architectures.

Mobicloud [20] is a cloud computing technology proposed for mobile ad hoc networks. In this architecture each mobile node is considered as a service node that can be used as a service provider or service broker depending on its computation and communication capabilities. Every service node is incorporated in to the cloud as a virtualized component and is mirrored in the cloud. As the applications mobile ad hoc networks are targeted for users having similar interest, cooperative caching can be effectively used in this type of networks. Hyrax proposed in [8] considers mobile devices as resource providers of cloud service making up a wireless peer to peer network. The collection of mobile devices that are within the vicinity collaborate each other to form a mobile cloud as shown in Fig 5. In this architecture distributed caches can be used to store data and computational results.

IX. Conclusions

Mobile cloud computing is a very promising approach for mobile devices. It enables the mobile device to act as thin clients by offloading the computation and processing overhead to cloud servers. Several architectures are proposed in literature for this. The full potential of both cloud computing and mobile applications have not been realized yet. Many deployment challenges have to be addressed before making this a reality. The cooperative caching approach introduced in this paper addresses some key issues in mobile cloud computing .We expect that the challenges posed in implementing our proposal shall be taken up for future studies.

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Analyse the Performance of Moblie Peer to Peer Network using Ant Colony Optimization

By S.J.K. Jagadeesh Kumar & R. Saraswathi

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Abstract - A mobile peer-to-peer computer network is the one in which each computer in the network can act as a client or server for the other computers in the network. The communication process among the nodes in the mobile peer to peer network requires more no of messages. Due to this large number of messages passing, propose an interconnection structure called distributed Spanning Tree (DST) and it improves the efficiency of the mobile peer to peer network. The proposed method improves the data availability and consistency across the entire network and also reduces the data latency and the required number of message passes for any specific application in the network. Further to enhance the effectiveness of the proposed system, the DST network is optimized with the Ant Colony Optimization method. It gives the optimal solution of the DST method and increased availability, enhanced consistency and scalability of the network. The simulation results shows that reduces the number of message sent for any specific application and average delay and increases the packet delivery ratio in the network.

Keywords : mobile peer to peer network, distributed spanning tree, global replica management, ACO, LRM, ORCS.

GJCST-E Classification : C.2.4

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S.J.K. Jagadeesh Kumar [α] & R. Saraswathi [σ]

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Keywords : mobile peer to peer network, distributed spanning tree, global replica management, ACO, LRM, ORCS.

I. Introduction

a) Mobile Peer to Peer Network

In a mobile P2P network, the mobile nodes are connected in mesh network within their communication range. Files can be shared directly between systems on the network without the need of a central server. The communication among the mobile nodes is to be carried in multi-hop fashion due to the design considerations such as radio power limitation and channel utilization. Any communication with external networks is performed through the AP which consumes relatively more time. In a mobile P2P network, the "peers" are computer systems which are connected to each other via the Internet.

A Mobile P2P network is composed of mobile hosts that are free to move around randomly, and to organize and collaborate together to share information among themselves. Files can be shared directly between systems on the network without the need of a central server. In other words, the P2P network is called a distributed structure if the participants share a part of their own resources. These shared resources are necessary to provide the service offered by the network. The participants of such a network are both resource providers and resource consumers. The P2P network has the following characteristics:

- All nodes are both clients and servers.
- Provide and consume data.
- Any node can initiate a connection.
- No centralized data source.
- Nodes contribute content, storage, memory, CPU.
- Nodes are autonomous (no administrative authority).
- Network is dynamic: nodes enter and leave the network "frequently".
- Nodes collaborate directly with each other.
- Nodes have widely varying capabilities.

The various benefits of P2P network has the efficient use of resources, scalability, reliability, ease of administration, Anonymity, Highly dynamic environment and Ad-hoc communication and collaboration. The various P2P applications are File sharing, Multiplayer games, Collaborative applications, Distributed computation and Ad-hoc networks. The various Challenges of the P2P network are Decentralization, Scalability, Performance, Anonymity, Fairness, Dynamism, Security, Transparency, Fault Resilience and Robustness.

b) Distributed Spanning Tree

The distributed spanning tree (DST) is an overlay structure designed to be scalable. It supports the growth from a small number of nodes to a large one. The DST is a tree without bottlenecks which automatically balances the load between its nodes. The DST breaks the common assumption that a tree is build of leaves and intermediate nodes. In a DST every nodes are equal. The nodes are put together into small cliques. Then, the cliques are put together into small cliques of higher level recursively. The cliques are represented in each node by a routing table. The memory space complexity of the routing tables is O(log(n)) for a n nodes DST.

The section 2 describes the related work and section 3 describes the proposed system and section 4 describes the simulation scenario and section 5 describes the conclusion of the work.

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c) Ant Colony Optimization

In computer science and operations research, the ant colony optimization algorithm (ACO) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. This algorithm is a member of the ant colony algorithms family, in swarm intelligence methods, and it constitutes some metaheuristic optimizations. Initially proposed by Marco Dorigo in 1992 in his PhD thesis, the first algorithm was aiming to search for an optimal path in a graph, based on the behaviour of ants seeking a path between their colony and a source of food. The original idea has since diversified to solve a wider class of numerical problems, and as a result, several problems have emerged, drawing on various aspects of the behaviour of ants.

II. Related Work

In [6], Takahiro Hara proposed new consistency maintenance based on local conditions such as location and time need to be investigated. It attempts to classify different consistency levels according to requirements from applications and provides protocols to realize them. In [8], Ren Xun-yil et al proposed a consistency technique based on a replica clustering coefficient to classify replica nodes into multi-levels. Replica consistency has been maintained in which the updating of the data item is performed at first-level replica nodes initially and then it is propagated to the next level of nodes in sequence. Though efficiency is proved in terms of response time and the number of message passes required. In [9], Chun-Pin et al propose a Dynamic Maintenance Service to maintain the data in gird environment. The Bandwidth Hierarchy based Replication algorithm was proposed to maintain the replica dynamically in grid environment. In [9],Chao-Tung et al proposed a One-way Replica Consistency Service (ORCS) for grid environment to resolve the consistency maintenance issues and also balancing the tradeoff between the improving data Access performance and replica consistency.

In [11] Sang-Min Park proposed a novel dynamic replication strategy; called BHR (Bandwidth Hierarchy based Replication). It tries to maximize locality of file to reduce data access time. However, grid sites may be able to hold only small portion of overall amount of data since very large quantity of data is produced in data grid and the storage space in a site is limited. Therefore, effect from this locality is limited to a certain degree. BHR strategy takes benefit from other form of locality, called network-level locality. In [12], Haiying Shen propose an Integrated file Replication and consistency Maintenance mechanism (IRM) that integrates the two techniques in a systematic and harmonized manner. It achieves high efficiency in file replication and consistency maintenance at a significantly low cost. Instead of passively accepting replicas and updates, each node determines file replication and update polling by dynamically adapting to time-varying file query and update rates, which avoids unnecessary file replications and updates. It dramatically reduces overhead and yields significant improvements on the efficiency of both file replication and consistency maintenance approaches. In [15], Xin Sun et al proposed a bidirectional linked list based replica location service to provide a global replica view for supporting the replica management to realize a replica selection strategy and optimal replication strategy on tree-based hierarchical unstructured overlay network.

In [16], Jun Zheng et al proposed a dynamic minimum access cost based replication strategy called MAC replication strategy. It takes into account the access frequency, the status of the network connection and average response time. It calculates an appropriate site to replicate for better shortening the response time of the data source. In [17], Wanlei et al propose the Hybrid Replica Control protocol that attempts to maximize the data availability and communication overhead. In [18], Feras et al propose a Constrained Fast Spread (CFS) method to alleviate the main problems encountered in the current replication techniques and mainly concentrating on the feasibility of replicating the requested replica on each node among the network. In [19] Baskaran et al proposed a GRM in a tree structured P2P network to preserve the replica consistency through the network and reduce the traffic in the network. In [20], Sylvain Dahan et al proposed a Distributed Spanning Tree structure and it is designed to support scalable searches and traversal algorithms. The DST based searches generates less messages to send the query and avoids tree bottleneck. In [21], Sylvain Dahan et al proposed a distributed Spanning tree Structure for large scale environment. This method achieves load balancing and Fault Tolerance in the network. In [22],Xin sun et al proposed the bidirectional linked list based replica location service (BLL-RLS) on tree-based hierarchical unstructured overlay networks, including the deployment of replica location service and the design of the bidirectional linked list based replica catalog. Based on the bidirectional linked list based replica catalog, replica location and selection algorithm is also proposed.

a) Drawbacks

- The Existing methods suffers from, huge number of messages sent or a higher volume of computations.
- Space complexity is very high.
- Communication overhead is high.
- When increasing the number of nodes in the network, the Consistency maintenance yields poor efficiency.

III. Proposed System

In a mobile peer to peer network, each node has to exchange information and services directly with each other without any dedicated intermittent. So it develops bottlenecks in the network due to the huge volume of messages being exchanged. This could be avoided to optimize the number of messages across the network. In this paper, a distributed spanning tree approach is proposed. The proposed system consists of the following steps:

- Formation of mobile peer to peer network.
- Formation of Distributed Spanning Tree.
- Optimization of DST with Ant Colony Optimization.
- DST for Global Replica Management.

a) Formation of Mobile Peer to Peer Network

There are various steps for creating the P2P network. In fig 1.a shows the sample mobile peer to peer network and fig 1.b shows the simulation on mobile peer to peer network.

- Define the network options such as communication channel, propagation models, queue types and the network interface.
- Creating the instance of the simulator and set up the trace file.
- Create a topology object that keeps the movement of the mobile nodes within the topological boundary and also set the coordinate values of the boundary.
- Configure the nodes and create the number of mobile nodes in the network. Establish the communication between the nodes.
- Define the initial position of the node when it displayed in the NAM simulator.
- NS-2 uses NAM (network animator) to provide visualization. NAM also allows users to design and debug the network protocols.

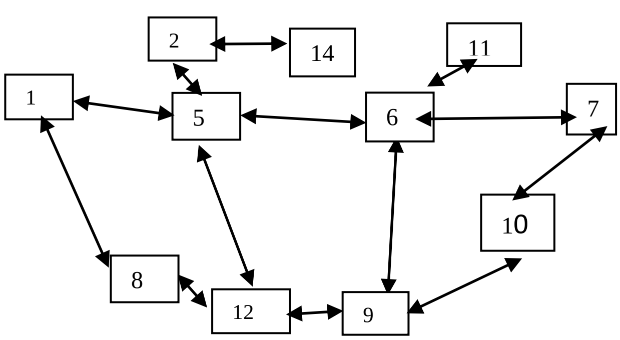

Figure 1a : Structure of Mobile P2P Network

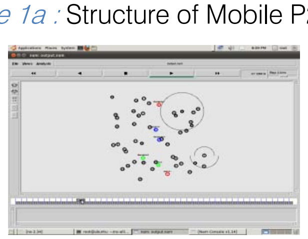

Figure 1b : Simulation of Mobile P2P Network

b) Formation of Distributed Spanning Tree

The mobile P2P network is converted into the set of spanning trees called the Distributed Spanning Tree (DST) and the corresponding graph based algorithms are developed to optimize the number of messages across the network. The DST is an overlay structure designed to be scalable, which supports the growth of the nodes from fewer nodes to higher volumes [16,17].It allows the instantaneous creation of spanning trees rooted by any node and maintains the load balancing between the nodes [16]. This instantaneous creation of spanning trees improves the overall scalability of the intended network [18]. So, DST structures help to automatically balance and optimize the load among the nodes.

The P2P network is converted into DST and each tree should have its root node, named as the Head Node (HN) and the possible Leaf Nodes (LNs). Every HN will hold the complete details regarding its LNs and vice versa. These HNs are to be generated dynamically and should hold the replica, which is to be accessed by their corresponding LNs and indeed by other HNs also. Fig 2a shows the simulation of distributed spanning tree. The DST algorithm consists of three procedures.

1. *Initialize():* This procedure create the set of Head Nodes (HNs) in a peer network based on criteria such as user approval, traffic in a particular region, etc. This procedure creates a list on each HN to hold its LNs details. This procedure assign unique id for every HN and then it calls the procedure probe ().
2. *Probe():* This procedure creates probe message and flood this message to all the nodes connected to it. On receiving a probe messages, every node executes receive () procedure.

- If the probe message is received by an HN, then it will be discarded.
- If the message is received by the LN, which is not under any HN, then the LN stores the head variable as the HeadID. Then the procedure reply() and the forward() will be called.
- If the reply message is received by the LN, it will be forwarded to the HN.
- If the reply message is received by the HN, then it reads the 'HeadId' from rmsg. If the 'Headid' equals the id of the current node then it concludes that the respective head node is reached.

3. *Reply():* The reply() procedure called by the corresponding LN to reply to its HN.

Definition 1: Let Ta be the graph of the peer network with HNs and LNs. Then G_a can be defined as,

$$Ga = \begin{cases} DST1 = (HN1, LN11, LN12, \ldots. LN1(j1-1)) \\ DST2 = (HN2, LN21, LN22, \ldots. LN2(j2-1)) \\ \ldots.. \\ DSTi = (HNi, LNi1, LNi2, \ldots.. LNi(ji-1)) \end{cases} \quad (1)$$

Where,

- 'DST_i' is the Distributed Spanning Tree and 'i' is the total number of DSTs formed in the network.
- 'HN_i' is the Head Node (HN) and 'i' is the total number of HNs in the peer network equal to the number of DSTs.
- 'LN' refers to the Leaf Node(s). In 'LN_{iz} ', refers to the corresponding HN_i and $0 < z \leq ij - 1$, where 'ij - 1' is the total number of LNs in the corresponding DST.

Definition 2: The number of messages required to pass the nodes in the MP2P network with the DST structure can be evaluated as the following equation,

$$n(msgpass) = ((P/LN) \times P \times R) + ((P/LN) \times T) \quad (2)$$

Where,

- 'T' refers to the number of message pass between one HN and another HN.
- 'R' refers to the number of message pass between HN and LN.
- 'P' refers to the number of peers in the network.
- 'LN' refers to the number of LN under HN (assume equal number of LN for all HN).
- '(P/LN)' refers to the number of DSTs in the MP2P network (or equals n(HN)).
- It can be interpreted that $1 \leq M \leq N \leq L$ and $1 \leq P \leq L$.

In Eq. (2), 'P/LN' gives the number of DSTs formed in the network which is also equal to n(HN). So the Eq. (2) can be rewritten as,

$$n(msgpass) = (L \times R) + (n(HN) \times T) \quad (3)$$

In other words, the total number of message passes required to form a DST in the MP2P network n(msgpass) is equal to the cumulative sum of the distance of each LN from its HN in terms of edges between them.

Algorithm for the Formation of DST:

Initialize()

1. Test the node v .If the test condition is satisfied then the node v is Head node.
2. Create an array to store all the LNs and call the function probe().
3. Create a variable Head as the LN.

Receive()

1. Check whether the message is the probe message and the node is HN means, discard the message
2. If the Head variable of the LN is also null means, delete the message.
3. If the Head variable of the LN equals the probe message of the HeadID means, call the reply() and forward() function.
4. If the node is HN then reply message of the HeadID equals the HeadID means, add the LN to the array else route the message to all the nodes connected to it.

Probe()

Send the probe message to all the LNs connected to the particular HN.

Forward()

Send the forward message to all nodes connected to it.

Reply()

1. Create a reply message to all the nodes.
2. Set the LeafID and HeadID field of the reply message as v.ID and v. Head.
3. Send the reply message to the Head node HN.

Figure 2 : Simulation of Distributed Spanning Tree

c) An Ant Colony Optimization of DST

The Ant Colony Optimization technique is a probabilistic optimization technique which could find the optimal path in a graph, which is based on behaviours of ant seeking a path between their colonies and source of food. By applying the ACO over the formulated DST, we can obtain the optimal path in terms of reduced number of message passes among the nodes in the network. The Ant colony optimization Algorithm for DST optimization is presented in the fig 3.This algorithm consists of four procedure; optimization (G),propagate (),construction() and daemon action().In Fig 3 shows the simulation of ant colony optimization of DST. The Procedure for optimization (G) consists of two operations:

1. Finding the optimal path between every HNs. Let HN_i is a HN among { HN_1,HN_2,.....HN_n}, where n is the number of HNs in the P2P network. HN_i use

probe message ‘p’ to find the optimal path between HN_i and other HNs.

2. The propagate (G,x,p) ,which propagates messages through different paths is called which takes graph G, HN_i as ‘x’ and probe message ‘p’ as parameters. Probe message ‘p’ is flooded through the possible path which increase the number of feasible path discovered between the HN_i and other HN.
3. The construction (G,Ţ,x,z) which calculates the edge value through the destination HN, is called by HN_i which takes the graph G, start HN ‘x’ start HN ‘x’ specific end HN ‘Z’ and ‘Ţ’ as the parameter. The ‘Ţ’ is the measure of cumulative edge value between ‘x’ and ‘z’.’ $Ţ_i$’ value is used to decide the optimal path between the nodes. The value of ‘Val’ can be given as

$$\mathrm{Val} = \sum_{i=0}^{p} (Ţi) \qquad (4)$$

Where

- ‘val’ is a variable to count the value of Ţ on each edge from ‘x’ to ‘z’.
- ‘p’ is the number of edges between HNs ‘x’ and ‘z’ in the MP2P network.
- ‘Ţ’ is the cumulative edge value between the node ‘x’ and ‘z’.

4. DaemonAction(Val) is called by the end HN ‘z’ which takes the ‘Val’ as parameter and decides the optimal path between the HNs ‘x’ and ‘z’ based on the value of ‘t’ along the path of each probe ‘p’. Every probe reaches ‘z’ with its ‘val’ then ‘z’ decides the optimal path based on the ‘val’ and the component type of ‘t’.

Algorithm for Ant Colony Optimization

Optimize()

1. Consider the graph that consists of vertices v and edges e such that G=(v,e).
2. Consider the HN x and z such that create a probe message p on x.
3. Call the function propagate(),construction() and daemonaction() to all HNs in the DST.
4. Consider the LN y for the particular HN x ,create a probe message p on y.
5. Call the function propagate(),construction() and daemonaction() to all the LNs.

Probe()

Forward the probe message p to all nodes.

1. For each non visited vertices in G, count the value of edge from node x to z and also calculate the cumulative edge value between the node x and z.

Construction()

1. Initialize val(z) and trial(z).
2. For each non visited vertices in G, count the value of edge from node x to z and also calculate the cumulative edge value between the node x and z.

DaemonAction()

1. Compare the cumulative edge value between the node x and z.
2. Find the optimal path between the node x and z based on the cumulative edge value ‘Ţ’.
3. If the value ‘Ţ’ can be compared with the positive Qos attribute like bandwidth and transmission speed of the node. If the node has the highest ‘Ţ’ value, then it chooses the optimal path between the nodes.

Let ‘τ’ be a positive QoS attribute like bandwidth, transmission speed, etc., then the path with highest value of ‘val’ is chosen to be optimal. On the other hand, if ‘τ’ is one of the negative QoS attributes like Hop count, congestion delay, propagation delay, etc., then the path with lowest value of ‘val’ is chosen to be optimal.

Definition 3: Let n(ACOmsgpass) be the number of message passes required for applying ACO in DST MP2P network and it can be estimated as,

$$n(\mathrm{ACOmsgpass}) = ((L/P) \times N) + ((P \times M) \times (L/P)) \qquad (5)$$

Where,

- ‘N’ refers to the number of message pass between one HN and another HN.
- ‘M’ refers to the number of message pass between HN and LN.
- ‘L’ refers to the number of peers in the network.
- ‘P’ refers to the number of LN under HN (assume equal number of LN for all HN).
- ‘(L/P)’ refers to the number of DSTs in the MP2P network (or equals n(HN)).
- It can be interpreted that $1 \leq M \leq N \leq L$ and $1 \leq P \leq L$.

Since ‘L/P‘ gives the number of DSTs formed in the network which is also equal to n(HN). So the Eq. (5) can be rewritten as,

$$n(\mathrm{ACOmsgpass}) = (n(HN) \times N) + (M \times L) \qquad (6)$$

Thus the total number of message passes required to perform ACO technique in DST P2P network is directly proportional to total number of peers and HNs in the network.

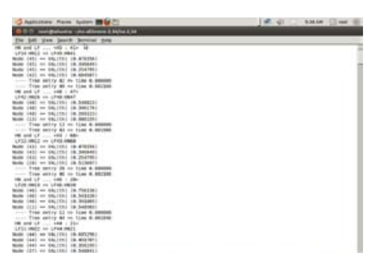

Figure 3 : Simulation of Ant Colony Optimization Method

IV. Simulation Scenario

This section describes the experimental set-up developed for investigating the proposed method with different performance criteria. The NS2 simulator is used for comparing the performance of mobile peer to peer network. A Mobile Peer-to-Peer network is simulated with 50 mobile nodes (N1, N2,.. .N50) moving at constant speed within a bounded region. Unit propagation delay of the wireless medium has been assumed as 10 ms. The experimentation and analysis have been carried out under two different scenarios: MP2P with DST and MP2P with ACO optimized DST networks. The Table 1 specifies the number of parameters used for the simulation of mobile peer to peer network.

In this phase, the performance of the Mobile P2P network is evaluated using the Ant colony optimization method. In fig 4.1a specifies the Number of nodes Vs number of packet request for that node. It shows when the number of nodes increases, the message sent for the node was also decreases by using DST method. But in optimized DST (ACO) method, the number of requested packets from the network was also decreased. In the second graph 4.1b shows the number of node Vs packet delivery ratio. By using ACO method, the packet delivery ratio for the node was increased compared to that of using DST method. In the third graph 4.1c shows number of nodes Vs average delay. By using optimized DST method, the average delay for the node was decreased when the number of node was increased.

Table 1 : Simulation Parameters

Parameters (unit)	Value(default)
Number of Mobile nodes	50
Radius of communication range	1~19
Size of the Network	100X100
Propagation delay	12 ms
Average moving speed	0 ~ 25m/s
Maximum transmission range	250 m
Simulation time	900 sec
Nodes Mobility	1,5,10,15,20 m/s
Maximum velocity of the node	1

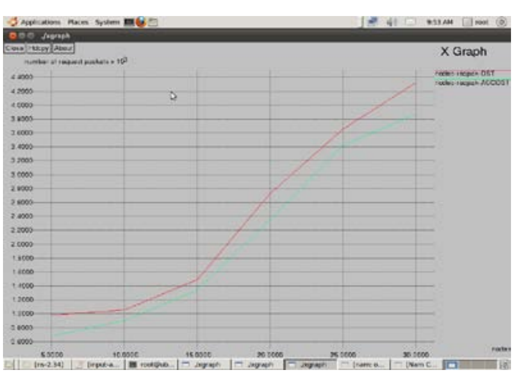

Figure 4.1a : No. of Node Vs No.of Request Packets

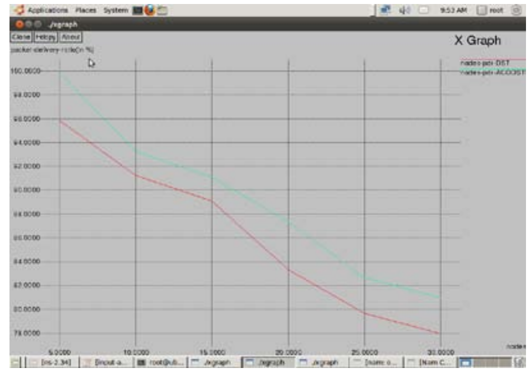

Figure 4.1b : Number of Node Vs Packet Delivery ratio

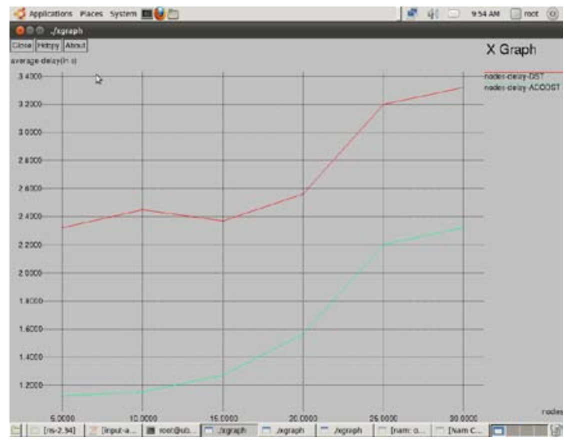

Figure 4.1c : Number of Node Vs Average Delay

V. Conclusion

By employing the DST structures in the P2P network, the consistency and replication efficiency can be achieved with the few messages compared to the traditional method. The scalability of the P2P network can be improved with the application of DST structures. The proposed model increases the data availability, reduces the bandwidth conception and number of messages in the network and also improves the fault tolerant capacity of the overall system. Further to enhance the effectiveness of the proposed system, the DST network is optimized with the Ant Colony Optimization method. It gives the optimal solution of the DST method and reduces the message sent and average delay and increases the packet delivery ratio in the network. We have to plan to achieve the cluster based replica allocation for mobile peer to peer networks and also achieve the effective service cache management in the network.

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Performance Comparison of Terrestrial DVB Detection using LDPC and Turbo Codes

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Abstract - Last-generation and future wireless communication standards, such as DVB-T2 or DVB-NGH, are including multi-antenna transmission and reception in order to increase bandwidth efficiency and receiver robustness. The main goal is to combine diversity and spatial multiplexing in order to fully exploit the multiple-input multiple output (MIMO) channel capacity. Full-rate full-diversity (FRFD) space-time codes (STC) such as the Golden code are studied for that purpose. However, despite their larger achievable capacity, most of them present high complexity for soft detection, which hinders their combination with soft-input decoders in bit-interleaved coded modulation (BICM) schemes. This article presents a low complexity soft detection algorithm for the reception of FRFD space-frequency block codes in BICM orthogonal frequency division multiplexing (OFDM) systems and gives the performance comparision using Ldpc and Turbo codes. The proposed detector maintains a reduced and fixed complexity, avoiding the variable nature of the list sphere decoder (LSD) due to its dependence on the noise and channel conditions. Complexity and simulation based performance results are provided which show that the proposed detector performs close to the optimal log-maximum a posteriori (MAP) detection in a variety of DVB-T2 broadcasting scenarios.

Indexterms : MAP detection, space frequency block coding (SFBC), digital video broadcasting terrestrial DVB-T), orthogonal frequency division multiplexing (OFDM).

GJCST-E Classification : C.2.0

PERFORMANCE COMPARISON OF TERRESTRIAL DVB DETECTION USING LDPC AND TURBO CODES

Strictly as per the compliance and regulations of:

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Indexterms : MAP detection, space frequency block coding (SFBC), digital video broadcasting terrestrial (DVB-T), orthogonal frequency division multiplexing (OFDM).

I. Introduction

SPACE-TIME coding is one of the main methods in order to exploit the capacity of multiple-input multiple-output (MIMO) channels [1]. Since STC techniques use both time and spatial domains for coding data symbols, diversity and spatial multiplexing can be combined achieving robustness at the receiver with a higher data rate transmission. As a result, STC techniques have been incorporated in many of the last-generation wireless communications systems, including the new generation of terrestrial and mobile digital video broadcasting (DVB) standards. If STC is joined to multi-carrier modulation, such as orthogonal frequency-division multilexing (OFDM), space frequency block coding (SFBC) can be performed. This way, codeword's are fed into adjacent of the two consecutive OFDM symbols, translated to the time domain and transmitted through several transmit antennas. This transmission scheme is usually combined with bit-interleaved coded modulation (BICM) giving good diversity results in a wireless communication link [2].

In order to achieve the full MIMO diversity-multiplexing frontier [3], the proposals for the future generations of terrestrial, portable and mobile digital video broadcasting standards, such as DVB-NGH, focus on the combination of both diversity and spatial multiplexing [4], [5] through full-rate full-diversity (FRFD) codes [6]. The main drawback of full-rate codes arises from their very high decoding complexity, which grows exponentially with the number of transmitted symbols per codeword. In order to reduce the complexity of the detection process, hard detection techniques such as sphere decoding (SD) or low complexity STC designs [7], [8] can be used. Nevertheless, when iterative decoders, such as turbo or LDPC codes, are included in the reception chain, soft information on the conditional probabilities for all possible transmitted symbols is required in the form of log-likelihood ratios (LLR). Moreover, the computation of the LLRs for the whole set of transmitted symbols is unfeasible, specially for large constellation sizes. Hence, the soft MIMO detector has to select a group of candidates to be fed to the decoder in order to compute the required LLRs. Several algorithms that serve this purpose can be found in the literature, such as list sphere detection (LSD) [9], near-optimal soft SD [10], list fixed-complexity sphere detection (LFSD) [11], QR decomposition associated with the M-algorithm (QRM-MLD) [12] or bounded soft sphere detection (BSSD) [13].

The contribution of this paper is comparing the performance of soft detection algorithm for FRFD SFBC and its assessment in an Ldpc/Turbo-based BICM scenario. The generation of the candidate list is carried out by means of a fixed tree search, whose complexity does not depend on the channel conditions or the noise level. Since the complexity of the proposed soft detector is closely linked to the architecture of the tree search, we analyze different tree configurations in order to find the best balance between complexity and performance. Simulation results are provided for the Golden [14] and the FRFD Sezginer-Sari (SS) codes [8] in a DVB-T2 framework [15]. Although our research has been carried out on a terrestrial TV system, the results can be generalized for any MIMO bit interleaved coded modulation scheme. The remainder of the paper is organized as follows: Section II details the system model, focusing on soft detection and LLR calculation.

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The design of the new algorithm is presented for two FRFD SFBCs in Section III, while Section IV shows the simulation-based performance comparison of receiver in DVB-T2 scenarios. Finally, the main concluding remarks are drawn in Section V.

II. System Model

The basic structure of the Ldpc/Turbo-coded BICM-OFDM system is depicted in Fig. 1. As can be seen, the bit stream is coded, interleaved and mapped onto a complex constellation.

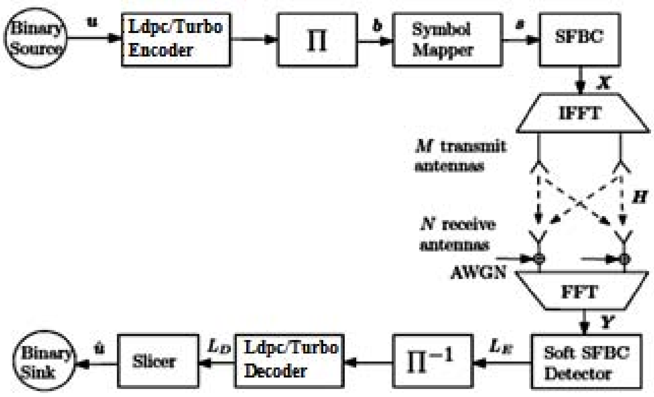

Figure 1 : Simplified diagram of a Ldpc/Turbo-based SFBC MIMO transmission and reception scheme based on DVB-T2

Next, a vector of *Q* symbols *s* is coded into space and frequency forming the codeword **X**, which is transformed into the time domain by an inverse fast fourier transform (IFFT) block and transmitted after the addition of fast Fourier transform (FFT) is carried out and the resulting signal **Y** of dimensions $N \times T$ can be represented mathematically as

$$\boldsymbol{Y} = \boldsymbol{HX} + \boldsymbol{Z}, \tag{1}$$

where H denotes the $N \times M$ complex channel matrix, **X** is any $M \times T$ codeword matrix composed by a linear combination of Q data symbols and **Z** represents the $N \times T$ zero-mean additive white Gaussian noise (AWGN) matrix whose complex coefficients fulfill $\mathcal{CN}$ $(0, 2\sigma^2)$ being σ^2 the noise variance per real component. The design of the codeword **X** follows the criteria defined in [16], [17] and will provide full rate when $Q = MT$, being T the frequency depth of the codeword. By taking the elements column-wise from matrices **X**, **Y** and **Z**, equation (1) can be vectorized as

$$\boldsymbol{y} = \breve{H}\boldsymbol{Gs} + \boldsymbol{z}, \tag{2}$$

where *y, s* and *z* are column vectors. The matrix $\breve{\mathrm{H}}$ is the equivalent $NT \times MT$ MIMO channel written as

$$\breve{H} = \begin{bmatrix} \mathrm{H}^1 & 0 & \cdots & 0 \\ 0 & \mathrm{H}^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \mathrm{H}^T \end{bmatrix} \tag{3}$$

where we have a block diagonal of channel realizations H^c at the carriers $c = 1, \ldots, T$. The complex coefficient $h^c{}_{ij}$ corresponds to the channel from transmit antenna j to receive antenna i at the c-th carrier. The off-diagonal entries are zero matrices with dimensions $N \times M$. The matrix **G** is the generator matrix for the SFBC such that x = **G**s, where s corresponds to the symbol column vector $[s1, \ldots, sQ]^T$.

a) *Soft Detection of SFBCs*

The soft information required by the Ldpc/Turbo decoder is obtained though maximum a posteriori (MAP) detection, which consists of evaluating the LLR of the *a posteriori* probabilities of a bit bk taking its two possible values,

i.e.

$$\mathrm{L_D}(\mathrm{b_k}) = \ln \frac{\Pr[\mathrm{b_k} = +|\mathrm{y}]}{\Pr[\mathrm{b_k} = -|\mathrm{y}]} \text{ with } \mathrm{k} = \{0, .., \mathrm{MT}\log_2 \mathrm{P} - 1\}.$$

Assuming statistically independent information bits and using the Bayes' rule, the a posteriori information $L_D(b_k/\boldsymbol{y})$ can be expressed as $L_D(b_k/\boldsymbol{y}) = L_A(b_k) + L_E(b_k/\boldsymbol{y})$, where $L_A(b_k)$ and $L_E(b_k/\boldsymbol{y})$ denote the a priori and extrinsic information, respectively. Considering our non-iterative model depicted in Fig. 1 and the vectorized model (2), the extrinsic information can be written using the Max-log approximation as

$$L_E(b_k/y) \approx \frac{1}{2}\max_{b \in B_{k,+1}}\left\{-\frac{1}{\sigma^2}\|\mathrm{y} - \breve{\mathrm{H}}G_s\|^2\right\} - \frac{1}{2}\max_{b \in B_{k,-1}}\left\{-\frac{1}{\sigma^2}\|\mathrm{y} - \breve{\mathrm{H}}G_s\|^2\right\}, \tag{4}$$

Where $\mathbb{B}_{k,\pm 1}$ represents the sets of $2^{MT\ \log 2\ P-1}$ bit vectors $\boldsymbol{b}$ having $b_k = \pm 1$ and the symbol column vector $s = map(\boldsymbol{b})$ is the mapping of the vector $\boldsymbol{b}$ into the symbols o column vector $\boldsymbol{s}$. The main difficulty in the calculation of (4) arises from the computation of the metrics $\|\boldsymbol{y} - \breve{\boldsymbol{H}}\boldsymbol{Gs}\|^2$ since a calculation of P^Q metrics is necessary for a FRFD SFBC, being P the modulation order. This becomes unfeasible for high modulation orders unless the calculation of (4) can be reduced. As a result, a good approximation based on a candidate list $\mathcal{L}$ is proposed in [9] in order to reduce the calculation of L_E in (4). The list includes $1 \leq N_{cand} < P^Q$ vectors s with the smallest metrics and the number of candidates N_{cand} must be defined sufficiently large in such a way that it contains the maximizer of (4) with high probability. Hence, (4) can be approximated as

$$L_E(b_k/y) \approx \frac{1}{2}\max_{b \in \mathcal{L} \cap B_{k,+1}}\left\{-\frac{1}{\sigma^2}\|\mathrm{y} - \breve{\mathrm{H}}G_s\|^2\right\} - \frac{1}{2}\max_{b \in \mathcal{L} \cap B_{k,-1}}\left\{-\frac{1}{\sigma^2}\|\mathrm{y} - \breve{\mathrm{H}}G_s\|^2\right\}, \tag{5}$$

III. Fixed-Complexity Detection

The design of efficient detection algorithms is one of the greatest challenges when implementing full-rate SFBC. Given the high complexity of performing an exhaustive search, special focus has been drawn into developing lower complexity detection algorithms that yield a close-to-ML performance. The LSD is one of the most remarkable approach but its complexity order is bounded by *(P^Q)* in the same way as the SD [9]. Even though the list of candidates corresponds to the set $\mathcal{L}$ of the smallest metrics, the complexity of performing such a selection may be considerably high for low signal-tonoise ratio (SNR) scenarios. Furthermore, an unsuitable choice of the initial radius may lead to a shortage in candidate points, which forces the algorithm to restart with a looser sphere onstraint. In order to limit the complexity and to facilitate the computation of soft detected symbols, a fixed-complexity tree-searchstyle algorithm was proposed in [18] for spatial multiplexing schemes, coined list fixed-complexity sphere decoder (LFSD).

The main feature of the LFSD is that, instead of constraining the search to those nodes whose accumulated Euclidean distances are within a certain radius from the received signal, the search is performed in an unconstrained fashion. The tree search is defined instead by a tree configuration vector $n = [n_1, \ldots, n_{MT}]$, which determines the number of child nodes (n_i) to be considered at each level. Therefore, the tree is traversed level by level regardless of the sphere constraints. Once the bottom of the tree is reached, the detector retrieves a list of N_{cand} candidate symbol vectors.

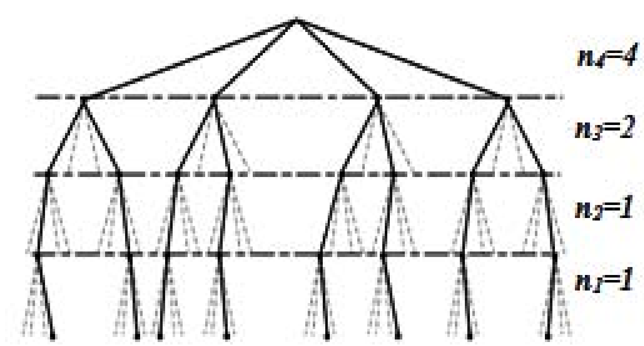

Figure 2 : Fixed-complexity tree search of a QPSK-modulated signal using a tree configuration vector of n = [1, 1, 2, 4]

It is worth noting that the set *G* composed the vectors of the set $\mathcal{L}$ with the smallest metrics given by the LSD, but provides sufficiently small metrics and diversity of bit values to obtain accurate soft information. A representation of an LFSD tree search is depicted in Figure 2 for a QPSK modulation and a tree configuration vector of $n = [1, 1, 2, 4]$.

a) Soft-output LFSD algorithm

For the sake of simplicity, the equations for the aforementioned FRFD codes will be rearranged so that ML metrics can be given by $\|\bar{y} - \boldsymbol{H}_{eq}\bar{s}\|^2$, where $\bar{y}$ and $\bar{s}$ are the received and transmitted signals respectively, reorganized according to the Corresponding SFBC code, and H_{eq} is the effective equivalent channel, which will be defined later for the SS and Golden codes.

A level-by-level computation of the metrics requires the conversion to the following equivalent system

$$\|U(\bar{s} - \hat{\hat{s}})\|^2, \quad (6)$$

where *U* is obtained through the Cholesky decom-position of $H^H_{eq}H_{eq}$ and $\hat{\hat{s}} = H^{\dagger}_{eq}\,\bar{y}$. Given the triangular structure of *U*, it is now possible to compute the accumulated Euclidean distances (AED) up to level *i* recursively by traversing the tree backwards from level $i = MT$ down to $i = 1$. The Euclidean distances that must be minimized in the cost function in (6) can be equivalently represented in a tree search fashion as

$$D_i = u_{ii}^2|\bar{s}_i - Z_i|^2 + \sum_{j=i+1}^{MT} u_{jj}^2|\bar{s}_j - Z_j|^2 = d_i + D_{i+1}, \quad (7)$$

and

$$Z_i = \hat{\hat{s}}_i - \sum_{j=i+1}^{MT}\frac{u_{ij}}{u_{ii}}\left(\bar{s}_j - \hat{\hat{s}}_j\right). \quad (8)$$

Therefore, the n_i symbols to be evaluated at each level *i* are chosen in accordance with the Schnorr-Euchner enumeration [19], being their corresponding partial Euclidean distances d_i computed and accumulated to the previous level's AED, that is, D_{i+1}. Once the bottom of the tree has been reached, a sorting operation is performed on the $n_T = \prod_{i=1}^{MT} n_i$ Euclidean distances in order to select the N_{cand} symbol vectors with the smallest metrics. This latter sorting procedure can be avoided if the tree configuration vector n is chosen so as to yield $n_T = N_{cand}$. In such a case, the complexity of the algorithm is reduced at the expense of a degradation in the quality of soft information as the selected metrics are higher in value.

b) Ordering Algorithm

The performance of the LFSD soft-detector in uncoded scenarios is strongly dependent on the ordering algorithm of the channel matrix and the choice of the tree configuration vector [18]. The ordering algorithm proposed in [18] to enhance the performance of the LFSD and FSD detectors was based on the fact that it was possible to mitigate the error propagation derived from ruling out several tree branches by ordering the several columns of the channel matrix according to their *quality*.

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More precisely, the FSD ordering scheme dictates that the subchannel with the worst norm needs to be processed first, since all the constelation symbols are evaluated at the first level (see Fig. 2), and therefore, there is no error propagation to the remainder levels. However, in the specific case of spacefrequency- coded systems, the effect of the ordering algorithm on the overall performance relies on the type of code utilized. In order to verify this assumption, two 2 × 2 FRFD SFBC codes have been assessed.

i. *Golden Code [14]*

For the Golden code, the data symbol vector *s* is transformed into the transmitted codeword as follows:

$$\mathbf{X_g} = \frac{1}{\sqrt{5}}\begin{bmatrix}\alpha(s_1+\theta s_3) & \alpha(s_2+\theta s_4)\\ i\bar{\alpha}(s_2+\bar{\theta} s_4) & \bar{\alpha}(s_1+\bar{\theta} s_3)\end{bmatrix}, \quad (9)$$

With $\theta = \frac{1+\sqrt{5}}{2}$ (the golden number), $\bar{\theta} = \frac{1-\sqrt{5}}{2}$,

$$\alpha = 1 + i - i\theta \text{ and } \bar{\alpha} = 1 + i - i\bar{\theta}.$$

The vectorization of (1) with *Xg* implies the following equivalent channel

$$\boldsymbol{H_{eq}} = \begin{bmatrix} h^1_{11}(1+i\bar{\theta}) & h^1_{12}(-\theta+i) & h^1_{11}(\theta+i) & h^1_{12}(-1+i\bar{\theta})\\ h^1_{21}(1+i\bar{\theta}) & h^1_{22}(-\theta+i) & h^1_{21}(\theta+i) & h^1_{22}(-1+i\bar{\theta})\\ h^2_{12}(1+i\theta) & h^2_{11}(1+i\bar{\theta}) & h^2_{12}(\bar{\theta}+i) & h^2_{11}(\theta+i)\\ h^2_{22}(1+i\theta) & h^2_{21}(1+i\bar{\theta}) & h^2_{22}(\bar{\theta}+i) & h^2_{21}(\theta+i)\end{bmatrix} \quad (10)$$

The fact that Golden code does not equally disperse the symbol energy in all spatial and temporal directions, generates an unbalanced structure of the transmitted symbols since the norms of the code weights in (10) are not equal, i.e. $1+\vartheta^2 \neq 1+\bar{\theta}^2$. Thus, given this difference in the absolute value of the weights, one of the symbols in each transmitted pair (s_1, s_3) and (s_2, s_4) always has a higher power than the other. Hence, the norms of the equivalent subchannels are $\|h_1\|^2 \neq \|h_3\|^2$ and $\|h_2\|^2 \neq \|h_4\|^2$ in any case, being h_j the j-th column vector of H_{eq}. This unbalanced structure allows for the implementation of a new ordering procedure in order to improve the overall system's performance.

On the other hand, if the channel is assumed quasi-static over adjacent carriers, are $\|h_1\|^2 \approx \|h_3\|^2$ and $\|h_2\|^2 \approx \|h_4\|^2$. An important feature when considering the optimum ordering approach is the tree configuration vector that will shape the search tree. As opposed to the LFSD detector presented in [18] for spatial multiplexing MIMO transmission, the tree configuration vector for the detection of the Golden Code has been set to $n = [k, k, P, P]$, where $k < P$. With such a tree structure, an exact ML search is performed in the first two levels of the tree, and therefore, there is no error propagation down to the next levels.

Consequently, by ordering the equivalent channel matrix in such a way that the *worst* sub-channel is processed in the first two levels of the tree, the probability of finding vectors with smaller metrics is increased. Moreover, it has to be taken into account that the symbols belonging to the same pair need to be detected together in the non-ML part of the tree search for a better performance of the algorithm, since there exists a correlation between their corresponding sub-channels due to the code structure.

The equivalent ordered channel matrix $\boldsymbol{H^{ord}_{eq}}$, which will be used in the detection of the Golden Code, can then be described as

$$\boldsymbol{H^{ord}_{eq}} = [h_{\tilde{b}}\ h_b\ h_{\tilde{w}}\ h_w], \quad (11)$$

Where

$$w = argmin_{j\in S}\ \|h_j\|^2, \quad (12)$$

and

$$b = argmax_{j\in S, j\neq w,\tilde{w}}\ \|h_j\|^2. \quad (13)$$

The two symbols that compose a symbol pair are represented as $(a, \bar{a})$ and the set of symbol indices is $S = \{1,\ldots,MT\}$. Given the chosen tree configuration vector, one can notice that the order of the first two selected symbols can be switched without having any impact on the final performance of the system.

ii. *The SS Code*

This 2×2 SFBC scheme was designed to enable optimum detection with lower complexity than the Golden code. The low complexity detection property of multistrata codes such as the SS code, was analyzed in [7], [8],where it was proven that optimum output was obtained with two symbol-by-symbol detection stages of complexity *P* and a ML detection of complexity $\mathcal{O}(P^2)$. The main difference between the SS [8] and the silver codes [7] is the larger coding gain of the latter. The SS code is the combination of two Alamouti schemes whose codeword can be written as

$$\boldsymbol{X_{ss}} = \begin{bmatrix} as_1 + bs_3 & as_2 + bs_4\\ -cs^*_2 - ds^*_4 & cs^*_1 - ds^*_3\end{bmatrix}, \quad (14)$$

With $a = c = 1/\sqrt{2}$, $b = \frac{1-\sqrt{7}+i(1+\sqrt{7})}{4\sqrt{2}}$ and $d = -ib$.

The vectorization of (1) for $\boldsymbol{X}_{ss}$ implies a rearrangement of the received and transmitted signals such that $\bar{\mathbf{y}} = [y_{11} y_{21} y_{12}^* y_{22}^*]^T$ and $\bar{\mathbf{s}} = [s_1, s_2, s_3^*, s_4^*]^T$ respectively.

The equivalent channel can be expressed as:

$$\boldsymbol{H}_{eq} = \begin{bmatrix} ah_{11}^1 & -ch_{12}^1 & bh_{11}^1 & -dh_{12}^1 \\ ah_{21}^1 & -ch_{22}^1 & bh_{21}^1 & -dh_{22}^1 \\ (ch_{12}^2)^* & (ah_{11}^2)^* & (dh_{12}^2)^* & (bh_{11}^2)^* \\ (ch_{12}^2)^* & (ah_{21}^2)^* & (dh_{22}^2)^* & (bh_{21}^2)^* \end{bmatrix}, \quad (15)$$

When considering the equivalent channel in (15), it is worth noting that the equivalent subchannels for the symbol pairs ($s1$, $s3$) and ($s2$, $s4$) have very similar norms. This is due to two main factors. On one hand, both symbol pairs undergo almost the same channel conditions as they are assigned to adjacent carriers ($H^1 \approx H^2$) in quasi-static fading channels). On the other hand, the code weights a, b, c and d imposed by the SS code fulfill a power constraint for linear dispersion codes [20], which forces the symbols to be dispersed with equal energy in all spatial and temporal directions, i.e. $|a| = |b| = |c| = |d| = 1/\sqrt{2}$.

The consequence of employing such a code is that the difference of the norms of the equivalent subchannels is negligible and, therefore, performing a matrix ordering stage does not provide any remarkable performance enhancement. As it will be shown in the next section, the proposed ordering approach yields close-to-optimum performance when combined with the suggested tree configuration vector. Moreover, the matrix ordering process only requires the computation of MT vector norms as opposed to other ordering algorithms such as FSD [18] or V-BLAST [21], which need to perform $MT - 1$ matrix inversion operations.

c) *Bit LLR generation for the proposed list fixed-complexity detector*

The expression for the LLRs in (5) can be rewritten to comply with the equivalent system in (6) as

$$L_E(b_{k|\mathbf{y}}) \approx \frac{1}{2}\min_{b \in \mathfrak{G} \cap B_{k,+1}} \frac{1}{\sigma^2}\|\bar{y} - \boldsymbol{H}_{eq}\bar{s}\|^2 - \frac{1}{2}\min_{b \in \mathfrak{G} \cap B_{k,-1}} \frac{1}{\sigma^2}\|\bar{y} - \boldsymbol{H}_{eq}\bar{s}\|^2, \quad (16)$$

Note that the list of candidates $\mathcal{L}$ of the ML/LSD detector has been substituted by the set G of the LFSD.

IV. Simulation Results

The performance of the overall system has been assessed by means of the bit error rate (BER) after the Ldpc/Turbo decoder. The DVB-T2 parameters used in the simulations are: 64800 bits of length of the Ldpc/Turbo block, $R = 2/3$ of Ldpc/Turbo code rate, 16-QAM modulation, 2048 carriers as FFT size and 1/4 of guard interval. The simulations have been carried out over a Rayleigh channel (Typical Urban of six path, TU6), commonly used as the simulation environment for terrestrial digital television systems [22]. Perfect CSI has been considered at the receiver.

a) *Candidate Choice*

When working with the ML metrics of LSD, i.e. the list L, the higher the number of candidates is, the more accurate the LE approximation is. Nevertheless, when considering the $\mathfrak{G}$ list of LFSD, the optimum value for N_{cand} will depend on the tree configuration vector n. Thus, the higher the value of n_T, the better the approximation is. In order to choose a suitable number of candidates for the detection algorithm, a battery of tests have been carried out. Fig. 3 depicts the bit error performance after the detection stage for a given SNR of 14.4 dB with different tree search configurations and N_{cand} values. The effect of the ordering preprocessing stage is also depicted in this figure. The analyzed tree search configuration vectors $\boldsymbol{n}$ have been obtained by setting $k = 1, 2, 3$, which is equivalent to calculating $n_T = P^2, 4P^2, 9P^2$ Euclidean distances, respectively. On one hand, one can observe that the list ML approximation (5) converges for $N_{cand} > 30$. This involves that computing a very large number of candidates is not necessary in order to obtain a good L_E approximation of (4) for the proposed non-iterative scheme in Fig.1. However, we should take into account that the exact computation of (4) provides a higher performance enhancement compared to applying the list ML approximation of (5) when iterative configurations are used [23].

On the other hand, a similar behavior for the fixed-complexity detector can be noticed, where the higher the value of k, the better the performance we obtain. Furthermore, it is noticeable that the ordering algorithm provides a performance enhancement such that the $k = 2$ LFSD approximates the BER values for the exhaustive MAP detector. Note that the BER degrades for a higher number of candidates with the tree search configuration $k = 1$.This is due to the fact that if we choose a large N_{cand} value from $n_T = P^2$ Euclidean distances, the probability of achieving the smallest or close to the smallest metrics is reduced. For $k > 1$, this effect is mitigated.

b) *Performance comparison over DVB-T2 BICM*

This section presents the performance assessment of the proposed list fixed-complexity soft detector over a SFBC DVB-T2 broadcasting scenario. The number of candidates considered for this study is $N_{cand} = 50$. Below graphs shows BER curves versus SNR for different configurations of the proposed algorithm in the detection of Golden and SS codes. For the Golden code, it is noteworthy that the ordering algorithm provides a gain of 0.4 and 0.25 dB compared to the non-ordering case for $n_T = P^2$ and $n_T = 4P^2$, respectively. However, as previously stated, the ordering algorithm does not provide any performance gain with the SS code. In this case, the subchannel norms of the symbol pair $(a, \tilde{a})$ are completely equal, i.e., $\|h_b\|^2=\|h_{\tilde{b}}\|^2$ and $\|h_w\|^2=\|h_{\tilde{w}}\|^2$, being negligible the enhancement provided by the ordering procedure.

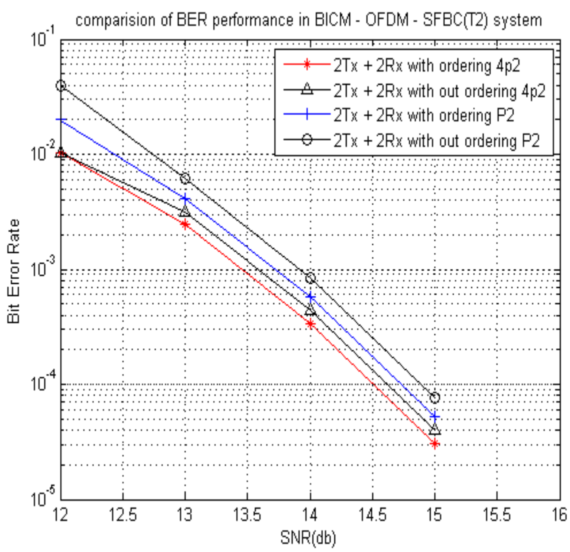

Figure 3 : Performance comparision with and with out ordering algorithm using LDPC codes

The Fig 3. shows that the performance Comparision based on different equlidian distances by using with and with out ordering algorithms.Here the first black colour plot represents that by with out using the ordering algorithm for the equlidian distance (p^2), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.9db. And the second blue colour plot represent that by using the ordering algorithm for the equlidian distance (p^2), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.7db. Next the third black colour plot on the graph represents that by with out using the ordering algorithm for the equlidian distance ($4p^2$), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.6db. And finally the fourth red colour plot represents that by using the ordering algorithm for the equlidian distance ($4p^2$), when BER (bit error rate) is 10^{-4} the signal to noise ratio(SNR) will be 14.5db.

In LDPC coding one bit is generating one parity, so the error rate is 14.5db with ordering algorithm. This gives the better performance when compared with out ordering algorithm for detecting the signals at the different signal to noise ratio condition.

The Fig 4. shows that the performance Comparision based on different equlidian distances by using with and with out ordering algorithms. Here the red colour plot represents that by with out using the ordering algorithm for the equlidian distance (p^2), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.45db. And the green colour plot represent that by using the ordering algorithm for the equlidian distance (p^2), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.35db.

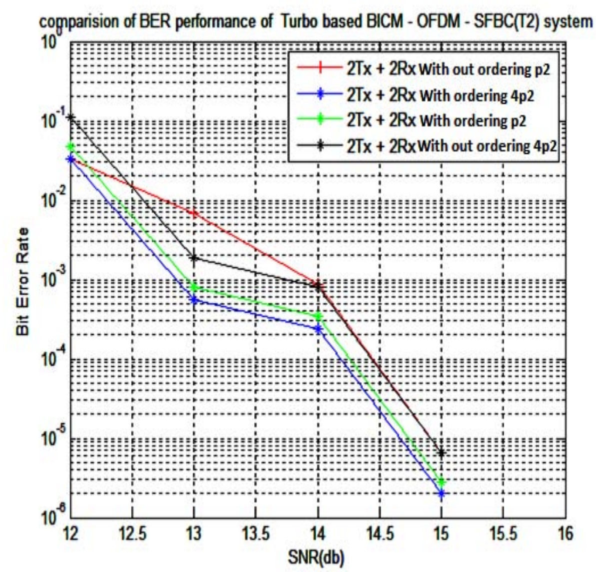

Figure 7 : Performance comparision with and with out ordering algorithm using Turbo codes

Above that the black colour plot on the graph represents that by with out using the ordering algorithm for the equlidian distance *($4p^2$)*, when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.4db. And finally the finally plot represents that by using the ordering algorithm for the equlidian distance ($4p^2$), when BER (bit error rate) is 10^{-4} the signal to noise ratio (SNR) will be 14.25db.

Thus in turbo codes one bit is generating two parity so the error rate is decreasing upto 14.25db with ordering algorithm. This gives the better performance when compared with out ordering algorithm for detecting the signals at the different signal to noise ratio condition. Also it will be giving the better performance with reduced complexity and achieve full rate for detecting the terrestrial digital TV signals in the different fading channel conditions like additive white gaussian noise and rayliegh channels.

V. Conclusion

Multi-antenna transmission using 2 $\times$ 2 FRFD codes, such as the Golden code or the SS code, increases the capacity allowing a higher data rate transmission with full diversity. This capacity increase involves a joint detection of a candidate list of four data symbol vectors in order to achieve soft information for the decoder. The complexity of this calculation can be reduced by means of different algorithms, being the

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most extended the LSD detector. However, the main drawback of this technique is its high and variable complexity, which can be upper-bounded by $\mathcal{O}$ (P^4). A list fixed-complexity detector with a novel ordering algorithm is proposed in this paper with the aim of approaching the performance of the LSD at a much lower complexity. Specifically, the complexity order can be reduced from $\mathcal{O}$ (P^4) to P^2 for the Golden code and from $\mathcal{O}$ (P^3) to P^2 for the SS code.

The analysis of the number of candidates shows that the list approximation does not need a high list size in order to converge to the exact soft information value. Provided simulation results show that a close-to-optimal detection can be achieved considering a reduced number of candidates (30 out of 65536 in 16-QAM). BER (bit error rate) simulation results show the close-to-optimal performance of the proposed low-complexity detector for both Golden and SS SFBC codes in a typical Ldpc/Turbo-based DVB-T2 broadcasting scenario. The performance is clearly improved when the proposed channel and candidate ordering algorithm is applied with Golden codes, though its effects are negligible for the SS code. In any case, the proposed detection algorithm can enable the realistic implementation and the inclusion of any FRFD SFBC code in any BICM-OFDM system such as the forth coming digital video broadcasting standards.

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A Framework for Cross-Platform E-Commerce Website Development for Multiple Devices and Browsers

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Abstract - The aim of this study has been to identify Human- Computer Interaction (HCI) design methods and techniques for the development of cross-platform e-commerce websites that can be used on multiple devices with different screen sizes and web browsers. The findings presented here are based on a theoretical framework consisting of three categorizations: composition, continuity and consistency. The framework was implemented with the aid of a case study and a prototype implementation that adapts to the user context. The development of the prototype was based on the evaluation of existing e-commerce websites. Identified usability issues were readability and the fact that tasks should be dependent on the user context. The overall results of this study are presented as a set of usability guidelines for cross-platform e-commerce, which highlight the importance of identifying the users' needs as well as the context in which they operate, by offering a common set of functionality between devices and using device specific input mechanisms.

Indexterms : e-commerce, cross-platform development, mobile devices, human computer interaction, HCI, usability, website design.

GJCST-E Classification : K.4.4

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Strictly as per the compliance and regulations of:

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Coen de Natris [α] & LeliaLivadas [σ]

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I. Introduction

MOBILE e-commerce is growing exponentially. The Internet is no longer bound to desktops and wired connections. Today it is possible to use mobile devices such as the iPhone, Blackberry and Android-based phones to do purchases online. E-commerce retailers have started using this advantage and have developed content and delivery mechanisms for this new platform. Many of these retailers already have an online store for a personal computer environment and need to develop a new platform for mobile devices. A possible alternative approach is the development of a cross-platform e-commerce website.

The scope of this research was to study usability issues that traditional e-commerce websites generate when used in an environment with multiple devices that have different screen sizes and web browsers. Traditional websites are defined as websites that have been developed for personal computers, such as laptops and desktops. The focus of this research is on e-commerce websites, which are used in a business-to-consumer relationship, also known as online stores or web shops. Devices included in this research are smart phones, tablets, laptops and desktops. The emphasis is on the usability issues generated by the user interface of these e-commerce websites. An e-commerce website consists of a multiple tier architecture. Excluded from this research are the usability issues caused by other tiers than the presentation layer.

The overall aim of this study was to identify Human-Computer Interaction (HCI) design methods and techniques for the development of cross-platform e-commerce websites that can be used on multiple devices with different screen sizes and web browsers. These HCI design methods and techniques have to address the usability issues that can be found when using traditional websites in a cross-platform environment.

II. Research Design/Methodology

a) Case Study Cross-Platform user Experience

The focus of this study was on the user interface to determine characteristics and the current issues of a given website when used on different devices. The evaluation of Amazon.com was based on the theory is developed by [1], which describes a framework for developing cross-platform applications. The framework is based on three key elements: composition, continuity and consistency. All three elements were used as criteria for the evaluation of Amazon's online B2C services. Sources of information were reports provided by the company Amazon, observations and expert reviews.

b) Case Study E-commerce Features

The second case study was conducted to determine the features that are required for an e-commerce web site to better understand the cross-platform service composition as discussed in the first case study. The features were based on the theory developed by [2]. This case study focused also on determining a common page layout for e-commerce websites. The Amazon website was compared with four other online stores, whose e-commerce websites have been evaluated to determine which features they have in common. The method used for this comparison is a

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heuristic evaluation of five e-commerce sites. All companies

Table 1 : Task

Section	Feature	Task
Header	Sign-up button; Product category navigation;	Register a new account; Find the price of a specific product;
Main	Submit form; Browse product catalog;	Register a new account; Find the price of a specific product;
Footer	On mobile devices: Link to telephone number; Link to Ordering FAQ.	Call customer service with mobile device; Find why people why people are charged sales tax on Internet orders.

are online retailers selling fast moving consumer goods.

- *Apple (apple.com) :* producing electronic consumer goods;
- *QVC (qvc.com) :* home shopping TV channel with an online store;
- *JC Penning (jp.com) :* department store;
- *Barnes & Noble (bn.com) :* bookstore;
- *Amazon (amazon.com) :* online retailer.

c) *Prototype Cross-Platform E-commerce Website*

A prototype was designed to address the findings of both case studies. The selected design technique for the prototype is responsive web design. HCI principles defined by [3] and [4] are being used for this design. Methods that were used for the development of the prototype were based on the theories developed by [5] and [6], using Concur Task Tree (CTT) and State Web Charts (SWC) notation. The main section of the website design was based on the visual principles: complexity and order. Deng and Poole (2012) argue that the best result for a successful e-commerce website is based on a high degree of order and a moderate complexity.

The prototype had to support the tasks that were being executed during interviews. The tasks were based on a limited set of features, which represented all the different functionalities of the website according to the 80/20 rule as defined in [7]. The prototype had to be able to execute the online shopping tasks. Table I shows an overview of the tasks and how they relate to the design of the prototype.

The user interface is normally part of a multi-tier architecture in the real world where different layers are used for transactions, databases and so forth. This research focused only on the user interface itself and therefore no interactions with other layers were implemented. As a result, the search functionality and the actual user registration have not been supported.

Breaking points are crucial in the development of

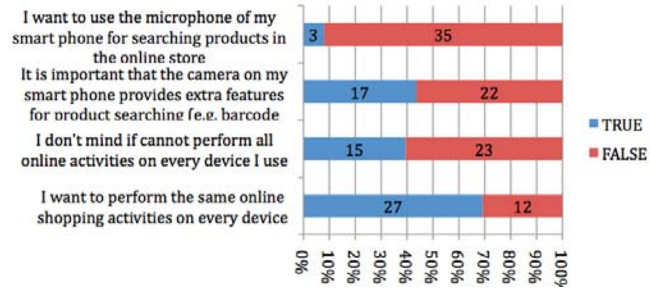

Figure 1 : Activities that you can perform in an online store

responsive web designs. Determining how many breakpoints are required is depending on the layout of the website. An iterative method has been used to determine the amount of breakpoints for the layout of the cross-platform e-commerce website. The first iteration starts with one breakpoint. The case study highlighted that websites without breaking points become unreadable for screen sizes that are used for smart phones. The first breakpoint is 768 pixels. The reason to select this point is the fact that the first and second generations of iPads have screen sizes of 768 pixels by 1024 pixels. Any device with smaller screen size than the first and second generation of iPads can be considered a smart phone. Reducing the screen size to less than 786 pixels can help identify other breakpoints. After identifying the first break point a HTML template was created that served as a basis for all the web pages for the prototype. Each web page is a copy of the template plus some additional features required for that specific page.

III. Evaluation and Analysis of Results

a) *Case Study Evaluation*

A survey has been conducted to analyze the case study. The questionnaire served two goals. The first goal was to gain feedback from people about the user context in which they use e-commerce websites. The second goal was to understand which of the following aspects are important for cross-platform e-commerce website design: composition, continuity and consistency. Participants were recruited amongst friends and colleagues plus the social networks FaceBook, LinkedIn, Yammer and an online community from the University of Liverpool to conduct a survey. In total, 39 people completed the survey. Three sets of statements were asked in relation to cross-platform composition, continuity and consistency. Participants had to answer them with true or false. The first set focused on statements related to the composition of a cross-platform e-commerce website. The results are shown in Fig 1.

The statements about the composition suggest that the majority of the participants would like to perform the same tasks on every device. Another observation is that the uses of device features like a camera and especially a microphone is not a hard requirement for cross-platform e-commerce websites. One of the reasons can be found in the case study where the camera and microphone features were tested. The noise level was considered too high in, for example and the store and barcode scanning only makes sense when you are close to the physical product. Even when you are close to the product, the store puts its own barcodes over the original codes, hence that this feature did not work anymore.

The second set of statements focused on continuity. Fig 2 shows the responses. The results suggest that the participants like to have their data available on all devices and the majority likes to

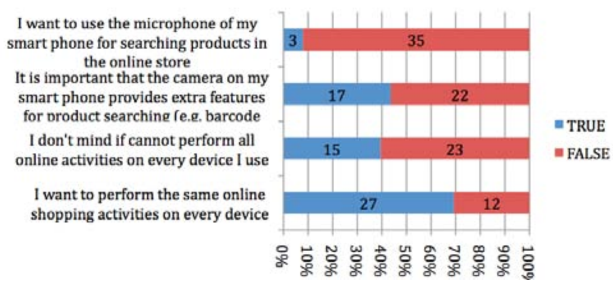

Figure 2 : Data synchronization when using multiple devices for online shopping activities

continue their tasks when switching devices.

The third set of statements focused on consistency. Fig 3 summarizes the responses. Based on the results, the conclusion can be drawn that the participants find the ease of use more important than the aesthetics of a website. The results do not show whether a website has to be exactly the same on every device or can be slightly different.

The results of the questionnaire are in line with the case study when it comes to continuity and consistency. They differ from a composition of the features perspective. During the case study, a traditional website and a native app were used and both had different features. The participants in the questionnaire preferred that the available features were the same for every device.

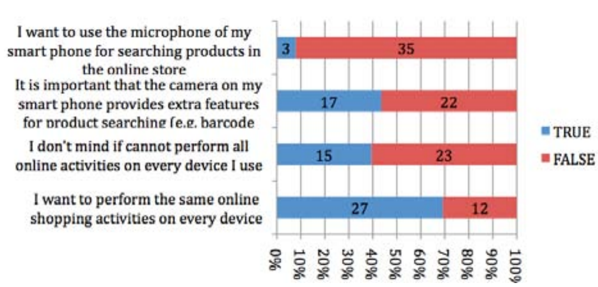

Figure 3 : The look and feel of the online store

b) Heuristic Evaluation of Prototype

The heuristic evaluation of the prototype took place in two steps. The first step was to validate the code using the Markup Validation Service and CSS Validation Service that has been made available by [8]. The prototype passes the Markup Validation and generated error during the CSS Validation. Main reason why it did not pass is because the CSS validation is using browser specific language. This is the trade off for a cross-platform application that needs to support multiple devices and browsers.

The second step was to test the prototype in different web browsers, with device emulators and on physical devices. The prototype works well in portrait mode and meets the basic requirements when it comes to web browsers and code validation. It does not display properly in landscape mode. The decision was made not to fix the landscape orientation issue in a second iteration. At this point, it is unknown what the user preference is for using applications on smart phones in relation to the orientation. The positions of the buttons and text on the device are made for portrait orientation. Furthermore, the screen to unlock the device and the home screen are in portrait orientation and forces users to start in this position. This suggests that the portrait orientation is the "natural" orientation in the eyes of the manufacturers. On the other hand, certain applications perform better in landscape orientation, such as applications to watch videos or playing games.

c) Information Architecture

The prototype has been verified against the information architecture. This was done by comparing the actual website to the navigation model. Links and buttons had to be on the expected pages. Figure 4 demonstrates that all links going out from the home page need to be made available.

d) Prototype Usability Test

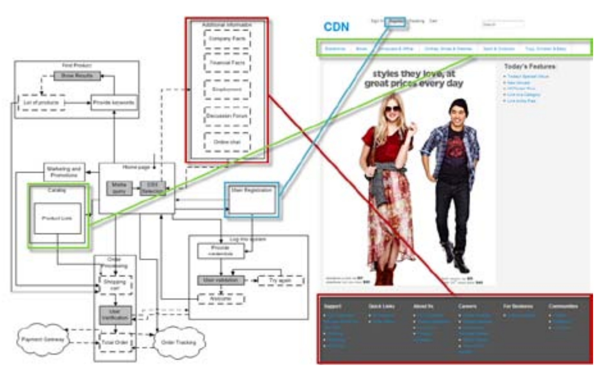

Figure 4 : Information architecture versus the prototype

The expectation of the usability test was to gain more insight from users on the acceptance level of cross-platform e-commerce websites regarding the ease of navigation. Interviews were conducted to analyze the usability of the prototype. The goal of the usability test was to generate concerns regarding the user interface. These concerns could be used to refine the design during future research activities. Nielsen (cited in [7]) suggests using the following formula to determine the percentage of usability problems that can be identified by users.

N=1-(1-L)n
Where:
N = Percentage of problems found
L = proportion of usability problems found by a single participant. 31% as suggested by Nielsen
n = number of user

Five participants were recruited for interviews. They were able to identify 85% (=1-(1-0.31)5) of the usability problems. All participants had online shopping experience and were familiar with smart phones, tablets and personal computers. Two of them were IT experts. All five users also responded to the survey. The usability tests were conducted in the office or at home because the survey highlighted that these are the locations where people shop online.

Participants in the usability test had to execute the following simple tasks using the prototype on their personal smart phone and PC. First all tasks were executed on their PC and then on their smart phone. They were observed while executing the following tasks and afterwards interviewed.

- Sign up for a new account;
- Find the price of a product;
- Find why people are charged sales tax on Internet orders;
- Go to Twitter to post a product review;
- On your mobile devices: call customer service.

All the participants were positive about the simplicity of the prototype site. It provided them with a clear overview and was readable on all devices. Three of them pointed out that they liked the consistent color scheme. Their overall impression of the website was good and indicated that they would use it again if it became a real web store site.

i. *Website Layout*

The test also highlighted three problems in usability. The first problem is related to the structure of the website. The layout is based on a model based on a header, main section and footer. The participants did not find the footer easily when they were using their smart phones. They missed an indication that more information was available at the bottom of the page. The website shows a scroll bar when visited with a PC, indicating that more information is available at the bottom.

ii. *User Interaction with Smart Phone*

The second problem is related to input mechanisms for the interaction between the smart phone and human beings. Four of the participants tried to swipe between the left side navigation and the main page. Participants explained that they expected swipe functionality because this would be more intuitive on a smart phone. This functionality was not available in the prototype.

iii. *Navigation Transformation*

The third problem is related to the navigation transformations, and influences the ease of navigation. The menu bar in the header changed into a menu button. Two participants had difficulties with finding the product catalog on their smart phones that became visible after clicking on the menu button. Potential future customers do not see the product catalog immediately when they visit the site for the first time with their smart phones. Hiding the product catalog behind a button takes away the information about which products are being sold. In line with the above observation is the feedback that was received about hiding links. If first time visitors had used their smart phone then they would not have known that more information was available compared to first time visitors using devices with a larger screen. This suggests that all features have to be available on all devices.

Additional feedback was received about search functionality during the usability test. This was the starting point for four participants to find the requested information. Furthermore, all participants indicated that it would be nice if the website would be able to offer product filters to minimize the search results (for example, price range).

IV. Conclusions

The aim of this study was to identify Human-Computer Interaction (HCI) design methods and techniques for the development of cross-platform e-commerce websites that can be used on multiple devices with different screen sizes and web browsers. These HCI design methods and techniques had to address the usability issues that can be found when using traditional websites in a cross-platform environment.

The study demonstrated that e-commerce websites could be used on multiple devices with different browsers by combining responsive web design with off-canvas layouts and HCI navigation transformations. Using this combination can solve usability issues found in traditional e-commerce websites. A case study related the usability issues to a theoretical framework, which consists of three categorizations: composition, continuity and consistency. Composition defines that the tasks should adapt to the user context. Identified usability issues were readability and tasks should be dependent on the user context. The evaluation of the prototype demonstrated that the readability issue can be solved with responsive web design but the task distribution shouldn't take place. Every device should offer the same features when it comes to e-commerce websites because they are only used in locations, which don't affect usability. The questionnaire confirmed that people like to visit e-commerce websites at home. Continuity describes that an amount data has to be available on every device. Consistency means that the look and feel is the same across multiple devices. The case study highlighted the fact that consistency is hard to maintain when using device specific applications and websites. Resolving this issue was achieved by developing a single website as a prototype that adapts to the user context.

The development of the prototype was based on the evaluation of existing e-commerce websites. A case study was used to evaluate the available features and to define a common layout. Two groups of features were identified: one related to the purchasing process and another related to providing additional information about the company. This was used as input for the design phase. The identified features were transformed into a task model, followed by a navigation model and finally into a conceptual design for the prototype. During the design process, the decision was made to make a difference in the available features depending on the device. The questionnaire and the feedback on the prototype showed that users like to have all features available on all devices instead of a differentiation per device. Furthermore, the decision was made to transform the horizontal navigation menu into a left navigation fly-out menu. The evaluation of the prototype demonstrated that users had difficulties with understanding the function of the menu button to find the product catalog. The chosen layout in the design phase for the prototype was based on the common layout, which was identified by the case study. It was based on a header, main and footer section. Participants had difficulties with finding the footer on the smart phones.

a) Usability Guidelines for Cross-Platform E-Commerce Websites

Based on the findings of this research, five usability guidelines for cross-platform e-commerce applications are recommended. They have a clear relevance to websites that are developed for multiple devices with different screen sizes and web browsers. Some of the guidelines can be applied to websites designed for a single type of device.

b) Identify user's needs

The design phase should start with understanding the tasks that users need to execute. E-commerce websites have primary tasks and secondary tasks. The primary tasks relate to the purchasing process and the secondary tasks provide additional features to the users. The tasks model will translate into a navigation model and finally into a conceptual design.

c) Be Context Aware

The device itself and the environment in which users execute their tasks define the context. Devices like smart phones and tablets have a smaller screen size compared to laptops and desktops. The environment is defined by the locations where the users prefer to shop online. The design of a cross-platform website has to fit in different contexts of use. Usability testing should be performed in every context.

d) Offer all functions on every device

It is unknown in which context the users will access the website for the first time. To make sure users have the best experience in any context, it is recommended that all tasks can be executed on every device. Users need to have immediate visibility on product information when they visit the web site.

e) Design Fluid Websites

The website has to adapt to the context to make sure it is readable and easy to navigate. A fluid website has this ability. It is based on a grid, which is able to respond to different devices. Images and typography resize depending on the used screen sizes. Designers should use navigation transformations to create a basic layout for devices with a smaller screen.

f) Use device specific input mechanisms

Every type of devices has different ways for interaction. Some devices use a touch screen and others a keyboard and mouse. Users should be able to use device specific features to navigate intuitively through the website to increase the user experience. Designers should not use device specific features to introduce new tasks for a specific device type.

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A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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