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Wireless Adhoc Network

Incentive Mechanism

Highlights

Dynamic Routing Protocol

Integrated Waveguide

Discovering Thoughts, Inventing Future

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# Wireless Measurement Scheme for Bandwidth Estimation in Multihop Wireless Adhoc Network

By GK Srinivasa Gowda, CV Srikrishna & Kashyap D Dhruve
*SSET, Ernakulum, Kerala*

*Abstract -* The necessity to bear real time and multimedia application for users of Mobile *Adhoc* Network (*MANET*) is becoming vital. Mobile *Adhoc* network facilitates decentralized network that can present multimedia users with mobility that they have demanded, if proficient *QoS* multicast strategies were developed. By giving the guarantee of *QoS* in *Adhoc* network, the proficient bandwidth estimation method plays a very important role. The research paper represented here presents a splendid method for estimating or measuring Bandwidth in *Adhoc* network whose character is decentralized in nature. Contrasting in the centralized formation, the bandwidth estimating in *Adhoc* is significant and this eventually makes an influence over the *QoS* of the network communication. The admission control and dynamic bandwidth management method which is presented here, facilitates it with fairness and rate guarantees despite the distributed link layer fair scheduling being absent. Alteration has been made over *MAC* layer and this method is appropriate where the peer-to-peer (*P2P*) multimedia transmissions rates are amended in compliantly fashion. In the research work presented here the architecture of the *MAC* layer has been altered and the data handling capacity has been increased. This technique is adopted to facilitate higher data rate transmission and eliminate congestion over the considered network.

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# Wireless Measurement Scheme for Bandwidth Estimation in Multihop Wireless Adhoc Network

GK Srinivasa Gowda [α], CV Srikrishna [σ] & Kashyap D Dhruve [ρ]

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*Keywords : QoS, bandwidth estimation, MANET, available bandwidth estimation, MAC alteration, bandwidth measurement, measurement techniques, multihop, mobile ad hoc networks.*

## I. Introduction

A decentralized multi hop wireless network and is referred as Adhoc network since every node is entrusted in forwarding its data, and so the strength of the node which forwards the data is made dynamically that is based on the connectivity of the network. Mobile *ADHOC* Networks *(MANETs)* facilitates composite distributed systems which include wireless mobile nodes that can autonomously and vigorously self-compose into erratic and temporary, "*ADHOC*" network topologies. In *MANETs* if a user wishes to use multimedia applications like audio and video conferencing, live streaming of audio and video files it requires an efficient *QoS* multicast method to be in place. *MAC* Layer performance and routing techniques generally provide for the *QOS* in *MANETs*. To formulate a trustworthy *QOS* in *MANET, QOS MAC* protocol, resource reservation techniques and QoS routing protocol a proper cooperation technique is to be adopted to achieve it [1]. Since the network topology in *MANET* changes continuously so, it is difficult to attain a good *QOS* routing. Best effort distributed *MAC* controllers are preferably used in accessible wireless ad hoc networks to attain a respectable *QOS* for real time application which is connected with the design of decentralized media access control *(MAC)* model.

Available bandwidth estimation is a most important part of the admission control for *QOS* in wired and wireless networks both. In wireless networks channel fading takes place persistently and there is also error induced from the physical obstacles due to which the available bandwidth endures rapid time In addition to this in the wireless network a shared-access medium exists because of which the available bandwidth changes with the number of hosts competing for the network. Wireless last-hop networks containing the *IEEE 802.11* protocol in Distributed Co-ordination Function *(DCF)* mode are becoming popular at dependent variations but these effects do not persist in the case of wired networks and thus makes the variable bandwidth measurement or estimation a challenging task.

A rapid rate. In DCF mode, the *802.11* protocol does not involve any centralized unit to co-ordinate user's transmissions. The *MAC* layer generally uses an *CSMA/CA* algorithm for common use of the medium. Bandwidth is generally related to spectral width of electromagnetic signals or propagation characteristic of communication system in physical layer communications, whereas in term of data networks, bandwidth refers to the data rate that a network link or a network path transfers. In this article we lay emphasis on estimation of bandwidth metrics in the later data network

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frame. Especially to packet networks, wherein the bandwidth refers to the amount of data/information that a link can deliver per unit time considered. In applications such as live streaming of audio or video data, file transfer the availability of bandwidth impacts the performance of the application directly. Multimedia based applications which are generally more responsive in networks exhibiting lower latency. Network latency minimization can be achieved through lower end-to-end delays, high bandwidth links and rather low packet transmission latencies. Bandwidth plays a very important role in various network technologies. Various applications can get benefited by knowing the characteristics of bandwidth in the network path. If we take the example of *P2P* applications we can clearly see that it creates variable user-level networks which based on the present bandwidth available between peers. Overlay network can organize their routing tables based on the availability of the bandwidth of overlay links. Network providers provide links to their customers and generally charges according to the bandwidth purchased. Service-Level-Agreements *(SLAs)* between providers and customers mainly define service in terms of availability of the bandwidth at key interconnection point. Network carriers generally plan capacity upgrade in their own network which is based on the rate of increase of bandwidth utilization of their users. Bandwidth is also is a main notion in content distribution networks, intelligent routing system, end-to-end admission control, and audio-video streaming. The presented research work presents an available bandwidth estimation method for *IEEE 802.11*-based wireless *AdHoc* network; this work is specially created for decentralized network. The presented research work employs the enhancements made to the *MAC* layer and then the data rate has been increased. The splitting of the *MAC* layer and then increasing data bit strength will enable achieving higher data transmission rates and reduced network congestion. Estimation of bandwidth which is available for a wireless host to each of its neighbor solely depends on the effect of the phenomena on the working of the medium access method.

The research paper has been organized in a way that the second section discusses some of the dominant literatures researches done for estimating and managing bandwidth in ad-hoc network. The third section of the paper represents some dominant key theoretical backgrounds of bandwidth estimation technique which is followed by next section that states our research contribution and techniques being implemented to attain the proposed measurement goals. The experimental study and results are discussed in the fifth section. The conclusion is discussed in the last section.

## II. Related Work

Bandwidth estimation and management mechanisms in networks have been researched upon for quite some time now. The swift growth in increasing requirement of the *QOS* oriented architectures that appropriately optimize the system functionalities and its overall performance are being invented and developed. Some of the dominating researches which are conducted for *QOS* optimization by implementing Bandwidth estimation are mentioned in this section. Research work [1] presents a protocol approach for access and routing facility, where the access is arbitrated by implementing synchronous signaling mechanism and the topology has been resolved by performing dissemination of node state. This work facilitates instinctive framework for providing arbitrating Radio frequency use and it employs the traffic mechanism to deliver *QOS*. *SWAN*, which is a stateless network model and uses a distributed control algorithm to bring service separation in mobile wireless ad hoc networks in a robust, simple and scalable manner, has been proposed in the research work [2]. An admission control and vibrant bandwidth management method which provides equality in the lack of distributed link level weighted fair scheduling is proposed in reference [3]. H. Luo et.al [4] projected a new scheme for packet scheduling which addresses this conflict. The significant contributions of this bandwidth estimation oriented work were, (a) a two tire service model, (b) an optimized algorithm for centralized scheduling, (c) a practical distributed back off based channel-estimation technique. A new distributive, localized, efficient and scalable solution to this problem has been in paper [5]. Ideal centralized fair queuing algorithm developed for ad hoc networks is being first analyzed and the desired global properties extracted. Then three localized fair queuing scheme has been proposed by the researchers. The work [6] represented various *QOS* requirements and elaborates the limitations and the advantages of the existing *QOS* routing protocol and comes with a QoS multicast Routing Protocol *(QMR)* with a variable hybrid method for *QOS* multicast routing. Literature [7] focused on multicast communication in ad-hoc networks and offered a simplification of routing trees into graphs that have more connectivity than trees and yet avoid long-term or enduring routing loops from happening.

For improving the Quality of Service *(QOS)* for multicast communication in *MANETs* some work has been presented in [8] *QAMNet* which propose the same.

Literature presented in [9] proposed a scalable *QOS* architecture in order to enhance the overall *QOS* for such networks. This method draws upon the positive aspects of both *IntServ* and *DiffServ*, and mainly extends upon the scalable *LANMAR* routing protocol to support *QOS*. A new *QOS*-aware medium access control *(MAC)*

protocol that takes the above requirements into thought is presented in research work [10] whereas [11] gives an outline of cross-layer design which approaches for resource allocation in 3G *CDMA* networks, summarizes state-of-the-art research results, and gives more research issues. A *QOS*-aware routing protocol that contains an admission control scheme and a feedback scheme to set up the *QOS* requirements of real-time applications has been proposed in [12]. A deterministic scheme of packet delay and how to use it to derive both the packet pair property of *FIFO*-queuing networks and a new system (packet tailgating) for dynamically measuring link bandwidths has been proposed in the paper [13]. The time scales of significance range from a few milliseconds to a few minutes are presented in paper [14]. They also examine a phenomenon of compression (or clustering) of the probe packets comparable to the acknowledgement compression phenomenon recently experimented in *TCP*. The investigation of cause of these errors has been presented by Prasad [15], and showed that the presence of Layer-2 $L_2$ store-and-forward devices, which include Ethernet switches, have a nun-favorable effect on the correctness of VPS tools. Generally, each $L_2$ store-and-forward device adds additional serialization latency in a packet's delay, which results in constant underestimation of that L3 hop's capacity. The findings from a large-scale study of Internet packet dynamics observed by tracing 20,000 *TCP* bulk transfers between 35 Internet sites has been presented in paper [16]. An end-to-end scheme, called Self-Loading Periodic Streams *(SLoPS)*, for measuring available bandwidth presented by Jain [17]. *SLoPS* implemented in the tool known as path load. Two available bandwidth measurement methods, first one is the initial gap increasing *(IGI)* method and the other is packet transmission rate *(PTR)* method presented in paper [18].

## III. Theoretical Background

This presented section describes the theoretical background and few key factors in estimating bandwidth in Ad-Hoc network.

### a) Bandwidth-Related Metrics

We introduce three bandwidth metrics: available bandwidth, capacity, and Bulk-Transfer-Capacity *(BTC)* in this section, the first two of which are defined for both individual links as well as end-to-end paths, and *BTC* is generally defined for end-to-end path. The next section discusses the differences between links at the data link layer and links at *IP* layer. We consider the *1st* as segments and *2nd* as hops. A segment generally represents a physical point-to-point link, to a shared access local area network, or to a virtual circuit. But, a hop consists of a sequence of one or more segments, which can be connected through bridges, switches, or some other layer-2 devices. Generally we classify and end-to-end path P from a *IP* host S which serves as source to a host V which serves as sink as the order of hops which connects S to V.

### b) Capacity

A segment or a layer 2 link in normal circumstances transfers data at a constant bit rate, which is the broadcast rate of the segment. This rate is *10Mbps* on a 10 Base *T* Ethernet segment, and a rate of *1.544 Mbps* on a $T_1$ segment. The broadcast rate of a segment is restricted by the physical bandwidth of the fundamental propagation medium and its optical or electronic transceiver hardware. Due to its overhead of layer-2 encapsulation and framing a hop delivers a lower transmission rate then its normal rate at the *IP* layer. Let us consider that the nominal capacity of a segment is $C_{L2}$, the transmission time for an *IP* packet of size $L_{L2}$ bytes is

$$_{L3} = \frac{L_{L3} + H_{L2}}{C_{L2}} \ldots\ldots\ldots (1)$$

Here, $H_{L2}$ represents the total layer-2 overhead that is needed to summarize the IP packet. So the capacity $C_{L3}$ of that segment at the *IP* layer can be defined as

$$C_{L3} = \frac{L_{L3}}{_{L3}} = \frac{L_{L3}}{\frac{L_{L3} + H_{L2}}{C_{L2}}}$$

$$= C_{L2}\frac{1}{1 + \frac{H_{L2}}{L_{L3}}} \ldots\ldots\ldots (2)$$

The *IP* layer capacity mainly depends on the size of the *IP* packet which is comparative to the layer-2 overhead. If we consider the *10BaseT* Ethernet, $H_{L2}$ is *38 bytes (12* bytes for the inter frame gap, 18 bytes for the Ethernet header, and the equivalent of 8 bytes for the frame preamble) and $C_{L2}$ is *10Mbps*. So the hop can deliver with a capacity of *7.24Mbps* for *100 – bytes* packets, and *9.75 Mbps* for *1500 – bytes* packets to the *IP* layer. Let us assume that the Maximum Transmission Unit *(MTU)* is *1500 bytes* whereas the layer-2 overhead (without any additional data-link encapsulation) is *8 bytes* for *PPP* transmissions.

We describe capacity $C_i$ of the hop *i* to be the maximum possible *IP* layer broadcast rate at the same hop. We can see from equation 2 that the maximum transmit rate at the *IP* layer result from *MTU*-sized packets. So, we can define the capacity of the hop the bit rate which is measured at the *IP* layer, at which the hop can transmit *MTU*-sized *IP* packets. If we extend the previous definition to a network route, capacity *C* of an end-to-end path is maximum *IP* layer rate that the path can transmit from source to sink or we can say that the capacity of a path provides an upper bund on the *IP* layer throughput that a user can get assured to get from

that path. The end-to-end capacity $C$ is determined by the maximum link capacity in the path, i.e.

$$C = \min_{i=1,\ldots,H} C_i \quad \ldots\ldots\ldots (3)$$

Here, $C_i$ is defined as the capacity of the $i^{th}$ hop and number of hops in the path is determined by H. the narrow link on the path is the hop with minimum capacity. Some of the paths contain rate limiters or the traffic shapers which make the definition of capacity complicated. Considerably a rate limiter at a link can transfer a "peak" rate $P$ for a definite burst length $B$, and a comparative lower "sustained" rate S for longer bursts. As we consider the capacity as an upper bound on the rate a path can transmit, it is beneficial to define the capacity of such a link to be based on peak rate S relative to the sustained rate $P$. Where as, a rate limiter produces only a part of its basic segment capacity to an *IP* layer hop. We can see the example like ISP's often use rate limiters to distribute the capacity of a *OC - 3* link between different customers, taking charge from each customer which is based upon the magnitude of the bandwidth distribution. The capacity of that hop is defined as the *IP* layer rate limit of that hop. Some layer-2 scheme do not function with a constant broadcast rate, we can see as instance we can see, *IEEE 802.11b* wireless *LANs* has a transmission rate of *11, 5.5, 2, or 1Mbps,* which depends on the bit error rate of the wireless medium. During the time gaps in which the capacity remains constant we can use the previous elaboration of link capacity for such technologies.

*c) Available Bandwidth*

Existing bandwidth of a link or end-to-end path is another important metric. The existing bandwidth of a link is related to the unused or free capacity of the link for a definite time period. Even if the capacity of the link depends on the underlying transmission scheme and propagation medium, the existing bandwidth of a link moreover depends on the network load at that link, and is usually a time-varying metric. At any given instant in time, a link is either transferring a packet at the full link capacity or it is idle so, the immediate utilization of a link can only be either "0" or "1" thus a significant definition of available bandwidth requires time averaging of the immediate utilization over the time burst of interest. We can represent the average utilization $\bar{\mu}(t-\tau,t)$ for a time period $(t-\tau,t)$ is given by

$$\bar{u}\,(t-\tau,t) = \frac{1}{\tau}\int_{t-\tau}^{t} u(x)\,dx \quad \ldots\ldots\ldots (4)$$

Here, $u(x)$ represents the instantaneous available bandwidth of the link at time $\tau$, we can refer time length as the average timescale of the existing bandwidth. Figure 2 will illustrate this averaging effect.

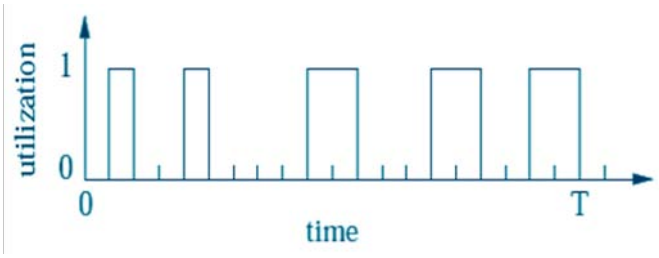


*Figure 1 :* Instantaneous utilization for a link during a time period *(0, T)*

The use of link is restricted to *8 out of 20* in this example between *0* and *T*, which yields an average use of *40%* now we will define the available bandwidth of a hop $i$ over a fixed time interval. The average available bandwidth $Ai$ of hop $i$ can be represented by utilizing fraction of capacity,

$$A_i = (1-u_i)C_i \quad \ldots\ldots\ldots (5)$$

Here, $C_i$ represents the capacity of hop $i$, and $u_i$ represents the average utilization of that hop in a certain given time interval. If we extend the definition what we have studied previously to a $H$ hop path, the bandwidth which will be available then is the minimum available bandwidth of all $H$ hops,

$$A = \min_{i=1,\ldots,H} A_i \quad \ldots\ldots\ldots (6)$$

The hop which has the minimum existing bandwidth is known as the tight link *1* of the end-to-end path. A *"pipe model with fiuld traffic"* presentation of of a network path, where a pipe represents each link is represented in figure 3. The width of the each pipe corresponds to the comparative capacity of their corresponding link. The utilized part of the link's capacity has been represented by shaded area, whereas spared capacity is represented by unshaded area. The end-to-end capacity is determined by the minimum link capacity $C_i$, whereas the end-to-end available bandwidth is determined by the minimum available bandwidth $A_i$. As shown in the figure 3, there is a difference between the path and the tight link.

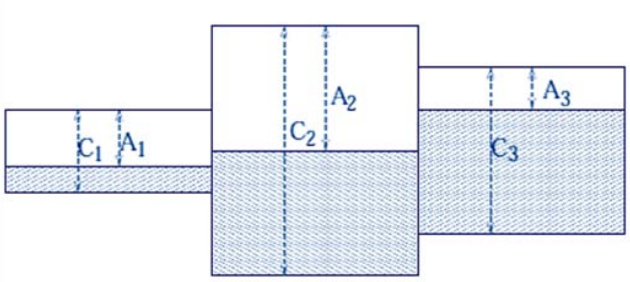


*Figure 2 :* Pipe model with fluid traffic for 3-hop network path

Various methodologies to measure existing bandwidth make the supposition that the link utilization remains stable when averaged over time, i.e. they suppose a stable network load on the network path. As

this hypothesis is logically over moderately short time bursts, diurnal load variations will make a change in measurements made over longer time bursts.

We can note that traffic variability or long-range dependency effects cannot be prevented by constant average utilization. As the average available bandwidth changes frequently with a certain time period so, it is needed to measure it quickly. This is very much useful for the application that uses the available bandwidth measurement to adapt their transfer rate. If we look at the capacity of a path it remains constant for a long interval of time so, the capacity of path need not to be measured in a hurry as compared to the available bandwidth.

*d) TCP Throughput & Bulk transfer capacity*

Throughput of a *TCP* connection is a very important bandwidth-related metric in *TCP/IP* networks as, *TCP* is the most important transfer protocol in the Internet which carries almost the *90%* of the network load [19]. So, a *TCP* throughput metric will be of a great significance to the end users. It is not an easy task to define the throughput of a *TCP* connection exactly. Various factors may cause change in *TCP* throughput which includes type of the cross network load such as *UDP* or *TCP*, the numbers of the connecting *TCP* connections, transfer size, the buffer size of the *TCP* socket at both sender and receiver's end, congestion along the acknowledgement path, router buffer's size, capacity and load of every link in the network route. *TCP* Throughput can also be affected by the selection of the primary window size [21], change in the requirement and implementation of *TCP*, as New Reno [20], Reno, or Tahoe, use of *SACK's* [22] versus *CACK's* and numerous other parameters. If we take the example of a typical web page, throughput of small transfer mainly depends on the Round-Trip Time *(RTT)*, congestion time, and slow-start scheme of *TCP*, rather than on the bandwidth which exists on the path. In addition to this when we use diverse versions of *TCP*, the throughput of a large *TCP* transfers over a fixed network path can vary drastically even when the available bandwidth is similar.

The Bulk-Transfer-Capacity *(BTC)* [21] usually defines a metric which represents the attainable throughput by a *TCP* connection. *BTC* is the highest throughput which can be obtained by a single *TCP* connection. *TCP* Congestion control algorithm which is specified in *RFC* 2581 [22] must be implemented in the connection. A *BTC* measurement must give in detail various other important parameters about the accurate implementation of *TCP* at the end hosts [21] because, *RFC* 2581 leaves some performance details open. Here we can note that the available bandwidth and *BTC* are essentially different metrics. Available bandwidth does not depend on the particular transport protocol whereas the *BTC* is specified by *TCP*. The *BTC* depends fully upon the how *TCP* shares bandwidth with other *TCP* flows, whereas available bandwidth metric normally assumes that the average network load remains fixed and estimates the extra bandwidth that a path generally offers before its tight link gets drenched. We elaborate this point by supposing a single-link path with capacity is being saturated by single *TCP* connection. Due to path saturation, we know that the available bandwidth in this part will be zero, but the *BTC* comes around *C/2* if the *BTC* connection uses the same *RTT* as the previous *TCP* connection.

## IV. Our Contribution

In our presented research work the bandwidth estimation scheme has been implemented as an essential component in the construction of: (a) a dynamic bandwidth management scheme for single-hop mobile ad hoc networks, and (b) an explicit rate-based flow control scheme for multi-hop mobile ad hoc networks.

In this proposed technique the *MAC* layer has been divided into two sub layers, in which the common sub layer transmits the data bits while another one is responsible for transmitting the control signals. In spite of the sub-layering *MAC* the *PHY* has been optimized for higher data rate and with optimal power efficiency. The data rate has been increased at this layer thereby increasing network throughput with minimized network congestion, maintenance count, networks overheads, and end to end delay with highly monitored data transmission.

*a) Available Bandwidth Estimation*

Stages in the transfer of a single packet using the *IEEE 802.11 DCF MAC* protocol has been shown in figure 4. Throughput of transferring a packet is measured as

$$TP = \frac{S}{T_r T_s} \dots\dots\dots(7)$$

Here the size of packet is represented by *S*, time when *ACK* is received is *tr* and *ts* represents the time when the packet is ready at the *MAC* layer. $T_r$-$T_s$ Is the time interval which includes channel busy and contention time. Since the channel condition is different to each one so the throughput estimates kept separate to different neighbors.

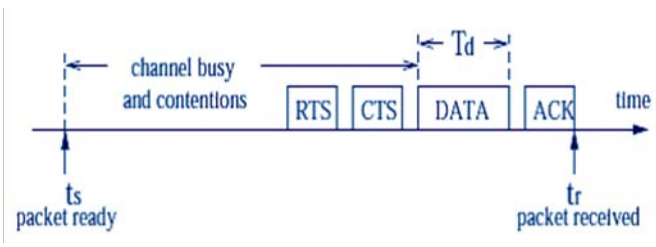


*Figure 4 :* IEEE 802.11 Unicast packet transmission sequence

Any other wireless host which is well within the reach of its broadcasting range is the neighbor of a wireless host. The effect of the contention on available bandwidth is captured by the link layer measurement method. $T_r$-$T_s$ Will increase if the contention is high and similarly the throughput *TP* will decrease. This scheme also facilitates the capture of effect of fading and interference error as, if the *RTS* or data packets get affected by this then they have to be re transmitted, this then increases the $T_r$-$T_s$ and subsequently decreases the available bandwidth. Thus our available bandwidth measurement scheme takes into an account by the phenomena causing it to diminish from the theoretical maximum channel capacity. We should take this into consideration that we can measure the available bandwidth only by using the successful link layer broadcasting of an ongoing data flow.

The measured throughput of the packet generally depends on the size of the packet and is directly proportional to it as the large packet sends more data once it grab the channel therefore it has more throughput. For the throughput to be not depends upon the packet size, we generally normalize the throughput to a pre defined packet size. In Figure 4, the actual time for the channel to transmit the data packet is represented by

$$Td = \frac{S}{BW_{ch}} \quad \ldots\ldots\ldots(8)$$

Where *BWch* represents the bit rate of the channel. We take the channel bit rate as pre defined. The broadcasting time of the two packets should be differ only in their times to transfer the *DATA* packets. Therefore, we have:

$$(T_{r1} - T_{s1}) - \frac{S_1}{BW_{ch}} = (T_{r2} - T_{s2}) - \frac{S_2}{BW_{ch}}$$

$$= \frac{S_2}{TP_2} - \frac{S_2}{BW_{ch}} \quad \ldots\ldots\ldots(9)$$

Here, $S_1$ represents the actual data packet size, and *Pre-defined* standard packet size is represented by $S_2$. During the course of simulation we generally varies the packet size from 64 bytes to 640 bytes and send the network load from one host to another. The raw throughput which we measured is normalized a standard packet of size 512 bytes. The raw throughput which generally depends upon the size of the packet is directly proportional to it whereas, normalized throughput does not depend upon it. Therefore to remove the disturbance introduced by the considered raw throughput from packets of different sizes we use the normalized throughput to be represented as the bandwidth of the wireless link. Robustness of the *MAC* layer bandwidth estimation is the one another main issue. To eliminate the bandwidth in the current time window we use the measurement of the bandwidth of a link in discrete time intervals by taking out the average of the throughputs in recent packets in the past time window.

Since the channel condition changes at time intervals so this estimation may not be perfect. Now, to evaluate the estimation error, we run a *CBR* flow with the use of *UDP* having data rate 160 kbps from one node to another in a 10 node one hop environment. The background network load contains one *TCP* flow in the light channel contention case, and seven *TCP* flows in the heavy contention case. The main to reason to use the *TCP* only is to generate a cross-traffic with bursts to the *UDP* flow. By using the average of packet throughput in the past time window we can measure and normalize the throughput of the *CBR* flow in every 2 seconds.

*b) Channel Time Proportion and Admission Control*

Bandwidth estimation scheme has been used in the admission control in single- and multi-hop wireless networks which was also used in the previous section. The concept of channel time proportion *(CTP)*, using a simple example is introduced. Let us assume that the throughput *TP* over a specific wireless link is 10 *MAC* frames of a specific size *S* per second, based on the point of argument and substantial error experienced on this link. Suppose a specific flow requires 3 frames over this link between the neighbors. Thus it need to be active must on the sending host's interface for 30% of unit time, on an average therefore, this leaves only 70% of unit time existing to other flows out of the interface, which affects their admission directly, we can also extend this logic to bits per second. Suppose K bits is being transmitted over a wireless link in a second, where a specific level of contention and physical error is present, and a user requires a minimum throughput of *E* bits per second, then from this effect user needs *1/k* of unit time on the source interface. Basically by dividing bandwidth requirement in bits per second by the available bandwidth which is estimated we can obtain the *CTP* requirement of a flow. The *CTP* obligation is a portion. Generally admission control divides up to 100% channel time on an edge among the various flows based on their requirement and some fixed fairness standard.

i. *Dynamic Bandwidth Management in Single-hop Ad hoc Networks*

Admission control and dynamic bandwidth management method which we represented in the paper give fairness and rate guarantee even in the absence of distributed link layer fair scheduling. The methodology is normally applicable where peer-to-peer multimedia broadcasting which need to adapt their broadcasting rate co-operatively such as smart-rooms. With particular *CTP* requirement we generally map minimum and maximum bandwidth needed of a flow.

The main part of the methodology, a bandwidth manager *(BM)*, a share of channel is allotted by the *BM* to each flow depending upon the need relative to the other flows. To obtain minimum *CTP* the *BM* uses an algorithm known as max-min fair algorithm. To make the admitted flow only occupy the channel for a burst of time allotted to them flows control their transfer rate co-operatively. Since, the existing bandwidth changes thus the network load change, then the channel access time for each individual flow has been re-allocated by the *BM*. By doing the simulation we can see that every flow in the network receives at least minimum requested share of the network bandwidth at a very low cost and with greater probability.

ii. *EXACT*

It is a rate based explicit flow control which is planned for the multi-hop ad hoc network situation. In this, data transfer rate of the flow, which is passing the router is determined by each router, which is generally based on the measurement of the bandwidth of the outgoing wireless links. First the request of every flow is transformed into a request for channel time fraction, and using the max-min fairness standard the total channel time is allocated to the contending flows.

## V. Results Obtained

The presented research work has been implemented with Dot net tool with provided operating conditions. In this research work the developed architecture for enhanced packetization scheme at *MAC* layer has provided a significant system enhancement and yielded much better results. Here in this research paper the comparison for both centralized and decentralized *AdHoc* network has been done and the graphs illustrating network congestion, throughput, transmission error rates and the utilization of bandwidth has been obtained. In spite of these dominating parameters a crisp and alarming facts has been observed that justifies the robustness and high performance of the presented system architecture for bandwidth estimation.

Figure 6 represents the comparative result illustrating the average congestion measured for both centralized as well as decentralized network topology. From figure it can be stated that the proposed technique has exhibited a very uniform with minimum congestion as compared to the centralized topology which is having much higher congestion load that decreases as per the increase in network size. The result data states that the proposed system has reduced the congestion by approximately two times.

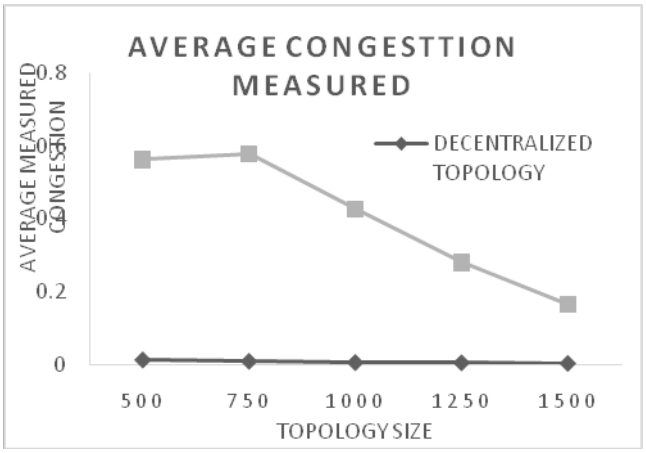


*Figure 6 :* Congestion measured for centralized and decentralized network

The ascending graph (Figure 6) for network throughput states that the overall network throughput is also higher by *0.01%* as compared to existing centralized system. Meanwhile Figure 7 illustrates the transmission error rates and the proposed system is found to be more productive as compared to the existing systems. One of the striking results has been found to for network congestion rate. The proposed scheme of bandwidth estimation has illustrated the congestion rate reduction five times better as compared to existing one. Thus the developed system architecture has presented a highly potential solution for *QOS* oriented bandwidth estimation technique.

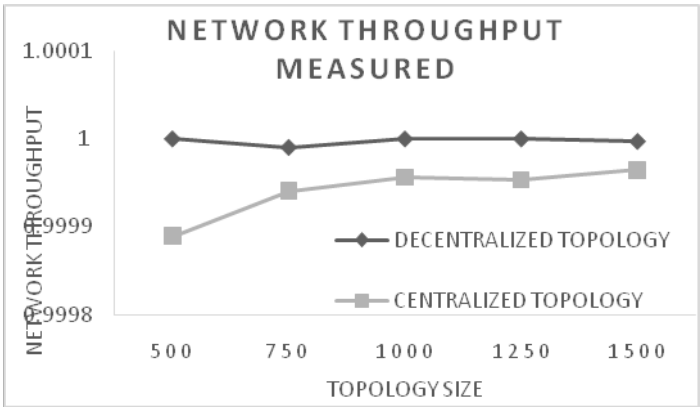


*Figure 7 :* Network throughput measured

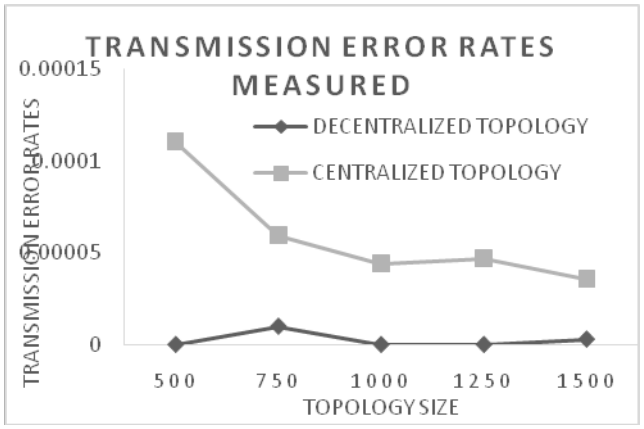


*Figure 8 :* Transmission error rate measured for centralized and decentralized AdHoc network

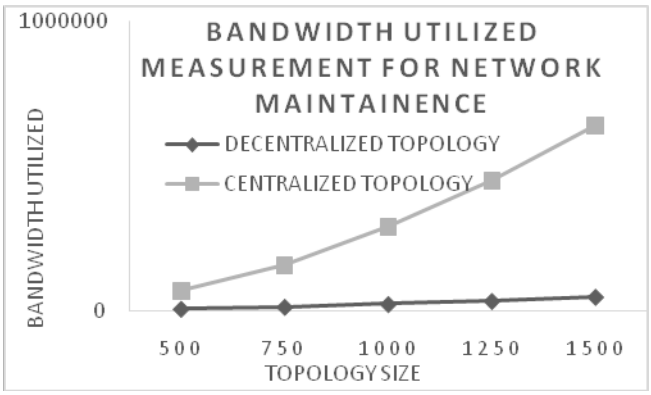


*Figure 9 :* Bandwidth utilized in centralized and proposed topology

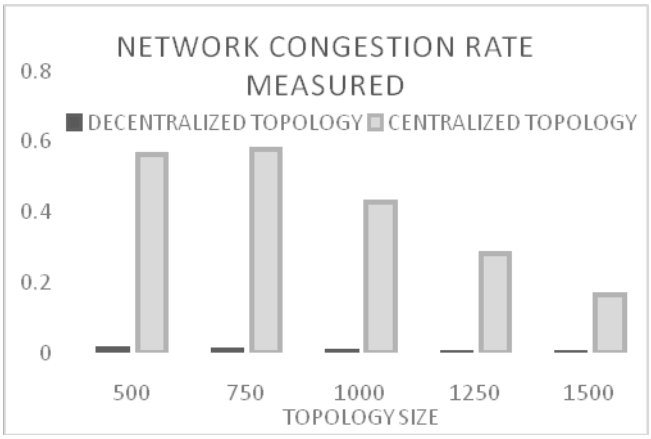


*Figure 10 :* Network Congestion rate for

## VI. Conclusion

In this research work effective and optimized system architecture for *QOS* oriented bandwidth estimation has been proposed where the scheduling at the *MAC* layer has been modified and the slots has been prepared to transmit the data, thus by increasing the data rate as well as increasing higher bandwidth utilization. The overall system architecture developed on Microsoft Visual Studio 2010 platform has exhibited highly optimized results based on quality oriented parameters like network throughput, network congestion rate, transmission error rate, bandwidth utilization, maintenance count packets, and end to end delay, monitoring overheads etc. the developed system architecture has illustrated the reduction of *160%* in network congestion and the overall network throughput has also increased by *0.01%.* The number of maintenance count has been reduced drastically. Thus the proposed system has exhibited a highly potent mechanism for bandwidth estimation.

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# Ku-Band Substrate Integrated Waveguide (SIW) Slot Array Antenna for Next Generation Networks

By Sourav Moitra, Asish Kumar Mukhopadhyay & Anup Kumar Bhattacharjee
*Jadavpur University, India*

*Abstract -* The design of an antenna based on Substrate Integrated Waveguide (SIW) has been realized in this paper. The structure consists of an array of slot antenna designed to operate in Ku-band applications. The effect of introducing arrays of slots has been extensively studied unlike any other recent publications in this field. The basic structure has been designed over a dielectric substrate with dielectric constant of 3.2 and with a thickness of 0.782mm. The design consists of a SIW antenna fed with a microstrip to SIW transition. Multiple slot array effects have been studied and analyzed using CST Microwave Studio full wave EM Simulator which supports Finite Element Method (FEM) of computational Electromagnetics. The design has been supported with its return loss and radiation pattern characteristics to validate Ku-band operation. The effect of increasing the number of slot arrays has also been analyzed to support integration to System-on- Substrate (SoS) which promises more compact layouts.

*Keywords :* *substrate integrated waveguide (SIW), dielectric filled waveguide (DFW), ku-band, antenna design.*

*GJCST-E Classification :* *C.2.1*


*Strictly as per the compliance and regulations of:*

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Sourav Moitra [α], Asish Kumar Mukhopadhyay [σ] & Anup Kumar Bhattacharjee [ρ]

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## I. Introduction

The next generation communication networks require ultra-wide bandwidth for which transmission antennas are required to operate in the Ku-band in particular for satellite and mobile communication. Nowadays, antenna design in Ku-Band has been one of the major focused areas. Ku-band systems have wide applications in satellite communications, especially in the mobile antenna systems used in vehicles. Apart from communication networks, there are several other application areas of Ku-band systems such as weather radars and fire detection radars. These systems need highly directive antennas with a very wide frequency band covering the entire Ku-Band to transmit signals to the receiver with equal power in the whole frequency range and an automatic tracking system to capture the maximum power incident from the satellite while the time and place of the receiver changed.

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Array antennas have several applications in communications systems. They are usually developed using microstrip or waveguide technologies. However, with the development of a novel technology called substrate integrated waveguide (SIW), it is possible to attain many advantages like low cost, reduced sizes, easy integration, etc [1].

Substrate Integrated Waveguide (SIW) has emerged as a new concept for millimeter-wave (mm-wave) integrated circuits and systems for the next generation due to their manifold advantages. A waveguide based on SIW is considered as a dielectric filled rectangular waveguide whose metallic walls are formed by cylindrical via arrays with diameter *d* and separation *p* between vias (pitch). SIW yields high performance from very compact planar circuits [2].

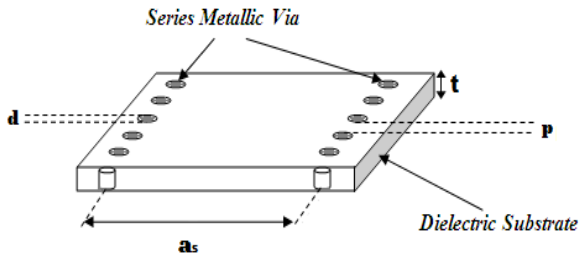


*Figure 1 :* Basic SIW structure realized on a dielectric substrate

## II. SIW Antenna Design

SIW are integrated waveguide-like structures fabricated by using two rows of conducting cylinders and slots embedded in a dielectric substrate that connect two parallel metal plates (Fig. 1). In this way, the non-planar rectangular waveguide can be made in planar form compatible with existing planar processing techniques. SIWs exhibit propagation characteristics similar to that of classical rectangular waveguides. The modes of the SIW practically coincide with a subset of the modes of the rectangular waveguide, namely with the $TE_{n0}$ modes, with $n = 1, 2, \ldots$ In particular, the fundamental mode is similar to the $TE_{10}$ mode of a rectangular waveguide, with vertical electric current density on the side walls. TM modes cannot exist in the SIW, due to the gaps between metal vias: in fact, transverse magnetic fields determine longitudinal

surface current. Due to the presence of the gaps, longitudinal surface current is subject to a strong radiation, preventing the propagation of TM modes [3]. Moreover, SIW structures preserve most of the advantages of conventional metallic waveguides, namely, high quality-factor and high power handling capability [4].

*a) Feed Design*

The proposed structure has been fed with a conventional microstrip line. The section of the microstrip line connecting the radiating surface has been tapered for proper impedance matching. The structure used is commonly known to us as 'Microstrip-to-SIW Transition'. Several other transition techniques can be consulted in [3].

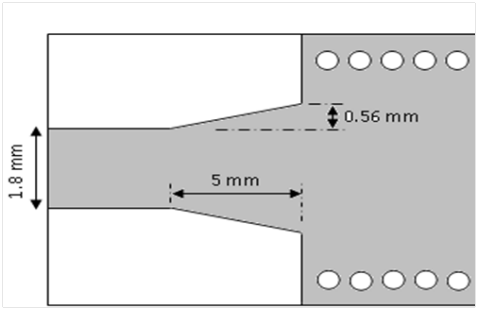


*Figure 2 :* Microstrip-to-SIW Transition

*b) SIW Slot Antenna Array Design*

Since SIW design generally works in $TE_{1,0}$ mode, so here m=1, n=0. Therefore the equation for cutoff frequency reduces to,

$$f_c = \frac{c}{2a} \tag{1}$$

For DFW (dielectric field waveguide) with same cut off frequency, dimension "$a_d$" is found by:

$$a_d = \frac{a}{\sqrt{\epsilon_r}} \tag{2}$$

Having determined the dimension "$a_d$" for the DFW, we can now pass to the design equations for SIW, which may be given as,

$$a_s = a_d + \frac{d^2}{0.95p} \tag{3}$$

where, $a$ is the total broad side dimension of the rectangular waveguide, $a_s$ is the separation between via rows (centre to centre), $a_d$ is the width of DFW, $d$ is the diameter, $p$ is the pitch (as shown in Figure 1) and $c$ is the velocity of light in free space [5-7].

Also TE and TM modes represent Transfer Electric Mode and Transfer Magnetic Mode respectively. The suffixes m and n represents number of half waves in the x and y direction considering z as the direction of wave propagation.

The cut-off frequency of the SIW can be obtained using the above design equations. In our design we focused on the Ku-band applications and in our case the antenna has been designed to resonate at frequency of 16GHz. The dimensions of the slots are important for the antenna to behave as a slot antenna. The dimensions of the slots can be obtained with the help of the following relations.

$$b = \frac{\lambda_0}{\sqrt{2(\epsilon_r + 1)}} \tag{4}$$

Dimension of $c$ doesn't matters much but should be less than half of $b$. The gap between centre to centre of slots has been considered as $\frac{\lambda g}{2}$ whereas the gap between the last slot and the closing face has been taken as $\frac{\lambda g}{4}$ (Figure 3).

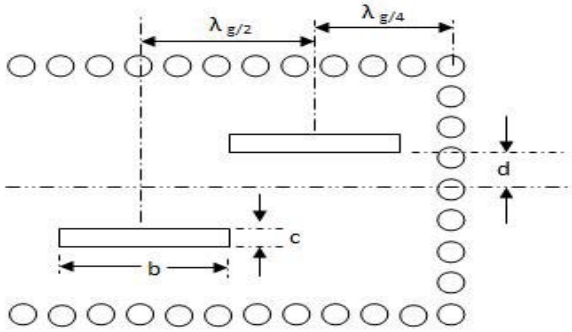


*Figure 3 :* Slot dimensions & gap between slots

The final structure as obtained after a microstrip to SIW transition with 2 slots has been shown in Figure 4. The return loss of the 2 slot structure as obtained using EM CAD tool has been shown in Figure 5. The antenna has been found to resonate at 15.75GHz with a return loss of 15dB.

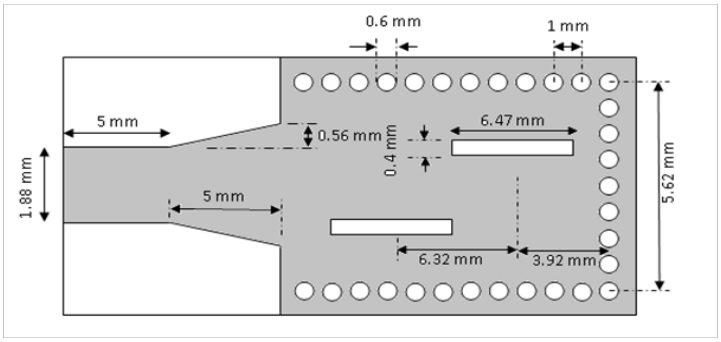


*Figure 4 :* Dimension for 2 slot SIW array antenna

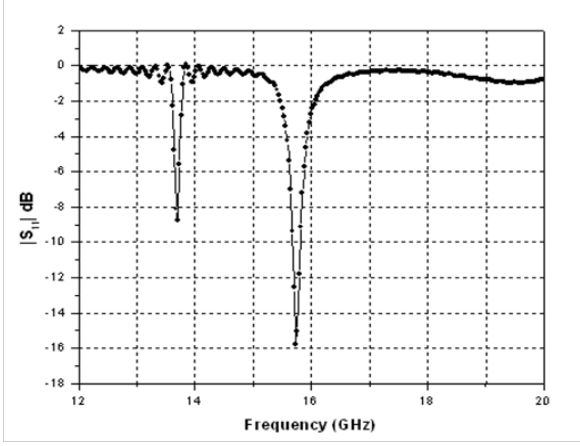


*Figure 5 :* S-parameter of 2 slot SIW array antenna

Our next objective has been to increase the number of slot and the effect on the return loss characteristic has been studied. The 2 slot array structure has been modified into a 4 slot array structure and the antenna has been found to resonate at 16.16GHz with a return loss of 16dB.

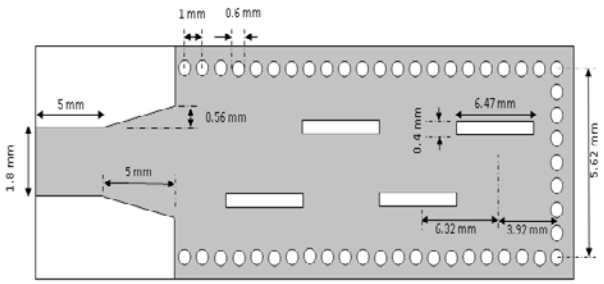


*Figure 6 :* Dimension for 4 slot SIW array antenna

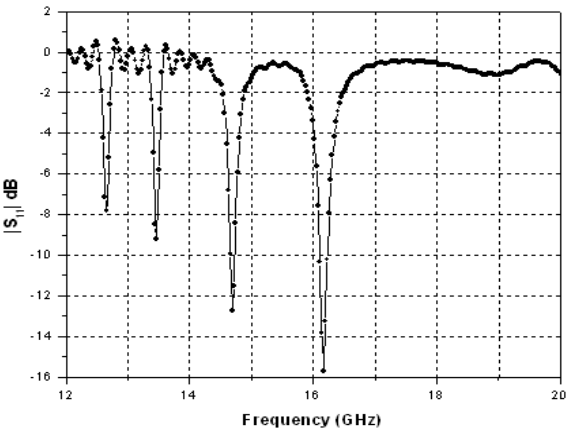


*Figure 7 :* S-parameter of 4 slot SIW array antenna

The 4 slot array structure has been modified to 6 slot array and the effect has been studied. The structure and the s-parameter of the 6 slot array have been shown in Figure 8 and Figure 9 respectively.

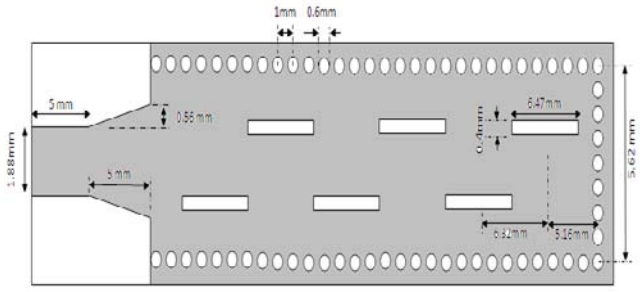


*Figure 8 :* Dimension for 6 slot SIW array antenna

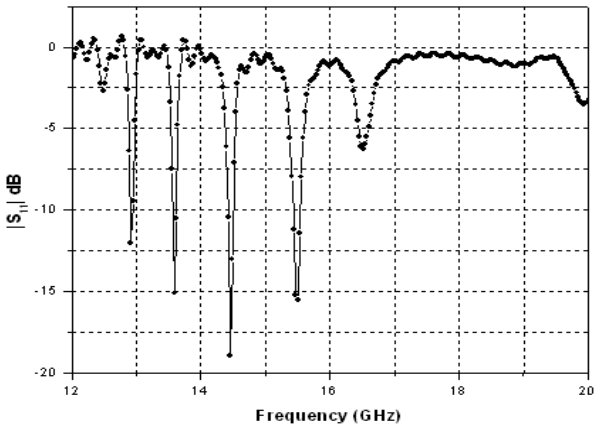


*Figure 9 :* S-parameter of 6 slot SIW array antenna

The 6 slot structure has been found to resonate at 15.5GHz with a return loss of 16dB. As found in 4 slot array structure, the increment of slots is creating separate resonant frequencies. In case of 6 slot array the structure tends to resonate at some other nearby frequencies within Ku-band. The antenna may be made to resonate at one single desired frequency by careful adjustments of the slot dimensions.

*Table 1 :* Comparison between multiple slot array antenna

| No. of Slots | Resonant Frequency | Return loss (dB) | Gain (dBi) |
|---|---|---|---|
| 2 | 15.75 | 15 | 3.7 |
| 4 | 16.16 | 16 | 5.7 |
| 6 | 15.5 | 16 | 6.3 |

## III. Radiation Pattern

The simulated radiation pattern (co-pole & cross-pole) of the multiple slot array antenna based on SIW technology has been shown in Fig. 10. The results show that the structure comes with a constant gain over the entire band of resonance with an increase of gain with greater number of slots.

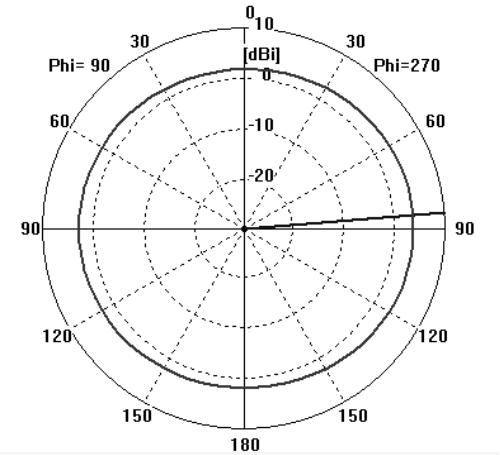


*Figure 10 (a) :* Radiation pattern of 2 slot array antenna (Co-polar)

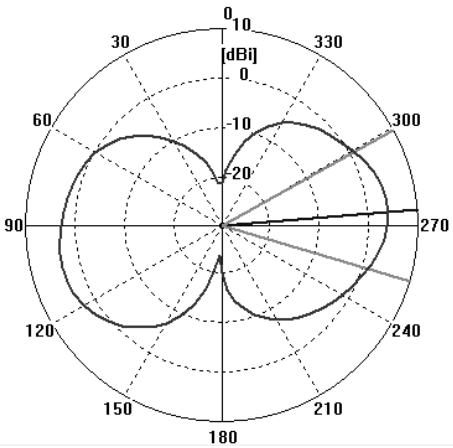


*Figure 10 (b) :* Radiation pattern of 2 slot array antenna (Cross-polar)

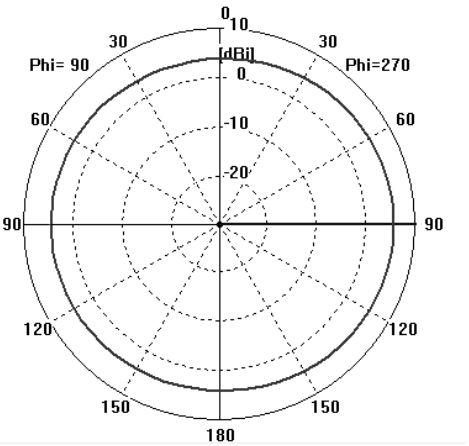


*Figure 10 (c) :* Radiation pattern of 4 slot array antenna (Co-polar)

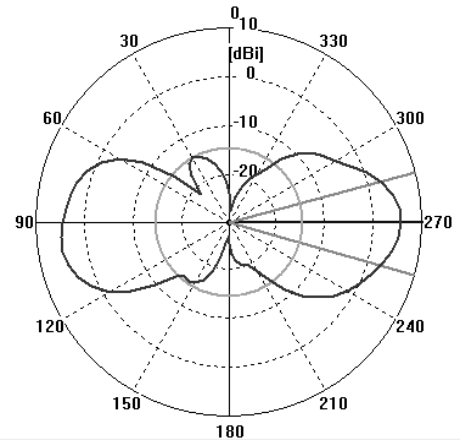


*Figure 10 (d) :* Radiation pattern of 4 slot array antenna (Cross-polar)

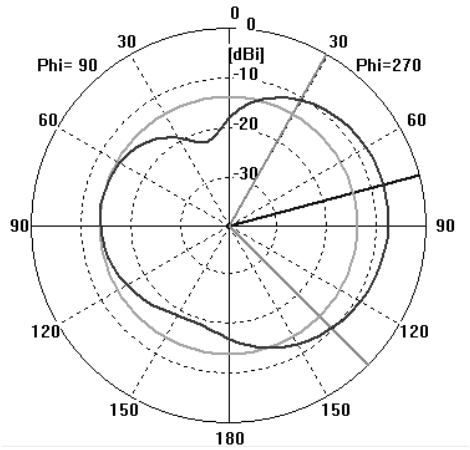


*Figure 10 (e) :* Radiation pattern of 6 slot array antenna (Co-polar)

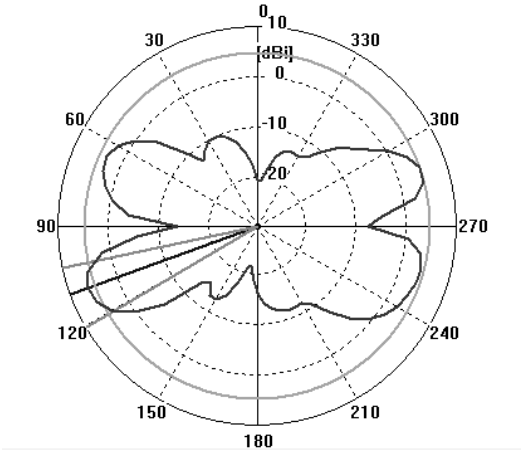


*Figure 10 (f) :* Radiation pattern of 6 slot array antenna (Cross-polar)

## IV. Conclusion

Antenna based on SIW technology has been proposed in this article. The structure can find wide application in Ku band radar and remote sensing mechanism. Significant increment of gain parameter has been obtained for introduction of more number of slots. The effect has been extensively studied unlike any other recent publications in this field. The structure is very simple and development of the prototype is easy in presence of advanced fabrication technology.

## Acknowledgement

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# An Efficient Multi Path Dynamic Routing Protocol for Computing and Constrained Mobile Ad-hoc Network Environment

By Zabi Ur Rahaman. K, Dr. M. Giri & Dr. M S Shashidhara
*CMJ University, Shillong*

*Abstract* - Wireless mobile ad-hoc networks are classified as ad-hoc networks with logical connections. These types of networks do not have fixed topology (or physical connections) due to the mobility property of nodes, interference, propagation and loss of path. Because of all these problems the path established between sources to destination is not reliable and efficient path. Hence a dynamic source routing protocol is required for these networks to working properly. Data transfer using this protocol based on shorted path, all packets need to be transferred using same path. The researcher on MANET proposed many Routing algorithms to this task. The main idea of this paper is to study, understand, and analyze the problems with existing routing methods. In the proposed multi path dynamic routing, first identify multi paths exist between source to destination and select best shortest path and then data is segmented into packets, each packet is transferred to receiver using selected best shortest path. At receiver end received data need to be rearranged. Finally the performance proposed system is compared with existing methods and proposed method shows better performance when compared with existing methods.

*Keywords :* *multi-path, 3D network, dynamic routing, packet segmentation and reassembly.*

*GJCST-E Classification :* *C.2.2*


*Strictly as per the compliance and regulations of:*

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## I. Introduction

A personal computer or desktop computer intended for computing purpose. It is fixed in a single location with modern devices. It is mainly working on 1D (one dimension) of computer science area, i.e., computing. Desk top computers are also called as standalone systems. If the person wants to use this category of system, they must be present at room where the system is located, because personal computer is fixed in a single position. The environment setup of standalone systems are shown in figure1.

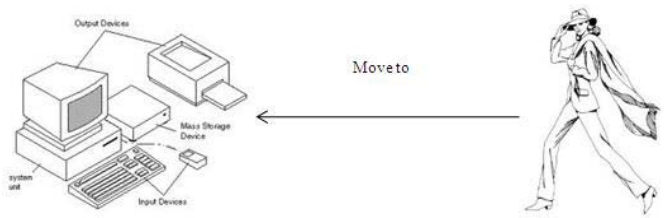


*Figure 1 :* Standalone system computing environment

Client-server model is architecture of a network in which a lot of clients are inter-connected with server. In this model, Client always request service from server, if the requested service is available immediately it is provided to client. Client system provides an interface to user to request services from the server. Many clients can access information from server simultaneously at the same time; a client computer can execute other tasks, such as sending mails. Both client and server are considering as intelligent systems, the client-server model is completely different from stand alone systems. A client server model working on 2D (two dimensions) of computer science, one is computing and other one is communication. That is, within this model client and server communicate with each other. In this model all the devices are fixed in a standard place. The environment setup of client server model is shown in figure 2.

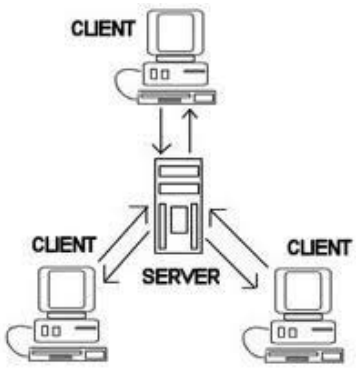


*Figure 2 :* Client server computing environment

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*Mobile computing* evolves during the most recent years as a need of portable and growing networks called wireless networks. Mobile computing enlarges the usability of systems, but raises many demanding challenges issues. Mobile computing working on 3D (three dimensions) of computer science, they are computing, communication, and mobility. In mobile computing mobile agents are connecting for computing and also communicating by moving its position. This property is called mobility. Mobile computing is also called as location independent computing.

Mobile computing provides computing for the users are who work from numerous locations. Seamless mobility of mobile agent "connect" from any of the location, at any time based on their convenience of use (no extra setup is required like "plug and play") same computing environment is sufficient, same services, in spite of location Mobile users may be willing to give up some performance for mobility. The environment setup of mobile computing is shown in figure 3.

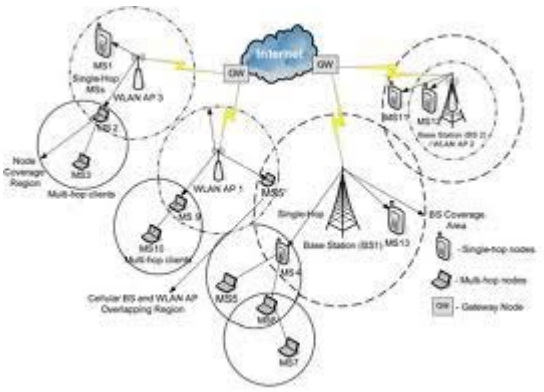


*Figure 3 :* Mobile computing environment

*a) A taxonomy of routing protocols for ad hoc networks*

This section provides a short overview of the different aspects of routing protocols for mobile ad hoc networks. Routing protocols are needed whenever delivered data packets need to be handed over several nodes to arrive at their destinations. Routing protocols have to find routes for packet delivery and make sure the packets are delivered to the correct destinations. The existing routing protocols such as distance vector routing and link-state routing were originally designed for static, wired networks and dynamic topology was not considered.

Routing protocols for ad hoc networks can be classified into different categories according to the following criteria:

Pro-active, re-active or hybrid
Centralized or distributed
Dynamic or static

The first criterion will be discussed in the next paragraph. As for the second criterion, when a routing protocol is centralized, all decisions are made at a centre node, whereas in a distributed routing protocol, all nodes cooperate, usually in a symmetric way, in order to reach a routing decision. The third criterion is concerned with the nature of the information used for the routing process. A dynamic protocol may change behavior according to the network status, which can be congestion on a link or many other possible factors. A link may fail unexpectedly, or a new link may be added.

A dynamic routing protocol must discover these changes, automatically adjust its routing tables, and inform other routers of the changes. The process of rebuilding the routing tables based on new information is called convergence. Static protocols on the other hand do not change when the network status changes, the changes must be added manually. An example of a static protocol is flooding; in which a node always retransmits an incoming packet, unless it already sent the same packet earlier.

*b) Pro-active, re-active and hybrid protocols*

The routing protocols for ad hoc networks can be classified in three different classes: pro-active protocols, re-active protocols and the hybrid protocols. These three classes differ in a number of ways.

Pro-active protocols (or table-driven protocols) work in a way similar to wired networks: they try to maintain an up-to-date map of the network, by continuously evaluating known routes and attempting to discover new ones. This way, when a path to a destination is needed at a node, or a packet needs to be forwarded, the route is already known and there is no extra delay due to route discovery. On the other hand, keeping the information up-to-date this way may require a lot of bandwidth, which is sparse, and battery power, which is limited in mobile ad hoc networks and even then information may still be out-of-date. The Distance-Vector protocols fall in the pro-active class.

Unlike pro-active protocols, re-active protocols (on-demand protocols) only start a route discovery procedure when needed. When a route from a source to a destination is needed, some sort of global search procedure is started. This does not require the constant updates being sent through the network, as in pro-active protocols, but it does cause delays, since the routes are not available and need to be found. In some cases the desired route(s) are still in the route cache maintained by nodes. When this is the case there is no additional delay since routes do not have to be discovered. Protocols such as DSR and AODV [1] are members of the re-active protocol class.

Pure pro-active protocols are likely not fit for ad hoc networks where nodes move a lot, because of the high traffic overhead caused by continuously updating the network information. On the other hand, pure re-active protocols may also have their problems; extreme delays and excessive control traffic, may make them unfit for certain applications.

Hybrid protocols combine the advantages of both pro-active and re-active routing, by locally using pro-active routing and inter-locally using re-active routing. This is partly based on the assumption that most communication in mobile ad hoc networks takes place between nodes that are close to each other, and the assumption that changes in topology are only important if they happen in the vicinity of a node. When a link fails or a node disappears on the other side of the network, it has only effect on local neighborhoods; nodes on the other side of the network are not affected. The ZRP is an example of a hybrid routing protocol.

Mobile ad hoc networks are deployed currently since they provide some features which are difficult or impossible to be emulated by conventional networks. MENET applications are range from the defense sector to general transportation to providing useful infrastructure during disaster recovery. Because of the significance attached to the applications of Mobile ad-Hoc networks security in ad-hoc networks is a latest research area and already substantial research is done in this field.

Routing plays a very important role in mobile ad-hoc networks which has been done by routing protocols and is used to route the packets depending on the path constraints. The design of network routing protocols for mobile ad-hoc networks is a challenging problem. These ad-hoc networks need efficient algorithms to determine network topology, link connectivity, and routing. A best approach is to consider routing algorithms in which network connectivity is determined in the process of establishing routes. Routing in a decentralized environment where network topology fluctuates is not a well-defined problem. The shortest path from a source to a destination in a static network is usually the optimal route this idea is not fit for mobile computing. The network should be able to adaptively alter routing paths to alleviate if any of these problems arises.

Most of the wireless ad-hoc networks probably prepare single source shortest path between participating nodes to transfer data. But, with shortest path some problems are occurred due to limited bandwidth. Route overhead is the one of the burning issue in shortest path routing protocols (all packets are transfer using same path, one packet is under transmission rest of the packets are in waiting stage, so the total turnaround time is increased). Hence we propose a new method of multi path dynamic routing protocols to address route overhead problem, where each packet use one of the path from multiple paths exist between participating nodes.

The main motivation is to identify the list problems in mobile ad-hoc networks like reducing the delay and route overhead occurred in single source shortest path.

The primary goals of this paper are to reduce transmission delay, route overhead between participating nodes in mobile ad-hoc networks using multi path dynamic routing instead of conventional shortest path routing.

Wireless mobile ad-hoc networks are classified as networks where nodes are logically connected with each other. These types of networks do not have fixed topology due to the mobility property of nodes, interference, propagation and loss of path. Hence a dynamic source routing protocol is required for these networks to working properly. Data transfer using this protocol based on shorted path, all packets need to be transferred using same path. The researcher on MANET proposed many Routing algorithms to this task. The main idea of this dissertation is to study, understand, and analyze the problems with existing routing methods. In the proposed multi path dynamic routing, first identify multi paths exist between source to destination and select best four paths and then data is segmented into four parts, each part is transferred to receiver using different paths which are already selected. At receiver end received data need to be rearranged. Finally the performance proposed system is compared with existing methods and proposed method shows better performance when compared with existing methods.

The remaining sections of the paper are structured as follows. We begin by describing the problem statement and objectives of the paper in section 2. In section 3, we present a new architecture of proposed system. In section 4, we discuss experimental setup of our proposed system. In section 5, discuss related work. Finally, section 6 gives conclusions and direction of future work.

## II. Problem Description

Current Ad-hoc routing protocols inherently trust all participants. Most Ad-hoc routing protocols are cooperative by nature and depend on neighboring nodes to route packets. This naive trust model allows malicious nodes to paralyze an Ad-hoc network by inserting erroneous routing updates, replaying old messages, changing routing updates or advertising incorrect routing information. Mobile ad-hoc network research is extended by using some factors. Factors such as power expended, variable wireless link quality, propagation path loss, fading, multi-user interference, and topological changes, become relevant issues.

Unlike their wired counterparts, design of software for mobile devices must consider resource limitation, battery power and display size. Consequently, new hardware and software techniques must be developed. Many Problems are exist with Ad-hoc routing protocols. The previous Researchers proposed many methods for transfer of data from one mobile agent to other. The Research dissertation studies a set of problems that are faced during mobile computing. A

mobile user must be able to deal with the problems like slow even though expensive connection lines, frequent interruption of connection to failures, limited mobile host performance. Requirements for mobile agent services are stability, bandwidth or cost considerations, integration into the well-known environment, application transparency, and extendibility. Proposed method for ad-hoc networks maximize total network throughput by using all available nodes for routing and forwarding.

There are two major differences between their proposals and existing methods. First, we construct multiple paths for the destination network and with the help of the performance monitoring ours may provide route with better performance. Second ours can get some novel paths that are not obtained by the existing one. Ad-hoc networks maximize total network throughput by using all available nodes for routing and forwarding. However a node may misbehave by agreeing to forward packets and then failing to do so, because it is overloaded, selfish, malicious or broken. Misbehaving nodes can be a significant problem. Although the average loss in throughput due to misbehaving nodes is not too high, in the worst case it is very high.

Researchers in mobile computing proposed many methods to transmit data from one mobile agent to other based shortest path and moreover they routes may be static routing or dynamic routing. These methods estimated the network bandwidth before transmit the data, and also select a single path to transmit data. Suppose bandwidth is greater than the data size, data is segmented into packets and packet are numbered with serial numbers and transferred to receiver. At receiver end all the packets are rearranged to restore original data. This research dissertation intended to address some of the problems and limitations of the use of single source shortest path static/dynamic routing. Problem with single source shortest is all packets are travelled using single path, route overhead, traffic, heavy load problems are raised. This method focuses on the following objectives:

- Focusing on the role of mobile agent and identifying list problems when a document is transfer from one mobile agent to other. Studying the solutions to these problems.
- Identification of dynamic routing between mobile agents.
- Presenting the method which is used to identify multiple paths from source mobile host to destination mobile host.
- Examining a number of available techniques that can be applied to distribute data from one mobile agent to other by solving these problems to achieve better performance.

## III. Architecture

Sender side architecture of proposed system is shown in figure 4. The main idea of proposed system is to use some routes from all pair shortest path between source mobile hosts to destination host. Architecture of proposed model has following components:

- Job size estimation
- Bandwidth estimation
- Load analyzer
- Job dispatcher
- Route decider

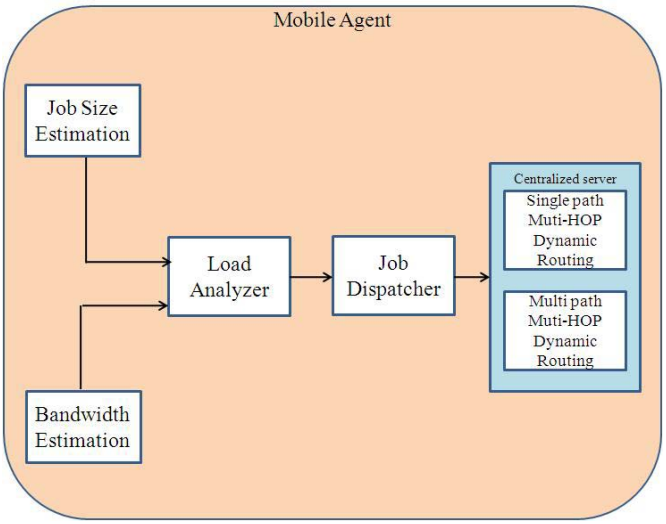


*Figure 4 :* Architecture of Mobile Agent at Sender Side

Source mobile agent generates a message or data and then size of the generated job is estimated. Find multiple paths from source to destination. Arrange paths based on distances and choose best paths. Next, estimate the network bandwidth. Data /job size is greater than network bandwidth then job is segmented into four smaller jobs and each job is dispatched through one shortest paths. So, all smaller jobs are transmitted to receiver through different channel which reduces route overhead and network traffic.

Receiver side architecture of proposed system is shown in figure 5. Architecture of proposed model has following components:

- Job receiver
- Job reassembly
- Display contents
- Job size Estimation

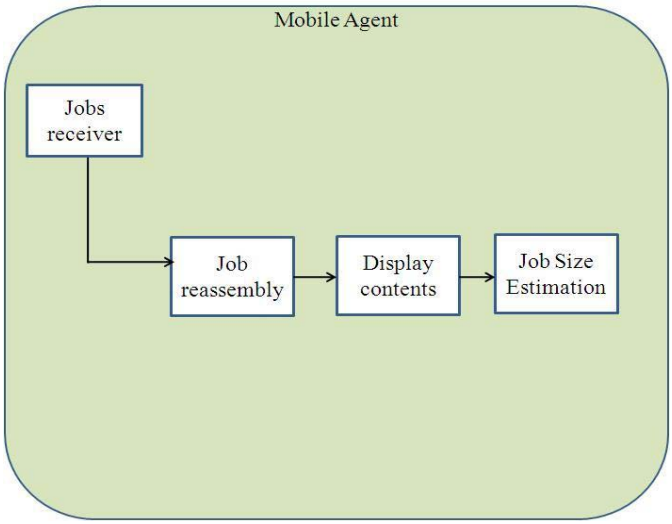


*Figure 5 :* Architecture of Mobile Agent at Receiver Side

At the receiver end first receiver receives data from various routes and rearranges the data into an order and final data is displayed to the user. At the receiver end received data size is estimated and it is compared with actual size. If both are equal then there is no loss of information or data during transit.

## IV. Experimental Results and Discussions

The experimental set of the proposed system is shown in figure 6, network is setup with 42 nodes (seven columns and six rows), and all these nodes are wireless nodes.

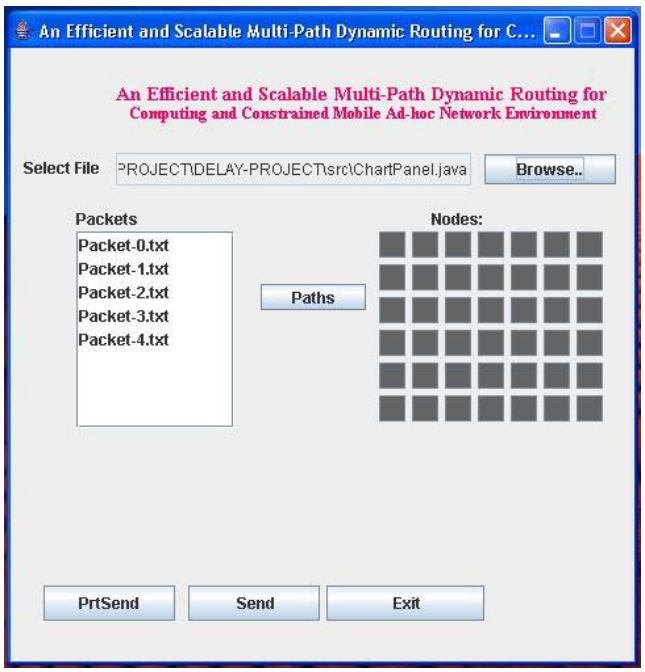


*Figure 6 :* Experimental Setup

Connections between these nodes are established dynamically, based on the necessity. Then the mobile node has to select a file to transfer to destination, once file is selected by the mobile user, immediately it is segmented into packets based on size of the file, for instance selected file is segmented into five packets is shown in the packet window. After segmentation process mobile agent select paths, for example source node is ACT0 and destination is ACT41, then multiple paths between source to destination is depicted in figure 7. Then send packets to destination using single or multiple paths.


*Figure 7 :* Multiple path from source to destination

At destination side, maintain a watch window to see route and how many packets received it is shown in figure 8 and 9, arrival time of packets are calculated and is shown in figure 10.

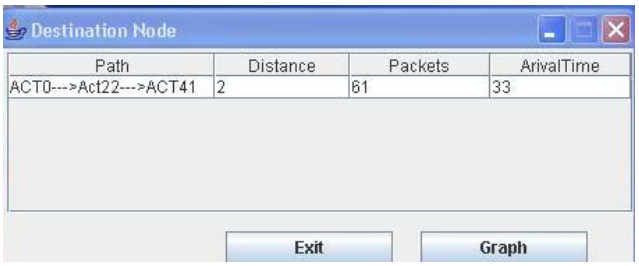


*Figure 8 :* Destination Node

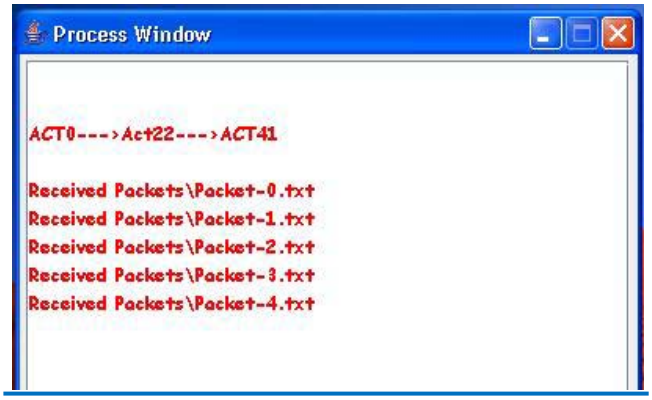


*Figure 9 :* Process Window


*Figure 10 :* Total arrival time of packets

Existing methods of data transfer using static or dynamic routing algorithm uses a single source shortest path. Let data is divided into N packets. In order to transmit a packet using shortest path requires N units of time. To transfer N packets requires N * N units of time. Therefore total time complexity is O (N2). In our proposed scheme data is divided into packets and each packet is transmitted through a single path from four selected shortest path. Therefore in order to transmit complete data N units of time is required; the time complexity of proposed system is approximately equal to O (N). Proposed method shows better performance when compared with existing methods.

## V. Related Work

Previous works have considered single source shortest path routing approaches to improve path performance and multiplicity. For example, miro [9], rbgp[10], yamr [11] and path splicing [12] also allow for discovery of additional inter domain routes besides BGP. Path Splicing gives a new routing primitive using splicing bits to accomplish the inter domain routing. Although it can bring up with the flexibility of the route selection, it does not essentially add new routes. RBGP and YAMR, through pre computing a few strategically chosen failover paths, ensure that Internet domains stay connected as long as the underlying network is connected. This method is used to avoid the link failure but cannot provide the path multiplicity and flexibility. Ours can not only avoid the link failure but also can select the routes with the higher performance.

In [5, 6], the structure and components of mobile backbone based on ad hoc wireless networks are defined. A Mobile Backbone Network (MBN) consists of a backbone network (Bnet), access networks (Anets), and regular ad hoc networks. Thick solid lines connecting large solid circles represent the Bnet. Dashed ovals consisting of thin solid lines connecting small solid circles represent the Anets. The small solid circles and the thin dashed lines connecting them to each other represent the regular ad hoc networks. MBN is designed so that it involves a sufficient but not excessive number of backbone nodes, while providing high coverage, so that a high fraction of the low-power nodes can access at least Backbone Node (BN) through one hop.

A problem with the use of distance vector routing protocols in networks where hosts are moving, is the likelihood of forming routing loops. In order to eliminate this likelihood, Perkins and Bhagwat have newly proposed adding sequence numbers to routing updates in Destination-Sequenced Distance Vector (DSDV) protocol [16]. These sequence numbers are used to match up to the age of information in a routing update, and allow each node to preferentially choose routes based on the fresh information. DSDV also uses trigger routing update to speed route convergence. In order to damp route variation and reduce congestion from large numbers of trigger updates after a route changes, each node in DSDV maintain information about the frequency with which it seems route changes and may delay some routing updates.

Dynamic source routing protocol is an approach to few source routing protocols used in wired r wireless networks, such as in the IEEE 802 SRT Bridge [17]. Route request packet serves basically the same role in route finding as an “all paths explorer” packet. But, in wired networks, a bridge can copy an all paths explorer from one network interface onto other interfaces and that the explorer will flood the network in a logical and complete way. Some protocol includes optimizations such as caching h sender address, request id i pairs to efficiently overflow explorers through a wireless network. We can also make extensive use of caching and can successfully make use of promiscuous receive mode in the network interface to optimize dynamic route discovery.

## VI. Conclusion

The previous Researchers proposed many methods to transfer of data from one mobile agent to other. The Research dissertation studies a set of problems that are faced during mobile computing. A mobile user must be able to deal with the problems like slow even though expensive connection lines, frequent interruption of connection to failures, limited mobile host performance. Requirements for mobile agent services are stability, bandwidth or cost considerations, integration into the well-known environment, application transparency, and extendibility. Proposed method for ad-hoc networks maximize total network throughput by using all available nodes for routing and forwarding.

The research study reveals that, proactive (DSDV) routing protocol consumes more and more bandwidth, because of the frequent broadcasting of routing updated information. While the Reactive protocol (AODV) is somewhat better than DSDV as it doesn’t maintain routing tables at nodes which results in less overhead and more bandwidth. In mobile computing many methods are used to transmit data from one mobile agent to other based shortest path and moreover they routes may be static routing or dynamic routing. These methods estimated the network bandwidth before transmit the data, and also select a single path to transmit data. All the data is transmitted using a single path only. In our proposed method data is segmented into four parts and each part is transmitted to receiver using different paths, which reduces transmission time. Proposed method shows better performance when compared with existing methods. in the proposed method only we consider file size and shortest path, in future we are planning to add

some more parameters like cost to increase the quality of service.

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# Ant-Based Routing Schemes for Mobile Ad Hoc Networks

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*Abstract -* An ad-hoc network is a collection of mobile nodes, which communicate over radio. These networks have an important advantage; they do not require any existing infrastructure or central administration. Therefore, mobile ad-hoc networks are suitable for temporary communication links. This flexibility, however, comes at a price: communication is difficult to organize due to frequent topology changes. Routing in such networks can be viewed as a distributed optimization problem. A new class of algorithms, inspired by swarm intelligence, is currently being developed that can potentially solve numerous problems of modern communications networks. These algorithms rely on the interaction of a multitude of simultaneously interacting agents. A survey of few such algorithms for ad hoc networks is presented here.

*Keywords :* *ad-hoc networks, swarm intelligence.*

*GJCST-E Classification :* *C.2.2*


*Strictly as per the compliance and regulations of:*

# Ant-Based Routing Schemes for Mobile Ad Hoc Networks

Dr. B. Narayana Babu [α], Dr. C.S. Ramanathan [σ] & Mr. M. Amenraj [ρ]

*Abstract -* An ad-hoc network is a collection of mobile nodes, which communicate over radio. These networks have an important advantage; they do not require any existing infrastructure or central administration. Therefore, mobile ad-hoc networks are suitable for temporary communication links. This flexibility, however, comes at a price: communication is difficult to organize due to frequent topology changes. Routing in such networks can be viewed as a distributed optimization problem. A new class of algorithms, inspired by swarm intelligence, is currently being developed that can potentially solve numerous problems of modern communications networks. These algorithms rely on the interaction of a multitude of simultaneously interacting agents. A survey of few such algorithms for ad hoc networks is presented here.

*Keywords :* *ad-hoc networks, swarm intelligence.*

## I. Introduction

In general case, ad-hoc networks are defined as networks formed by users or devices wishing to communicate, without the necessity for the help or existence of any infrastructure or previously established relationship between the potential network members. Ad-hoc communication can take place in different scenarios and is independent of any specific device, wireless transmission technology, network or protocol. Some examples of the possible uses of ad hoc networking include sensor networks, search and rescue operations, vehicle communication networks, and possible military applications, etc.

### *a) Overview*

In particular, we expect that ad hoc networks will be formed in situations where no infrastructure is available. As for the mode of operation, they are basically peer-to-peer multi-hop wireless networks where information packets are transmitted in a store and forward manner from a source to an arbitrary destination, via intermediate nodes. The network topology changes dynamically and in an unpredictable manner since the nodes can move freely. Therefore, outdated topology information must be updated or removed. Since there is no centralized entity to keep the topology up-to-date, a *distributed algorithm* is required.

Finding a route to a destination requires exchange of control information among the nodes. Thus, the amount of update traffic can be quite high when the number of highly mobile nodes is large. Thus, the highly dynamic nature of ad hoc networks motivates the study of routing protocols, which aim at achieving *routing stability*.

Again the wireless communication media has a limited bandwidth, which is susceptive to various interferences that can lead to establishment of useless routes, low throughput and other problems. Some of the protocols assume that the communication links are symmetric. Although this assumption is not always valid, it is usually made because routing in asymmetric networks is a relatively hard task. In certain cases, it is possible to find routes that could avoid asymmetric links, since it is quite likely that these links imminently fail. The issue of symmetric and asymmetric links is one among the several challenges encountered in ad hoc networks. Mobile hosts are powered by battery. Hence, energy efficient routing protocols are required to minimize power consumption.

### *b) Desirable Properties of Ad-hoc Routing*

As for the mode of operation, ad hoc networks are basically peer-to-peer multi-hop mobile wireless networks where information packets are transmitted in a store-and-forward manner from a source to an arbitrary destination, via intermediate nodes. In such networks, routing decision depends on many factors including topology, selection of routers, initiation of request, and specific underlying characteristic that could serve as a heuristic in finding the path quickly and efficiently. The desirable properties of a routing protocol for ad hoc networks supposed to include the following [1]:

i. *Distributed Operation*

The routing algorithm should not be dependent on a centralized controlling node to cope with topological changes.

ii. *Loop Free*

The routing protocol must guarantee that the routes supplied are loop-free. This avoids any waste of bandwidth or CPU consumption.

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iii. *Demand based operation*

To minimize the control overhead in the network and thus not wasting network resources more than necessary, the protocol should be reactive.

iv. *Multiple Routes*

To reduce the number of reactions to topological changes and congestion multiple routes could be used.

v. *Unidirectional link support*

The radio environment can cause the formation of unidirectional links. Utilization of these links along with the bi-directional links can improve the routing protocol performance.

vi. *Security*

The radio environment is especially vulnerable to impersonation attacks. So to ensure the wanted behavior from the routing protocol, we need some sort of preventive security measures.

vii. *Power Conservation*

The nodes in an ad-hoc network are very limited in battery power. Nodes use some sort of stand-by mode to save power. The routing protocol must have support for these sleep-modes.

viii. *Quality of service support*

Some sort of Quality of Service support is probably necessary to incorporate into the routing protocol. It could for instance be real-time traffic support. There are several routing protocols proposed for usage in ad-hoc networks. None of the proposed protocols have all the desirable properties.

## II. Ad Hoc Routing Schemes

Most of these protocols are designed for IP (Internet Protocol) based homogenous, mobile adhoc networks [2]. Each node in the network has identical capability (identical communication devices and ability to perform functions from the common set of services). It is assumed that each node has a unique address (IP address for example). Number of hops is used as the only route selection criteria. These protocols focus on *fast route establishment* and reestablishment and route *maintenance with minimal overhead*.

A majority of these ad hoc routing protocols can be classified as either proactive (table-driven) protocols or reactive (demand-driven) protocols. In either case, the routing protocols typically specify that each node periodically advertise current routing information to its neighbors. The neighbor is then able to calculate routes to network nodes based on the received information. The node can also incorporate the information it has received into its own advertisements, as necessary according to the protocol. In the case of proactive protocols, the advertisements can contain information about every known link between other routing agents in the network. Reactive protocols, on the other hand, supply next-hop information about all destinations in the network. However, due to high mobility of nodes such periodic advertisements may impact route maintenance overhead of routing protocols in such a way that no bandwidth might remain leftover for the transmission of data packets. Two techniques for solving this problem are to limit the amount of information advertised and to establish routes only on demand so that periodic advertisements are no longer mandatory.

Routing schemes solely inspired from the biological swarm intelligence can adapt to the changing network requirements by means of the principle of *emergence* via "stigmergy". There are few routing schemes based on swarm intelligence proposed for ad hoc networks.

## III. Swarm Intelligence and Ad Hoc Routing

Swarm intelligence [3] refers to the "intelligent" behaviors arising from the interactions among a swarm of social insects, such as ants, when working collectively towards a common goal, e.g., food foraging. Ants can find shortest paths through a process called "stigmergy", which could be described as indirect communication between individuals through the environment.

*a) Basic ant algorithm*

The basic idea of the ant algorithm is taken from the food searching behavior of real ants. When ants search for food, they start from their nest and walk toward the food. When an ant reaches an intersection, it has to decide which branch to take next. While walking ants deposit *pheromone* which marks the selected route. The concentration of pheromone on a certain path is an indication of its usage. Other ants are attracted by these pheromone trails and in turn reinforce them even more. As a result of this *autocatalytic* reaction, the shortest path emerges rapidly.

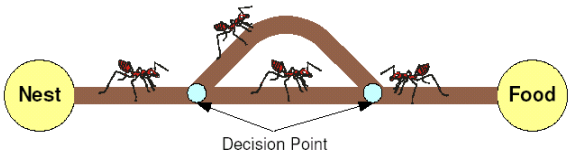


*Figure 3.1 :* All ants take the shortest path after an initial searching time

Figure 3.1 shows a scenario with two routes from the nest to the food. At the intersection the first ants randomly select a branch. Since the lower route is shorter than the upper one, the ants, which take this path, will reach the food place first. On their way back to the nest, the ants again have to select a path. After a while the pheromone concentration on the shorter path will be higher than on the longer path, because the ants

using the shorter path will increase the pheromone concentration faster. Thus, eventually all ants will only use this path. This behavior of the ants can be used to find the shortest path in networks. Especially the dynamic component of this method provides for a high degree of adaptation to changes in mobile ad-hoc network topology, since in these networks the existence of links is not guaranteed and link changes occur frequently.

Swarm intelligence boasts a number of advantages due to the use of mobile agents and stigmergy [4]. These include:

i. *Scalability*

Population of the agents can be adapted according to the network size. Scalability is also promoted by local and distributed agent interactions.

ii. *Fault Tolerance*

Swarm intelligent processes do not rely on a centralized control mechanism. Therefore the loss of a few nodes or links does not result in catastrophic failure, but rather leads to graceful, scalable degradation.

iii. *Adaptation*

Agents can change, die or reproduce, according to network changes.

iv. *Modularity*

Agents act independently of other network layers [11].

v. *Autonomy*

Little or no human supervision is required.

vi. *Parallelism*

Agent's operations are inherently parallel.

These properties make swarm intelligence very attractive for ad-hoc wireless networks.

*b) A simple ant-based scheme*

Let G = *(V, E)* be a connected graph with n = |*V*| nodes. The simple ant colony optimization metaheuristic can be used to find the shortest path between a source node *vS* and a destination node *vD* on the graph G. The number of nodes on the path gives the path length. A variable j *ij* (artificial pheromone), which is modified by the ants when they visit the node is associated with an edge e*(i, j)* Î *E* of the graph connecting the nodes *vi* and *vj* . The pheromone concentration j *ij* is an indication of the usage of this edge. Initially j *ij* is constant for each edge *e(i, j).*

An ant located in node *vi* uses pheromone j *ij* of node *vj* Î *Ni* to compute the probability of node vj being the next hop. *Ni* is the set of one-step neighbors of node *vi.* The transition probabilities *Pi,j* of a node *vi*, i.e. the probability that the ant selects node *vj* after it has visited *vi*, are defined as follows:

$$p_{i,j} = \begin{cases} \frac{\varphi_{i,j}}{\sum_{j \in N_i} \varphi_{i,j}} & \text{if } j \in N_i \\ 0 & \text{if } j \notin N_i \end{cases}$$

$$\sum_{j \in N_i} p_{i,j} = 1, \qquad i \in [1, N]$$

During the route finding process, ants deposit pheromone on the edges. In the simplest version of the algorithm, the ants deposit a constant amount Dj of pheromone, i.e. the amount of pheromone of the edge e*(vi, vj)* when the ant is moving from node vi to node vj is changed as follows:

$$\varphi_{ij} := \varphi_{ij} + \Delta\varphi$$

Like real pheromone the artificial pheromone concentration decreases with time. In the simple ant algorithm this is described by:

$$\varphi_{ij}(t+\tau) := (1-q).\varphi_{ij}(t),\ q \in (0, 1) \qquad (1)$$

The simple ant algorithm shown in this section illustrates different reasons why this kind of algorithms could perform well in mobile multi-hop ad-hoc networks. These include the following:

- Ant-based can show better adaptation to continuously changing network topologies in multi-hop ad-hoc networks [4, 5].
- In contrast to other routing approaches, the ant based algorithm is based only on local information, i.e. no routing tables or other information blocks have to be transmitted to other nodes of the network.
- It is possible to integrate the link quality into computation of the pheromone concentration, especially into the evaporation process. This will improve the decision process with respect to the link quality. It may be noted that the approach can be modified so that nodes can also manipulate the pheromone concentration independent of the ants, e.g. if a node detects a change of the link quality.
- Each node has a routing table with entries for all its neighbors, which also contains the pheromone concentration. The decision rule for selection of the next node is based on the pheromone concentration at the current node, which is provided for each possible link. Thus, the approach supports multi-path routing.

*c) Ant-based Routing in Ad hoc Networks*

Several variations of Ant Net [5, 6] have been developed but all of them rely on the same concept where forward ants are launched towards destinations and backward ants travel back and update pheromone along the backward paths. The amount of added pheromone is proportional to the goodness of the path measured by the forward ant. In the following sections some of these routing schemes are discussed.

i. *Ant-colony based Routing Algorithm (ARA)*

ARA is an on-demand routing protocol [7] and it performs routing in three phases: Route discovery,

Route maintenance, and Route failure handling. Each of these phases is discussed briefly in this section.

a. *Route Discovery*

In ARA new routes are created in the *route discovery* phase by means of a *forward ant* (FANT) and a *backward ant* (BANT). A *forward ant* is an agent, which establishes the pheromone track back to the source node. In analogous, a *backward ant* establishes the pheromone track back to its origin, namely the destination node.

The FANT is a small packet with a unique sequence number. Nodes are able to distinguish duplicate packets on the basis of the sequence number and the source address. A node that receives a FANT for the first time creates a record in its routing table. The node interprets the source address of the FANT as destination address, the address of the previous node as the next hop, and computes the pheromone value depending on the number of hops it took the FANT to reach the node. The node then relays the FANT to its neighbors. Duplicate FANTs are identified through the unique sequence number, and are removed. The destination node extracts the information of the FANT, creates a BANT and returns it to the source node. The BANT's task is to establish a track to source node. When the sender receives the BANT from the destination node, the path is established and data packets can be sent.

Figure 3.2 shows the establishment of the pheromone track back to the source node *S*. The forward ant only creates one pheromone track to the source node in node 6, but two tracks in node 5, via node 3 and node 4. Figure 3.3 depicts analogous situation for the backward ant. It only creates one pheromone track to the destination node *D* in node 5 and two tracks in node 6. Thus, ARA also supports *multi-path* routing.

b. *Route Maintenance*

For *maintenance of the routes* during the communication ARA does not need any special packets. Once the FANT and BANT have established the pheromone tracks for the source and destination nodes *regular data packets* are used to maintain the path. As in biological systems, established paths do not keep their initial pheromone values forever. When a node *vi* relays a data packet to destination *vD* to a neighbor node *vj*, it increases the pheromone value of the entry (*vD, vj,* j) by Dj, i.e. this path to the destination is strengthened by the data packet. Likewise, the next hop v*j* increases the pheromone value of the entry (*vD, vj,* j) by Dj, i.e. the backward path to the source node is also strengthened. The evaporation process of the real pheromone is modeled by decreasing the pheromone values according to equation 1.

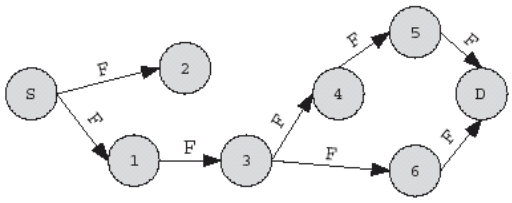


*Figure 3.2*

Route discovery phase. A forward ant (F) is send from the sender (S) toward the destination node (D). The forward ant is relayed by other nodes, which initialize their routing table and the pheromone values.

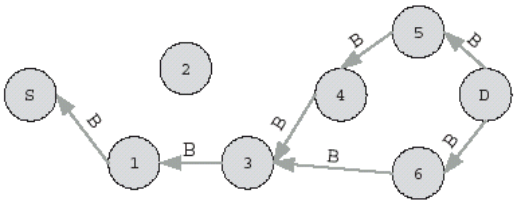


*Figure 3.3*

Route discovery phase. The backward ant (B) has the same task as the forward ant. It is send by the destination node toward the source node.

c. *Handling Route Failure*

*Routing failures*, which are especially caused by node mobility, are very common in ad-hoc networks. ARA assumes IEEE 802.11 on the MAC layer. This enables ARA to recognize a route failure through a missing acknowledgement on the MAC layer. If a node receives a ROUTE_ERROR message for a certain link, it first deactivates this link by setting the pheromone value to 0. Subsequently, the node searches for an alternative link in its routing table. If there is another route to the destination it will send the packet via this path. Otherwise, the node informs its neighbors, hoping that they can forward the packet to the destination. Either the packet can be transported to the destination node or the backtracking continues to the source node. If the packet does not reach the destination, the source node has to initiate a new route discovery process.

d. *Properties of ARA*

Each node controls the pheromone counter independently when ants visit the node on route search for, or when the node detects a link failure. Route finding process is performed on-demand basis when the pheromone entry for the target at sender node is below threshold.

Nodes are able to function sleep-mode when the amount of pheromone in their routing table has reached a lower threshold. Other nodes will then not consider this node, unless packets are destined to it. This saves energy and power.

ARA supports multipath routing. Each node can have several paths to a destination and the choice of a certain route depends on the environment, e.g. link quality to the relay node. In case of link failure the alternative routes when available can be used without going for a costly route discovery process.

ARA, however, because ants are broadcasted into the network for on-demand route-discovery, may not scale for large-scale mobile ad hoc networks.

ii. *Scalable Ant-based Routing Protocols*

a. *Adaptive-SDR Protocol*

The same concept as in AntNet [6] has been extended and applied to Adaptive Swarm-based Distributed Routing (Adaptive-SDR) [8] for routing in wireless and satellite networks. Adaptive-SDR resolves the *scalability* limitations of AntNet by incorporating a mechanism to cluster nodes into colonies.

Clustering is performed less frequently, in the beginning stage of the algorithm and whenever the network topology changes enough to justify a reclustering of the nodes. Then, it finds routes in network by using special agents called ants and forwards the network traffic using the routes discovered by the ants. The route discovery (by ants) and the network data traffic forwarding are performed constantly as part of regular network operation.

Adaptive-SDR is scalable and can avoid routing loops. In addition this scheme performs well with high utilization of the network capacity. By monitoring the state of the queues of the links to all outgoing neighbors, the next-hop probabilities are adjusted according to the load in each queue. Then, the node with the highest adjusted probability is selected as next-hop. This probability adjustment is only temporary and for the purpose of forwarding data at that specific time instant. It does not permanently change the routing table probabilities. The advantage of this method is that the best next hop is penalized when it is congested, while it is still the best, and thus always chosen, when there is no congestion.

b. *GPS/Ant-Like Routing Algorithm*

GPS-AL is a *source routing* scheme in which the network relies on location information and support from fixed infrastructure [9].

The routing protocol is based on the physical location of a destination host *d* stored in the routing table. If there is an entry in the routing table for host *d*, the best possible route is chosen using a shortest path algorithm. The route comprised of a list of nodes and the corresponding TTL's, is attached to the packet, which is sent to first host in the list. If host *d* is not found in the routing table, the mobile node sends a message to the nearest fixed node that tries to find the destination node. GPS-AL employs ants during route discovery only to accelerate the dissemination of routing information, and hence, does not make use of the above-described "*autocatalytic*" effect for finding shortest paths.

Hence, ants are not used as feedback agents to reinforce routes positively (in the case when a route is still good), negatively (when a route is no longer good) or explore new routes randomly – ants in this approach are unicasted to specified direction, not allowing for amplification of fluctuations, and depending on known metrics such as timestamp of a route in the routing table. Further, a shortest path algorithm is applied to determine the best possible route to a destination, therefore assuming that a node knows a lot about the links currently present in the network, and as well a lot about positions of other nodes, which certainly will not be true for the large scale ad hoc networks.

c. *Mobile Agent Based Routing (MABR)*

MABR is a *proactive* approach [10] for routing in large-scale mobile ad hoc networks. The nodes are assumed to be aware of their position by means of a positioning service (e.g., GPS) and are able to determine other nodes position accurately enough through a location management scheme.

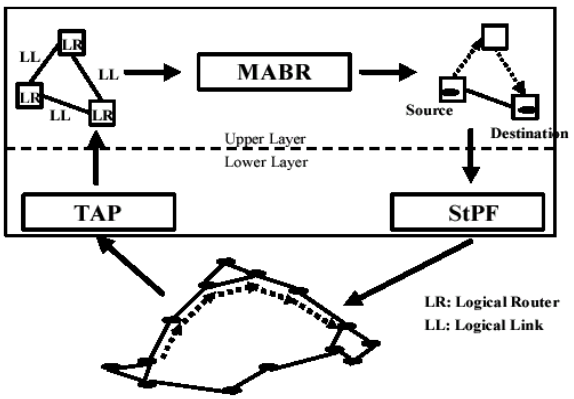


*Figure 3.4 :* Two layer architecture proposed for Ant based Routing in [10]

This scheme uses a two-layered architecture, as shown in Figure 3.4, where TAP (Topology Abstracting Protocol) is used to supply a simplified topology with fixed "logical routers" and fixed "logical links". A logical router represents an aggregated collection of mobile hosts, which all together build and share among each other the same routing tables. A logical link represents a path along a roughly straight line to a distant logical router over possibly multiple hops. On top of this abstract topology the actual routing protocol MABR (Mobile Ants Based Routing) runs and is responsible for updating the routing tables of logical routers and determining logical paths for routing packets over this abstract topology. MABR Finally, the StPF (Straight Packet Forwarding) protocol is applied in order to transmit packets over a logical link. Therefore, it

forwards packets along this logical link in a greedy manner.

Each node is at every moment part of a specific logical router and, hence, makes uses of the corresponding routing tables. So when a node whishes to send a packet to another node, it first discovers that node's location through any location management scheme [10] and stores these coordinates in the header fields of the packet. By applying MABR, it determines to which zone the destination coordinates belong in its view and selects any logical link with the probability given in the routing table R for that zone. The packet is tagged as well with the corresponding logical router k (geographical coordinates) as a next logical hop. Then SPF is employed in order to route the packet to these coordinates; i.e. the source node transmits the packet to a node closer to logical router k and so forth. Any node at logical router k in turn carries out the same procedure again, first determining a next outgoing logical link by MABR, and then routing the packet to these coordinates by SPF. Eventually the packet will arrive at the logical router for the destination coordinates. The receiving node finally sends the packet to the intended destination node.

The advantages include the ability to react and deal quickly with local and global changes, not only in the network topology, but as well in the communication bandwidth, in the transmission delay, etc. However, with this approach no random exploration of routes is possible. Also, in a network where the topologies change frequently, the overhead of doing proactive routing may far outweigh the benefits of doing so.

## IV. Conclusion

In this paper, we have presented an overview of *swarm intelligence* applied to routing schemes in ad hoc networks. Inherent properties of swarm intelligence as observed in nature include: massive system scalability, emergent behavior and intelligence from low complexity local interactions, autonomy, and *stigmergy,* or communication through the environment. These properties are desirable for many types of networks. Ant-based approaches hold great promise for solving numerous problems of adhoc power aware networks. *Swarm intelligence* however is a new field and much work remains to be done. Comparison of the performance of swarm based algorithms has been done by emulation. Analytic proof and models of the swarm based algorithm performance remain topics of ongoing research.

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# Survey on Incentive Mechanism

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*Abstract -* P2P network have dramatically gain popularity for the past few years. However, these networks suffer from problem like free-riding, Tragedy of Common which degrades the performance of the network. Here, the authors present several approaches to overcome the problem of free-riding. They have categorized the approaches and have described each category's important features and implementations.

*Keywords :* *P2P network, free-riding.*

*GJCST-E Classification :* *C.2.6*


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# Survey on Incentive Mechanism

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*Abstract* - P2P network have dramatically gain popularity for the past few years. However, these networks suffer from problem like free-riding, Tragedy of Common which degrades the performance of the network. Here, the authors present several approaches to overcome the problem of free-riding. They have categorized the approaches and have described each category's important features and implementations.

*Keywords : P2P network, free-riding.*

## I. Introduction

P2P network have dramatically gain popularity for the past few years. P2P are overlay network since P2P network runs on top of internet. In a P2P network, the peers are computer systems which are connected to each other via internet. Files can be shared directly between systems on the network without the need of a central server. In other words, each computer on a P2P network becomes a file server as well as a client .The only requirement for a computer to join a peer-to-peer network are an internet connection and P2P software [1]. Each node can join or leave the network at anytime.

P2P systems are usually designed on the assumption that all peers can share their resources consciously. P2P is currently receiving considerable interest but still there are threats like free riding and tragedy of common which are degrading the performance of P2P system. Free Riding is not a new problem, it has existed in community –sharing based fields of human endeavour for centuries. Economist have done comprehensive studies on the twin problem of free riding and tragedy of Common[2].Hardin [3] proved that common resources without any exclusive ownership will be consume without limit. He named this phenomenon Tragedy of Common.

A Free rider is a peer that uses the P2P services but does not contribute to the network at an acceptable level. In [4] authors reported that 70% of peers did not share any files at all, and 25% provide 99% of all query hits in the network. Self interest of the peer is the main cause of free riding. Causes of free-riding are as follows.

1) Sharing of resources requires usage of bandwidth, hard disk space, CPU cycles etc. Therefore a peer does not share in order to avoid the usage of these things.
2) Usually peers does not get benefit for sharing others, therefore they are not interested in sharing.
3) To facilitate digital contents to be downloadable by other peers, the computer is required to open several ports for such activities. This also opens the computer for attacks and viruses [6].
4) If peers, start sharing popular files. All the download request will be directed to those peers. This causes overloading the machine and congestion in network.

According to [5] there are two kinds of free riding

1) The peers who shared little or no files.
2) The peers who tend to share fake or unpopular files instead of popular to decrease their load.

Some free riders act in different way than others, they don't contribute to the network as well as they don't forward the query. These types of free riders are called Droppers.

## II. Impact of Free Riding

1) Large number of free riders and their queries will generate a large amount of P2P network traffic, which may lead to the degradation of P2P service.
2) The system will not have a large and growing number of interesting files. Therefore system will fail to attract users.
3) High level of Free Riding activity increases load on the contributor nodes which is not a positive sign for P2P network.
4) Quality of search is degraded due to the increase in traffic.

## III. Free Riding Solutions

Researchers have come up with several approaches to combat free riding in P2P network. Solutions are used to encourage peers to contribute more to the network in order to improve the utility of the network. These free riding solutions are further classified into the following:

*a) Monetary/Micropayment Based Approach*

In this approach peers are charge for the services they receive. Peers have to buy virtual currency in order to avail the services. Any monetary –based system require two key mechanisms [7].

i. *Accounting Module*

It is used to securely store each peer's virtual currency.

ii. *Settlement Module*

It is used to fairly exchange virtual currency for services. A single authority is used to manage each peer's balance and transaction. PKI is used to provide

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security against fraud and error. In this approach a peer is charged for initiating a query and a peer is rewarded for every referral.

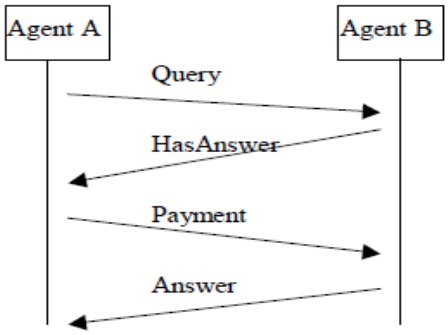


*Figure 1 :* A referring process involving two agents A and B, where A sends Query to B[13]

Micropayment approach works in the following way

*SCENARIO 1:*

When there is only two peer i.e Peer A and Peer B. If Peer A initiates a query and Peer B has the answer then monetary fund for peer A and peer B will be

Peer A =T-Q
Peer B = T+Q

Where

T is initial monetary fund that peer A and peer B have in the beginning.

Q is the cost for answer to query.

*SCENARIO 2:*

When there are three peer i.e Peer A, Peer B and Peer C.

If Peer A initiates a query and Peer B does not has the answer then it will forward the query to Peer C. Monetary fund deducted for peer A , Peer B and peer C will be

Peer A =T-Q-R
Peer B = T+R
Peer C= T+Q

Where

R is incremented for referral a query monetary approach can be implemented in two ways [7].

*Online Approach:*

Exchange of virtual currency takes place at the same time as peer receives services. A central authority must be present (online) at the time of transaction.

*Offline Approach:*

If Central Authority (CA) is not present at the time of transaction then exchange of service is done and payment of virtual currency is executed when the CA is available.

*b) Reciprocity-Based Approach*

In reciprocity-based approach [8] [9], a peer monitors other peer's behavior and evaluates their contribution level [7]. The quality of service receive by a peer depend upon its contribution level. This approach usually measure other peer's contribution only for current session, which means a peer judged as contributor in one session can be judged as free rider in another session. Reciprocity-based approach is further classified into two parts [10].

i. *Non Real Time Approach*

A node collects information about the other nodes from their neighbours, trusted third party, local information etc. A reputation value of each and every node is calculated to determine their performance in the past.

ii. *Real-Time Reciprocity Approach*

In this approach, transaction partners evaluate each other only at the time of transaction. If a peer is consuming a resources from other then it is compulsory for a peer to make sources available for other peer. This approach is like a barter system.

Reciprocity-based approaches face several implementation issues.

1) Peers publish fake services so that they can gain higher levels of contribution.
2) Peers are identified by their values. However, if newcomers are assigned a higher standard utility value than free riders, a free rider can try to get rid of its degraded value by constantly getting a new identity.

*c) Reputation Based Approach*

Reputations of the peers are evaluated on the basis of feedback receive from the peer who have already interacted with that peer. Data is exchanged among the peer depending upon their reputation. It is assumed that the peers report their interaction honestly. Reputations can be positive, negative or both. Services are provided to the peer depending upon their reputations value. A peer with positive reputation will be offered with better service as compared to the peer with negative reputations. In this approach, it is not easy to convert a bad reputation to good reputation and vice versa. Reputations approach is further classified into two parts.

i. *Autonomous Reputation Approach*

It stores the reputation information of only those peers's to whom they have interacted with.

ii. *Global Reputation Approach*

In this approach, average of reputation information is obtained from several peers or all peers. Average reputation is stored at central location or is stored with a set of peers in the network. This approach provides long term reputation information about peers

In P2P network some peers are likely to manipulate reputation value by forging transaction history. There are three main type of such behaviour [11].

a. *Collude Inflating*

A set of peers rates one another with satisfactory values for some download that never existed or download of fake files. Peers misbehave in this manner in order to increase their reputation value.

b. *Deflating*

A set of peers rates one peer with unsatisfactory values in order to increase their own reputation value.

c. *Faker*

A peer of low reputation value pretend to act as a peer of high reputation value in order to gain the profit from the network.

*d) Fixed Contribution*

This approach follows a simple rule: if a node wants to join a network, it has to contribute to the network. Direct Connect [12] is the example of fixed contribution. Contribution to the network consist of sharing of files and minimum upload bandwidth available. If a user does not upload the requires amount of data then it is not allowed to join the network. Fixed contribution approach discourages free-riding since in this approach it is compulsory to share data and if every node is sharing something in network then there is no scope of free riders in network. This approach attracts many other users since there are many contributors in this network.

The main problem with this approach is that it does not check the data which is shared by the joining nodes. The user can enter the system by sharing some useless files or by sharing the same old file again and again. There is no such mechanism to stop such kind of activities.

## IV. Conclusion

In order to deal with free-riding in P2P system, different incentive mechanisms are presented in this paper that are currently being used. In this paper we have presented a survey of free riding solutions while at the same time laying down the problems of existing mechanism that need to be kept in mind while designing such scheme.

As the research on incentive mechanism in P2P networks are being done on wide basis, it is not possible to present the work of each and every researcher in this field of study.

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**21. Arrangement of information:** Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**23. Multitasking in research is not good:** Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

## Informal Guidelines of Research Paper Writing

**Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

**Final Points:**

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.

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**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.

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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
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- 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

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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.

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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.

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- 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
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- 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
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- 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<br><br>Above 200 words | No specific data with ambiguous information<br><br>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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