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# Efficient Algorithm For Cooperative Node Communication Using Signal Strength Tracking For Use In Modern Digital And Mobile Communication

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**Abstract**
A wireless network (WN) is expected to provide mobility, flexibility, composed of active nodes, ease to distribute and low cost. WNs are self-organized and widely distributed networks which are composed of many battery-powered, low-cost wireless sensor nodes deployed in monitoring area. Practically, the wireless network nodes are less feasible with respect to the limitations of coverage ability and power/energy of network nodes. In WSNs, localization algorithms need to measure the actual distances between adjacent nodes and use the measured data to locate unknown nodes. However, they are constrained to use the estimated distances between nodes to calculate the unknown node's positions and are therefore subject to errors. It uses the triangulation method to calculate the mobile node's position, which requires hardware support to increase the spending methods to calculate distance-independent localization algorithms. The distances for position estimation have the information to provide connectivity to other nodes and identification of neighboring nodes. The localization methods based on received signal strength indicator (RSSI) can satisfy the coverage requirements (without extra hardware requirement) by measuring the distances between nodes. In this work, a methodology to find the node affinity to an access point in a network to ensure maximal coverage and longevity is discussed.

**Keywords:** Wireless Network, wireless Sensor Network, Localization Algorithms, Nodes, RSSI.

### 2.1 Channel Characteristics

Channel characteristics differ from one path to the other; channel fading arises from so many factors like, reflection, diffraction, attenuation, and atmospheric ducting, and ionosphere reflection, correlative functions of transmitter, receiver and channel parameters. A large frequency reuse distance can enhance the channel quality by reducing low interference but will decrease the system capacity. It optimizes the tradeoff among channel quality, system capacity, and the costs of infrastructure and user terminals. Thus, if multiple signal components of different frequency arrive to the receiver in one direction, then they all experience the same Doppler shift. Certain integer combinations of frequency result in constructive interference and larger signal amplitude, while certain others result in destructive interference and produce small signal amplitude. In addition to variation in signal frequency, if the delay spread (requires the calculation of difference in path length) also varies, then the coherence bandwidth will also differ. Usually Rayleigh fading is considered as a reference statistical model to measure the propagation effects in wireless devices. In addition to the scattering if there is strong dominant signal present at the receiver then it is called as Rician fading. In line of sight environment the mean of the random process will no longer be zero, power level of dominant path varies (Rician fading).

Wireless sensor nodes communicate with their neighboring nodes, which is equivalent to measuring the transmitted signal strength by each receiver during communication without presenting additional bandwidth requirements. RSSI based localization technique is attractive for a wide variety of applications, where the significant estimation error has negative effects related to signal propagation. RSSI is a common way to represent the signal energy in the local environment and RSSI characterize the attenuation of radio signals during propagation and is adopted in a large number of localization systems. The RSSI localization algorithm calculates the distances between nodes by measuring the signal attenuation. However, RSSI is sensitive to the distances and if they aren't accurate, there will be inaccuracy in localization. A reliable RSSI-based positioning system should therefore, maintain level accuracy, answer the location query of where the network nodes are available. Supplement to RSSI at the MAC layer at main position of multipath signals with fast changing phases, channel response should be able to discriminate multipath characteristics.

### *2.2 Literature survey:*

In [2] Channel estimation is done by using minimum mean square error in orthogonal frequency division multiplexing signals which are corrupted by fading.

[8] Has defined and examined fading rapidity in channel. Wireless communication experiences packet drops, which might lead to a serious degradation in safety critical connected vehicle applications.

The use of wireless communication simulators to emulate the communications performance is reported in [3] with a need to properly replicate the real world vehicular communication environments.

From [9] the parameters such as source velocity and outage probability play very important role in the performance analysis and design of the digital communication systems over the multipath fading environment. The outage probability in the Rician fading channel is lower than that of the Rayleigh fading channel, which is due to the presence of line-of-sight path in the Rician channel. As the vehicle speed of the user increases, fading also increases. While speed increases most of the signal goes below threshold and amount of fading increases.

[11] uses statistical simulation models directly to generate multiple uncorrelated fading waveforms for frequency selective channels, multiple input and multiple output channels, and reported to have good agreement among these.

Gummadi, R., et al., [2007] presented synchronized frequency hopping among the beacons and receive tag to enable adaptive and continuous network localization.

Bahl, P., et al., [2004] presented frequency hopping which is used to explore available capacity over multiple wireless channels.

Srinivasan, K. and Levis [2006] presented higher RSSI that does not necessarily imply a higher probability to successfully receive the packet.

Wu, C., et al., [2012] presented the finger printing lies in its cumbersome efforts when building and updating the database.

The antenna arrays attracted increasing interest with the rapid development of Multiple Input Multiple Output (MIMO) techniques are reported by Xiong and Jamieson [2012].

Jiang, Z., et al., [2013] proposed a scheme capable of rejecting the Denial of service (DoS) attack: source authentication for WiFi management frames using CSI information. They designed a spoofing detection prototype on commercial WiFi with the impact of environmental dynamics.

Liu, H., [2012] enabled off-the-shelf applications and tested the feasibility of key generation with coarse-grained RSSI and with RSSI based localization, have triggered increasing to the ubiquity of RSSI.

***2.3 Network Traversing***

The requirement in network traversing is to find the optimal number of routes and also each section of the link in a network is to be used by only one route. For the example network shown in figure 1, multiple routes can exist as listed in table 1 and out of those the optimal one is to be chosen.

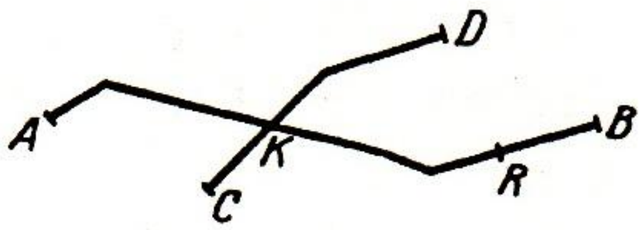



**Table 1**

| Option | Route | Track1 | Track2 | Track 3 | Interchange point |
|---|---|---|---|---|---|
| 1 | 1 | A to B | | | |
| | 2 | | C to D | | k |
| 2 | 1 | A to D | | | |
| | 2 | | B to C | | k |
| 3 | 1 | A to C | | | |
| | 2 | | B to D | | k |
| 4 | 1 | A to R | | | |
| | 2 | | C to D | | |
| | 3 | | | R to B | |
| 5 | 1 | | A to D | | |
| | 2 | B to R | | | |
| | 3 | | | R to C | |

In above table, optimal number of routes or transfer points (i.e. tracks) is the requirement. For ex: option 4 and 5 are non-optimal since three routes are required.

Considering a closed network like in figure 2, then for each section of the link in a network to be used by only one route (refer figure 2), the different routes can be listed in table 2.


**Figure 2**

**Table 2**

| Option | Route | Track1 | Track2 | Track 3 | Track 4 | Track 5 |
|---|---|---|---|---|---|---|
| 1 | 1 | A to B to C to D to E to A | | | | |
| | 2 | | A to F to G to H to D | | | |
| | 3 | | | B to F | | |
| | 4 | | | | E to G | |
| | 5 | | | | | C to H |
| 2 | 1 | A to B to C to D to E to A to F to G to H to D | | | | |
| | 2 | | B to F | | | |
| | 3 | | | E to G | | |
| | 4 | | | | C to H | |

Again in Table 2, route 1 is non-optimal since 5 routes exist.
Thus, for optimal routes in a network

(i) Count in a network the junctions of odd order i.e. the number of nodes with odd degree. For best case the number of nodes with odd degree is even.

(ii) Divide the result of (i) with 2. This gives the optimal number of routes.

***2.4 Capacity of wireless channels (Rate of communication and capacity)***

(i) Reliable communication at rate R bits/symbol means that one can design codes at that rate with arbitrarily small error probability.

(ii) To get reliable communication, one must code over a long block; this is to exploit the law of large numbers to average out the randomness of the noise.

(iii) Repetition coding over a long block can achieve reliable communication, but the corresponding data rate goes to zero with increasing block length.Repetition coding does not pack the code words in the available degrees of freedom in an efficient manner.

(iv) To maintain the data rate to be strictly positive even as reliability is increased arbitrarily by increasing the block length requires efficient bin packing algorithms. This packs a number of code words that is exponential in the block length and still communicates reliably.

(v) The maximum data rate at which reliable communication is possible is called the capacity C of the channel.

***2.5 Adaptive Modulation for Transmissions with Channel Mean Feedback***

Adaptive modulation has the potential to increase the system throughput significantly by matching transmitter parameters to time-varying channel conditions. However, adaptive modulation schemes that rely on perfect channel state information (CSI) are sensitive to CSI imperfections induced by estimation errors and feedback delays. This work includes design of adaptive modulation schemes for adaptive modulation transmissions based on partial CSI that models the spatial fading channels as Gaussian random variables with nonzero mean and unit covariance, conditioned on feedback information. The performance is optimized for a fixed constellation; transmitter optimally adjusts the basis beams, the power allocation between two beams, and the signal constellation, to maximize the system throughput while maintaining a prescribed bit-error rate (BER).

The rapid increase of node devices withWiFi as preferred method of network access, predominantly within campus or buildings demands the location analysis method to haveminimum mean square error (MSE) so as to realize unprecedented benefits from location-based services. This includes;

(i) *Location analytics:* Estimates the number of visitors to the network and the amount of time spend and the frequency of their visits within the site.

(ii) *Advanced analytics*: Provides knowledge of movement patterns by the visitors while available in the campus.

***3.1 Problem statement 1 :***

A wireless network consistsof insignificance, low-cost and resource-constrained network nodes and deployed in unattended and unkind environments to perform various monitoring node tasks. The wireless node localization generates frequent location-based applications in a wide range of areas. The node localization use RSSI technique where signals are rarely accessible, due to the ubiquitous deployment of wireless networks and devices. The mainstream wireless signal measurements use RSSI to characterize the attenuation of radio signals during propagation and espouse in a large body of node localization systems.

***Problem solution 1:***

In this research the node network focuses on a scheme that ensures the robust mapping between the measured RSSI vector and the existing RSSI signature.

*3.2 Problem statement 2:*

If a network has the ability to analyze the direction in which packets are sent without collision this improves the throughput of the system.

***Problem solution 2:***

It is a dynamic autonomous wireless network formed by node with wireless communication capability, where each node carries out basic operation routing and packet forwarding. All nodes are connected dynamically in an arbitrary manner, where no default router is available and potentially every node behaves as a router (must be able to forward traffic on behalf of others) as well as an end host.

***3.3 Problem statement 3:***

In a MANET, the router connectivity may change frequently, leading to the multi-hop communication paradigm that can allow communication without the use of BS/AP, and provide alternative connections inside hotspot cells. Routing is one of the core problems of networking for delivering data from one node to the other. The aim of such networks is to provide communication capabilities to areas with limited or no existing communication infrastructures.

***Problem solution 3:***

Some salient characteristics of MANETs are:-

1. Dynamic topologies
2. Bandwidth constrained, variable capacity links,
3. Energy constrained operation and
4. Limited physical security.

The structure presented in this research permits simulations to be written and modified in an interpreted environment without having to resort to recompiling the simulator each time a structural change is made.

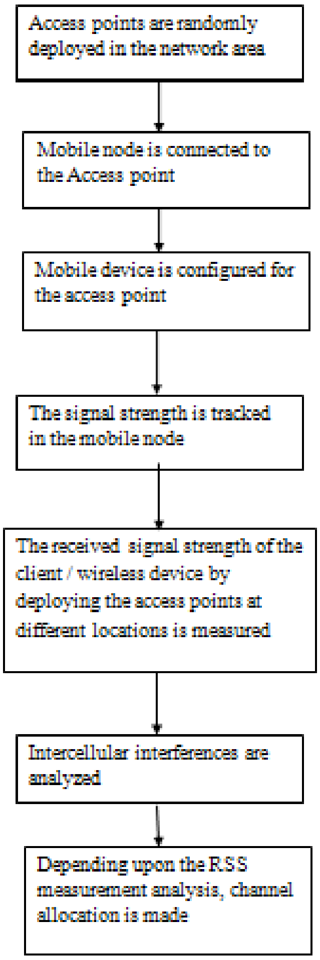
The process of creating a simulation is classified into following steps:-

1. Topology definition:- To ease the creation of basic facilities and define their interrelationships.
2. Model usage:- Models are added to simulation (for example, UDP, IPv4, point-to-point devices and links, applications);
3. Node and link configuration:- Models set their default values (for example, the size of packets sent by an application or MTU of a point-to-point link); most of the time this is done using the attribute system.
4. Execution:- Simulation facilities generate events, data requested by the user is logged.
5. Performance analysis:- After the simulation is finished and data is available as a time-stamped

event trace. This data is then statistically analyzed with tools to draw conclusions.

6. Graphical Visualization:- Raw or processed data collected in a simulation is graphed using relevant tools.

### *3.4 Study Methodology:*




### *3.5 Algorithm:*

**SOURCE/SERVER:**

Step 1: Listens for incoming packets / connections from the client.

Step 2: set the transmit power for the configured client.

**DESTINATION/CLIENT:**

Step 1: Connect the mobile node with the access point

Step 2: Configure the mobile node with the access point

Step 3: Track the RSS (Received Signal Strength) of the mobile node w.r.t the access point

Step 4: Step 3 is repeated at different locations of mobile nodes in the network area.

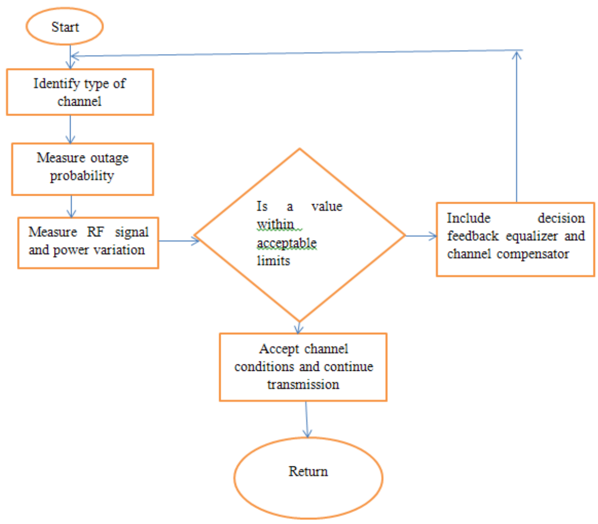
Step 5: RSS readings are tabulated and the procedure is repeated for different locations of access points

Step 6: Results are analyzed and the number of access points and topology is determined for effective channel allocation

### *3.6 Analysis:*

The size of the network considered for the Wi-Fi connection is 100ft x 100ft grid. There are interferences such as building structures, glass and wooden structures inside the network area. The wireless network area is divided into numerous small regions say 10x10, 20x10 etc which covers the entire area planned for wireless network connectivity. Every region is deployed with a access point. The regions are represented w.r.t x and y co-ordinates. For instance, consider the region 1, the x co-ordinate is (1,1) and the y co-ordinate is (1,10) where the y co-ordinate represent the diagonal length of the x co-ordinate. The same is set for all the regions in the network area and these values are entered while configuring the mobile device/mobile phone with the access point. The mobile node is connected to the access point. Now, the mobile phone with the android application is configured with the access point to which the mobile node is connected. The RSS from the access point is tracked in the mobile node and the signal strength is noted. The same procedure is repeated by placing the mobile phone at different locations in the network area and its corresponding received signal strength measurements are noted. These values are tabulated which shows the coverage area w.r.t its signal strength of the individual access points. The mobile phone is now configured with the rest of the available access point and their signal strength is examined at different mobile locations. The topology of deployment of access point is changed and the above discussed procedure is repeated. CCI (Co-channel Interference) and ACI (Adjacent Channel Interference) are analyzed from the RSS values. Depending upon the resulted tabulation, the deployment of access point in the network area and the number of access point for the good coverage is determined. The application is developed in python and run in Linux environment. The regions in the network area can be named according to the requirement which makes the coverage-density area study simple and also helps in tracking.

### *4.2 Implementation:*




### *4.3 Objectives of Research work:*

(1) Reliable and faster node to node communication

(2) Group communication or cooperative network
(3) Channel effects compensation for wireless network infrastructure or infrastructure less network (Ex:MANET).

*5.2* ***Improving channel capacity and handling channel fading effects,***

This work is done in the paper, “Improving Channel Capacity in Wireless Network by Mitigating Co-Channel Interference and Channel Fading Effects”. In this work, schemes to improve channel capacity by mitigating co channel interference and channel fading effects are considered. The nodes are arranged as cells and interference among one another is determined by identifying its location.

An adaptive algorithm that updates the transmit powers of the mobiles with an objective of converging to the component wise minimal power among all assignments is used in this work. The adaptive algorithm involves

Step 1:
Calculate the interference seen by $i^{th}$ mobile at each of the base stations
Step 2:
Start with an arbitrary power vector at starting time $t_1$.
Step 3:
Using Greedy algorithm, determine the base station which requires the least transmit power on the part of mobile ‘k’ to achieve the target value
Step 4:
Assign $k^{th}$ mobile to the base station determined in step 3.
Step 5:
For every mobile node:
Perform greedy update i.e. the updates of transmit power in step 2 and base station assignment in step 3 at time $t_{m+1}$ using the updates at time $t_m$.

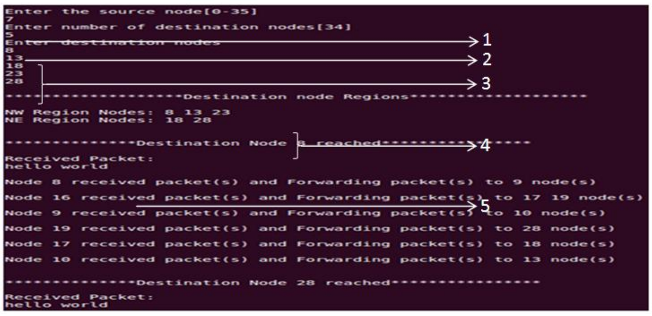
In this work, step 5 i.e. the update is done both synchronously and asynchronously. In asynchronous update model, the update in step 5 is based on some previous knowledge of all the other nodes transmit powers.

The study includes:
(1) RSSI technique for locating the position of the Wi-Fi enabled nodes
(2) Use of triangulation method along with (1)
(3) Determining the variation in the strength of the individuals is connected to an access point, as the number of nodes increases or decreases.

Results demonstrated include:
(1) Estimated location using proximity method, scene and triangulation method
(2) Investigation of energy consumption using the RSSI based localization
*(3)* Channel capacity improvement

***Efficient design using scheduler, to optimize the nodes through which*****the datais transmitted.**

The following results are demonstrated:Using Linux OS, a scheduler is implemented and results are obtained for (a) varying topology with maximum of 35 nodes b.Variable size Packet transfer




1. Source Node; 2. Total Number of nodes selected to receive packet 3. Nodes to which data packet is to be Multicast (User input); 4.Neighbor Nodes automatically clustered by the proposed algorithm as per optimal path algorithm; 5. Multicast data packet; 6. Intermediate stages of packet transfer.

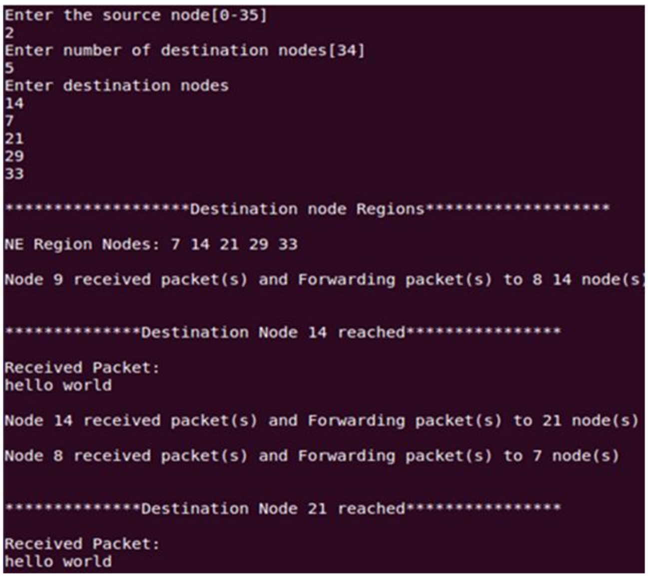



**Table 1**

| | Average value proposed for research | Reported work |
|---|---|---|
| Node packet size | Linear | Non linear |
| Throughput | 600000 bits/sec | 450000bits/sec |
| End to end delay (jitter) | 0.00175 sec | 0.002 sec |

The nodes end-to-end delay for data packets as shown in Figure 8.

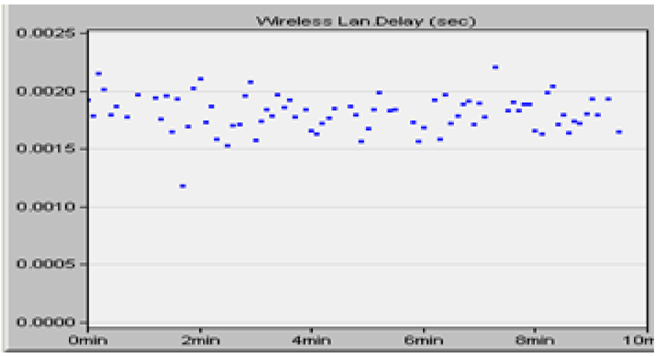



**Fig. 14 Nodes end-to-end delay for packets**

## Conclusion

This work evaluates protocols and their abilities, assuming varying degrees of mobility within a bounded space, usually with all nodes and within few hops of each other. The metrics evaluated include: the packet drop rate, the overhead introduced by the routing protocol, end to end packet delays, network throughput, ability to scale etc.

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