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Dynamic Channel Assignment Protocols for Mobile Networks

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Abstract: The wireless Mobile Ad Hoc Networks (MANET) are a relatively new field gaining more popularity for various new applications. Although a MANET does not have the infrastructure of base stations. In these networks Dynamic channel assignment protocols are responsible for coordinating the access from active nodes. These protocols are of significant importance since the wireless communication channel is inherently prone to errors and unique problems. We therefore make an attempt to present a comprehensive survey of major schemes, integrating various issues and challenges with a view to providing a big-picture outlook to this vast area. We present a classification of Dynamic channel assignment protocols and their brief description, based on their operation principles and underlying features.

Key words: Dynamic channel, protocols for mobile, MANET, active nodes

INTRODUCTION

A Mobile Ad-hoc Network (MANET) is formed by a cluster of mobile hosts without the infrastructure of base stations. Due to the transmissions range constraint of transceivers, two mobile hosts may communicate with each other either directly, if their are close enough, or indirectly, by having other intermediate mobile hosts relay their packets. Since no base station is required, one of its main advantages is that it can be rapidly deployed. The applications of MANETs appear in places where pre-deployment of network infrastructure is difficult or unavailable in some regions, a base station may not be established due to high cost, low utilization, or poor performance. In situations such as war or natural disasters, a base station is hard to establish but is easily destroyed. Without supporting base station or access point, a MANET (Mobile Ad Hoc wireless Network) includes low-cost mobile hosts with high mobility and enables mobile users to communicate with each other.

Communication between a pair of hosts uses channel resources, causing the channel to be unable to be used by neighboring host. A channel used by one pair of hosts, say {a, b}, can be reused by another pair of hosts, say {c, d}, only if their communication ranges do not overlap. Channels are limited resources, so exploiting channel reuse opportunities and enhancing the channel utilization is the key technique for increasing the system's capacity. However, exploiting channel reuse opportunities may cause the problem of co-channel interference. Consider a situation in which host a gradually moves toward host c. As hosts a falls into the communication range of host c, their communication signals interfere with each other. At this moment, if the host pair {a, b} can rapidly switch to a new communication channel, then the communication of these two pairs can be maintained without breakage.

PREVIOUS WORK

Many MAC protocols have been proposed for wireless networks, which assume a common channel shared by mobile hosts. We call such protocols single-channel MAC protocols. A standard that has been widely accepted based on the single-channel mode is the IEEE 802.11(IEEE, 1997). One common problem with such protocols is that the network performance will degrade quickly as the number of mobile hosts increased due to higher contention/collision.

One approach to relieving the contention/collision problem is to utilize multiple channels. Providing multiple channel access can increases the bandwidth resources, reduce the normalized propagation delay (Nasipuri *et al*., 1999; Marsan and Roffinella, 1983) and thus guarantee that the QOS requirement is met, where the normalized propagation delay is defined to be the ratio of the propagation time over the packet transmission time.

Dong and Lai (1997) proposed an efficient priority based channel allocation strategy for mobile cellular networks. In this study the authors derived a new dynamic priority strategy called Two-Step Dynamic Priority (TSDP) strategy. The new strategy adopts the optimal carrier reuse pattern concept and significantly improves overall existing static/hybrid/dynamic-priority strategies the TSDP strategy could reduce the call

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blocking/failure rate by a margin of 15-95% under both uniform and non-uniform traffic distributions. Parakash, (1997) proposed distributed wireless channel allocation in cellular systems with mobile base stations. This study reports work in progress on integrated channel allocation for backbone and short-hop links in a fully wireless system, a cellular model of mobile computing systems with no fixed nodes was presented. Parakash *et al.* (1999) proposed distributed dynamic fault-tolerant channel allocation for mobile computing, the proposed algorithm does not need a central network switch. The mobile service station of a cell makes all the decisions about channel allocation in that cell based on the information available locally. The mobile service station only needs to exchange information with its neighbors within the co-channel interference range. Unlike the Fixed Channel Allocation (FCA) algorithms, the proposed algorithm can adopt to changing load distribution in the network. It is more robust than existing DCA algorithms as it does not depend on a central network switch whose failure can bring down the entire network. The algorithm also exploits the temporal locality of loads distribution to make quick decisions about channel allocation. Cao and Singhal (2000) proposed a fault-tolerant channel acquisition algorithm which tolerates communication link failures and node [mobile host or mobile service station] failures, in the algorithm a borrower does not need to receive a response from every interference neighbors. It only needs to receive response from each cell in an interference partition subset as long as there is one common available channel among them since the number of cells in an interference portion subset is far less than the number of cells in an interference neighbors, the algorithm tolerates network congestion, communication link failures and node (mobile host or mobile service station) failures. Based on the typical cellular networks model. Yang *et al.* (2003) proposed a fault tolerant, distributed channel allocation algorithm under Non-Resource planning model. In this model, all the channels used in the system are kept in a set, which is known to each cell channels are pre-allocated to any cell. Each cell has a fixed number of neighbors, which are divided into groups, In this approach, a cell that wants to borrow a channel does not need to get a reply message from each neighbor. It may borrow a channel as long as it receives replay message from all members in one of the group. A cell can lent a channel to multiple borrowers as long as any 2 of them are not neighbors. Jianchang and Manivannan (2005) proposed an efficient fault-tolerant channel allocation algorithm which makes efficient reuse of channels. In this algorithm a cell that tries to borrow a channel does not have to wait until it receives a reply message from each of its interference neighbors. A cell can borrow a channel as long as it receives reply message from each cell in a subgroup in it's interference neighborhood and their is at least one common primary channel which is not being used by any cell in this subgroup, It can tolerate the failure of mobile nodes as well as static nodes without any significant degradation in service.

We can categorize a mobile host based on its capability to access multiple channels as follows:

Single-transceiver: A mobile host can only access one channel at a time. The transceiver can be simplex or duplex. Note that this is not necessarily equivalent to the single channel model, because the transceiver is still capable of switching from one channel to another channel.

Multiple-transceiver: Each transceiver could be simplex or duplex. A mobile host can access multiple channels simultaneously.

A multi-channel MAC typically needs to address two issues: Channel assignment and medium access. The former is to decide which channels to be used by which hosts and the latter is to resolve the contention/collision problem when using a particular channel. These 2 issues are sometimes addressed separately, but eventually one has to integrate them to provide a total solution.

CHANNEL ASSIGNMENT PRINCIPLES

As mentioned above, a multi-channel MAC protocol needs to address two issues: Channel assignment and medium access. In this study we discuss the channel assignment part.

GRID: A static channel assignment protocol: We assume that each mobile host is installed with a positioning device such as GPS, by which a mobile host can determine its current location. The MANET is assumed to operate in a pre-defined geographic area. The area is partitioned into 2D logical grids (Fig. 1).

Each grid is a square of size d*d. Grids are numbered (x,y) following the conventional xy-coordinate. To be location-aware a mobile host must know how to map a physical location to the corresponding grid coordinate.

The channel assignment works as follows. We assume that the system is given a fixed number, n, of channels. For each grid, we will assign a channel to it.

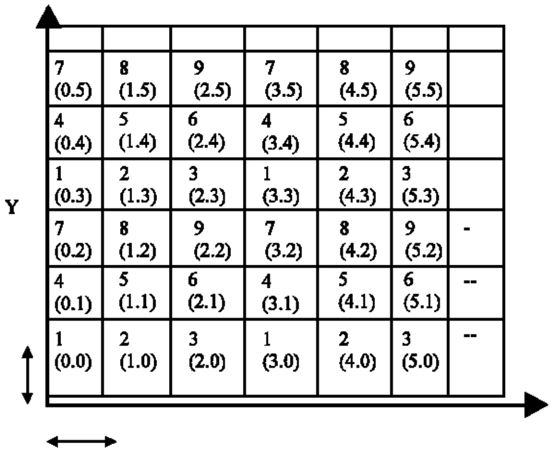


Fig. 1: Assigning channels to grids in a band-by-band manner: n = 9. In each grid, the number on the top is the channel number, while those on the bottom are the grid coordinate. Here we number channels from 1 to n

When a mobile host is located at a grid, say (x, y) it will use the channel assigned to grid (x,y) for transmission. The assignment of channels to grids should follow two rules:

- We should avoid interference among grids by assigning different channels to neighboring grids.
- The grids which use the same channel should be spatially separated appropriately so as to exploit the largest frequency reuse.

The above formulation turns out to be similar to the channel arrangement in the GSM system. One heuristic to do the assignment is to let m = [√n]. We first partition the grids vertically into a number of bands such that each band contains m columns of grids. Then for each band, we sequentially assign the n channels to each row of grids, in a row-by -row manner. Grid assigns a channel to a host based on the grid where the host is currently located. Thus, beside the positioning cost, their is no communication cost for our channel assignment (no message will be sent for this purpose).

GRID-B: A dynamic channel assignment protocol: In the above GRID protocol, channels are assigned to grids statically. In real world, some grids could be very crowded and thus hot while some could be cold. Apparently, it will be more flexible if channels can be borrowed among grids to resolve the contention in hot spots. The physical area covered by the MANET is first partitioned into a number of squares called grids. A mobile host, on needing a channel to communicate, will dynamically compute a list of channels based on the grid where it is currently located. The basic idea is that we will assign to each grid a default channel and a list of channels owned by its neighboring grids from which it may borrow. The purpose is two fold:

- We dynamically assign channels to mobile hosts so as to take care of the load unbalance problem caused by differences among areas (such as hot and cold spots).
- We sort channels based on mobile hosts current locations so as to exploit larger channel reuse.

What we have done in the GRID protocol is to carefully arrange the usage pattern of each channel so as to exploit the largest channel reuse (and thus the throughput of each channel). As channels are borrowed among grids, the usage pattern will be disturbed and thus the channels usage pattern will not be so compact. For example, in Fig. 1 if grid (0.2) borrows channel 1, the two grids (0.0) and (0.3) may be deprived of the right of using that channel, due to possible interference. Thus the potential number of users of channel 1 may be decreased (of course, the lending grids may be cold and do not need that channel). This is the cost of flexibility. As a result, the borrowed channels should always be returned to the owner grids whenever necessary to maintain a compact channel usage pattern. In this work we will let channels be borrowed among grids such that when looking from a global view, the usage pattern of each channel is as compact as possible. However, no global channel usage status will be collected. In the following, we propose four channel borrowing strategies. Let A be a mobile host located at grid (x,y) who intends to communicate with a mobile host B located at grid (x',y'). The channels that may be borrowed by A are given different priorities as follows:

- Sequential-sender-based borrowing (denoted as GRID-B_{ss}): Let i be the channel assigned to grid (x, y). Host A will try to borrow channels i+1, I+2,….n, 1, 2, 3,…………i-1, in that order. Intuitively, this will make all grids who also use channels i to borrow channels in the same order.
- Sequential-receiver-based borrowing (denoted as GRID- B_{sr}). Let i be the channel as signed to grid (x',y') Host A will try to borrow channels I+1,i+2,……n,1,2, …….i-1 in that order.
- Distance-sender-based borrowing (denoted as GRID-B_{ds}): for convenience, let's denote by c(p,q) the channel assigned to grid(p,q). For each channel i, define a distance function as follows:

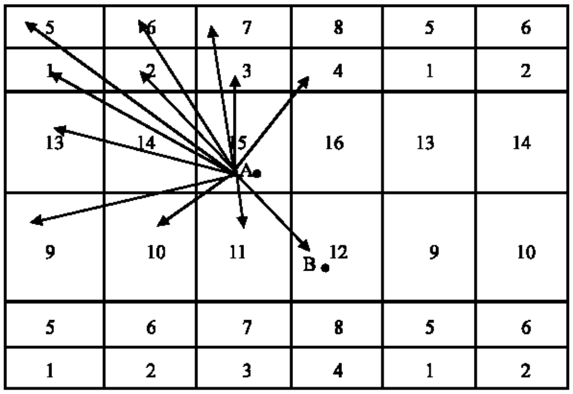


Fig. 2: An example to determine the channel borrowing sequences in our strategies. The arrows radiated for A and B indicates the values of the distance functions dist1 and dist 2, respectively

$$\text{dist1}(i) = \min_{\forall (p,q)::c(p,q)=c(x,y)} \{\sqrt{(p-x)^2 + (q-y)^2}\}$$

This is the distance from (x,y) to the nearest grid that is also assigned the same default channel. Then we sort all channels that can be borrowed by A based on a descending order of their distance functions. The underlying idea of the borrowing is to incur as little interference to A's neighborhood as possible.

- Distance-receiver-based borrowing (denoted as GRID-B_{dr}). This is similar to the distance-sender-based borrowing, except that we will define for each channel i, a different distance function based on where B is located:

$$\text{Dist2}(i) = \min_{\forall ((p,q)::c(p,q)=c(x',y')} \{\sqrt{(p-x')^2 + (q-y')^2}\}$$

Then we sort all channels that can be borrowed by A based on a descending order of their distance functions. The underlying idea of the borrowing is to incur as little interference to B's neighborhood as possible.

For example as shown in Fig. 2 where A wants to communicate with B in a MANET with n = 16 channels. The channels to be used, form higher priority to lower priority, for the 4 strategies are (note that the default channels is always at the beginning of the list):

- GRID-B_{ss}: {15,16,1,2,3,4,5,6,7,8,9,10, 11,12,13,14}
- GRID-B_{sr}: {12,13,14,15,16,1,2,3,4,5,6,7,8,9, 10,11}
- GRID-B_{ds}: {15,5,1,6,8,9,7,13,2,4,10,12,3, 11, 14, 16}
- GRID-B_{dr}: {12,2,1,3,6,14,10,5,7,13,15,8,9, 11, 16}

The proposed GRID-B protocol is based on RTS/CTS handshaking to guarantee the safety (freedom of interference) in using a borrowed channel. The loan period of a borrowed channel is not long and is equal to the transmission time of the packet to be sent. To use the same channel again, the host should compete again with RTS/CTS dialogues. Also the host chooses channels to borrow based on the priority assignment.

THE MAC PROTOCOL

The medium access protocol which integrates the above channel assignment strategies. The MAC protocol is characterized by the following features:

- It follows an on-demand style to access the medium and thus a mobile host will occupy a channel only when necessary
- No form of clock synchronization is required.

The channel model is as follows. The overall bandwidth is divided into one control channel and n data channels D1, D2, D3 ………, Dn. Each channel, including control and data ones, has the same bandwidth.

The Fig. 3 shows the control and data channels based on FDMA model.

The purpose of data channels is to transmit data packets, while that of the control channels is to schedule and synchronize the use of data channels among hosts.

Each Mobile host is equipped with 2 half-duplex transceivers:

Control transceiver: This transceiver will operate on the control channel to exchange control packets and acknowledgements with other mobile hosts and to obtain rights to access data channels.

Data transceiver: This transceiver will dynamically operate on one of the data channels, according to our channel assignment strategy, to transmit data packets.

Each mobile host *X* maintains the following data structure.

- CUL []: This is called the channel usage list. Each list entry CUL[i] keeps records of how and when a host neighboring to X uses a channel.

CUL[i] has 4 fields:

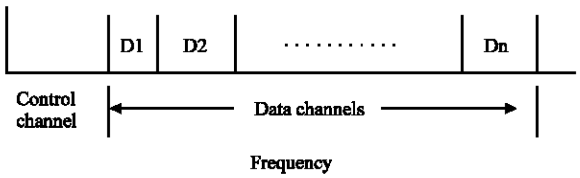


Fig. 3: The channel model of our protocol under the FDMA technology

- CUL[i].host: A neighbor host of X
- CUL[i].ch: A data channel used by CUL[i].host.
- CUL[i].type: RTS or CTS, Indicating that CUL[i].host is Sending data (RTS) or receiving data (CTS).
- CUL[i].rel-time: When channel CUL[i].ch will be released by CUL[i].host.

Note that this CUL is distributedly maintained by each mobile host and thus may not contain the precise information.

FCL: This is called the free channel list, which is dynamically computed from CUL.

The main idea of our protocol is as follows. For a mobile host A to communicate with host B, A will send a RTS (request to send) to B. This RTS will carry a list of available channels that A may use based on its neighborhood status. On receiving the RTS, B will match the list with its CUL[] to choose a channel for their subsequent communication by replying a CTS. How the channel is selected will depend on the channel borrowing strategy. The purposes of the RTS/CTS dialogue are thus: To exchange A's and B's channel usage information to select an appropriate channel and to warn the neighborhood of A and B not to interfere their subsequent transmission on the channel they selected to use.

As 2 pairs of communication hosts gradually move toward each other, co-channel interference. Increases. Power control techniques help a little to mitigate co-channel interference if the received signal is weaker than the Signal-to-Noise Radio (SNR) value. The reassignment of a new channel to an interfered host greatly helps to prevent communicative hosts from being affected by co-channel interference.

A channel assignment protocol (Chih *et al.*, 2003) is presented to exploit channel reuse opportunities. The number of communicating pairs of mobile devices is guaranteed to be maximized. A channel reassignment protocol is also proposed to eliminate the co-channel interference, when two pairs of communicating hosts gradually move close to each other, The proposed channel reassignment protocol dynamically reassigns a new channel to one pair of hosts that are suffering from the co-channel interference problem.

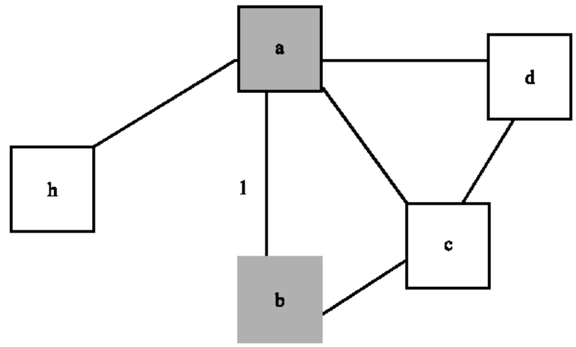


Fig. 4: An example of Ad Hoc network. Hosts a and b communicate on channel 1

A channel that is used by one pair of hosts can be reused by another pair of hosts only if their communication ranges do not overlap.

In Fig. 4 square node represents a host. A connecting link between the two hosts indicates that they are within the communicative range. Any mobile host is either in the idle state or the communication state. The gray-colored square nodes are in the communication state. A symbol on a node represents the ID of a host, whereas the number on a link specifies the channel that is occupied by the pair of hosts connected by the link. For example, hosts a and b are in a communication state and use channel 1 for communication. Hosts c, d and h are in the communicative range of host a. The following set of definitions is used in illustrating the operation of the proposed protocol.

Definition: Neighbor(x) and Neighbor(X)
Neighbor(x) represents the set of hosts located in communicative range of host x. Let X be the set of hosts $x_1, x_2, \ldots x_n$.
Neighbor(X) denotes the union of sets Neighbor(x_1), Neighbor(x_2)……. and
Neighbor(x_n). That is

$$\text{Neighbor}(X) = \bigcup_{i=1}^{n} \text{Neighbor}(x_i)$$

Where $X=\{x_1, x_2, \ldots\ldots x_n\}$.
For example in Fig. 4, Neighbor (a) = {b,c,d,h} and Neighbor({a,b}) = {c,d,h}.

Definition: One-hop Communication Com (a, b, j), Com (a, b, j) represents the communication between a pair of hosts a and b over channel j.

For example, in Fig. 4 communication performend by hosta a and b is represented by Com (a, b, 1).

For simplicity of presentation of the communication state of a MANET, the communication of a pair of hosts {a,b} on channel j is represented by a circle numbered j and labeled Com(a,b,j) in the graph (Fig. 5).

Definition: Host (Com)
Host is a function that extracts the communicating hosts of a communication Com. For example Host (Com (a,b,j)) = {a,b}.

Definition: Channel (Com)
Channel is a function that extracts the occupied channel of a communication Com. For example Channel (Com (a, b, j)) = {j}

Definition: Interference Hosts IH (Com 1, Com 2) and Interference Channel IC (Com1, Com 2) Two communications Com 1(x, y, j) and Com 2 (x', y', j) interfere with each other if the communication range of one host, say x, of Com1 overlaps the communication range of another host, say x', of Com 2. The interference hosts IH is defined as the set of hosts that interfere with each other. That is, Interference Hosts = {x, x'}.

The channel j, which is used by Interference Hosts, is defined as Interference Channel IC.

Examples and the cache structure of each host are introduced below to illustrate the basic concepts of the proposed protocol. Two pairs of hosts that use a common channel for communication and move close to each other will interfere with each other. At this moment, one of the pair requires a mechanism for reselecting a channel. Each mobile host maintains a Neighboring Communication Table (NCT) in its cache, which records the neighbors channel usage information, to determine efficiently which channel is selected.

The information stored in NCT includes the ID of the neighboring hosts; the channel occupied by the one-hop and two-hop neighbors and the cost of those channels.

The Fig. 6 demonstrates the NCT of each mobile host. Each row in above figure records a neighbor's communication information. The Neighbor field records the ID of every neighbor, including idle and communicating neighbors. The Nchannel field records the channel that is occupied by the neighbor and Nnchannel records the channel that is occupied by the neighbors neighbor (that is, the two-hop neighbor). If the neighbor

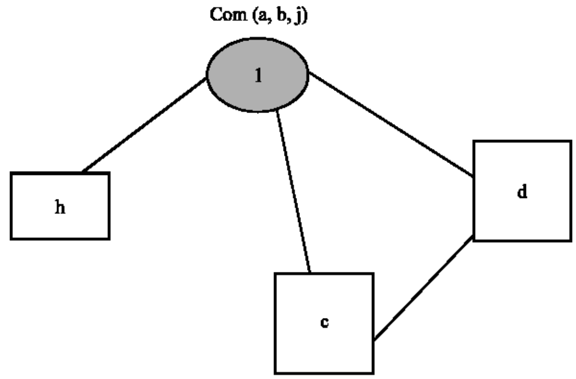


Fig. 5: An equivalent communication graph to Fig. 4

Neighbor	*Nchannel*	*Nnchannel*	Cost
...	....	......	....

Fig. 6: Neighboring Communication Table (NCT)

is in the communication state, then the Nchannel field records the occupied channel otherwise; Nchannel has a null value.

The Cost field records the cost of reassigning a new channel to the neighbor. Let two communications Com 1(x,y,j) and Com 2(x',y',j) interfere with each other and IH = {x, x' }. Hosts x and x' will check the cost of assigning a new channel to itself, exchange the cost evaluation information and then determine which of x and x' is assigned a new channel to minimize the cost. If no channel is available for the interference hosts, the new channel should be selected from those channels that are currently being used by neighbors. However this change may cause another co-channel interference problem for, say, neighbor z, since neighbor host z must be reassigned a new channel which may be currently used by a neighbor of x. An in appropriate switch in the new channel will cause that the co-channel interference to propagate over the MANET. The Cost field records the number of neighbors whose channels must change. This field helps the interference hosts to evaluate the cost of updating a new channel that is currently being used by their neighbors.

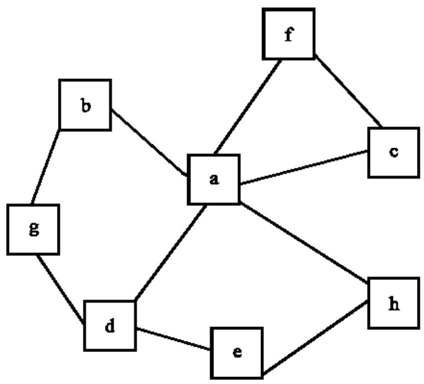
CHANNEL ASSIGNMENT PROTOCOL

This section proposes examples to illustrate the basic operation of the proposed channel assignment protocol. A channel assignment protocol (Chih *et al*., 2003) for enhancing the channel utilization is then presented.

Figure 7 presents an example to illustrate the communication process and the contents of cache table

Neighbor	Nchannel	Nnchannel	Cost
a	Null	Null	0
e	Null	Null	0
g	Null	Null	0

(a) The origional communication state diagram



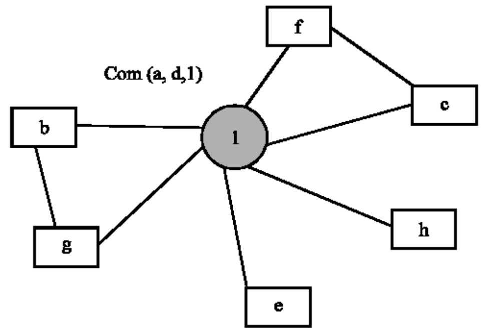
(b) NCT stored in host d

ID	Channel

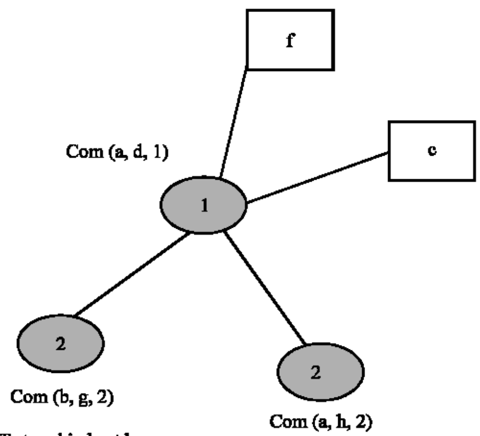
(c) Format of Communication Notification Message (CNM)

Neighbor ID	Channel	Total cost

(d) Format of Communication State Information (CSI)



(e) Hosts a and d create a communication link Com (a, d, 1)



(f) NCT stored in host b

Neighbor	Nchannel	Nnchannel	Cost
{a, d}	1	Null	1
g	Null	Null	0

(g) Communication state diagram Host pairs {b, g} and {e, h} create a communication links

Fig. 7: An example for illustrating channel assignment

of hosts that establish new communications. In this example, three channels, 1, 2 and 3, are assumed to be provided by system. In Fig. 7a, hosts a, b, c, d, e, f, g and h are in the idle state. Host d has neighbors a, e and g and its cache table is shown in Table 2, in which Nchannel and Nnchannel fields have a null value because hosts a, e and g are in the idle state.

The following example clarifies how hosts a and d execute the channel assignment protocol to assign a common channel for communicating with each other.

Step 1: Host d sends a Communication Request Message (CRM) to host a. On receiving the message, host replies with a Communication Approved Message (CAM) to host d.

Step 2: When host d receives the CAM message, it exchanges with host the information stored in cache table, including neighbor ID, Nchannel and Cost fields.

Step 3: Hosts a and d simultaneously compare the received message with the information stored in their NCT tables and add the two-hop information to their tables. Hosts a and d thus have identical tables.

Step 4: Hosts a and d select the minimum Cost value for communication. In this case, the cost of channels 1, 2 and 3 are equal. To enhance the channel utilization, the minimum csot channel will be selected. Thus, hosts a and d select channel 1 for communication and then send a Communication

Notification Message (CNM) and Communication State Information (CSI) to their neighbors b, c, e, f, g and h. Figure 7c and d show the format of the CNM and CSI messages, respectively.

Step 5: Hosts b, c, e, f, g and h integrate the received CNM and CSI messages into their NCT tables. The operation of integration will be discussed later.

Step 6: Any neighbor of hosts a or d in the communication state also transmits the integrated CSI information to its neighbors. In this case, however, since all the neighbors of hosts a and d are in the idle state, this step is omitted.

Figure 7g plots the communication state graph. Table 3 presents the contents of host b, after it has integrated CNM and CSI information in its table.

The protocol for channel assignment: Assume that host {a, b} seek to establish a communication link:

- Host a sends a CRM request to host b. If host b agrees to communicate with host a, it replies to host a with a Communicataion Approved Message (CAM).
- On receiving CAM, hosts {a,b} exchange their information, including Neighbor ID, Nchannel, Nnchannel and Cost.
- Hosts {a, b} complement each other's information, renew their NCT table and then select an available channel that is not being used. If no channel is available, then hosts {a,b} select a channel with minimal Cost for communication.
- Hosts {a, b} transmit the CNM and CSI information to neighbors so that all their neighbors know the communication state of {a, b}.
- On receiving the CNM and CSI information, each neighbor x of {a, b} executes the following operations.

    - Let Neighbor = y be the value shared by the NCT and CSI tables. Set Nchannel = c for the row that corresponds to Neighbor = y in NCT, where c is the Channel value of the row that corresponds to Neighbor = y in CSI.
    - Remove those rows of CSI that satisfy Neighbor = *x*.
    - Sum the Cost values of CSI with the same Channel values. For each row (Channel = i, Cost = j) in CSI, perform the following operations on NCT:

For those rows for which Neighbor = (a, b) apply,
If (Nnchannel = i)
    Set Cost = j
else
    Insert a row with value (Neighbor = (a,b) Nchannel = Channel (Com(a, b)), Nnchannel = i, Cost = j) 6. If x is in the communication state, it generates CSI information, according to the new table and then transmits this information to its neighbors.

The presented channel assignment protocol fully exploits the channel reuse opportunities and maintains the evaluated Cost to reallocate the channels. Information stored in the NCT table is also referenced by the channel reassignment protocol.

Channel reassignment protocol: In the previous study, each mobile host maintains a NCT table that includes neighbors, the channel used by neighbors and the Cost of that channel. In establishing a communication link, a host selects an available channel that is not used by a neighbor. If no channel is available, the host refers to its table and selects a channel with minimal Cost. As soon as a new communication link has been built up, the CNM and CSI information should be transmitted to those neighbors that are currently in the communication state to maintain up-to-date communication information. This section introduces a channel reassignment protocol (Chih *et al*., 2003) to increase the capacity of Ad Hoc networks.

The protocol for channel reassignment: Assume that 2 pairs of hosts, a and b, experience co-channel interference on channel c.

Step 1: Host pairs a and b check their NCT tables; select a minimal channel, say c_a and c_b, respectively, as candidate channels for the new channels and send a Communication Interference Message (CIM) to each other. Let the CIM sent by host a be (a, c_a, $Cost_a$) and the CIM sent by host b be (b, c_b, $Cost_b$)

Step 2: On receiving the CIM packet, a host pair compares the received CIM with the CIM it sent. If the partial order ($Cost_a$, c_a, a) < ($Cost_b$, c_b, b) then,
Pair a executes the channel reassignment process and changes a new channel c_a for communication.
Else
Pair b executes the channel reassignment process and determines a new channel c_b for communication.
End if

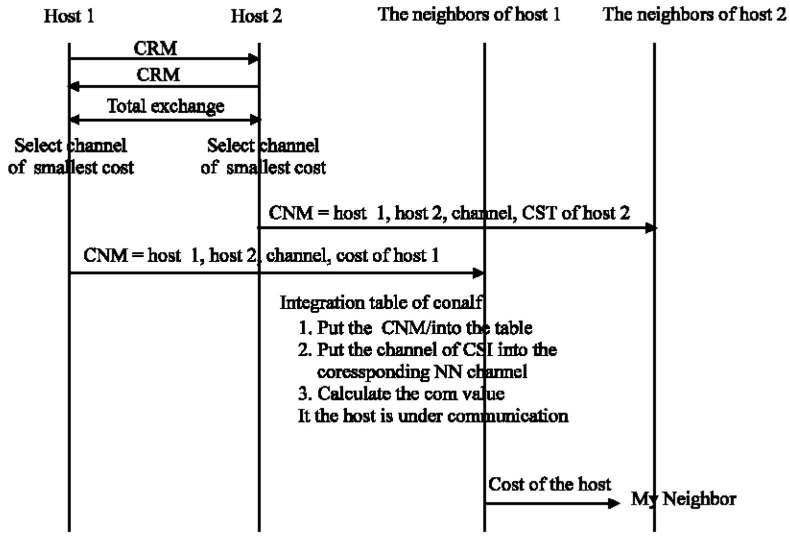


Fig. 8: Protocol for host's creating a new communication

Step 3: After the channel reassignment process is executed, the reassigned pair sends a CNM packet to its neighbors.
Step 4: All neighbors that receive the CNM packet will update their NCT tables.
Step 5: If the channel reassignment process creates co-channel interference among neighbors, these neighbors will execute operations similar to those involved in the channel assignment protocol.

If no common channel is available over which a pair of hosts can communicate, the proposed channel reassignment protocol reassigns the allocated channel so that the common channel can be released to establish a new communication and increasing the network capacity and effectively exploiting channel reuse opportunities. For those hosts that are suffering from co-channel interference, the proposed channel reassignment protocol reassigns a channel with minimal Cost, to prevent the communication from breaking.

CONCLUSION

This investigation presents channel assignment and medium access GRID-B protocol for MANET that is characterized by interesting on-demand, dynamic and location-aware properties, a channel assignment protocol for exploiting channel reuse opportunities, increasing system capacity and maintaining the lowest-cost channel information. The proposed channel assignment protocol evaluates the cost associated with each channel and stores the communication state of communicating neighbors in each host's NCT table. Frequent reuse of channel resource increases the system capacity but introduces co-channel interference when 2 pairs of hosts that use a single channel gradually move toward each other. Based on the NCT, a channel reassignment protocol is proposed to prevent the communication from breaking. By applying the proposed channel reassignment protocol, one of the two pairs is reassigned a lowest-cost channel in time to eliminate co-channel interference. The proposed protocols increase the system capacity, reduce the rate of communication breakage and thus improve the performance of Ad Hoc networks.

REFERENCES

Ajmone-Marsan, M. and D. Roffinella, 1983. Multichannel local area networks protocols. IEEE. J. Sel. Areas Commun., 5: 885-807.

Cao, G. and M. Singhal, 2000. Distributed Fault-Tolerant Channel Allocation for Cellular Networks. IEEE J. Selected Areas Comm., 18: 1326-1337.

Chih-Yung Chang, Po-Chih Huang, Chao-Tsun Chang, 2003. Nonmembers and Yuh-Shyan Chen Regular Member. Dynamic Channel Assignment and Reassignment for Exploiting Channel Reuse Opportunities in Ad Hoc Wireless Networks. IEICE Trans. Conmun., E86-B, No.4.

Dong, X. and T.H. Lai, 1997. An Efficient Priority-Based Dynamic Channel Allocation for Mobile Cellular Networks. Proc. IEEE Infocom.

IEEE Std 802.11-1997. Wireless LAN Medium Access Control (MAC) and Physical Layer (Phy) specifications. Institute of Electrical and Electronics Engineers, Inc., New York, USA.

Nasipuri, A., J. Zhuang and S.R. DAS, 1999. A Multichannel CSMA MAC Protocol for Multihop Wireless Networks. Proc. WCNC, pp: 1402-1406.

Prakash, R., 1997. Distributed Wireless Channel Allocation in Cellular Systems with Mobile Base Stations. Proc. Workshop Nomadic Computing.

Prakash, R., N.G. Shivaratri and M. Singal, 1999. Distributed Dynamic Fault-Tolerant Channel Allocation for Cellular Networks. IEEE Trans. Vehicular Tech., 48: 1874-1888.

Yu-Chee Tseng, Chih-min Chao, Shih-Lin Wu and Jang-Ping Sheu. Dynamic Channel Allocation With Location Awareness for Multi-hop Mobile AD Hoc Networks. available at www.csie.nctu.tw/~yctseng /papers.pub/mobile21-gmb-comcom.ps.

Yang, J., D. Manivaannan and M. Singhal, 2003. A Fault-Tolerant Dynamic Channel Allocations Scheme for Enhancing QOS in Cellular Networks. IEEE Proc. 36th Hawaii Int. Conf. System Sciences (HICSS-36), pp: 306-315.

Yang, J. and D.Manivannan, 2005. An Efficient Fault-Tolerant Distributed channel Allocation Algorithm for Cellular Networks. IEEE Trans. Mobile Computing, Vol. 4.