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	Pan Zhong, *Wu Xuyong,* *Zhao Quanbo* *Huawei* *Huawei Industrial Base, Bantian,* *Longgang, Shenzhen 518129 P.R.C*	*Voice: +86-755-28971675* *Fax: +86-755-28972149* *panz@huawei.com* *wuxuyong@huawei.com* *zhaoquanbo@huawei.com*

Re:	*80216h-06_005： Call for Comments and Contributions: IEEE 802.16 License-Exempt Task Group (2006-02-06)*
Abstract	*Base on 3 cases of channel switching allowance, we find the capacity of the channels is quite different, study on the result and continue on, we may discuss on choosing the method of ACS. Allowing channel request in the neighborhood may be a realistic tradeoff between performance and complexity.*
Purpose	*Propose a realizable optimization of channel distribution*
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Optimization of channel distribution

Panzhong, Zhaoquanbo, Wuxuyong
Huawei Technologies Co., Ltd.

Overview

In current working document [2], ACS will be executed in whole community while IBS cannot find a free channel to occupy. ACS means optimization of channel distribution. A smaller scale adjustment will be proposed in this contribution for discussion.

Base on 3 cases of channel switching allowance, we find the capacity of the channels is quite different, study on the result and continue on, we may discuss on choosing the method of ACS. Allowing channel request in the neighborhood may be a realistic tradeoff between performance and complexity.

Abbreviations and acronyms

ESCCH *escape channel*

Reference:

[1] IEEE802.16-2004: IEEE standard for Local and metropolitan area networks Part16: Air Interface for Fixed Broadband Wireless Access Systems 2004-10-01

[2] IEEE P801.16h/D0: Air Interface for Fixed Broadband Wireless Access Systems, Amendment for Improved Coexistence Mechanisms for License-Exempt Operation 2006-01-05

Proposal

We have proposed an optimized channel distribution within the whole community in #40 meeting, Vancouver. But, it is not a very good ideal for most cases because channel switches may be required on some BSs far away from IBS, because it means those BSs should pay the bill for an irrespective happening. So we will propose a smaller scale optimized channel distribution, it is implemented in neighborhood community, as a great difference from the former.

For a well description, we define two kinds of community. A geography community is the whole community, consists of a group of BSs, in which any two of them form a neighborhood or have a successive neighborhood relationship between each other, that's same to the former definition of community. And a neighborhood community is a part of the whole community, consists of a certain BS and its all of neighbors. For ACS executed during the initialization of IBS, neighborhood community in the proposal indicates IBS and its neighbors.

For optimized channel distribution in neighborhood community, a part of neighbors of IBS should switch to another channel that will not cause new interference to vacate their working channel for IBS.

Comparison on performance is needed between two kind of optimizations. A better distribution will cause more BSs admitted in a given area with certain amount of channels. Obviously, optimized distribution in geography community is better than that in neighborhood community because more BSs may switch their channels, but how many additional BSs can be admitted using optimized distribution in geography community contrasting to that in neighborhood community, how much percent will be lost using optimized distribution in neighborhood community, is it acceptable?

We take the same assumption as in our former proposal, listed below:

1. BSs are added into a rectangle of 8000 * 8000 one by one, with a uniform distribution on their position.

2. Each BS's coverage diameter is 2000.

3. A certain number of channels are available in the rectangle, and intersecting BSs cannot occupy the same channel.

4. The newest add-in BS scan all of the available channels for find a free one. If no free channel can be found, channel distribution will be optimized both in geography community and in neighborhood community. If no channel can be free for the newest BS using channel distribution optimization, no more BS can be added and the amount of BSs that has been admitted is the maximum for current process using this optimization. Until both of two kinds of optimization cannot permit more BSs added in, two maximum for each optimization will be recorded.

5. For more precise, comparison is based on the average value of 40 times results for each number of channels.

6. Increase the number of channels, repeat 1 to 5 above.

7. Figure out the difference between two kinds of optimization vs. number of channels.

Here is an example of random position of BSs in the given area without any interference while every BS's coverage diameter is 2000, and different color stands for different channel. Left distribution is optimized distribution in geography community admitting 32 BSs for 5 channels, and another is optimized distribution in neighborhood community admitting 26 BSs for 5 channels.

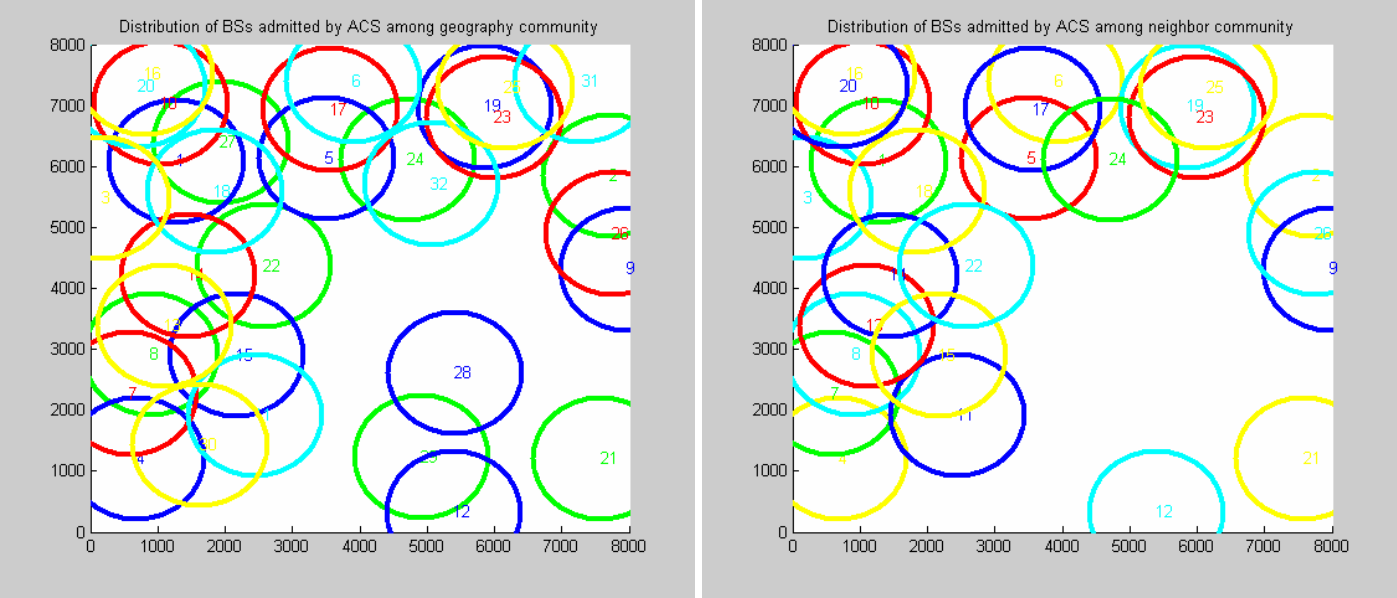


Figure 2 Example of random position of BSs

Simulation results are shown in following table.

Table 1 Simulation result 1 for BS's coverage diameter is 2000

Number of channels	Average number of BSs admitted without any optimization of channel	Average number of BSs admitted with optimization in whole geography	Average number of BSs admitted with optimization in neighborhood	Ratio of decrease (R=1-N/G)

	distribution(S)	community(G)	community(N)	
4	16.725	20.225	19.65	2.84%
5	23.975	29.325	28.625	2.39%
6	26.8	32.575	32.375	0.61%
7	34.475	43.875	42.325	3.53%
8	41.725	54.075	51.5	4.76%
9	47.85	60.675	58.82	3.05%
10	53.87	71.675	67.475	5.86%
11	61.4	81.375	78.4	3.66%
12	66.5	89.675	86.55	3.48%
13	73.6	101.5	96.525	4.90%
14	81.825	111.1	105.3	5.22%
15	88.05	121.725	112.7	7.41%
16	101.25	133.4	125.475	5.94%
17	104	139.85	132.625	5.17%
18	111.15	511.375	144.55	6.67%
19	119.75	165.9	156.075	5.92%
20	125.825	175.775	162.925	7.31%

Curves about numbers of BSs admitted by two kinds of optimization vs. number of channels are shown in following figure.

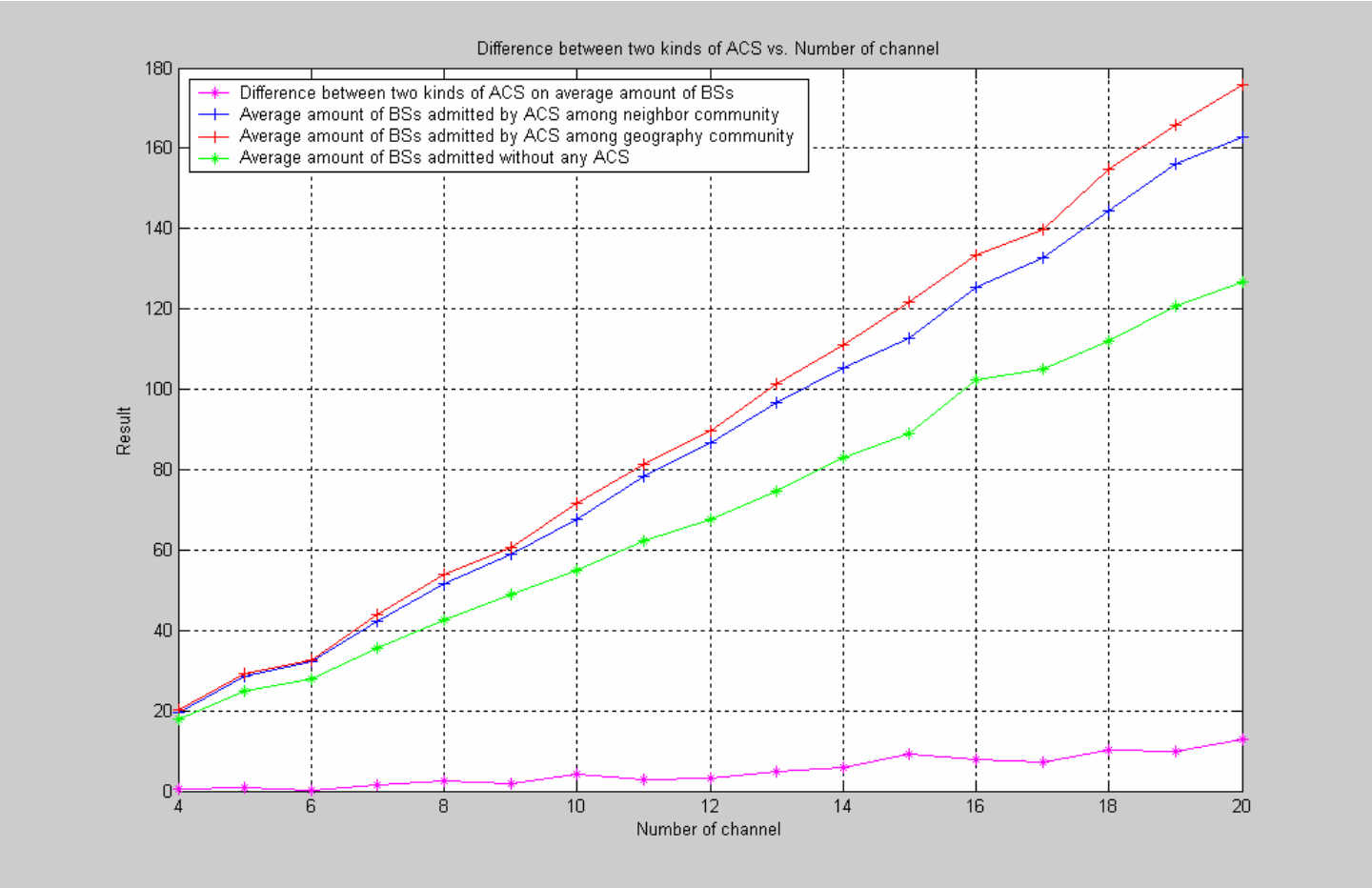


Figure 3 Comparison on number of BSs admitted by two kinds of optimization

If each BS's coverage diameter distributes uniformly on range from 800 to 1300, then results are shown in table 2, and curves are shown in figure 4.

Table 2 Simulation result 2 for BS's coverage diameters range from 800 to 1300

Number of channels	Average number of BSs admitted without any optimization of channel distribution(S)	Average number of BSs admitted with optimization in whole geography community(G)	Average number of BSs admitted with optimization in neighborhood community(N)	Ratio of decrease (R=1-N/G)
4	41.35	50.474	49.075	2.77%
5	58.025	71.025	67.95	4.33%
6	73.9	94.6	92.925	1.77%
7	86.425	119.325	111.65	6.43%
8	109.175	147.275	141.325	4.04%
9	131.175	179.975	170	5.54%
10	149.775	207.875	197.425	5.03%
11	164.9	233.3	222.575	4.60%

12	188.2	258.675	249.975	3.36%
13	202.575	293.6	275.45	6.18%
14	225.2	317.3	308.225	2.86%
15	262.05	360.475	342.125	5.09%
16	275.15	393.4	372.05	5.43%
17	291.525	424.95	403.55	5.04%
18	315.825	457.3	429.3	6.12%
19	351.225	496.325	474.65	4.37%
20	361.025	520.325	507.6	2.45%

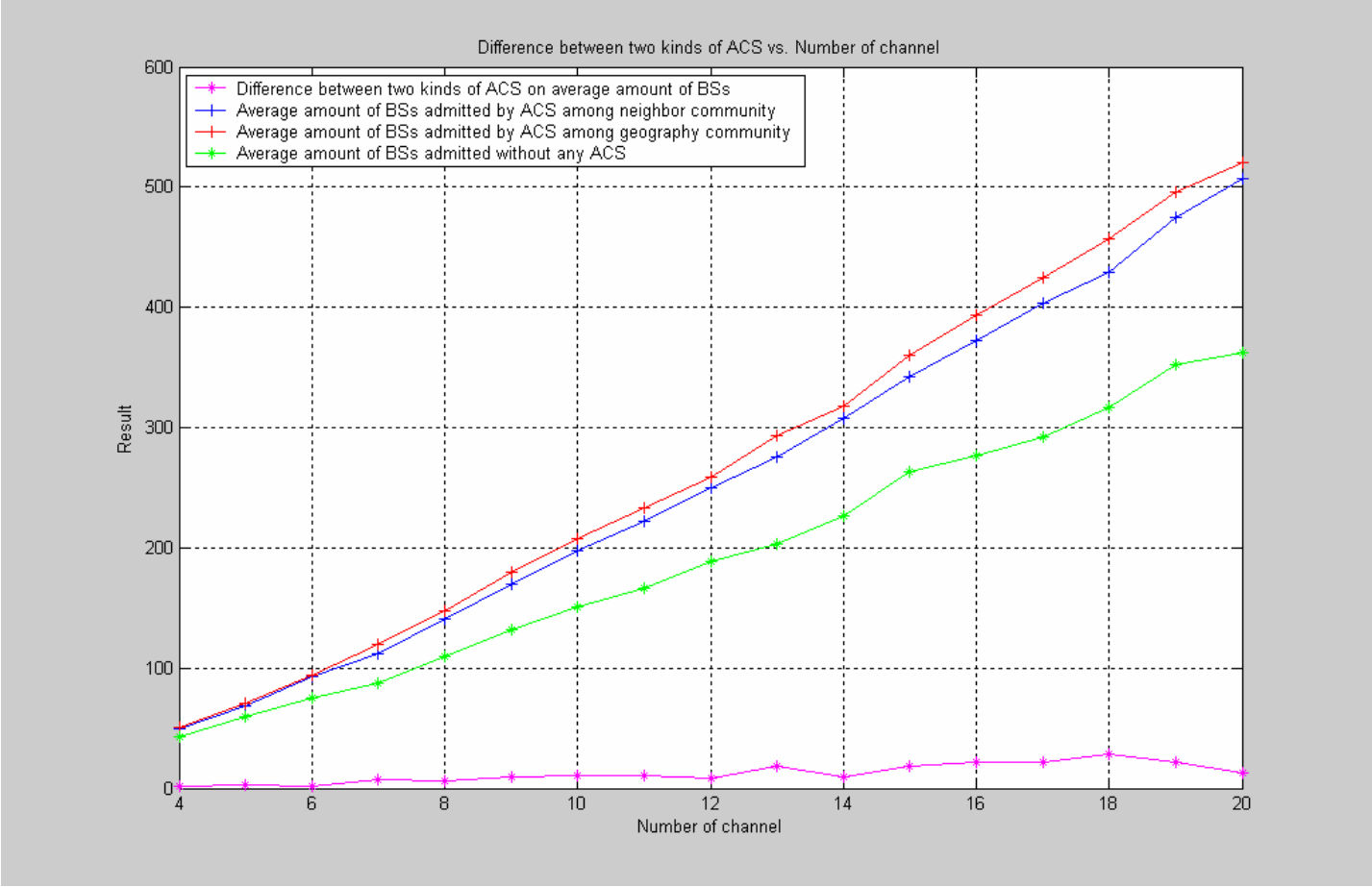


Figure 4 Comparison on number of BSs admitted by two kinds of optimization

We can find that both two kinds of optimization can admit a great more number of additional BSs in the area than distribution without any optimizations. And optimization in neighborhood community doesn't seem a great worse than optimization in geography community. 6%~8% is the greatest difference, that's a quite small

ratio considering the great increase production. So, we think the performance of optimization in neighborhood community is acceptable.

Here is the process of the smaller scale optimization.

Smaller scale optimization makes channel switches only on neighbors of IBS. IBS figures out the optimized channel distribution according to some assumptions that channel switch on certain neighbor will not bring any interference. In order to calculate the target working channel which IBS will occupy the neighbors currently working on it will switch to another channel without bringing any new interference.

All neighboring OBSs should maintain its own list of escape channels, which are the channels that the OBS may work on it without any interference with other BSs.

When IBS cannot find any free channels for itself at the initialization, IBS may collect channel occupancies of each neighbor. If all OBSs working on same channel have one or more escape channels, the channel that those BSs working on is a potential target channel for IBS. If IBS has several potential target channels, IBS may select the one on which less neighbors are working. The selected channel will be the working channel of IBS, and those BSs working on it should switch to one of their escape channels. At last, each BS should update its list of escape channels according to the working channels of all its neighbors.

Proposed text changes

Proposed text changes

Add the following section into clause 3. Definitions:

Escape Channel(ESCCH)*: The alternative working channel decided by the base station, on which the base station haven't detected any primary user or neighbors and also not currently chosen to be the working channel of this base station.*

Add the following items into clause 4. Abbreviations and acronyms

ESCCH escape channel

15.2.2.4 Information table in share database

[Change the following text in 15.2.2.4]

Table h2—This BS information table

Syntax	Size	Notes
Profile(){		
Band		
PHY mode(){		
Modulation		
Working Channel ID	*8bit*	*Identifier of the working channel of this BS.*

Number of escape Channels	*8bit*	*p: The number of escape channels to which this BS can switch without interference.*
For(i = 1; i <= p; i++){		
Escape Channel ID	*16bit*	*Identifier of the escape channel.*
}		
(Tbc).		
}		

Table h3—BS information table

Syntax	Size	Notes
Number of Coexistence neighbors	*8bits*	*m: The number of coexistence neighbors of this BS*
For(i = 1; i <= m; i++){		
BSID		
Working Channel ID	*16bit*	*Identifier of the working channel of this neighbor.*
Escape Channel Flag	*1bit*	*Flag indicates this neighbor has one or more escape channels.*
(Tbc).		
}		

15.7.1.4 Optimization of Channel Distribution

[Insert the following text in 15.7.1.4]

In the initialization phase of an IBS, IBS's neighbors will send their current OCTS allocation or subframe allocation to IBS using CP message, as well as a flag of having escape channels. IBS may maintain the channel information of all neighbors in BS information table.

When IBS cannot find any free channels for itself at the initialization, channel distribution may be optimized to vacate a free channel for IBS by switch some neighbors' working channels to others.

First, IBS picks up all the channels that every neighbor working on it has escape channels, and sorts them according to the number of neighbor BSs working on it.

Afterwards, IBS selects one of the channel used by lest BS, and considers this channel as its potential working channel. The neighbors working on the selected channel are to be negotiated.

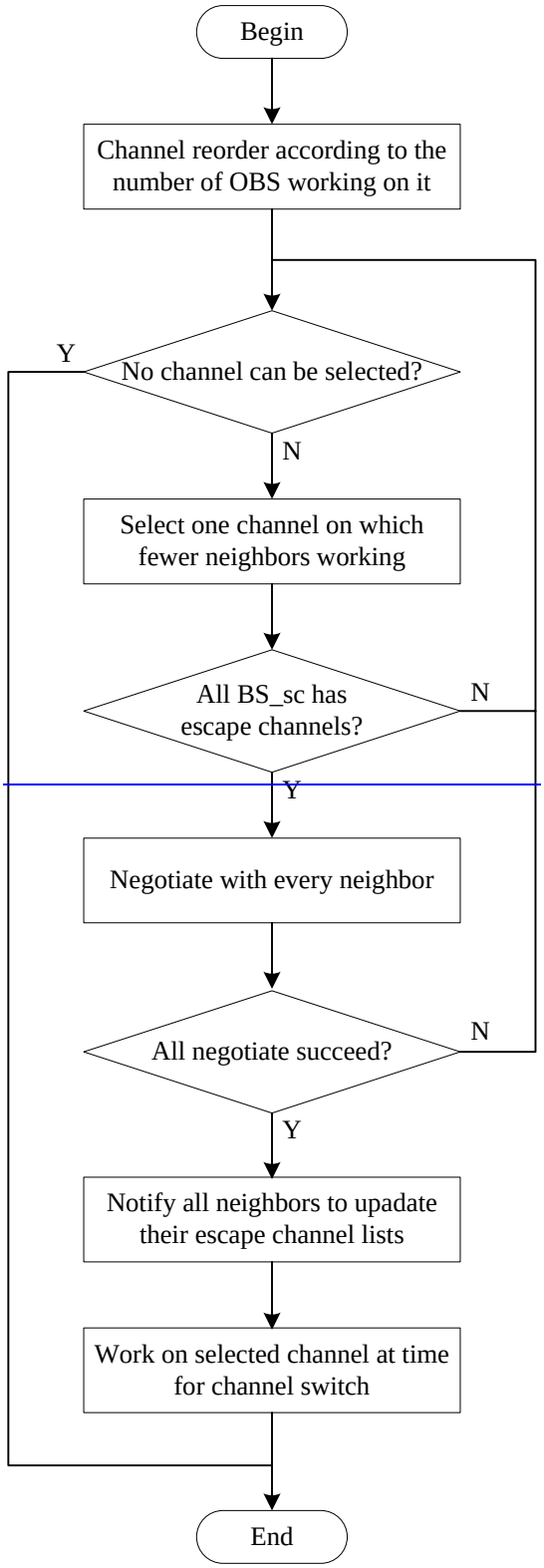
Then, to negotiate to every neighbor BS working on this channel, IBS should send channel switch request message. Neighbor OBS which have received this message should select one of its escape channels as the its target working channel, and try to move its working channel to that channel as long as the request is qualified. After its working channel switch to its escape channel, The neighbor OBS should acknowledge to IBS by sending back channel switch reply message with success indication, otherwise it should show rejection to IBS by sending back channel switch reply message with fail indication. If IBS received any rejection from the neighbors which IBS have sent the request, IBS should cancel the request by sending another message with the indication for the neighbors to back to the channel they used before the IBS's channel switching request.

When IBS receives all the acknowledged messages, it means the channel distribution optimization procedure has succeeded to vacate a channel for IBS. Otherwise, IBS should try the next channel.

In the case of success of the optimization procedure, list of escape channels of relative BSs should be updated because its neighbors may change their working channels. For IBS, it should broadcast to all its neighbor that it will working on the selected channel, and all its neighbors should add IBS as its new neighbor in BS information table, and exclude IBS's target working channel in the list of escape channel. For the neighbor OBSs working on this channel, they also should notify their change to all their neighbors for their switching from its current working channel to another, so their neighbors can update the database and their escape channel according to that change.

If all the potential channels can not be vacated to become IBS's working channel, channel distribution optimization procedure is failed, and IBS shall try to share one channel with some of its neighbors.

The process of channel distribution optimization is shown in Figure h26a.


Begin
Channel reorder according to the number of OBS working on it
No channel can be selected?
Y
N
Select one channel on which fewer neighbors working
All BS_sc has escape channels?
N
Y
Negotiate with every neighbor
All negotiate succeed?
N
Y
Notify all neighbors to upadate their escape channel lists
Work on selected channel at time for channel switch
End

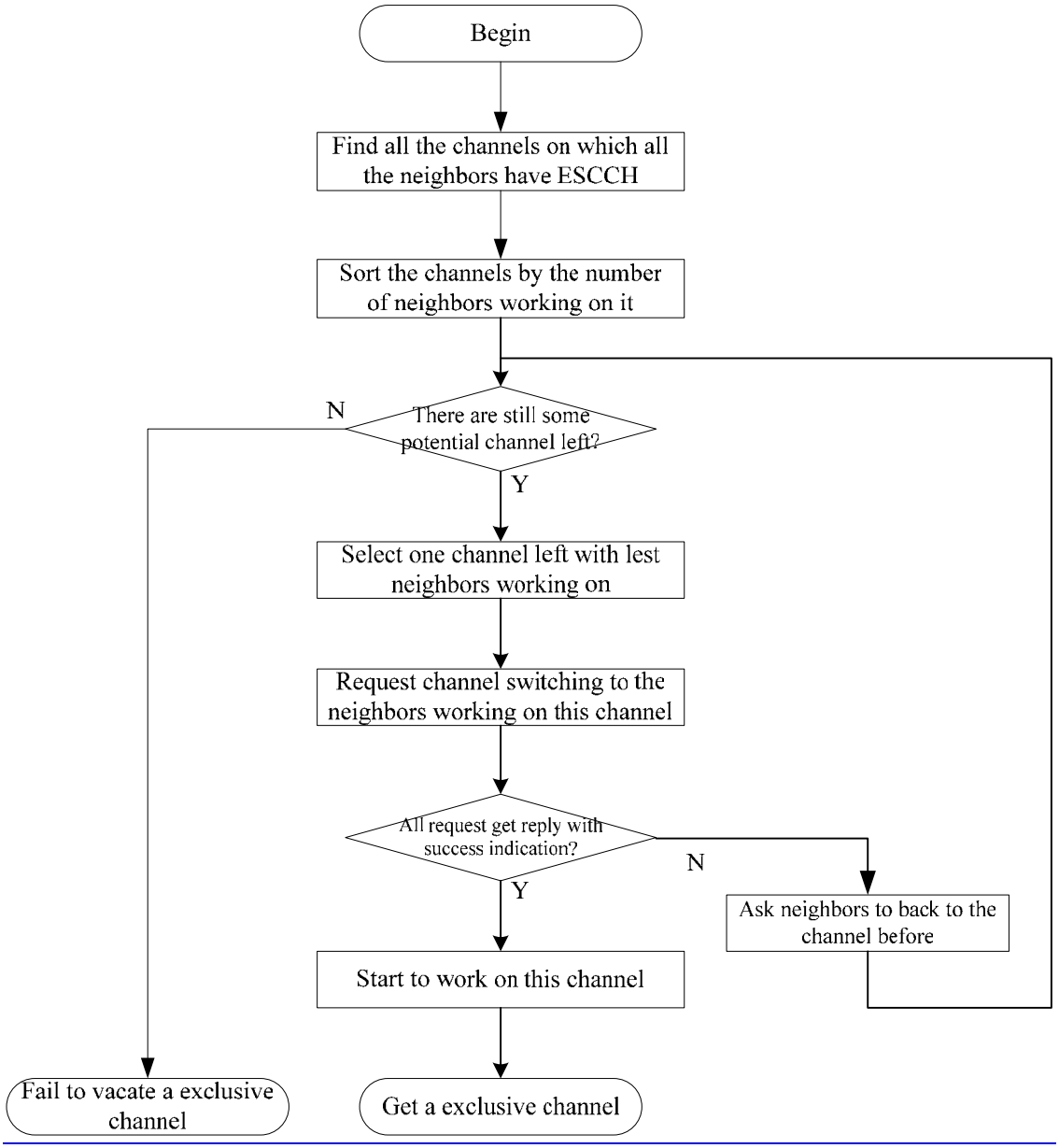


Figure h26a—Process of channel distribution optimization

[Change Table h8 as indicated:]

Table h8. LE_CP message codes

Code	CP Message type	MAC Message Type	Protocol type	Direction
…	…	…	…	…
37	Channel ~~Switch~~ Negotiation Request	LE_CP-REQ	TCP	BS->BS
38	Channel ~~Switch~~ Negotiation ~~Request~~	LE_CP-RSP	TCP	BS->BS

	Reply			
~~39~~	~~Channel Switch Request~~	~~LE_CP_REQ~~	~~TCP~~	~~BS->BS~~
~~40~~	~~Channel Switch Reply~~	~~LE_CP_RSP~~	~~TCP~~	~~BS->BS~~
~~39~~	~~Channel Occupy Notify~~	~~LE_CP_REQ~~	~~TCP~~	~~BS->BS~~
~~40~~	~~Channel Occupy Acknowledge~~	~~LE_CP_RSP~~	~~TCP~~	~~BS->BS~~
41~255	reserved			

[Change the following text at the paragraph of 15.6.1.37]

15.6.1.37 Channel Switch ~~Negotiation~~ Request message

This message is send by BS to another coexistence BS in the community to negotiate to switch ~~to a certain target~~ channel.

Code: 37

Parameters:

Table h19a—Channel Switch Request message attributes

Operator ID	The Operator identifier of requesting BS.
BSID	The requesting BS identifier
Requested BSID	BS identifier of the requested BS
Working Channel ID	The current working channel ID of the requested BS
Rolling back indication	0: to switch to one of the escape channels 1: to switch back to the channel before the last channel switching request
FSN	Frame sequence number to switch channel

[Change the following text at the paragraph of 15.6.1.38]

15.6.1.38 Channel Switch ~~Negotiation~~ Reply message

A message sent by BS, reply to Channel Switch ~~Negotiation~~ Request message about whether it agree or refuse to switch channel.

Code: 38

Parameters:

Table h19b—Channel Switch Reply message attributes

Operator ID	The Operator identifier of requesting BS.
BSID	The requesting BS identifier
Requested BSID	BS identifier of the requested BS

Acknowledge	*0: rejection for fail in switching* *1: succeeded in switching*
Target working channel ID (new working channel)	*The channel ID of the requested BS will switch to*
FSN	*Frame sequence number of the channel switching*

[Delete the following text]

~~**15.6.1.39 Channel Switch Request message**~~

~~This message is send by BS to another coexistence BS in the community to request *negotiate* to switch to a certain target channel.~~

~~Code: 39~~

~~[Change the following text at the paragraph of 15.6.1.40]~~

~~**15.6.1.40 Channel Switch Reply message**~~

~~A message sent by BS, reply to Channel Switch Request message.~~

~~Code: 40~~