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Title	A proposal for timing compensation of idle mode in MR
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Source(s)		
	Keiichi Nakatsugawa Fujitsu Laboratories Ltd. Kamikodanaka 4-1-1, Kawasaki, 211-8588, Japan	Voice: +81-44-754-2811 Fax: +81-44-754-2786 nakatsugawa@jp.fujitsu.com
	Yuefeng Zhou Fujitsu Laboratories of Europe Ltd. Hayes Park Central Hayes Middx., UB4 8FE, UK	Voice: +44 (0) 20 8573 4444 FAX: +44 (0) 20 8606 4539 Yuefeng.zhou@uk.fujitsu.com
	Shiao-Li Tsao, Fang-Ching Ren, Wern-Ho Sheen, I-Kang Fu National Chiao Tung University (NCTU) /Industrial Technology Research Institute (ITRI), Taiwan No. 195, Sec. 4, Chung Hsing Rd., Chutung, Hsinchu, Taiwan 310, R.O.C.	Voice: +886-3-5712121-54717 Fax: +886-3-5721490 E-mail: sltsao@cs.nctu.edu.tw, frank_ren@itri.org.tw
	Shulan Feng,Yanling Lu, Ting Li, Liangliang Zhang Hisilicon Technologies Harbour Building, No.8, Dongbeiwang West Road, HaiDian District, Beijing, China	Voice: 86-10-82829010 Fax: 86-10-82829075 mailto:luyanling@hisilicon.com

Re:	IEEE802.16j-07/007r2: “Call for Technical Comments and Contributions regarding IEEE Project 802.16j”
Abstract	This contribution proposes the method of timing compensation for idle mode.
Purpose	Text proposal for 802.16j Baseline Document
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A proposal for timing compensation of idle mode in MR

[***This contribution propose a harmonization text proposal on Idle Mode in MR***]

Introduction

This contribution proposes a method of timing compensation for timing-related control function, such idle mode. In 802.16e specification, several messages such as MOB_PAG-ADV are received at the pre-notified timing. However, in a non-transparent RS system[1], the message processing delay in RS makes it hard to fulfill that reception timing requirement. In order for MS to receive messages at the pre-notified timing, MR-BS compensates the timing when MS can receive messages with taking account of RS processing delay.

Details

In this proposed method, based on the following assumptions:

- The MR system is a non-transparent RS system[1].

- The RS can not relay message and data within the current frame. The message is delayed for fixed duration on account of relay processing in the RS.

- Each frame sent by MR-BS and RS are synchronized and has same frame number.

Timing compensation for idle mode

As shown in Fig. 1, MS enters idle mode by receiving DREG-CMD message involving "PAGING_OFFSET" parameter from MR-BS. F_B, the beginning frame of Paging Listening Interval (PLI), is decided by condition defined in section 6.3.24.5.

According to the above assumption, the frame number in MR-BS and RS are same, both F_B decided by MR-BS and MS indicate same frame. So, timing of PLI managed in both MR-BS and MS are synchronized absolutely.

However, MOB_PAG-ADV message sent from MR-BS will delay of "D_R" in RS, it is received at MS D_R frame later. Therefore, it depends on the length of PLI and the timing of that MOB_PAG-ADV message is sent from MR-BS, MOB_PAG-ADV message does not reach within PLI of MS and MS fails to receive the message.

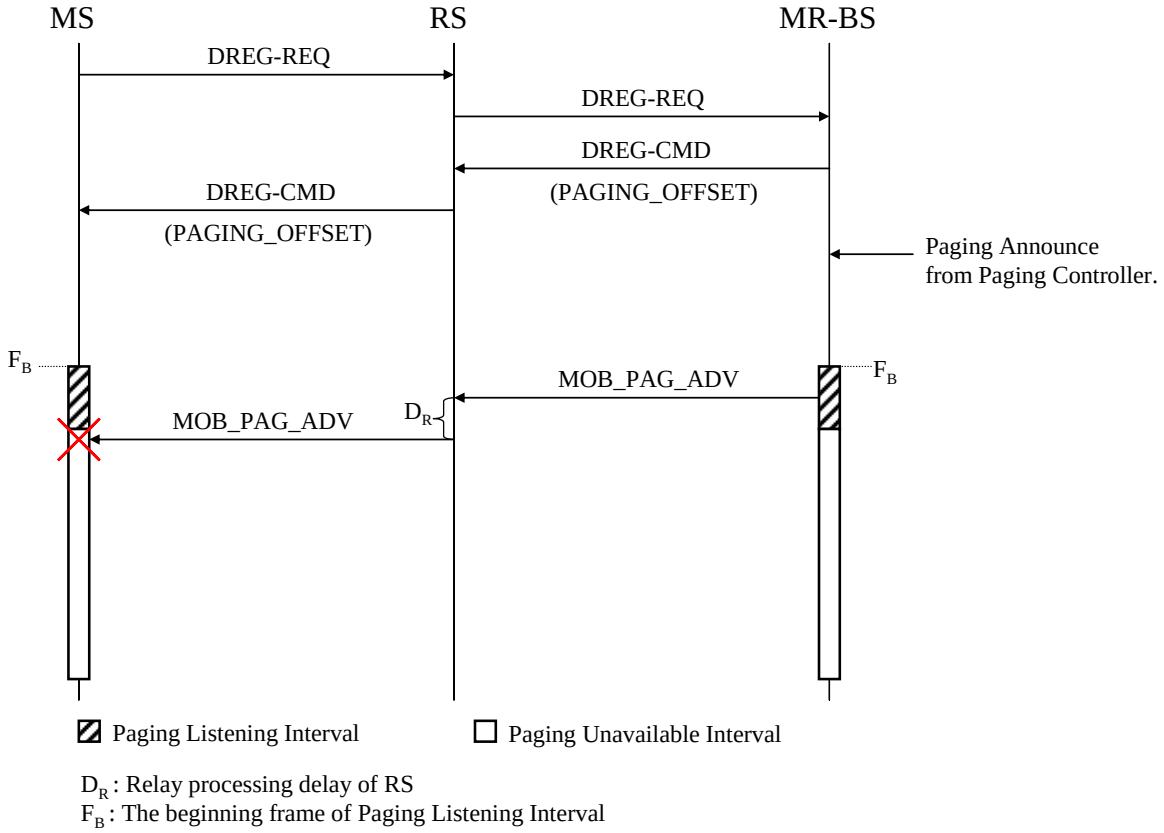


Fig. 1 PLI slipping problem of idle mode in MR

To avoid this problem, the timing of PLI managed in MR-BS and MS should be compensated. Proposed method is shown in Fig. 2.

When MR-BS receives DREG-REQ message and decides PAGING_OFFSET, MR-BS decides normal PAGING_OFFSET value using regular condition at first. MR-BS notifies MS of the beginning timing of PLI with this normal value. Then, MR-BS also decides modified PAGING_OFFSET value for itself. Modified value will be decided that the PLI managed internally in MR-BS is just shifted D_R earlier from the PLI of MS.

With this compensation method, MOB_PAG-ADV sent over the R-DL at any frame within PLI managed in MR-BS is received successfully within MS's PLI via RS relaying.

In order to decide the modified PAGING_OFFSET value in MR-BS, MR-BS needs to know D_R of RS. The value of D_R will be given to the MR-BS as a capability parameter of SBC-REQ message.

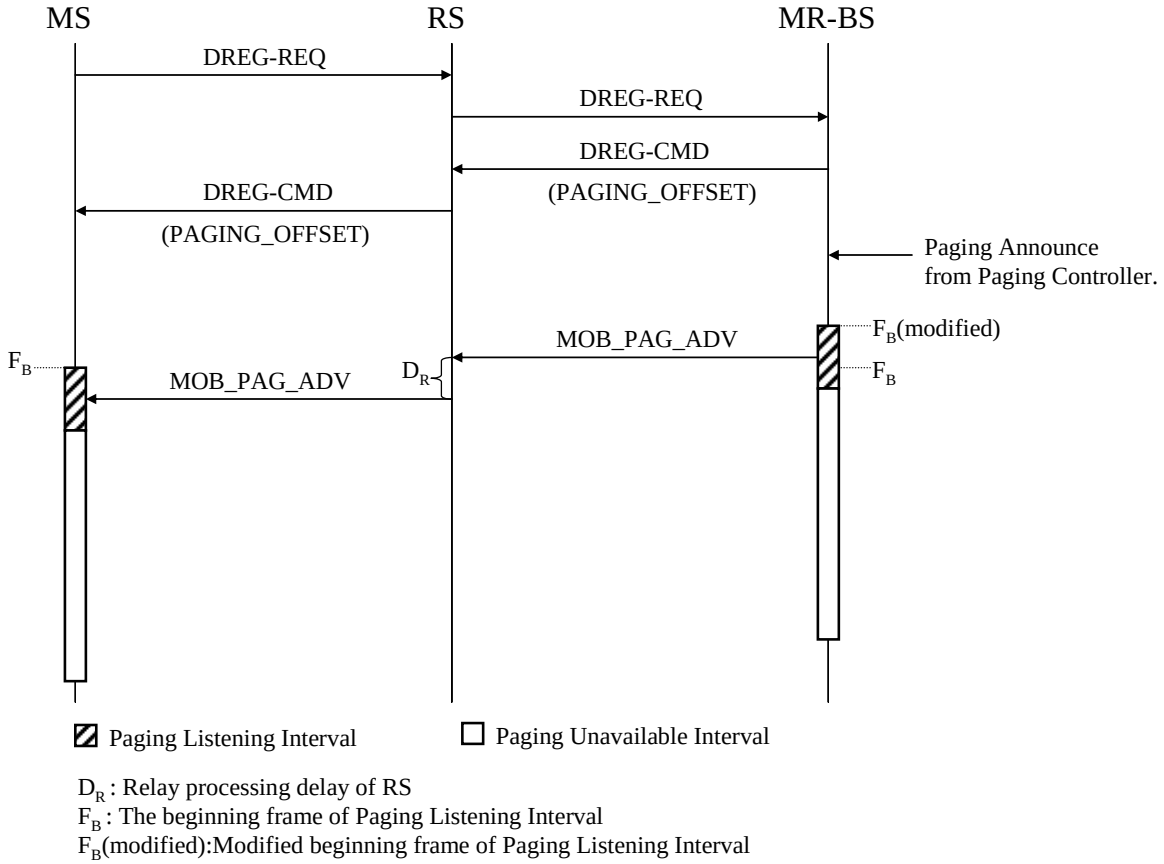


Fig. 2 Compensation for timing of PLI

Consider the case the MS moves across the areas of MR-BS and RS during the idle mode.

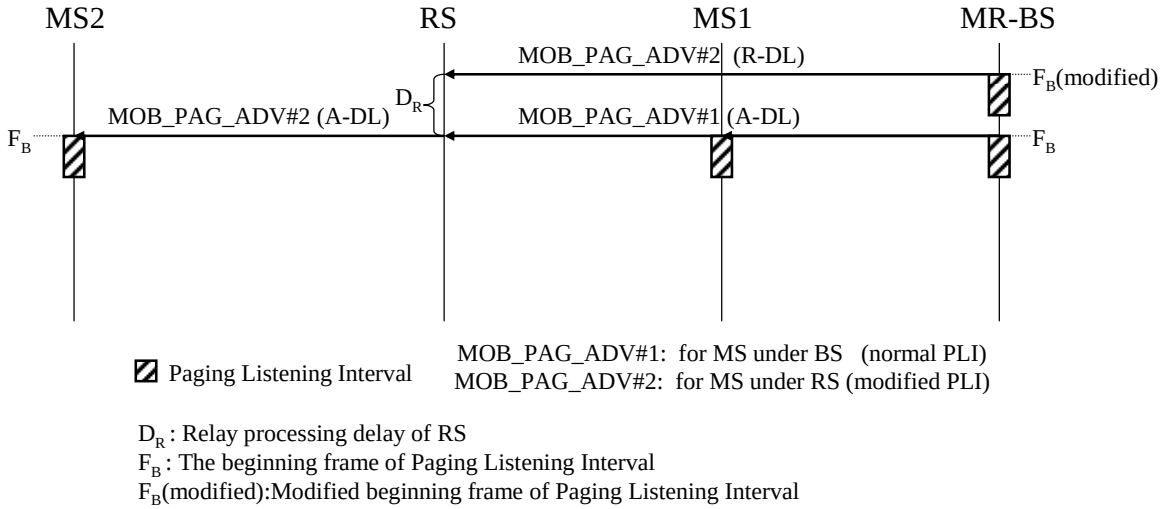


Fig. 3 MS under the MR-BS and RS

As shown in Fig. 3, MS1 entered idle mode under MR-BS and MS2 entered idle mode under RS. MR-BS can't recognize the location of each MS1 and MS2 because of idle mode. Both MS1 and MS2 are

managing normal PLI timing, and MR-BS are managing normal PLI timing for MS1 and modified PLI timing for MS2.

In order for both MSs to receive MOB_PAG-ADV, MR-BS shall send both MOB_PAG-ADV#1 for normal PLI over the access link and MOB_PAG-ADV#2 for modified PLI over the relay link.

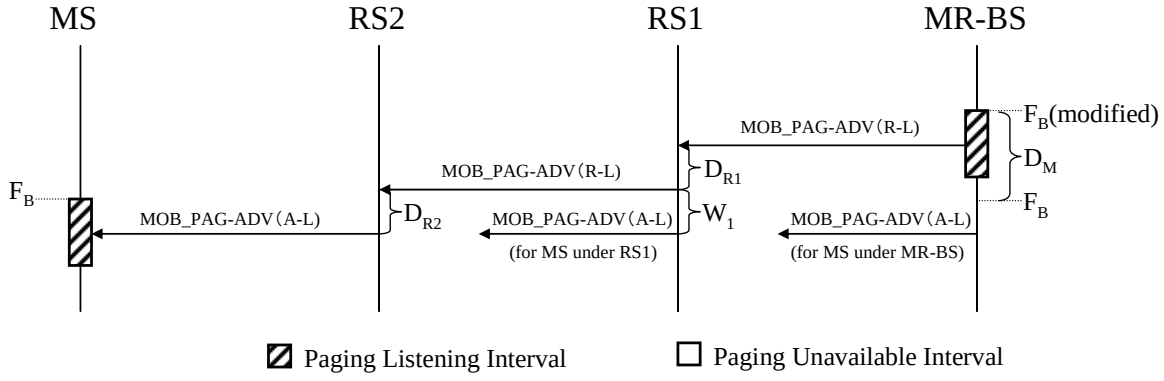
Note that RS doesn't receive MOB_PAG-ADV#1 because it is sent over the access link. RS relays only MOB_PAG-ADV#2.

Consider the case that there are multiple RSs existing with different processing delay performance and hop counts between the MR-BS and MS, as shown in Fig. 4.

In this case, the MR-BS calculates the cumulative processing delay "D_C" of each path between the MR-BS and the MS, then finds the maximum of "D_C", which is "D_M". As shown in Fig. 4, the cumulative delay "D_C" is equal to $D_{R1}+D_{R2}$. And also the maximum "D_M" is $D_{R1}+D_{R2}$. The MR-BS decides modified beginning frame of PLI for itself with "D_M". Then MR-BS examine the waiting time "W" for each RS. In this case, RS1 needs to wait "W_1", which is D_M - D_{R1} between finishing relay processing and sending MOB_PAG-ADV over access link. Such the waiting time will be notified in SBC-RSP message.

The MR-BS sends MOB_PAG-ADV over the R-DL as a pre-transmission D_M frame earlier than the normal MOB_PAG-ADV transmission over access link. The MR-BS shall waiting for D_M frames, and the RS which is notified waiting time by the MR-BS shall waiting for W frames, and then sends MOB-PAG-ADV data again over the access link.

If the MR-BS detects that the waiting time for some RS needs to be changed, MR-BS may send unsolicited SBC-RSP message and notifies RS which needs to change the waiting time of it.



D_R : Relay processing delay of RS
D_M : Maximum cumulative Relay processing delay
W_1: Wait for access link transmission of RS1
F_B : The beginning frame of Paging Listening Interval
F_B(modified):Modified beginning frame of Paging Listening Interval

Fig. 4 Compensation for timing of PLI over multiple RSs

Conclusion

According to this compensation method, the MOB_PAG-ADV messages are surely delivered from MR-BS to MS through RS relaying.

Specific text changes

[Insert the following text at the end of 6.3.24.5:]

For MR, all the idle-mode MSs which have same PLI within same paging group shall receive the MOB_PAG-ADV at the same time. The RS delay, D_R, is given to MR-BS as a capability parameter of SBC-REQ message. MR-BS sends MOB_PAG-ADV over the R-DL as a pre-transmission D_R frame earlier than the normal MOB_PAG-ADV transmission time. MR-BS shall wait for D_R frames, and then sends MOB-PAG-ADV data again over the access link.

If multiple RSs with different delay performance existing, MR-BS shall firstly examine the cumulative processing delay "D_C" of each path between the MR-BS and the MS, then finds the maximum of "D_C", which is "D_M". The MR-BS decides modified beginning frame of PLI for itself with "D_M". Then MR-BS examine the waiting time "W" for each RS. Such the waiting time will be notified in SBC-RSP message.
The MR-BS sends MOB_PAG-ADV over the R-DL as a pre-transmission D_M frame earlier than the normal MOB_PAG-ADV transmission over access link. The MR-BS shall wait for D_M frames, and the RS which is notified waiting time by the MR-BS shall wait for W frames, and then sends MOB-PAG-ADV again over the access link.

If the MR-BS detects that the waiting time for some RS needs to be changed, MR-BS may send unsolicited SBC-RSP message and notifies RS which needs to change the waiting time of it.

[Insert new subclause 11.8.3.7:]

11.8.3.7.X RS waiting time for Paging

Type	Length	Value	Scope
TBA	1	RS waiting time for Paging (unit: frame)	SBC-RSP

References

[1] IEEE 802.16j-06/026r2, "P802.16j Baseline Document"