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Title	An Efficient Scanning Mechanism for Inter-RAT Operation in IEEE 802.16m
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Re:	IEEE 802.16m-07/040 - Call for Contributions on Project 802.16m System Description Document (SDD)
Abstract	This contribution proposes text proposal for Scanning Mechanism of Inter-RAT Operation in IEEE 802.16m.
Purpose	For discussion and approval by TGm
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An Efficient Scanning Mechanism for Inter-RAT Operation in IEEE 802.16m

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1. Introduction

According to IEEE 802.16m System Requirements Document (SRD)[1], IEEE 802.16m shall support handover and internetworking functionalities with other RATs (radio access technologies). In response, this contribution proposes an efficient scanning mechanism to assist 16m MS to scan other RATs for system and channel information. As a result, service continuity can be maintained during Inter-RAT operation.

2. Discussion and Proposal

During Inter-RAT operation, BS shall schedule a period of time for MS to scan other RATs for potential Inter-RAT handover, if the MS has only one transceiver. During this time, MS needs to disconnect with original RAT and turns to other frequencies for searching other RATs. In the legacy scanning procedure of the IEEE 802.16 system, as shown in Figure 1, a frame-based scheduling is used and a MOB_SCN-RSP message is sent to MS with associated scanning parameters.. The scanning parameters include:

- Start frame number: the absolute frame number at which the first scanning interval starts.
- Scanning interval: a period of time (in frames) where the MS may perform scanning or association for available BSs.
- Interleaving interval: the period of time (in frames) between scanning intervals where MS shall perform normal operation.
- Scan iteration: the number of iterating scanning interval.

This legacy method in IEEE 802.16 also works well for intra-RAT handover in IEEE 802.16m because 16m BSs are well-synchronized with each other, and the serving 16m BS can accurately calculate the necessary frames for scanning other 16m BSs. For Inter-RAT operations, however, 16m BS may not have full knowledge of other RATs, such as frame structure, center carrier frequency, etc. As a result, 16m BS may need to schedule scanning interval as long as possible to avoid wasted scanning. Therefore, the interleaving interval may need to be compressed or the scanning period be increased; both of which degrade the service performance..

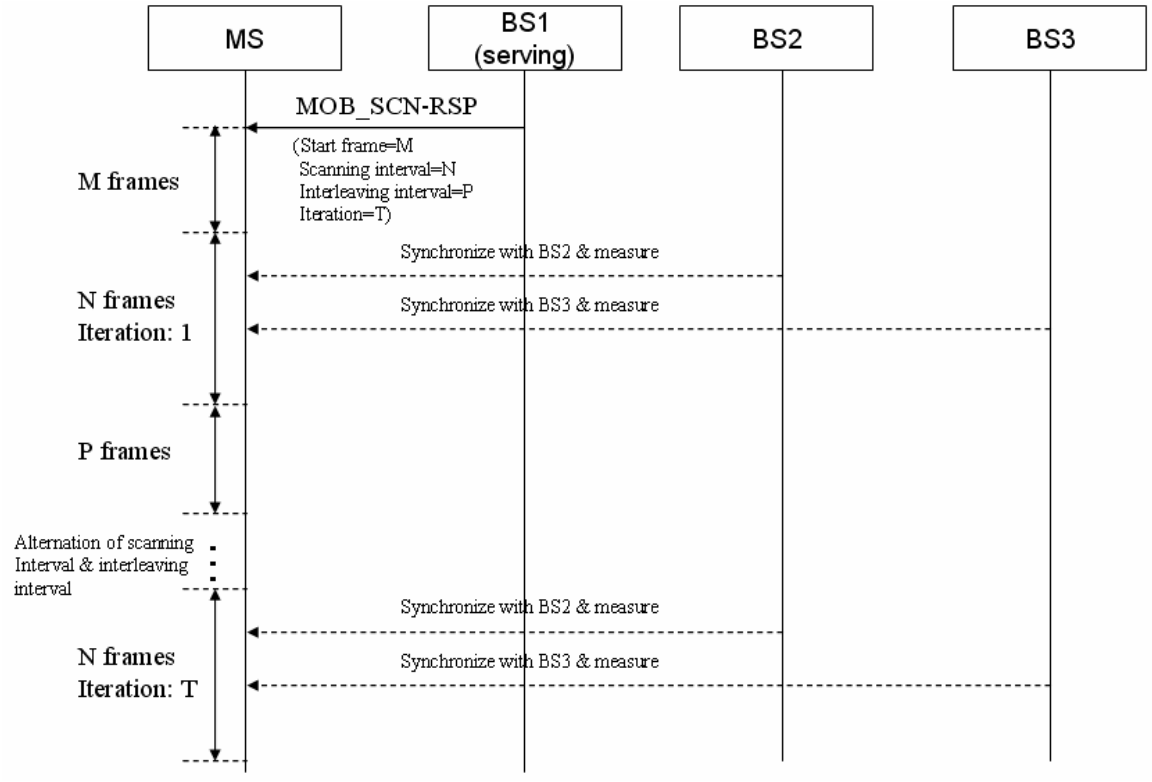

Figure1. IEEE 802.16 measurement scheduling

To make scanning more efficient, two new operations are proposed to add on the legacy method for the Inter-RAT operation in IEEE 802.16m. All MSs and BSs in the following context are assumed to have 802.16m capability if no specific statement is made

- ***Pre-negotiation before scheduling:***

Before scheduling the scanning period, BS can request operating parameters of other RATs from internetworking server. With this information, BS can calculate the maximum time to finish measuring the target cells, and in turn, calculate the scanning interval (in 16m frame) to support this measurement. Equation (1) is an example for this calculation.

$$SI = \left\lfloor \frac{\rho + N \times T}{S} \right\rfloor \quad , \tag{1}$$

Where *SI* is the scanning interval, *N* is the number of target cells, ρ is the frequency switch processing time, *T* is the frame duration of the target RAT, and *S* is the frame duration of 16m. It is assumed that one frame is used for measuring a cell in the target RAT.

- ***Early-return mechanism:***

Although pre-negotiation can help BS schedule appropriate scanning interval, it may happen that the scanning is completed earlier than the one scheduled. For example, if the reference signal used for measurement in a target RAT (ex: beacon in IEEE 802.11 system) comes immediately after the frequency

switching, the scanning interval will be $\left\lfloor \frac{\rho + (N-1)\times T}{S} \right\rfloor$ which is smaller than original scheduled one. In addition, when event-triggered reporting is employed, see Figure 2, it may have reporting delay due to the processing of BR (Bandwidth Request). To overcome these issues, an early-return mechanism is proposed.

The basic idea is as follows. When BS gives the scanning response, two dedicated orthogonal Ranging codes, ie. {C1, C2}, are assigned to this specific MS. When scanning is completed before the end of scanning interval, and the measurement results are needed to report to the serving BS, the MS will send C1 code in the ranging sub-channel of the serving BS. Due to the dedicated assignment, the serving BS can receive it without any collision and be notified that this specific MS has already finished its scanning and request for resuming its normal operation and bandwidth for reporting. Therefore, the serving BS will allocate corresponding DL-MAP/ UL-MAP for these purposes in the next frame. The scanning may be reinitiated at the next iteration of scanning interval. Alternatively, when the MS finishes the scanning without the need to make reporting, MS will send the C2 code in the ranging sub-channel of the serving BS. By the way, the serving BS will only allocate DL-MAP/UL-MAP for MS's normal operation. Figure3 shows the complete operation of this proposal.

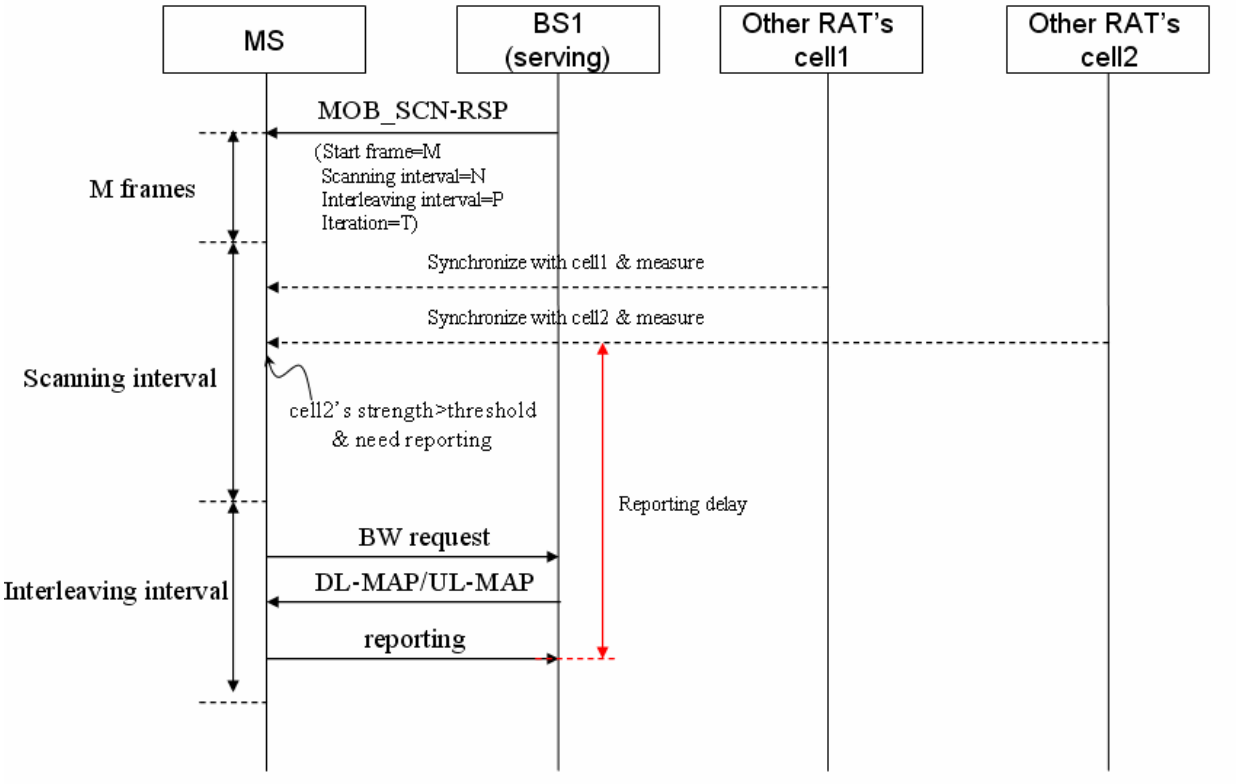

Figure2. Reporting delay in legacy 802.16 measurement

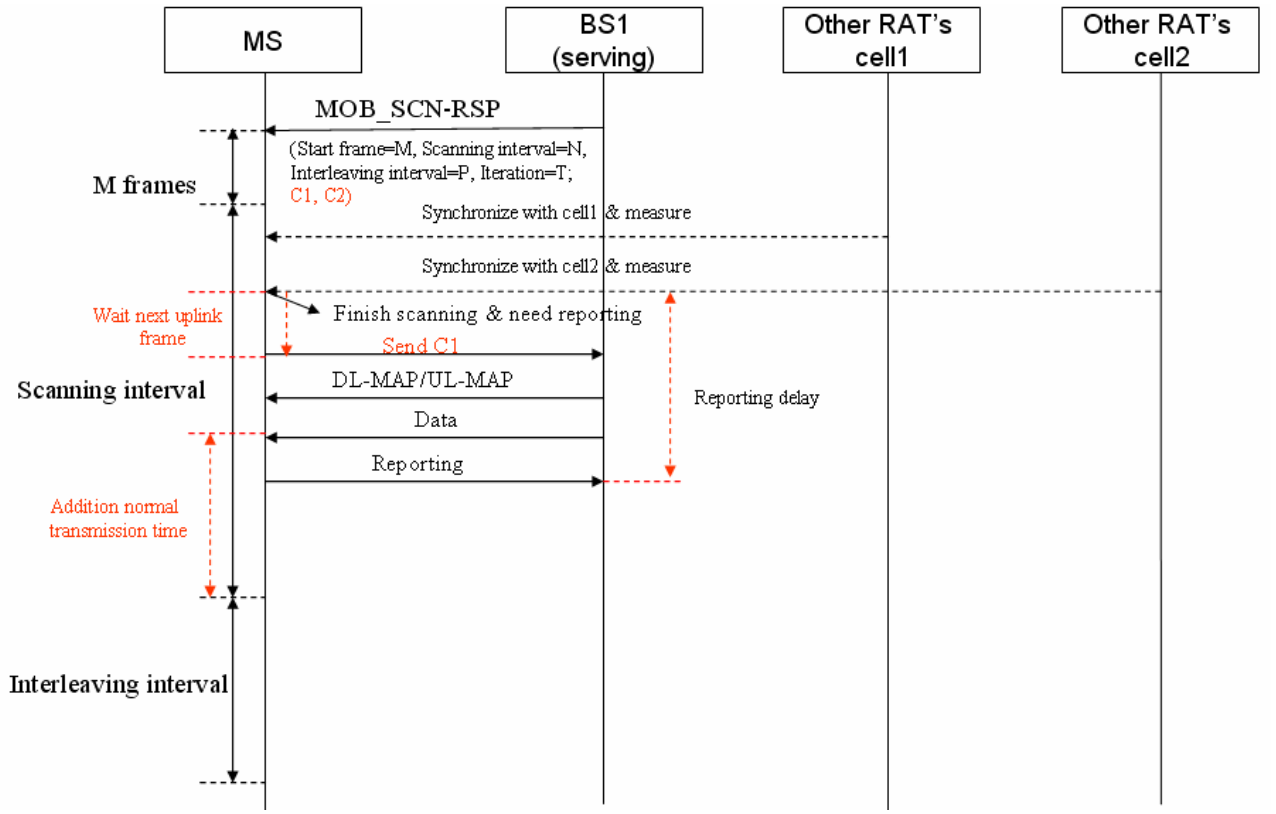

Figure3. Proposal for Inter-RAT scanning

In summary, by adding the proposed steps of processing to the legacy 16e scanning procedure, the BS is able to make an appropriate scheduling for scanning other RATs and provide MS the capability of requesting early-return to its normal operation and reporting. Therefore, an efficient Inter-RAT operation with less scanning time and reporting delay can be expected.

3. Proposed Text

----------Start of the text----------

2.2.1.2.1 MS scanning of other RAT in single-receiver case

(This section is referred from the Table of Contents proposed by [2])

[Insert the following text into this section]

When the serving BS decides to send an unsolicited MOB_SCN-RSP or responds to a MOB_SCN-REQ, the parameter of scanning interval specified in this message should take the neighboring RATs' information such as frame duration, carrier frequency offset, etc into consideration [How does BS acquire other RATs' information is out of IEEE802 std scope and is not discussed in this part]. In addition, two dedicated and reserved Ranging codes are also given in MOB_SCN-RSP.

When the MS completes the scanning during the scanning interval and finds the signal strength satisfies the

reporting threshold, it will send Ranging Code1 in the ranging sub-channel of the serving BS to request the termination of scanning interval and re-allocation of DL/UL-MAP to start normal operation and make reporting. MS will return to scanning for other RATs in the next scan iteration. Alternatively, if MS completes the scanning without the need to make reporting, it will send the Ranging Code2 in the ranging sub-channel of the serving BS and then DL/UL-MAP with corresponding transmission will be allocated in next frame.

6.3.2.3.49 Scanning Response (MOB_SCN-RSP) message

[Add the following text in this section]

If the Inter-RAT scanning is implemented, two dedicated Ranging codes are assigned by TLV tuples in this message to provide MS the capability of requesting the early-return to normal transmission during scanning interval.

11.20 MOB_SCN-REQ/RSP message encodings

[Insert the new subclause in this section]

11.20.3 Ranging Code information

Name	Type (1 byte)	Length	Value	Scope
Ranging Code1	TBA	1	Ranging Code1 is a dedicated assignment for MS to request normal transmission and reporting during Inter-RAT scanning.	SCN-RSP
Ranging Code2	TBA	1	Ranging Code2 is a dedicated assignment for MS to request normal transmission during Inter-RAT scanning.	SCN-RSP

---------- End of the text ----------

References

[1] IEEE802.16m-07/002r4 “Draft IEEE 802.16m Requirements”

[2] IEEE802.16m-07/284 “Inter-RAT Operations in IEEE 802.16m System Description Document”