Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Correction of RS Preamble Configuration Request (RS_Config-REQ) Message
Date Submitted	**2007-05-03**
Source(s)	Changqin Huo, Dorin Viorel, Aram Sukiasyan, Chad Gilbertson, Jagan Seshadri Fujitsu Microelectronics Canada Inc. — dviorel@fmci.fujitsu.com; Voice: +1 403-207-6311 Mike Hart Fujitsu Laboratories of Europe Ltd. — mike.hart@uk.fujitsu.com; +44 (0) 20 8606 4539 Peiying Zhu, Israfil Bahceci Nortel 3500 Carling Avenue Ottawa, Ontario K2H 8E9 — pyzhu@nortel.com Voice: +1 613 763-1315 Mary Chion, Kim Olszewski ZTE USA — mchion@zteusa.com Jeffrey Z. Tao, Koon Hoo Teo, Jinyun Zhang Mitsubishi Electric Research Lab — tao@merl.com, Voice : +1 617 621 7557 Toshiyuki Kuze Mitsubishi Electric Corp — Kuze.Toshiyuki@ah.MitsubishiElectric.co.jp, Voice : +81 467 412885 Junhong Hui, D.H. Ahn ETRI 161, Gajeong-Dong, Yuseong-Gu, Daejeon, 305-350, Korea — junhonghui@etri.re.kr
Re:	Call for Technical Comments regarding IEEE Project P802.16j (IEEE 802.16j-07/013r2)
Abstract	In this contribution, we propose a correction of RS preamble configuration request to avoid the problem of low power-amplifier (PA) efficiency at a RS
Purpose	To incorporate the proposed change into the P802.16j Baseline Document (IEEE 802.16j-06/026r3)
Notice	
Release	

Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Correction of RS Preamble Configuration Request (RS_Config-REQ) Message

Changqin Huo, Dorin Viorel, Aram Sukiasyan, Chad Gilbertson, Jagan Seshadri and Mike Hart

Fujitsu

Peiying Zhu, Israfil Bahceci

Nortel

Mary Chion, Kim Olszewski

ZTE

Jeffrey Z. Tao, Koon Hoo Teo, Jinyun Zhang, Toshiyuki Kuze

Mitsubishi Electric

Junhong Hui, D.H. Ahn

ETRI

1. Statement of the Problem

In Section 6.3.2.3.69 in [1], RS preamble configuration request (RS_Config-REQ) message is specified for a MR-BS (or parent RS) to send configuration information to its subordinate RSs. The 2-bits parameter N_Preamble indicates the number of preambles assigned to the potential RS, to be transmitted simultaneously. When N_Preamble is equal to 2 or 3, the RS will transmit 2 or 3 sets of preambles with different segment numbers simultaneously.

Transmitting 2 or 3 sets of preamble subcarriers simultaneously will cause serious problems in the PHY layer and required increased MAC layer complexity compared to the case of just transmitted 1 preamble sequence, as described hereby:

1. Multiple MAC instances & duplicated PHY layer elements

Any multiple preamble transmission would require a multiple segment transmission for the same amount of time. Accordingly with [3] #8.4.3.2:

"A Segment is a subdivision of the set of available OFDMA subchannels (that may include all available subchannels). One segment is used for deploying a single instance of the MAC."

Therefore a multiple preamble transmission would require, when implemented, a RS equipped with a processor sized for handling multiple MAC entities running in parallel.

At the MAC layer the RS will effectively look like two or more RSs in the same box. Currently it is unclear how to handle the HO of MSs within the physical RS with two logical, orthogonal MAC layers. Without any optimization HO will be effectively as if they are two separate devices.

At the PHY layer, because the segment ID is different, then effectively separate PHY processing chains will be required, one of the main reasons why is because multiple parallel PRBS generators will be required, because the segment ID is different. PRBS generators are used for the following:

- Ranging code generation
- Data randomization
- Data modulation
- Pilot modulation

Consequently, all of the PHY elements that use the PRBS output will need to be duplicated.

As a result, multiple preamble transmission support at RS, will require complete duplication in the MAC layer and significant duplication in the PHY layer, as it will be difficult, probably impossible, to use the same PHY layer to support two different MAC instances. All of these duplicated processing elements will then be redundant during single preamble transmission support.

As the degree of duplication is large, the difference between an RS that supports multiple preamble transmission and two RSs in the same physical box becomes negligible. Therefore the cost of two, one segment supporting RSs will be similar to that of multiple single preamble transmission RS, in which case we do not need to define such an RS in the standard because an implementer can simply use the existing standard to package two RSs into the same box and if they wish. If they believe that the RF related issues raised in this contribution could be considered as minor or circumvented in some way, then they can let the two RSs share the elements of the RF front-end, however nothing is required in the standard to enable this type of implementation.

2. Preamble related RF transmit power increase.

The preamble related RF power gets increased during a multiple preamble transmission, due to the following factors.

A. Average preamble RF transmit power increase

The average RF transmit-power at the output of the RF PA is increased, during the transmission of the multiple access preambles. Specifically, the average transmit-power for the preamble symbol will be increased by a factor of 2, or 3 dB, and a factor of 3, or 4.8 dB, for N_Preamble of 2 and 3, respectively.

B. PAPR preamble related degradation

The Peak-to-Average-Power-Ratio (PAPR) performance gets degraded, when more than one set of preamble gets transmitted during the same symbol. It could be seen from Table 1, that in a conservative case, the maximum PAPR performance gets degraded by 2.8 dB and 4.3 dB for N_Preamble of 2 and 3, respectively (2k FFT), where the maximum PAPR is obtained by examining the PAPR performance of the various combinations of preambles from 2 or 3 different segments with the assumption of the same preamble transmit power for each used segment.

In other words, for FFT size of 2048, when N_Preamble (number of simultaneous transmissions) is 2 or 3, the average and PAPR RF transmit power will be about 5.8 dB or 9.0 dB higher than a regular single-preamble transmission, respectively, when you combine the issue raised in item 1 with the increase in PAPR. To maintain linearity of transmission, higher input back-off - IBO factors are required for the RF PA, as presented in Table 1.

This increase in the back-off RF power factor is unacceptable as it effectively results in lower power amplifier efficiency at the RS and consequently poor relay performance at RSs caused by the lower transmit power available for each segment (assuming the amplifier size remains unchanged).

In other words, we can state that for a regular OFDM amplifier, with an efficiency of 10%, the overall efficiency of the OFDM RF power amplifier will get degraded to 2.5% (when 2 preambles are concurrently transmitted) or 1.25% (when 3 preambles are concurrently transmitted).

Figure 1 depicts the RF coverage shrinkage effect due to the power backoff for N_Preamble of 2 and 3 when the path loss exponent γ is 4 (NLOS), 3 (OLOS) and 2 (LOS), respectively. It could be noticed that the coverage area approximately shrinks by 58% and 75% for N_Preamble of 2 and 3, respectively, at γ of 3 (a typical value for obstructed LOS wireless environment), for 1k FFT case. When γ equals 2 (LOS), the RF coverage approximately shrinks by 63% and 87% for N_Preamble of 2 and 3, respectively.

	Parameter	**FFT Size**		
$N_{preamble}$		**2048**	**1024**	**512**
1	Max PAPR dB]	4.9113 dB	4.4924 dB	4.4450 dB
2	Max PAPR [dB]	7.7079 dB	7.1161 dB	6.9343 dB
	Power increase [dB]	3.01	3.01	3.01
	Max RF power back-off factor [dB]	10.72	10.13	9.93
	Overall input back-off factor degradation [dB]	**5.81**	**5.63**	**5.50**
3	Max PAPR [dB]	9.1988	8.6532	8.3600
	Power increase [dB]	4.77	4.77	4.77
	Max RF power back-off factor [dB]	13.97	13.42	13.13
	Overall input back-off factor degradation [dB]	**9.06**	**8.93**	**8.69**

Table 1—Overall input back-off factor for the RS RF Power Amplifier when multiple preamble transmissions are used

Considering Fig. 1, the following assumptions have been made:

- The outer circle (annotated with 100%) corresponds to the service area covered by a one preamble related transmitting RF power
- The first inner circle (pattern filled) represents the 2 preamble coverage area, referenced to the same initial transmitted (one preamble) RF power

- The inner circle represents the 3 preamble coverage area, referenced to the same initial transmitted (one preamble) RF power

- The 1k FFT case is analyzed, considering the input back off factor degradation presented in Table 1, for 2 and 3 preambles referenced to the one preamble transmission situation

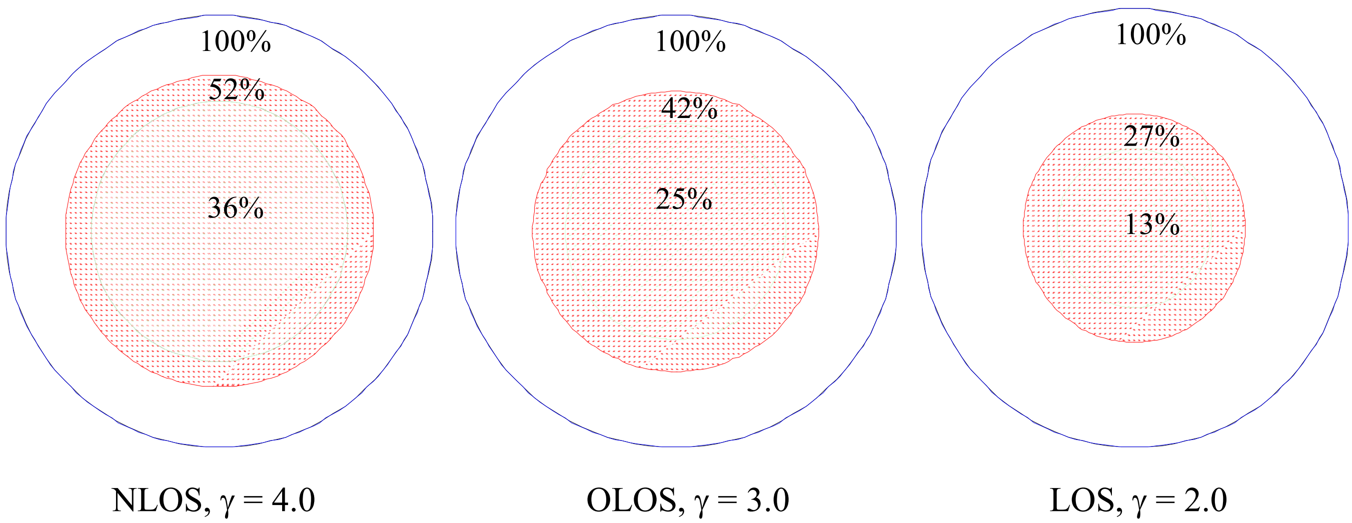


Figure 1 Cell coverage area augmentation due to RF power amplifier's input backoff factor

It should be also noted that the resulting service area for the related network synchronization will get decreased under the size of the MAPs coverage area (assuming repetition rate 1) and in the same service area (assuming QPSK1/2 data coverage area), which is a significant functional and performance degradation for a mobile OFDMA network, requesting the increase of the BS or RS density in order to properly provide the network coverage, thus triggering significant cost increases in the network infrastructure.

It also appears that any HO process developed during a multiple preamble transmission will be severely impacted, due to the reduced cell coverage. Any cooperative RS operation will be compromised when multiple preambles are transmitted, due to the related cell coverage reduction.

If an RS is equipped with an oversized RF PA, in order to accommodate the degraded input back-off factor, the related cost of the respective RS will go up significantly.

3. HO related issues

Assuming an RS RF PA transmitting multiple preambles, will not have enough overhead to accommodate multiple preamble transmissions, then accordingly with the cell coverage reduction effect resulted as the IBO degradation, presented in subsection 2, the transmitted RF power will be reduced due to the input back-off factor reduction. Due to the significant cell coverage reduction, no soft or hard HO procedure will be possible for any user (either MS or RS) located in the coverage reduction area, therefore the respective MS/RS would drop the connection.

In either case (no RF headroom provided or enough RF headroom provided) the HO procedure will get impacted.

4. Spectrum re-growth

In order to simulate the spectral mask impact of a multiple preamble transmissions, the following assumptions have been made concerning typical RF Power Amplifier (PA) with the following characteristics: P1=34 dBm, TOI (IP3)= 45 dBm, Gain = 35.0 dBm, BW=10 MHz. The RF PA has been modulated with an 802.16e frame structure based on a 1k FFT, DL PUSC allocation.

The purpose of the exercise was to simulate the compliance level of the related spectrum against a WIMAX 2.5 GHz spectrum mask (pre-approved WIMAX spectrum mask for 3A profile, for the May 2007 WIMAX TWG FtF meeting).

The following results have been plotted for one, two and three simultaneous transmitted preambles.

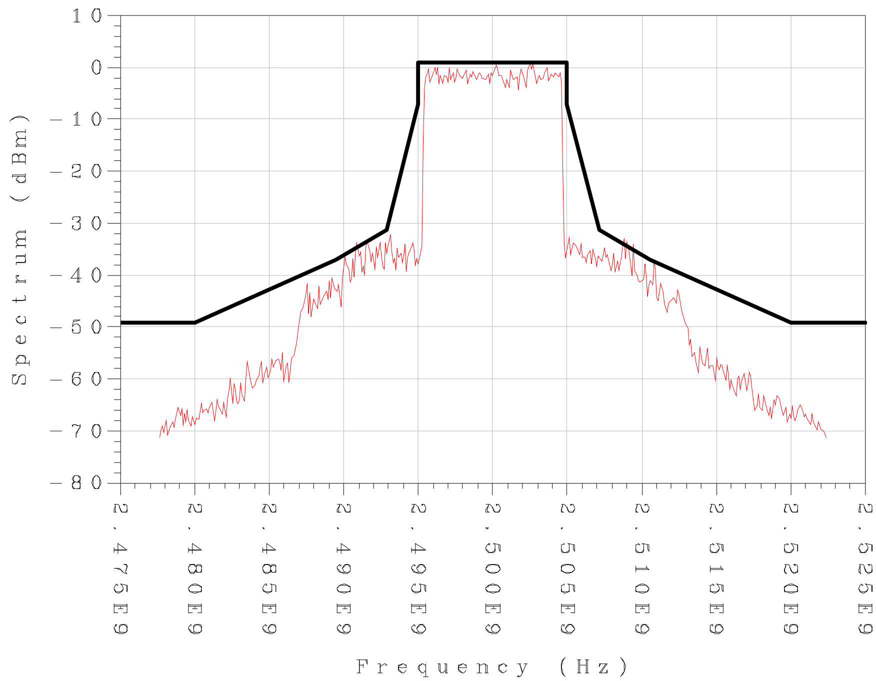
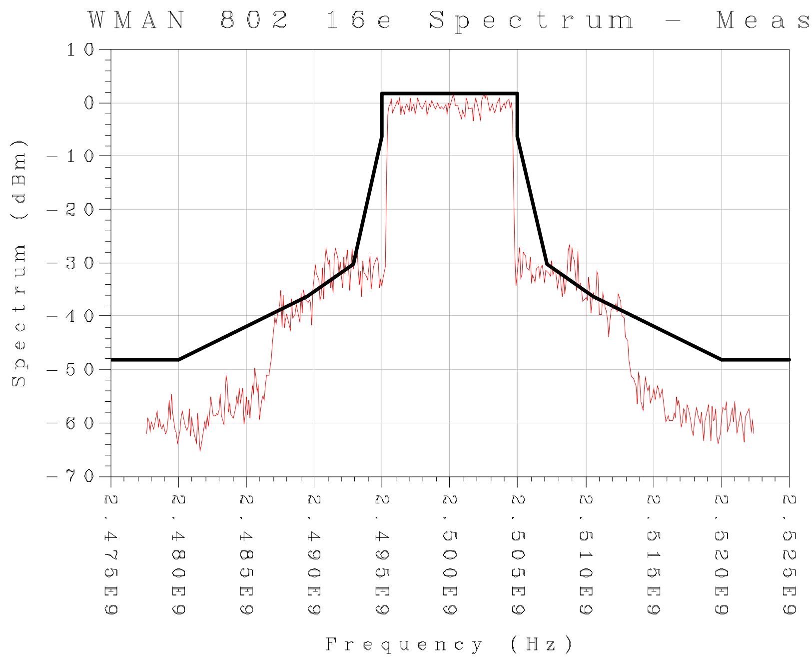


Figure 2 RF spectrum of a RF PA (see assumptions) when a one preamble is transmitted, against a WIMAX 2.5 GHz spectrum mask



.

Figure 3 Two simultaneous preambles transmission impact over the spectrum of a RF PA (see assumptions) against a WIMAX 2.5 GHz spectrum mask

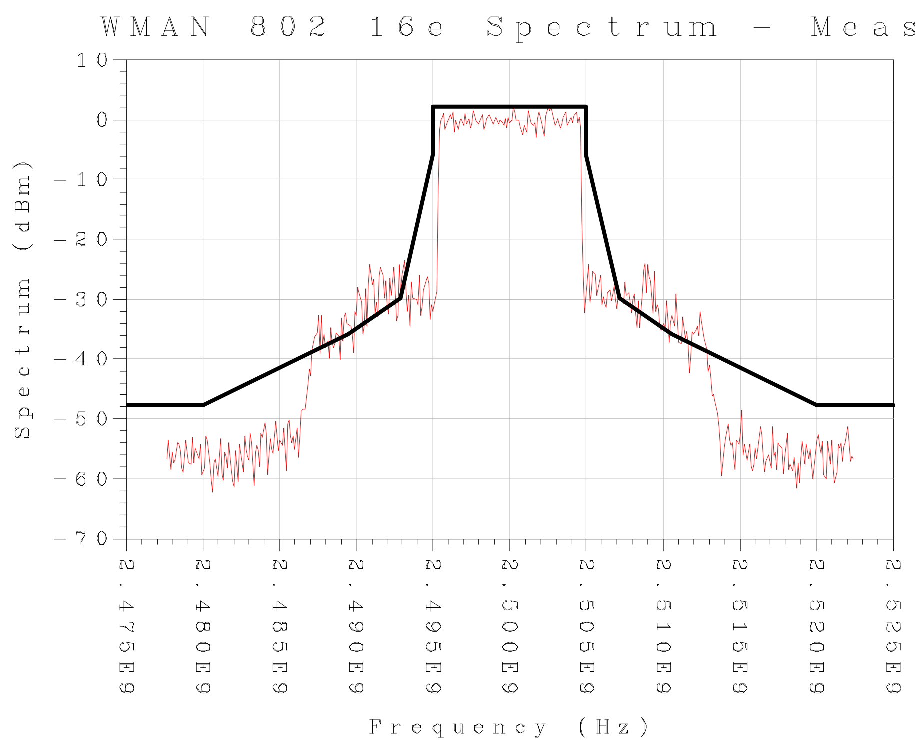


Figure 4 Three simultaneous preamble transmission related impact over the spectrum of a RF PA (see assumptions) plotted against a WIMAX 2.5 GHz spectrum mask

Following the same assumptions, other simulations could be run for different RF profiles.
Concluding the simulations presented in Fig.2, 3 and 4, it is apparent that a multiple preamble 802.16j frame structure would require a different WIMAX spectrum mask than the actually pre-approved one. Therefore the 802.16j RSs would require a different spectral mask than the (expected to be) certified 802.16e BS spectral mask.

2. Conclusions

Following the technical rationale presented in the items #1 to 4, it appears that an RS transmitting more than one set of preamble subcarriers will trigger significant functional and performance issues for all child RSs and MSs connected to that RS, causing network malfunctions during the concurrent preamble transmissions.

Additionally, item #1 indicates that significant duplication of processing functionality is required in the MAC and PHY layer, such that an RS capable of multiple preamble transmission will result in similar MAC/PHY layer complexity to that of two, single preamble transmitting RSs. In which case, it would be better to simplify the situation and bundle two or more, single segment transmitting RSs into the same packaging rather than define a single RS that supports two or more segments. The former type of RS can then share the RF chain, if the implementer wishes, and nothing is required in the standard to describe this as it is purely an implementation issue.

3. Proposed Remedy

The multiple preamble transmission at a single RS shall not be supported. In other words, N_Preamble shall be 0 (transparent mode) or 1 (non-transparent mode).

4. Proposed text change

++++++++++++++ Start Text +++

6.3.2.3.69 RS preamble configuration request (RS_Config-REQ) message

Syntax	**Size**	**Notes**
N_Preamble	~~2~~ 1 bit~~s~~	N_Preamble = 0 specifies NULL preamble (e.g., Transparent RS), N_Preamble = 1 assigns one preamble to the RS ~~N_Preamble=2 assigns two preambles on different segments to the RS N_Preamble=3 assigns three preambles on different segments to the RS~~
Reserved	~~6~~ 7 bits	Reserved
if (N_Preamble == 1){		
Preamble index	8 bits	Assign a preamble index value to the potential RS

}		
TLV Encoded Information	Variable	TLV specific

4. References

[1] IEEE P802.16j-06/026r3
[2] IEEE Std 802.16e-2005
[3] IEEE Std 802.16-2004