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Title	**Comments related to using the TG1 MAC for TG3 purposes**	
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Re:	IEEE 802.16.1-00/01r4	
Abstract	The purpose of this contribution is to comment on some aspects of the TG1 MAC proposal from the point of view of using it for TG3 purposes. Section 1 provides some background and motivation behind the specific, itemized comments, which is contained in Section 2.	
Purpose	To present issues for consideration by both TG1 and TG3 in the revision of the MAC protocol.	
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Comments on issues of using the TG1 MAC for TG3 purposes

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1 Introduction

It is impossible to evaluate a MAC protocol without knowing the underlying PHY layer characteristics, and the PHY(s) that TG3 will consider are expected to be very different from the TG1 PHY. This is driven by the frequency bands (smaller allocations, higher spectral efficiency), propagation characteristics (non line-of-sight and rich multipath environment), and the expected applications (residential & SOHO vs business, which means low-cost subscriber stations and large number of them per base station). The comments in the next section are based on the following PHY characteristics:

- OFDM as the modulation scheme to take advantage of multipath environment
- TDD as the duplexing scheme to take advantage of the path reciprocity and the flexibility to support upstream/downstream asymmetry
- Multibeam base station using adaptive beam forming techniques to achieve higher spectral efficiency and better coverage
- No beam forming is required at the subscriber station to keep the cost low.

The motivation for the above mentioned characteristics are as follows:

- TG3 air links must be able to deal with non line-of-sight propagation paths and multipath fading. OFDM has proven to be a robust method in such an environment. Hence it can play an important role in TG3 air interface.
- OFDM typically assumes a comprehensive digital signal processing architecture compared to other more traditional approaches to support the FFT processing. Taking advantage of the digital hardware and with modest additional processing power, one can add adaptive multibeam capability to the base station, and reap the benefits dramatically increased capacity and coverage.
- While adaptive multibeam can be used with either FDD or TDD, an important synergy exists with TDD. In TDD, there is a path-reciprocity between uplink and downlink, so that adaptation parameters in one direction can be derived from the adaptation parameters in the other. The upshot is that it is sufficient to perform adaptation only at the base station and not at the subscriber station. Therefore, adaptive multibeam does not add to the cost of the subscriber station.

It is worth emphasizing that an adaptive multibeam base station is very different from a base station using sectorized antenna, which has a fixed beam pattern. Adaptive multibeam can simultaneously form a beam toward a desired subscriber station and nulls toward multiple co-frequency interferers, thus increasing the signal to noise and interference ratio by many orders of magnitude. The SNR and SINR improvements can be used to bring many benefits to the system, among them:

- Increased the range of coverage

- Increased the frequency reuse, both between cells and within a cell (spatial-division multiple access)
- Improved coverage by reducing areas with unacceptable SNR and SINR
- Relaxed requirements on RF equipment.

A major difference between the adaptive multibeam and the sectorized antenna considered by TG1 is that the former is more like a point-to-point link in both upstream and downstream, whereas the latter is broadcast in the downstream. Therefore, downstream TDM is not an appropriate multiple access method for adaptive multibeam. Many link control mechanisms in the TG1 MAC that are based on downstream broadcast will have to be re-examined. In fact, one can argue that TG1 downstream already looks very TDMA-like in order to accommodate adaptive modulation. One possible approach is to separate those frame-by-frame broadcast messages that are truly tied to the TG1 PHY, from the less dynamic ones that can be considered as provisioning messages, which may be usable by TG3. As a general principle, it is desirable to provide options so that the TG3 protocol would not have to emulate TG1 features it does not need.

2 Specific Comments

Please note that the page numbers are referenced from the beginning of the whole document. They are offset by 15 from the page numbers that appear in the lower right corner of the printed pages. For instance, the first comment labeled Page 25, Line 10, actually refers to Page 10, Line 10.

Annotations from 802161-00_01r4-102000.pdf

Page 25

Annotation 1; Label: Huanchun Ye; Date: 10/27/2000 6:11:18 PM
Line 10: ATM support should be made optional rather than required, because it is excluded by TG3 FRD.

Page 26

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 9:52:38 AM
Line 13: For consumer services, PPP should be made more prominent because it provides the same service paradigm that people use today. It also fits well with the existing service provider infrastructure.

Page 27

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 9:54:02 AM
Line 51: Here a broadcast mechanism is assumed. Multibeam systems do not have this capability. The TG3 MAC protocols must take into account of this basic difference.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 9:59:53 AM
Line 57: TG3 must not limit itself to the "classical" sectorized antenna systems. Adaptive multibeam systems offer significant advantages in capacity and coverage, with its ability to steer a narrow beam toward a user and nulls toward interferers.

Page 30

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:05:16 AM
Line 10: What's the basis for this 19.5 ms delay rquirement? The precision implies that there is a good justification, which I am not aware off and very much would like to know. Moreover, what does it include? For instance, does it include fragment queueing delay? If so, the delay is bandwidth dependent. TG3 systems typically have less bandwidth than TG1 systems due to smaller FCC allocation, so the queueing delay will be larger. Consider make the delay requirements larger (say 30-40 ms) for TG3.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 10:06:35 AM
Line 16: The same question as the previous comment: What is the basis for this 1.5 ms delay value? Is it appropriate for TG3?

Page 33

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:11:41 AM
Line 18: An implicit assumption in the second statement is that downstream is a broadcast channel, which in turn implies fixed sectorized antennas. As we argued earlier, TG3 should not limit itself to such configurations only. Multibeam systems are more like switched LAN from network point of view, and both upstream and downstream are like point to point link.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 10:15:26 AM
Line 34: This section on MAC services to the higher layer deviates from the 802.16 LLC standards. We must have a good justification if we want to deviate from the existing standards. For example, why do we drop the flow control primitives?

Page 35

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:22:07 AM
Line 60: Here the connection setup includes an encryption indicator. Later in the document we also have frame by frame encryption control. This redundancy seems unnecessary and raises the

question of which is the governing rule and may lead to significant complications in implementations. I propose we include encryption at connection setup and remove the per frame indication.

Page 41

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:29:32 AM
Line 53: Encryption indication is already used in the connection set up. It does not seem necessary to include the same indication for each frame, unless we want to send some frames encrypted and others unencrypted in the same connection. I don't see why we want to do such a thing.

Page 43

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:31:02 AM
Line 7: Again, broadcast is assumed. In multibeam systems, different SS can be in different beams and do not receive the same transmission. TG3 MAC must accomodate multibeam systems.

Page 44

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:33:45 AM
Line 16: Later in the document the Primary CID is called Basic CID, and it is stated that unclassified flows can use primary CID. That statement should be fixed.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 12:28:49 PM
Line 19: Does this mean there is only one security association per SS?

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 10:41:08 AM
Line 33: The Interval Usage Code, Physical Slots, Minislots,etc. all seem specific to TG1 PHY. For TG3, we may need to either (1) generalize these concept and make them applicable to TG3 PHYs (OFDM, TDD, multibeam), or (2) make them optional so TG3 systems are not forced to emulate features they don't need.

Annotation 4; Label: Huanchun Ye; Date: 10/20/2000 10:41:45 AM
Line 59: Later in the document there is a contradictory statement about bit ordering.

Annotation 5; Label: Huanchun Ye; Date: 10/20/2000 10:37:43 AM
Line 23: Is 14 bits CID sufficient for TG3 systems?

Page 45

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:43:07 AM
Line 1: Please explain why the TC layer interfaces are treated differently in upstream and downstream?

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 10:46:01 AM
Line 49: Later in the document it says 64-bit MAC address. Should we make the MAC address longer than 48 bits now that we are accomodating TG3 and HUMAN devices in the same MAC?

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 10:45:27 AM
Line 55: Earlier it was said to be 14 bits. Which is correct?

Annotation 4; Label: Huanchun Ye; Date: 10/20/2000 10:48:15 AM
Line 59: This statement is in contradiction to Section 2.1.1.1. However, I understand that we need to separate control channels that terminate at the MAC itself (for real time management) and those that terminate at a higher layer (for non real time management). So the statements here seem correct. Fix the earlier statement.

Page 46

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:48:52 AM
Line 2: Need to question the size of 16 bit CID field for MMDS systems.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 10:52:12 AM
Line 15: Allowing multiple hosts to use the same CID may disallow Ethernet header suppression. TG3 MAC must leave room to allow payload header suppression as BW efficiency is more important here.

Page 47

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:54:30 AM
Line 1: The numbers is Table 2 seem specific to TG1 PHY. TG3 will have very different PHYs and these number must be re-considered.

Page 49

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:54:55 AM
Line 44: We need to separate which parameters are TG1 PHY specific and which are not, in order for TG3 to evaluate the MAC.

Page 50

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 10:55:48 AM
Line 1: Why don't we need a upstream frequency setting? Many LMDS systems have multiple upstreams for one downstream. It seems that we also need upstream frequency setting for load balancing.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 10:56:08 AM
Line 17: This statement implies downstream broadcast. Multibeam systems cannot support this feature.

Page 51

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:03:33 AM
Line 39: Layer 2 bridging devices may not have an IP address. Since BS pretty much knows everything about the SS in its domain, SNMP proxy at the BS is sufficient for management. This can lead to low management overhead and low cost SS. It is an overkill to require every SS to implement SNMP, which should be optional and not mandatory.

Page 52

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:05:56 AM
Line 3: As commented earlier, there are too many encryption options at too many stages. I propose encryption on a per connection basis and include the encryption indication only in the connection set up message.

Page 53

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:08:11 AM
Line 3: There is no strong reason to require that all messages be an integral number of 32 bit words. It is unnecessary since we do have a end of data marker. I don't think the standards should mandate 32-bit.

Page 57

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:09:11 AM
Line 1: Please explain the use of authorization hint in detail.

Page 65

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:13:25 AM
Line 5: The reason for this policy is unclear. Please elaborate its use.

Page 68

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:18:10 AM
Line 16: IP address at SS should be optional, for (1) as argued earlier, SNMP at SS should be optional due to its overhead and cost, as well as the fact BS has most of the information about the SS. (2) for systems that use PPP as the primary user management scheme, SS acts as a layer 2 bridging device and does not need an IP address. Moreover, these systems do not need DHCP.

Page 73

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:22:07 AM
Line 52: Since the CRC itself is optional, why mandate 32 bit CRC? For some systems this may be too large an overhead, depending on the frame size. I propose we include in the call setup message not just a flag for CRC, but also include which CRC to use. This is more flexible.

Page 74

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:21:36 AM
Line 1: This bit ordering is in contradiction to an earlier statement.

Page 75

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:25:11 AM
Line 42: (1) Why do we need EC and EKS, since encryption setting is configured in connection setup? (2) FSN may not be big enough if low modulation is used for far away SS. (3) We need to allow ARQ piggyback acks. (4) It may be a good idea to have a bit to indicate if a broadcast capability is available in the system. Or more geneally, to have a field to indicate TG1 or TG3 MAC, as suggested by Marianne.

Page 76

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:25:34 AM
Line 54: We will also need a bandwidth allocation message. Especially for multibeam systems, we cannot rely on broadcast map alone.

Page 77

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:26:15 AM
Line 24: Please elaborate on the use of CSI bit.

Page 78

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:26:56 AM
Line 14: The fragment sequence number of 4 bits may not be big enough. Needs further investigation.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:27:29 AM
Line 20: I would like to make the grant scheme more general than interval so as to accomodate OFDM in TG3 systems.

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 11:28:36 AM
Line 30: Question the size of the length field. Also, why do we drop the fragmentation header in some earlier versions? Why not make MAC header extensible?

Annotation 4; Label: Huanchun Ye; Date: 10/20/2000 11:29:44 AM
Line 45: CRC setting is contained in connection setup. Why do we need this header? Also, consider

expand CRC indicator to indicate which CRC algorithm.

Page 79

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:33:55 AM
Line 17: Is ARQ done for each fragment or for the whole packet? It should be done for each fragment for efficiency reasons. If ARQ is on, there should be two piggyback fields for send and receive sequence numbers. Otherwise standalone messages must be sent as acks, which is inefficient. Also, the ARQ described in the next paragraph does not make sense to me.

Page 81

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:36:19 AM
Line 24: DMC-REQ is specific to the TG1 PHY. So are some of the other messages in this table. We need to either generalize them, or make them optional.

Page 85

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:36:38 AM
Line 38: DCD is TG1 PHY specific.

Page 97

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:37:14 AM
Line 50: Why leave two bytes outside of the general TLV scheme? Why not use TLV for everything?

Page 98

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:37:31 AM
Line 1: Table 13 is in the wrong place.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:40:16 AM
Line 50: It makes sense to transmit initial ranging messages using QPSK, but why require that periodic RNG-REQ also be transmitted using QPSK? Change this requirement to apply to initial ranging only.

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 11:40:35 AM
Line 63: What is the difference between Initialization CID and Temporary CID?

Page 99

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:41:20 AM
Line 15: What is the meaning of this Pending Till Complete parameter? Is it TG1 PHY specific? Why make ranging parameters cumulative?

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:41:33 AM
Line 26: Make the Requested Downlink Burst Type parameter more general so it is usable for OFDM systems.

Page 101

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:43:06 AM
Line 38: The Modulation Type parameter is not present in the RNG-REQ message.

Page 102

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:43:57 AM
Line 18: The 1/4 symbol unit may not be appropriate for OFDM systems. It may be better to make it microseconds or nanoseconds.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:44:22 AM
Line 36: This seems TG1 PHY specific.

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 11:44:43 AM
Line 39: Please explain the use of this parameter.

Annotation 4; Label: Huanchun Ye; Date: 10/20/2000 11:45:47 AM
Line 46: SS MAC address is said to be 48 bits in some places and 64 bits in other places in this document. Which is correct?

Page 103

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:46:02 AM
Line 30: OFDM does not need equalization. This is TG1 PHY specific.

Page 121

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:47:36 AM
Line 56: Multibeam systems do not have broadcast or multicast capability. Make it optional.

Page 124

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:48:17 AM
Line 1: Normally ARQ will use piggyback fields and not use standalone ACK messages because the latter is inefficient. Please consider adding these fields to the MAC header.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:49:40 AM
Line 10: This was called Downlink Modulation Change Request in the previous revision, which is more general and may be made applicable for OFDM systems.

Page 125

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:50:52 AM
Line 1: This section 2.6 is very TG1 PHY specific. The framing, frame time, etc. will be very different in OFDM systems. Also, DL-MAP and UL-MAP imply broadcast capability that is not available in multibeam systems. We need to separate these from the rest of the MAC and perhaps make them optional for TG3 MAC.

Page 127

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:52:13 AM
Line 36: The logic of this statement seems backwards. Change this sentence to: The modulation rate is selected to maximize spectrum usage. The frame time is selected to obtain integral number of PS within each frame.

Page 129

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:52:36 AM
Line 47: Again, this section 2.6.4.1 is TG1 PHY specific and does not apply to OFDM systems.

Page 134

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:56:36 AM
Line 28: Some OFDM systems may have dedicated access channel, or use data channels for access. In this case, the Initial Maintenance IE should be optional. Perhaps we can call it Registration IE and make it more general?

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 11:57:15 AM
Line 44: Why not use data grant IE for this function? It should be possible to use data grant IE, at

least in the GPT mode.

Page 137

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:59:06 AM
Line 25: Multibeam systems do not have a broadcast downstream. Possible reconciliation: Allow UL-MAP to be provisionable? Allow UL-MAP to be sent unicast? Allow default UL-MAP where all channels are subject to collision? Change UL-MAP to generalize it to OFDM? More investigation is needed.

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 12:40:19 PM
Line 27: Why BS is controlling this? Why EITHER requests OR maintenance, and not BOTH? Why not include data PDU?

Page 138

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 11:59:19 AM
Line 54: What is MSAP?

Page 139

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:00:23 PM
Line 8: 16 may not be not big enough for Fragment Sequence Number for OFDM systems especially when low modulation is used.

Page 145

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:02:54 PM
Line 3: In the multibeam system, explicit messages must be send to poll the SS.

Page 147

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:03:24 PM
Line 1: Multicast and broadcast are not possible in multibeam systems. Make them optional.

Page 162

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:04:35 PM
Line 33: Some low cost SS implementation may be layer 2 only, so IP connectivity should be optional. See earlier comments on this issue.

Page 173

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:06:06 PM
Line 39: According to the MAC header format, MAC management messages and traffic cannot mix. Earlier statement in this document also explicitly prohibits such a mix.

Page 177

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:16:35 PM
Line 39: According to this document, service classes are identified by name, each SS contain a list of SFIDs that are instances of service classes, and CID is assigned for active service flows. Explcit signaling is required to set up SFID and then again for CID, which seems unnecessary. One signaling should be enough. Why not make SFID a class and CID an instance?

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 12:17:20 PM
Line 45: What is the format of Service Class Name?

Page 221

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:25:58 PM
Line 55: In order to allow a low cost SS implementation for consumer applications, an option should be provided to allow secret key-based PKM rather than mandate public key PKM.

Page 222

Annotation 1; Label: Huanchun Ye; Date: 10/20/2000 12:19:09 PM
Line 34: Sharing SA among multiple SS is only necessary in case of multicast and broadcast. By default, SS will use its Primary SA which means that encryption is done per SS, not per CID. Are these correct?

Annotation 2; Label: Huanchun Ye; Date: 10/20/2000 12:19:27 PM
Line 45: It seems that SA can be tied to CID, so why not use CID to identify SA? What is the reason for having a separate SAID?

Annotation 3; Label: Huanchun Ye; Date: 10/20/2000 12:19:57 PM
Line 62: Is the limited lifetime of a SA keying material the reason for separating SAID and CID?