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Title	***Proposal for Adaptive HARQ ACID Expansion on Relay Links***
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Re:	*Response to the call for technical proposal regarding IEEE Project 802.16j (i.e., IEEE 802.16j-06/034, "Call for Technical Proposals regarding IEEE Project P802.16j", December 12, 2006).*
Abstract	*This contribution describes an adaptive HARQ ACID expansion mechanism on relay links.*
Purpose	*To adopt the adaptive HARQ ACID expansion mechanism proposed herein into IEEE 802.16j.*
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Proposal for Adaptive HARQ ACID Expansion on Relay Links

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1. Introduction

As illustrated in Figure 1, the new mobile multi-hop relay-based (MMR) network architecture imposes a demanding performance requirement on relay links, whereupon traffic collected from and distributed to multiple MSs are aggregated. Therefore, it is imperative to improve the capacity of relay links to support this inherent notion of "traffic aggregation".

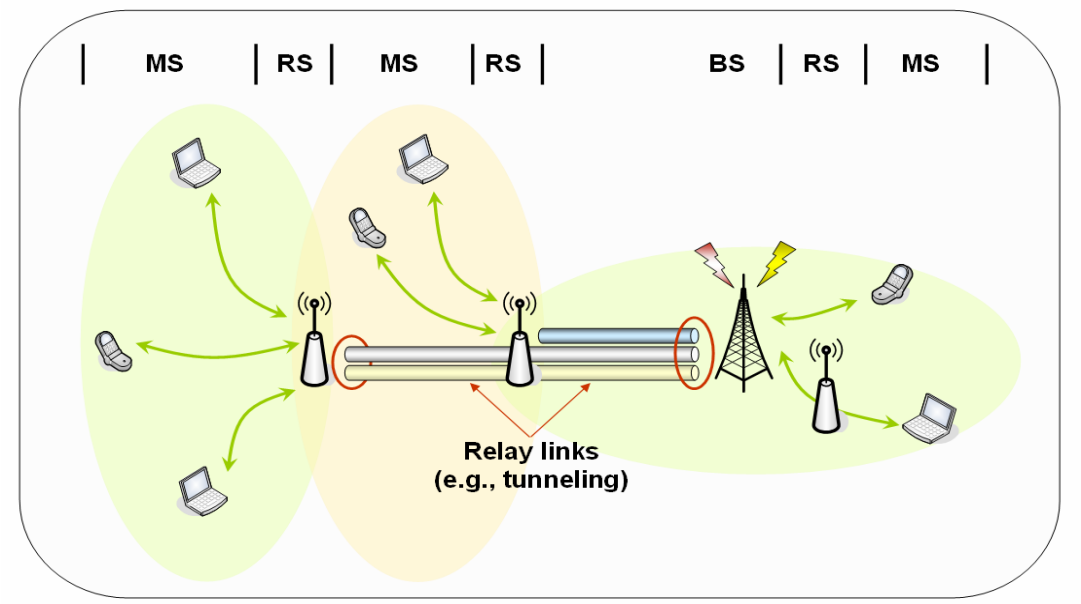

Figure 1: An illustration of performance demand on relay links in an MMR network.

Hereby, we propose to expand the HARQ channel ID (ACID) field in an adaptive manner for HARQ operation on relay links, thus helping eliminate throughput performance bottleneck.

2. Summary of Proposal

In the IEEE 802.16e standard [1], ACID is used to identify multiple HARQ channels that can operate in parallel. Current ACID field is four-bit long, implying that the maximum number of parallel HARQ channels is 16. This unfortunately prevents the total link capacity to be fully unleashed.

For example, Figure 2 depicts the performance of an 802.16e network, wherein MAC ARQ and HARQ are deployed in conjunction to provide reliable data transfer. Apparently, the throughput achieved on the relay link becomes significantly lower than the actual MAC layer capacity, as the length of ACID field decreases. A

closer examination reveals that the primary culprit of this performance degradation is the limited number of parallel HARQ channels supported at the physical layer. The major simulation parameters are shown in Table 1.

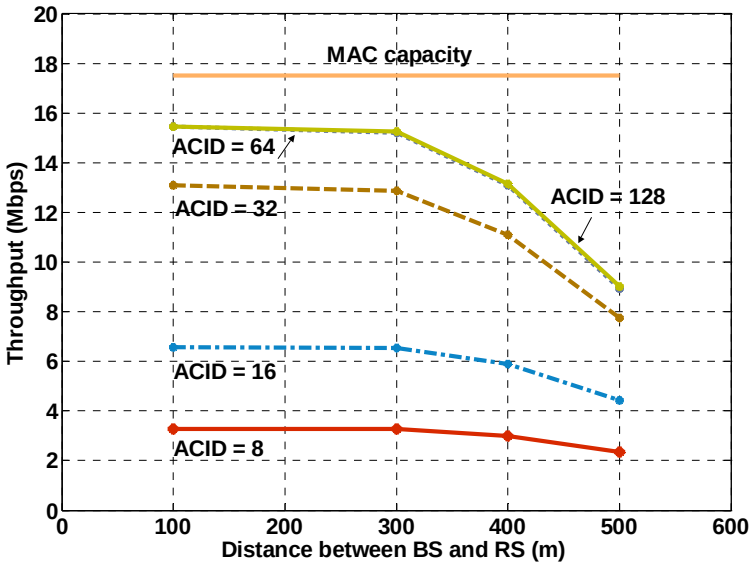

Figure 2: Performance degradation caused by limited ACID size.

HARQ Mode	Maximum HARQ retransmission	Number of ACID	Fragmentation at HARQ layer
IR	3	16	Disabled
Coding	AMC	Frame duration	PDU SN Extended SH
CTC 1/3	64 QAM	5 ms	Not used

Table 1: Key PHY and MAC parameters.

To address the aforementioned problem, we propose to expand the ACID field in an adaptive manner. More specifically,

- The ACID field is extended to 8 bits in the related MAC message.
- The actual number of parallel HARQ channels to be used is adaptively selected during the network entry/re-entry process, subject to the constraint of the given capability of the BS and RS devices.

3. Proposed Text Changes

8. PHY

8.4.5.3.21 HARQ DL MAP IE

[Insert following paragraph and new Table 286m1 as follows]

For HARQ on relay links, the format of DL HARQ Chase sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286m1.

Table 286m1 — DL HARQ Chase sub-burst IE format

Syntax	Size	Notes
…		
}		
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
ACK disable	1 bit	
Dedicated DL Control Indicator	2 bits	
Reserved	4 bits	
…		

[Insert following paragraph and new Table 286n1 as follows]

For HARQ on relay links, the format of DL HARQ IR CTC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286n1.

Table 286n1 — DL HARQ IR CTC sub-burst IE format

Syntax	Size	Notes
…		
SPID	2 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
ACK disable	1 bit	
Reserved	6 bits	
…		

[Insert following paragraph and new Table 286o1 as follows]

For HARQ on relay links, the format of DL HARQ IR CC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286o1.

Table 286o1 — DL HARQ IR CC sub-burst IE format

Syntax	Size	Notes
…		
}		
ACID	8 bits	The ACID field is extended to 8 bits

AI_SN	1 bit	
SPID	2 bits	
ACK disable	1 bit	
Dedicated DL Control Indicator	2 bits	
Reserved	6 bits	
…		

[Insert following paragraph and new Table 286p1 as follows]

For HARQ on relay links, the format of DL MIMO DL Chase sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286p1.

Table 286p1 — MIMO DL Chase HARQ sub-burst IE format

Syntax	Size	Notes
…		
If (ACK Disable == 0) {		
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
Reserved	4 bits	
}		
…		

[Insert following paragraph and new Table 286q1 as follows]

For HARQ on relay links, the format of DL MIMO DL IR HARQ sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286q1.

Table 286q1 — MIMO DL IR HARQ sub-burst IE format

Syntax	Size	Notes
…		
SPID	2 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
Reserved	4 bits	
}		
…		

[Insert following paragraph and new Table 286r1 as follows]

For HARQ on relay links, the format of DL MIMO DL IR HARQ for CC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286r1.

Table 286r1 — MIMO DL IR HARQ for CC sub-burst IE format

Syntax	Size	Notes
...		
If (ACK disable == 0) {		
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
SPID	2 bits	
Reserved	4 bits	
}		
...		

[Insert following paragraph and new Table 286s1 as follows]

For HARQ on relay links, the format of DL STC HARQ sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 286s1.

Table 286s1 — MIMO DL STC HARQ sub-burst IE format

Syntax	Size	Notes
...		
If (ACK disable == 0) {		
ACID	8 bits	The ACID field is extended to 8 bits
Reserved	4 bits	
}		
...		

8.4.5.4.24 HARQ UL MAP IE

[Insert following paragraph and new Table 302k1 as follows]

For HARQ on relay links, the format of UL HARQ Chase sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302k1.

Table 302k1 — UL HARQ Chase sub-burst IE format

Syntax	Size	Notes
...		
Duration	10 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
ACK disable	1 bit	
Reserved	5 bits	

}		

[Insert following paragraph and new Table 302I1 as follows]

For HARQ on relay links, the format of UL HARQ IR CTC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302I1.

Table 302I1 — UL HARQ IR CTC sub-burst IE format

Syntax	Size	Notes
...		
SPID	2 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
ACK disable	1 bit	
Reserved	7 bits	
}		

[Insert following paragraph and new Table 302m1 as follows]

For HARQ on relay links, the format of UL HARQ IR CC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302m1.

Table 302m1 — UL HARQ IR CC sub-burst IE format

Syntax	Size	Notes
...		
SPID	2 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
ACK disable	1 bit	
Reserved	7 bits	
}		

[Insert following paragraph and new Table 302n1 as follows]

For HARQ on relay links, the format of MIMO UL Chase HARQ sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302n1.

Table 302n1 — MIMO UL Chase HARQ sub-burst IE format

Syntax	Size	Notes
...		

If (ACK disable == 0) {		
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
Reserved	4 bits	
}		
…		

[Insert following paragraph and new Table 302o1 as follows]

For HARQ on relay links, the format of MIMO UL IR HARQ sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302o1.

Table 302o1 — MIMO UL IR HARQ sub-burst IE format

Syntax	Size	Notes
…		
If (ACK disable == 0) {		
SPID	2 bits	
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
Reserved	4 bits	
}		
…		

[Insert following paragraph and new Table 302p1 as follows]

For HARQ on relay links, the format of MIMO UL IR HARQ for CC sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302p1.

Table 302p1 — MIMO UL IR HARQ for CC sub-burst IE format

Syntax	Size	Notes
…		
If (ACK disable == 0) {		
ACID	8 bits	The ACID field is extended to 8 bits
AI_SN	1 bit	
SPID	2 bits	
Reserved	4 bits	
}		
…		

[Insert following paragraph and new Table 302q1 as follows]

For HARQ on relay links, the format of MIMO UL STC HARQ sub-burst IE is the same as that on access link, except that ACID field is expanded to 8 bits and new reserved bits are added, which is shown in Table 302q1.

Table 302q1 — MIMO UL STC HARQ sub-burst IE format

Syntax	Size	Notes
...		
If (ACK disable == 0) {		
ACID	*8 bits*	*The ACID field is extended to 8 bits*
Reserved	*4 bits*	
}		
...		

11 TLV Encodings

11.8.3.7.2 OFDMA SS demodulator

[Insert the paragraph in this subclause as follows]

For HARQ on relay link, this field specifies the number of downlink H-ARQ channels (n) the SS supports, where n = 1..255. The value of the TLV shall be set to n.

11.8.3.7.3 OFDMA SS modulator

[Insert the paragraph in this subclause as follows]

For HARQ on relay links, this field specifies the number of uplink H-ARQ channels (n) the SS supports, where n = 1..255. The value of the TLV shall be set to n.

11.13.32 HARQ Service Flows

[Insert the paragraph in this subclause as follows]

For HARQ on relay link, the format of this TLV is shown as follows:

Type	Length	Value	Scope
[145/146].44	1	0 = Non HARQ (default) *1= HARQ Connection,* *Support 1 HARQ channel* *2 = HARQ Connection,*	DSA-REQ, DSA-RSP, REG-REQ, REG-RSP

		Support 2 HARQ channels *…* *255 = HARQ Connection,* *Support 256 HARQ channels*	

The HARQ Service Flows TLV not only indicates whether the connection uses HARQ or not, but also conveys the number of HARQ channels that the HARQ transmitter desires to use.

4. References

[1] "IEEE Standard for Local and Metropolitan Area Networks − Part 16: Air Interface for Fixed Broadband Wireless Access Systems, Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands," IEEE Computer Society and the IEEE Microwave Theory and Techniques Society, February 2006.