Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Channel Access for Multihop Relay Chains**
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Re:	IEEE 802.16j-06/034: “Call for Technical Proposals regarding IEEE Project P802.16j”
Abstract	This contribution proposes a channel access approach for multihop relay chains of IEEE 802.16j
Purpose	Inclusion in IEEE 802.16j specification
Notice	
Release	
Patent Policy and Procedures	

Channel Access for Multihop Relay Chains

I. Introduction

Multihop relay networks introduce new dynamics in how RSs and MSs contend for channel access to the MR-BS. In current IEEE 802.16 networks, MSs contend for channel access to the MR-BS to solely exchange traffic that has originated from the MSs themselves. So MSs directly contend for channel access.

However in multihop relay networks, there are differences in channel access contention among RSs that immediately neighbour the MR-BS and those that do not, i.e. RSs more than 1 hop from the MR-BS.

RSs that are immediate-MR-BS neighbours contend for channel access for traffic originating from their own cells and also for traffic originating from other RS cells that are non-immediate-MR-BS neighbours. In this way, immediate-MR-BS neighbours directly contend for channel access, while non-immediate MR-BS neighbours indirectly contend for channel access. The current IEEE 802.16 specifications [1] do not address indirect contention for channel access.

This contribution describes the dynamics of indirect channel access and proposes mechanisms to provide consistent responses to both types of channel access contention. Section 2 describes these contention characteristics and motivates towards a suitable mechanism to address them. Section 3 illustrates the proposed mechanism and Section 4 proposes text corresponding to it for the baseline document [2].

II. Contention Characteristics

Multihop relay networks can be considered to be a collection of RSs arranged in a chain formation. RSs communicate with other RSs over the chain ultimately with the MR-BS. Multihop Relay Chains (MR-Chains) provide a systematic means of studying contention characteristics. Figure 1 illustrates a multihop relay network with 2 MR-Chains.

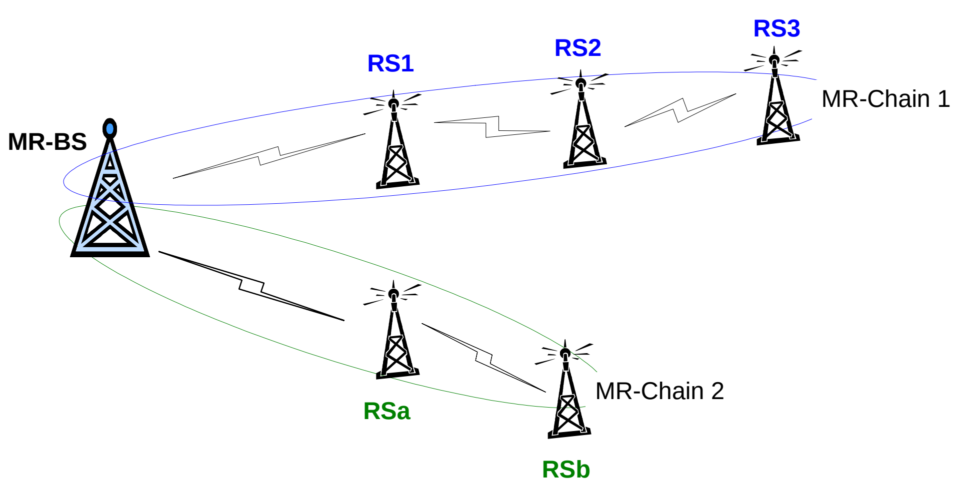

Figure 1: Multihop Relay Chains

Figure 1 illustrates MR-Chain-1 with 3 RSs and MR-Chain-2 with 2 constituent RSs. MR-Chain-1's RS1 and MR-Chain-2's RSa are referred to as Anchor-RSs as they serve to anchor their respective MR-Chains to the MR-BS. Anchor-RSs therefore contend for channel access to the MR-BS directly, while the remaining RSs contend indirectly through their respective Anchor-RSs.

Following the base IEEE 802.16e-2005 specifications, the MR-BS in Figure 1 would not have information on bandwidth and other resource requirements for MSs in non-Anchor-RS cells. This unfairly prevents MSs at non-Anchor-RS cells from being provisioned adequate resources. In practical terms, service providers would lose subscribers as service agreements on resources would not be met. This raises serious concerns for both subscribers and service providers.

It is therefore important to consider the dynamics of channel access contention in multihop relay networks. Indirect contention for channel access to the MR-BS must be adequately addressed by the Anchor-RSs for each MR-Chain. Anchor-RSs must be capable of consolidating bandwidth and other resource requests from their MR-Chains and also be capable to correspondingly fulfill those requests on behalf of the MR-BS.

III. Proposed Solution

The proposed mechanism to address the dynamics of channel access contention is based on Anchor-RSs acting as consolidating nodes on behalf of their MR-Chains and the MR-BS.

The MR-BS maintains a multihop contention profile (MCP) for each of the Anchor-RSs and their respective MR-Chains. MCPs are representative of consolidation contention for channel access to the MR-BS, i.e. they account for both direct and indirect contention.

Multihop contention profiles consolidate the following metrics;

- Number of Anchor-RSs simultaneously contending for channel access to the MR-BS
- Number of RSs constituting each MR-Chain – represents direct & indirect contention
- Bandwidth requests from each RS

The MR-BS continually monitors MCPs for each of the MR-BS based on feedback from the Anchor-RS and other RS.

The MCPs are then used to compute bandwidth allocations.

Annex A outlines an algorithm for computing bandwidth allocations based on multihop contention profiles.

IV. Proposed Text

Add the following definitions in Section 3 (Definitions)

MR-Chain: A logical aggregation of RSs. Each MR-Chain originates at the MR-BS

Anchor-RS: The RS of a MR-Chain that is 1 hop away from the MR-BS. Anchor-RSs are immediate neighbours of the MR-BS.

Multihop Contention Profile: A consolidation of contention characteristics of a MR-Chain. MCP accounts for both direct contention (by Anchor-RSs) and indirect contention (by other RSs of a MR-Chain).

Add the following messages in Section 6.3.2.3 (MAC Management Messages)

6.3.2.3.5 RS Resource Management

Relay networks are characterized by distinct contention profiles. In particular, channel access to the MR-BS is made up of direct contention and indirect contention.

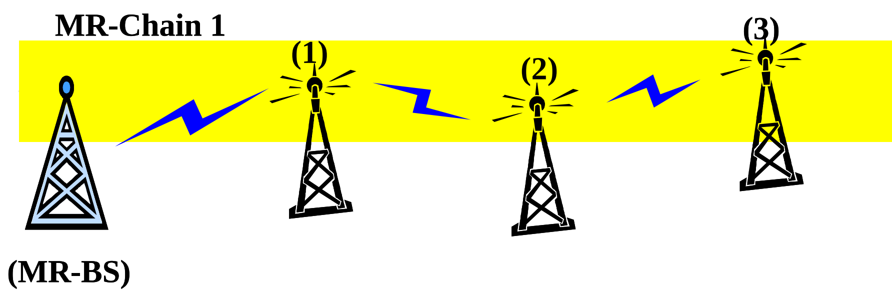

Figure 2: Relay Network Contention Profile

Direct contention refers to RSs directly communicating with the MR-BS. From Figure 2, RS(1) engages in direct contention for channel access to MR-BS.

Indirect contention refers to that by RSs that are 1 or more relay hops away from the MR-BS. From Figure 2, RS(2) and RS(3) engage in indirect contention for channel access to MR-BS through RS(1).

Bandwidth requests and grants in relay networks must account for both types of contention.

6.3.2.3.5.1 RS Bandwidth Request (RS_BW_Req)

The RS_BW_Req message is used by the RS directly communicating with the MR-BS to make aggregated bandwidth requests for both itself and other downstream RSs. This message contains the number of downstream RSs, average traffic volume from the downstream RSs and other statistical parameters.

6.3.2.3.5.2 RS Bandwidth Grant (RS_BW_Grant)

The RS_BW_Grant message is used by the MR-BS to grant resources in response to the aggregated RS_BW_Req. This message contains the total bandwidth granted and a proportionality factor corresponding to the aggregated bandwidth request.

Figure 3 below illustrates the exchange of RS_BW_Req and RS_BW_Grant messages.

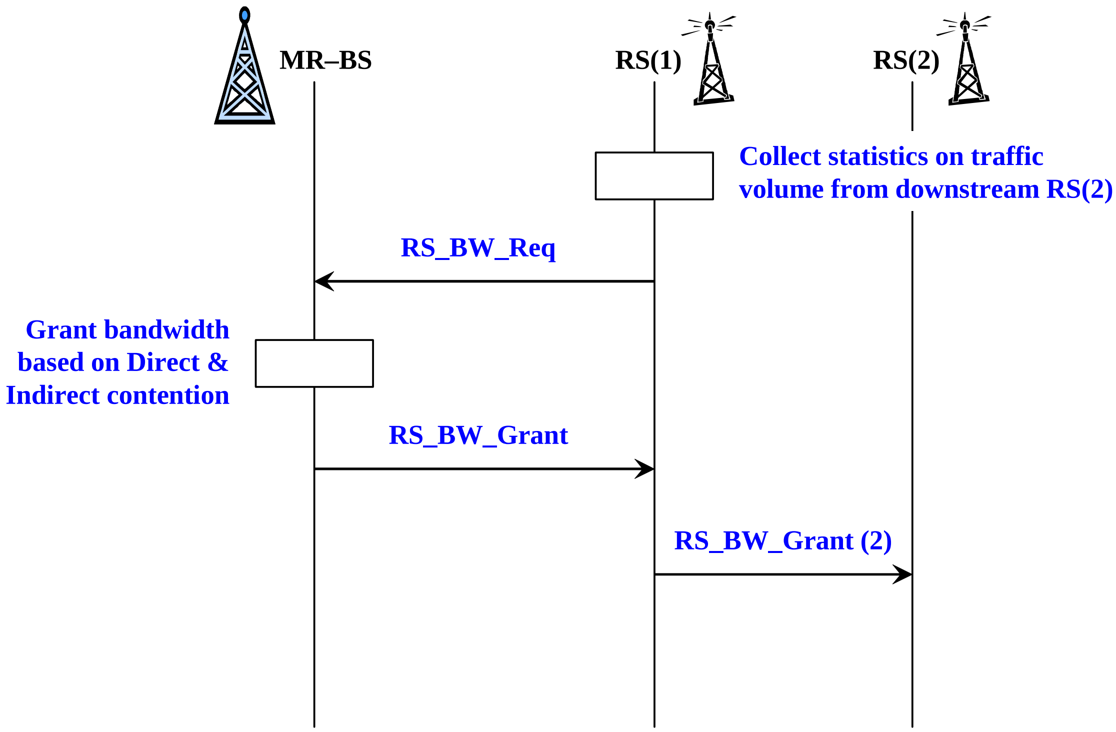

Figure 3: Direct & Indirect Contention

V. References

[1] IEEE 802.16e-2005

[2] IEEE 802.16-06/017r2, Baseline document

Annex A

This section describes bandwidth allocation by means of computing channel access parameters, particularly Bandwidth Request, based on MCPs. While the specifics means of calculating parameters are left to implementation, the following provides an algorithmic outline;

$$ChP_{MR\text{-}x} = f\ (MCP_{MR\text{-}x})$$

$$= f\ (\#AR\ ,\ \#N_{MR\text{-}x})$$

$$= (P1 \times \#N_{MR\text{-}x})\ /\ (P2 \times \#AR)$$

where;

- Subscript qualifies the base parameter
- **MR-x** denotes the MR-Chain being represented
- **ChP** is the generic channel access parameter being calculated
- **MCP** is the multihop contention profile maintained by the MR-BS
- **#AR** is the number of Anchor-RSs simultaneously contending for channel access to the MR-BS
- **#N** is the number of RSs constituting a MR-Chain
- **P1, P2** are representative of weights assigned to relative parameters

The proposed algorithm ensures that contention is managed by accounting for direct channel access (by Anchor-RSs) and for indirect channel access (by the number of RSs constituting each MR-Chain).