Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>
Title	Action Item from Session # 48: Credit token based coexistence protocol text update
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Re:	Working Group Letter Ballot #24a for IEEE P80216h/D2a
Abstract	During sessions # 48, several comments (2127, 2148L, 2149L, 2150L) were made to update and clean up text related to the credit token based coexistence protocol. This contribution provides some text remedy proposals for these comments to be included within IEEE 802.16h/D2a, and consolidates the previous preliminary contribution [3].
Purpose	Action Item from Session # 48: Credit token based coexistence protocol text update
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Action Item from Session # 48: Credit token based coexistence protocol text update

David Grandblaise
Motorola

Overview

During sessions # 48, several comments (2127, 2148L, 2149L, 2150L) were made to update and clean up text related to the credit token based coexistence protocol. This contribution provides some text remedy proposals for these comments to be included within IEEE 802.16h/D2a, and consolidates the previous preliminary contribution [3].

Following modifications are proposed as remedies to the comments, and to make the mechanism simpler while providing more flexibility:

- scalable offering/renting modes:
  - non negotiated (no iteration, fast)
  - negotiated (complexity of procedures has been decreased)

  => let vendor differentiating implementation
- The non negotiated mode is both over the air or backhaul based
- The negotiated mode is backhaul based
- SATI and SADD are removed
- no need MATI/MADD => use BSD/SSURF within CX_CTL and/or contribution IEEE C80216h-07_027/IEEE C80216h-07_045
- Updated coexistence message (including RAIS for the credit token management)
- Two pricing methods for negotiated mode (context adaptive):
  - CT can be transfered > negotiated mode,
  - CT cannot be transfered > negotiated and non negotiated
- Acronym for credit token based coexistence protocol: CT-CXP

Specific editorial changes

This section provides a list of changes to the draft document.

Blue text represents specific editorial additions.

~~Red strikethrough~~ text is to be deleted.

Black text is text already in the draft.

Bold italic text is editorial instructions to the editor.

Proposed text changes

[Change title of section 15.4.2.4. as indicate. Remove current text of section 15.4.2.4., and replace text as indicate:]

15.4.2.4 Credit token based coexistence protocol (CT-CXP)

In some traffic conditions circumstances, some master subframes are temporally under-used by some BS (offering BS, namely offeror) due to some low traffic activity while some of its neighboring BSs (requesting BS, namely requester) require temporally some additional master sub frame capacity to face some traffic increase. With respect to this, master sub frame sharing between neigbhouring systems contributes for better spectrum efficiency. The typically operation of sharing is illustrated in Figures ha and hb where system S1 proposes to rent out its assigned last OFDM symbols (for a time duration T_ renting_subframe per master subframe over several consecutive CX frames of total time duration T_ renting_epoch) to system S2 and S3. This master sub frame sharing is supported by the credit token based coexistence protocol (CT-CXP). CT-CXP provides the means for an offeror to rent out temporally some of its master sub frame capacity to some competing requester(s) willing to rent in simultaneously this proposed additional resource. CT-CXP guarantees exclusive access of the offeror's unused master subframe resource to the requester(s) for an agreed time period between the offeror and the requester. During this agreed period, the requester is granted with the resource during which the offeror will not use the resource. Also, CT-CXP ensures over time a fair access of the offeror's master subframe available resource between competing requesters.

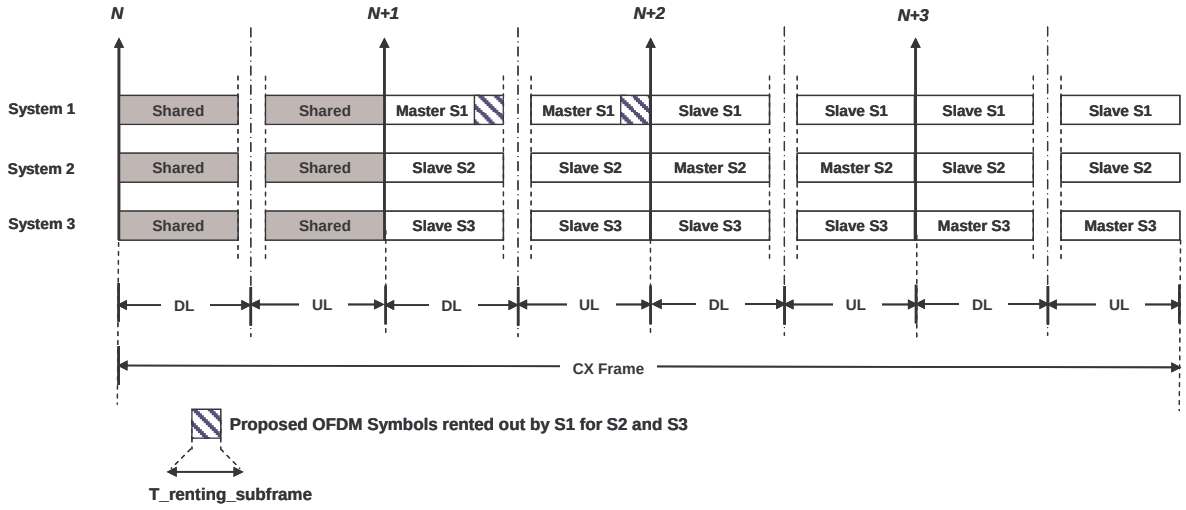

Figure ha: Master subframe (OFDM symbols) sharing within CXCC

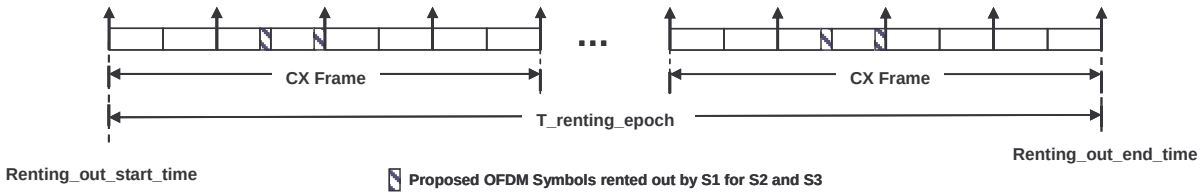

Figure hb: Master subframe (OFDM symbols) sharing over T_renting_epoch

15.4.2.4.1 CT-CXP Procedures

15.4.2.4.1.1 Whole CT-CXP Procedure

CT-CXP can be instantiated either in a non-negotiated mode or in a negotiated mode. This allows CT-CXP to be flexibly executed as a function of the context (e.g time constraints for negotiation, regulatory spectrum sharing policies and so forth). The followed approach is flexible in that it is scalable and it allows a vendor differentiated implementation of non-negotiated or negotiated (of any types) based CT-CXP.

The non-negotiated mode requires the minimum messages exchange to support CT-CXP between the offeror and requester(s). This mode requires no negotiation iteration between the offeror and requester. This mode can be applied when time availability is very limited to handle several iterations for the negotiations and/or when the negotiated mode is executed over the air (safe mode) through over the air inter-BSs communications.

The negotiated mode is used when time availability is enough to handle several iterations for the negotiation. This mode is operated through IP network based inter-BSs communications.

CT-CXP is composed of several consecutive procedures (offering advertisement, renting request, iterative negotiation, and resource allocation) as shown in Figure hc. For the sake of simplicity, this figure is only depicted for one (among multiple) requesters. Over the air based instantiation of CT-CXP for the non negotiated mode is depicted on the left hand side of Figure hc. The over IP network based instantiation of CT-CXP for the negotiation or non negotiated mode is depicted on the right hand side of Figure hc. MAC messages related to the over the air instantiation are specified in section 6.3.2.3. Inter system over the air communications mechanisms are described in subclause 15.x. CXP messages related to IP network based instantiation are specified in section 15.5.1. The offering advertisement message (Advertisement Request) specifies which negotiation mode is used by the CT-CXP. The iterative negogiation procedure is executed only with the negotiated mode and not with the non-negotiated mode.

Within CT-CXP, a resource unit is defined as the minimum time x frequency unit (e.g. OFDM symbol, or a minimum number of symbols and subcarriers in OFDMA) that can be rented in/out between the offeror and a requester. A master sub-frame is composed of a fixed amount of resource units. The part of the offeror’s available master sub-frame to be rented out is named rented resource. Consequently, an offeror’s rented resource is defined as an amount of resource units. A credit token (CT) is the pseudo monetary unit used by CT-CXP to let the requester to rent in a resource unit to the offeror. A resource unit is charged as a number of CTs. Each BS is inially assigned with a CT budget, i.e. a maximum number of CTs. This maximum number can be normalized to the total number of resource units per master sub-frame. Also, this number can be dynamically specifed by policy issued by the RAIS via the BSIS (subclause 15.7).

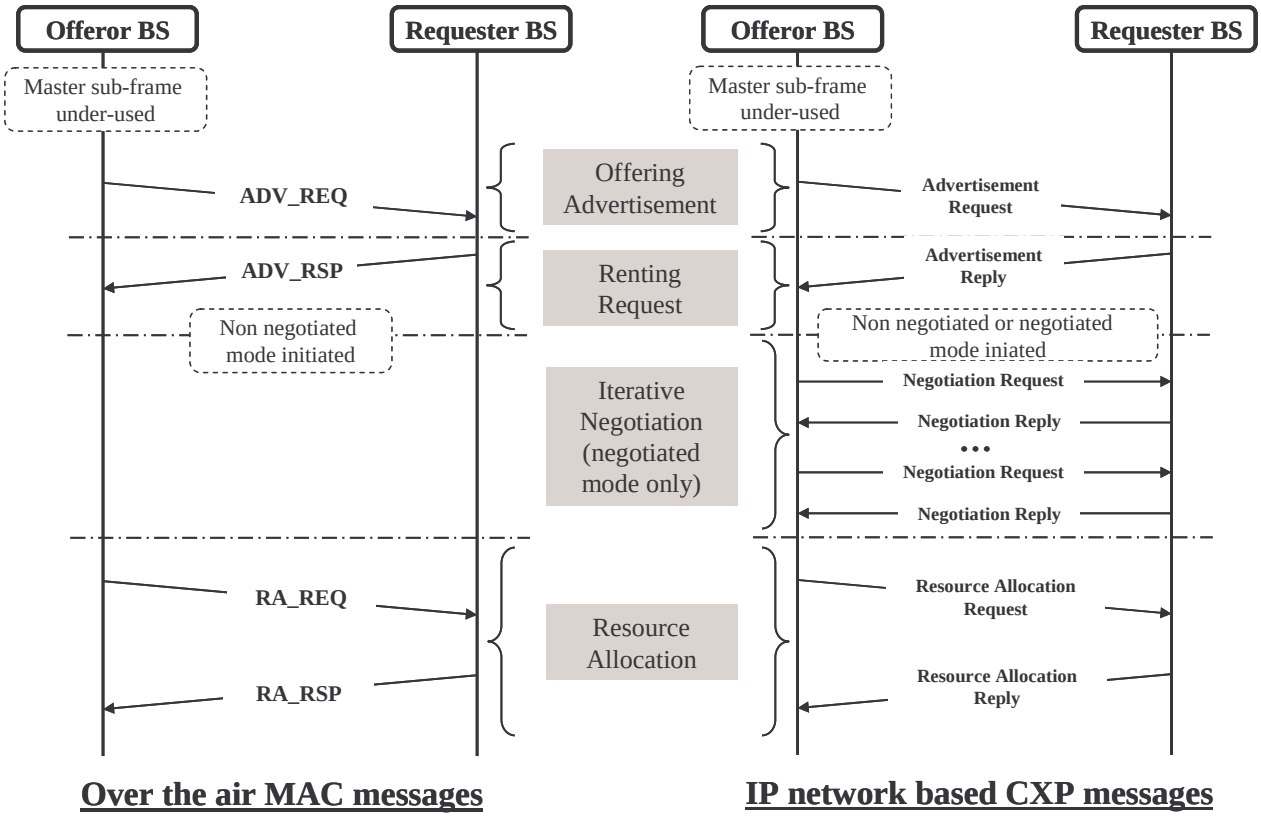

Figure hc: Whole CT-CXP Procedure

The details of these procedures are specified in subsections hereafter.

15.4.2.4.1.2 CT-CXP Offering Procedure

The over the air and IP network based CT-CXP offering procedures are respectively depicted in Figure hd and Figure he.

a) The procedure described in Figure hd is as follows:

- A BS identifies that a part of its master subframe is going to be under-used and can be rented out. With respect to this, this BS becomes an offeror BS and initiates the renting advertisement by broadcasting the ADV_REQ message. In particular, this message includes information related to the available resource (T_renting_subframe, Renting_out_start_time, Renting_out_end_time) as well as the renting conditions (MNCT: Minimum number of credit tokens per resource unit required per requester's bid).
- If the offeror BS receives one single ADV_RSP message, then the offeror BS grants the renting resource to the single resquester by setting the Resource Granting Bit Flag (RGBF) to 1 in the RA_REQ message. The granted requester is not charged with credit token since it is not competing with some other requesters.
- If the offeror BS receives more than one ADV_RSP message, then it assesses whether he can supply each requester or not:
    - If it can supply, the offeror BS grants the renting resource to all requesters by setting the Resource Granting Bit Flag (RGBF) to 1 in the RA_REQ message.
    - If it cannot, the offeror BS derives and selects requesters with higher bids based on the information received from competing requesters. The offeror BS grants the resource to the selected requesters by setting the Resource Granting Bit Flag (RGBF) to 1 in the

RA_REQ message. These selected requesters can access to their requested resource (Rented_resoure_amount) during the guaranteed requested time period (Renting_in_start_time, and Renting_in_end_time). RGBT is set to 0 for the non selected requesters.

- The RA_REQ message includes the clearing price (Clearing_price) mentioning the number of credit tokens the requester has to freeze to acquire the granted resource.

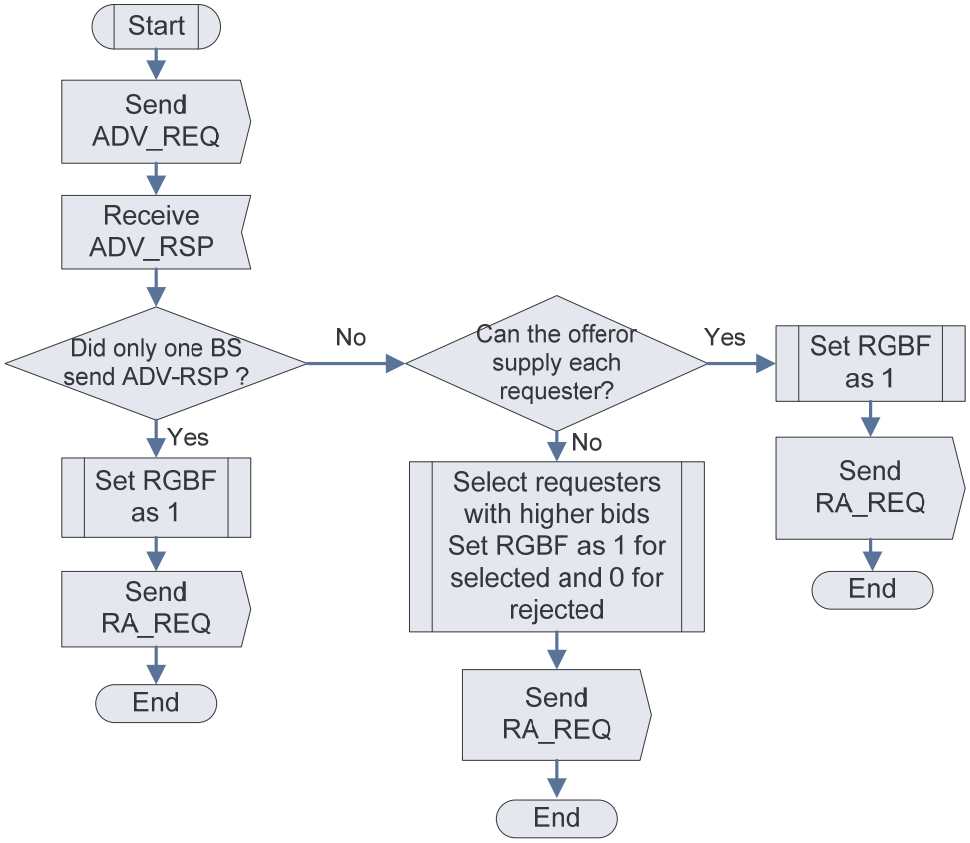

Figure hd: Over the air based CT-CXP offering procedure

b) The procedure described in Figure he is as follows:

- A BS identifies that a part of its master subframe is going to be under-used and can be rented out. With respect to this, this BS becomes an offeror BS and initiates the renting advertisement by broadcasting the "Advertisement Request" message. In particular, this message includes information related to:
  - The available resource (T_renting_subframe, Renting_out_start_time, Renting_out_end_time),
  - The negotiation mode (NMBF == 0: non negotiated mode is active, NMBF == 1: negotiated mode is active),
  - The renting conditions (Start_negotiation_time, End_negotiation_time, MNCT),
  - The pricing method in case NMFF == 1.
- If the offeror BS receives one single "Advertisement Request" message, then the offeror BS grants the renting resource to the single resquester by setting the Resource Granting Bit Flag (RGBF) to 1 in the "Resource Allocation Request" message. The granted requester is not charged with credit token since it is not competing with some other requesters.

- If the offeror BS receives more than one “Advertisement Request” message, then it assesses whether he can supply each requester or not:
    - If it can supply, the offeror BS grants the renting resource to all requesters by setting the Resource Granting Bit Flag (RGBF) to 1 in the “Resource Allocation Request” message.
    - If it cannot, the offeror BS follows the negotiated mode under consideration:
        - If NMBF == 0, same procedure as a) is executed. The Offeror BS derives and selects requesters with higher bids based on the information received from competing requesters. The offeror BS grants the resource to the selected requesters by setting the Resource Granting Bit Flag (RGBF) to 1 in the “Resource Allocation Request” message. These selected requesters can access to their requested resource (Rented_resoure_amount) during the guaranteed requested time period (Renting_in_start_time, and Renting_in_end_time). RGBT is set to 0 for the non selected requesters.
        - If NMBF == 1, iterative negotiation occurs between the offeror BS and each requester BS. Based on the infomation received within the “Advertisement Reply” message, the offeror BS calculates respectively a minimum and maximum payoff (Minimal_payoff and Maximal_payoff) at each iteration. These payoffs allow selecting the remaining requesters at each iteration. An example of payoff calculation is given in section 15.4.2.4.2. At each iteration, Minimal_payoff and Maximal_payoff are sent within the “Negotiation Request” message. The iterative negotiation occurs until the negotiation period (bounded by End_negotiation_time) is elapsed. At the end of the negotiation, the final requesters are selected by the offeror BS. The offeror BS grants the resource to the selected requesters by setting the Resource Granting Bit Flag (RGBF) to 1 in the “Resource Allocation Request” message. These selected requesters can access to their requested resource (Rented_resoure_amount) during the guaranteed requested time period (Renting_in_start_time, and Renting_in_end_time). RGBT is set to 0 for the non selected requesters.

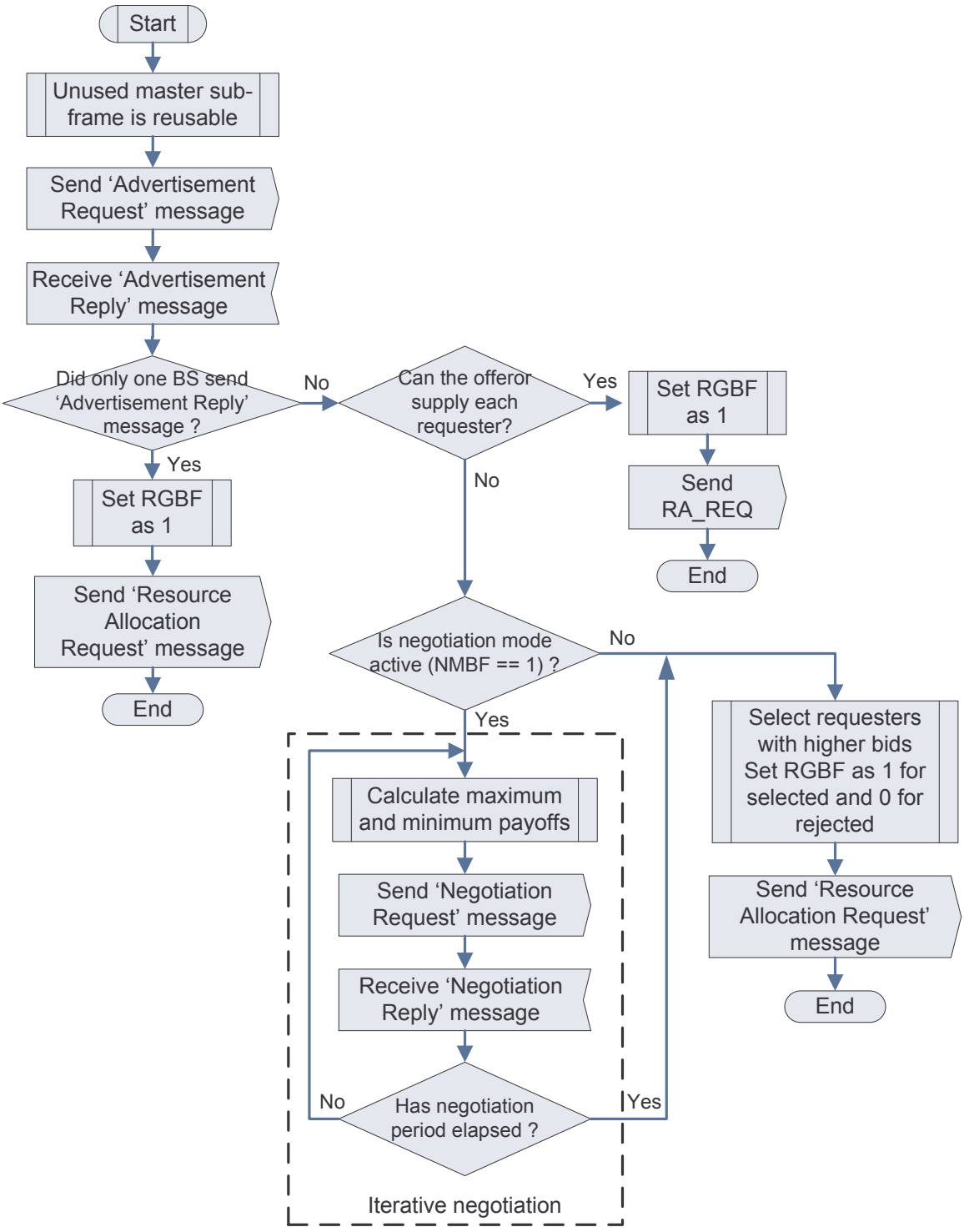

Figure he: IP network based CT-CXP offering procedure

15.4.2.4.1.3 CT-CXP Requesting Procedure

The over the air and IP network based CT-CXP requesting procedures are respectively depicted in Figure hf and Figure hg.

a) The procedure described in Figure hf is as follows:

- If a BS is in need of additional resource and can meet MNCT requirements, he can make a request (ADV_RSP message) upon the reception of ADV_REQ.
- Within ADV_RSP, the requester informs about the amount of required resource (Rented_resoure_amount), the rented in start and end time (Renting_in_start_time, Renting_in_end_time) and the requester's bid (Requester_bid) in term of number of credit tokens bidded per resource unit.
- Upon reception of RA_REQ message, the requester BS knows whether it has been selected or not. If RGBF is set to 1, the requester BS is selected, otherwise (RGBF set to 0) the requester is rejected.
- The requester decides to accept (Acceptation Bit Flag ABF set to 1) or to reject (ABF set to 0) the resource granting based on the Clearing_price information. This information is sent within the RA_RSP message.
- If ABF is set to 1, a number of credit tokens equal to the clearing price will not be usable (for some other renting requests by this requester) for a time duration equal to [renting_in_start_time; renting_in_end_time + δ] where δ is a frozen period margin. This ensures fairness over time between competing requester BSs to access to some other renting offers.

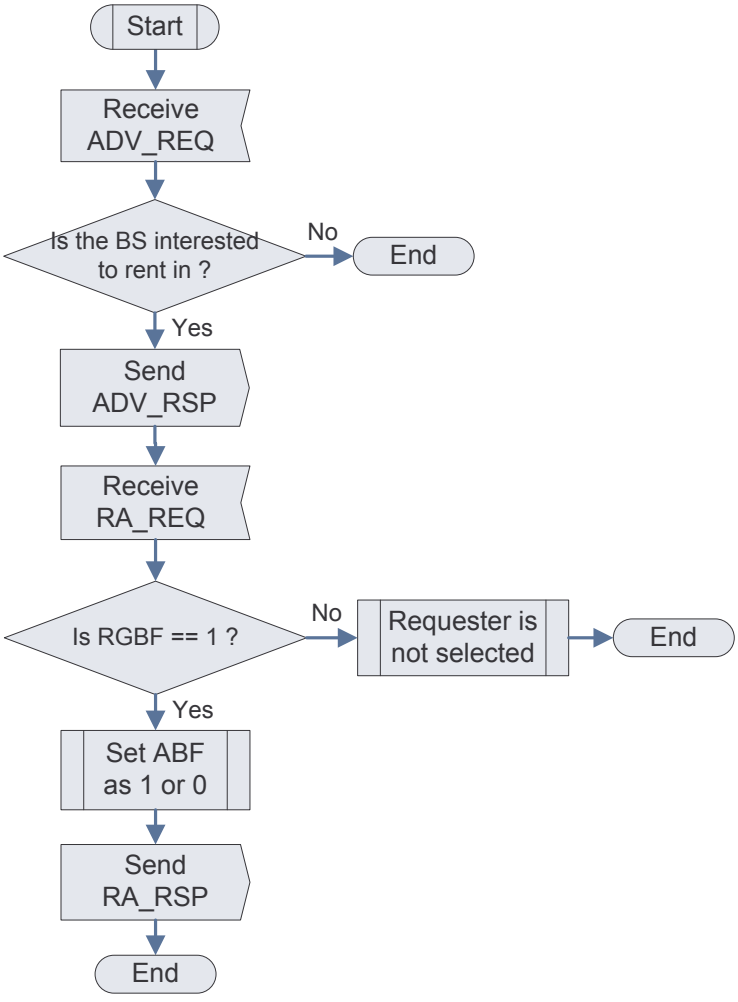

Figure hf: Over the air based CT-CXP requesting procedure

b) The procedure described in Figure hg is as follows:

- If a BS is in need of additional resource, meets MNCT requirements, and agree with the proposed negotiation mode (NMBF) and pricing method (PBF) specified within the "Advertisement Request" message , he can submit a bid ("Advertisement Reply" message) upon the reception of the "Advertisement Request" message.
- Within the "Advertisement Reply" message, the requester informs about the amount of required resource (Rented_resoure_amount), the rented in start and end time (Renting_in_start_time, Renting_in_end_time) and the requester's bid (Requester_bid) in term of number of credit tokens bidded per resource unit.
    - If the non negotiation mode is active (NMBF == 0), same procedure as a) is executed. If the offerer BS can supply to the requester BS, the offeror BS grants the renting resource by setting the Resource Granting Bit Flag (RGBF) to 1 in the "Resource Allocation Request" message.
    - If the negotiation mode is active (NMBF == 1), iterative negotiation occurs between the offeror BS and each requester BS. At each iteration, based on the information Minimum_payoff and Maximal_payoff received from the "Negotiation Request" message, the requester decides to submit a new bid (Requester_bid_update) or not. Requester_bid_update is sent within the "Negotiation Reply" message. The iterative negotiation occurs until the negotiation period (bounded by End_negotiation_time) is elapsed.
- Upon reception of the "Resource Allocation Request" message, the requester BS knows whether it has been selected or not. If RGBF is set to 1, the requester BS is selected, otherwise (RGBF set to 0) the requester is rejected.
- The requester decides to accept (Acceptation Bit Flag ABF set to 1) or to reject (ABF set to 0) the resource granting based on the Clearing_price information. This information is sent within the "Resource Allocation Reply" message.
- If ABF is set to 1:
    - If PBF == 0, a number of CTs equal to the Clearing_price* Rented_resource_amount*T_renting_subframe *(Renting_in_end_time - Renting_in_start_time)/CX_Frame_duration is transferred from the requester's ownership to the offeror's one.
    - If PBF == 1, the CT are not transferred but remains to the requester ownership. However, a number of credit tokens equal to the clearing price will not be usable (for some other renting requests by this requester) for a time duration equal to [renting_in_start_time; renting_in_end_time + δ] where δ is a frozen period margin. This ensures fairness over time between competing requester BSs to access to some other renting offers.

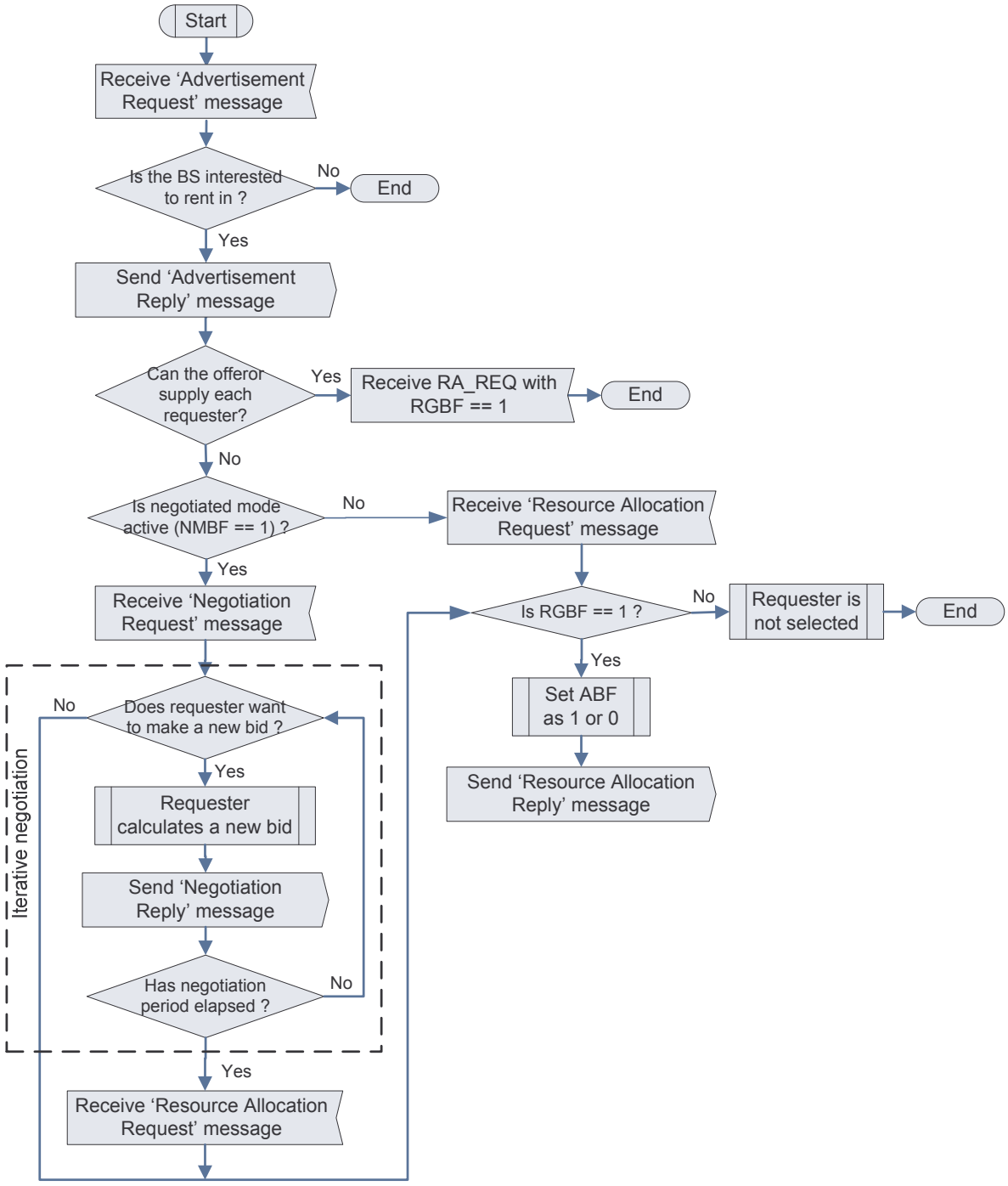

Figure hg: IP network based CT-CXP requesting procedure

15.4.2.4.2 Payoff calculation

This section provides an example on how the payoff and clearing price mentioned in section 15.4.2.4.1.2 can be calculated. This method is an example and the implementation is vendor specific.

At each iteration:

i) The offeror BS calculates the payoff (Payoff_requester) corresponding to each remaining requester as follows:

ii) Payoff_requester = Requester_bid_update* Rented_resource_amount*T_renting_subframe *(Renting_in_end_time - Renting_in_start_time)/CX_Frame_duration.

iii) The offeror selects the requesters that maximise jointly sum(Rented_resource_amount) and sum(Payoff_requester) over all the remaining requesters.

iv) The offeror BS derives the Minimal_payoff and Maximal_payoff from the selected requesters and sends this information to all initial remaining requesters.

v) Based on this information, each requester knows whether it has been selected or not by comparing its own Payoff_requester with Minimal_payoff.

vi) Based on this comparison, the requester decides to make a new bid (Requester_bid_update) or not for the next iteration of the negotiation.

15.4.2.4.3 Inter BSs communications for CT-CXP

CT-CXP requires inter BSs communication between different systems. These inter BS communications are necessary to exchange the parameters (Table h8) related to the CT-CXP procedures described in section 15.4.2.4.1.

The parameters related to CT-CXP (Table h8) are stored into the BSIS and into the database of each WirelessMAN-CX BS of the shared distributed system architecture (section 15.1.6).

The exchange of these parameters between BSs is supported through IP network inter-BS communications for the negotiated and non-negotiated modes. The related CXP messages are defined in section 15.5.1.

The exchange of these parameters between BSs is also supported with over the air MAC messages (defined in section 6.3.2.3) for the non-negotiated mode. Inter system over the air communications mechnanisms are detailed within clause 15.x.

[Remove text of section 15.4.2.4.6 only if text of contribution C80216h-07_047 is accepted:]

4. Abrevations and acronmys

[Add following acronym to the list as indicate:]

CT-CXP	Credit Token based Coexistence Protocol

15.5 Messages for WirelessMAN-CX

15.5.1 Coexistence Protocol (CXP) messages (CXP-REQ/CXP-RSP)

[Update messages in Table h7 as indicate:]

Table h7—CXP message codes

Code	CXP Message Name	CXP Message Type	Protocol type	Direction
35	Advertisement Request	CXP-REQ	TCP	BS->BS
36	Advertisement Reply	CXP-RSP	TCP	BS->BS
37	Negotiation ~~Process~~ Request	CXP-REQ	TCP	BS->BS
38	Negotiation ~~Process~~ Reply	CXP-RSP	TCP	BS->BS
39	Resource Allocation Request	CXP-RSP	TCP	BS->BS
40	Resource Allocation Reply	CXP-RSP	TCP	BS->BS
~~39~~	~~Credit Token Proposal Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~40~~	~~Credit Token Proposal Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~41~~	~~Negotiation Results Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~42~~	~~Negotiation Results Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~43~~	~~Granting Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~44~~	~~Granting Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~45~~	~~Coexistence Conflict Identification Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~46~~	~~Coexistence Conflict Identification Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~47~~	~~Intra Operator Coexistence Coordination Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~48~~	~~Intra Operator Coexistence Coordination Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~49~~	~~Inter Operator Coexistence Coordination Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~50~~	~~Inter Operator Coexistence Coordination Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~
~~51~~	~~Final Coexistence Decision Request~~	~~CXP-REQ~~	~~TCP~~	~~BS->BS~~
~~52~~	~~Final Coexistence Decision Reply~~	~~CXP-RSP~~	~~TCP~~	~~BS->BS~~

[Update Table h8 as indicate:]

Table h8—TLV types for CXP payload

Type	Parameter Description	Length (bytes)	Comment
…	….	…	…
34	Renting_out_start_time	2	in microsecond
35	Renting_out_end_time	2	in microsecond
36	Negotiation_Mode_Bit_Flag (NMBF)	1	scalar
37	T_renting_subframe	2	in microsecond
38	Start_negotiation_time	2	in microsecond
39	End_negotiation_time	2	in microsecond
40	Pricing_Bit_Flag (PBF)	1	scalar
41	Minimum number of Credit Token (MNCT)	6	in number of credit tokens
42	Requester_bid	6	in number of credit tokens
43	Rented_resource_amount	1	scalar
44	Renting_in_start_time	2	in microsecond
45	Renting_in_end_time	2	in microsecond
46	Minimal_payoff	6	scalar
47	Maximal_payoff	6	scalar
48	Requester_bid_update	6	in number of credit tokens
49	Resource_Granting_Bit_Flag (RGBF)	1	scalar
50	Clearing_price	6	in number of credit tokens
51	Acceptation_Bit_Flag (ABF)	1	scalar
~~34~~	~~T_{Start} [Notes: For Credit Token till 48]~~	~~2~~	~~In microsecond~~
~~35~~	~~T_{End}~~	~~2~~	~~In microsecond~~
~~36~~	~~$T_{Start\ Renting}$~~	~~2~~	~~In microsecond~~
~~37~~	~~$T_{End\ Renting}$~~	~~2~~	~~In microsecond~~
~~38~~	~~MRCTN~~	~~2~~	~~In number of credit token~~
~~39~~	~~$T_{Start\ Negotiation}$~~	~~2~~	~~In microsecond~~
~~40~~	~~$T_{End\ Negotiation}$~~	~~2~~	~~In microsecond~~
~~41~~	~~BS_CT~~	~~2~~	~~In number of credit token~~
~~42~~	~~frac~~	~~2~~	~~Scalar~~
~~43~~	~~$T_{Start\ proposal}$~~	~~2~~	~~In microsecond~~
~~44~~	~~$T_{End\ proposal}$~~	~~2~~	~~In microsecond~~
~~45~~	~~Pmin~~	~~2~~	~~In number of credit token~~
~~46~~	~~Pmax~~	~~2~~	~~In number of credit token~~

47	Pr	2	In number of credit token
48	Credit token transaction confirmation	1	
49	Resource usage confirmation	1	
50	Resource usage confirmation notification	1	
51	BSID Interfered	1	
52	Intra Operator Coexistence Coordination Status	1	1 - Acceptance 2 - Rejection
53	Inter Operator Coexistence Coordination Status	1	1 - Acceptance 2 - Rejection
54	Coexistence Decision Status	1	1 - Acceptance 2 - Rejection

[Replace section 15.5.1.33 text by the text below:]

15.5.1.33 Advertisement Request

The master BS advertises to the surrounding slave BSs that it offers temporally some resources for renting.

Code: 35

Attributes as shown in Table h29.

The offerer sends this broadcast this message to advertise to the surrounding future potential requester candidates that it offers temporally resource for renting.

Table h29—Advertisement Request message attributes

Attribute	Contents
BSID	BSID of the master BS
T_{Start}	Starting time of the renting period
T_{End}	Ending time of the renting period
$T_{Start\_Renting}$	Starting time of the subframe under renting
$T_{End\_Renting}$	Ending time of the subframe under renting
MRCTN	Minimum number of credit tokens required for renting

Table h29— Advertisement Request message attributes

Attributes	Contents
BSID of the source BS	BSID of the offeror
Renting_out_start_time	The starting time of the renting out period proposed by the offeror on that channel
Renting_out_end_time	The ending time of the renting out period

	proposed by the offeror on that channel
Negotiation Mode Bit Flag (NMBF)	This flag indicates which of negotiation mode of CT-CXP is used: 0 - non-negotiation mode is active 1 - negotiation mode is active
T renting subframe	Total amount of time per master subframe rented out by the offer or
Start negotiation time	If NMBF == 1, this field specifies the starting time of the negotiation between the offerer and the competing requesters.
End negotiation time	If NMBF == 1, this field specifies the ending time of the negotiation between the offerer and the competing requesters.
Pricing Bit Flag (PBF)	If NMBF == 1, PBF specifies the CT-CXP pricing method applicable to the negotiation mode for the selected requesters: 0 – CTs are transferred from the requester's ownership to the offeror's one 1 – No CTs transfer ownership from the requester to offeror. However, selected requester's CTs are not usable by this requester for a given time period before reuse (the freezing time period).
Minimum number of Credit Token (MNCT)	Minimum number of credit tokens per resource unit required per requester's bid.

[Replace section 15.5.1.34 text by the text below:]

15.5.1.34 Advertisement Reply

~~The interested slave BSs respond to the master BS with an Advertisement Reply message mentioning their interest or not to rent totally or partially the resources offered by the master BS.~~

Each requester responds to the offeror with an Advertisement Reply message mentioning its interest to rent totally or a fraction of the resource offered by the offeror for the total or a portion of the proposed renting out period [Renting_out_start_time, Renting_out_end_time].

~~.~~Code: 36

Attributes as shown in Table h30.

~~**Table h30—Advertisement Reply message attributes**~~

~~**Attribute**~~	~~**Contents**~~
~~BSID~~	~~BSID of the slave BS~~

Table h30— Advertisement Reply message attributes

Attributes	Contents
BSID of the source BS	BSID of the requester
BSID of the destination BS	BSID of the offeror
Requester_bid	Number of credit tokens per resource unit bidded by the requester in response to the offeror advertisement

Rented_resource_amount	Fraction (scalar) of T renting subframe the requester is interested in and bidding for
Renting_in_start_time	Starting time of the period from which the requester is interested to rent in within [Renting_out_start_time, Renting_out_end_time], and for which the requester's bid applies for.
Renting_in_end_time	Ending time of the period the requester is interested to rent in within [Renting_out_start_time, Renting_out_end_time], and for which the requester's bid applies for.

[Replace section 15.5.1.35 text by the text below:]

15.5.1.35 Negotiation ~~Process~~ Request

~~The master BS provides the following information to the interested slave BSs to initiate the negotiation process.~~

This message is used only if NMBF == 1.

The Negotiation Request message is sent out by the offerer only when the CT-CXP mode flag is set to 1 in the Advertisement Request message, i.e. when the CT-CXP negotiation mode is active. At each iteration of the negotiation, the decision making algorithm applied by the offeror derives a minimum and maximal payoff based on the requesters' bids. At each of these iterations, updated values of these payoffs are provided by the offeror to the requesters still bidding for the renting.

Code: 37

Attributes as shown in Table h31.

~~**Table h31—Negotiation Process Request message attributes**~~

~~Attribute~~	~~Contents~~
~~$T_{Start\ Negotiation}$~~	~~Time from which the negotiation will start~~
~~$T_{End\ Negotiation}$~~	~~Time at which the negotiation will end~~

Table h31— Negotiation Request message attributes

Attributes	Contents
BSID of the source BS	BSID of the offeror
BSID of the destination BS	BSID of the requester
Minimal_payoff	Minimal derived payoff corresponding to the lower selected bid at the nth iteration of the negotiation
Maximal_payoff	Maximal derived payoff corresponding to the higher selected bid at the nth iteration of the negotiation

[Replace section 15.5.1.36 text by the text below:]

15.1.5.36 Negotiation ~~Process~~ Reply

~~In response, each slave BS informs the master BS about its first number proposition of credit token per time unit.~~

Based on the minimal and maximal payoff information, the Negotiation Reply message is sent out by the requester in response to Negotiation Request message in case the requester is willing to make a new bid proposal to be part of the selected requesters.

Code: 38

Attributes as shown in Table h32.

~~**Table h32—Negotiation Process Reply message attributes**~~

~~Attribute~~	~~Contents~~
~~BS_CT~~	~~Number of credit tokens per time unit~~
~~frac~~	~~Fraction of $[T_{Start\ Renting}, T_{End\ Renting}]$ for which BS_CT applies for.~~
~~$T_{Start\ proposal}$~~	~~Starting time from which BS_CT applies for.~~
~~$T_{End\ proposal}$~~	~~Ending time from which BS_CT applies for.~~

Table h32— Negotiation Reply message attributes

Attributes	Contents
BSID of the source BS	BSID of the requester
BSID of the destination BS	BSID of the offeror
Requester_bid_update	Updated number of credit tokens per resource unit bidded by the requester in response to Negotiation Request message

[Replace section 15.5.1.37 text by the text below:]

15.1.5.37 ~~Credit Token Proposal Request~~ Resource Allocation Request

~~The master BS informs the slave BSs about the minimal and maximal payoffs resulting from the scheduling process applied by the master BS.~~

After the negotiation is complete, the Allocation Request message informs each requester whether he is granted with the resource he bidded for. Each granted requester is informed about the credit token clearing price. Clearing pricing is executed followup the method specified in the Advertisement Request message.

Code: 39

Attributes as shown in Table h33.

~~Table h33—Credit Token Proposal Request message attributes~~

~~Attribute~~	~~Contents~~
~~Pmin~~	~~Minimal payoff~~
~~Pmax~~	~~Maximal payoff~~

Table h33— Resource Allocation Request message attributes

Attributes	Notes
BSID of the source BS	BSID of the offeror
BSID of the destination BS	BSID of the requester
Resource_Granting_Bit_Flag (RGBF)	This flag indicates whether the offeror supplies the resource requested by the requester or not: 1 – resource allocation is granted 0 – resource allocation is rejected
Clearing_price	This field is useful only when RGBF == 1. Derived from the selection process, clearing price is the number of credit tokens the renter has to freeze to acquire the granted resource.

[Replace section 15.5.1.38 text by the text below:]

15.1.5.38 ~~Credit Token Proposal Reply~~ Resource Allocation Reply

~~In response to the Credit Token Proposal Request message, the slave BS proposes a new BS_CT for the previous frac, TStart proposal and TEnd proposal values.~~

In response to the Resource Allocation Request message, the Resource Allocation Reply message indicates whether the requester accepts the granting at the proposed clearing price.

Code: 40

Attributes are shown in .

~~Table h34—Credit Token Proposal Reply message attributes~~

~~Attribute~~	~~Contents~~
~~BS_CT~~	~~Updated number of credit tokens per time unit~~

Table h34— Resource Allocation Reply message attributes

Syntax	Notes
BSID of the source BS	BSID of the requester
BSID of the destination BS	BSID of the offeror
Acceptation_Bit_Flag (ABF)	In case RGBF == 1, this flag indicates whether the requester accepts the granting at the proposed clearing price: 1 – acceptation 0 – rejection

~~The messages "Credit Token Proposal Request" and "Credit Token Proposal Reply" are repeated as long as $T_{End\ Negotiation}$ is not reached~~

[Remove section 15.5.1.39:]

[Remove section 15.5.1.40:]

[Remove section 15.5.1.41:]

[Remove section 15.5.1.42:]

[Remove section 15.5.1.43:]

[Remove section 15.5.1.44:]

[Remove section 15.5.1.45:]

[Remove section 15.5.1.46:]

[Remove section 15.5.1.47:]

[Remove section 15.5.1.48:]

[Remove section 15.5.1.49:]

[Remove section 15.5.1.50:]

[Update text of section 15.5.1.51 as indicate:]

15.5.1.51 Regulatory Authority Request Message

The Regulatory Authority (RAIS) communicates to BSIS which are the operating parameters of the service to be protected, the date and time requested for protection, the area of protection, etc. The message is sent separately for each application to be protected. This message is also used for the administration (policy) of credit token for CT-CXP.

Code: 53

Attributes are show in *Regulatory Authority* Request Message attributes

Table h47—Regulatory Authority Request Message attributes

Attribute	Contents
Radio Application identifier	Radio Application identifier
Tx power	Tx power (EIRP) of the application to be protected
Antenna type	Of the application to be protected, same for Tx and Rx
Antenna gain	Of the application to be protected, same for Tx and Rx
Antenna direction	Of the application to be protected, same for Tx and Rx

Latitude	The latitude information of the center of the area to be protected.
Longitude	The longitude information of the center of the area to be protected.
Altitude	The altitude information of the center of the area to be protected.
Maximum coverage	Required radius of the protection area (optional) for a transmitter power of 1W EIRP
Number of structures	Number of elements of the following seven fields structures
Number of TLVs in a structure	7
Absolute frequency of the transmit channel	Center frequency of Tx operation of the protected application
Channel width of the transmit channel	Channel width of operation of the protected application
Absolute frequency of the receive channel	Center frequency of Rx operation of the protected application
Tx power	Maximum transmitted power in the channel
ACLR	ACLR of the first adjacent channel, for the protected application
ACLR	ACLR of the second adjacent channel, for the protected application
Channel width of the receive channel	Channel width of operation of the protected application
Date	Date of the requested operation start
Absolute time	Hour/min/sec of the requested operation start
Long duration	Duration of the requested operation
BSIS destination	Id of the BSIS to be reached by RAIS
Credit token budget	Credit token budget policy per BS covered by the BSIS
Negotiation mode	Negotiation mode(s) policy applicable BSs covered by the BSIS
Pricing method	Pricing methods(s) policy applicable BSs covered by the BSIS
Credit token policy (reserved)	Reserved field as additional material to further administrate the credit token usage for CT-CXP.

[Update text of section 15.7 as indicate:]

15.7 Network - based identification of specific spectrum services or applications

Architecture

The proposed architecture uses different servers for the BWA systems and the systems to be protected, namely the BSIS (Base Station Identification Server) for the BWA systems and the RAIS (Radio Application Identification Server) for the devices providing specific radio applications. Generally the BSIS will be maintained by a Service Provider and the RAIS will be provided by the National Radio Administration. The communication of the BS with the BSIS or of the specific radio devices with the RAIS is secured by VPN or other procedures.

Architecture for coexistence of BWA and preferred radio applications gives an example of the proposed architecture. The BSIS are connected to the Base Stations providing BWA services. The RAIS has connections with the Base Stations providing TV applications, Satellite applications, Military applications, Health applications, Security applications, etc. In all these cases secure communication shall be established between the RAIS and the Base Stations or the Service Providers providing these services.

A special class is the Ad-Hoc protected applications, as wireless microphones or TV vehicle transmissions, which are mobile ad-hoc protected applications. In this situation a secure communication will be established between a Laptop with cellular interface or a hand-held device and the RAIS.

In addition to these functions, this architecture can also serve for the administration of the credit tokens to be used for the CT-CXP operations. For that purpose, RAIS can specify to BSISs some policies (ruling) for the usage of the credit tokens for the BS covered by this BSIS. For example, polices can specify the number of credit tokens to be assigned to each BS at some given locations or some given time periods, the negotiation mode, the pricing method, and so forth. The BSIS communication with RAIS is supported by the Coexistence Protocol messages Regulatory Authority Request and Regulatory Authority Response.

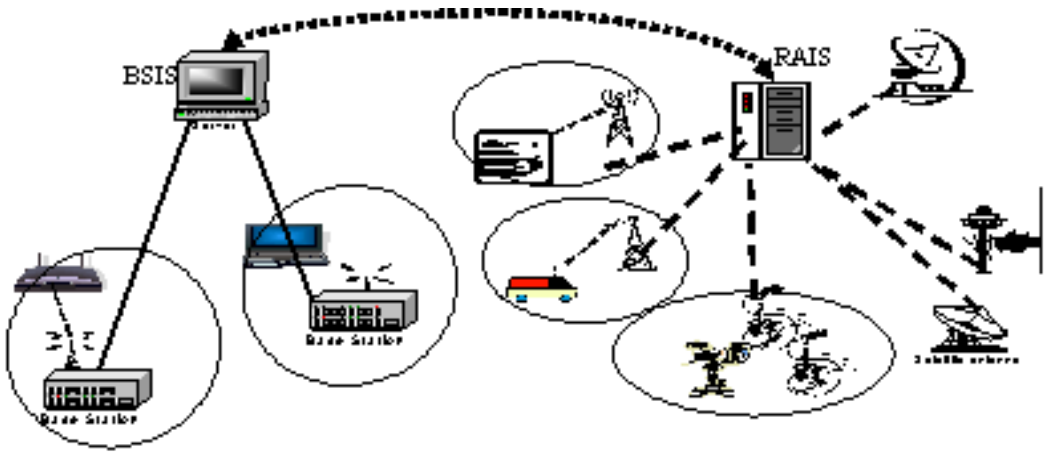

Figure h69—Architecture for coexistence of BWA and preferred radio applications

References

[1] IEEE 802.16h/D2a: Part 16: Air Interface for Fixed Broadband Wireless Access Systems Amendment for Improved Coexistence Mechanisms for License-Exempt Operation; 2007-03-28.
[2] IEEE 80216h-07_016r4: New Call for Reply Comments to address the comments from Letter Ballot #24a Commentary file with resolutions from Session #48.
[3] IEEE C80216h-07_030r1: Action Item from Session #47: Credit token based coexistence protocol text update, David Grandblaise, 2007-03-01