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Re:	Call for Contribution: IEEE 802.16d-03/02	
Abstract	Connection Oriented Mesh proposal that scales for large deployments and supports end-to-end MAC-level QoS.	
Purpose	For inclusion in 802.16d - to add Scalable Connection Oriented Mesh	
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Scalable Connection Oriented Mesh Proposal

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Introduction

The existing 802.16a Mesh standard provides connection-less services with no support for end-to-end QoS. The mesh standard is also limited to small deployments of mesh nodes because of the limitations of the network configuration messages. This document proposes changes to the existing 802.16a standard to support connection-oriented Mesh networks for large deployments.

This proposal addresses the following problems with the 802.16a standard:

1. Lack of support for end-to-end QoS and different types of services in Mesh mode as specified in Section 6.2.5 of the standard. QoS parameters are based on Diffserv like bits in message header that are used by intermediate nodes for routing. This makes end-to-end QoS difficult to implement.
2. Limit on size of network due to the structure of mesh mode tables (MSH-CSCF, MSH-CSCH).
3. Each node needs to know about all the links/nodes in network (burst profiles) to interpret schedule.
4. Time to collect bandwidth requests and distribute grants (schedule validity time) is very long.
5. End-to-end MAC messaging is tunneled on top of UDP/IP.

This document is organized into sections in the same order as the 802.16a specification. The specific changes proposed in this document address all the problems listed above. The proposal is broadly divided into the following parts:

1. Connection Management
2. Data/Control Plane and Link layer
3. Link Setup and Adaptation
4. Connection Oriented Mesh Centralized Scheduling

Connection Oriented Mesh Overview

With **Section 6.B** – MAC sub-layer – common part: Mesh

A connection oriented mesh network provides connection based BS-SS service flows through intermediate SS nodes. QoS parameters associated with the end-to-end service flows (through the mesh network) are used in scheduling traffic through the network. This is different from the connection-less mesh specification currently in the standard that only provisions QoS over individual links in the mesh network.

Segmentation of higher layer packets is performed at the ingress point into the mesh and these are reassembled at the egress point of the mesh. ARQ is used by nodes on each link in the mesh to ensure reliable delivery of packets at each hop.

Centralized scheduling is used in the proposed connection oriented mesh to allocate network resources (mini-slots) for data traffic. The messages used for centralized scheduling allow for a large number (1000 nodes per sector) of mesh nodes to be supported, as envisioned in the 802.16 requirements. The proposed scheduling mechanism and request/grant messages also enables each node in the network to determine the mini-slots allocated to it without any knowledge of the burst profiles of other links in the network.

The connection oriented mesh proposal supports end-to-end control signaling (necessary for network control messaging).

Connection Management (Section 6.1)

No Change to Section 6.1.1 – MAC service definitions.

The connection oriented mesh uses existing PMP Connection management messages. No new messages need to be added.

Service Class Management (Section 6.2.5)

No Change to Section 6.2.5 – MAC service types.

The connection oriented mesh uses existing PMP service classes/types. No new messages need to be added.

Dynamic Service Management Messages (Section 6.2.2.3.10 – 6.2.2.3.17)

Modify **Dynamic Service Addition/Change/Deletion (DSA/DSC/DSD)** messages to carry information relevant to new form of multi-hop connections. The format of the Dynamic Service messages (add/change/delete, request/response/acknowledge) shall remain as described in **Sections 6.2.2.3.10** through **6.2.2.3.17**.

The proposed changes are to include a Path field in the DSA-RSP message to enable all the intermediate nodes on the path to set up the CID and associated QoS parameter set in their internal data structures. The minimum parameters for each message are as follows:

Minimum Parameters for Connection Control Messages			
	xxx-REQ	xxx-RSP	xxx-ACK
DSA-xxx	Service Class, QoS Params	CID, SFID, **Path,** QoS Params	Confirmation code
DSC-xxx	CID, Service Class, QoS Params	CID, SFID, QoS Params	Confirmation code
DSD-xxx	CID	CID	Confirmation code

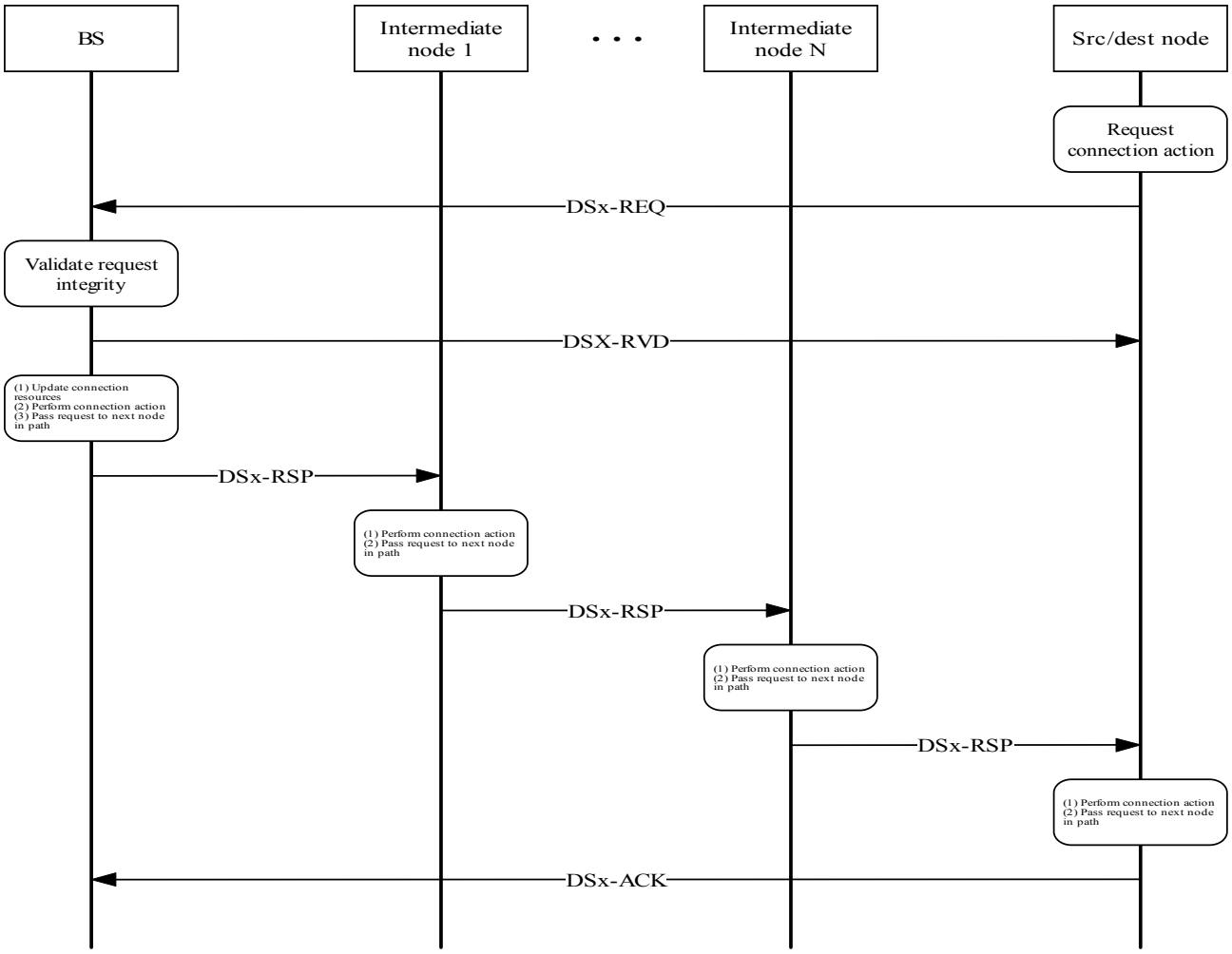
These parameters can be expressed by using existing TLV definitions, adapting existing TLV definitions, or creating new TLV definitions, as follows:

1. **Service Class :** Service Class identifier (**Section 11.4.8.3**) – no change

2. **SFID** : Service flow identifier (**Section 11.4.8.1)** – no change
3. **CID** : Connection identifier (**Section 11.4.8.2)** – no change
4. **Path** : Connection path specification – new TLV, as follows:

Type	Length	Value	Scope
[25]	2 to 8	Sequence of 2-byte node identifiers (between 1 and 4)	DSA-RSP

5. **QoS Parameter Set** : Any new/changed QoS parameters associated with this Service Flow that are not defined in the associated provisioned Service Class – no change.
6. **Confirmation code** – (**Section 11.4.12**) – no change.

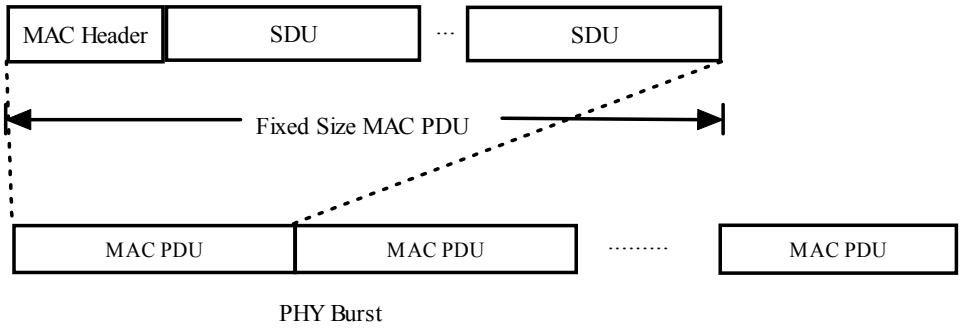


Data/Control Plane

MAC PDU Format (Section 6.2.2)

MAC PDUs are created at the ingress point of the Connection and re-assembled at the egress point of the Connection. So, it is required that each MAC PDU be a switchable unit. This puts a requirement that each MAC PDU be of a fixed size and fit into the smallest capacity mini-slot (PHY burst). Variable size MAC PDUs are not suitable for switching because the PDUs will have to re-fragmented if they do not fit into small capacity mini-slots.

It is proposed that the MAC PDU size (fixed for a network) and the number of symbols in a mini-slot be included in the MSH-NCFG message to enable a service provider to assign appropriate parameters based on channel bandwidth.



Generic MAC Header (Sec 6.2.2.1.1)

PMP and the connection-less mesh architecture uses CID as a link connection identifier for ARQ operation. In a connection oriented mesh, connection is defined end-to-end and link operation is between 2 peer nodes. So, one needs a link identifier to operate a connection-oriented link. It is proposed that the CID also be interpreted as the link identifier as each CID uniquely identifies a link (transmitter and receiver nodes) for any pair of nodes.

Segmentation and re-assembly (SAR) is performed on an end-to-end basis. The existing FSN field is divided into 2 fields – Link SN and SAR SN. The Link SN is used for the ARQ operation. The SAR SN is used for re-assembly at the destination.

HT + EC + Type	Rsv+ CI + EKS + LEN (msb3)
LEN (lsb 8)	**CID (msb 8)**
CID (lsb 8)	HCS (8)

There is no need to change generic MAC header format. CID used in this header can be used as the end-to-end CID for each MAC PDU. When a node receives MAC PDU with a specific CID, it maps a CID to a logical link connection.

Fragmentation sub-header (Sec 6.2.2.2.1)

Syntax	Size	Notes
FC	2 bits	Indicates fragmentation state of payload 00 = no fragmentation 01 = last fragment 10 = first fragment 11 = continuing fragment
if (Type bit == Extended Type		
FSN **Link SN** **SAR SN**	**11 bits** **5 bits** **6 bits**	Re-used (Sequence number of a fragment) Link sequence number – valid on link basis SAR Sequence Number – valid end-to-end basis
Else		
FSN	**3 bits**	Not used in Connection oriented Mesh
Reserved	3 bits	

FSN used is always 11 bits (extended format). FSN is divided into 2 fields.

Link SN: This 5 bits field represent Sequence number on a link basis for ARQ operation.

SAR SN: This 6 bits field represent sequence number for segmentation and re-assembly on end-to-end basis. At each intermediate node, this number is preserved.

Packing sub-header (Sec 6.2.2.2.3)

Syntax	Size	Notes
FC	2 bits	Indicates fragmentation state of payload 00 = no fragmentation 01 = last fragment

		10 = first fragment 11 = continuing fragment
if (Type bit == Extended Type		
FSN **Link SN** **SAR SN**	**11 bits** **5 bits** **6 bits**	Re-used (Sequence number of a fragment) Link sequence number – valid on link basis SAR Sequence Number – valid end-to-end basis
Else		
FSN	**3 bits**	Not used in Connection oriented Mesh
Length	11 bits	

FSN used is always 11 bits (extended format). FSN is divided into 2 fields.

Link SN: This 5 bits field represent Sequence number on a link basis for ARQ operation.

SAR SN: This 6 bits field represent sequence number for segmentation and re-assembly on end-to-end basis. At each intermediate node, this number is preserved.

ARQ Messages (Section 6.2.2.3)

Connection ID is specified as part of these messages. If such a message is received at a node, with a specific connection ID, then the corresponding Link SN (extended FSN sub-field) is the link sequence number.

All the ARQ related MAC Management messages operate between a node and its sponsor (Parent) using the appropriate control connection.

Control Connections (Section 6.2.2.3)

Control messages flow in set of well-known control connections, e.g. connection and CoS create/modify/delete. Setup of initial control connection done by parent/hub, as part of link setup. Each node in the network requires 2 sets of control connections (SS-terminal – SS-sponsor, SS – BS) to be setup at link setup for control traffic.

Bandwidth management messages use control connections to traverse the network. This is in contrast with the control messages tunneled over UDP in the connection-less Mesh standard.

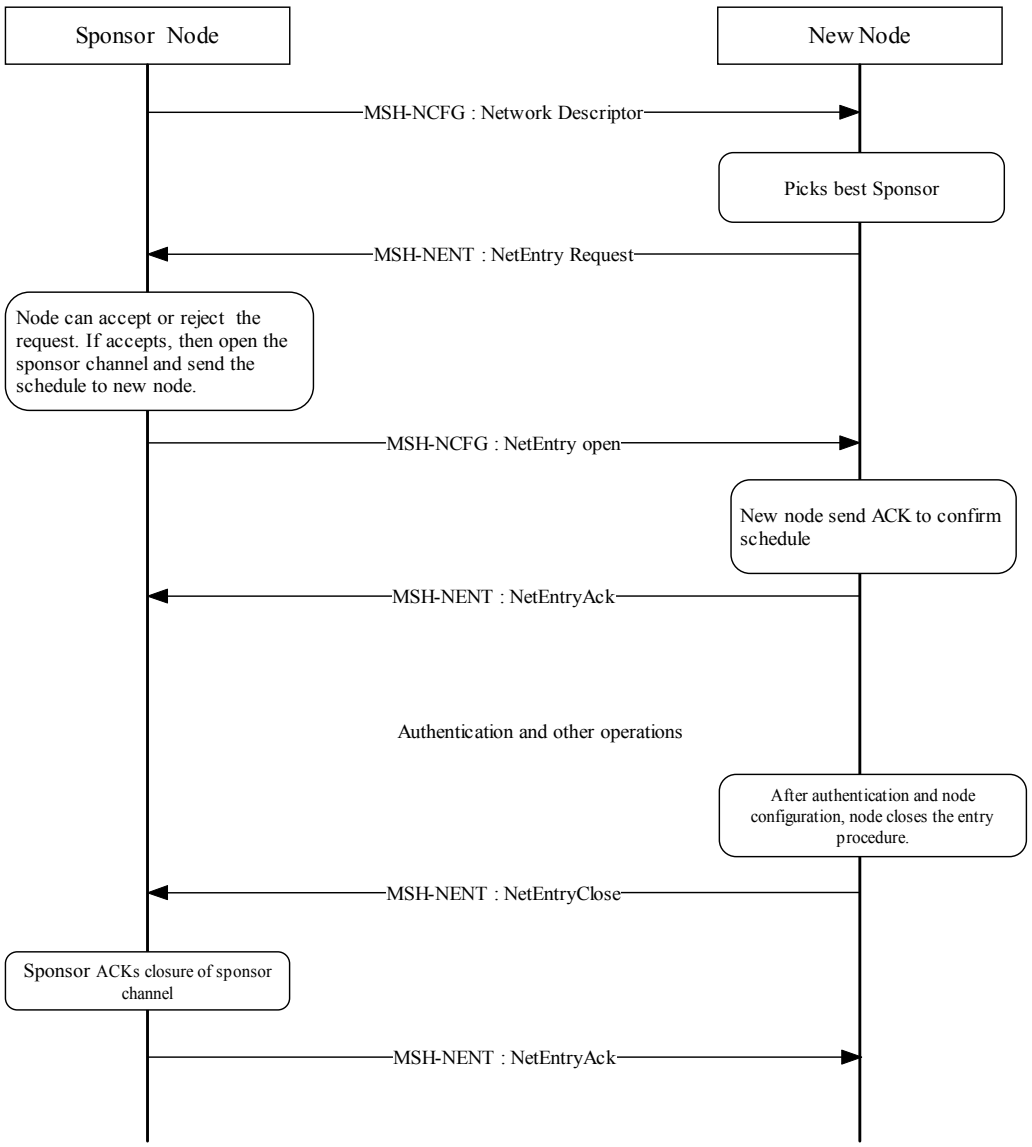
Link Setup and Adaptation

The MSH-NCFG message is modified in the proposal. The following messages are used without modification:

RNG-REQ REG-REQ MSH-NENT
RNG-RSP REG-RSP

The above messages are proposed to be as small as possible, preferably less than 50 bytes in length, to enable the messages to fit into a single control mini-slot (defined in Framing Section). The node id of the transmitter is present in the MAC mesh sub-header. So the messages do not carry them explicitly.

The protocol diagram below shows the proposed steps involved in link setup.



Mesh network configuration (MSH-NCFG) message (Section 6.2.2.3.34)

All nodes in the network transmit this message. This message is used to enable new nodes to join the network.

Table 56f- MSH-NCFG Message Format

Syntax	Size	Notes
MSH-NCFG_Message_Format(){		
Management Message Type = 39	8 bits	
Node type	2 bits	0 = BS, 1 = Repeater, 2 = Terminal (NEW)
Hops From Base Station	3 bits	0 = BS, 1 = 1 hop away, 2 = 2 hops away, Max = 7 hops away (NEW)
Embedded Packet Flag	1 bits	0 = Not present, 1 = Present
Operator ID	16 bits	Moved here from Network Descriptor Information Element
Network base channel	4 bits	
Xmt power	4 bits	
Xmt Antenna	3 bits	Supports up to 8 antenna faces
NetEntry MAC Address Flag	1 bit	0 = Not present, 1 = Present
Time Stamp Frame Number Network Control Slot Number	12 bits 4 bits	
If(NetEntry MAC Address Flag) NetEntry MAC Address	48 bits	
If(Embedded Packet Flag) MSH-NCFG_embedded_data()	variable	See Table 56i
}		

Node Type

This is a new field added. This specifies the node type of the transmitter. The node types can be BS, repeater or terminal.

Hops From Base Station

The number of hops away from BS. The BS will have a hop count of 0. This helps in determining the sponsor node if the new node hears more than one repeater.

Network base channel

The base channel being used in this node's network, which is the logical number of the physical channel, which shall be used to broadcast schedule control information. A subset of the possible physical channel numbers is mapped to logical channels in the network descriptor.

Operator ID

Moved here from "Network Descriptor Information Element".

Xmt Power
In 2dBm steps, starting from 8dBm (i.e. 1111 indicates 38 dBm)

Xmt Antenna
The logical antenna used for transmission of this message. This allows for support for up to eight antenna directions.

Frame Number
A modulo 2^12 number, which shall be increased by one for every frame.

Network Control Slot Number
The slot number in the network control sub frame.

NetEntry MAC Address Flag
Indicates presence or sponsorship of new node.

The MSH-NCFG message described in 802.16 standard, has some more fields (listed below) that we propose to be removed from the Connection-oriented MSH-CNFG message.

a) NumNbrEntries : No need to build neighbor list
b) NumBSEntries : No need to build neighbor list
c) NetConfig Count : One message fits in one burst.
d) Synchronization Hop Count : Always synch with sponsor.
e) NetConfig schedule Info : Separate scheduling method (discussed separately in this document)
f) BS Node Id, Number of hops : No need to report BS identifier in message
g) Xmt energy/bit : Not needed
h) Nbr Node Id, MSH-Nbr_Physical_IE, MSH-Nbr_Logical_IE: Neighbor information is not needed

MSH-NCFG Embedded data

This is same as described in 802.16 Mesh document (**Section 6.2.2.3.34.3**).

The network descriptor Information Element has been changed. Some new fields have been added and few have been removed. The Operator ID field has been moved to the main body of the MSH-NCFG message.

Table 56j – Network Descriptor Information Element

Syntax	Size	Notes
MSH-NCFG_embedded_data_IE{		
Frame Length Code	4 bits	4 lsb of frame duration code.
MAC PDU Size (fixed)	4 bits	Multiple of 32 bytes. 1 = 32 bytes, 2 = 64 bytes, Max = 512 bytes (NEW)
Data Mini Slot Size (fixed)	4 bits	Multiple of 2 symbols. 1 = 2 symbols, 2 = 4 symbols, Max = 32 symbols (NEW)
MSH-CTRL_LEN	4 bits	Control subframe length
MSH-DSCH_NUM	4 bits	Number of DSCH opportunities in schedule control subframe (0 for Connection Mesh)
MSH-CSCH_DATA_FRACTION	4 bits	
Scheduling frames	4 bits	The number of frames with schedule control subframe between two frames with network control subframe in multiple of 4 frames 0 = 0 frames 1 = 4 frames
Num_Burst_Profiles	4 bits	Number of burst profile definitions. If not set to zero, shall total all defined burst profiles.
Channels	4 bits	Number of logical channels.
MinCSForwardingDelay	7 bits	Number of OFDM symbols delay inserted between receiving and forwarding control packets.
XmtEnergyUnitsExponent	4 bits	
If(channels) MSH-NCFG_Channel_IE()	variable	
for(I=0;I<Num_Burst_Profiles){		
FEC Code Type	8 bits	
Mandatory Exit Threshold	8 bits	
Mandatory Entry Threshold	8 bits	
}		
}		

MAC PDU Size
Size of the fixed MAC PDU being used in this network.

Mini Slot Size
The size of the unit (number of symbols) in which bandwidth allocation is performed for data traffic. The number of symbols contains symbols for preamble and symbols for carrying data packets. This applies only to the data frame.

MSH-CSCH-DATA-FRACTION
Maximum percentage (value * 6.67) of mini-slots in the data sub-frame allocated to centralized scheduling. The number of mini-slots is rounded to the nearest whole number of mini-slots and allocated starting from the beginning of the data sub-frame.

Channels
Number of logical channels. A value of 0 indicates the channel information is not carried in this message.

MinCSForwardingDelay
The minimum delay in the OFDM symbols that shall be inserted between the end of reception and the start of transmission of centralized scheduling message (i.e. MSH-CSCH and MSH-CSCF) by any node.

Num_Burst_Profile
The total number of burst profiles supported in this network

FEC Code Type
A code that identifies the modulation and coding scheme combination. It is defined in Table 125b.

Mandatory Entry Threshold, Mandatory Exit Threshold
A range of the received SNR that qualifies for the corresponding FEC Code type.

The "Network Channel Information Element Table – Table 56l", the "Network Entry Open Information Element – Table 56m", the "Network Entry Reject Information Element – Table 56n" and the "Neighbor Link Establishment Information Element – Table 56o) remain same.

Mesh Network Entry (MSH-NENT) message

The message format for MSH-NENT is not modified.

This message is sent by a new node to its sponsor node. The power level of this transmit is derived from the receive signal level of the MSH-NCFG message and the transmit power (field) of the sponsor that sent the MSH-NCFG message.

Initial ranging and automatic adjustments

In 802.16 mesh implementation, ranging and adjustments are done using the MSH-NCFG message resulting in a very large message. It is proposed that the ranging function be removed from the MSH-NCFG message. The ranging and adjustment of the following parameters can be performed using RNG-REQ and RNG-RSP

messages (defined in the PMP mode). This message flows between sponsor and its child. The parameters gets adjusted are:

1. Timing Adjustment
2. Power Adjustment
3. Frequency Adjustment

As in PMP mode, in the mesh mode the child node periodically transmits RNG-REQ to its sponsor using the basic control channel. The sponsor responds to this request using RNG-RSP with the above adjustment parameters.

Ranging Request and Response (RNG-REQ, RNG-RSP) messages

Same as in PMP mode described in **Section 6.2.2.3.5** and **6.2.2.3.6.**

Mesh (Connection-oriented) Centralized Scheduling (Section 6.2.2.3.37)

Either BS or SS can create a Mesh Centralized Scheduling (MSH-CSCH) message.

BS shall broadcast the MSH-CSCH grant message to all its 1-hop-away neighbors. These SSs then together broadcast the message to SSs 2 hop away from the BS. In turn, these 2-hops-away SSs broadcast the message to SSs 3 hops away from the BS. This process continues until all SSs receive the message. The number of broadcasts is equal to the number of hops of the farthest (in terms of hop count) SS.
The Grant/Request Flag is 0 in MSH-CSCH grant message.

SSs can use MSH-CSCH request message to request bandwidth from the mesh BS by setting the Grant/Request Flag to 1. SS only reports if bandwidth request of a link in its sub-tree has been changed from the last request. MSH-CSCH request message includes only bandwidth requests of links, which have renewed bandwidth requests. SS shall consolidate all bandwidth requests in its sub-tree, which includes itself, and forward them up to its parent/sponsor.

The format of the proposed MSH-CSCH message is very compact and can support a large number of nodes in the network. The proposed mechanism for collecting the bandwidth requests and the broadcast mechanism for the grant also reduces the overhead (time and message size) of scheduling. This is especially important to enable a connection-oriented mesh to scale for large network deployments. For example, a 1000 node network with a 5% activity rate and with 20% of the active nodes requesting a change in their bandwidth allocation at the same time requires a MSH-CSCH message of 42 bytes (including headers) for the grant.

Each node in the network can determine the mini-slots allocated to it from the MSH-CSCH without any knowledge of the burst profiles of other links in the network. The burst profile of a link is only known to the BS and the nodes connected by the link. This also significantly reduces the overhead associated with broadcasting the burst profile of each link to every other link in the network.

MSH-CSCH message format

Syntax	Size	Notes
MSH-CSCH_Message_Format() {		
Management Message Type = 42	8 bits	
Grant / Request Flag	1 bit	0 = Grant, 1 = Request
if(Grant/Request Flag == 0) {		
Schedule Allocation Start	7 bits	
Start Frame Number	8 bits	8 lsb of frame number
} else {		
Reserved	7 bits	
}		
NumGrant/ReqEntries	8 bits	
for(i=0;i<NumGrant/ReqEntries;i++) {		
NodeId	16 bits	
Direction	1 bit	
BWGrant/Request	7 bits	
}		

Grant/Request Flag

0=Grant(broadcast in downlink)
1=Request(unicast in uplink)

Schedule Allocation Start

Starting point of the allocation for this schedule. Bandwidth grants are allocated in blocks of mini-slots. Schedule Allocation Start is the offset in number of mini-slots of the first grant in the MSH-CSCH message.

Start Frame Number

Indicates lowest 8 bits of frame number in which the schedule starts becoming effective

NumGrant/ReqEntries

Number of grant or request entries in the message

NodeId

Node Id of the child on which the link involving grant/request terminates. In a tree topology, a unidirectional link can be identified by the child nodeId of the link and direction of the link (downlink or uplink)

Direction

Direction of the link involving grant/request
0=downlink
1=uplink

BWGrant/Request

Normalized bandwidth grant/request for the link, in units of mini-slots.

MSH-CSCF (message type 43) not needed (Section 6.2.2.3.38)

This message is not needed in this proposed scheme.

New Burst Profile Change Request (MSH-BPC-REQ) message

This message is the connection oriented mesh version of DBPC-REQ. It reuses the Message Type 23.
The MSH-BPC-REQ Message is sent by an SS (or BS if appropriate) to either its parent or its child to request a change of either uplink or downlink, respectively, burst profile used by the other node to transport data to it. The message is sent on the SS's (or BS's) basic CID with the other node.

MSH-BPC-REQ message format

Syntax	Size	Notes
MSH-BPC-REQ_Message_Format() {		
Management Message Type = 23	8 bits	
Reserved	4 bits	
DIUC	4 bits	
}		

New Burst Profile Change Response (MSH-BPC-RSP) message

This message is the connection oriented mesh version of DBPC-RSP. It reuses the Message Type 24.
The MSH-BPC-RSP message is transmitted by either the SS or BS on the basic CID in response to a MSH-BPC-REQ message from the other node. If the DIUC parameter is the same as requested in the MSH-BPC-REQ message, the request is accepted. Otherwise, the request is rejected.

MSH-BPC-RSP message format

Syntax	Size	Notes
MSH-BPC-RSP_Message_Format() {		
Management Message Type = 24	8 bits	
Reserved	4 bits	
DIUC	4 bits	
}		

New Mesh Burst Profile Update (MSH-BPU) message

The MSH-BPU message is sent by the SS to the BS to inform the BS that a link burst profile has been changed. A link connects a parent SS and a child SS. Only parent SS needs to send this message to BS.

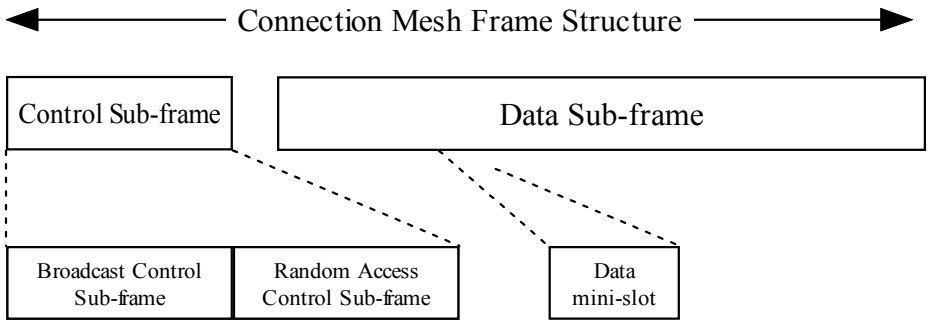
Syntax	Size	Notes
MSH-BPU_Message_Format() {		
Management Message Type = 43	8 bits	
NodeId	16 bits	
Direction	1 bit	
DIUC	4 bits	
Reserved	3 bits	
}		

Frame and Mini-slot Structure (Section 8.4.4.2)

The proposed frame structure for Connection oriented Mesh is very similar to 802.16 Mesh frame structure. Each frame is between 4-12ms in duration. A frame consists of control and data sub-frames. The number of symbols in a frame is a function of Channel Bandwidth (specified in Network Descriptor IE) that should be known to each SS before deployment.

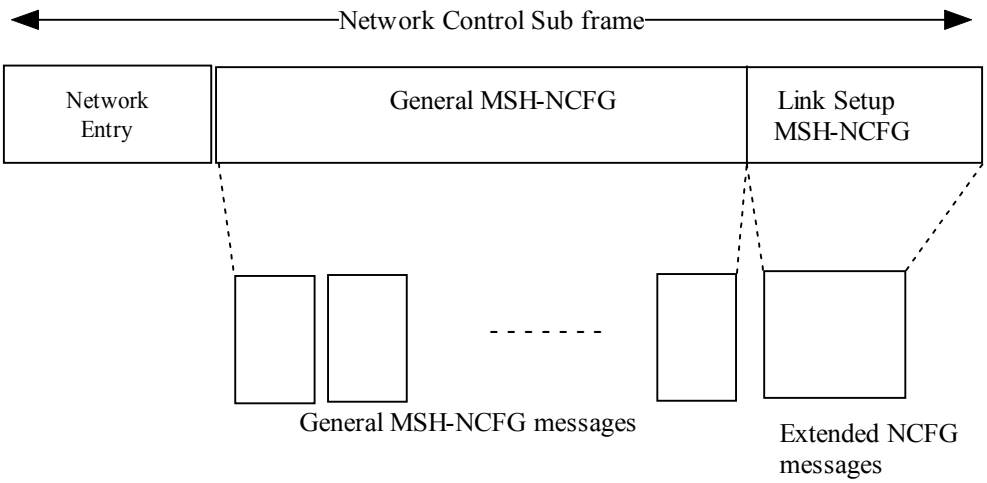
It is proposed that the control sub-frame be 1/8th of the frame length, i.e. a frame length of 256 symbols implies a control sub-frame of 32 symbols. The first half of the control sub-frame is for Broadcast control channel and the second half of the control sub-frame is for contention based Random access control channel.

Data sub-frame is divided into a number of data mini-slots. Each mini-slot has several symbols (multiples of 2, specified in MSH-NCFG message). Each link can be assigned a burst (multiple contiguous mini-slots) within a frame. A burst includes a long or short preamble as required for synchronization and channel estimation.



It is also proposed that the network control sub-frame be modified. This is done to allow more nodes to transmit the MSH-NCFG message (required to support a larger network). A large majority of the nodes need to transmit a small MSH-NCFG message (with Embedded Packet Flag = 0, i.e. there is no embedded data). The larger MSH-NCFG message is only needed for link-setup purposes.

It is proposed that the network control sub-frame be divided as shown in the diagram below.



The first part carries the general MSH-NCFG messages (multiples of 4 symbols). The second part carries only MSH-NCFG messages with embedded data. The first part is contention free (scheduled) to allow all nodes in the network to transmit their MSH-NCFG. The second-part is contention based (multiples of 8 symbols) and is only used for link setup protocol.

Appendix A

Summary of Proposed Changes to 802.16a Standard Document

Section #	Connection-Mesh (Proposed)
6.B	MAC sub-layer common part – Connection Oriented Mesh Overview
6.1	Uses PMP connection management messages – no new messages
6.2.5	Uses PMP service classes/types – no new messages
6.2.2.3.10 – 6.2.2.3.17	Modify PMP DSA-RSP message to add Path TLV
6.2.2	Connection oriented MAC PDU format definition
6.2.2.1.1	Generic MAC header (CID) interpretation
6.2.2.2.1 – 6.2.2.2.3	Fragmentation & Packing Sub-headers – Extended FSN divided into Link SN & SAR SN
6.2.2.3	ARQ messages use CID for link identification – no new messages. New control connections defined between SS-BS and SS-Sponsor.
6.2.2.3.5 – 6.2.2.3.6	PMP ranging messages – RNG-REQ, RNG-RSP – no changes
6.2.2.3.34	Network configuration messages
6.2.2.3.35	MSH-NENT message – no changes
6.2.2.3.37	Connection Mesh Centralized Scheduling – MSH-CSCH – new message format allowing a large number of requests and grants to be supported
6.2.2.3.38	MSH-CSCF message not needed in Connection Mesh. New Burst Profile Change Request, Response and Update messages (MSH-BPC-REQ, MSH-BPC-RSP, MSH-BPU) proposed – reusing PMP messages DBPC-REQ, DBPC-RSP. Enables large number of nodes to be supported in a network.
8.4.4.2	Connection Mesh frame structure – similar to existing Mesh frame structure

Applicability of 802.16a Sections to PMP, Connectionless Mesh and Proposed Connection-Oriented Mesh

Section	PMP	Connectionless Mesh	Connection Oriented Mesh Proposal
6.A	√		N/A
6.B		√	Add overview of connection oriented mesh
6.1.1	√		Uses PMP as is
6.1.2		√	N/A
6.2.1.1	√		Use as is
6.2.1.2		√	Use as is (Rename section – Connection-less Mesh)
6.2.1.3			Add new Connection oriented Mesh description
6.2.2	√	√	Add new Connection oriented MAC PDU format definition
6.2.2.1	√	√	Use as is
6.2.2.1.1	√	√	Add interpretation of generic MAC header for connection mesh
6.2.2.1.2	√		N/A
6.2.2.2.1 & 6.2.2.2.3	√	√	New FSN definition for connection mesh
6.2.2.2.2	√		N/A
6.2.2.2.4	√	√	Use as is
6.2.2.2.5		√	Use as is
6.2.2.3	√	√	ARQ messages use CID for link identification – no new messages. New control connections defined between SS-BS and SS-Sponsor. Add new management messages to Table 13a. Add paragraph about Control Connection.
6.2.2.3.1-6.2.2.3.4	√		N/A
6.2.2.3.5 & 6.2.2.3.6	√		Use PMP messages as is
6.2.2.3.7 – 6.2.2.3.9	√	√	Use as is
6.2.2.3.10-6.2.2.3.17	√		Add Path TLV to DSA-RSP message. New TLV defined in 11.4.??
6.2.2.3.18-6.2.2.3.19	√		N/A
6.2.2.3.20-6.2.2.3.21	√		Add new messages for Burst profile request, response and update (MSH-BPC-REQ, MSH-BPC-RSP and MSH-BPU).

6.2.2.3.22-6.2.2.3.24	√	√	Use as is
6.2.2.3.25-6.2.2.3.26	√		Use PMP as is
6.2.2.3.27	√		Use PMP as is
6.2.2.3.28-6.2.2.3.29	√	√	Use as is
6.2.2.3.30-6.2.2.3.32	√	√	Use as is
6.2.2.3.33	√		Use PMP as is
6.2.2.3.34		√	Modify for connection oriented mesh
6.2.2.3.35		√	Use as is
6.2.2.3.36		√	N/A
6.2.2.3.37		√	Modify for connection oriented mesh (MSH-CSCH)
6.2.2.3.38		√	N/A
6.2.2.3.39	√	√	Use as is
6.2.3 & 6.2.4	√	√	Use as is
6.2.5	√	(√)	Enables all service types
6.2.6.1 - 6.2.6.4.1	√		Use as is
6.2.6.4.2 – 6.2.6.4.3	√		N/A
6.2.6.5 – 6.2.6.6	√		N/A
6.2.6.7 – 6.2.6.7.1		√	N/A
6.2.6.7.2		√	Add Connection Mesh Centralized scheduling
6.2.7.1-6.2.7.5	√		N/A
6.2.7.6.1-6.2.7.6.3	√		N/A
6.2.7.6.4		√	Use as is – new Connection Mesh Structure defined in 8.4.4.2
6.2.7.7	√	√	Use as is
6.2.8	√	√	Use as is
6.2.9.1-6.2.9.13	√		Use as is

6.2.9.14		√	Use as is from Mesh mode
6.2.10	√		Use as is
6.2.11	√		N/A
6.2.12	√		N/A
6.2.13	√		Use as is
6.2.14	√	√	Use as is – add new Table 63b from Page 7 of proposal
6.2.15		√	N/A
8.4.4.2		√	Add new framing structure for connection oriented mesh