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Title	**Mesh mode text for 802.16ab standard**
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Abstract	This paper consists of clauses describing mesh mode of 802.16ab air interface standard. Clause numbering used is from the draft under comments and the intention is to provide a comprehensive description of all related messages and functionalities. This document is not a standalone document but should be used in parallel with the related commentary file giving definite instructions.
Purpose	Adopt the text proposed to the 802.16ab-01/01 to make mesh mode description more thorough.
Notice	
Release	
Patent Policy and Procedures	

Mesh mode text for 802.16ab standard

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Comment 1:

1.4.1 License Exempt Mesh Topology Option

The IEEE 802.16 TG4 system has an optional mesh topology. Unlike the basic point-to-multipoint (P-MP) mode, there are no clearly separate downlink and uplink subframes in the mesh mode. Each station (BS or SS) is able to create direct communication links to a number of other stations in the network instead of communicating only with the BS. However, in typical installations, there will still be certain nodes which provide the BS function of connecting the mesh network to the backhaul links. In fact, when using the mesh centralized scheduling (described below), these BS nodes perform much of the same basic functions as do the BS in the P-MP mode. Thus, the key difference is that in mesh mode all the SSs may have direct links with other SSs. Further, there is no need to have direct link from a SS to the BS of the mesh network. This connection can be provided via other SSs. Communication in all these links shall be controlled by a centralized algorithm (either by the BS or "decentralized" by all nodes periodically), scheduled in a distributed manner within each node's extended neighborhood, or a scheduled using a combination of these.

1.4.1.1 Distributed scheduling

The stations with which a station has direct links are called neighbors and shall form a neighborhood. A node's neighbors are considered to be "one hop" away from the node. A two-hop extended neighborhood contains, additionally, all the neighbors of the neighborhood. In the coordinated distributed scheduling mode, all the stations (BS and SSs) shall coordinate their transmissions in their extended two-hop neighborhood.

The coordinated distributed scheduling mode uses some or the entire control portion of each frame to regularly transmit its own schedule and proposed schedule changes on a P-MP basis to all its neighbors. Within a given channel all neighbor stations receive the same schedule transmissions. All the stations in a network shall use this same channel to transmit schedule information in a format of specific resource requests and grants.

Coordinated distributed scheduling ensures that transmissions are collision-free and scheduled in a manner that does not rely on the operation of a BS, and that are not necessarily directed to or from the BS.

Within the constraints of the coordinated schedules (distributed or centralized), uncoordinated distributed scheduling can be used for fast, ad-hoc setup of schedules on a link-by-link basis. Uncoordinated distributed schedules are established by directed requests and grants between two nodes, and must be scheduled to ensure that the resulting data transmissions (and the request and grant packets themselves) do not cause collisions with the data and control traffic scheduled by the coordinated distributed nor the centralized scheduling methods.

1.4.1.2 Centralized and Decentralized scheduling

In the centralized scheduling mesh mode the BS shall act as a centralized scheduler for the SSs within a certain hop range ($HR_{threshold}$) from the BS. The network connections and topology are just the same as in the distributed scheduling mode described in [REF]1.4.1.1, but the BS shall control some portion of the scheduled transmissions for the

SSs less than or equal to $HR_{threshold}$ hops from the BS. This hop range, $HR_{threshold}$, may be determined at the system start up phase or may be dynamic according to considerations such as network density, the proximity of other BSs, and/or the dynamic characteristics of the traffic streams.

In centralized scheduling mode the BS shall provide the schedule for all the SSs less than or equal to $HR_{threshold}$ hops from the BS. The BS determines the schedule from the resource requests from the SSs within the $HR_{threshold}$ hop range. Thus the BS acts just like the BS in P-MP network except that not all the SSs have to be directly connected to the BS and the schedule determined by the BS extends to also those SSs that are not directly connected to the BS but less than $HR_{threshold}$ hops from it. The SS resource requests and the BS schedule are both transmitted during the control portion of the frame.

Decentralized scheduling uses the same scheduling algorithm, but rather than have the BS collect all requests and then broadcast the schedule during each scheduling cycle, the requests themselves are broadcast to all the affected nodes which themselves run the same scheduling algorithm to compute the new schedule. So, no separate schedule messages are needed since all the nodes, including SSs, shall be able to determine their schedule.

Centralized scheduling ensures that transmissions are coordinated to ensure collision-free scheduling over the links in the routing tree to and from the BS, typically in a more optimal manner than the distributed scheduling method for traffic streams (or collections of traffic streams which share links) which persist over a duration that's greater than the cycle time to relay the new resource requests and distribute the updated schedule.

Decentralized scheduling has the additional advantage of lower communication overhead when the routing tree to and from the BS is known by the nodes within $HR_{threshold}$ hops of the BS, and can work well when changes to the network topology are relatively infrequent relative to the scheduling cycle.

Comment 2:

6.2.2.4.33 Mesh Schedule with Distributed Scheduling (MSH-DSCH) Message

A Mesh Schedule with Distributed Scheduling (MSH-DSCH) message shall be transmitted in a mesh mode when using distributed scheduling. In coordinated distributed scheduling, all the stations (BS and SS) shall transmit a MSH-DSCH in a P-MP fashion at a regular interval to inform all the neighbors of the schedule of the transmitting station. The MSH-DSCH message shall be used in parallel also to convey resource requests to the neighbors. Each station shall regularly transmit its MSH-DSCH message in a collision-free manner within its extended neighborhood. In uncoordinated distributed scheduling, the stations shall transmit the MSH-DSCH in a directed fashion to an intended neighbor. The MSH-DSCH message format is given in Table 1, including all of the following parameters:

Frame Number
: Incremental counter identifying the MAC frame

Hop Number
: Indicates the number of hops to the BS. 0xF indicates 15 hops or greater, or no nearby BS detected.

No. Grants
: Number of Grant IEs in the message

No Requests
: Number of Request IEs in the message

Table 1—MSH-DSCH Message Format

Syntax	Size	Notes
MSH-DSCH_Message_Format() {		
Generic_MAC_Header()	48 bits	
Management Message Type = TBD	8 bits	
Frame Number	12 bits	
Hop Number	4 bits	
No Requests	4 bits	
No Grants	4 bits	
for (i=0; i< No_Requests; ++i) {		
Neighbor ID	8 bits	
Start Frame Offset	4 bits	
Direction	1 bit	
Channel	3 bits	
Position	8 bits	
Duration	6 bits	
Priority	2 bits	
}		
for (i=0; i< No_Grants; ++i) {		
Neighbor ID	8 bits	
Start Frame Offset	4 bits	
Direction	1 bit	
Channel	3 bits	
Position	8 bits	
Duration	6 bits	
Persistence	2 bits	
}		

The Requests and Grants carried in the MSH-DSCH message shall include all of the following parameters:

Neighbor ID
The ID assigned by the transmitting node to the neighbor that this request or grant involves.
Start Frame Offset
Start frame identifier as frame offset.
Direction

0= From requester (i.e. to granter)
1= To requester (i.e. from granter)

Position
The start position of the reservation (PHY slot as time unit)

Duration
The number of slots reserved

Channel
Logical channel number

Persistence
Persistency field for grants

Priority
Priority field for requests

6.2.2.4.34 Mesh Schedule with Centralized Scheduling (MSH-CSCH) Message

A Mesh Schedule with Centralized Scheduling (MSH-CSCH) message shall be created by a BS in mesh mode when using centralized scheduling. The BS will send (unicast or broadcast) the MSH-CSCH message to all its neighbors, and all the SSs within the $HR_{threshold}$ hop range shall forward the MSH-CSCH message to their neighbors that are further away from the BS (i.e. more hops to the BS). The BS shall generate MSH-CSCHs in the format shown in Table 3, including all of the following parameters:

Flow Scale
Determines scale of the granted bandwidth

NumAssignments
Number of 8-bit assignment fields followed

UpstreamAssignment
Base of the granted bandwidth as bits/s for the ingress traffic of the node in the BS's routing tree

DownstreamAssignment
Base of the granted bandwidth as bits/s for the egress traffic of the node in the BS's routing tree

The actual granted bandwidth shall be calculated as

BW = **UpstreamAssignment** * ($2^{\mathbf{FlowScale}}$), for ingress traffic
BW = **DownstreamAssignment** * ($2^{\mathbf{FlowScale}}$), for egress traffic

The nodes in the list are ordered according to a (higher-layer) routing protocol's ordering of the current routing tree to and from the BS, known to all nodes in the network.

Table 2—MSH-CSCH Message Format

Syntax	Size	Notes
MSH-CSCH_Message_Format() {		
Generic_MAC_Header()	48 bits	
Management Message Type = TBD	8 bits	
Flow Scale	4 bits	
NumAssignments	8 bits	
for (i=0; i< NumAssignments; ++i) {		
UpstreamAssignment	4 bits	
DownstreamAssignment	4 bits	
}		
}		

6.2.2.4.35 Mesh Network Configuration (MSH-NCFG) Message

Mesh Network Configuration (MSH-NCFG) messages provide a basic level of communication between nodes in different nearby networks whether from the same or different equipment vendors or wireless operators. All the nodes (BS and SS) in the mesh network shall transmit MSH-NCFGs as described in clause [REF]6.2.7.6.1.1.4.

Table 3—MSH-NCFG Message Format

Syntax	Size	Notes
MSH-DSCH_Message_Format() {		
Generic_MAC_Header()	48 bits	
Management Message Type = TBD	8 bits	
Frame Number	12 bits	
Hop Number	4 bits	
Sequence	8 bits	
Net Entry Address	32 bits	
Power & antenna	4 bits	
Channel	4 bits	
Next Xmt Time	5 bits	
Xmt Holdoff	3 bits	

Table 3—MSH-NCFG Message Format

Syntax	Size	Notes
NumFullNbrEntries	4 bits	
NumCompNbrEntries	4 bits	
for (i=0; i< NumFullNbrEntries; ++i) {		
Nbr MAC Adr	32 bits	
Node Identifier	8 bits	
Nbr Link Info	24 bits	
}		
for (i=0; i< NumCompNbrEntries; ++i) {		
Node Identifier	8 bits	
Nbr Link Info	24 bits	
}		

All the nodes shall generate MSH-NCFGs in the format shown in Table 4, including all of the following parameters:

Frame Number
Incremental counter identifying the MAC frame
Hop Number
Indicates the number of hops to the BS
Sequence
Sequence number used by neighbors to detect missed transmissions
Net Entry Address
MAC address of the new node which this node is supporting in entering the network, or 0xFFFFFFFF if a neighbor node is either entering the network or sponsoring a network entry, or 0x00000000 if no nearby node is attempting to enter the network
Power & antenna
Transmit power & antenna settings used for this message
Channel
The base channel being used in this node’s network
Next Xmt Time
This node’s next transmission time for MSH-NCFG
Xmt Holdoff
This node’s transmit holdoff delay (rounded up to the nearest compressed value)
NumFullNbrEntries
Number of entries in the list of full neighbor information
NumCompNbrEntries
Number of entries in the list of compressed neighbor information

The list of neighbors is selected in a round-robin manner from the node’s 1-hop neighbors. The neighbor entries shall include the following parameters:

Nbr MAC Adr
32-bit MAC address, present only in full neighbor information list
Node Identifier

This node's neighbor ID for this physical neighbor

Nbr Link Info

Contains precise information about link status and quality. Consists of several subfields and the format described below.

A node shall generate **Nbr Link Info** field in the format shown in Table 5, including all of the following subfields:

Xmt Holdoff Time

The holdoff time for this neighbor

The **Xmt Holdoff Time** transmitted in the packet shall be quantized to 3 bits with a range of 16 to 2048 MSH-NCFG transmission opportunities, using the following formula (where x is the value transmitted in the packet):

$$\text{Xmt Holdoff Time} = 2^{(x + 4)}$$

Next Xmt Time

The next transmit time for this neighbor

Next Xmt Time shall be compressed in MSH-NCFG packets to 5 bits giving the **Next Xmt Time** "block." The block size is the number of MSH-NCFG opportunities and is related to the value of "x" used in the corresponding Xmt Holdoff Time by the following formula:

$$\text{Next Xmt Time Block Size} = 2^{x}$$

So, if x equals 0 (corresponding to a Xmt Holdoff Time of 16), then the block size is 1 and the **Next Xmt Time** value indicates the actual Next Xmt Time opportunity. If x equals 1, then the block size is two, and the **Next Xmt Time** actual refers to two possible transmit opportunities given by the value passed in the **Next Xmt Time** field times two, and that value plus 1.

For the above scheduling and Mesh Election algorithm, a neighbor node should be considered to be transmitting for any MSH-NCFG opportunity within its Next Xmt Time block. If the Next Xmt Time field is set to 0x1F (all ones), then the neighbor should be considered to be transmitting from the time indicated by this value and every MSH-NCFG opportunity thereafter.

Propagation delay

The propagation delay estimate for this neighbor in time slots

Rcv Link Quality

Measure of the receive link quality from this neighbor

Rcv PHY

PHY mode for this neighbor to use for initial packet transmissions over this link

Rcv Xmt Power

The transmit power for this neighbor to use for this link

Reserved

Reserved for future use, set to 0

Table 4—Contents of the “NBR Link Info” Field

Syntax	Size	Notes
Next Xmt Time	5 bits	
Xmt Holdoff Time	3 bits	
Propagation Delay	4 bits	
Rcv Link Quality	4 bits	
Rcv PHY	3 bits	
Rcv Xmt Power	3 bits	
Reserved	2 bits	Set to 0

The following procedure is used to select the list of physical neighbors to report in the compressed neighbor section of the MSH-NCFG message:

- Any neighbors reported in the round-robin (full neighbor entry) list are excluded.
- All neighbor entries with the “Reported Flag” set are excluded.
- The remaining neighbor entries are ordered by the **Next Xmt Time**, and the NumCompNbrEntries entries with the **Next Xmt Time** the furthest in the future are reported in this MSH-NCFG packet. (In general, learning of nodes with **Next Xmt Times** furthest into the future is more valuable than learning of nodes with **Next Xmt Times** approaching soon, since the neighbors will have more time to use this ineligibility information before it’s stale.)

The “Reported Flag” for all neighbors in either of the above neighbor lists is set to TRUE upon transmission of this MSH-NCFG packet.

6.2.2.4.36 Mesh Network Entry (MSH-NENT) Message

Mesh Network Entry (MSH-NENT) messages provide the means for a new node to gain synchronization and initial network entry into a mesh network. The MSH-NENT message format is given in Table 6, including all of the following parameters:

Frame Number
Incremental counter identifying the MAC frame

Hop Number
Indicates the number of hops to the BS

Sponsor Address
Address of sponsor node

Sequence
Sequence number used by neighbors to detect missed transmissions

Release Flag
Set to 1 for the final MSH-NENT packet transmitted by this node at the completion of the network entry process

Xmt Power
Transmit power used for this message

Reserved
Reserved for future use, set to 0

Table 5—MSH-NENT Message Format

Syntax	Size	Notes
MSH-DSCH_Message_Format() {		
Generic_MAC_Header()	48 bits	
Management Message Type = TBD	8 bits	
Frame Number	12 bits	
Hop Number	4 bits	
Sponsor Address	32 bits	
Sequence	8 bits	
Release Flag	1 bit	
Xmt Power	3 bits	
Reserved	4 bits	Set to 0
}		

6.2.2.4.37 Mesh Centralized Request (MSH-CRQS) Message

SSs in mesh network can use Centralized Request (MSH-CRQS) messages to request bandwidth from the BS. The de-centralized requests and request distribution also use the MSH-CRQS message format. Each node reports the individual traffic demand requests of each “child” node in its subtree from the BS. The nodes in the subtree are those in the current routing tree to and from the BS, known to all nodes in the network, and ordered by address. The MSH-CRQS message format is given in Table 7.

Table 6—MSH-CRQS Message Format

Syntax	Size	Nodes
MSH-DSCH_Message_Format() {		
Generic_MAC_Header()	48 bits	
Management Message Type = TBD	8 bits	
Usage	4 bits	
Flow Scale	4 bits	
NbrDemands	8 bits	
for (i=0; i< NbrDemands; ++i) {		
UpstreamRequest	4 bits	
DownstreamRequest	4 bits	
}		
}		

The parameters in the message are:

Usage
0=Request message to the BS when using centralized or decentralized scheduling
1=Request message summary from the BS when using decentralized scheduling
Flow Scale
Determines scale of the requested bandwidth
NbrDemands
Number of entries in the list of demands followed
UpstreamRequest
Base of the requested bandwidth as bits/s for the ingress traffic
DownstreamRequest
Base of the requested bandwidth as bits/s for the egress traffic

The actual requested bandwidth shall be calculated as

BW = **UpstreamRequest*** ($2^{\textbf{Flow Scale}}$), for ingress traffic
BW = **DownstreamRequest***($2^{\textbf{Flow Scale}}$), for egress traffic

Comment 3:

6.2.7.6.1.1.4 Mesh Mode Schedule Relevance and Synchronization

Only TDD is supported in mesh mode. On contrary to the basic P-MP mode, there are no clearly separate downlink and uplink subframes in the mesh mode. Stations shall transmit to each other either in scheduled channels or in random access channels just like in P-MP mode. The basic frame structure is also similar to the one in P-MP mode.

In all scheduling modes, transmission scheduling obeys the following frame structure:

- Time is divided into physical slots of duration 2^X microseconds (X integer).
  Using 20 MHz channelization, the default slot duration (T_{dslot}) is 32 microseconds.
  Using 10 MHz channelization, the default slot duration (T_{dslot}) is TBD microseconds.
- Slots are then grouped into frames of length 256 slots.
- Frames are further grouped into super-frames of length 2048*T_{dslot} microseconds[1].
  Using 20 MHz channelization, the super-frame length is 65536 microseconds, fitting 8 default frames.
  Using 10 MHz channelization, the super-frame length is TBD microseconds, fitting 8 default frames.
- For the first frame in each super-frame, the period of 32*T_{dslot} at the start of the frame form the control portion of the frame and super-frame. This control period is used for the network configuration packets detailed in clause [REF]6.2.2.4.35.
- For other frames, the first N_{slot} (integer) slots of each frame constitute the "control" portion of the frame (or "control slots"). The default size of the control portion (N_{dslot}) of the frame is 32 slots.
- The remaining (non-control) slots in each frame (256-N_{slot}) constitute the "data" portion of the frame, or the "data slots."
- The control portion of frames other than those at the start of the super-frame may be used for the transmission of distributed and centralized scheduling control packets.
- In all scheduling modes, data packets are scheduled for transmission during the data portion of the frame.

The precise frame structure (e.g., number of microseconds per slot, number of slots in a frame) may vary as a configuration option, but shall be static during normal system operation.

6.2.7.6.1.1.4.1 Physical Neighborhood List

All the basic functions like scheduling and network synchronization are based on the neighbor information all the nodes in the mesh network shall maintain. Each node (BS and SS) maintains a physical neighborhood list with each entry containing the following fields:

MAC Address
32-bit MAC address of the neighbor

Distance
Indicates distance in hops of this neighbor from the present node. If a packet has been successfully received from this neighbor recently (defined further below), it is considered to be 1 hop away.

Node Identifier
8- or 16-bit Number used to identify this node in a more efficient way in MSH-NCFG messages.

Xmt Holdoff Time
The minimum number of frames between MSH-NCFG message transmissions by this node

Next Xmt Time
The super-frame and slot number before which this node is guaranteed not to transmit a MSH-NCFG message. This is initialized to MSH_NEXT_XMT_TIME_NOW. As part of the Aging procedure, and to avoid roll-over problems, this **Next Xmt Time** is also reset to this value whenever this **Next Xmt Time** plus the node's **Xmt Holdoff Time** is equal to or less than the current time.

Earliest Subsequent Xmt Time
The earliest time that this neighbor can transmit its subsequent MSH-NCFG message (following the node's **Next Xmt Time**).

Reported Flag
Set to TRUE if this **Next Xmt Time** has been reported by this node in a MSH-NCFG packet. Else set to FALSE.

1. The super-frame length is fixed to ensure interoperability of network configuration packets between mesh systems.

For direct (one-hop) neighbors the Node Identifier field shall contain:

Nbr ID
8-bit number indicating the neighbor number which this node has assigned to this neighbor

For indirect (two-hop) neighbors the Node Identifier field shall contain:

Rep ID
Nbr ID for the neighbor that is reporting this two-hop neighbor
Rep Nbr ID
The **Nbr ID** used by the direct (reporting) neighbor to identify this two-hop neighbor node

6.2.7.6.1.1.4.2 Schedule Relevance with Distributed Scheduling

When using coordinated distributed scheduling all the stations in a network shall use the same channel to transmit schedule information in a format of specific resource requests and grants in Mesh Mode Schedule Messages with Distributed Scheduling (MSH-DSCH). A station shall indicate its own schedule by transmitting a MSH-DSCH regularly. The MSH-DSCH messages shall be transmitted during the control portion of the frame. Relevance of the MSH-DSCH is variable and entirely up to the station. An example case is given in Figure 1, in which super-frame size of eight frames has been assumed.

MSH-DSCH messages are transmitted regularly throughout the whole mesh network to distribute nodes' schedules and (together with network configuration packets) provide network synchronization information. A SS that has a direct link to the BS shall synchronize to the BS while a SS that is at least two hops from the BS shall synchronize to its neighbor SSs that are closer to the BS.

The control portion of the first frame in each super-frame is reserved for communication of mesh network configuration packets (MSH-NCFG), as detailed in clause [REF]6.2.2.4.35. The MSH-NCFG packets shall be used to convey information about network status and configuration such as:

1) Synchronization across multiple mesh networks,
2) Communication of channels in use across multiple networks, and
3) Support of network entry for new or mobile nodes.

6.2.7.6.1.1.4.3 Schedule Relevance with Centralized Scheduling

When using centralized scheduling the BS shall act as a centralized scheduler for the SSs within a certain hop range ($HR_{threshold}$) from the BS. The BS shall control all the scheduled transmissions for the SSs less than or equal to $HR_{threshold}$ hops from the BS.

While in distributed scheduling mode all the stations within each two-hop neighborhood shall exchange their schedules in MSH-DSCH messages, in centralized scheduling mode the BS shall indicate all the SSs less than or equal to $HR_{threshold}$ hops from the BS their schedule. BS shall use the Mesh Mode Schedule Messages with Centralized Scheduling (MSH-CSCH) message for that purpose. The MSH-CSCH shall apply to a certain fixed period called an Epoch. An Epoch consists of a variable number of frames. The number of frames in an epoch can be configured during system installation, and can occasionally adapt due to considerations like network size, but shall generally remain static during system operation. This is illustrated in Figure 2, in which an Epoch consists of four frames and a super-frame is equal to eight frames. One should note, that the figure doesn't show messages like MSH-CRQSs required for the successful scheduling. Further, it's a simplified snapshot from the BS's perspective: no MSH-CSCH messages forwarded by the SSs in the network are shown in the figure.

The BS determines the schedule from the resource requests received from the SSs within the $HR_{threshold}$ hop range. Intermediate SSs are responsible for forwarding these requests for SSs that are further from the BS (i.e. more hops from the BS) as needed. Thus the BS acts just like the BS in P-MP network except that not all the SSs have to be directly connected to the BS and the schedule determined by the BS extends to also those SSs that are not directly connected to the BS but less than or equal to $HR_{threshold}$ hops from it. All the SSs within the $HR_{threshold}$ hop range shall listen and install the schedule for the next Epoch indicated in the MSH-CSCH message. Further, they shall forward the MSH-CSCH message to their neighbors that are further away from the BS.

Additionally, as with distributed scheduling, the control portion of the first frame in each super-frame is reserved for communication of mesh network configuration packets (MSH-NCFG).

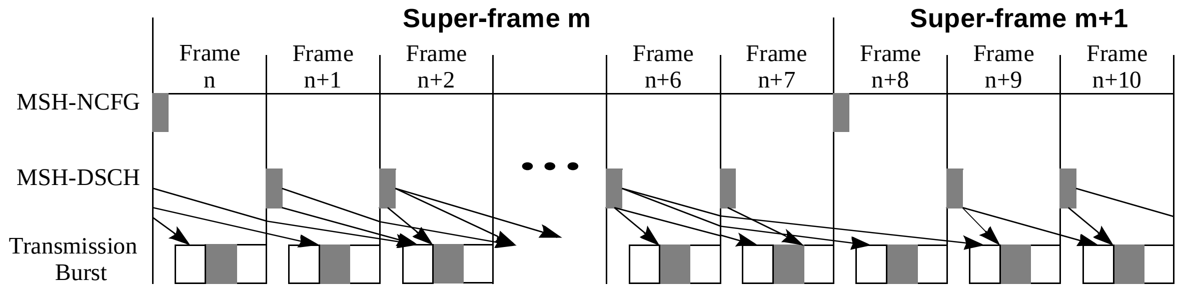

Figure 1—Time Relevance of MSH-DSCH in Distributed Scheduing Mode

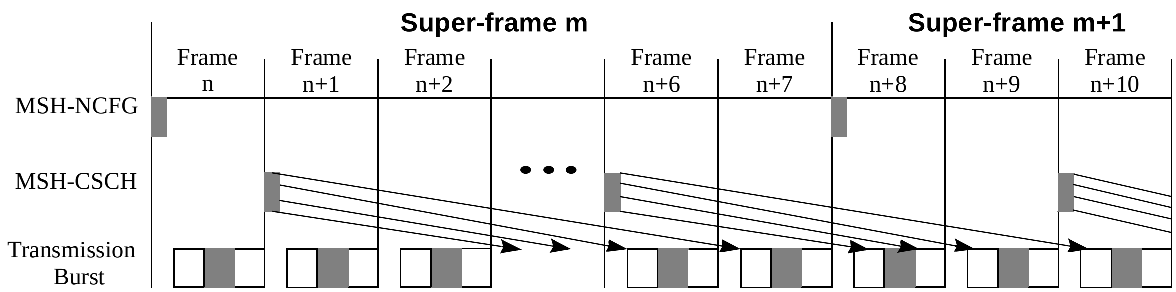

Figure 2—Time Relevance of MSH-CSCH in Centralized Scheduing Mode

6.2.7.6.1.1.4.4 Mesh Network Synchronization

Network configuration (MSH-NCFG) and network entry (MSH-NENT) packets provide a basic level of communication between nodes in different nearby networks whether from the same or different equipment vendors or wireless operators. This communication is used to support basic configuration activities such as:

1) synchronization between nearby networks used, for instance, for multiple, co-located BSs to synchronize their upstream and downstream transmission periods,
2) communication and coordination of channel use by nearby networks, and
3) discovery and basic network entry of new nodes.

MSH-NCFG/MSH-NENT Transmission Timing

MSH-NCFG and MSH-NENT packets are scheduled for transmission during the control portion of the first frame in each super-frame. So that all nearby nodes receive these transmissions, the channel used is cycled through the available channels in the band, with the channel selection being based on the super-frame number. So, for super-frame number i, the channel is determined by the array lookup:

netConfigChannel = channelList[i % channelListLen];

Where the channelList and channelListLen are configuration parameters, which shall be the standard channel selections for the band.

- MSH-NCFG and MSH-NENT packets are transmitted at the most robust modulation level. With 20 MHz channelization the default duration of the control portion of the frame used for MSH-NCFG and MSH-NENT packets is $32*T_{dslot}$ = 1,024 microseconds. This is divided as follows:
- 256 microseconds reserved for the changing to the netConfigChannel channel[1]
- 144 microseconds reserved for MSH-NENT “network entry” transmissions by new nodes with transmission of preamble commencing at 280 microseconds into the frame.
- 184 microseconds for first opportunity for MSH-NCFG transmissions by other nodes with transmission of preamble commencing at 416 microseconds into the frame.
- 184 microseconds for second opportunity for NetConfig transmissions by other nodes, with transmission of preamble commencing at 600 microseconds into the frame.
- 256 microseconds reserved for returning to the appropriate network channel.

For other channelization schemes both the duration of the control portion of the frame and its subparts shall be determined accordingly.

MSH-NCFG Reception Procedure

When a MSH-NCFG packet is received from a neighbor, the following is performed:

- The distance of the transmitting node is updated to 1-hop (direct) if necessary.
- For each node reported in this packet which is not a direct 1-hop neighbor, the distance to the reported node is updated to 2.
- The **Next Xmt Time** and **Xmt Holdoff Time** of the transmitting node and all reported nodes are updated. Also, the Earliest Subsequent Xmt Time is updated to equal the neighbor’s **Next Xmt Time** plus its **Xmt Holdoff Time**.
- If any reported neighbor is found with a **Next Xmt Time** equal to the present node’s **Next Xmt Time**, then the MSH_SKIP THIS NCFG_XMT flag is set. (This could occur as a transient condition with topology changes due to channel dynamics or mobility.)
- The “Reported Flag” for each entry in the Physical Neighbor Table which was modified is set to FALSE.

If the Node Identifier for any reported node in the compressed neighbor list cannot be resolved to a neighbor entry (with MAC address) using the information in the Physical Neighbor Table (see clause 6.2.7.6.1.1.1), then the corresponding neighbor entry is skipped.

Comment 4:

6.2.8.13 Network Entry Procedure in Mesh mode

A new node entering the mesh network obeys the following procedure.

- The new node listens to the channel for a MSH_NET_ENTRY_INITIAL_LISTEN period to overhear a number of MSH-NCFG packets in order to build the node’s physical neighbor table, to select a sponsor node based on

1. If the particular equipment requires more time than this to change the channel, then it will need to schedule for the channel change to commence at the appropriate time during the previous frame. A similar statement applies to the channel change required at the end of the MSH-NCFG control slots.

receive signal quality, and to gain coarse network synchronization using a received MSH-NCFG packet from the selected sponsor.

- The new node transmits a MSH-NENT packet which includes the selected sponsor node's address.
  - If the selected sponsor does not advertise the new node's address in the sponsor's next MSH-NCFG transmission, then the procedure is repeated MSH_SPONSOR_ATTEMPTS times using a random backoff between attempts.
    - If these attempts all fail, then a different sponsor is selected and the procedure repeated (including reinitializing coarse network synchronization).
- If the sponsor advertises this new node's address in its next MSH-NCFG packet, then the sponsor will also include the link information for this new node in the packet's complete neighbor info list, which includes the propagation delay estimate.
- The new node shall adjust its network clock by subtracting half of the propagation delay reported in the packet.
- If the reported propagation delay was not the maximum value (0xF), then network synchronization has been achieved, and the new node may participate in transmission of MSH-NCFG packets and is ready for higher-layer network entry procedures if any. Otherwise, the node remains in coarse synchronization and shall repeat the above network time correction handshake with the sponsor node.