

IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)	
Title	MSCs Incorporating New FC SL/DME/MLME Functional Division and Imm-ACK Removal	
Date Submitted	[15 July, 2004]	
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Re:	[]	
Abstract	[This document contains a list or proposed changes to IEEE Std 802.15.3.]	
Purpose	[The purpose of this document is to propose changes to IEEE Std 802.15.3 to improve compatibility, performance and clarity in the standard.]	
Notice	This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.	
Release	The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.	

1. Introduction

This document presents new clause 8 MSCs resulting from Imm-ACKs no longer being used as confirmation commands as presented in 04/202r0 and with the following functional division as defined in the May 2004 802.15.3b meeting.

Note: The italicized items have been moved or renamed since the May 2004 meeting.

FCSL/PAL

- Map Upper layer identifier (e.g., MAC address) to DEVID for data frames
- Maintain List of available DEVs
- Map upper layer stream IDs to 15.3 indices
- Pass data to MAC
- Fragmentation
- Maintain list of DEVIDs
- *Convert Async Data to MAC SAP Async Data Requests*
- Rate adjustment decisions

DME

- Master MAC Address - DEVID table
- Stream index only
- Start/Stop scan
- Associate/disassociate
- Track Security Problems
- Determine PM Mode
- Convert stream requirements to CT requests
- Determine when to scan and process results
- *KOME (Key originator management entity)*
- *Change Data keys*

PNC DME (PME)

- Select Piconet channel

- Associate/disassociate DEVs
- Handover
- Scan for interference
- Start/stop network (including child/neighbor)
- Change PNID/BSID
- Maintain list of associate DEVs
- Allocate channel time
- Track PM DEVs
- Change Superframe Duration
- Change Superframe Location

MAC/MLME

- DEVID and Stream Index only
- Data queues
- 15.3 Fragmentation/Reassembly
- ACKs
- On-air timing – data, command, beacon
- Keep data and management keys (because this is where encryption happens)
- Secure frame processing
- Channel quality (e.g. FER and retry), TX power adaptation
- Perform scan and report capacity (status, scan)
- Rate adaptation implementations (affects CTAs)
- Identify current Piconet (BSID, PNID and PNC MAC address)
- Prepare Async CTRq's and tracks async. time requirements.
- *Manage ATP to stay associated (DEV)*
- *Track ATPs for DEVs (PNC)*

2. Clause 8 MSC changes

2.1 Section purpose

This section shows through comparison how the MSCs in Clause 8 of IEEE 802.15.3 would need to be modified in order to support the changes suggested by this document.

The Figure numbers in this section represent Figure numbers from IEEE 802.15.3.

On each of the following pages in this section a version of an MSC as currently defined in IEEE 802.15.3 is shown on the left side of the page. The right side of each page shows the new suggested MSC, along with a list of the changes made to the original MSC to support the changes suggested by this document.

2.2 Strategies/Guidelines used

The following are the strategies and guidelines that were followed in the creation of the new MSCs presented in this section. This was done in an effort to have consistencies between all the frame exchanges sequences represented by the MSCs.

- Imm-ACK frames (part of the over-the-air retry mechanism) should not be used as management level confirmations because they are meaningless if security is used or if the standard is extended to support mesh networks.
- Although it is possible in some instances for a requesting DEV to confirm that a command was received via information transmitted in a beacon, a beacon can not be used as a confirmation when the request is denied. Furthermore, a response command typically contains more information than is put into a beacon. Therefore, Request commands are always acknowledged with response commands when a confirmation that the command was received and processed is necessary.

- If a DEV request results in a change to the overall piconet state, the other DEVs in the piconet are notified of the piconet state change via information broadcast in a beacon.
- The start Beacon timer symbol (shown below) indicates that starting of the continuously running Beacon timer at a rate equal to the current superframe duration.



- The Beacon timer timeout symbol (shown below) indicates that the time to transmit a beacon has arrived. This timer is considered to be running continuously once a piconet is started. This timeout should be considered to occur “sometime in the future” with respect to previous information shown on the MSC.



- Scenarios identified as “fire and forget” can not be confirmed, so no timeout timer should be started and no MLME confirm primitive should be generated as part of the message exchange sequence.
- Specific information associated with an over-the-air command frame is only shown once on an MSC with the over-the-air command itself. It can be assumed that the information is also contained in the MLME request/response that caused the over-the-air command to be generated, and also in the MLME indication/confirm generated by the reception of the command.
- The first MSC in clause 8 (Figure 91) shows that the result code associated with an MLME confirm is always COMPLETED if the timeout timer associated with the original request does not timeout. Therefore, this information is not repeated in the MSCs.

2.3 The MSCs

Current

No Change

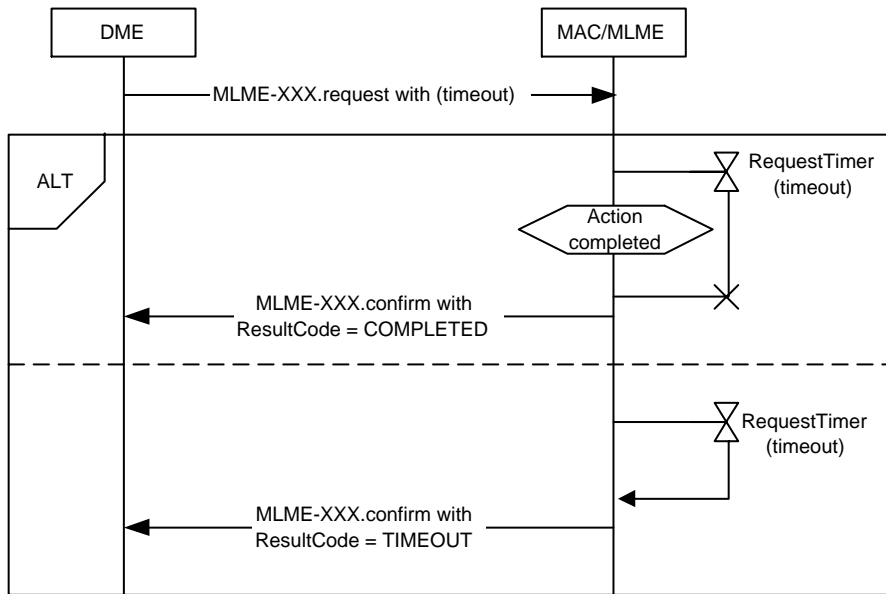


Figure 91 - MSC showing examples of primitive timers

Current

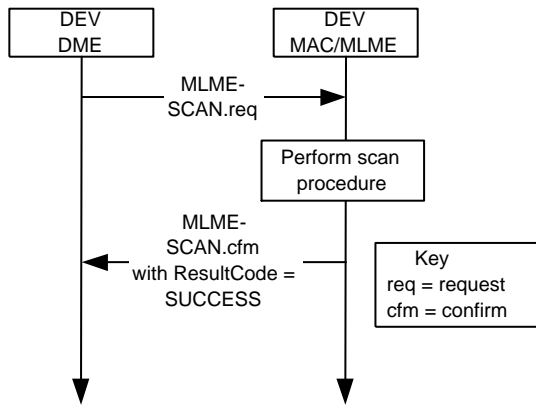


Figure 92 -MSC for scan operation

Suggested

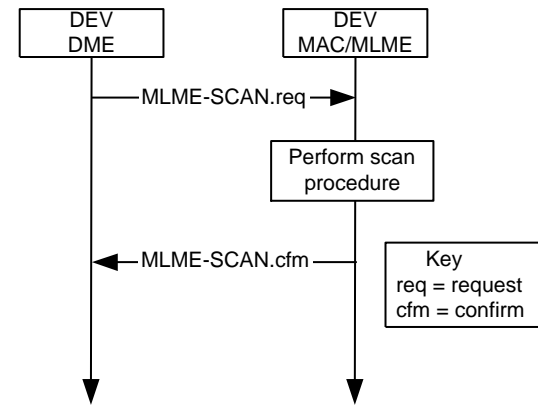


Figure 92 -MSC for scan operation

Current

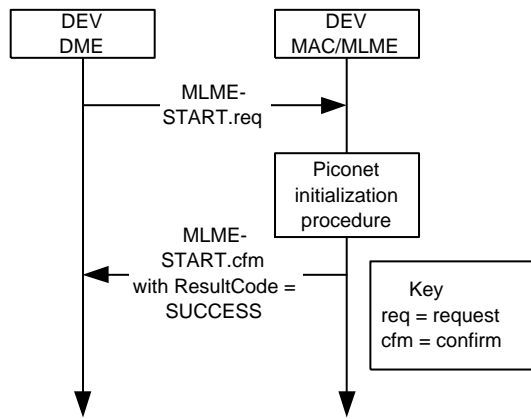


Figure 93 - MSC for starting a piconet

Suggested

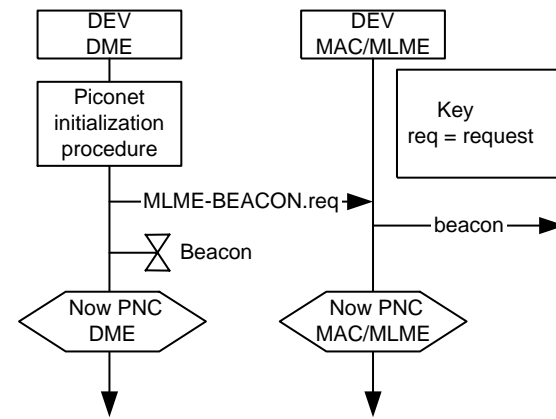


Figure 93 - MSC for starting a piconet

- The PME (PNC DME) maintains the information that is contained in a beacon so a MLME-START primitive is no longer needed because the PME can simply make a request to send a beacon when it is ready to start a piconet.
- MLME-BEACON is a new primitive with a “request” component to request the transmission of a beacon frame and a “indication” component to indicate the arrival of a beacon frame.
- When a piconet is started, a Beacon timer is required for transmitting beacons at the superframe interval.

Current

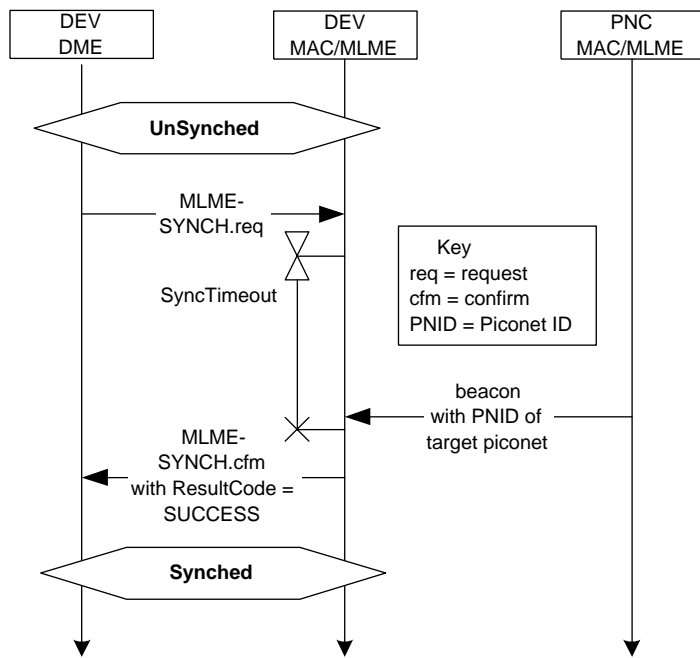


Figure 125 - MSC of a DEV synchronizing with a PNC

Suggested

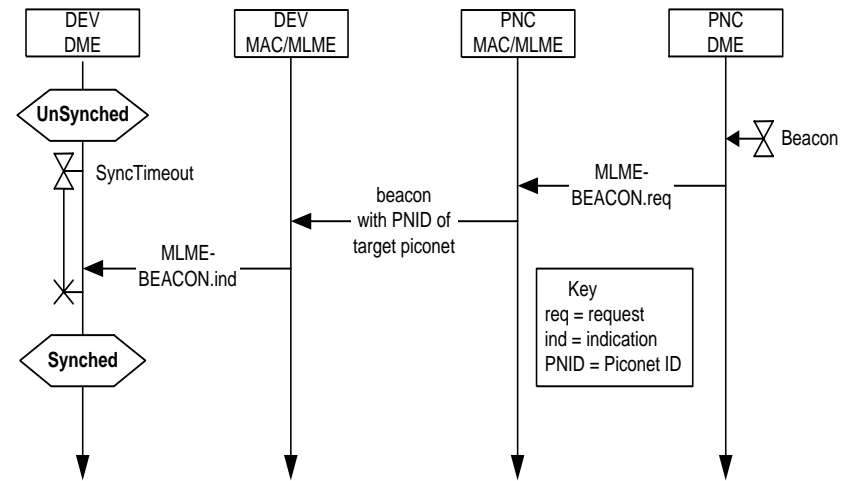


Figure 125 - MSC of a DEV synchronizing with a PNC

- DME can sync itself because it receives beacon indications. Therefore, MLME-SYNCH primitives are no longer needed.

Current

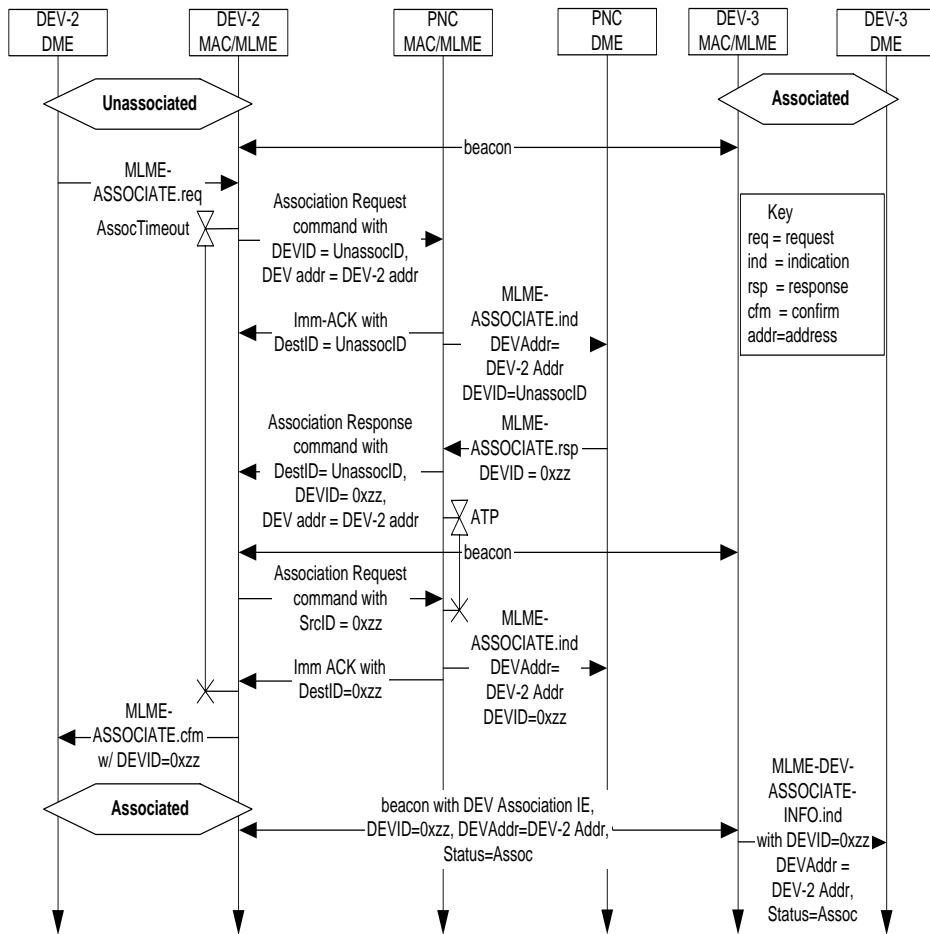


Figure 102 - MSC of DEV-2 associating

Suggested

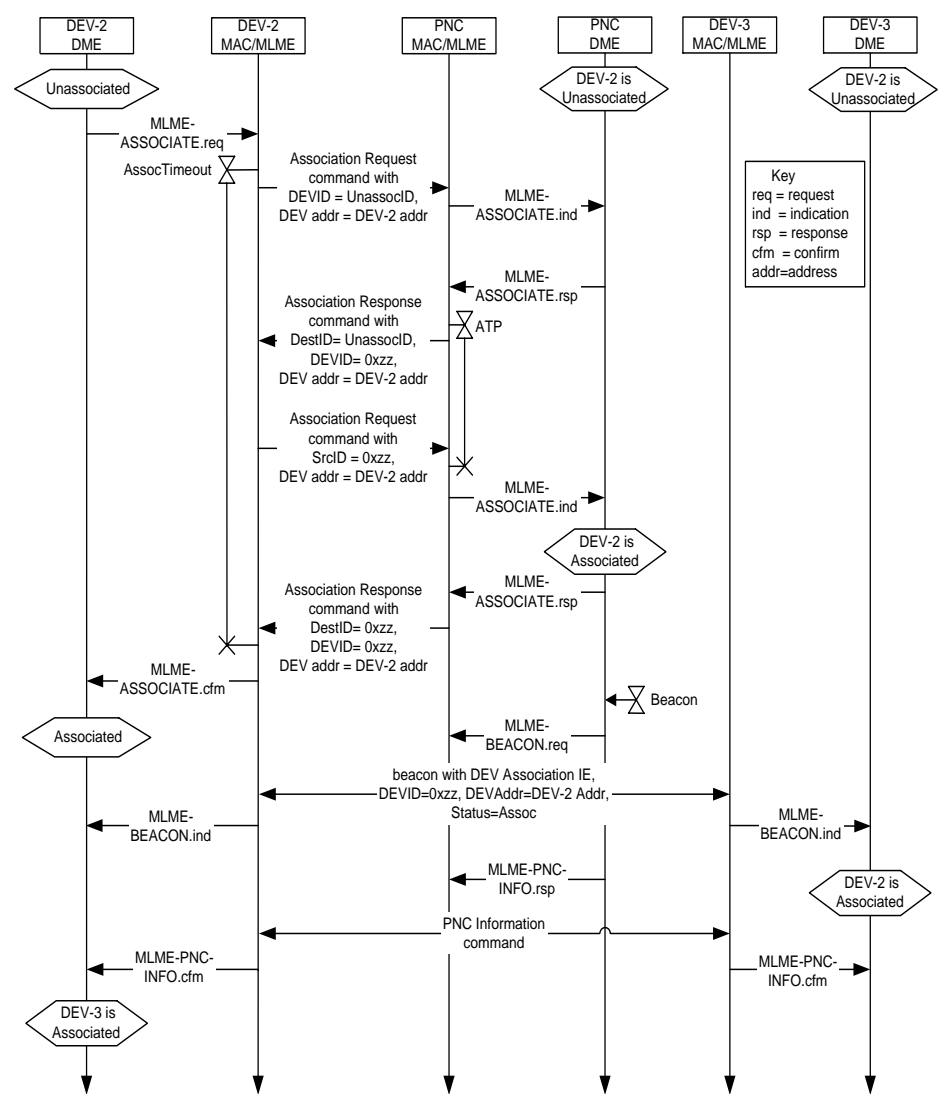


Figure 102 - MSC of DEV-2 associating

- Requesting DEV knows it is associated when it receives the second Association Response command. Other DEVs in the piconet know when they receive a beacon with a DEV Association IE. The associating DEV learns of other DEVs via the PNC Information command.

Current

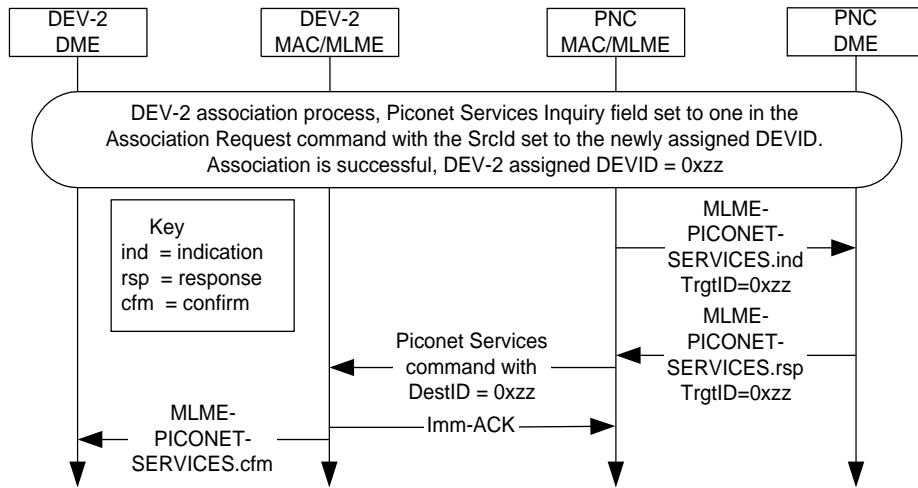


Figure 103 - PNC sending the Piconet Services command to a newly associated DEV in response to a request in the association process

Suggested

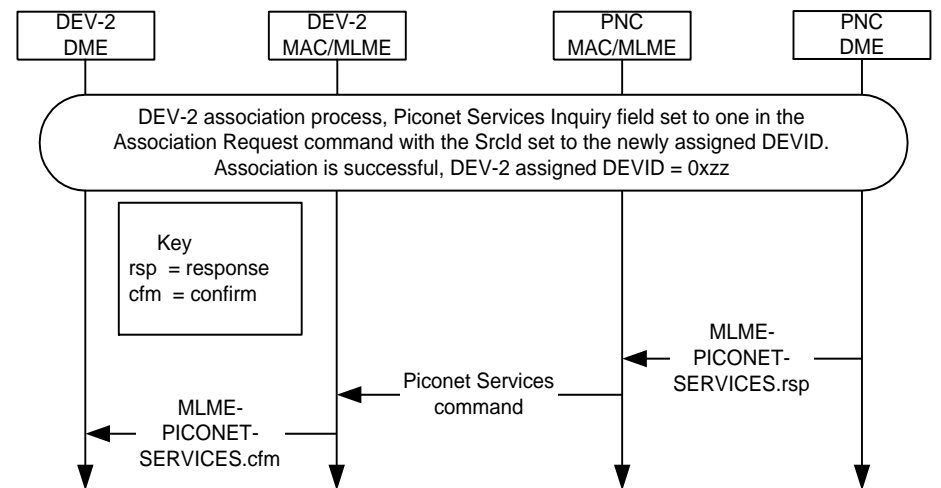


Figure 103 - PNC sending the Piconet Services command to a newly associated DEV in response to a request in the association process

- PME is aware when a DEV associates with the Piconet Services Inquiry field set therefore the PNC MAC/MLME does not need to send an indication to the PME.

Current

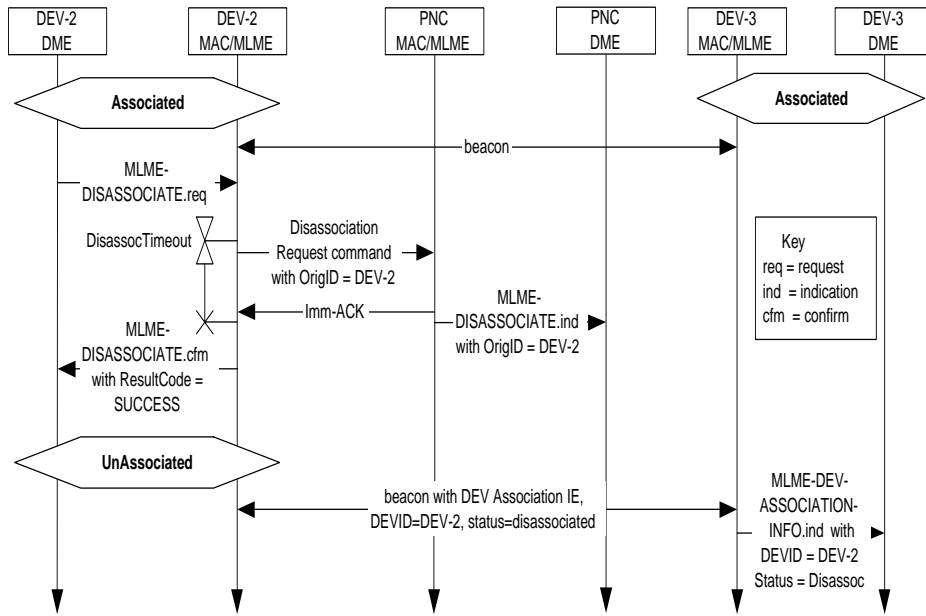


Figure 104 - DEV initiated disassociation MSC

Suggested

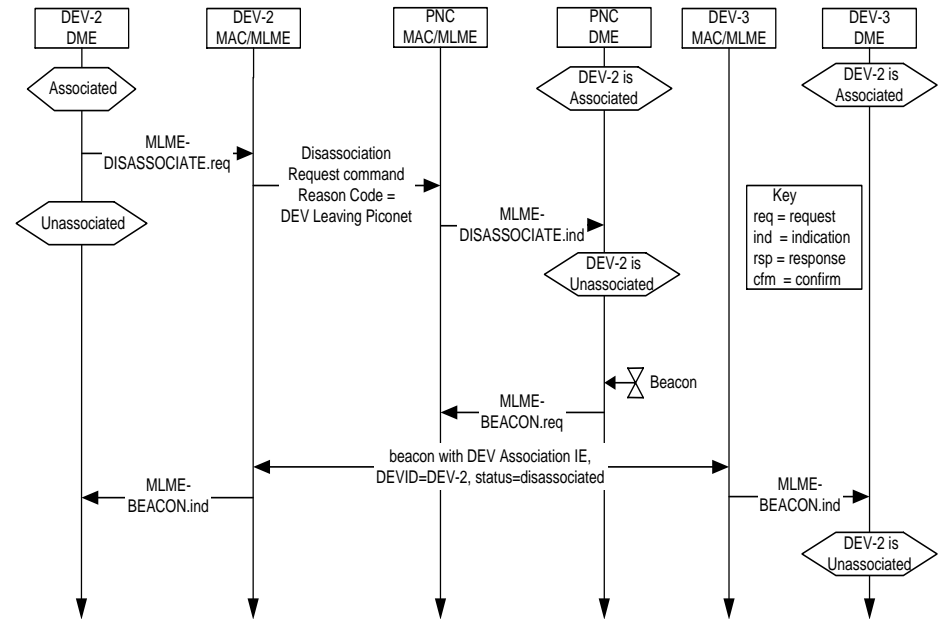


Figure 104 - DEV initiated disassociation MSC

- DEV initiated disassociation is a “fire and forget” scenario.
- Disassociating DEV can immediately mark itself as disassociated. Other DEVs know when they receive a beacon with a DEV Association IE.

Current

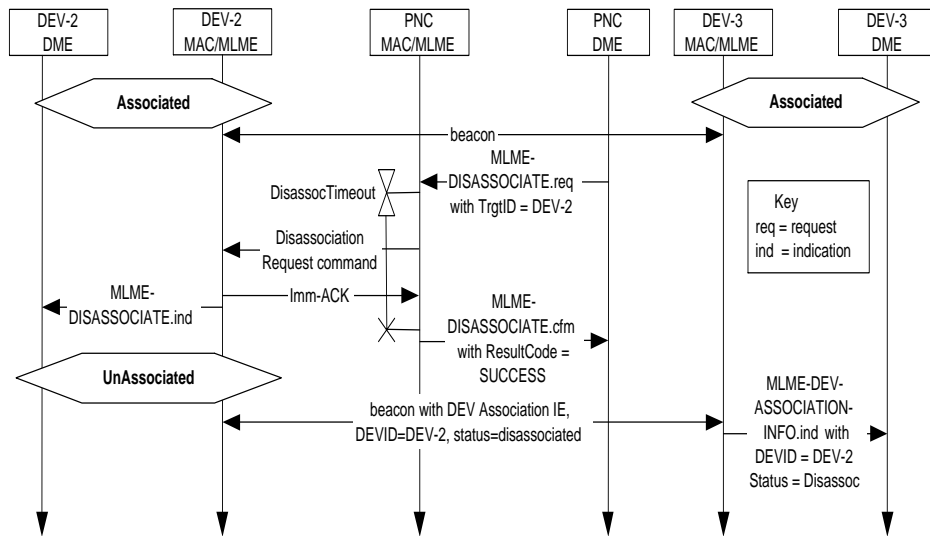


Figure 105 - PNC initiated disassociation MSC

Suggested

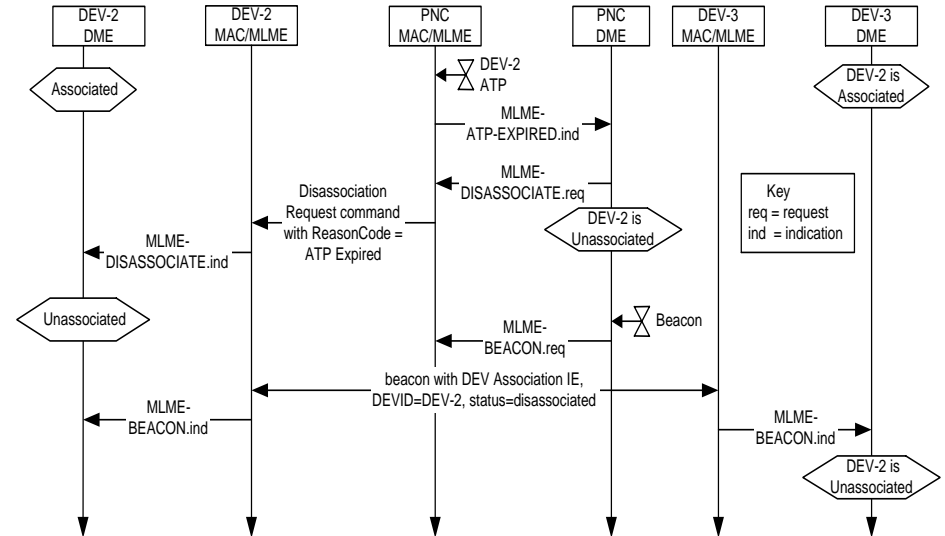
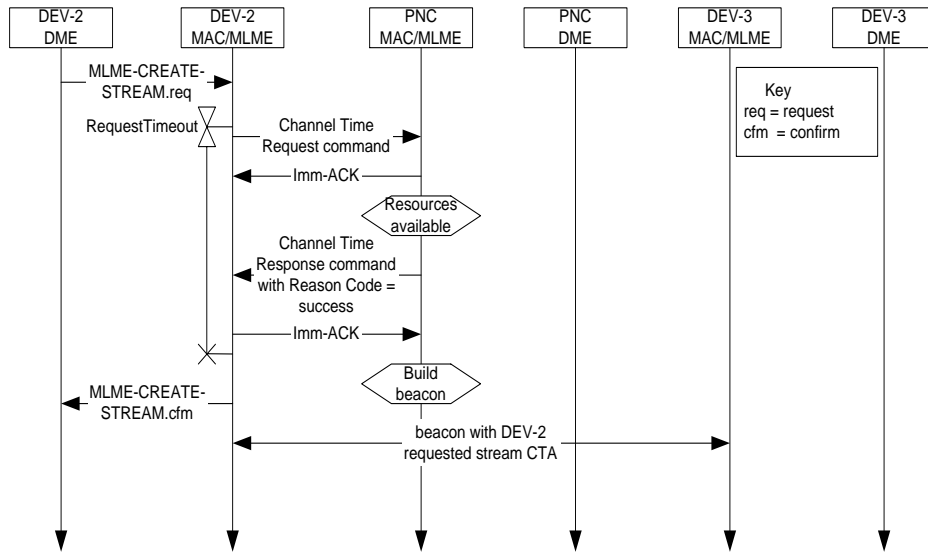


Figure 105 - PNC initiated disassociation MSC

- PNC initiated disassociation is a “fire and forget” scenario.
- DEV is disassociated when it receives a MLME-DISASSOCIATE.ind. Other DEVs know about the disassociation when they receive a beacon with a DEV Association IE.
- If a DEV receives a beacon with a DEV Association IE indicating it is disassociated, it should consider itself disassociated.
- Took opportunity to add MLME-ATP-EXPIRED.ind to at least one MSC (Note: MAC/MLME must maintain ATP timers because the DME does not see data frames.)

Current



Suggested

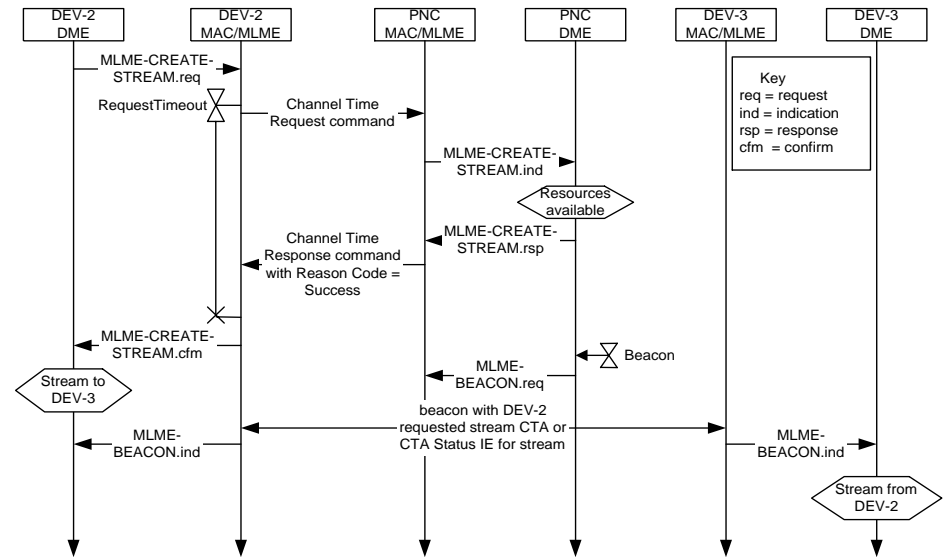


Figure 114 - MSC for creating a DEV-2 to DEV-3 stream

Figure 114 - MSC for creating a DEV-2 to DEV-3 stream

- PME is responsible for channel time allocation so MLME-CREATE-STREAM indication and response primitives are required.
- Requesting DEV knows stream is created when it receives the Channel Time Response command.
- Target DEV knows about the stream when it receives a beacon with a CTA or CTA Status IE indicating it is the target of a stream.

Current

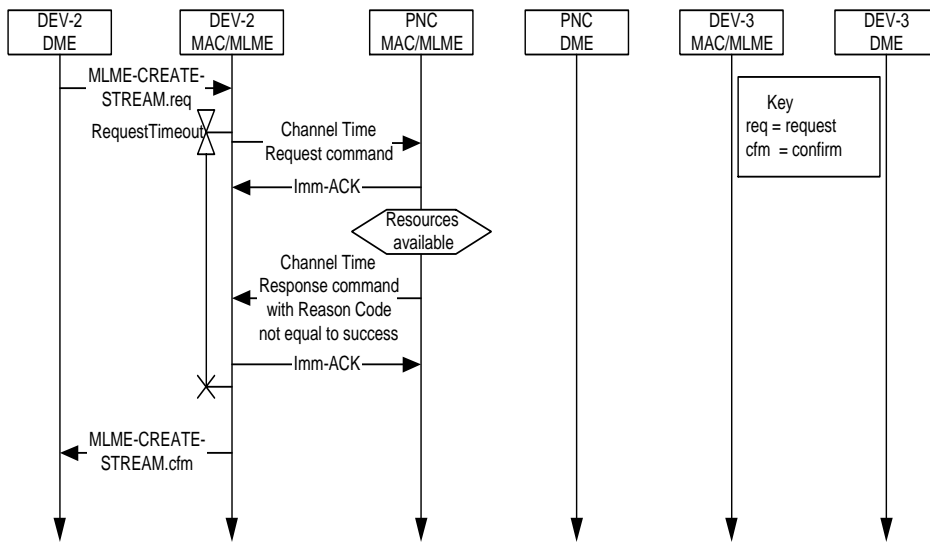


Figure 115 - MSC for a denied DEV-2 to DEV-3 stream

Suggested

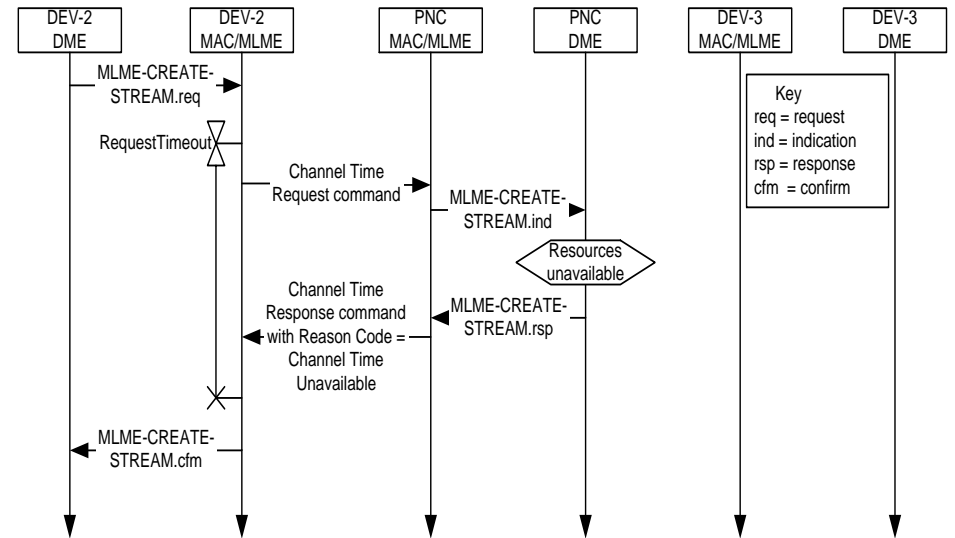
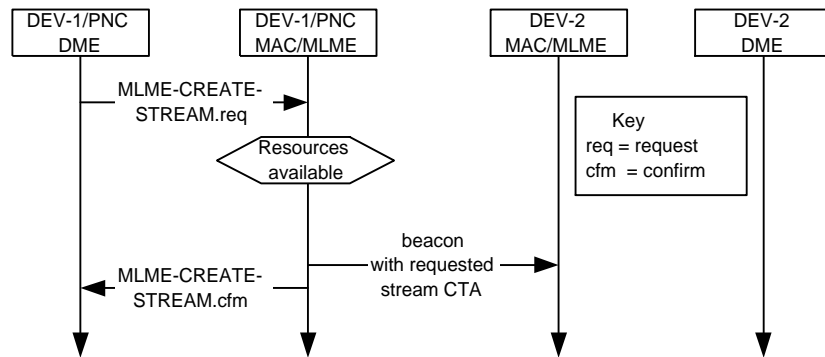


Figure 115 - MSC for a denied DEV-2 to DEV-3 stream

Current

Suggested



- Suggest removing this MSC and add text to standard that describes that the DEV component of the PNC does not send commands over the air when it wishes to communicate with the PME.

Figure 116 - MSC for creating a DEV-1/PNC to DEV-2 stream

Current

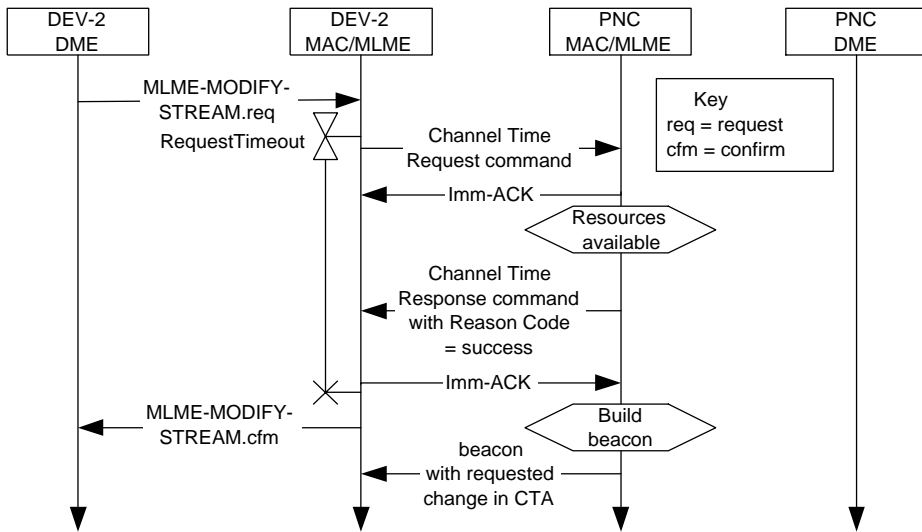


Figure 117 - MSC for modifying a stream

Suggested

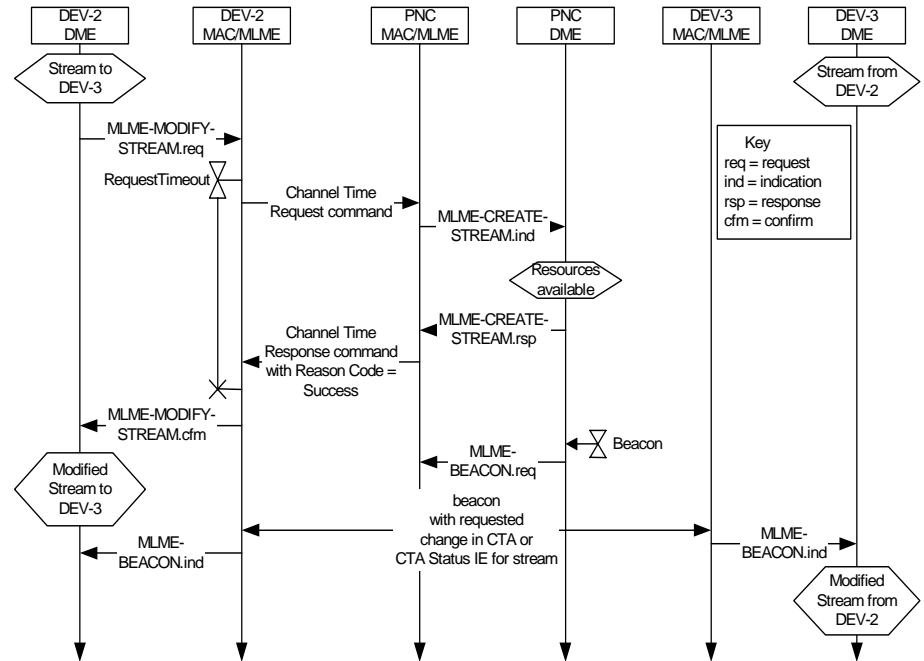
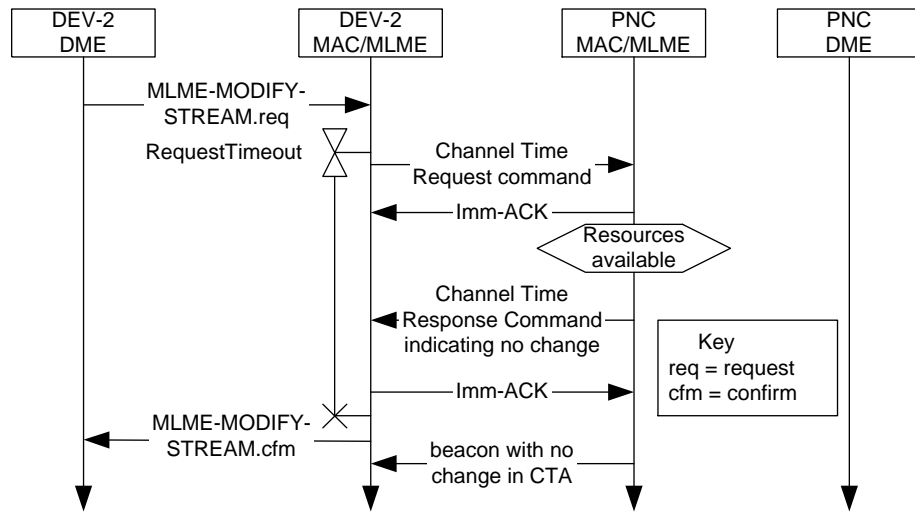


Figure 117 - MSC for modifying a stream

- Requesting DEV knows stream is modified when it receives the Channel Time Response command.
- Target DEV knows about the stream modification when it receives a beacon with a modified CTA or a CTA Status IE.

Current



Suggested

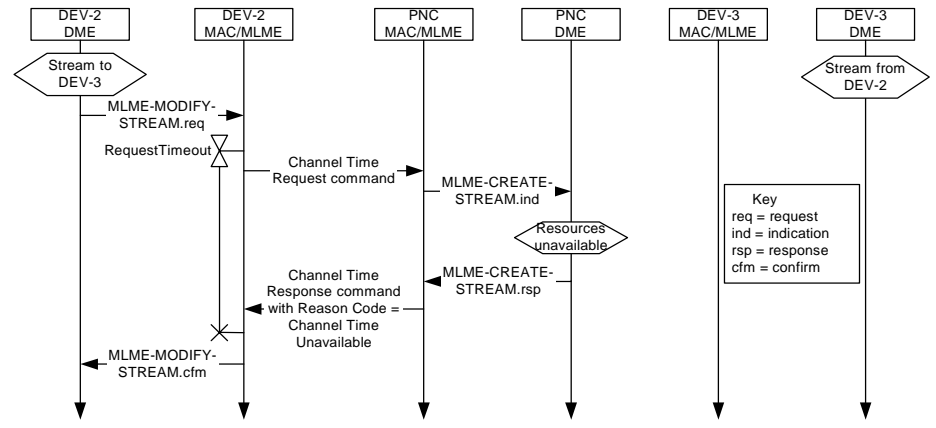


Figure 118 - MSC for a denied stream modification

Figure 118 - MSC for a denied stream modification

Current

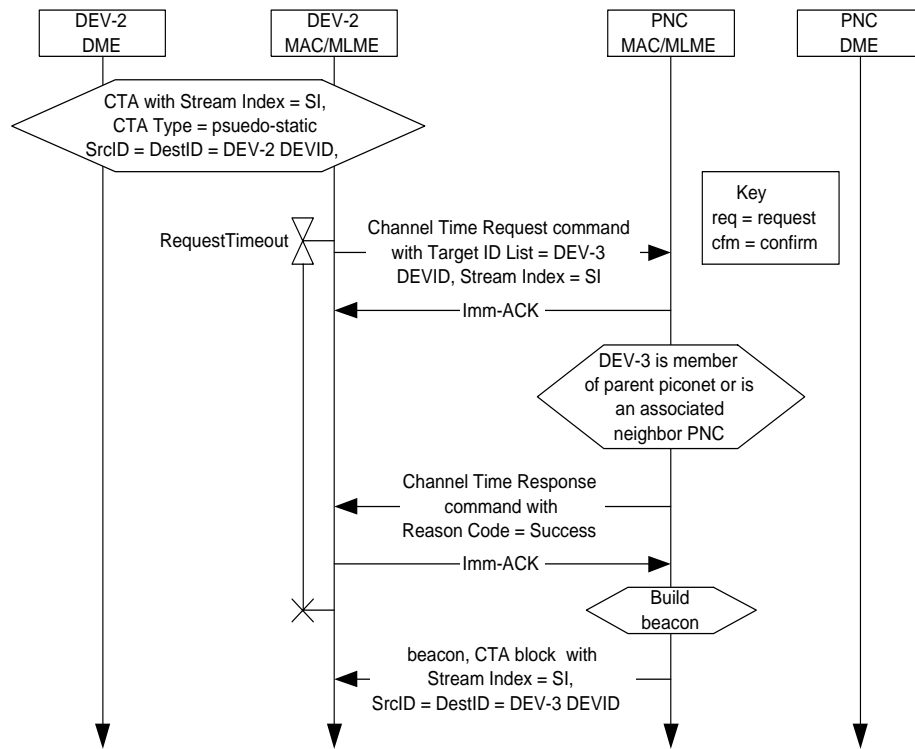


Figure 119 - MSC for the handing over control of a private, pseudo-static CTA

Suggested

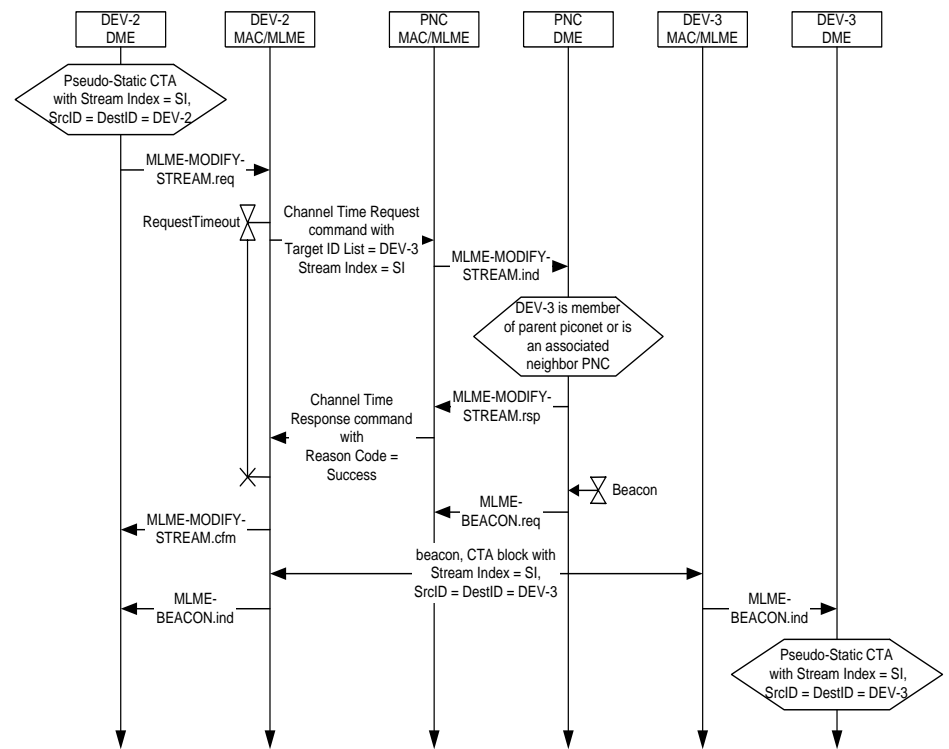


Figure 119 - MSC for the handing over control of a private, pseudo-static CTA

Current

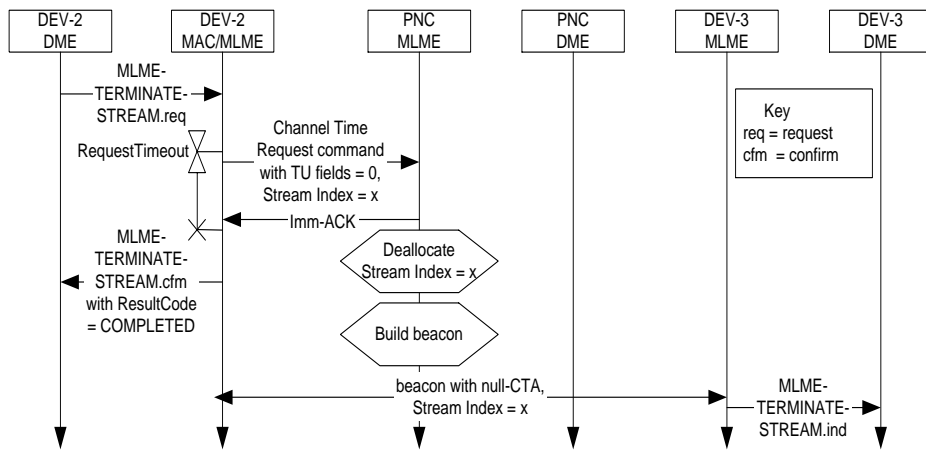


Figure 120 - MSC of source DEV-2 requesting termination of its stream

Suggested

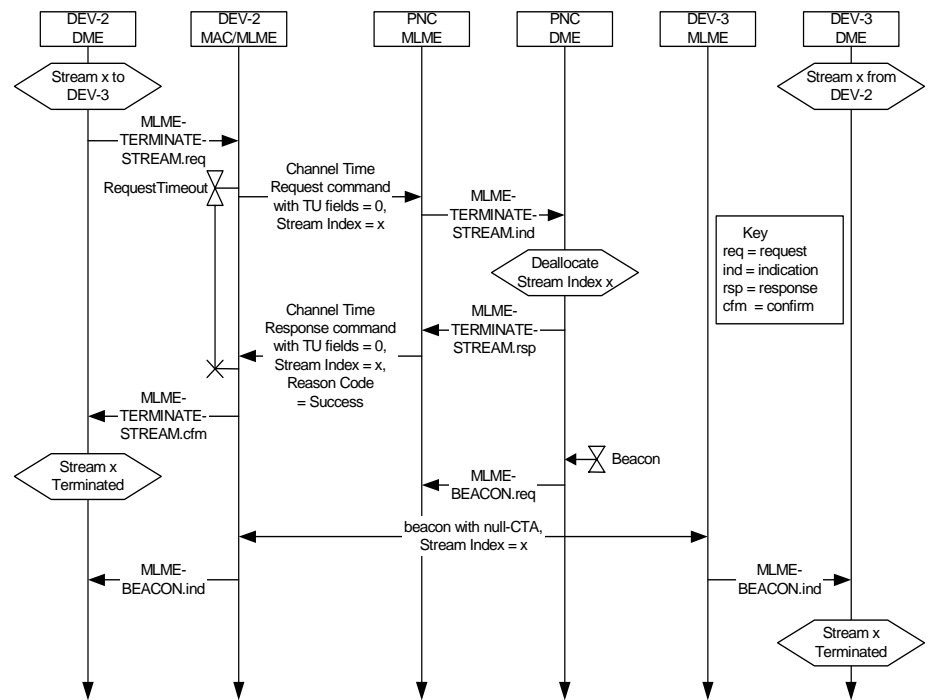


Figure 120 - MSC of source DEV-2 requesting termination of its stream

- If the we desire the target to know why a stream was terminated, then the target DEV must receive a Channel Time Response command. Otherwise, it will know the stream is terminated when it receives the Null CTA but it will not know why the stream was terminated.

Current

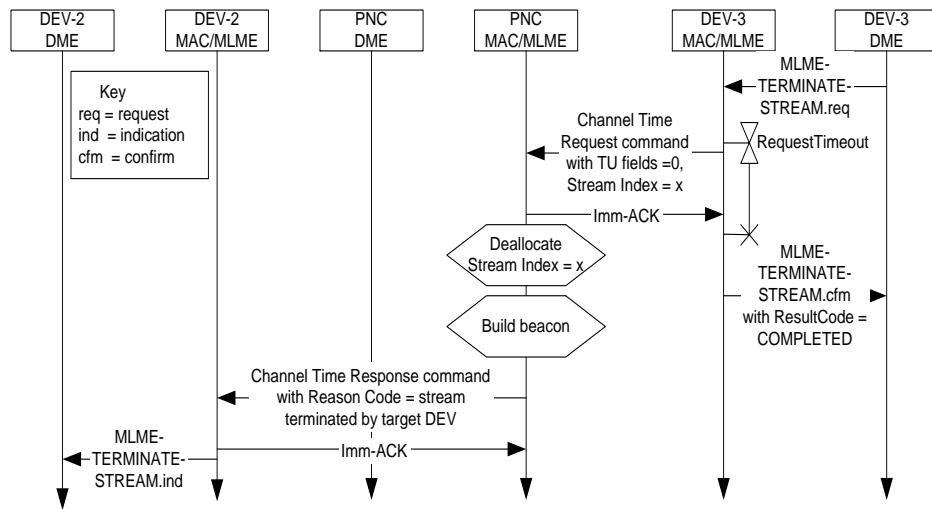


Figure 121 - MSC of target DEV-3 requesting termination of source DEV-2's stream

Suggested

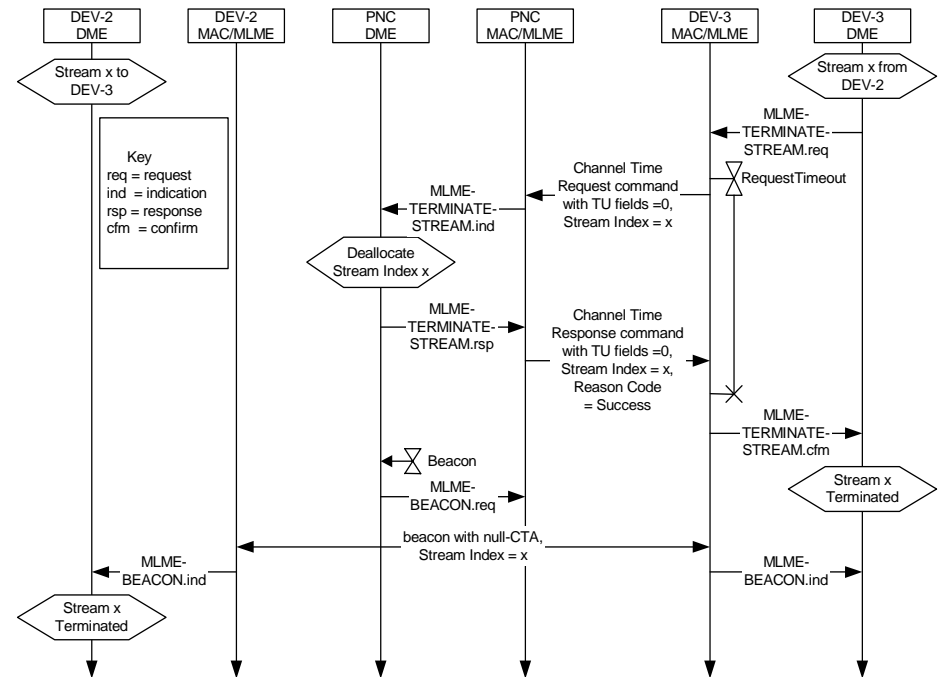


Figure 121 - MSC of target DEV-3 requesting termination of source DEV-2's stream

- If we desire the stream source to know why the stream was terminated, then the source DEV must receive a Channel Time Response command. Otherwise, it will know the stream is terminated when it receives the Null CTA but it will not know why the stream was terminated.

Current

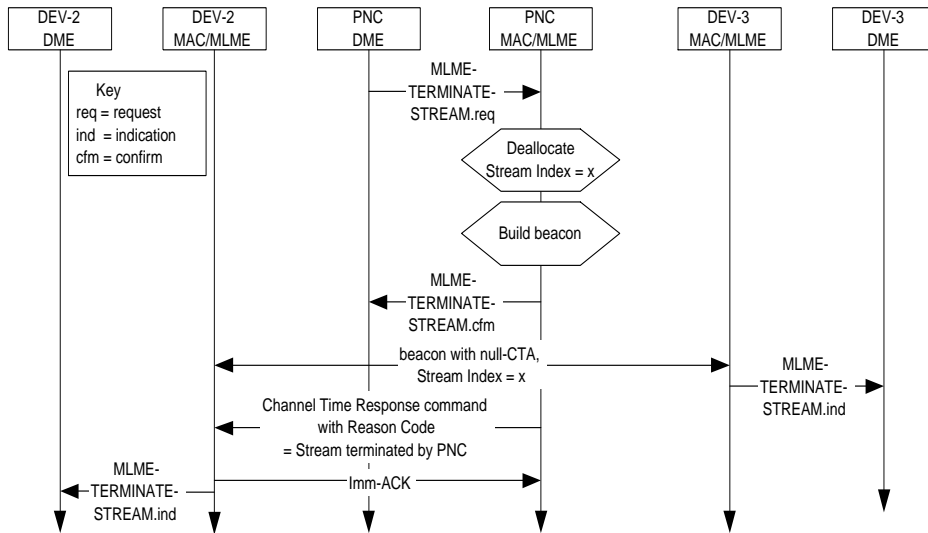


Figure 122 - MSC of PNC terminating a stream

Suggested

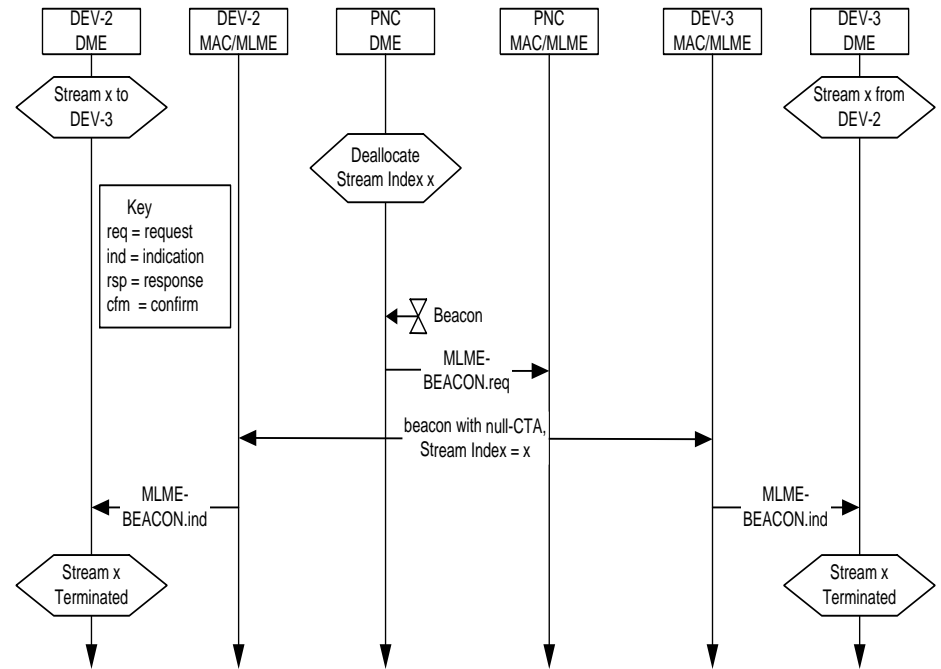


Figure 122 - MSC of PNC terminating a stream

- If the we desire the stream source and target to know why a stream was terminated, then both DEVs must receive a Channel Time Response command. Otherwise, both DEVs will know the stream is terminated when they receives the Null CTA but they will not know why the stream was terminated.

Current

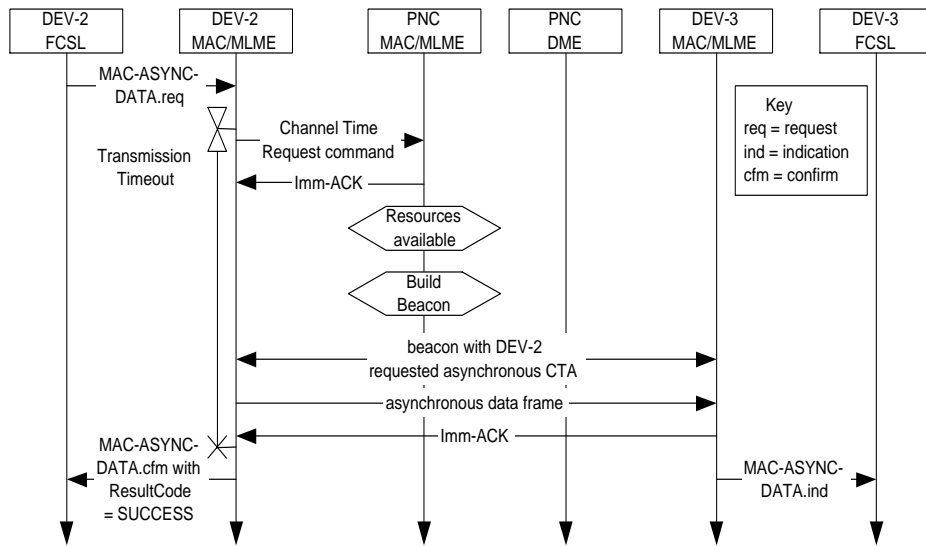


Figure 123 - MSC for reserving asynchronous data channel time

Suggested

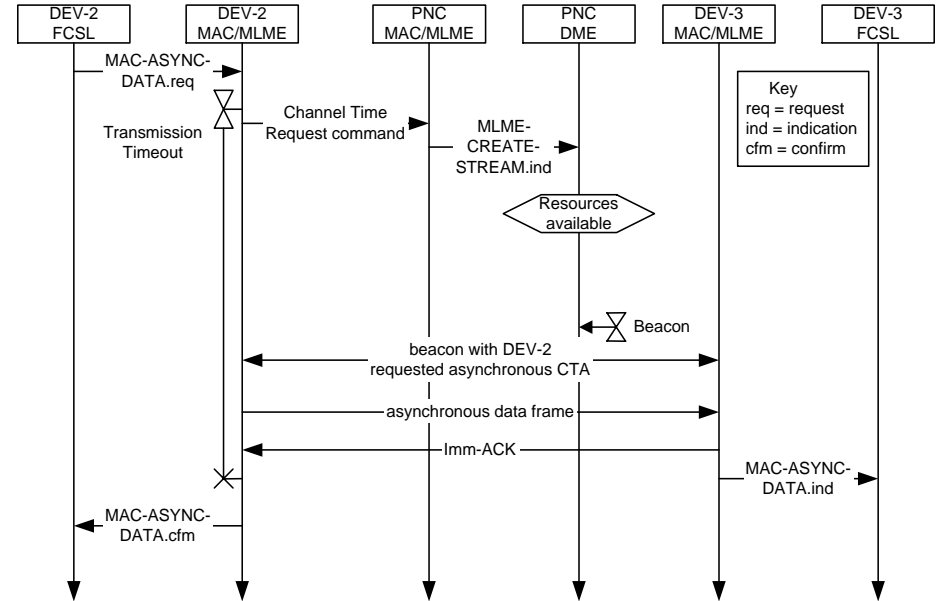
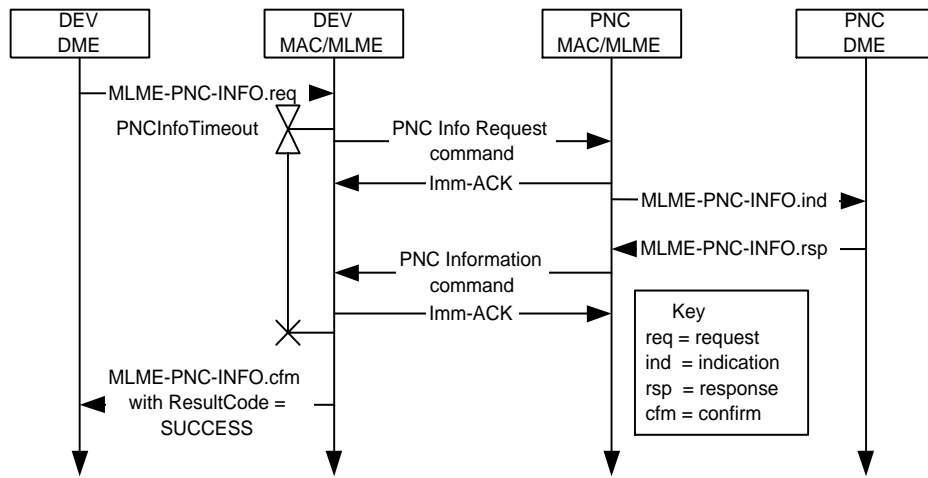


Figure 123 - MSC for reserving asynchronous data channel time

Current



Suggested

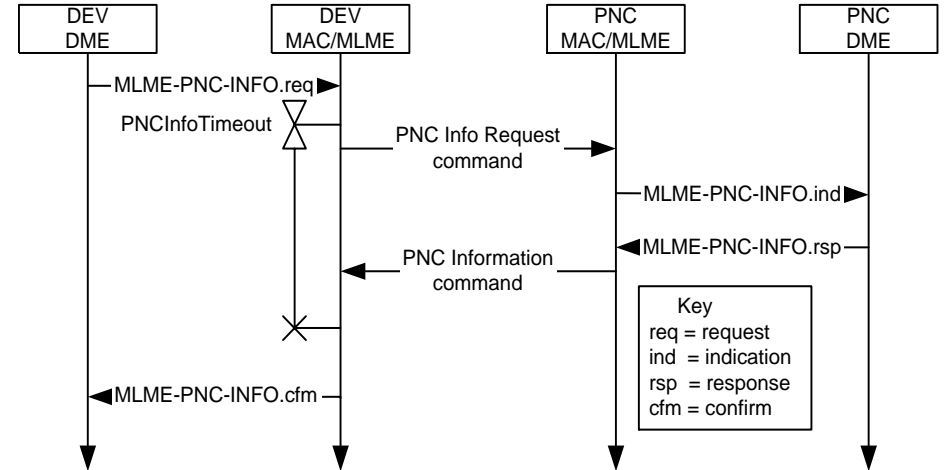


Figure 127 - MSC for acquiring information regarding a specific DEV or all of the DEVs from the PNC using the PNC Information Request and PNC Information commands

Figure 127 - MSC for acquiring information regarding a specific DEV or all of the DEVs from the PNC using the PNC Information Request and PNC Information commands

- Only change is Imm-ACKs removed.

Current

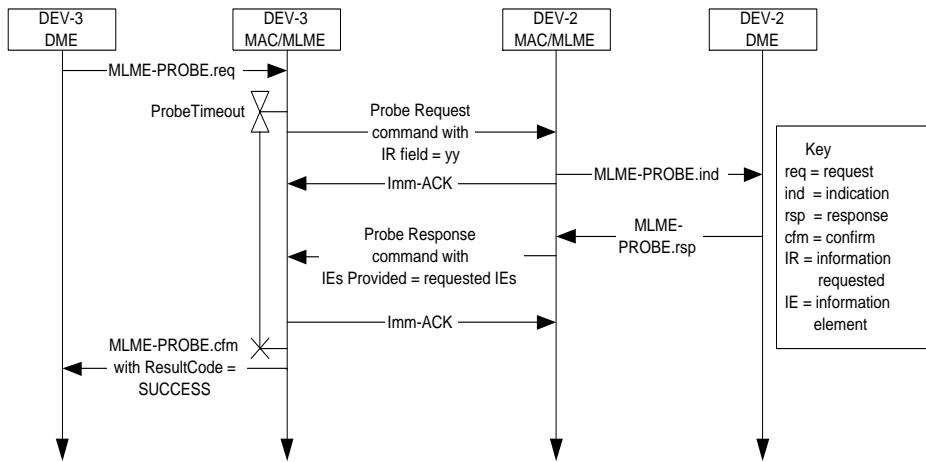


Figure 128 - MSC for acquiring DEV IEs using the Probe Request and Probe Response commands

Suggested

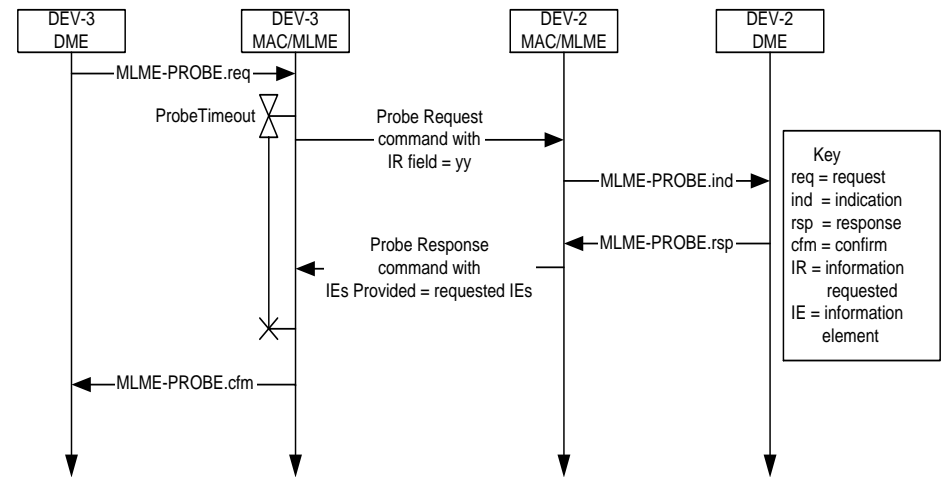


Figure 128 - MSC for acquiring DEV IEs using the Probe Request and Probe Response commands

- Only change is Imm-ACKs removed.

Current

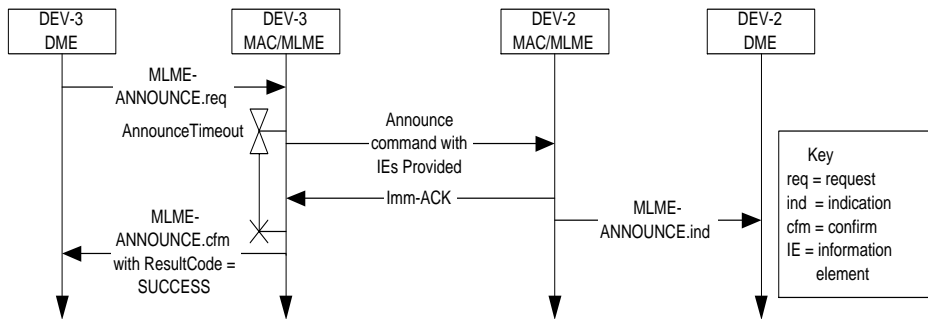


Figure 129 - MSC showing sending of information using the Announce command

Suggested

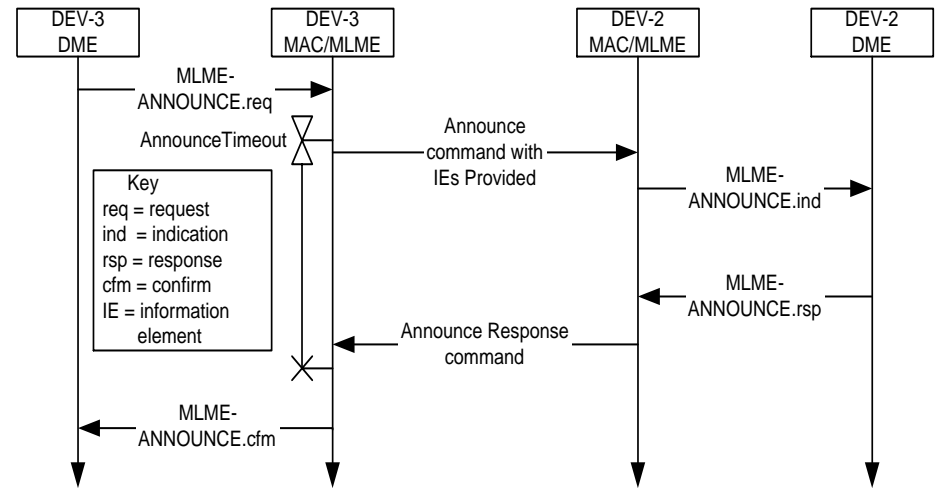


Figure 129 - MSC showing sending of information using the Announce command

- MLME Announce Response and Announce Response command added.

Current

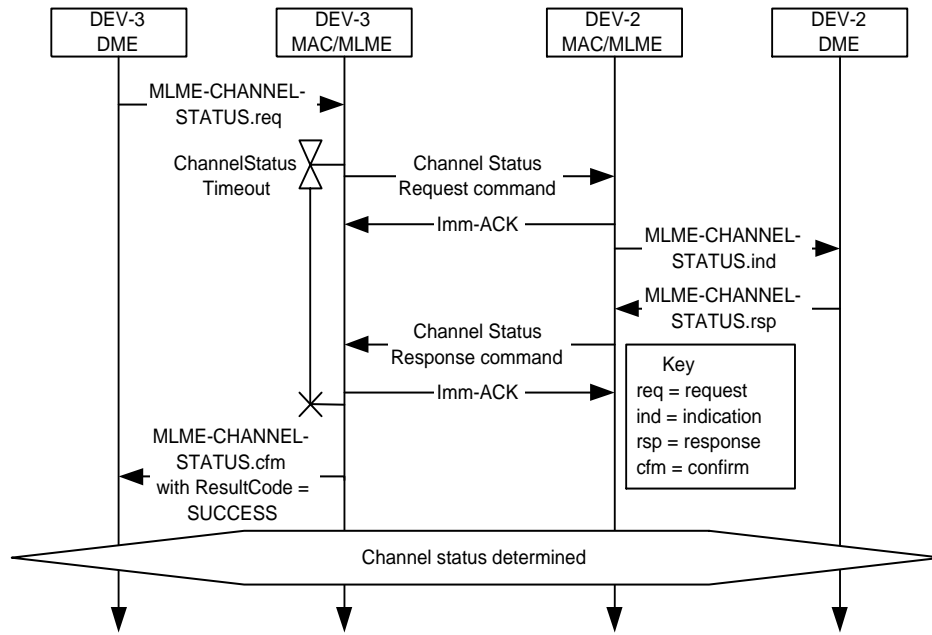


Figure 130 - MSC for determining the channel status between two DEVs using the Channel Status Request and Channel Status Response commands

Suggested

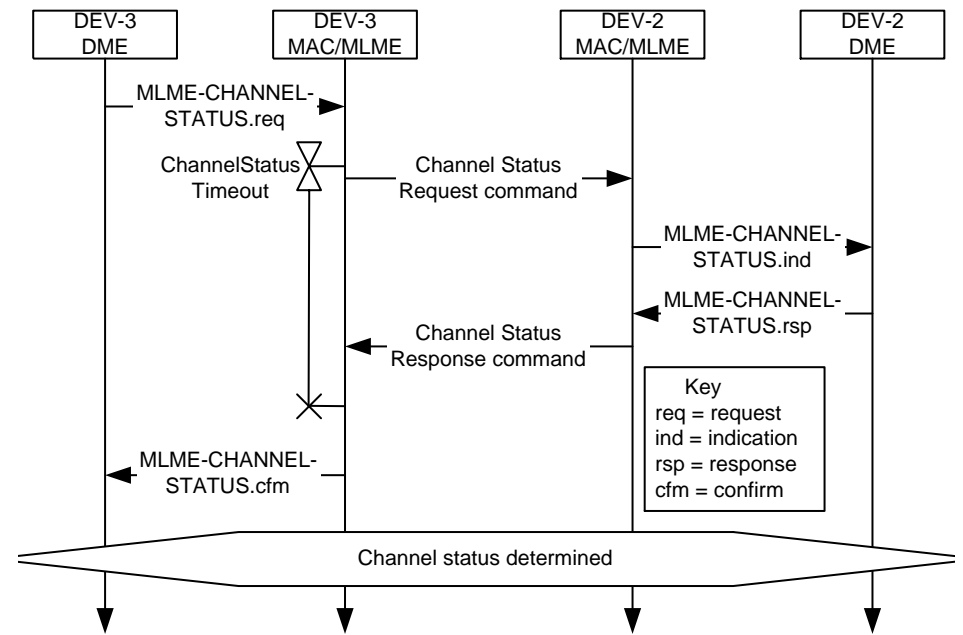


Figure 130 - MSC for determining the channel status between two DEVs using the Channel Status Request and Channel Status Response commands

- Only change is Imm-ACKs removed.

Current

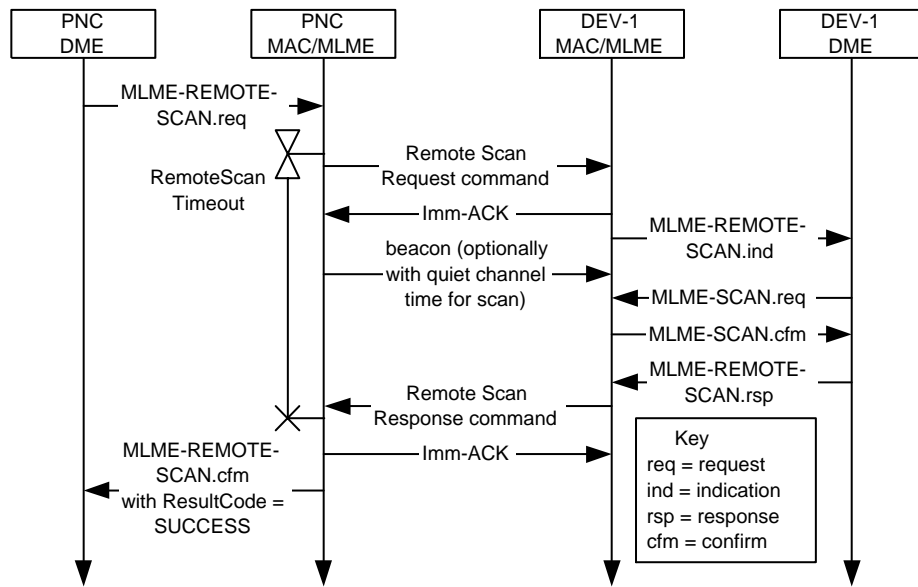


Figure 131 - Remote scan MSC

Suggested

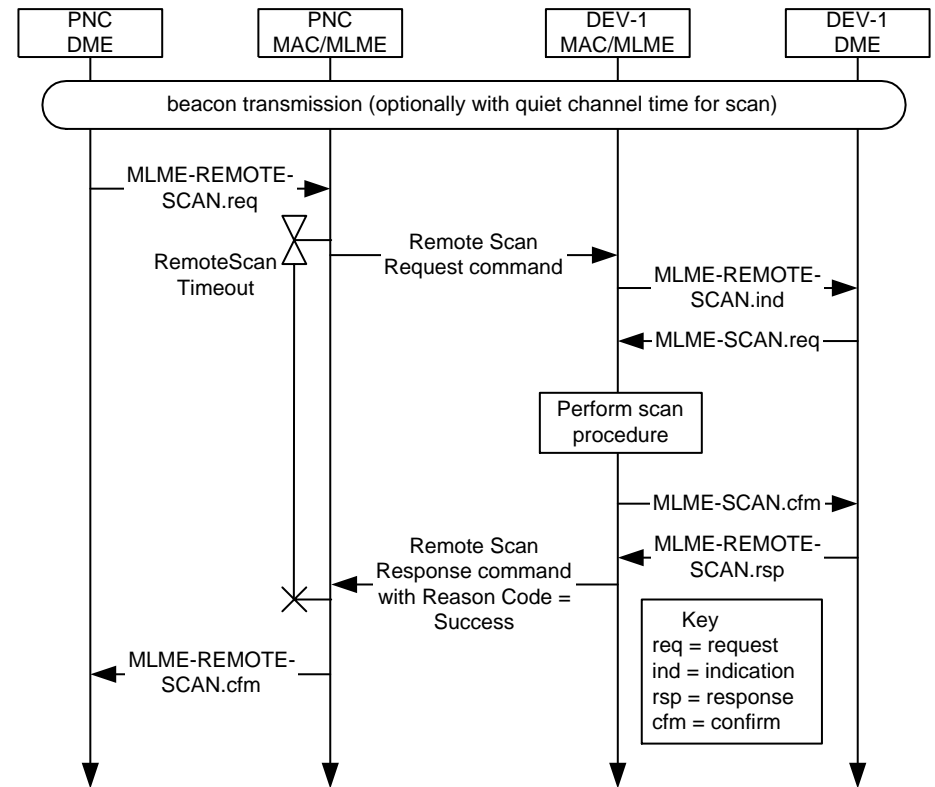


Figure 131 - Remote scan MSC

- Only real change is Imm-ACKs removed.

Current

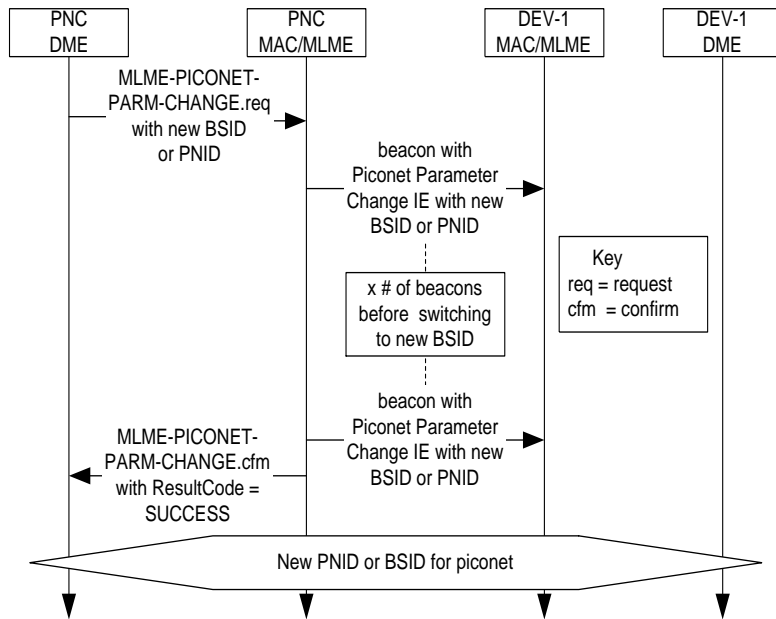


Figure 134 - MSC for changing either the PNID or BSID for a piconet

Suggested

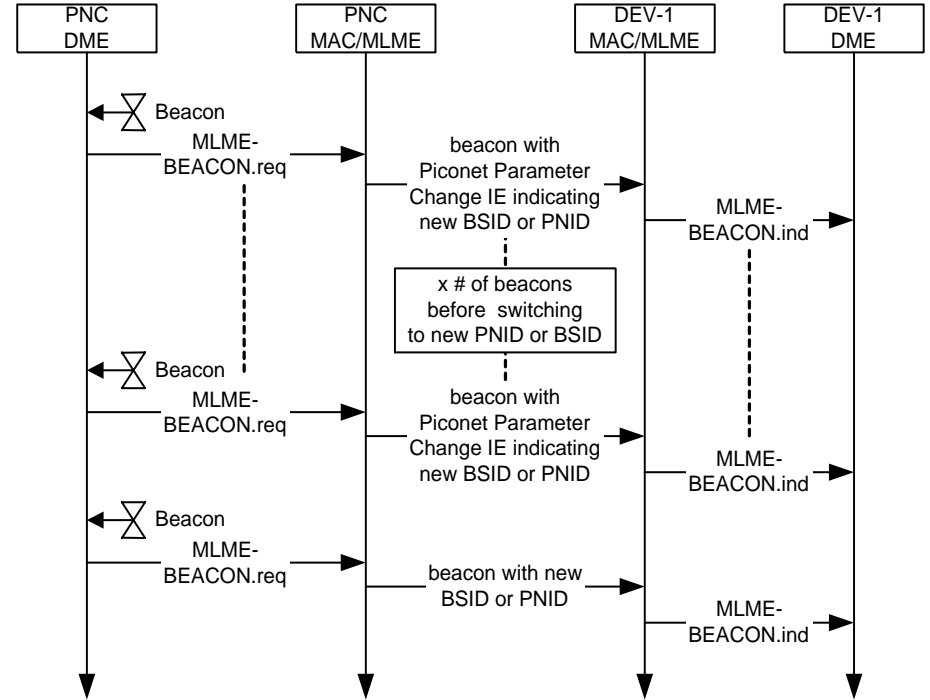


Figure 134 - MSC for changing either the PNID or BSID for a piconet

- PME is responsible for information in the beacon so the MLME-PICONET-PARM-CHANGE primitives are no longer needed.

Current

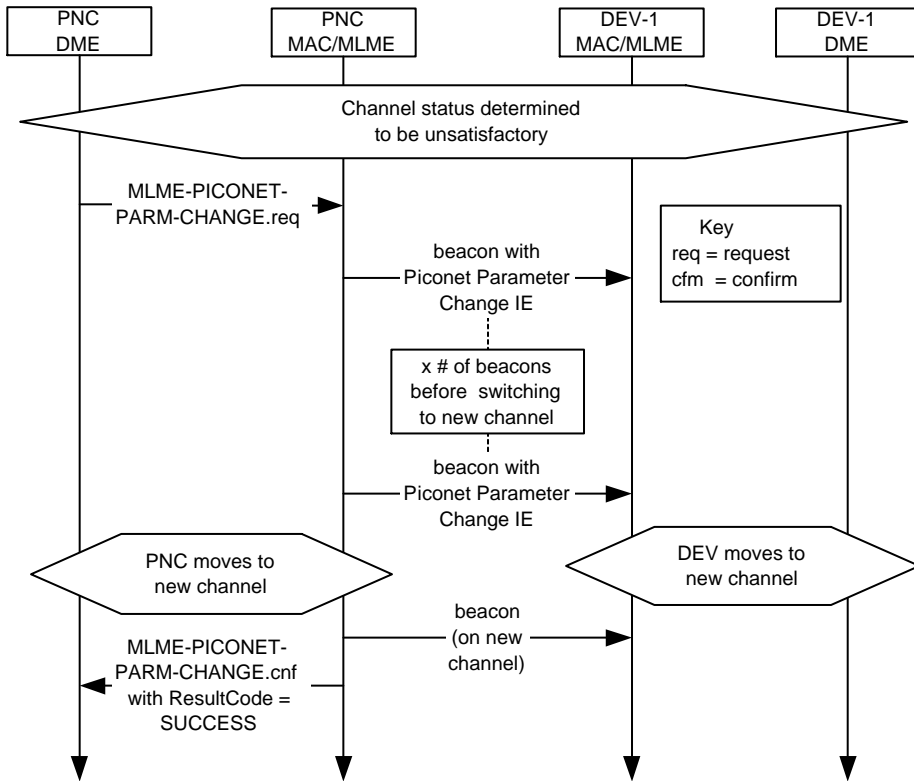


Figure 135 - MSC for changing piconet parameters

Suggested

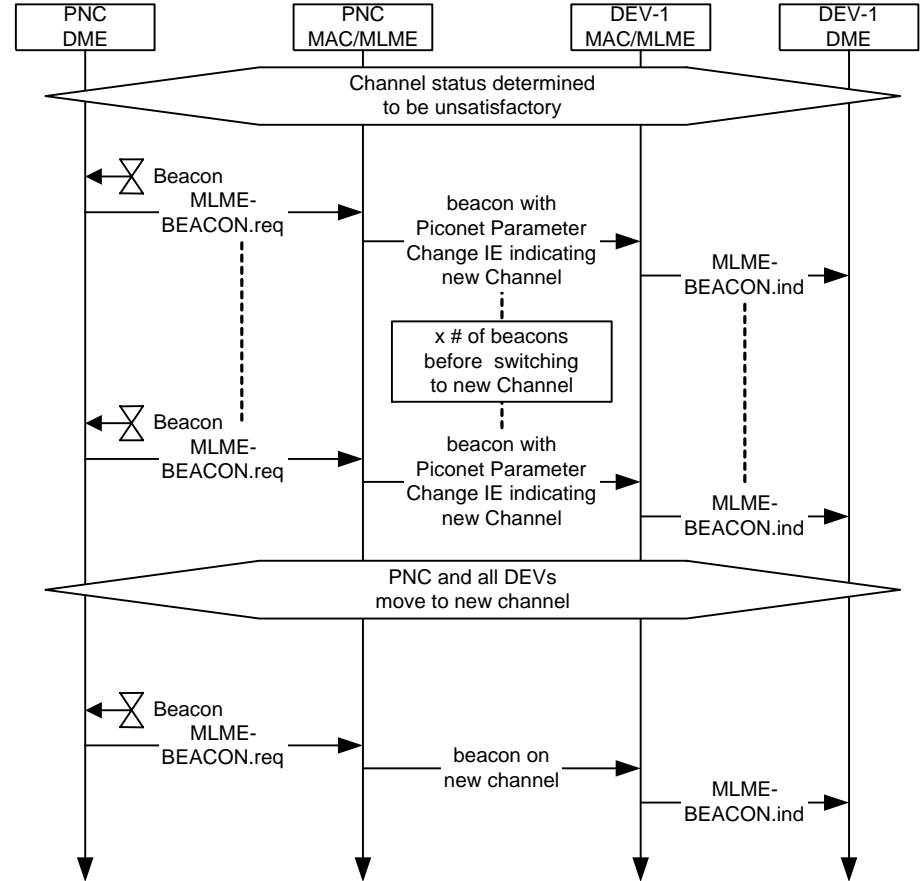


Figure 135 - MSC for changing piconet parameters

Current

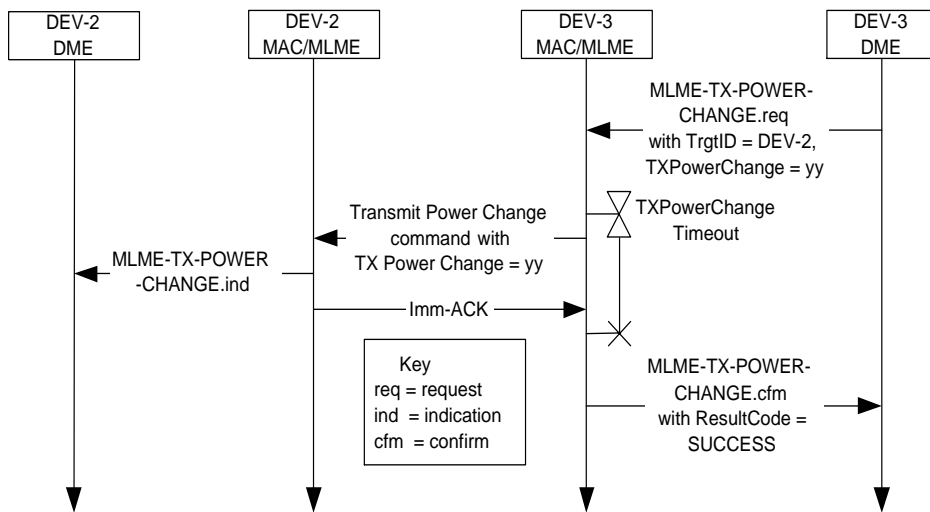


Figure 136 - Transmit power change MSC

Suggested

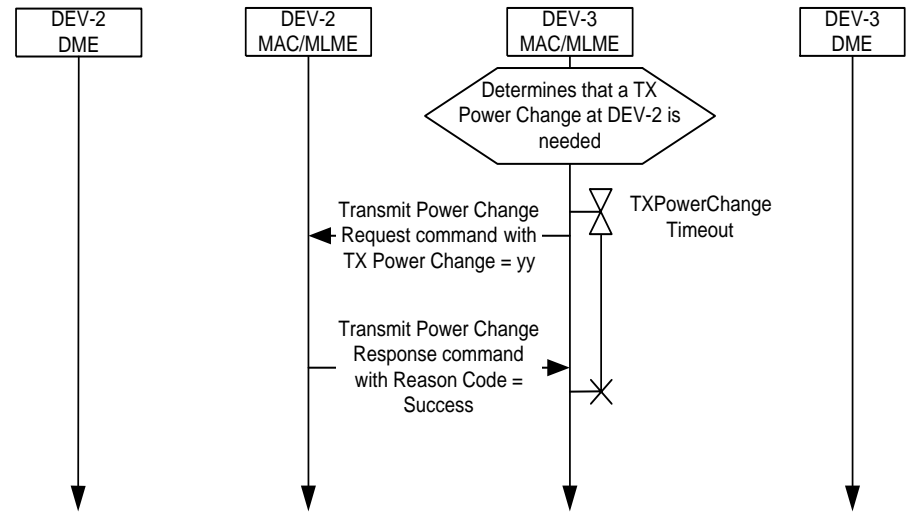


Figure 136 - Transmit power change MSC

- MAC/MLME responsible for TX power adaptation, therefore MLME-TX-POWER-CHANGE primitives are no longer needed.

Current

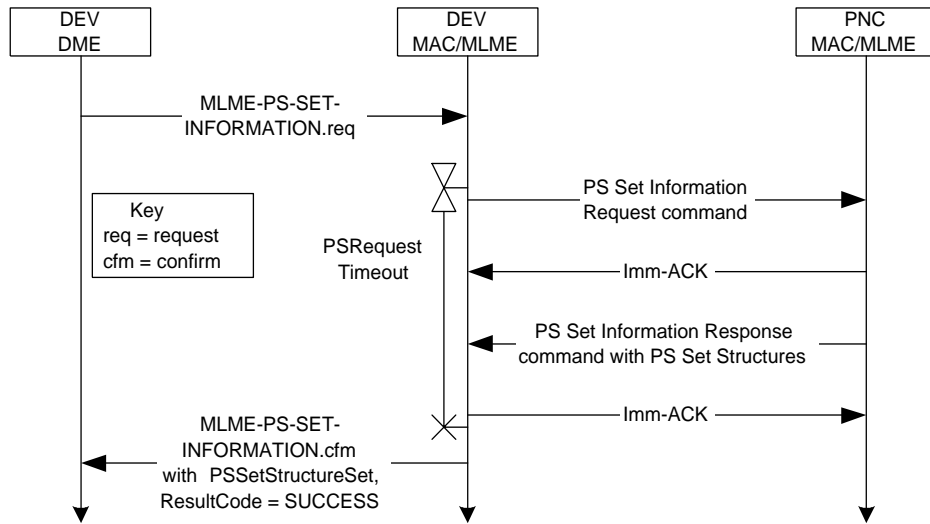


Figure 140 - MSC for PS set information exchange

Suggested

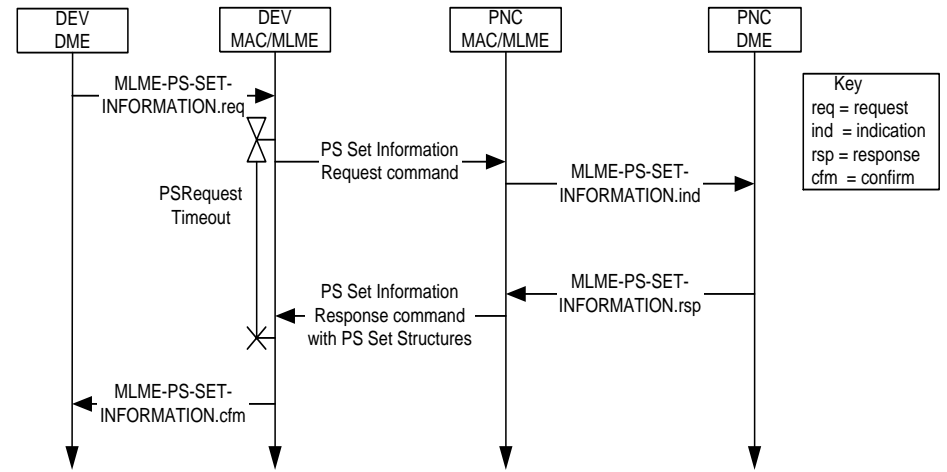


Figure 140 - MSC for PS set information exchange

- PME is responsible for maintaining power set information, therefore, MLME-PS-SET-INFORMATION indication and response primitives are needed.

Current

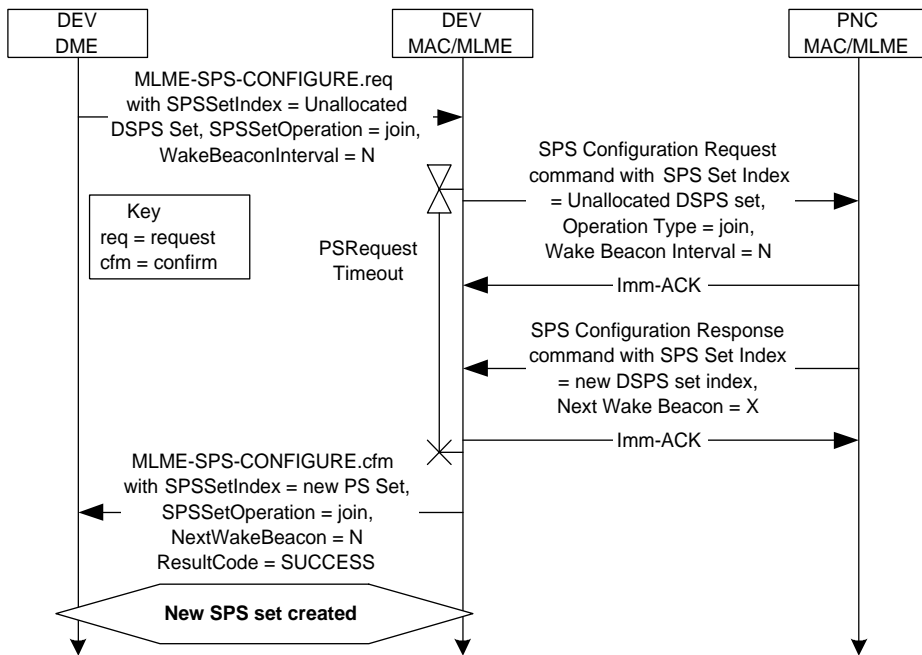


Figure 141 - MSC for DSPS set creation

Suggested

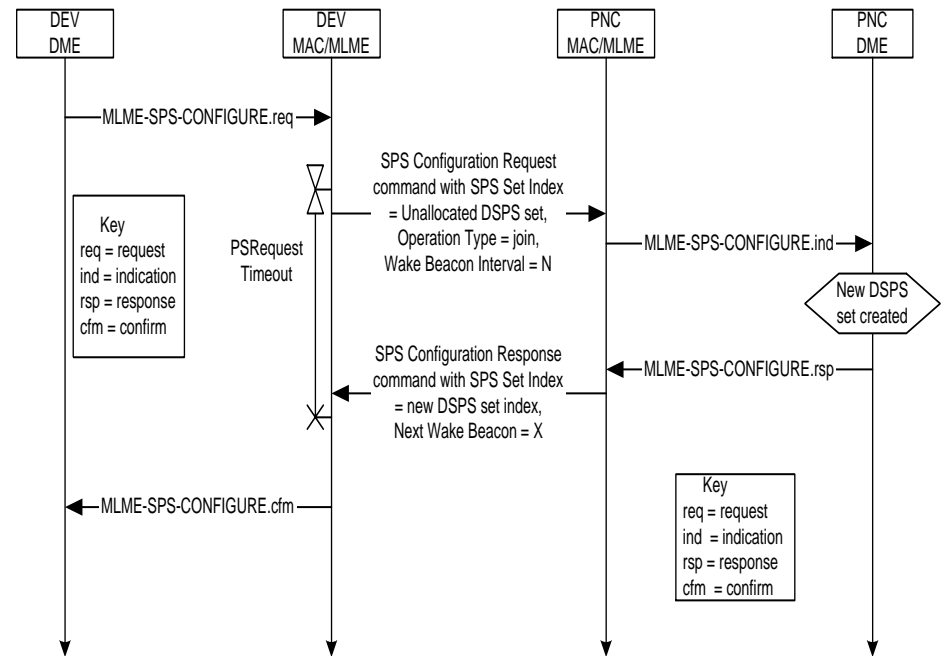


Figure 141 - MSC for DSPS set creation

- PME is responsible for maintaining power set information, therefore, MLME-SPS-CONFIGURE indication and response primitives are needed.

Current

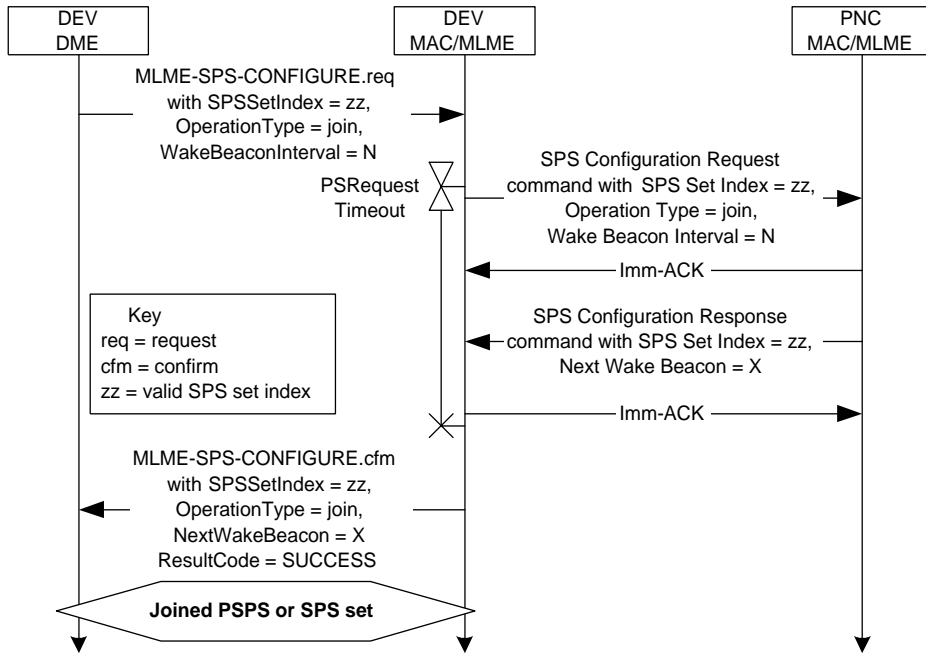


Figure 142 - MSC showing a DEV joining an existing SPS set

Suggested

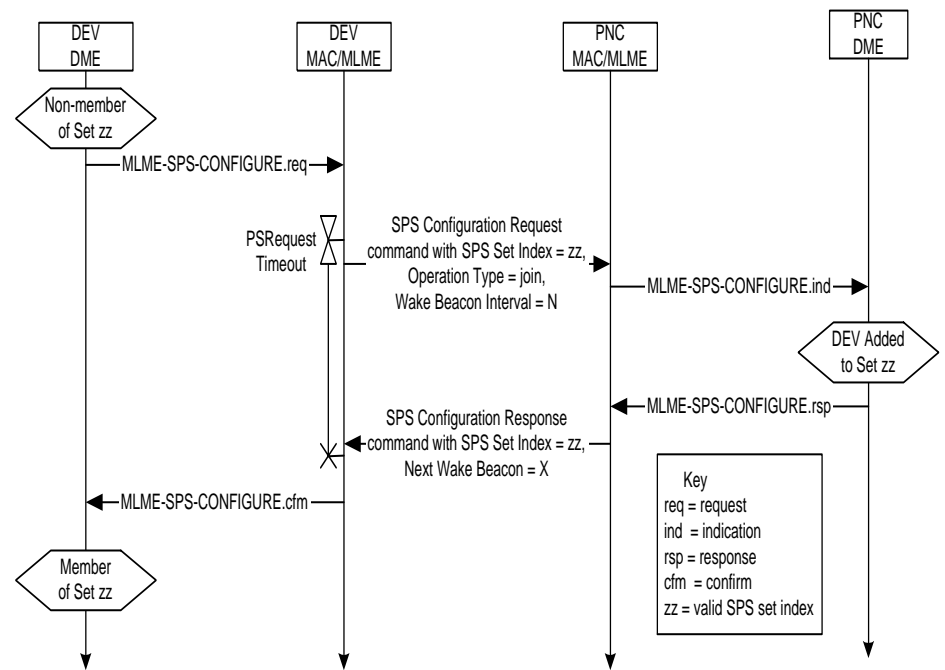
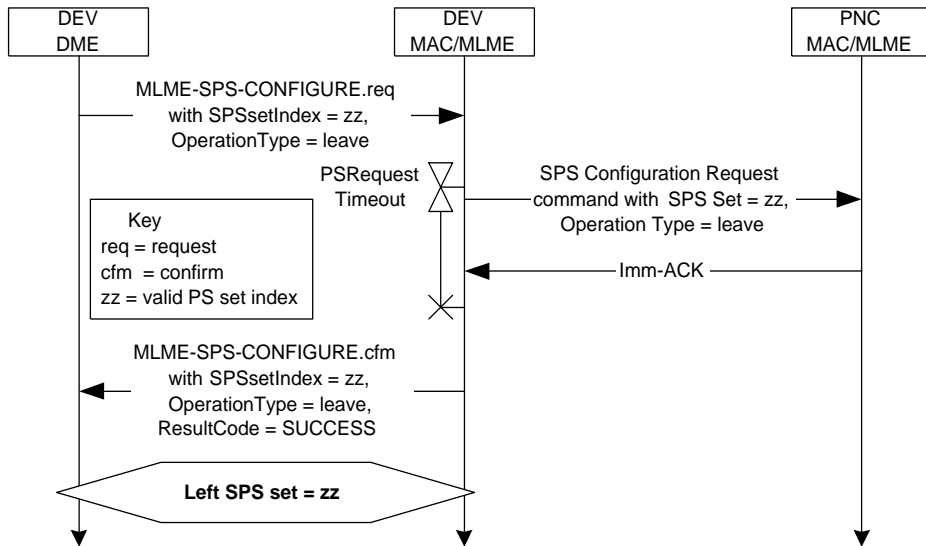


Figure 142 - MSC showing a DEV joining an existing SPS set

- PME is responsible for maintaining power set information, therefore, MLME-SPS-CONFIGURE indication and response primitives are needed.

Current



Suggested

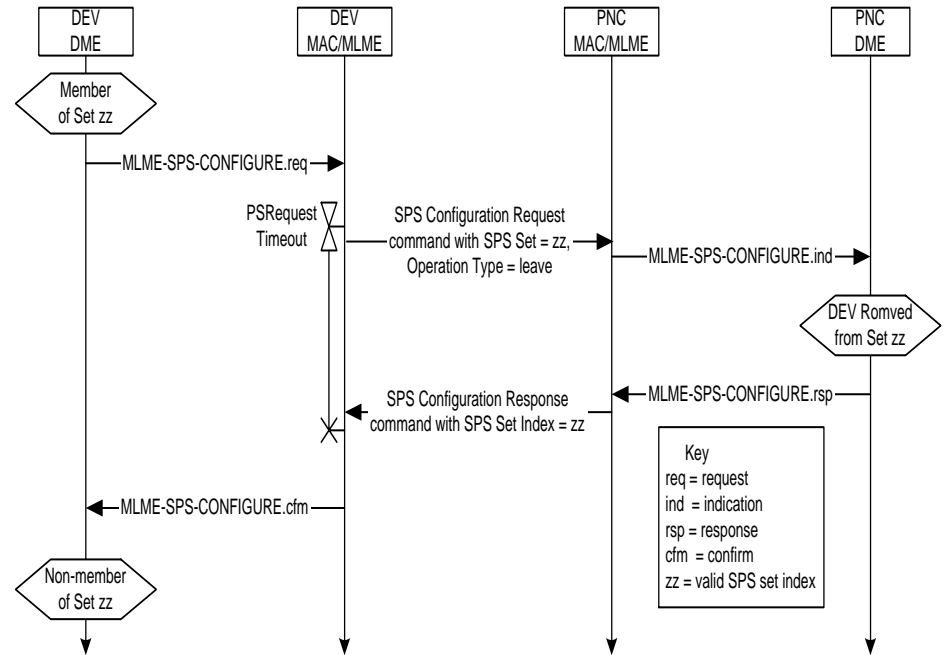


Figure 143 - MSC showing a DEV leaving an SPS set

Figure 143 - MSC showing a DEV leaving an SPS set

- PME is responsible for maintaing power set information, therefore, MLME-SPS-CONFIGURE indication and response primitives are needed.

Current

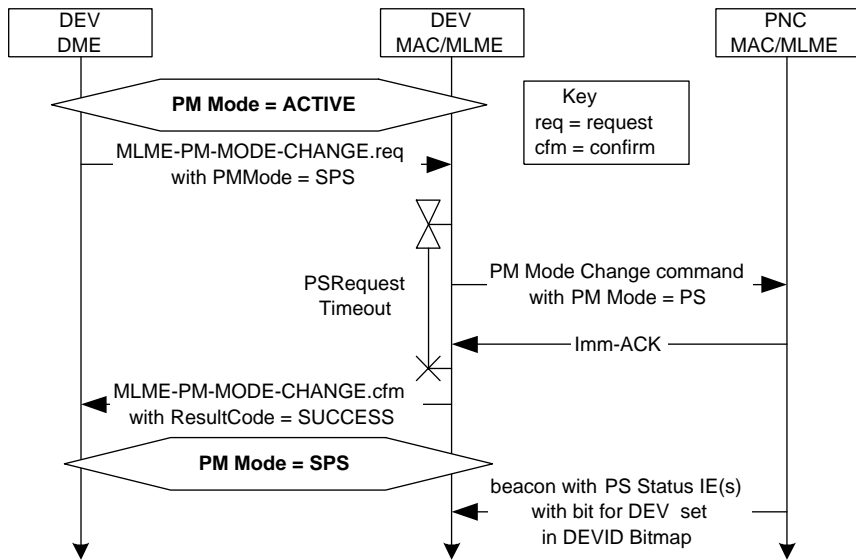


Figure 144 - MSC showing DME initiated PM mode change from ACTIVE to an SPS mode

Suggested

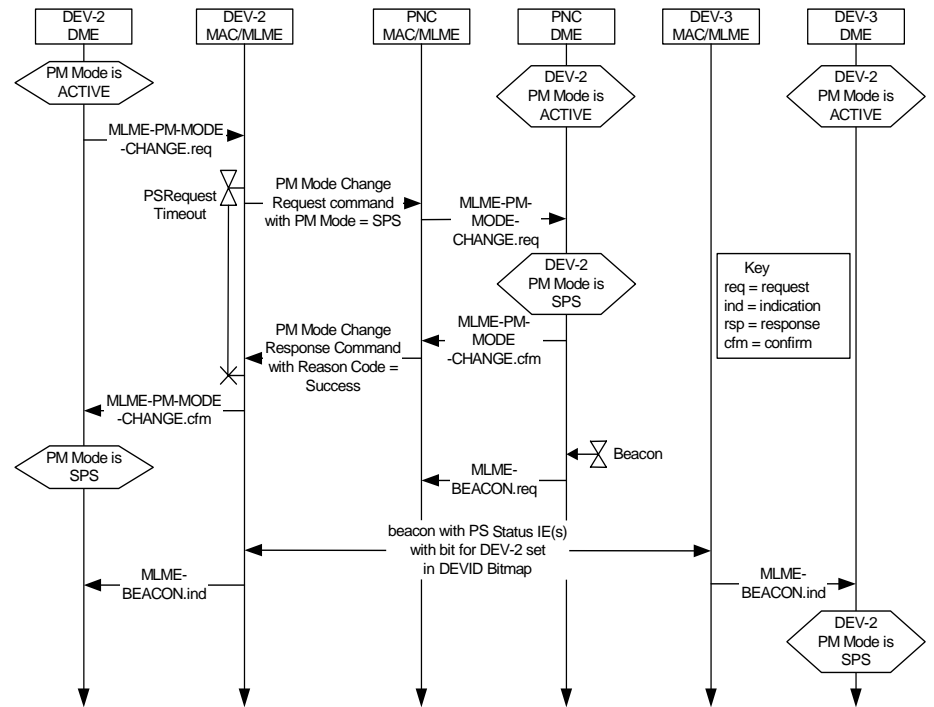
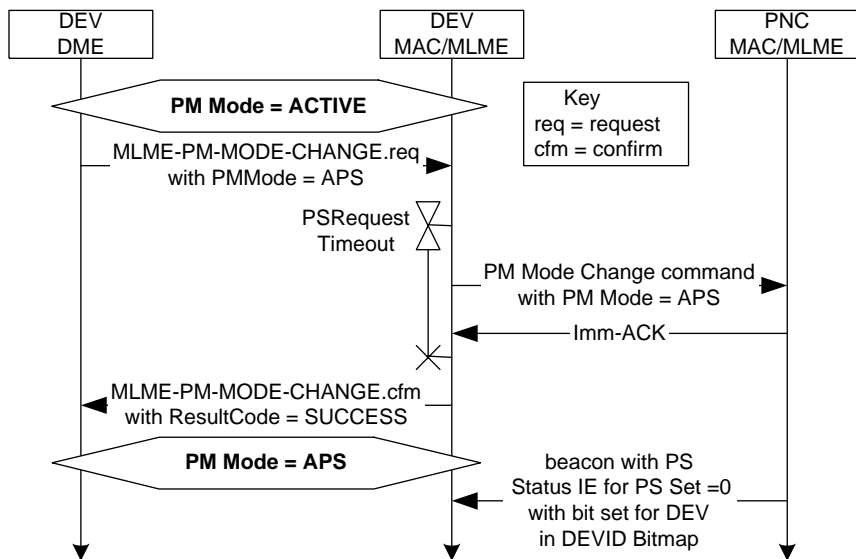


Figure 144 - MSC showing DME initiated PM mode change from ACTIVE to an SPS mode

- PME is responsible for maintaining power save state information, therefore, MLME-PM-MODE-CHANGE indication and response primitives are needed.
- Other DEVs aware of mode change when they receive beacon.

Current



Suggested

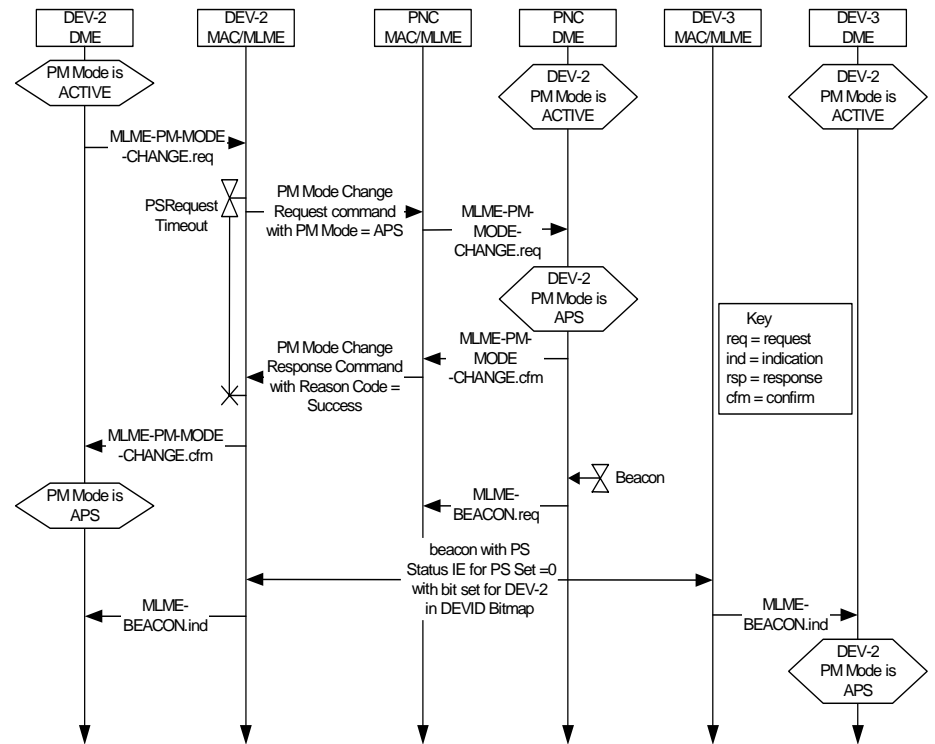


Figure 145 - MSC showing DME initiated PM mode change from ACTIVE to APS

Figure 145 - MSC showing DME initiated PM mode change from ACTIVE to APS

- PME is responsible for maintaining power save state information, therefore, MLME-PM-MODE-CHANGE indication and response primitives are needed.
- Other DEVs aware of mode change when they receive beacon.

Current

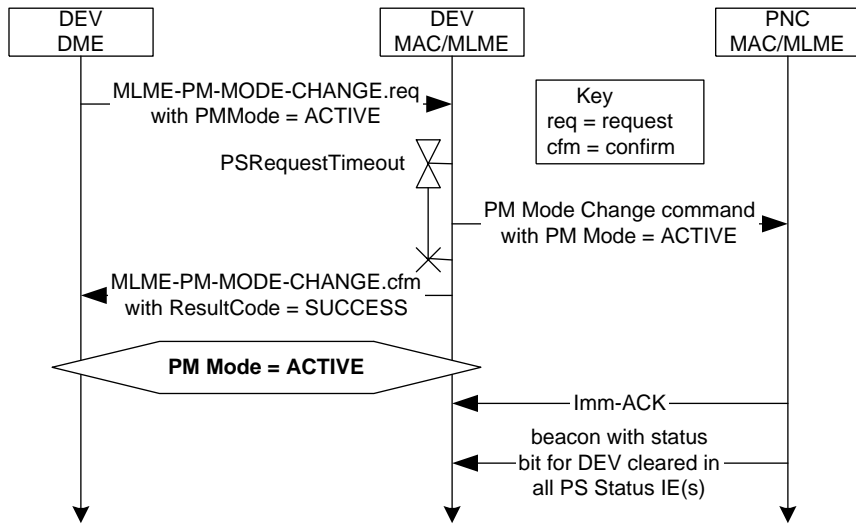


Figure 146 - MSC showing DME initiated PM mode change from any PS mode to ACTIVE

Suggested

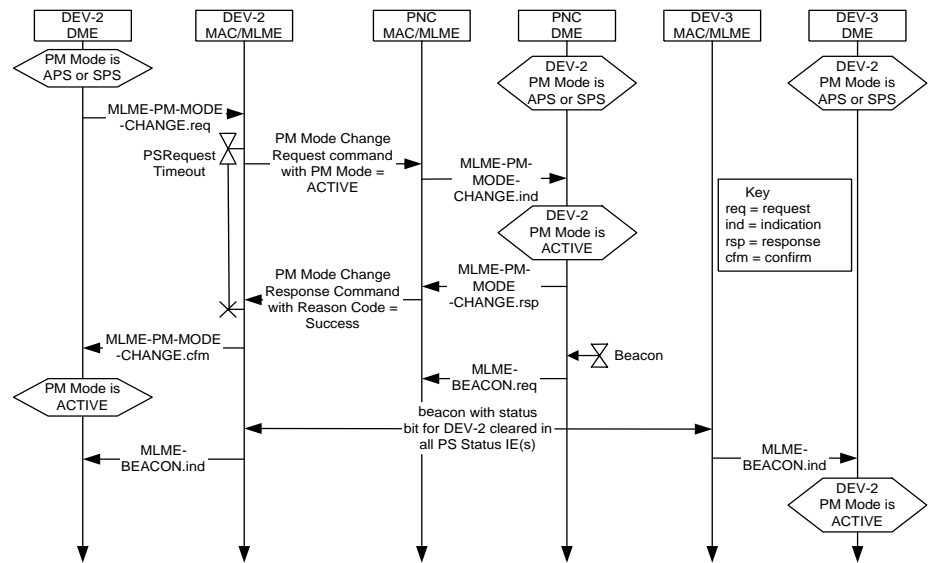


Figure 146 - MSC showing DME initiated PM mode change from any PS mode to ACTIVE

- PME is responsible for maintaining power save state information, therefore, MLME-PM-MODE-CHANGE indication and response primitives are needed.
- Other DEVs aware of mode change when they receive beacon.

Current

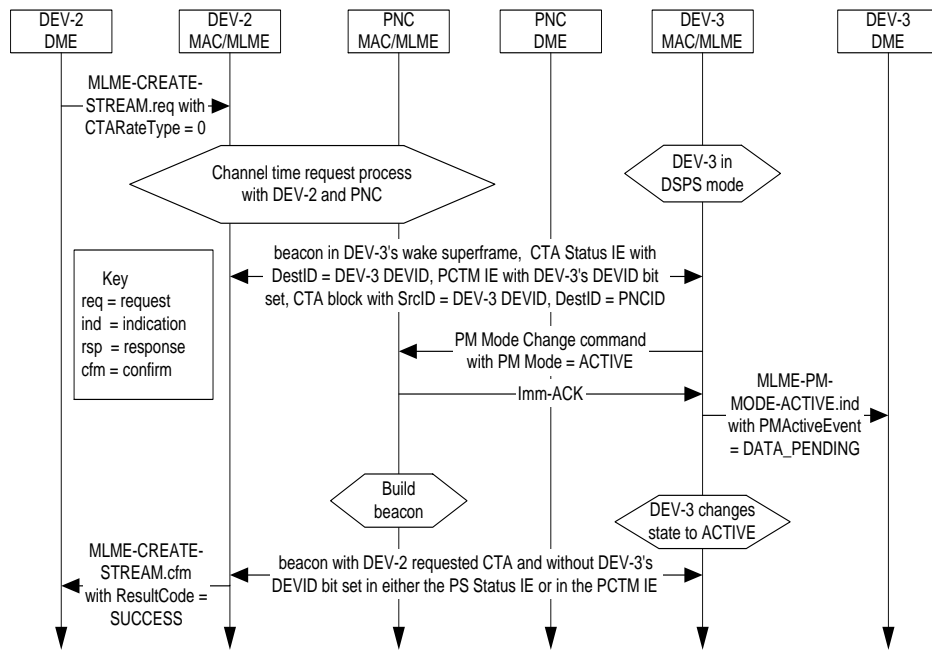


Figure 147 - Message sequence showing MLME initiated PM mode change from DSPS to ACTIVE in response to a new channel time allocation

Suggested

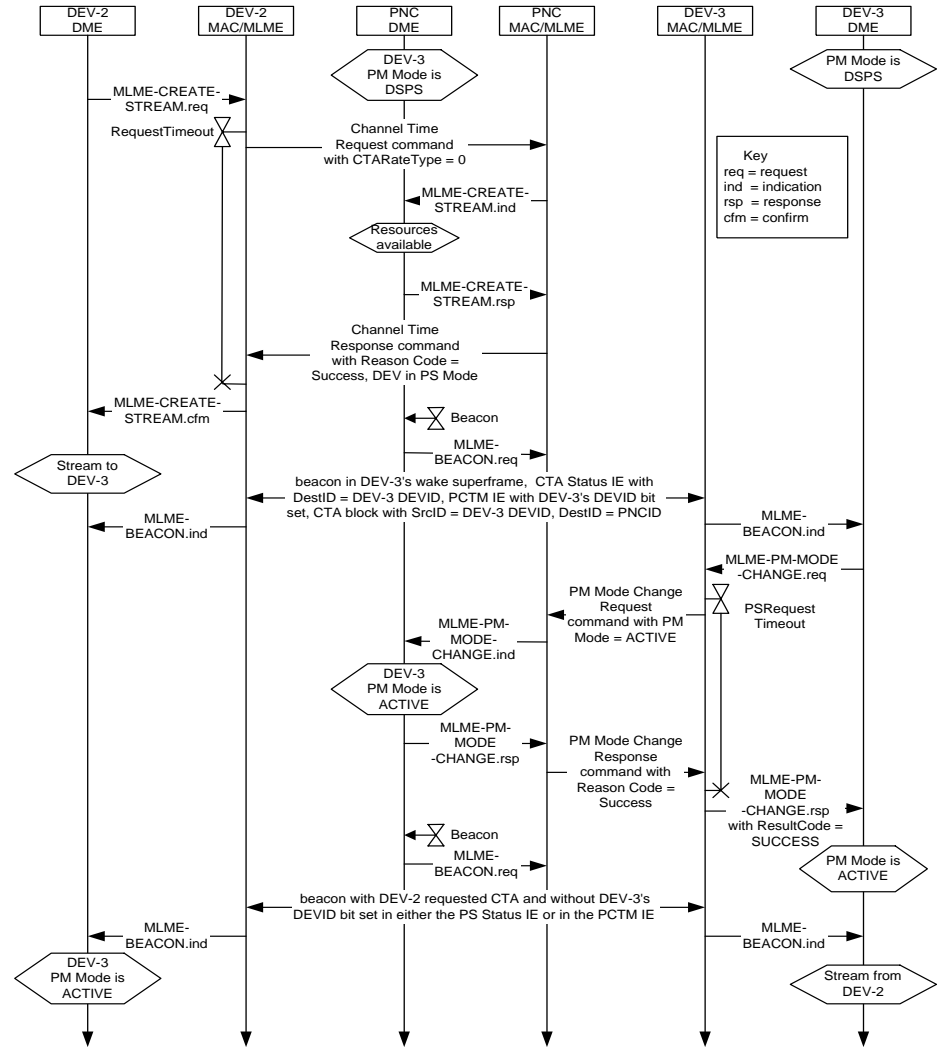


Figure 147 - Message sequence showing MLME initiated PM mode change from DSPS to ACTIVE in response to a new channel time allocation

- To be consistent with other scenarios, requesting DEV is aware of stream when it receives a Channel Time Response command.

Current

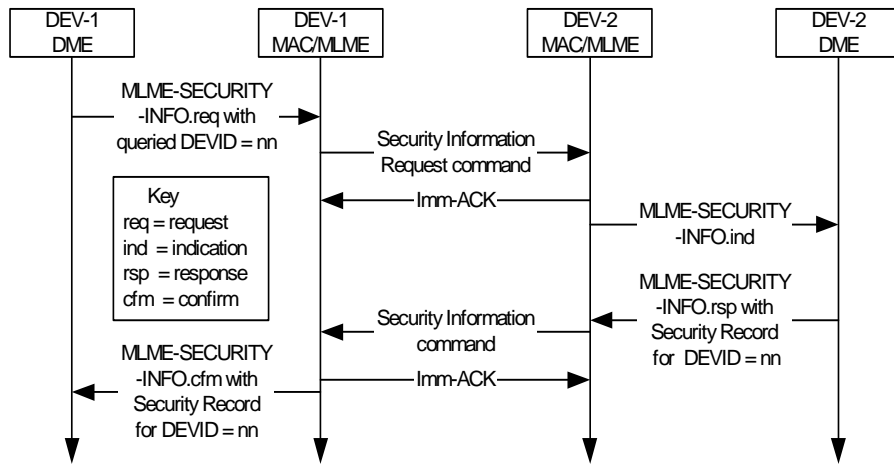


Figure 148—Message sequence chart for DEV-DEV Security information request

Suggested

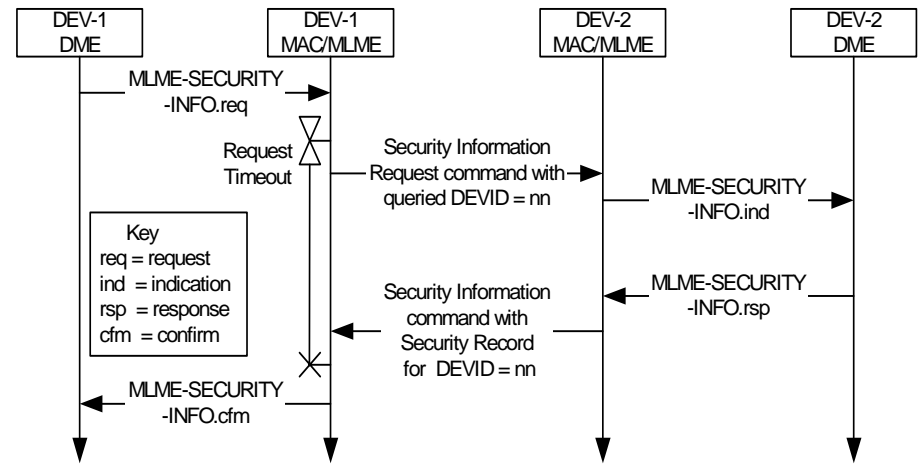


Figure 148—Message sequence chart for DEV-DEV Security information request

- Only change is Imm-ACKs removed.

Current

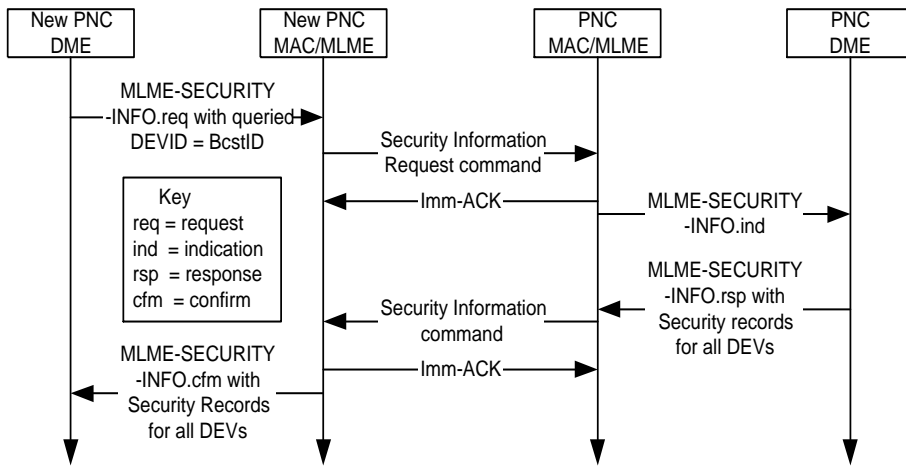


Figure 149—Message sequence chart for New PNC-Old PNC Security Information transfer

Suggested

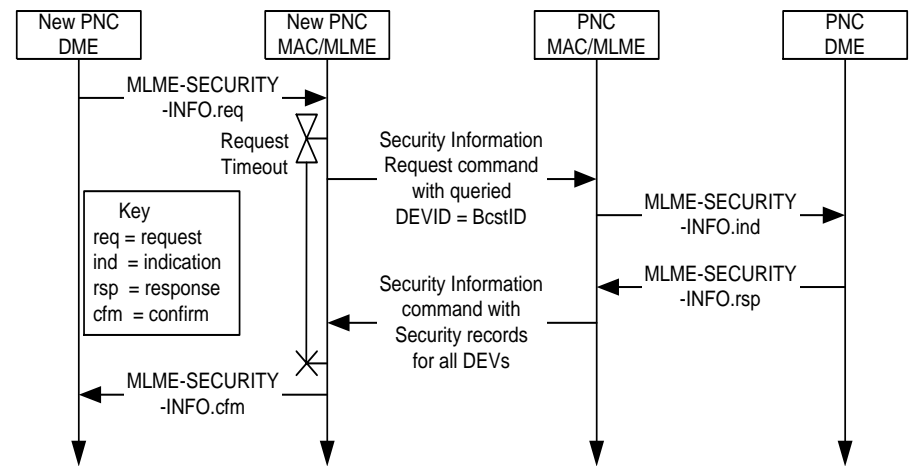


Figure 149—Message sequence chart for New PNC-Old PNC Security Information transfer

- Only change is Imm-ACKs removed.

Current

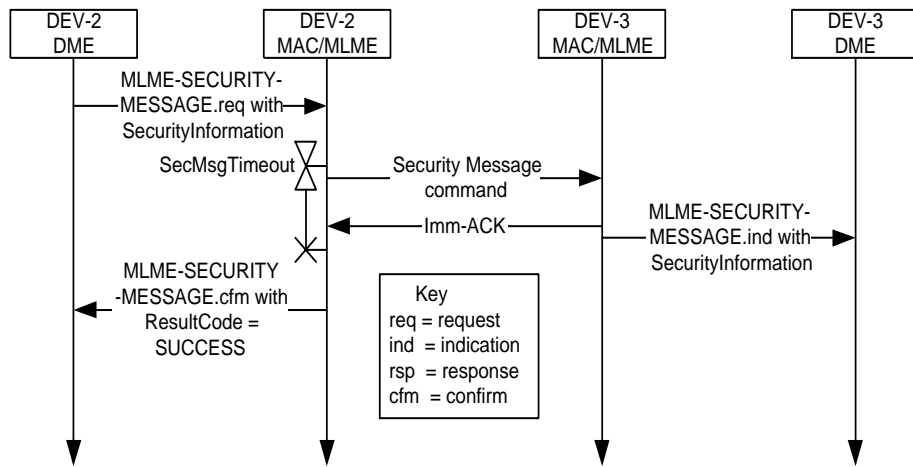


Figure 150—Message sequence chart for sending security information with the Security Message command

Suggested

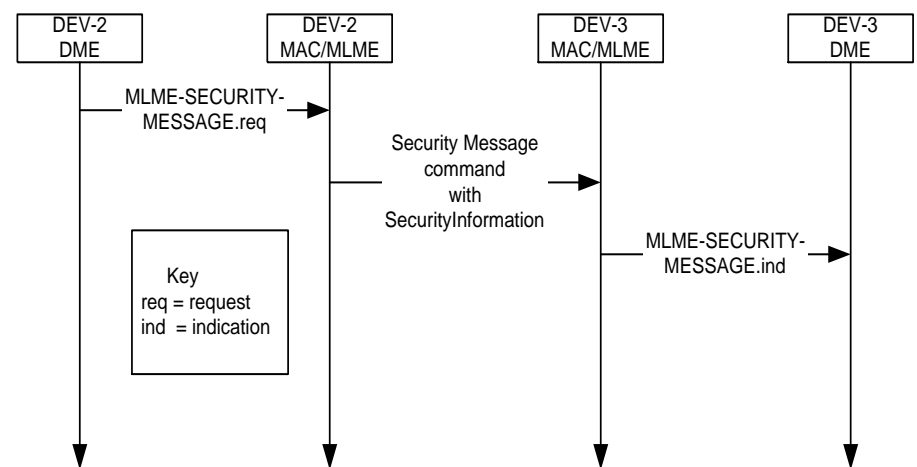


Figure 150—Message sequence chart for sending security information with the Security Message command

- Fire and forget so no confirm is needed.

Current

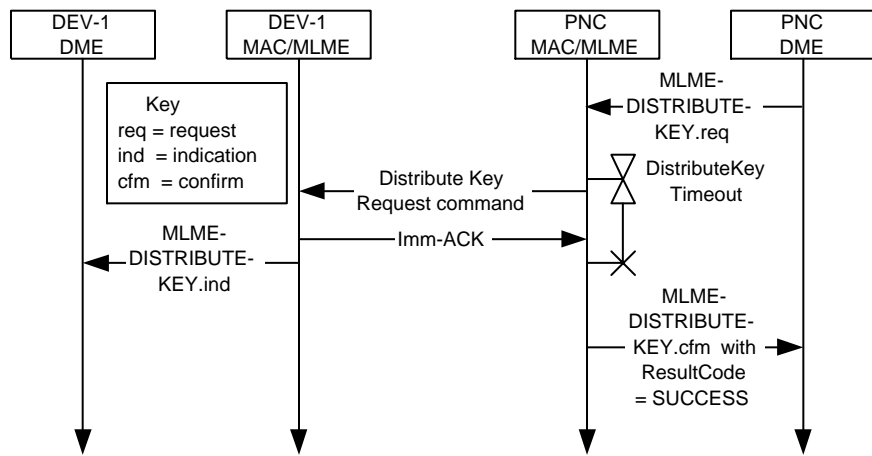


Figure 151—Message sequence chart for PNC-DEV key distribution

Suggested

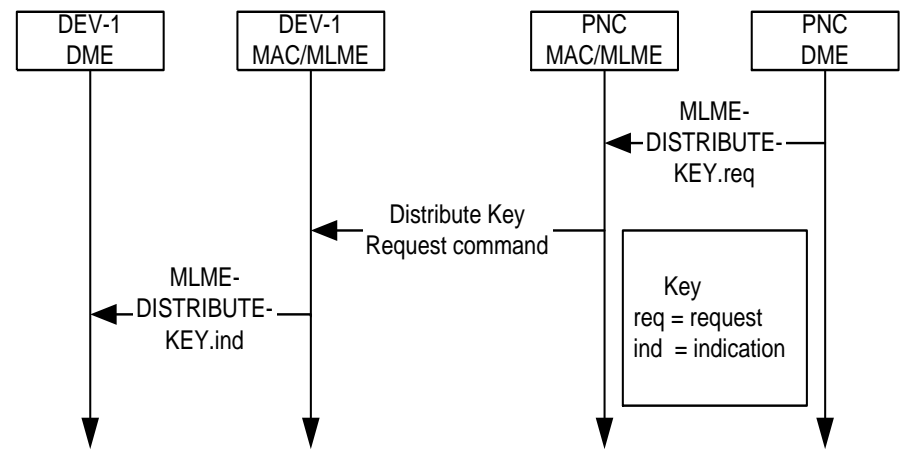


Figure 151—Message sequence chart for PNC-DEV key distribution

- Fire and forget scenario

Current

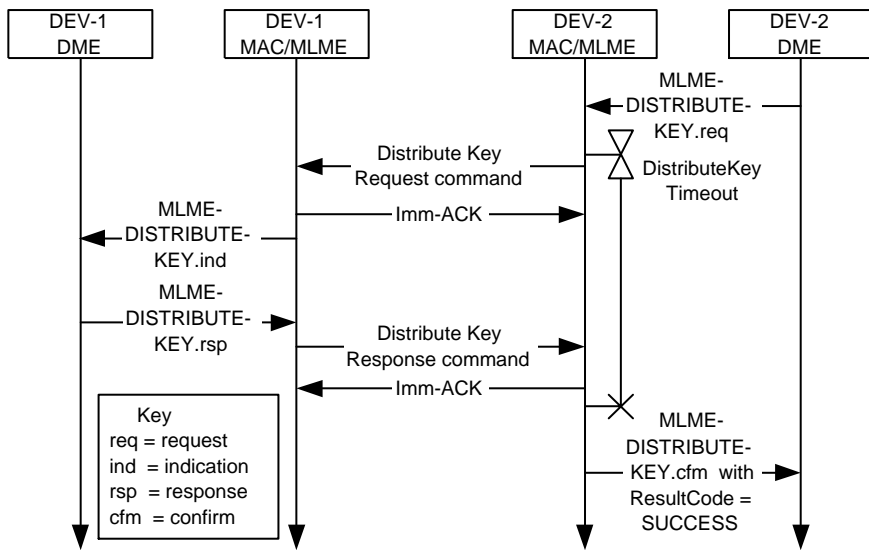


Figure 152—Message sequence chart for peer-to-peer key distribution

Suggested

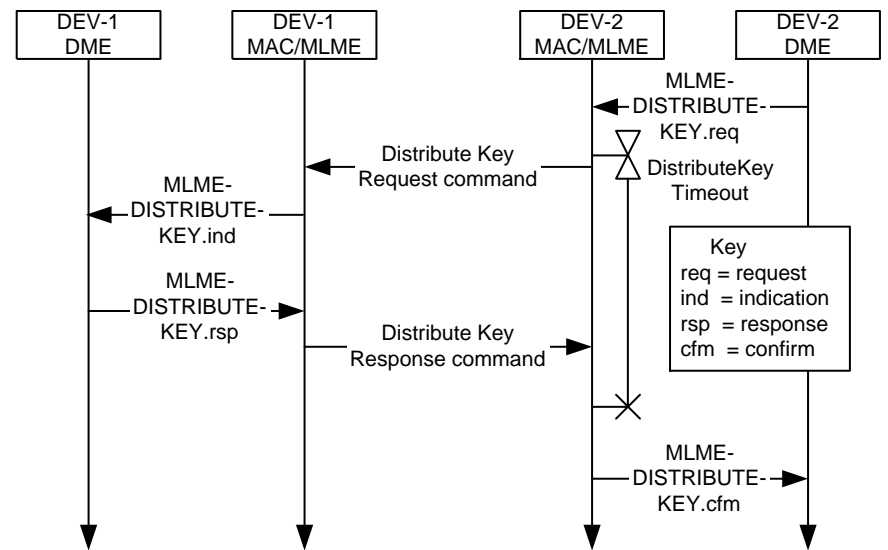


Figure 152—Message sequence chart for peer-to-peer key distribution

- Only change is Imm-ACKs removed.

Current

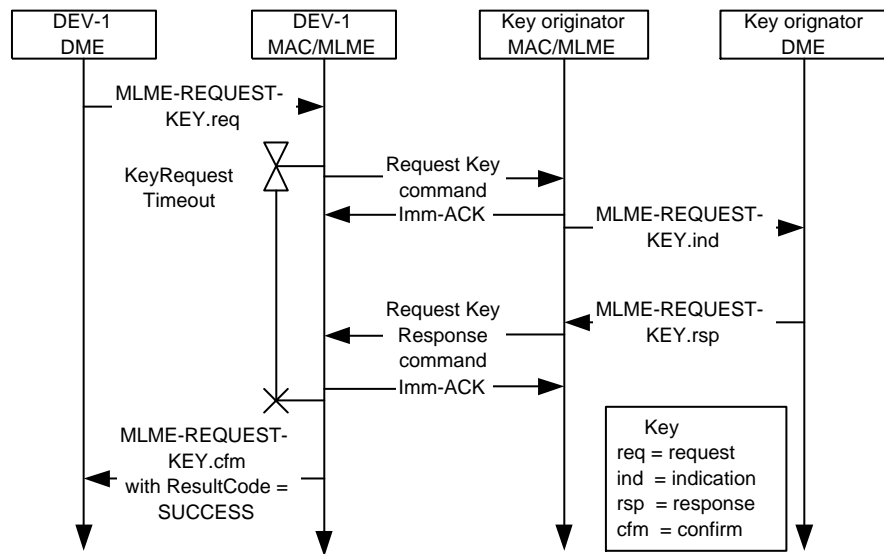


Figure 153—Message sequence chart for DEV key request

Suggested

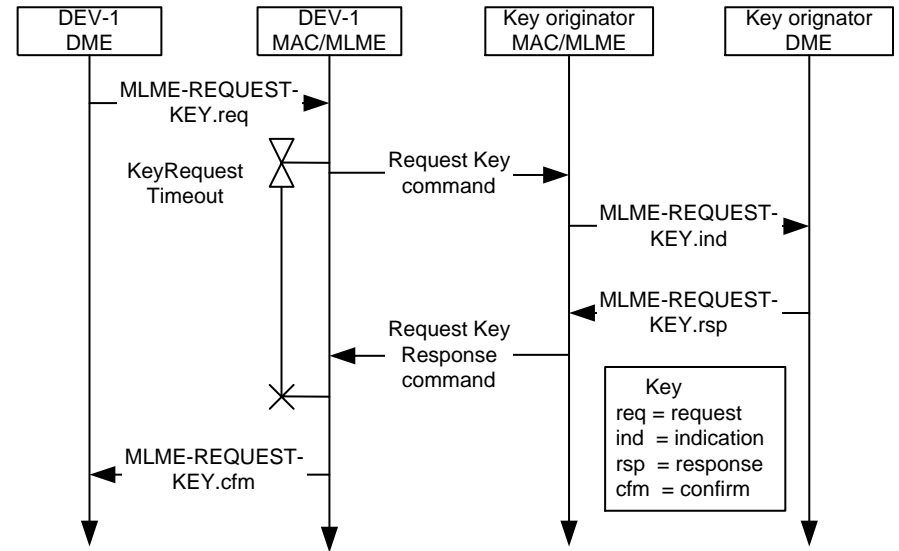


Figure 153—Message sequence chart for DEV key request

- Only change is Imm-ACKs removed.

Current

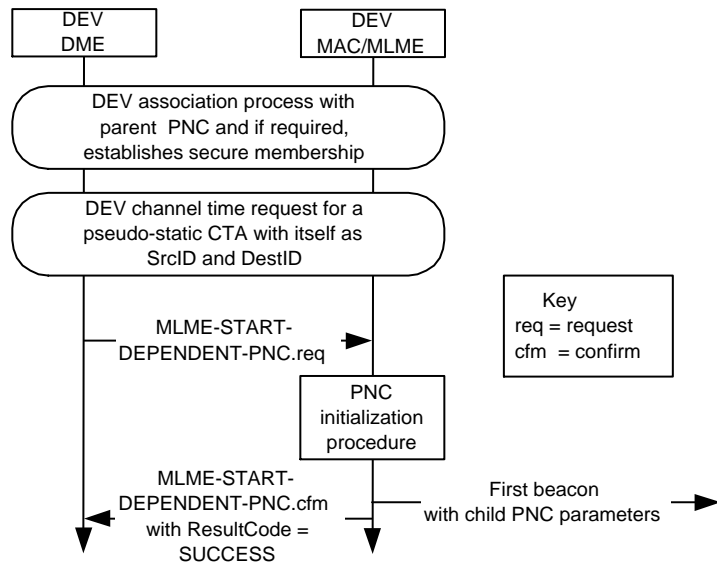


Figure 99 - MSC for creating a child piconet

Suggested

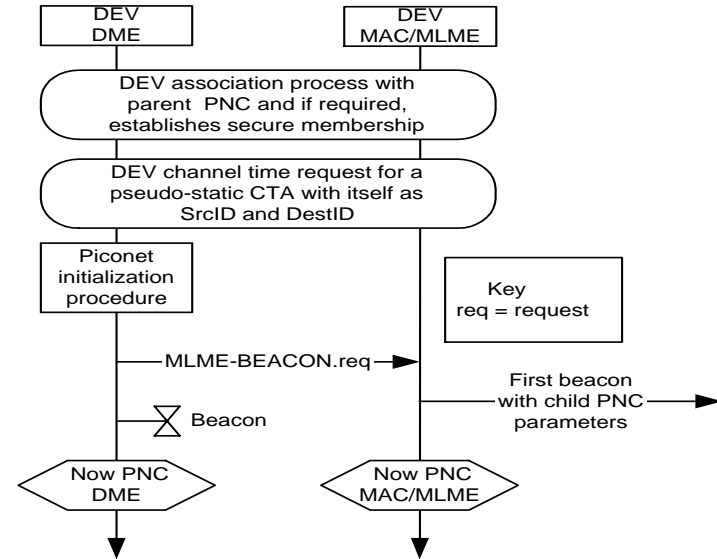


Figure 99 - MSC for creating a child piconet

- The PME (PNC DME) maintains the information that is contained in a beacon so a MLME-START primitive is no longer needed because the PME can simply make a request to send a beacon when it is ready to start a piconet.
- When a piconet is started, a Beacon timer is required for transmitting beacons at the superframe interval.

Current

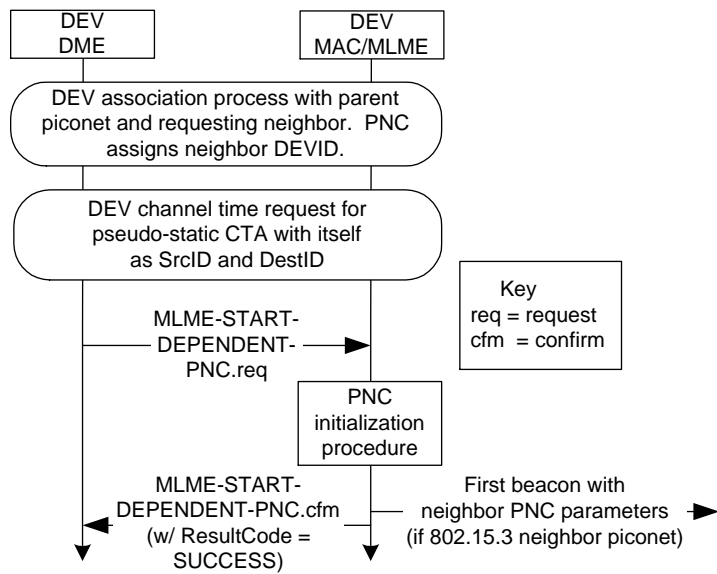


Figure 101 - MSC for initiating a neighbor piconet

Suggested

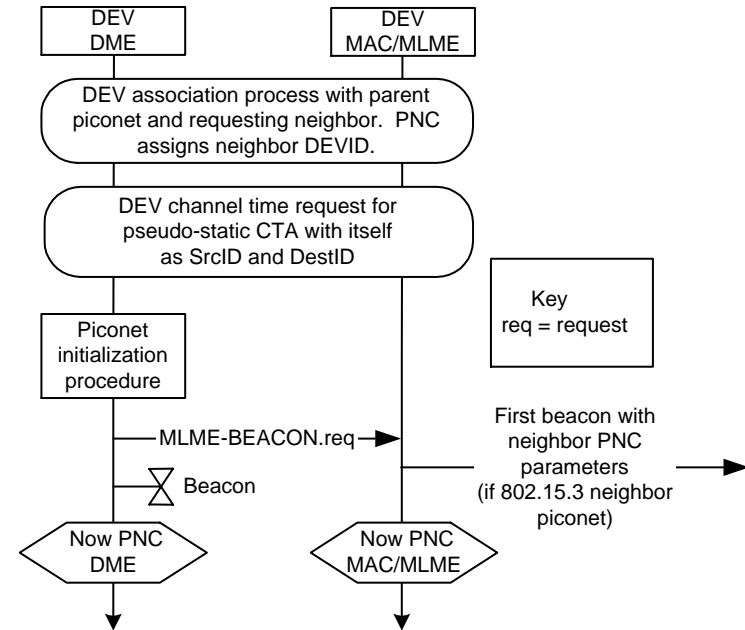


Figure 101 - MSC for initiating a neighbor piconet

- The PME (PNC DME) maintains the information that is contained in a beacon so a MLME-START primitive is no longer needed because the PME can simply make a request to send a beacon when it is ready to start a piconet.
- When a piconet is started, a Beacon timer is required for transmitting beacons at the superframe interval.

Current

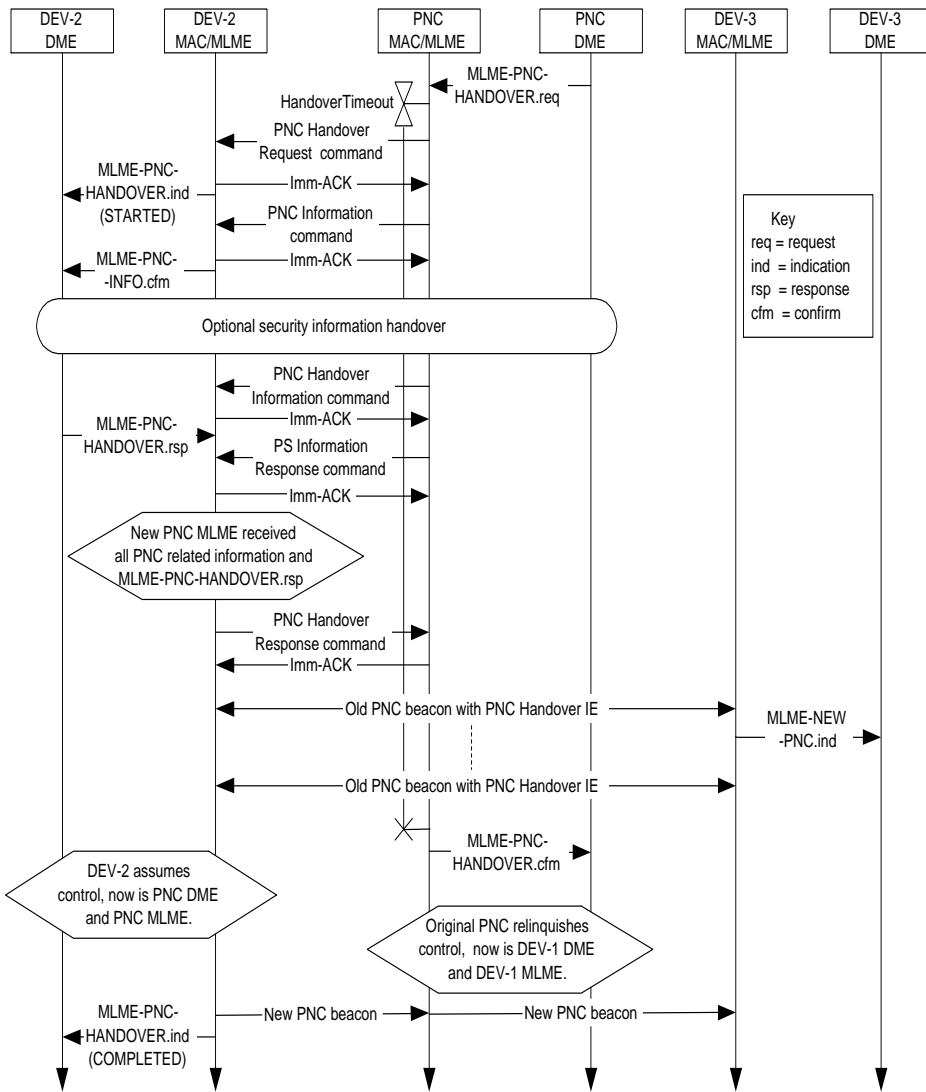


Figure 94 - PNC handover MSC

Suggested

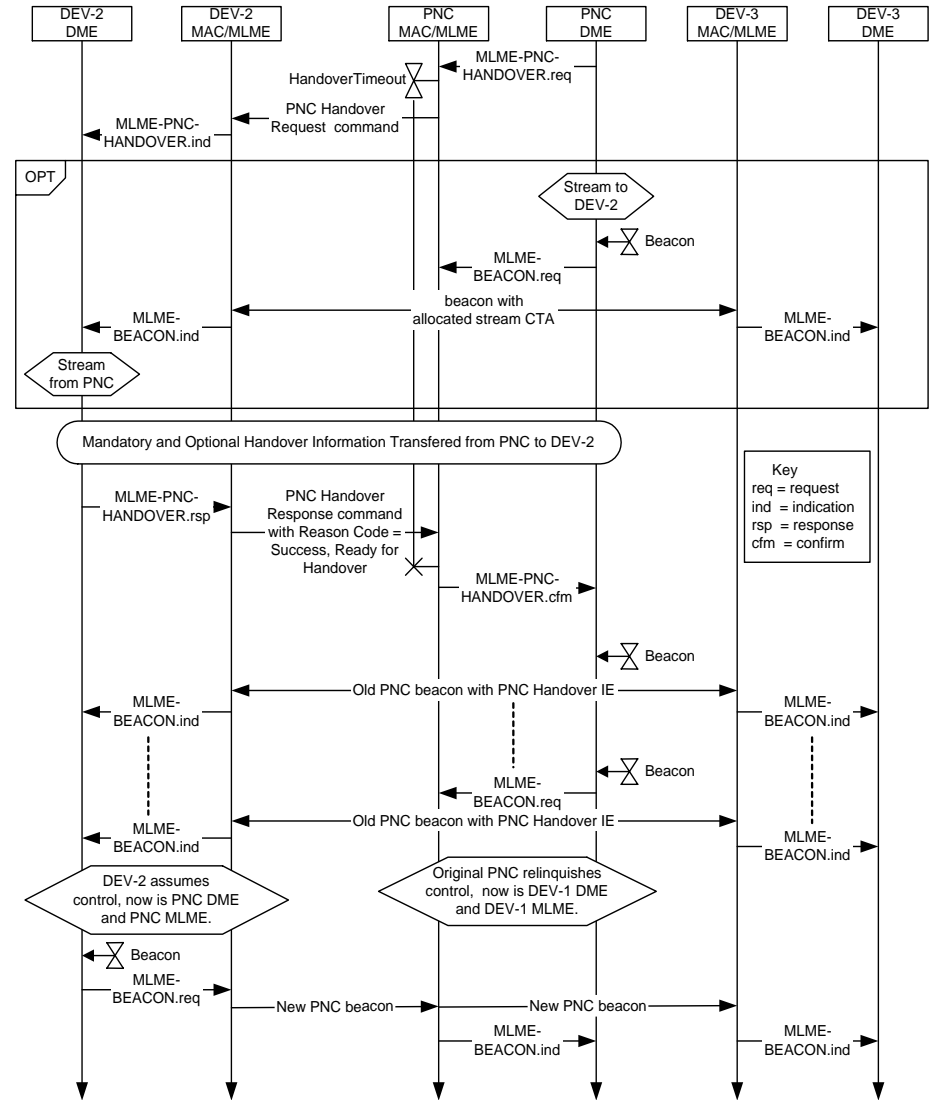
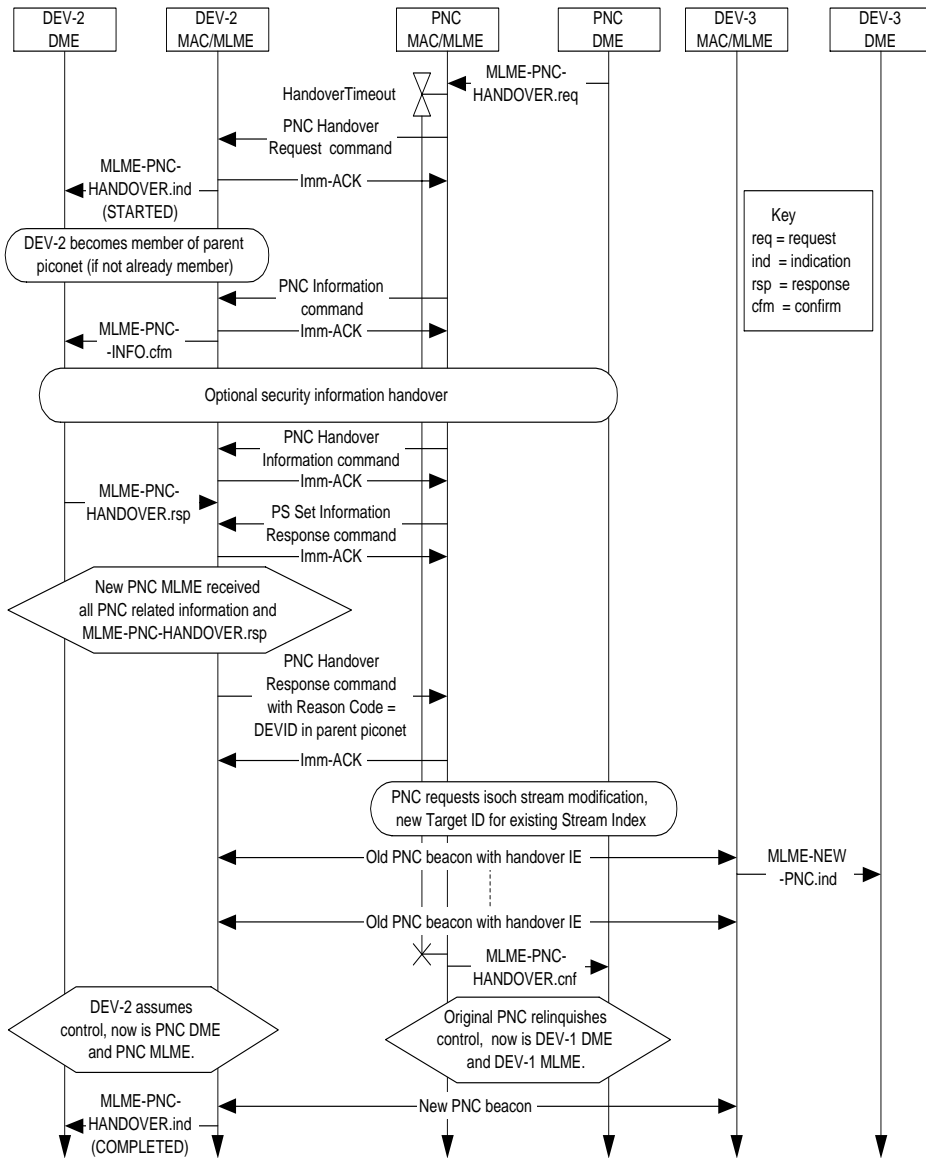


Figure 94 - PNC handover MSC

- Shows handover data is optionally transferred in a stream.

Current



Suggested

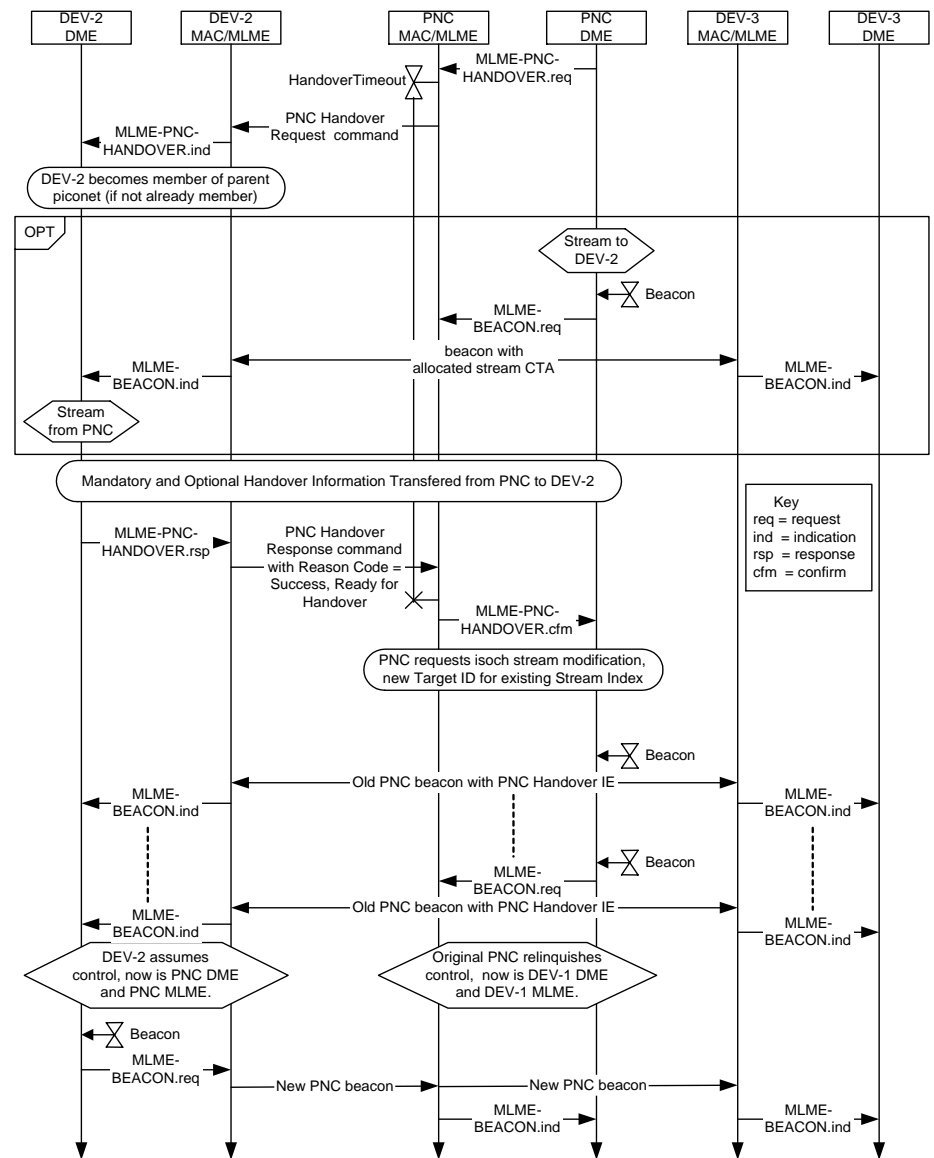


Figure 95 - Successful PNC handover in a dependent piconet

Figure 95 - Successful PNC handover in a dependent piconet

Current

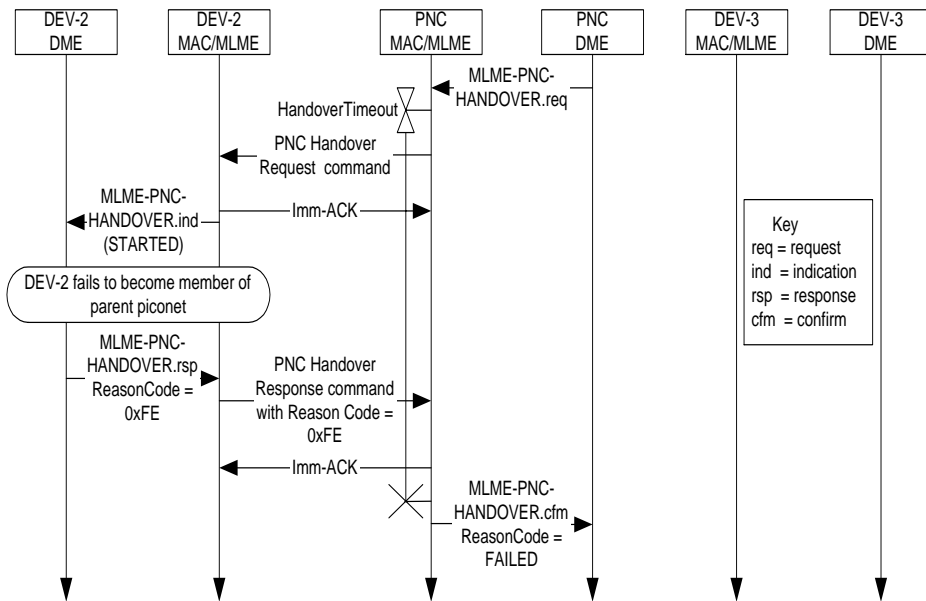


Figure 96 - Failed dependent PNC handover when target DEV fails to join parent piconet

Suggested

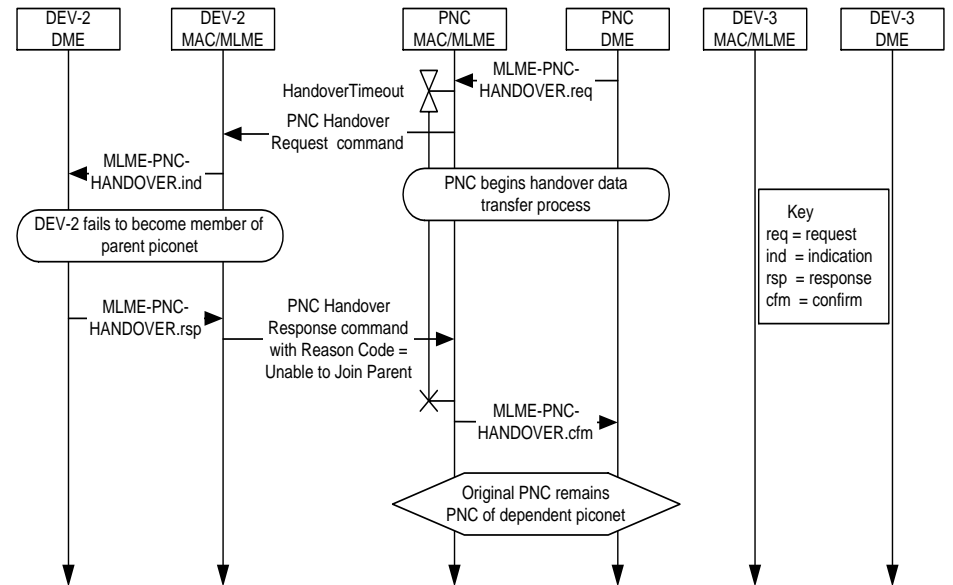


Figure 96 - Failed dependent PNC handover when target DEV fails to join parent piconet

Current

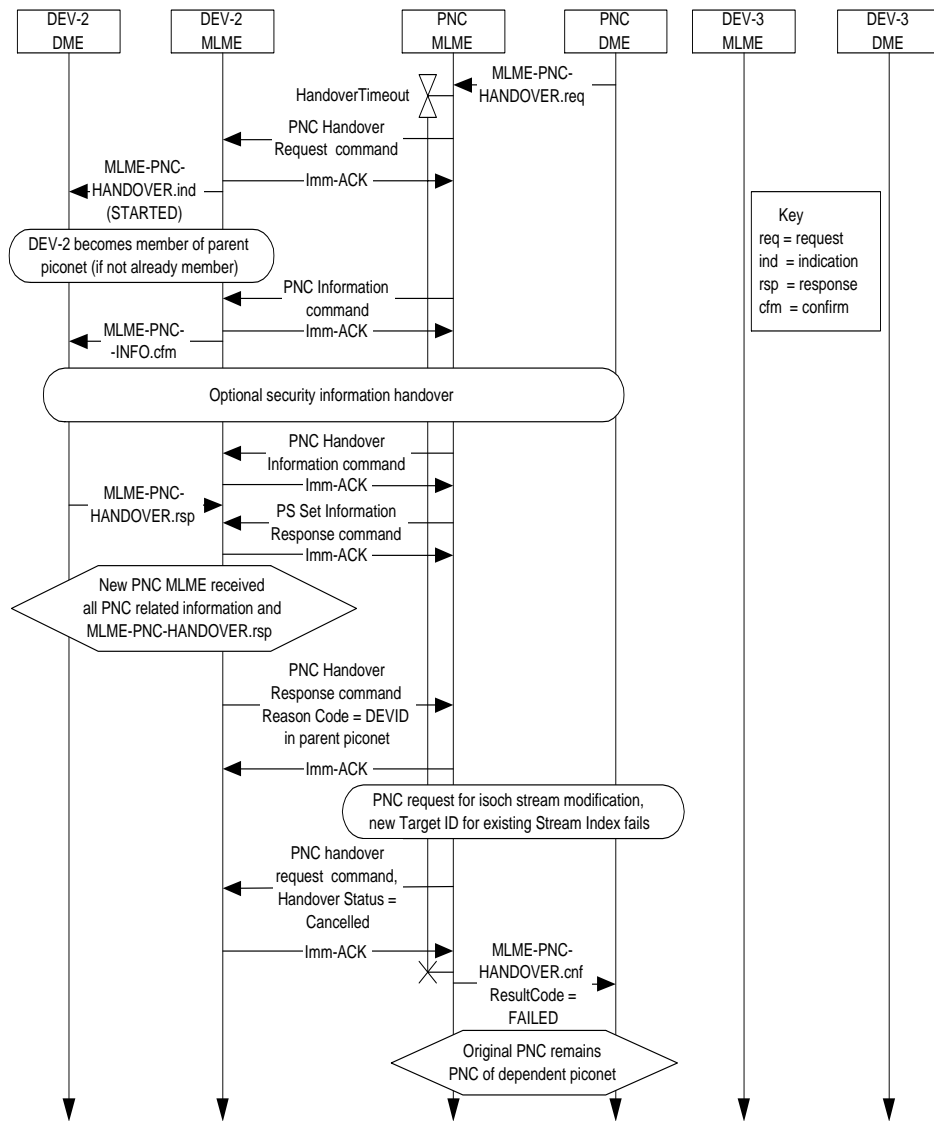


Figure 97 - Failed dependent PNC handover when control for the dependent piconet CTA is handed over in the parent piconet

Suggested

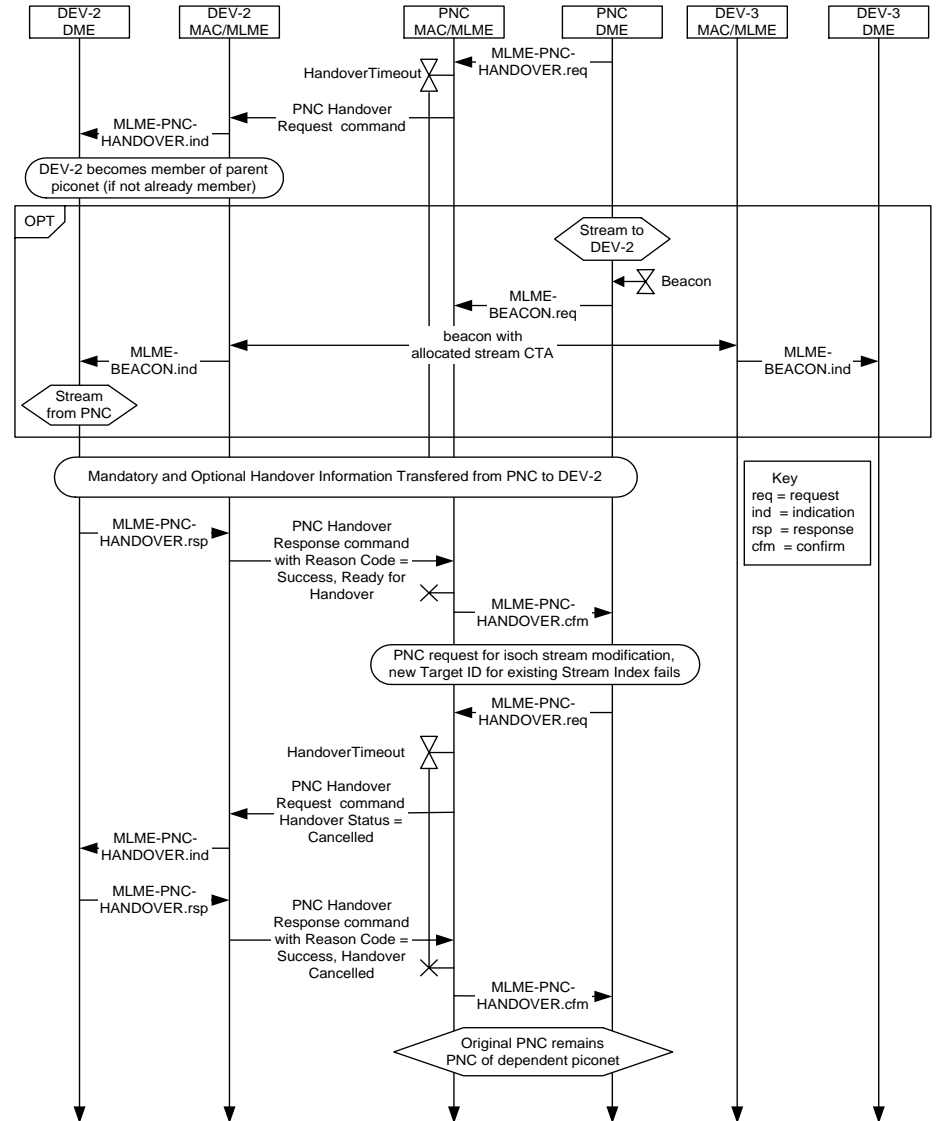


Figure 97 - Failed dependent PNC handover when control for the dependent piconet CTA is handed over in the parent piconet

3. MLME Impact Summary

The following identifies the necessary changes to the existence of MLME primitives based on the suggested MSCs in the previous section.

Table 1: Summary of MLME primitives

Name	Request	Indication	Response	Confirm
MLME-RESET	X			
MLME-SCAN	X			X
MLME-START	X			X
MLME-START-DEPENDENT	X			X
MLME-SYNCH	X			X
MLME-ATP-EXPIRED		X		
MLME-ASSOCIATE	X	X	X	X
MLME-DEV-ASSOCIATION-INFO		X		
MLME-DISASSOCIATE	X	X		X
MLME-REQUEST-KEY	X	X	X	X
MLME-DISTRIBUTE-KEY	X	X	X	X
MLME-MEMBERSHIP-UPDATE	X			
MLME-SECURITY-ERROR		X		
MLME-SECURITY-MESSAGE	X	X		X
MLME-PNC-HANDOVER	X	X	X	X
MLME-NEW-PNC		X		
MLME-PNC-INFO	X	X	X	X
MLME-SECURITY-INFO	X	X	X	X
MLME-CREATE-ASIE	X			X
MLME-RECEIVE-ASIE		X		
MLME-PROBE	X	X	X	X
MLME-ANNOUNCE	X	X	X	X

Table 1: Summary of MLME primitives (Continued)

Name	Request	Indication	Response	Confirm
MLME-PICONET-SERVICES		X	X	X
MLME-CREATE-STREAM	X	X	X	X
MLME-MODIFY-STREAM	X	X	X	X
MLME-TERMINATE-STREAM	X	X	X	X
MLME-MULTICAST-RX-SETUP	X			
MLME-CHANNEL-STATUS	X	X	X	X
MLME-REMOTE-SCAN	X	X	X	X
MLME-PICONET-PARM-CHANGE	X			X
MLME-TX-POWER-CHANGE	X	X		X
MLME-PS-SET-INFORMATION	X	X	X	X
MLME-SPS-CONFIGURE	X	X	X	X
MLME-PM-MODE-CHANGE	X	X	X	X
MLME-PM-MODE-ACTIVE		X		
MLME-BEACON	X	X		

The following table shows the fully editing MLME table after all deletions and additions.

Table 2: Summary of MLME primitives

Name	Request	Indication	Response	Confirm
MLME-RESET	X			
MLME-SCAN	X			X
MLME-ATP-EXPIRED		X		
MLME-ASSOCIATE	X	X	X	X
MLME-DISASSOCIATE	X	X		
MLME-REQUEST-KEY	X	X	X	X
MLME-DISTRIBUTE-KEY	X	X	X	X
MLME-MEMBERSHIP-UPDATE	X			
MLME-SECURITY-ERROR		X		
MLME-SECURITY-MESSAGE	X	X		
MLME-PNC-HANDOVER	X	X	X	X
MLME-PNC-INFO	X	X	X	X
MLME-SECURITY-INFO	X	X	X	X
MLME-PROBE	X	X	X	X
MLME-ANNOUNCE	X	X	X	X
MLME-PICONET-SERVICES			X	X
MLME-CREATE-STREAM	X	X	X	X
MLME-MODIFY-STREAM	X	X	X	X
MLME-TERMINATE-STREAM	X	X	X	X
MLME-MULTICAST-RX-SETUP	X			
MLME-CHANNEL-STATUS	X	X	X	X
MLME-REMOTE-SCAN	X	X	X	X
MLME-PS-SET-INFORMATION	X	X	X	X
MLME-SPS-CONFIGURE	X	X	X	X

Table 2: Summary of MLME primitives (Continued)

Name	Request	Indication	Response	Confirm
MLME-PM-MODE-CHANGE	X	X	X	X
MLME-BEACON	X	X		

4. Command Impact Summary

The following commands would need to be renamed if the suggested MSCs of section 2 were adopted.

- Transmit Power Change becomes Transmit Power Change Request
- PM Mode Change becomes PM Mode Change Request

The following commands would need to be created if the suggested MSCs of section 2 were adopted. Note that these commands will likely have zero length payloads or only a reason code.

- Announce Response
- Transmit Power Change Response
- PM Mode Change Response