



**IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements**

**Part 15.3: Wireless Medium Access Control
(MAC) and Physical Layer (PHY)
Specifications for High Rate Wireless
Personal Area Networks (WPANs)**

Amendment 1: MAC Sublayer

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997, USA
5 May 2006

IEEE Std 802.15.3b™-2005
(Amendment to
IEEE Std 802.15.3™-2003)

*Recognized as an
American National Standard (ANSI)*

IEEE Std 802.15.3b™-2005

(Amendment to
IEEE Std 802.15.3™-2003)

**IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements**

**Part 15.3: Wireless Medium Access Control
(MAC) and Physical Layer (PHY)
Specifications for High Rate Wireless
Personal Area Networks (WPANs):**

Amendment 1: MAC Sublayer

Sponsor

**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 28 March 2006

American National Standards Institute

Approved 6 December 2005

IEEE-SA Standards Board

Abstract: This amendment provides corrections and optimizations to IEEE Std 802.15.3-2003. The management service access points (SAPs) have been completely updated to create a consistent, logical interface. As a consequence, most of the message sequence charts (MSCs) in the medium access control (MAC) functional specification have been updated as well. Channel time usage is more efficient with the addition of multiple contention periods, releasing channel time, implied acknowledgment, and multicast groups.

Keywords: channel time reuse, handover, implied acknowledgment, multicast, wireless personal area network, WPAN

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2006 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 5 May 2006. Printed in the United States of America.

IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

Print: ISBN 0-7381-4872-5 SH95506
PDF: ISBN 0-7381-4873-3 SS95506

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied “**AS IS.**”

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854
USA

NOTE—Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Introduction

This introduction is not part of IEEE Std 802.15.3b-2005, IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 15.3: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for High Rate Wireless Personal Area Networks (WPANs)—Amendment 1: MAC Sublayer.

IEEE Std 802.15.3b-2005 is an amendment to IEEE Std 802.15.3-2003 that fixes mistakes, clarifies the intent of the original standard, and adds enhancements that improve the efficiency of the base standard. The continuing goal of this standard is to enable low-cost, low-power, high-speed wireless multimedia applications for portable and stationary consumer electronic devices. In addition to the minor corrections, some of the key changes/additions in this amendment are as follows:

- A new definition of the medium access control (MAC) layer management entity (MLME) service access point (SAP) so that it now provides a consistent interface.
- A new acknowledgment (ACK) policy, implied-ACK, which allows polling and a more efficient use of channel time.
- An additional data frame, the logical link control/subnetwork access protocol (LLC/SNAP), which allows multiple protocols to share a single data connection.
- A method for relinquishing time in a channel time allocation (CTA) to allow another device (DEV) time to transmit data.
- The allowing of a DEV to return information about a signal quality of a received packet in an ACK frame.
- The ability to assign device identifiers (DEVIDs) to group addresses to allow multicast connections.
- Faster recovery of network operations when the piconet coordinator (PNC) abruptly disconnects with the conditional handover and the next PNC processes.
- A protocol by which a DEV can request that the PNC place an application-specific information element (ASIE) in the beacon.
- The allowing of multiple contention periods during a superframe.

Interest in working on an amendment to fix and enhance IEEE Std 802.15.3 began in the September 2003 meeting in Singapore. A study group was formed at the November 2003 meeting in Albuquerque, which completed a project authorization request that was approved in March 2004. Work progressed quickly, and the first task group letter ballot was successfully completed in March 2005. After one recirculation, the draft began sponsor ballot in August 2005. The ballot was successful, and after a recirculation ballot to validate some minor changes, IEEE Std 802.15.3b was approved by the IEEE Standards Board on 6 December 2005, just over two years after the study group started.

Notice to users

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents or patent applications for which a license may be required to implement an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Conformance test methodology

An additional standards series, identified by the number 1802™, has been established to identify the conformance test methodology documents for the IEEE 802® family of standards. Thus the conformance test documents for IEEE 802.3™ are numbered 1802.3™, the conformance test documents for IEEE 802.5™ will be 1802.5™, and so on. Similarly, ISO will use 18802 to number conformance test standards for 8802 standards.

Participants

At the time this standard was completed, the IEEE 802.15 Working Group had the following officers:

Robert F. Heile, *Chair*
James D. Allen, *Vice-Chair*
Patrick Kinney, *Vice-Chair/Secretary*
James P. K. Gilb, *Technical Editor*

When the IEEE 802.15 Working Group approved this standard, Task Group 3b had the following membership:

John R. Barr, *802.15.3b Chair*
James D. Allen, *802.15.3b Vice Chair*
James P. K. Gilb, *802.15.3b Technical Editor*
John Sarallo, *802.15.3b Assistant Editor*

Roberto Aiello
Richard Alfvén
Kyu Hwan An
Mikio Aoki
Yasuyuki Arai
Takashi Arita
Larry Arnett
Naiel Askar
Arthur Astrin
Yasaman Bahreini
Jay Bain
Feng Bao
Anuj Batra
Phil Beecher
Bruce Bosco
Monique Bourgeois Brown
Mark Bowles
Charles Brabenac
David Brenner
Vern Brethour

Ronald Brown
Ed Callaway
Pat Carson
Kisoo Chang
Jonathon Cheah
Francois Chin
Kwan-Wu Chin
Yu-Chang Chiu
Sarm-Goo Cho
Sangsung Choi
Chia-Chin Chong
Manoj Choudhary
Celestino Corral
Robert Charles Cragie
Scott Davis
Joe Decuir
Javier Del Prado Pavon
Kai Dombrowski
Stefan Drude
Eryk Dutkiewicz

Michael Dydyk
Jason Ellis
Shahriar Emami
Yew Soo Eng
Frederick Enns
Mark W. Fidler
Reed Fisher
Kristoffer Fleming
Ricardo Gandia Sanchez
Ian Gifford
Sung-Wook Goh
Sorin Goldenberg
Paul Gorday
Bernd Grohmann
Rainer Hach
Julian Hall
Robert Hall
Shinsuke Hara
Jeff Harris
Allen Heberling

Robert Heile
 Barry Herold
 Karl Heubaum
 Jin-Meng Ho
 Patrick Houghton
 Chi-Hao Huang
 Robert Huang
 Xiaojing Huang
 Akira Ikeda
 Tetsushi Ikegami
 Oyvind Janbu
 Yeong Min Jang
 Adrian Jennings
 Ho-In Jeon
 Hong Jiang (Chiang)
 Peter Johansson
 Jeyhan Karaoguz
 Michael Kelly
 Stuart Kerry
 Haksun Kim
 Jae-Hyon Kim
 Jaeyoung Kim
 Yongsuk Kim
 Young Hwan Kim
 Youngsoo Kim
 Kursat Kimyacioglu
 Matthias Kindler
 Patrick Kinney
 Guenter Kleindl
 Ryuji Kohno
 Yasushi Kudo
 Thomas Kuehnel
 Haim Kupersmidt
 Yuzo Kuramochi
 Kyung Sup Kwak
 Do-Hoon Kwon
 Ismail Lakkis
 John Lampe
 Colin Lanzl
 Dongjun Lee
 Hyung Soo Lee
 Kyung Kuk Lee
 Myung Lee
 Wooyong Lee
 David Leeper
 Israel Leibovich
 Henry Li
 Huan-Bang Li
 Liang Li
 Haixiang Liang
 Darryn Lowe
 Ian Macnamara
 Tadahiko Maeda
 Akira Maeki
 Patricia Martigne

Frederick Martin
 Abbie Mathew
 Taisuke Matsumoto
 Masafumi Matsumura
 Michael McLaughlin
 John McCorkle
 Michael McInnis
 Charlie Mellone
 Jim Meyer
 Klaus Meyer
 Akira Miura
 Hitoshi Miyasaka
 Samuel Mo
 Andreas Molisch
 Mark Moore
 Marco Naeve
 Ken Naganuma
 Yves Paul Nakache
 Hiroyuki Nakase
 Chiu Ngo
 Erwin Noble
 Mizukoshi Nobuyuki
 Masaki Noda
 Richard Noens
 John (Jay) O'Connor
 Knut Odman
 Yasuyuki Okuma
 Philip Orlick
 Laurent Ouvry
 John Pardee
 Jonghun Park
 Young Jin Park
 Dave Patton
 Miguel Pellon
 Xiaoming Peng
 Robert Poor
 Clinton Powell
 Vidyasagar Premkumar
 Yihong Qi
 Raad Raad
 Ajay Rajkumar
 Pekka Ranta
 Dani Raphaeli
 Gregg Rasor
 Charles Razzell
 Joseph Reddy
 Ivan Reede
 Yuko Rikuta
 Benno Ritter
 Terry Robar
 Richard Roberts
 Martin Rofheart
 Jaeho Roh
 Philippe Rouzet
 Chandos Rypinski

Saeid Safavi
 Zafer Sahinoglu
 Tomoki Saito
 Sidney Schrum
 Erik Schylander
 Alireza Seyedi
 Sanjeev Sharma
 Stephen Shellhammer
 John (Chih-Chung) Shi
 Shusaku Shimada
 Yuichi Shiraki
 Matthew Shoemake
 Gadi Shor
 William Shvodian
 Thomas Siep
 Michael Sim
 Kazimierz Siwiak
 Zachary Smith
 V. Somayazulu
 Carl Stevenson
 Marinus Struik
 Kazuaki Takahashi
 Kenichi Takizawa
 Teik-Kheong Tan
 Mike Tanahashi
 James Taylor
 John Terry
 Arnaud Tonnerre
 Jarvis Tou
 Jerry Upton
 Robin Vaitonis
 Bart Van Poucke
 Nanci Vogtli
 Jerry Wang
 Jing Wang
 Chris Weber
 Matthew Welborn
 Richard Wilson
 Gerald Wineinger
 Andreas Wolf
 Marcus Wong
 Timothy G. Wong
 Patrick Worfolk
 Tracy Wright
 Xiaodong Wu
 Yu-Ming Wu
 Hirohisa Yamaguchi
 Kamya Yekeh Yazdandoost
 Su-Khiong Yong
 Serdar Yurdakul
 Honggang Zhang
 Frank Xiaojun Zheng
 Zheng Zhou
 Chunhui Zhu

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention:

Toru Aihara	Sergiu R. Goma	Knut T. Odman
James D. Allen	Randall C. Groves	Satoshi Oyama
Butch Anton	Qiang Guo	Glenn W. Parsons
Mikio Aoki	C. G. Guy	Sunil Parthasarathy
Michael P. Baldwin	Siamack Haghighi	Subburajan Ponnuswamy
Charles L. Barest	Samudra E. Haque	Cam K. Posani
John B. Barnett	Allen D. Heberling	Vikram Punj
John R. Barr	Karl F. Heubaum	Jose P. Puthenkulam
Gennaro Boggia	Shui H. Heung	Philip T. Robinson
Matthew K. Burnburg	Dennis Horwitz	John C. Sargent III
William A. Byrd	Lalit R. Kotecha	Michael Scholles
Sean S. Cai	Jeremy A. Landt	Stephen C. Schwarm
James T. Carlo	Colin Lanzl	Perry L. Schwartz
Juan C. Carreon	Solomon Lee	George G. She
Jay Catelli	Tsungyu Lee	William M. Shvodian
Yi-Ming Chen	Charles A. Lennon Jr	Thomas M. Siep
Danila Chernetsov	Daniel G. Levesque	Zachary B. Smith
Aik Chindapol	Jan-Ray Liao	Jung Je Son
Todor V. Cooklev	William Lumpkins	Amjad A. Soomro
Tommy P. Cooper	G. L. Luri	Robert T. Soranno
Javier Del Prado Pavon	Steve Ma	Thomas E. Starai
Thomas J. Dineen	Ben L. Manny	Mark A. Sturza
Sourav K. Dutta	Kevin D. Marquess	Joseph J. Tardo
Carl Eklund	Jonathon C. McLendon	David W. Thompson
Marc Emmelmann	Francisco J. U. Melendez	Thomas A. Tullia
John W. Eng	George J. Miao	Mark-Rene Uchida
Avraham Freedman	Gary L. Michel	Thomas M. Wandeloski
John N. Fuller	William J. Mitchell	Stanley S. Wang
Devon L. Gayle	Ronald G. Murias	Hung-Yu Wei
Michael D. Geipel	M. Narayanan	Jason J. Wilden
Fernando Genkuong	Michael S. Newman	Chaehag Yi
Theodore Georgantas	Paul Nikolich	Takahito Yoshizawa
Ian C. Gifford	Erwin R. Noble	Oren Yuen
James P. K. Gilb	Robert O'Hara	Janusz Zalewski
Nikhil Goel		

Major technical contributions were received from the following individuals

James D. Allen	Karl Heubaum	Charlie Mellone
John R. Barr	Jin-Meng Ho	Knut Odman
Ian Gifford	Peter Johansson	Mike Rudnick
James P. K. Gilb	Chieh-Ying Kang	John Sarallo
Dan Grossman	Charlie Fox	Mark Schrader
Julian Hall	Colleen McGinn	Bill Shvodian
Allen Heberling		Larry Telle

When the IEEE-SA Standards Board approved this standard on 6 December 2005, it had the following membership:

Steve M. Mills, *Chair*
Richard H. Hulett, *Vice Chair*
Don Wright, *Past Chair*
Judith Gorman, *Secretary*

Mark D. Bowman
Dennis B. Brophy
Joseph Bruder
Richard Cox
Bob Davis
Julian Forster*
Joanna N. Guenin
Mark S. Halpin
Raymond Hapeman

William B. Hopf
Lowell G. Johnson
Herman Koch
Joseph L. Koepfinger*
David J. Law
Daleep C. Mohla
Paul Nikolich

T. W. Olsen
Glenn Parsons
Ronald C. Petersen
Gary S. Robinson
Frank Stone
Malcolm V. Thaden
Richard L. Townsend
Joe D. Watson
Howard L. Wolfman

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Satish K. Aggarwal, *NRC Representative*
Richard DeBlasio, *DOE Representative*
Alan H. Cookson, *NIST Representative*

Don Messina
IEEE Standards Project Editor

Contents

3.	Definitions	1
4.	Acronyms and abbreviations	2
6.	Layer management.....	2
6.1	Overview of management model.....	2
6.2	Generic management primitives	3
6.2.1	MLME-GET.request and PLME-GET.request	4
6.2.2	MLME-GET.confirm and PLME-GET.confirm	5
6.2.3	MLME-SET.request and PLME-SET.request	5
6.2.4	MLME-SET.confirm and PLME-SET.confirm	5
6.3	MLME SAP interface	5
6.3.1	Resetting the MAC/MLME	7
6.3.2	Scanning for piconets.....	8
6.3.3	Starting a piconet	11
6.3.4	Stopping a piconet	13
6.3.5	Associating with a piconet.....	14
6.3.6	Disassociation from a piconet.....	16
6.3.7	Security management.....	17
6.3.8	PNC handover.....	20
6.3.9	Requesting DEV information from the PNC	21
6.3.10	Security information retrieval	22
6.3.11	Application specific data management	24
6.3.12	Piconet services management	26
6.3.13	Stream management.....	29
6.3.14	Piconet parameter management.....	33
6.3.15	Power management.....	34
6.3.16	Multicast operations.....	39
6.3.17	Timing synchronization	41
6.5	MAC management.....	42
6.5.1	MAC PIB PNC group	42
6.5.2	MAC PIB characteristics group	43
6.6	MAC SAP	44
6.6.1	MAC-ASYNC-DATA.request	46
6.6.2	MAC-ASYNC-DATA.confirm	46
6.6.3	MAC-ASYNC-DATA.indication	47
6.6.4	MAC-ISOCH-DATA.request	47
6.6.5	MAC-ISOCH-DATA.confirm.....	47
6.6.6	MAC-ISOCH-DATA.indication.....	48
7.	MAC frame formats.....	48
7.1	Frame format conventions	48
7.2	General frame format.....	49
7.2.1	Frame control	49
7.2.3	SrcID and DestID.....	50
7.2.4	Fragmentation control.....	51
7.2.5	Stream index	51
7.2.6	MAC header validation.....	51
7.2.7	MAC frame body	51

7.3	Format of individual frame types.....	52
7.3.1	Beacon frame	52
7.3.2	Acknowledgment frames	52
7.3.4	Data frame.....	53
7.3.5	LLC/SNAP data frame.....	53
7.4	Information elements	54
7.4.2	BSID	54
7.4.7	Application specific	54
7.4.10	CTA status	55
7.4.11	Capability.....	55
7.4.16	Piconet services.....	56
7.4.18	Group ID	57
7.4.19	Stream renew	57
7.4.20	Next PNC.....	57
7.4.21	Piconet channel status	58
7.5	MAC command types	58
7.5.1	Association and disassociation commands	59
7.5.3	PNC handover commands	59
7.5.4	Information request commands	59
7.5.5	Information announcement commands.....	60
7.5.6	Channel time allocation request, modification, and termination commands.....	61
7.5.7	Channel status commands.....	63
7.5.8	Power management commands	63
7.5.9	Special commands	64
7.5.10	Multicast configuration commands	65
8.	MAC functional description	66
8.1	Introduction.....	66
8.2	Starting, maintaining, and stopping piconets.....	67
8.2.1	Scanning through channels	67
8.2.2	Starting a piconet	68
8.2.3	PNC handover.....	68
8.2.3a	Preliminary handover.....	71
8.2.3b	Next PNC.....	72
8.2.4	Dependent PNC handover	73
8.2.5	Child piconet.....	75
8.2.6	Neighbor piconet.....	76
8.2.7	Stopping piconet operations.....	77
8.3	Association and disassociation with a piconet.....	78
8.3.1	Association.....	78
8.3.2	Piconet services.....	80
8.3.3	Broadcasting piconet information.....	82
8.3.4	Disassociation	82
8.4	Channel access.....	83
8.4.1	Interframe space (IFS)	84
8.4.2	<u>Carrier sense multiple access with collision avoidance (CSMA/CA)</u> <u>Contention-based channel access</u>	84
8.4.3	Channel time allocation period channel access	85
8.5	Channel time management.....	89
8.5.1	Isochronous stream management.....	89
8.5.2	Asynchronous channel time reservation and termination.....	96
8.5.3	Multicast group configuration	97
8.6	Synchronization	99

8.6.2	Beacon generation.....	99
8.6.3	Beacon reception.....	99
8.6.4	Beacon information announcement	100
8.8	Acknowledgment and retransmission.....	100
8.8.3	Delayed acknowledgment.....	100
8.8.3a	Implied acknowledgment (Imp-ACK).....	101
8.8.4	Retransmissions	103
8.9	Peer discovery.....	103
8.9.1	PNC information request	103
8.9.2	Probe request and response.....	103
8.9.3	Announce command	104
8.9.4	Channel status request	104
8.9.5	Remote scan	104
8.9.6	PNC channel scanning	104
8.10	Changing piconet parameters.....	104
8.10.3	Setting the PNID or BSID	104
8.11	Interference mitigation.....	105
8.11.1	Dynamic channel selection	105
8.11.2	Transmit power control.....	106
8.13	Power management.....	106
8.13.1	Piconet synchronized power save (PSPS) mode.....	107
8.13.2	Device synchronized power save (DSPS) mode.....	107
8.13.4	Message sequence charts for power save modes	107
8.14	ASIE operation	111
8.15	MAC parameters.....	114
9.	Security	114
9.1	Security mechanisms	114
9.1.1	Security membership and key establishment.....	114
9.1.4	Data integrity	114
9.1.6	Command integrity protection.....	115
9.3	Security support.....	115
9.3.4	Membership update.....	115
9.3.5	Secure frame generation	116
9.3.6	Secure frame reception	116
9.3.8	Key selection.....	117
9.4	Protocol details	118
9.4.1	Security information request and distribution	118
9.4.2	Key distribution protocol	119
9.4.3	Key request protocol.....	120
10.	Security specifications	120
10.2	Symmetric cryptography building blocks.....	120
10.2.4	Nonce value	120
11.	PHY specification for the 2.4 GHz band	121
11.2	General requirements.....	121
11.2.7	PHY layer timing.....	121
11.7	PHY management	121

Annex A (normative) Frame convergence sublayer	124
A.1 Generic convergence sublayer	124
A.1a ~~A.1.1~~ FCSL PDU classification	124
A.1b ~~A.1.2~~ IEEE 802.2 FCSL	125
A.1b.1 ~~A.1.2.1~~ IEEE 802.2 FCSL QoS support	125
A.1b.2 ~~A.1.2.2~~ Data entity inter-relationships	125
A.2 802.2 FCSL SAP	126
A.2.1 MA-UNITDATA.request	126
A.2.3 MA-UNITDATA-STATUS.indication	127
Annex B (informative) Security considerations	128
B.1 Background assumptions	128
B.1.4 Security key lifecycle issues	128
B.3 Properties of the 802.15.3 security suite	128
B.3.1 Key usage	128
B.3.2 Replay prevention	128
Annex D (normative) Protocol implementation conformance statement (PICS) proforma	130
D.7 PICS proforma—IEEE Std. 802.15.3-2003	130
D.7.1 Major roles for IEEE 802.15.3 DEVs	130
D.7.2 PHY functions	130
D.7.3 Major capabilities for the MAC sublayer	131
Annex D1 (informative) Implementation considerations	134
D1.1 Channel time requests	134
D1.1.1 Types of CTAs	134
D1.1.2 Interpretation of channel time requests	135
D1.1.3 Determining CTA Rate Factor from stream requirements	136
D1.1.4 PNC interpretation of CTA rate factor	138
D1.1.5 Creating channel time requests from MLME requests	139
D1.1.6 Interpreting channel time requests	141
D1.2 Sample frames	143
D1.3 64-bit DEV address mapping	145
Annex E (informative) Bibliography	146

**IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements**

**Part 15.3: Wireless Medium Access Control
(MAC) and Physical Layer (PHY)
Specifications for High Rate Wireless
Personal Area Networks (WPANs):**

Amendment 1: MAC Sublayer

[This amendment is based on IEEE Std 802.15.3™-2003.]

NOTE—The editing instructions contained in this amendment define how to merge the material contained herein into the existing base standard to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strike through~~ (to remove old material) or underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instructions. ***Replace*** is used to make changes in figures or equations by removing existing figure or equation and replacing it with a new one. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

3. Definitions

Delete the following definition:

3.13 ~~device host~~: The equipment that incorporates an 802.15.3™ device. The device host may have more than one device incorporated in it as well as other networking connections, both wired and wireless.

Change the definition for 3.24 as shown:

3.24 parent piconet: A piconet which creates channel time allocations ~~allocates guaranteed time slots~~ for another piconet (child or neighbor types) operating in the same channel.

Insert the following definitions in alphabetical order:

3.43 implicit handover: A procedure by which a device (DEV) becomes the piconet coordinator (PNC) when the DEV determines that the old PNC either is no longer active or is out of range and without the old PNC explicitly indicating that the handover will take place.

3.44 preliminary handover: The process of transferring all of the necessary handover information from the piconet coordinator (PNC) to another device (DEV) while not handing over control of the piconet.

4. Acronyms and abbreviations

Insert the following acronyms:

CP	contention period
Imp-ACK	implied acknowledgment
NAK	negative acknowledgment
PAL	protocol adaptation layer
SNAP	subnetwork access protocol
STP	stream timeout period

Delete the following acronym:

DEV-host	device-host
----------	-------------

6. Layer management

6.1 Overview of management model

Change the first and second paragraphs in 6.1 as shown:

Both MAC and PHY layers conceptually include management entities, called the MAC sublayer management entity and PHY layer management entity (MLME and PLME, respectively). These entities provide the layer management service interfaces for the layer management functions. Figure 3 depicts the relationship among the management entities. The protocol adaptation layer (PAL) includes both the FCSL and DME. The reference model depicts the interactions of a single PAL in a single piconet; support for multiple piconets and/or PALs is implementation-dependent.

~~In order to provide correct MAC operation, a device management entity (DME) should be present within each DEV. The DME is a layer-independent entity that may be viewed as residing in a separate management plane or as residing off to the side. The exact functionality of the DME is not specified in this standard, but in general this entity may be viewed as being responsible for such functions as the gathering of layer-dependent status from the various layer management entities, and similarly setting the value of layer-specific parameters. The DME typically performs such functions on behalf of the general system management entities and implements standard management protocols. Figure 3 depicts the relationship among the management entities.~~

Replace Figure 3 with the figure below:

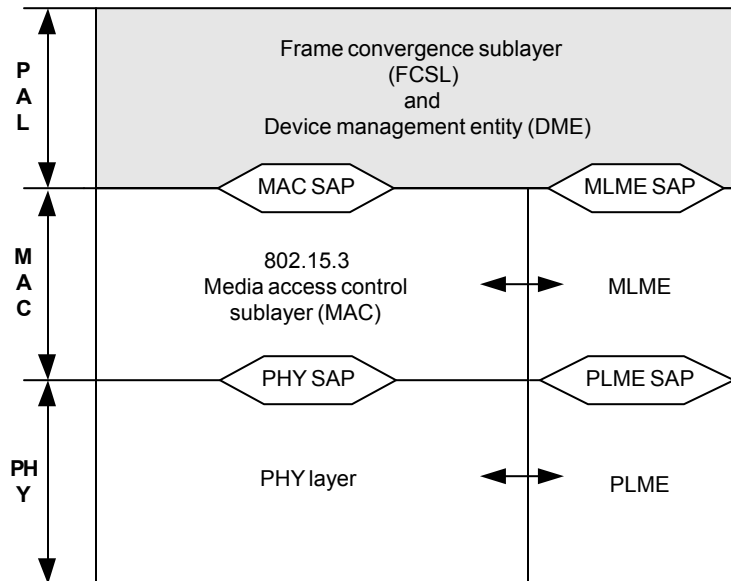


Figure 3—The reference model used in this standard

Change the fourth paragraph in 6.1 as shown and reletter the list:

The various SAPs within this model are the following:

- a) ~~FCSL-PAL~~ SAP (not shown)
- b) MAC SAP
- c) ~~PHY~~ SAP
- d) MLME SAP
- e) ~~PLME~~ SAP
- f) ~~MLME-PLME~~ SAP

In 6.1, delete the fifth paragraph, which states “The latter two SAPs support” Insert the following paragraph in its place:

The PHY SAP and PLME SAP are not defined in this standard as they are rarely, if ever, exposed in a typical implementation. The PHY management objects and attributes are accessed through the MLME SAP with the generic management primitives defined in 6.2.

In 6.1, delete the eighth paragraph, which states “The split in functionality”

6.2 Generic management primitives

Insert the following sentence at the end of the second paragraph in 6.2:

An attempt to “GET” a PIB attribute identified as “write only” attribute is not a valid operation. An attempt to “SET” a PIB attribute identified as a “read only” attribute is not a valid operation.

Change the third paragraph in 6.2 as shown:

The GET and SET primitives are represented as requests with associated confirm primitives. ~~These primitives are prefixed by MLME or PLME depending upon whether the MAC or PHY layer management SAP is involved. The DME uses the services provided by the MLME through the MLME SAP to access the management objects in either the MAC PIB or PHY PIB. The primitives are summarized in Table 1. In Table 1 and in the subclauses that describe the primitives, XX denotes either MLME or PLME.~~

Change Table 1 as shown:

Table 1—Summary of generic management primitives

Name	Request	Confirm
~~XX~~ MLME-GET	6.2.1	6.2.2
~~XX~~ MLME-SET	6.2.3	6.2.4

Change Table 2 as shown:

Table 2—MLME and PLME generic management primitive parameters

Name	Type	Valid range	Description
PIBattribute	Octet string	Any PIB attribute as defined in 6.5 or 11.7	The name of the PIB attribute
PIBvalue	Variable	As defined in 6.5 or 11.7	The PIB value
ResultCode	Enumeration	SUCCESS, FAILURE ~~INVALID_PIB_ATTRIBUTE_NAME,~~ ~~INVALID_PIB_ATTRIBUTE_VALUE,~~ ~~READ_ONLY_PIB_ATTRIBUTE,~~ ~~WRITE_ONLY_PIB_ATTRIBUTE~~	Indicates the result of the MLME or PLME request.
<u>ReasonCode</u>	<u>Enumeration</u>	<u>INVALID_PIB_ATTRIBUTE_NAME,</u> <u>INVALID_PIB_ATTRIBUTE_VALUE,</u> <u>READ_ONLY_PIB_ATTRIBUTE,</u> <u>WRITE_ONLY_PIB_ATTRIBUTE</u>	<u>Indicates the reason for a ResultCode of FAILURE</u>

Change the title of 6.2.1 as shown:

6.2.1 MLME-GET.request and ~~PLME-GET.request~~

Change the primitive semantics in 6.2.1 as shown:

~~XX~~MLME-GET.request
(
PIBattribute
)

Delete 6.2.1.1 and 6.2.1.2.

Change the title of 6.2.2 as shown:

6.2.2 MLME-GET.confirm and ~~PLME-GET.confirm~~

Change the primitive semantics in 6.2.2 as shown:

```

XXMLME-GET.confirm      (
                           ResultCode,
                           PIBattribute,
                           PIBvalue,
                           ResultCode,
                           ReasonCode
                           )

```

Delete 6.2.2.1 and 6.2.2.2.

Change the title of 6.2.3 as shown:

6.2.3 MLME-SET.request and ~~PLME-SET.request~~

Change the primitive semantics in 6.2.3 as shown:

```

XXMLME-SET.request      (
                           PIBattribute,
                           PIBvalue
                           )

```

Delete 6.2.3.1 and 6.2.3.2.

Change the title of 6.2.4 as shown:

6.2.4 MLME-SET.confirm and ~~PLME-SET.confirm~~

Change the primitive semantics in 6.2.4 as shown:

```

XXMLME-SET.confirm      (
                           ResultCode,
                           PIBattribute,
                           ResultCode,
                           ReasonCode
                           )

```

Delete 6.2.4.1 and 6.2.4.2.

6.3 MLME SAP interface

Change the paragraph in 6.3 as shown:

The services provided by the MLME to the DME are specified in this subclause. These services are described in an abstract way and do not imply any particular implementation or exposed interface. MLME SAP primitives are of the general form ACTION.request followed by ACTION.confirm. An ACTION.indication provides information to the DME that originated either in the local MAC or from another DEV. The ~~DEV~~ DME optionally responds to the indication by issuing an ACTION.response. The DME uses the services provided by the MLME through the MLME SAP. The MLME interface models a single piconet

environment; support for multiple piconets is implementation-dependent. The primitives are summarized in Table 3.

Delete Table 3 and insert the following table in its place:

Table 3—Summary of MLME primitives

Name	Request	Confirm	Indication	Response
MLME-RESET	6.3.1.1	6.3.1.2	—	—
MLME-SCAN	6.3.2.1	6.3.2.2	6.3.2.3	—
MLME-START	6.3.3.1	6.3.3.2	—	—
MLME-STOP	6.3.4.1	6.3.4.2	—	—
MLME-ASSOCIATE	6.3.5.1	6.3.5.2	6.3.5.3	—
MLME-DISASSOCIATE	6.3.6.1	6.3.6.2	6.3.6.3	—
MLME-MEMBERSHIP-UPDATE	6.3.7.1	6.3.7.2	—	—
MLME-SECURITY-ERROR	—	—	6.3.7.3	—
MLME-SECURITY-MESSAGE	6.3.7.4	6.3.7.5	6.3.7.6	—
MLME-PNC-HANDOVER	—	—	6.3.8.1	6.3.8.2
MLME-NEW-PNC	—	—	6.3.8.3	—
MLME-DEV-INFO	6.3.9.1	6.3.9.2	6.3.9.3	—
MLME-SECURITY-INFO	6.3.10.1	6.3.10.2	6.3.10.3	6.3.10.4
MLME-APPLICATION-SPECIFIC	6.3.11.1	6.3.11.2	6.3.11.3	—
MLME-ANNOUNCE-SERVICE	6.3.12.1	6.3.12.2	—	—
MLME-PICONET-SERVICES	6.3.12.3	6.3.12.4	6.3.12.5	—
MLME-CREATE-STREAM	6.3.13.1	6.3.13.2	6.3.13.3	—
MLME-MODIFY-STREAM	6.3.13.4	6.3.13.5	—	—
MLME-TERMINATE-STREAM	6.3.13.6	6.3.13.7	6.3.13.8	—
MLME-BSID-CHANGE	6.3.14.1	6.3.14.2	—	—
MLME-PICONET-PARM-CHANGE	—	—	6.3.14.3	—
MLME-PS-SET-INFORMATION	6.3.15.1	6.3.15.2	—	—
MLME-SPS-CONFIGURE	6.3.15.3	6.3.15.4	—	—
MLME-PM-MODE-CHANGE	6.3.15.5	6.3.15.6	6.3.15.7	—
MLME-MONITOR-PM-MODE	6.3.15.8	6.3.15.9	6.3.15.10	—
MLME-MULTICAST-CONFIGURATION	6.3.16.1	6.3.16.2	—	—
MLME-MULTICAST-RX-SETUP	6.3.16.3	6.3.16.4	—	—
MLME-BEACON-EVENT	6.3.17.1	6.3.17.2	6.3.17.3	—

The MLME interface defined in IEEE Std 802.15.3-2003 did not provide a consistent interface. For example, one set of primitives expected information, such as the list of associated DEVs, to reside in the DME whereas other primitives expected these data to reside only in the MLME. When the task group developed a consistent model for the information and interface, it became clear that the edits were too extensive to be represented as delete and add without causing unnecessary confusion for the reader. Instead, to make it easier to read, the old interface has been deleted, and it is being replaced with the one that follows.

Delete 6.3.1 through 6.3.22.7.2 (including Table 4 through Table 30).

After 6.3, insert the following subclauses as 6.3.1 through 6.3.17.3 (including the new tables, Table 3a through Table 3w):

6.3.1 Resetting the MAC/MLME

These primitives support the process of resetting the MAC/MLME, which also resets the PHY/PLME. The parameters used for these primitives are defined in Table 3a.

Table 3a—MLME-RESET primitive parameters

Name	Type	Valid range	Description
SetDefaultPIB	Boolean	TRUE, FALSE	If TRUE, all PIB attributes are set to their default values. The default values are implementation-dependent. If FALSE, the MAC is reset, but all PIB attributes retain the values that were in place prior to the generation of the MLME-RESET.request primitive.
ResultCode	Enumeration	READY, ERROR	If READY, the MLME has successfully completed initialization and is ready to receive requests. If ERROR, the MLME was unable to successfully complete initialization and is unable to receive requests.

6.3.1.1 MLME-RESET.request

This primitive requests that the MAC entity be reset to its initial conditions. The semantics of this primitive are:

```
MLME-RESET.request      (
                          SetDefaultPIB
                          )
```

The primitive parameter is defined in Table 3a.

The MLME restores the MAC and its internal variables (other than PIB attributes) to their initial state and values. The SetDefaultPIB parameter governs whether PIB attributes are reinitialized or left unchanged.

6.3.1.2 MLME-RESET.confirm

This primitive is generated by the MLME when it completes its initialization process. The semantics of this primitive are:

```
MLME-RESET.confirm      (  
                           ResultCode  
                           )
```

The primitive parameter is defined in Table 3a.

6.3.2 Scanning for piconets

These primitives support the process of determining the presence or absence of piconets, as described in 8.2.1. The parameters used for these primitives are defined in Table 3b.

Table 3b—MLME-SCAN primitive parameters

Name	Type	Valid range	Description
ScanForBSID	Boolean	TRUE, FALSE	Indicates if the scan process should search for a specific BSID, as described in 8.2.1.
BSIDLength	Integer	As defined in 7.4.2	The number of octets in the BSID.
BSID	Octet string	As defined in 7.4.2	The text string of a specific piconet for which to scan. This parameter is not used if ScanForBSID is FALSE.
ScanForPNID	Boolean	TRUE, FALSE	Indicates if the scan process should search for a specific PNID, as described in 8.2.1.
PNID	Integer	0–65535	The ID of a specific piconet for which to scan. This parameter is not used if ScanForPNID is FALSE.
ScanForPNCAddress	Boolean	TRUE, FALSE	Indicates if the scan process should search for a PNC with a specific MAC address, as described in 8.2.1.
PNCAddress	MAC address	Any valid individual MAC address, as described in 7.1	The MAC address of a specific PNC for which to scan. This parameter is not used if ScanForPNCAddress is FALSE.
NumberOfPiconets	Integer	0–255	The number of piconets found during the scanning process.
PiconetDescriptionSet	Set of piconet descriptions, as defined in Table 3c.	A set containing zero or more instances of a PiconetDescription	The PiconetDescriptionSet is returned to indicate the results of the scan request.
NumberOfChannels	Integer	0 to the maximum number of PHY-dependent channels, as defined in 11.2.3	Indicates the number of channels scanned.

Table 3b—MLME-SCAN primitive parameters (continued)

Name	Type	Valid range	Description
ChannelRatingList	Ordered list of integers.	0 to the maximum number of PHY-dependent channels, as defined in 11.2.3	Specifies a list of the channels scanned ordered from the best to the worst in terms of interference.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	OTHER	Indicates the reason for a ResultCode of FAILURE.

In Table 3b, a PiconetDescriptionSet is a set of PiconetDescriptions. Each PiconetDescription consists of the elements shown in Table 3c.

Table 3c—Elements of PiconetDescription

Name	Type	Valid range	Description
BSIDLength	Integer	As defined in 7.4.2	The number of octets in the BSID.
BSID	Octet string	As defined in 7.4.2	The text string identifier of a discovered piconet.
PNID	Integer	0–65535	The PNID of a discovered piconet.
PNCAddress	MAC address	Any valid individual MAC address	The MAC address of the PNC of the piconet that was found.
ChannelIndex	Integer	0 to the maximum number of PHY-dependent channels, as defined in 11.2.3	A PHY-dependent channel number on which the piconet was found.
SECmode	Enumeration	MODE_0, MODE_1	The security mode of the piconet that was found, as described in 7.3.1.
SignalQuality	Integer	0–15	Indicates the quality of the received frame or beacon for this piconet. The value is implementation-dependent with 0 indicating the lowest quality and 15 the highest quality.
NumApplicationSpecificData	Integer	0–255	Indicates the number of ApplicationSpecificDataSets advertised in the beacon of a discovered piconet.
ApplicationSpecificDataSet	Set of application specific data, as defined in Table 3d.	A set containing zero or more instances of ApplicationSpecificData	The ApplicationSpecificDataSet is returned to indicate the ApplicationSpecificData offered by the discovered piconet.

In Table 3b, the ChannelRatingList is a set of N integer values, where N equals the number of channel numbers provided by the PHY. The elements of the set are channel numbers and they are ordered from best (least interference) at the lowest set index to worst (most interference) at the highest set index.

In Table 3c, an ApplicationSpecificDataSet is a set of ApplicationSpecificData. Each ApplicationSpecificData consists of the elements shown in Table 3d. The ApplicationSpecificDataSets are only the current values advertised in the beacon and potentially are different in subsequent beacons.

Table 3d—Elements of ApplicationSpecificData

Name	Type	Valid range	Description
OUI	Octet string	Any valid OUI, as defined in 7.4.7	The unique identifier for the data, as described in 7.4.7.
ApplicationDataLength	Integer	As defined in 7.4.7	The length of the ApplicationData in Octets.
ApplicationData	Octet string	Any valid octet string of length up to ApplicationDataLength	Application-dependent data, as described in 7.4.7.

Any security features of an existing piconet are ignored during the scan process.

It is not possible to obtain piconet services information, as described in 8.3.2, during the scan process.

6.3.2.1 MLME-SCAN.request

This primitive is used to initiate the passive scan procedure to search for either a specific piconet or any piconet. The semantics of this primitive are:

```
MLME-SCAN.request  
(  
    ScanForBSID,  
    BSIDLength,  
    BSID,  
    ScanForPNID,  
    PNID,  
    ScanForPNCAAddress,  
    PNCAAddress,  
    Timeout  
)
```

The primitive parameters are defined in Table 3b.

6.3.2.2 MLME-SCAN.confirm

This primitive is used to report the result of the request to initiate the passive scan procedure to search for either a specific piconet or any piconet. The semantics of this primitive are:

```
MLME-SCAN.confirm
(
  NumberOfPiconets,
  PiconetDescriptionSet,
  NumberOfChannels,
  ChannelRatingList,
  ResultCode,
  ReasonCode
)
```

The primitive parameters are defined in Table 3b. All of the piconets found during the scan will be reported in separate elements of the PiconetDescriptionSet, even if more than one piconet is found on a given channel.

6.3.2.3 MLME-SCAN.indication

This primitive is used to report the result of a passive scan that was initiated by the MAC. The semantics of this primitive are:

```
MLME-SCAN.indication
(
  NumberOfPiconets,
  PiconetDescriptionSet,
  NumberOfChannels,
  ChannelRatingList
)
```

The primitive parameters are defined in Table 3b.

6.3.3 Starting a piconet

These primitives support the process of creating a new piconet with the DEV acting as PNC, as described in 8.2.2. The parameters used for these primitives are defined in Table 3e.

Table 3e—MLME-START primitive parameters

Name	Type	Valid range	Description
BSIDLength	Integer	As defined in 7.4.2	The number of octets in the BSID.
BSID	Octet string	As defined in 7.4.2.	The BSID of the new piconet.
SECMODE	Enumeration	MODE_0, MODE_1	The security mode of the piconet, as described in 7.3.1.
DEVID	Integer	Any valid DEVID, as defined in 7.2.3	The assigned DEVID for the DEV that is acting as the PNC, as described in 8.2.2.
MinDepSuperframe Percent	Integer	1–100	The minimum percent of the superframe requested as a CTA for the dependent piconet, as described in 8.2.5 and 8.2.6.

Table 3e—MLME-START primitive parameters (continued)

Name	Type	Valid range	Description
DesiredDepSuperframePercent	Integer	1–100	The desired percent of the superframe requested as a CTA for the dependent piconet, as described in 8.2.5 and 8.2.6.
AllocatedSuperframePercent	Integer	0–100	The percent of the superframe allocated to the new dependent piconet. If the channel time request was rejected, the value shall be set to zero. This parameter is ignored if the DEV is starting an independent piconet.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	NOT_PNC_CAPABLE, NO_CHANNELS_AVAILABLE, ALREADY_PNC, OTHER	Indicates the reason for a Result-Code of FAILURE.

6.3.3.1 MLME-START.request

This primitive is used to start a piconet. If the DEV is not a member of the piconet, this primitive causes the DEV to start an independent piconet. If the DEV is a member of the piconet, this primitive causes the DEV to start a child piconet. If the DEV is associated as a neighbor member of a piconet, this primitive causes the DEV to start a neighbor piconet. The semantics of this primitive are:

```
MLME-START.request      (  
    BSIDLength,  
    BSID,  
    SECMODE,  
    MinDepSuperframePercent,  
    DesiredDepSuperframePercent,  
)
```

The primitive parameters are defined in Table 3e.

6.3.3.2 MLME-START.confirm

This primitive reports the results of a piconet creation procedure. The semantics of this primitive are:

```
MLME-START.confirm      (  
    DEVID,  
    AllocatedSuperframePercent  
    ResultCode,  
    ReasonCode  
)
```

The primitive parameters are defined in Table 3e.

6.3.4 Stopping a piconet

These primitives support the process of stopping operations as a PNC. The process may result in the shut-down of piconet operations, as described in 8.2.7, or the handover of PNC operations to another DEV in the piconet, as described in 8.2.3 and 8.2.4. The parameters used for these primitives are defined in Table 3f.

Table 3f—MLME-STOP primitive parameters

Name	Type	Valid range	Description
RequestType	Enumeration	SHUTDOWN, HANDOVER	If SHUTDOWN, the current piconet operations will be stopped. If HANDOVER, an attempt to handover PNC operations will be made.
AllowedHandoverTime	Duration	0–65535	If RequestType is HANDOVER, the time in milliseconds in which a handover attempt must be completed.
NumHandoverTargetDEV	Integer	0–mMaxNumValid- DEVs	The number of DEVs in the HandoverTargetList
HandoverTargetList	List of DEVIDs	0 to maximum number of DEVIDs, as defined in 7.2.3	If RequestType is HANDOVER, specifies a list of Target DEVIDs for a handover attempt.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	NOT_A_PNC, HANDOVER_FAILED, OTHER	Indicates the reason for a ResultCode

In Table 3f, the HandoverTargetList is a set of N DEVIDs, where N equals the number of target DEVIDs for a handover provided by the DME. The elements of the set are DEVIDs and they are ordered from preferred target at the lowest set index to the least preferred target at the highest set index. If the HandoverTargetList contains only the BcstID, as defined in 7.2.3, the DME is not indicating any preference for the handover target.

6.3.4.1 MLME-STOP.request

This primitive initiates the piconet shutdown procedure or the piconet handover procedure. The semantics of this primitive are:

```
MLME-STOP.request
(
    RequestType,
    AllowedHandoverTime,
    NumHandoverTargetDEV,
    HandoverTargetList
)
```

The primitive parameters are defined in Table 3f.

6.3.4.2 MLME-STOP.confirm

This primitive reports the results of the request to stop operations as a PNC. The semantics of this primitive are:

```
MLME-STOP.confirm  
(  
    ResultCode,  
    ReasonCode  
)
```

The primitive parameters are defined in Table 3f.

6.3.5 Associating with a piconet

The following primitives support the process of a DEV associating with a PNC, as defined in 8.3.1. The parameters used for these primitives are defined in Table 3g.

Table 3g—MLME-ASSOCIATE primitive parameters

Name	Type	Valid range	Description
BSIDLength	Integer	As defined in 7.4.2	The number of octets in the BSID.
BSID	Octet string	As defined in 7.4.2	The BSID of the target PNC for the association.
PNID	Integer	0–65535	The PNID of the target PNC for the association, as defined in 7.2.2.
PNCAddress	MAC address	Any valid individual MAC address	The MAC address of the target PNC for the association.
ChannelIndex	Integer	0–255	A PHY-dependent channel number to search for the target PNC for the association.
PiconetServicesInquiry	Boolean	TRUE, FALSE	Requests that the PNC send the services information about the piconet, as described in 8.3.2.
DEVID	Integer	Any valid DEVID, as defined in 7.2.3	The DEVID assigned to a DEV as the result of an association or the DEVID of a DEV that has joined the piconet.
DEVAddress	MAC address	Any valid individual MAC address	The MAC address of a DEV that has joined the piconet.
NeighborPiconetRequest	Boolean	TRUE, FALSE	Indicates that the DEV will join as a neighbor PNC rather than as a member of the piconet.
VendorSpecificIE	Octet string	Any valid Vendor Specific IE, as defined in 7.4.17	The Vendor Specific IE, if present, in the Association Response command, as described in 7.5.1.2.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.

Table 3g—MLME-ASSOCIATE primitive parameters (continued)

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, PNC_NOT_FOUND, PNC_DENIED, PNC_BUSY, ALREADY_ASSOCIATED, NEIGHBOR_REFUSED, OTHER	Indicates the reason for a ResultCode of FAILURE.

6.3.5.1 MLME-ASSOCIATE.request

This primitive initiates the association procedure. The semantics of this primitive are:

```
MLME-ASSOCIATE.request      (
                               BSIDLength,
                               BSID,
                               PNID,
                               PNCAddress,
                               ChannelIndex,
                               NeighborPiconetRequest,
                               PiconetServicesInquiry,
                               Timeout
                              )
```

The primitive parameters are defined in Table 3g.

6.3.5.2 MLME-ASSOCIATE.confirm

This primitive reports the result of the association procedure. The semantics of this primitive are:

```
MLME-ASSOCIATE.confirm      (
                               DEVID,
                               VendorSpecificIE,
                               ResultCode,
                               ReasonCode
                              )
```

The primitive parameters are defined in Table 3g.

6.3.5.3 MLME-ASSOCIATE.indication

This primitive is used to indicate that a new DEV has associated with the same piconet as this DEV. The semantics of this primitive are:

```
MLME-ASSOCIATE.indication    (
                               DEVID,
                               DEVAddress
                              )
```

The primitive parameters are defined in Table 3g.

6.3.6 Disassociation from a piconet

The following primitives are used when a DEV disassociates from a PNC and when the PNC disassociates a DEV from the piconet, as described in 8.3.4. The parameters used for these primitives are defined in Table 3h.

Table 3h—MLME-DISASSOCIATE primitive parameters

Name	Type	Valid range	Description
DEVID	Integer	Any valid DEVID, as defined in 7.2.3	The DEVID of the disassociated DEV.
DEVAddress	MAC address	Any valid individual MAC address	The MAC address of the disassociated DEV
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, CURRENTLY_PNC, DEV_ATP_EXPIRED, PNC_ATP_EXPIRED, DEV_DISASSOCIATED, OTHER_PNC_ACTION, UNKNOWN	Indicates the reason for the disassociation of a DEV from a piconet.

6.3.6.1 MLME-DISASSOCIATE.request

This primitive initiates the procedure for a DEV to disassociate from a piconet. The semantics of this primitive are:

```
MLME-DISASSOCIATE.request    (  
                                Timeout  
                                )
```

The primitive parameter is defined in Table 3h.

6.3.6.2 MLME-DISASSOCIATE.confirm

This primitive is used to confirm the result of the disassociation procedure. The semantics of this primitive are:

```
MLME-DISASSOCIATE.confirm    (  
                                ResultCode,  
                                ReasonCode  
                                )
```

The primitive parameters are defined in Table 3h.

6.3.6.3 MLME-DISASSOCIATE.indication

This primitive is used to indicate that either this DEV or another DEV has been disassociated from the pico-net. The semantics of this primitive are:

```
MLME-DISASSOCIATE.indication    (
                                DEVID,
                                DEVAddress,
                                ResultCode,
                                ReasonCode
                                )
```

The primitive parameters are defined in Table 3h.

6.3.7 Security management

These primitives are used to initialize, update or delete the security information as a result of a membership or key change process, as described in 9.3.4, or as the result of a security event, as described in 9.3.5 and 9.3.6. Primitives are also provided to transfer security messages. These primitives are suitable for use in an authentication process.

The parameters used for the MLME-MEMBERSHIP-UPDATE and MLME-SECURITY-ERROR primitives are defined in Table 3i.

**Table 3i—MLME-MEMBERSHIP-UPDATE and
MLME-SECURITY-ERROR primitive parameters**

Name	Type	Valid range	Description
SECID	2 octets	As defined in 7.2.7.2	The identifier for the key.
OrigID	Integer	Any valid DEVID, as defined in 7.2.3, except for the BestID, the McastID or the UnassocID	Either the PNCID, if this key is for the DEV's PNC personality, or the DEV's DEVID.
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3, except for the BestID, the McastID or the UnassocID	The DEVID of the target DEV for this relationship.
MembershipStatus	Enumeration	MEMBER, NON-MEMBER	Indicates the membership status for the provided SECID. If NON-MEMBER, KeyInfoLength is 0.
KeyOriginator	Boolean	TRUE, FALSE	Indicates if the DEV is the key originator for this relationship. This is always true when the OrigID is the PNCID.
KeyInfoLength	Integer	0 or 16	Length of KeyInfo.
KeyInfo	Octet string	Any valid symmetric key for the symmetric key security operations, as defined in 10.3	The key used for protecting frames between this DEV and the TrgtID DEV.
SrcID	Integer	Any valid DEVID, as defined in 7.2.3, except for the BestID, the McastID or the UnassocID	The DEVID of the DEV that is the source of a security error.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.

**Table 3i—MLME-MEMBERSHIP-UPDATE and
MLME-SECURITY-ERROR primitive parameters (continued)**

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	NOT_ASSOCIATED, TARGET_UNAVAILABLE, UNAVAILABLE_KEY, FAILED_SECURITY_CHECK, BAD_TIME_TOKEN, INVALID_SEC_VALUE, OTHER	The reason for a security error.

The parameters used for the MLME-SECURITY-MESSAGE primitive are defined in Table 3j.

Table 3j—MLME-SECURITY-MESSAGE primitive parameters

Name	Type	Valid range	Description
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the target of the MLME request.
OrigID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the originator of the MLME request.
OUI	Octet string	Any valid OUI, as defined in 7.4.7	A unique identifier for the security information, as described in 7.4.7.
SecurityInformationLength	Integer	0–252	The length of SecurityInformation in octets.
SecurityInformation	Octet string	Any valid octet string	Security information that will be passed from one DEV to another peer DEV in the piconet.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, TARGET_UNAVAILABLE, OTHER	The reason for a security error.

6.3.7.1 MLME-MEMBERSHIP-UPDATE.request

This primitive initiates the membership update procedure by either installing or removing a management key. Data keys are generated by the key originator of the relationship and are exchanged between peer MLMEs, as described in 9.3.4. The semantics of this primitive are:

```
MLME-MEMBERSHIP-UPDATE.request (
    OrigID,
    TrgtID,
    MembershipStatus,
    SECID,
    KeyOriginator,
    KeyInfoLength,
    KeyInfo,
    Timeout
)
```

The primitive parameters are defined in Table 3i.

6.3.7.2 MLME-MEMBERSHIP-UPDATE.confirm

This primitive indicates the result of a membership update request. The semantics of this primitive are:

```
MLME-MEMBERSHIP-UPDATE.confirm (
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3i.

6.3.7.3 MLME-SECURITY-ERROR.indication

This primitive allows the MLME of any DEV to indicate a failed security processing operation. The semantics of this primitive are:

```
MLME-SECURITY-ERROR.indication (
    SrcID,
    ReasonCode
)
```

The primitive parameters are defined in Table 3i.

6.3.7.4 MLME-SECURITY-MESSAGE.request

This primitive initiates the sending of a Security Message command, as described in 7.5.9.1, to the target DEV in the piconet. The semantics of this primitive are:

```
MLME-SECURITY-MESSAGE.request (
    TrgtID,
    OUI,
    SecurityInformationLength,
    SecurityInformation,
    Timeout
)
```

The primitive parameters are defined in Table 3j.

6.3.7.5 MLME-SECURITY-MESSAGE.confirm

This primitive indicates the result of a request to send a Security Message command. The semantics of this primitive are:

```
MLME-SECURITY-MESSAGE.confirm (
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3j.

6.3.7.6 MLME-SECURITY-MESSAGE.indication

This primitive reports the reception of a Security Message command, as described in 7.5.9.1, from a DEV in the piconet. The semantics of this primitive are:

```
MLME-SECURITY-MESSAGE.indication (
    OrigID,
    OUI,
    SecurityInformationLength,
    SecurityInformation
)
```

The primitive parameters are defined in Table 3j.

6.3.8 PNC handover

These primitives are used as part of the handover process, as described in 8.2.3 and 8.2.4, where the current PNC's responsibilities are transferred to another DEV in the piconet. The parameters used for these primitives are defined in Table 3k.

Table 3k—MLME-PNC-HANDOVER and MLME-NEW-PNC primitive parameters

Name	Type	Valid range	Description
HandoverStatus	Enumeration	STARTED, IMPLICIT, PRELIMINARY, CANCELLED	Indicates if the PNC is beginning or cancelling a handover to the DEV.
NewPNCDEVAddress	MAC address	Any valid individual MAC address	The DEV address of the DEV assuming responsibilities as PNC.
SECMode	Enumeration	MODE_0, MODE_1	The security mode of the piconet, as defined in 7.3.1.

6.3.8.1 MLME-PNC-HANDOVER.indication

This primitive indicates the reception of a directed PNC Handover Request command, 7.5.3.1. The semantics of this primitive are:

```
MLME-PNC-HANDOVER.indication    (
                                   HandoverStatus
                                   )
```

The primitive parameter is defined in Table 3k.

6.3.8.2 MLME-PNC-HANDOVER.response

This primitive indicates that DME of the device targeted for PNC handover is ready to act as PNC. The semantics of this primitive are:

```
MLME-PNC-HANDOVER.response      ()
```

There are no primitive parameters.

6.3.8.3 MLME-NEW-PNC.indication

This primitive indicates that the role of the PNC has been assumed by a different DEV in the piconet. The semantics of this primitive are:

```
MLME-NEW-PNC.indication          (
                                   NewPNCDEVAddress,
                                   SECMODE
                                   )
```

6.3.9 Requesting DEV information from the PNC

This mechanism supports the ability for a DEV to request information from the PNC about either a specific DEV or all of the DEVs in the piconet, as described in 8.9.1. The parameters used for these primitives are defined in Table 3l.

Table 3l—MLME-DEV-INFO primitive parameters

Name	Type	Valid range	Description
QueriedDEVID	Integer	Any valid DEVID, as defined in 7.2.3, except for the McstID or the UnassocID	The DEVID of the DEV for which information is being requested from the PNC. If it is the BcstID, the request is for information for all of the DEVs in the piconet.
NumDEVInfo	Integer	1–mMaxNumValidDEVs	Number of entries in the DEVInfoSet.
DEVInfoSet	A set of DEV Info fields, as defined in 7.5.4.2.	A set containing 1 to mMaxNumValidDEVs instances of fixed length DEV Info fields	The DEVInfoSet is returned to indicate the results of a PNC Information Request command.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.

Table 3l—MLME-DEV-INFO primitive parameters (continued)

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, TARGET_NOT_ASSOCIATED, OTHER	Indicates the reason for a ResultCode of FAILURE.

6.3.9.1 MLME-DEV-INFO.request

This primitive initiates a request to the PNC for information regarding either a single DEV or all of the DEVs in the piconet. The semantics of this primitive are:

```
MLME-DEV-INFO.request      (  
                             QueriedDEVID,  
                             Timeout  
                             )
```

The primitive parameters are defined in Table 3l.

6.3.9.2 MLME-DEV-INFO.confirm

This primitive provides the result of the request to the PNC for information regarding either a single DEV or all of the DEVs in the piconet. The semantics of this primitive are:

```
MLME-DEV-INFO.confirm      (  
                             NumDEVInfo,  
                             DEVInfoSet,  
                             ResultCode,  
                             ReasonCode  
                             )
```

The primitive parameters are defined in Table 3l.

6.3.9.3 MLME-DEV-INFO.indication

This primitive indicates the reception of DEV information that was not requested using the MLME-DEV-INFO.request primitive. The semantics of this primitive are:

```
MLME-DEV-INFO.indication    (  
                             NumDEVInfo,  
                             DEVInfoSet  
                             )
```

The primitive parameters are defined in Table 3l.

6.3.10 Security information retrieval

These primitives are used to request security information about other DEVs in the piconet, as described in 9.4.1. The parameters used for the MLME-SECURITY-INFO primitives are defined in Table 3m.

Table 3m—MLME-SECURITY-INFO primitive parameters

Name	Type	Valid range	Description
QueriedDEVID	Integer	Any valid DEVID, as defined in 7.2.3, except for the Mcs-tID or the UnassocID	The DEVID of the DEV for which information is being requested. If it is set to the BcstID, then the information is being requested for all DEVs.
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3	The DEVID of the DEV for which the security information request is intended.
OrigID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the DEV that initiated the MLME request.
NumSecurityRecords	Integer	0–65535	Number of entries in the Security-RecordSet.
SecurityRecordSet	A set of Security Record fields, as defined in 7.5.4.4.	A set containing 0 or more instances of variable length Security Record field. The maximum number of instances depends on the size of the records, pMaxFrame-BodySize and the length of the secure command security fields, as defined in 7.3.3.2	The SecurityRecordSet is returned to indicate the results of a Security Information Request command.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, TARGET_NOT_ASSOCIATED, OTHER	Indicates the reason for a ResultCode of FAILURE.

6.3.10.1 MLME-SECURITY-INFO.request

This primitive initiates a request to a DEV for security information regarding either a single DEV or all of the DEVs in the piconet. The semantics of the primitive are as follows:

```

MLME-SECURITY-INFO.request    (
                                TrgtID,
                                QueriedDEVID,
                                Timeout
                                )

```

The primitive parameters are defined in Table 3m.

6.3.10.2 MLME-SECURITY-INFO.confirm

This primitive reports the result of the request to a DEV for security information regarding either a single DEV or all of the DEVs in the piconet. The semantics of the primitive are as follows:

```
MLME-SECURITY-INFO.confirm    (  
                                TrgtID,  
                                NumSecurityRecords,  
                                SecurityRecordSet,  
                                ResultCode,  
                                ReasonCode  
                                )
```

The primitive parameters are defined in Table 3m.

6.3.10.3 MLME-SECURITY-INFO.indication

This primitive indicates the reception of a request by a DEV for security information it manages regarding either a specific DEV or all of the DEVs in the piconet. The semantics of the primitive are as follows:

```
MLME-SECURITY-INFO.indication (  
                                OrigID,  
                                QueriedDEVID  
                                )
```

The primitive parameters are defined in Table 3m.

6.3.10.4 MLME-SECURITY-INFO.response

This primitive is used by a DEV to respond to an MLME-SECURITY-INFO.indication. The semantics of the primitive are as follows:

```
MLME-SECURITY-INFO.response   (  
                                OrigID,  
                                NumSecurityRecords,  
                                SecurityRecordSet  
                                )
```

The primitive parameters are defined in Table 3m.

6.3.11 Application specific data management

These primitives are used to request that the PNC add, modify or remove application specific data in the beacon and to report the reception of application specific data in a beacon, as described in 8.14. The parameters used for these primitives are defined in Table 3n. If the RequestType is “ADD,” then the MAC ignores the ASIEIndex.

Table 3n—MLME-APPLICATION-SPECIFIC primitive parameters

Name	Type	Valid range	Description
RequestType	Enumeration	ADD, MODIFY, REMOVE	If ADD, a request that a new ASIE be placed in the beacon. If MODIFY, a request to change the contents of an existing ASIE. If REMOVE, a request that a previously added ASIE be removed from the beacon.
ASIEIndex	Octet	0–255	An ID assigned by the PNC to each ASIE successfully added to the beacon. If RequestType is MODIFY or REMOVE, it specifies the ASIE to modify or remove.
RequestID	Octet	0–255	A unique number assigned by the requesting DEV to identify the request.
OUI	Octet string	Any valid OUI, as defined in 7.4.7	If RequestType is ADD or MODIFY, the OUI for the Application-Data.
ApplicationDataLength	Integer	As defined in 7.4.7	If RequestType is ADD or MODIFY, the length of the Application-Data to add to the beacon in octets.
ApplicationData	Octet string	Any valid octet string of length up to ApplicationDataLength	If the RequestType is ADD or MODIFY, the application specific data to add to the beacon, as described in 8.14.
NumApplicationSpecificData	Integer	0–255	Indicates the number of ApplicationSpecificData in the piconet beacon.
ApplicationSpecificDataSet	Set of application specific data, as defined in Table 3d.	A set containing zero or more instances of an ApplicationSpecificData	The ApplicationSpecificDataSet is returned to indicate the ApplicationSpecificData in the piconet beacon.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, UNKNOWN_ID, PNC_DENIED, OTHER	Indicates the reason for a Result-Code of FAILURE.

6.3.11.1 MLME-APPLICATION-SPECIFIC.request

This primitive is used to request to add, modify or remove application specific data in the piconet beacon. The semantics of this primitive are:

```
MLME-APPLICATION-SPECIFIC.request (
    RequestType,
    RequestID,
    ASIEIndex,
    OUI,
    ApplicationDataLength,
    ApplicationData,
    Timeout
)
```

The primitive parameters are defined in Table 3n.

6.3.11.2 MLME-APPLICATION-SPECIFIC.confirm

This primitive is used to report the result of the request to add, modify or remove application specific data in the beacon. The semantics of this primitive are:

```
MLME-APPLICATION-SPECIFIC.confirm (
    ASIEIndex,
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3n.

6.3.11.3 MLME-APPLICATION-SPECIFIC.indication

This primitive is used to indicate that application specific data was in a successfully received beacon. The MLME passes all of the ASIEs found in every beacon to the DME. The semantics of this primitive are:

```
MLME-APPLICATION-SPECIFIC.indication(
    NumApplicationSpecificData,
    ApplicationSpecificDataSet
)
```

The primitive parameters are defined in Table 3n.

6.3.12 Piconet services management

These primitives are used to transfer information regarding the services offered by DEVs in a piconet, as described in 8.3.2. The parameters used for these primitives are defined in Table 3o.

In Table 3o, a PiconetServicesSet is a set of PiconetServices. Each PiconetService consists of the elements shown in Table 3p.

**Table 3o—MLME-ANNOUNCE-SERVICE and MLME-PICONET-SERVICES
primitive parameters**

Name	Type	Valid range	Description
OUI	Octet string	Any valid OUI, as defined in 7.4.7	The OUI for the ServiceData.
ServiceDataLength	Integer	0–124	The length of the ServiceData.
ServiceData	Octet string	Any valid octet string of length ServiceDataLength	The ServiceData, as described in 8.3.2.
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the DEV to request service information.
NumberOfServices	Integer	0–255	The number of PiconetServices in the PiconetServicesSet.
PiconetServicesSet	Set of piconet services, as defined in Table 3p.	A set containing zero or more instances of a PiconetService	The PiconetServicesSet is returned to indicate the PiconetServices offered.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, TARGET_NOT_ASSOCIATED, OTHER	Indicates the reason for a ResultCode of FAILURE.

Table 3p—Elements of PiconetService

Name	Type	Valid range	Description
DEVID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the DEV offering the service.
OUI	Octet string	Any valid OUI, as defined in 7.4.7	The OUI for the ServiceData.
ServiceDataLength	Integer	0–128	The length of the ServiceData.
ServiceData	Octet string	Any valid octet string of length up to ServiceDataLength	The ServiceData, as described in 8.3.2.

6.3.12.1 MLME-ANNOUNCE-SERVICE.request

This primitive is used to request the announcement of the availability of a service offered by this DEV. The semantics of this primitive are:

```
MLME-ANNOUNCE-SERVICE.request (
    OUI,
    ServiceDataLength,
    ServiceData,
    Timeout
)
```

The primitive parameters are defined in Table 3o.

6.3.12.2 MLME-ANNOUNCE-SERVICE.confirm

This primitive is used to report the result of the request to announce the availability of a service offered by this DEV. The semantics of this primitive are:

```
MLME-ANNOUNCE-SERVICE.confirm (
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3o.

6.3.12.3 MLME-PICONET-SERVICES.request

This primitive is used to request piconet service information from a DEV in the piconet. If the target DEV is the PNC, then it is a request for all piconet service information previously announced by DEVs and stored in the PNC. The semantics of this primitive are:

```
MLME-PICONET-SERVICES.request (
    TrgtID,
    Timeout
)
```

The primitive parameters are defined in Table 3o.

6.3.12.4 MLME-PICONET-SERVICES.confirm

This primitive is used to report the result of the request for piconet service information from a DEV in the piconet. The semantics of this primitive are:

```
MLME-PICONET-SERVICES.confirm (
    NumberOfServices,
    PiconetServicesSet,
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3o.

6.3.12.5 MLME-PICONET-SERVICES.indication

This primitive indicates the reception of piconet services information that was not requested with the MLME-PICONET-SERVICES.request primitive. The semantics of this primitive are:

```
MLME-PICONET-SERVICES.indication (
    NumberOfServices,
    PiconetServicesSet
)
```

The primitive parameters are defined in Table 3o.

6.3.13 Stream management

This mechanism supports the creation, modification, and termination of isochronous streams, as described in 8.5.1. The parameters used for the MLME-CREATE-STREAM, MLME-MODIFY-STREAM and MLME-TERMINATE-STREAM primitives are defined in Table 3q.

**Table 3q—MLME-CREATE-STREAM, MLME-MODIFY-STREAM,
and MLME-TERMINATE-STREAM primitive parameters**

Name	Type	Valid range	Description
RequestID	Integer	0–255	A unique value created by the originating DME to match the request primitive with the response primitive it receives from the PNC MLME.
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the target DEV for an isochronous stream.
SourceDataRate	Integer	$1-(2^{64} - 1)$	The minimum required data rate of the stream source at the MAC SAP in bits per second, as described in D1.1.5.
DesiredDataRate	Integer	$1-(2^{64} - 1)$	The desired data rate of the stream source at the MAC SAP in bits per second, as described in D1.1.5.
MaxRetries	Integer	0–255	Specifies the maximum number of retries to attempt per transmitted frame.
ACKRequested	Boolean	TRUE, FALSE	Indicates if acknowledgments will be used for the stream.
MaxTransmitDelay	Duration	$1-(2^{64} - 1)$	Maximum allowed delay in microseconds for transmitting a MSDU once it is presented to MAC SAP.
UserPriority	Integer	As defined in Table A.1	User priority of the stream, as described in Table A.1.
TypicalDataFrameSize	Integer	0–pMaxFrameBodySize	The typical size in octets of an MSDU to be presented to the MAC SAP.
SECMODE	Boolean	TRUE, FALSE	Indicates if security is to be applied to the stream.

**Table 3q—MLME-CREATE-STREAM, MLME-MODIFY-STREAM,
and MLME-TERMINATE-STREAM primitive parameters (continued)**

Name	Type	Valid range	Description
StreamGrpID	Integer	0–255	A nonzero value specifies that channel time associated with this stream may be shared by other streams associated with the same stream group ID, as described in 8.5.1.
StreamIndex	Integer	Any valid stream index, as defined in 7.2.5	The index of a stream created or the index of a stream to modify or terminate.
OrigID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the source DEV for an isochronous stream.
AvailableDataRate	Integer	$1-(2^{64} - 1)$	If the request was successful, the data rate available for the stream. If the request was unsuccessful, the data rate that the PNC would have been able to allocate.
ReliabilityExponent	Integer	0–31	The negative power of 10 that is the maximum frame error ratio (FER) desired including retries and frames lost due to MaxTransmitDelay. For example, a value of 4 corresponds to an $FER < 10^{-4}$. If the value of the parameter is zero, then the parameter is ignored.
Timeout	Integer	0–65535	The time in milliseconds allowed for the primitive to complete.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	REQUEST_TIMEOUT, TARGET_UNAVAILABLE, RESOURCES_UNAVAILABLE, TERMINATED_BY_PNC, TERMINATED_BY_DEST, TRANSMIT_DELAY_UNSUPPORTED, PNC_BUSY, DEV_IN_PS_MODE, NOT_ASSOCIATED, UNKNOWN_STREAM, OTHER	The reason for a ResultCode of FAILURE.

6.3.13.1 MLME-CREATE-STREAM.request

This primitive is used to request the creation of an isochronous stream. The semantics of this primitive are:

```
MLME-CREATE-STREAM.request    (
                                RequestID,
                                TrgtID,
                                SourceDataRate,
                                DesiredDataRate,
                                MaxRetries,
                                ACKRequested,
                                MaxTransmitDelay,
                                UserPriority,
                                TypicalDataFrameSize,
                                SECMODE,
                                StreamGrpID,
                                ReliabilityExponent
                                Timeout
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.2 MLME-CREATE-STREAM.confirm

This primitive is used to report the result of the request for the creation of an isochronous stream. The semantics of this primitive are:

```
MLME-CREATE-STREAM.confirm    (
                                RequestID,
                                StreamIndex,
                                AvailableDataRate,
                                ResultCode,
                                ReasonCode
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.3 MLME-CREATE-STREAM.indication

This primitive is used to inform a DEV that it is the target of an isochronous stream sourced from another DEV in the piconet. The semantics of this primitive are:

```
MLME-CREATE-STREAM.indication (
                                StreamIndex,
                                OrigID
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.4 MLME-MODIFY-STREAM.request

This primitive is used to request a modification to the parameters defining an existing isochronous stream. The semantics of this primitive are:

```
MLME-MODIFY-STREAM.request    (
                                StreamIndex,
                                SourceDataRate,
                                DesiredDataRate,
                                MaxRetries,
                                ACKRequested,
                                MaxTransmitDelay,
                                UserPriority,
                                TypicalDataFrameSize,
                                SECMODE,
                                StreamGrpID,
                                ReliabilityExponent
                                Timeout
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.5 MLME-MODIFY-STREAM.confirm

This primitive is used to report the result of the request to modify the parameters defining an existing isochronous stream. The semantics of this primitive are:

```
MLME-MODIFY-STREAM.confirm    (
                                StreamIndex,
                                AvailableDataRate,
                                ResultCode,
                                ReasonCode
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.6 MLME-TERMINATE-STREAM.request

This primitive is used to request the termination of an existing isochronous stream. The semantics of this primitive are:

```
MLME-TERMINATE-STREAM.request (
                                StreamIndex,
                                Timeout
                                )
```

The primitive parameters are defined in Table 3q.

6.3.13.7 MLME-TERMINATE-STREAM.confirm

This primitive is used to report the result of the request to terminate an existing isochronous stream. The semantics of this primitive are:

```
MLME-TERMINATE-STREAM.confirm (
    StreamIndex,
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3q.

6.3.13.8 MLME-TERMINATE-STREAM.indication

This primitive is used to report to a DEV other than the DEV terminating the stream that an isochronous stream has been terminated. The semantics of this primitive are:

```
MLME-TERMINATE-STREAM.indication (
    StreamIndex,
    ReasonCode
)
```

The primitive parameter is defined in Table 3q.

6.3.14 Piconet parameter management

These primitives allow a DEV acting as PNC to change the BSID of the piconet and allow all DEVs to be informed of changes to piconet characteristics, as defined in 8.10 and 8.11. The parameters used for these primitives are defined in Table 3r.

Table 3r—MLME-BSID-CHANGE and MLME-PICONET-PARM-CHANGE primitives parameters

Name	Type	Valid range	Description
IndicationChangeType	Enumeration	BSID, PNID, CHANNEL	Indicates the parameter of the piconet that was changed.
BSIDLength	Integer	As defined in 7.4.2	The number of octets in the BSID.
BSID	Octet string	As defined in 7.4.2	If a request or if the IndicationChangeType is BSID, a new BSID for the piconet, as described in 7.4.2.
PNID	Integer	0–65535	If the IndicationChangeType is PNID, the new ID for the piconet.
ChannelIndex	Integer	0–255	If the IndicationChangeType is CHANNEL, the new PHY-dependent channel number on which the piconet is operating.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	NOT_A_PNC, OTHER	The reason for a ResultCode of FAILURE.

6.3.14.1 MLME-BSID-CHANGE.request

This primitive initiates changing the BSID. The semantics of this primitive are:

```
MLME-BSID-CHANGE.request
(
    BSIDLength,
    BSID
)
```

The primitive parameter is defined in Table 3r.

6.3.14.2 MLME-BSID-CHANGE.confirm

This primitive reports the result of a request to change the BSID. The semantics of this primitive are:

```
MLME-BSID-CHANGE.confirm
(
    ResultCode,
    ReasonCode
)
```

The primitive parameters are defined in Table 3r.

6.3.14.3 MLME-PICONET-PARM-CHANGE.indication

This primitive reports to a DEV a change to a piconet characteristic that was not requested by the DME. The semantics of this primitive are:

```
MLME-PICONET-PARM-CHANGE.indication
(
    IndicationChangeType,
    BSIDLength,
    BSID,
    PNID,
    ChannelIndex
)
```

The primitive parameters are defined in Table 3r.

6.3.15 Power management

This mechanism supports the process of establishment and maintenance of power management (PM) modes of a DEV, as described in 8.13. The parameters used for these primitives are defined in Table 3s.