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This a NetMan Task Group P802.16g Baseline Document.
This is not an IEEE Draft Standard.

Draft Amendment to IEEE Standard for
Local and metropolitan area networks

Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems

Amendment to IEEE Standard for Local and Metropolitan Area Networks - Management Plane Procedures and Services

Sponsor
LAN MAN Standards Committee
of the
IEEE Computer Society

and the
IEEE Microwave Theory and Techniques Society

Abstract: This document defines Management Procedures as enhancements to the IEEE 802.16 air interface standard for fixed and mobile broadband wireless systems. It specifies the management functions, interfaces and protocol procedures.

Keywords: fixed broadband wireless access network, mobile broadband wireless access network, metropolitan area network, microwave, millimeter wave, management, WirelessMAN™ standards

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NOTE-The editing instructions contained in this amendment define how to merge the material contained herein into the existing base standard IEEE Std 802.16-2004.

The editing instructions are shown ***bold italic***. Four editing instructions are used: ***change***, ***delete***, ***insert***, and ***replace***. ***Change*** is used to make small 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) and 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 instruction. ***Replace*** is used to make large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

1. Introduction

Scope: This document provides enhancements to the MAC and PHY management entities of IEEE Standard 802.16-2004, as amended by P802.16e, to create standardized procedures and interfaces for the management of conformant 802.16 devices.

Purpose: The purpose of this project is to provide conformant 802.16 equipment with procedures and services to enable interoperable and efficient management of network resources, mobility, and spectrum, and to standardize management plane behavior in 802.16 fixed and mobile devices.

2. References

This standard shall be used in conjunction with the following publications. When the following specifications are superseded by an approved revision, the revision shall apply.

IEEE 802.16-2001, "IEEE Standard for Local and Metropolitan area networks - Part 16: Air Interface for Fixed Wireless Access Systems".

IEEE 802.16a-2003, "IEEE Standard for Local and Metropolitan area networks - Part 16: Air Interface for Fixed Wireless Access Systems - Amendment 2: Medium Access Control Modifications and Additional-Physical Layer Specifications for 2-11 GHz.

IEEE 802.16-2004, "IEEE Standard for Local and Metropolitan area networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems", October, 2004

IEEE P802.16e-D5, "Draft IEEE Standard for Local and Metropolitan area networks - Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems", October, 2004

3. Definitions

[Insert the following definitions as specified below]

U Interface - The management and control interface that exists between the SS and the BS over the air interface.

4. Abbreviations and acronyms

[Insert the following abbreviations and acronyms into the the text as specified below]

GPCS - Generic Packet Convergence Sublayer

IRP - Integration Reference Point

NRM - Network Reference Model

MIB - Management Information Base

RRM - Radio Resource Management

RRC - Radio Resource Controller

RRA - Radio Resource Agent

5. Service-Specific CS

5.2 Packet CS

[Insert new subclause 5.2.7 and subsequent text below]

5.2.7 Generic Packet Convergence Sublayer (GPCS)

The Generic Packet CS supports multiple protocols over 802.16 air interface.

5.2.7.1 Generic Packet CS SDU Format from the higher layer service entity to 802.16 GPCS

It required that the higher layer service entity indicate to the 802.16 GPCS the Protocol Type (PT) of each SDU. In addition, the higher layer entity may also indicate its perception of the class of service and the logical Link layer ID.

Protocol Type indicates the outermost protocol of the SDU. The protocol type may be used by the Generic Packet CS to inspect packets to further classify the SDU to a particular CID.

The Logical Link ID identifies a logical interface on the receiver side. The Logical Link identifier must be unique within the scope of the Generic Packet CS. The 802.16 GPCS may use the Logical Link ID to perform the classification.

The Class of Service ID indicates the class of service as perceived by the higher application. The 802.16 GPCS may use the COS ID to perform the classification.

Figure 17c shows the Generic Packet CS SDU format. Note that the prepend information (indicated by dotted line) is communicated between the transmitter side and the receiver side for the connection through TLVs in DSx messages, but it shall not be transmitted over the air with each SDU.

Figure 17c—SDU format between the higher layer entity and the 802.16 layer

11. TLV Encodings

[Insert new subclause 11.8.9]

11.8.9 Service Information Query (SIQ) TLV

Service Information Query is included by MS in SBC-REQ to request the Service Network Provider Identifiers supported by the Operator Network that includes the current BS.

Name	Type	Length	Value	Scope
SIQ	4	1	NULL	SBC_REQ

[Insert new subclause 11.8.10]

11.8.10 Service Identity Information(SII) TLV

Service Identity Information is a compound TLV that contains one or more Network Service Provider Identifiers, and it may be included in a SBC-RSP message. When an SBC-REQ message with an SIQ TLV is received, the BS should respond with an SBC-RSP message with an SII TLV.

Name	Type	Length	Value	Scope
SII TLV	5	3*n	Including n, 24 bit Network Service Provider IDs, n is greater than or equal to 1.	SBC_RSP

[Insert new subclause 11.13.19]

11.13.19 CS specific service flow encodings

[Insert new subclause 11.13.19.1]

11.13.19.1 CS specification

Type	Length	Value

[145/146].28	1	0: No CS 1: Packet, IPv4 2: Packet, IPv6 3: Packet, 802.3/Ethernet 4: Packet, 802.1Q VLAN 5: Packet, IPv4 over 802.3/Ethernet 6: Packet, IPv6 over 802.3/Ethernet 7: Packet, IPv4 over 802.1Q VLAN 8: Packet, IPv6 over 802.1Q VLAN 9: ATM 10: Packet, IPv4 with Header Compression (ROHC) 11: Packet, IPv4 with Header Compression (ECRTP) 12: Packet, IPv6 with Header Compression (ROHC) 13: Packet, IPv6 with Header Compression (ECRTP) 14: Packet, IPv4 over 802.3/Ethernet with Header Compression (ROHC) 15: Packet, IPv4 over 802.3/Ethernet with Header Compression (ECRTP) 16: Packet, IPv6 over 802.3/Ethernet with Header Compression (ROHC) 17: Packet, IPv6 over 802.3/Ethernet with Header Compression (ECRTP) 18: Packet, IPv4 over 802.1Q VLAN with Header Compression (ROHC) 19: Packet, IPv4 over 802.1Q VLAN with Header Compression (ECRTP) 20: Packet, IPv6 over 802.1Q VLAN with Header Compression (ROHC) 21: Packet, IPv6 over 802.1Q VLAN with Header Compression (ECRTP) 22: GPCS (Generic Packet Convergence Sublayer) ~~10~~ 23~255: reserved

[Insert new subclause 11.13.19.2]

11.13.19.2 CS Parameter encoding rules

CST	CS
98	No CS
99	ATM
100	Packet, IPv4
101	Packet, IPv6
102	Packet, 802.3/Ethernet
103	Packet, 802.1Q VLAN
104	Packet, IPv4 over 802.3/Ethernet
105	Packet, IPv6 over 802.3/Ethernet
106	Packet, IPv4 over 802.1Q VLAN
107	Packet, IPv6 over 802.1Q VLAN

108	Packet, IPv4 with header compression (ROHC)
109	Packet, IPv4 with header compression (ECRTP)
110	Packet, IPv6 with header compression (ROHC)
111	Packet, IPv6 with header compression (ECRTP)
112	Packet, IPv4 over 802.3/Ethernet with header compression (ROHC)
113	Packet, IPv4 over 802.3/Ethernet with header compression (ECRTP)
114	Packet, IPv6 over 802.3/Ethernet with header compression (ROHC)
115	Packet, IPv6 over 802.3/Ethernet with header compression (ECRTP)
116	Packet, IPv4 over 802.1Q VLAN with header compression (ROHC)
117	Packet, IPv4 over 802.1Q VLAN with header compression (ECRTP)
118	Packet, IPv6 over 802.1Q VLAN with header compression (ROHC)
119	Packet, IPv6 over 802.1Q VLAN with header compression (ECRTP)
120	Packet, Generic Packet CS (GPCS)

11.13.19.2.1 Protocol Type Encoding

The encoding of the value field is that defined by the IANA document "Protocol Numbers".

Type	Length	Value	Scope
[1445/146].cst.3.3	2	Protocol number as defined by IANA (Internet Assigned Numbers Authority)	DSx-REQ, DSx-REP

For IPv4, the value of the field specifies a matching value for the IP Protocol field. If this parameter is omitted, then the comparison of the IP header Protocol field for this entry is irrelevant.

For IPv6 (IETF RFC 2460), this refers to next header entry in the last header of the IP header chain. If this parameter is omitted, then the comparison of the IP header Protocol field for this entry is irrelevant.

For "no CS", the value field specifies the protocol type of the MAC SDUs that are transported over the no-CS connection. This parameter shall be specified for a no-CS connection.

For a Generic Packet CS, this TLV shall be used to indicate the protocol carried over the CID connection.

11.13.19.2.2 Logic Link Identifier

For a Generic Packet CS, this TLV may be used to identify a logical interface within the scope of the Generic Packet CS when it has more than one interface. An example of a logical interface is an embedded management channel between an SS and an external management entity. A logical interface may be addressed using IP/Ethernet addressing thus allowing routers and bridges to learn the existence of such interface, but the addressing scheme of the interface is above the scope of the 802.16 standard.

Type	Length	Value	Scope
[1445/146].cst.3.19	1	Logical Link Identifier	DSx-REQ, DSx-REP

11.13.19.2.2.1 Class of Service (CoS) Identifier

For a Generic Packet CS, this TLV may be used to indicate the class of service as perceived by the higher application, and the 802.16 GPCS may use it to perform the classifications. If it's not, the 802.16 layer can perform its own classification to determine the 802.16 CoS. The encoding of CoS for a Generic Packet CS is left for vendors' implementation and is beyond the scope of the standard.

Type	Length	Value	Scope
[1445/146].cst.3.20	1	Class of Service ID	DSx-REQ, DSx-REP

[Insert new subclause 11.18.2]

11.18.2 NSP List TLV

NSP List is an optional compound TLV that contains one or more Network Service Provider Identifiers, and it may be included in a MAC message transmitted on a broadcast CID.

Name	Type	Length	Value	Scope
NSP List	6	3*n	Including n, 24 bit Network Service Provider IDs, n is greater than or equal to 1.	SII Message

[Insert new subclause 11.18.3]

11.18.3 NSP Count TLV

NSP Count TLV is an optional TLV that indicate the change of the NSP list. It will be increased by one (modulo 256) by the Operator Network whenever the NSP list changes. NSP Count TLV should be sent in a more frequent manner than NSP List TLV.

Name	Type	Length	Value	Scope
NSP Count	7	1	Increment by one (modulo 256) by the Operator Network whenever the list of the NSP changes.	SII Message

[Insert a new chapter 14 and then insert the text specified below]

14. Management Interfaces and Procedures

14.1 Overview

The 802.16 devices within the purview of this specification can include 802.16-2004 subscriber stations (SS) or 802.16e mobile subscriber stations (MSS) or base stations (BS). As the 802.16 devices may be part of a larger network and therefore would require interfacing with entities for management and control purposes, this document assumes a Network Control and Management System (NCMS) abstraction that interfaces with the base stations. The NCMS abstraction allows the PHY/MAC/CS layers specified in 802.16 to be independent of the network architecture, the transport network, and the protocols used at the backend and therefore allows greater flexibility on the network side. Any necessary inter-BS coordination is handled through the NCMS. This specification will only describe procedures for management and control interactions between the MAC/PHY/CS layers of the 802.16 devices and the NCMS. The details of the various entities that form the Network Control and Management System are outside the purview of this specification. An abstracted network reference model is presented to clearly depict the interfaces that are assumed to be in scope of the specification.

14.2 Requirements

<Section Notes: This section describes the functional requirements that need to be addressed by the 802.16g specification. However this section is purely informational and meant to guide the development of this document.>

14.2.1 Architectural Requirements

These are requirements that impact the FS, MS or BS from an air interface management and control perspective. These requirements do not assume a specific radio access network architectural topology and any implied physical connectivity model (eg. Routed vs Switched).

a) Data, Control and Management Plane separation shall be maintained for all protocol procedures specified.
b) The protocol procedures shall not tie a service to the access network.
c) The communication mechanisms assumed between BSes shall be protocol agnostic.

14.2.2 Configuration Requirements

a) BS shall be able to manage FS/MS configuration parameters individually or as a group.
b) BS shall be able to request parameters from neighboring BSes, including information about MSes attached to it.
c) FS/MS shall be able to override some of the configuration parameters that are managed by the BS when they do not impact the network.
d) BS should provide an interface for reading configuration parameters.
e) BS should provide the ability to update software and service capabilities on the mobile station.

14.2.3 Security Requirements

a) BS shall be able to request FS/MS re-authentication at anytime.

b) The security capabilities of the weakest FS/MS or BS should not compromise the security of the other devices.

c) BS should support faster HO re-authentication.

14.2.4 Mobility Requirements

a) MS and BS shall support primitives for enabling upper layer mobility management protocols

b) HO capabilities at varying levels should be exposed appropriately to the upper layers.

c) Location determination shall be supported within the accuracy as determined by the laws and regulations of the geographical area.

d) Location servers may request location information on demand.Primitives for a loss less handoff shall be supported for non real time traffic (e.g. HTTP.) A loss less handoff is characterized by no frame loss during the handoff. The MAC frames could be buffered at the source BS and delivered to the target after the handoff completion.

14.2.5 Data Traffic Requirements

14.2.5.1 Traffic Policies

a) Traffic Policies may be advertised during network entry and handover and may be enforceable by the BS.

b) QoS differentiation shall be supported through primitives to enable proper traffic prioritization by upper layer protocols.

14.2.5.2 Traffic filters

<Tbd>

14.2.6 Performance Requirements

14.2.6.1 Network Performance Requirements

a) Protocol primitives defined shall maximize the MS battery lifetime.

b) Protocol primitives for fast and seamless handoff shall be supported for real time traffic (e.g. VoIP). A fast and seamless handoff is characterized by low latency and tolerance for few frame drops without any noticeable glitch to the end user.

c) The following values must be made available in real-time with redisplay intervals of no less than 1000 msecs, with the option to be displayed in both cumulative and delta modes:

1) "Paging Channel
   -Paging Channel Delivery
   -Occupancy/capacity used

2) "Access Channel
   -Access Channel Reception
   -Occupancy/ Capacity

3) "State transitions
   -Timing/ delay

4) "Registrations
   -Successful and failed
   -Forward Traffic Channel Delivery
   -Total and Per user

5) "MAC retries
6) "PHY retries
7) "MAC latency
8) "Total blocks/PDU assigned and delivered
9) "Uncorrectable Errors
10) "Signal Strength (RSSI)
11) "CINR
12) "Reverse Traffic Channel Reception
    -Total and Per user
13) "UL & DL Power Measurements
    -Total and per user

14.2.6.2 User Performance Requirements

Mobility creates a dynamic environment for the network that will require constant monitoring and optimization. To accomplish these tasks it is import that the network has a reasonable idea of how mobile stations are performing while moving through the network. Therefore, the air interface shall support the collection of the following metrics so that a network operator to can effectively monitor the performance of the 802.16 air interfaces.

CDLs are generally used to answer questions about a specific call that has completed, used to spot large numbers of call failures or short duration calls that are associated with specific equipment and to provide an indication as to why specific types of call failures (e.g. RF Losses) occurred. Performance management statistics provide an overall view of system performance (e.g. number of calls, equipment usage) and aggregate failures so that problem areas can be spotted. Call processing exception reports provide information about failures associated with a specific call. Information from both the CDL and from exception reports may be necessary to diagnose a call. A Call Detail Log (CDL) is generated by the access point (AP) or anchor point if soft handoff is used, when its participation in a call ends with the generation of one of a set of designated call final classes (CFCs). The CDL are sent up to the OMC periodically. These statistics should be made available via PM data forwarding mechanisms as defined by 3GPP (32-series) & 3GPP2 (S.S0028)

Access information
- Network details – access serving BS ID
- RF details -
  - first MOB_SCAN-REPORT,
  - first REP-RSP,
  - total timing adjustment
- Access system time

Device information
- Entry type – origination / termination, hard hand-in, cell update
- QoS Class – Best Effort, Gaming, VoIP, …
- CC status
- Service level prediction
- SS ID (mac id?)
- IP address

Summary call quality information
- Forward /Reverse packet retransmission (error) rate
- Forward / Reverse average throughput
- Constellation usage

Average latency
Average jitter

RF information
Last REP-RSP
Last MOB_SCAN-REPORT

Last sector information
BS Transmit power
BS Reverse RSSI

Last sector vector (NOTE: not sure what to call this but with smart antennas the location of the user to build a traffic distribution map is very useful.)
Direction
Distance
RTT

Call release information
Release system time
Call final class

14.2.6.3 HO Latency

a) FBSS - BS transition latency < (tbd)
b) Hard-HO - BS transition latency < (tbd)

14.2.7 Resource Management Requirements

a) Procedures for Emergency services shall be supported also for unidentified/unauthorized user. These procedures shall be given priority in resource allocation so as to increase the chance of success in connection initiation and handoffs.
b) Primitives for sharing available Resource/Traffic Load information dynamically among the neighbor BSs for the efficient use of radio resources.
c) Flexible bandwidth allocation shall be supported to fulfill the QoS requirement with any possible adaptation to efficiently utilize the spectrum
d) Procedures supporting load balancing shall be supported and provisioned among the BSs for increased system utilization and accommodating more users
e) BS supporting mobility, shall provide protocol primitives for collecting and forwarding neighbor BS information advertisements.
f) BSes should be capable of providing default transport connections for MSes that need to use it for emergency services.
g) 802.16g entities (BS/MS) shall provide relevant reports (e.g. measurements) on resource information for use by entities on the network.

14.2.8 Element Management Requirements

a) Statistics for the FS/MSes should be collected by the BS using primitives defined and available to a higher layer Network Management Protocols.
b) Statistics for the BS (e.g. usage of resources) should be collected by the BS and available to a higher layer Network Management Protocols
c) MS should collects statistics on the radio link that may be queried by the BS.
d) MSes and BSes should also collect statistics on neighboring BSes for the purposes of HO.

14.2.9 Specification Requirements

There are several usage scenarios based on 802.16's specifications, such as Fixed Access, Nomadicity, Portability with Simple Mobility Support, Full Mobility Support. If a procedure, message, IE or IRP does not apply to all usage scenarios, the scenarios it applies to will be clearly specified.

14.3 Information Model Aspects

For the purpose of Management Interface development an Interface Methodology known as Integration Reference Point (IRP) was developed to promote the wider adoption of standardized Management interfaces in telecommunication networks. The IRP methodology employs Protocol & Technology Neutral modeling methods as well as protocol specific solution sets to help achieve its goals. The Integration Reference Point is a methodology to aid a modular approach to the development of standards interfaces.

There are three cornerstones to the IRP approach:

1.Top-down, process-driven modeling approach

The process begins with a requirements phase, the aim at this step is to provide conceptual and use case definitions for a specific interface aspect as well as defining subsequent requirements for this IRP.

2.Technology-independent modeling

The second phase of the process is the development of a protocol independent model of the interface. This protocol independent model is specified in the IRP Information Service.

3. Standards-based technology-dependent modeling

The third phase of the process is to create one or more interface technology and protocol dependent models from the Information Service model. This is specified in the IRP Solution Set(s).

14.3.1 Information Service Models

Information Service Models refer to both Interface IRPs and NRM IRPs.

This section is providing the IEEE 802.16 protocol neutral (IS) resource model (NRM/MIB) definitions.

14.3.1.1 Information entities imported and local labels

Table 450—Information entities imported and local labels

Label reference	Local label
information object class, ManagedElement	ManagedElement
information object class, ManagedFunction	ManagedFunction
information object class, SubNetwork	SubNetwork
information object class, Top	Top

14.3.1.2 Class diagram

14.3.1.2.1 Attributes and relationships

Figure 1. establishes the naming and containment for the protocol neutral network management models of the 802.16 standard. The inheritance diagram show in Figure 2. is based on 802.16e and 802.16-2004. This diagram establishes the context of the IOC and shows ME's as inventory items and MF's as the functions that perform functions in the 802.16 network.

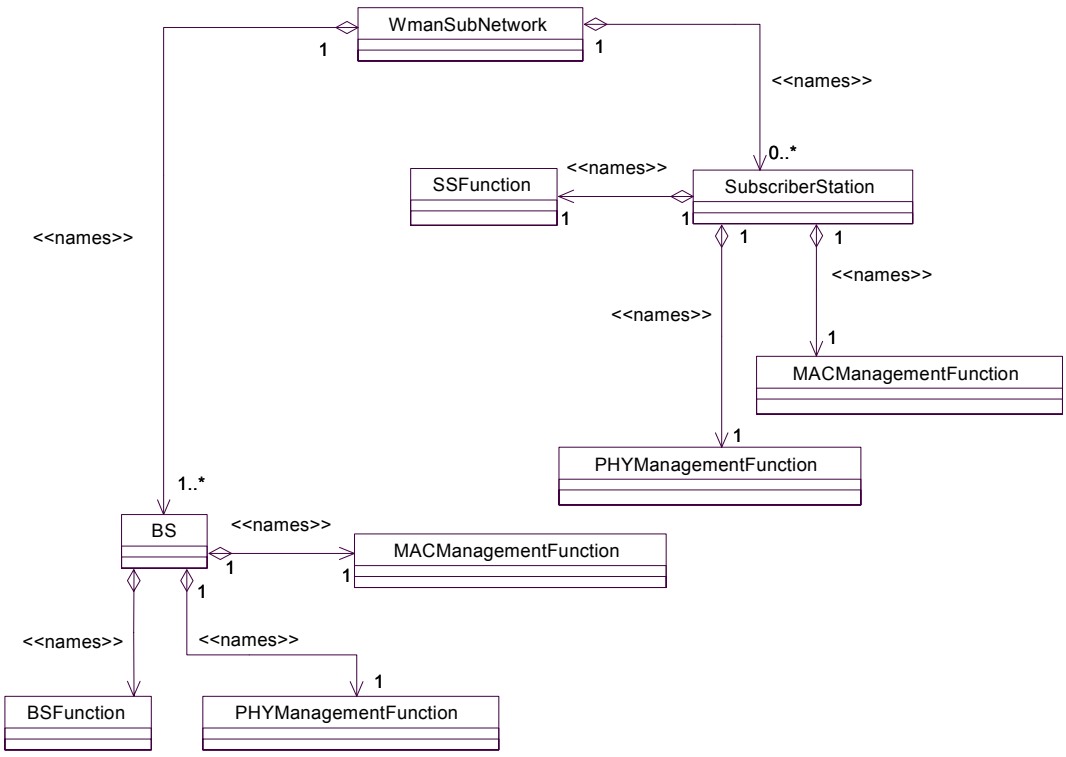

Figure 300—Containment and Naming Diagram

14.3.1.2.2 Inheritance

This clause depicts the inheritance relationships that exist between information object classes.

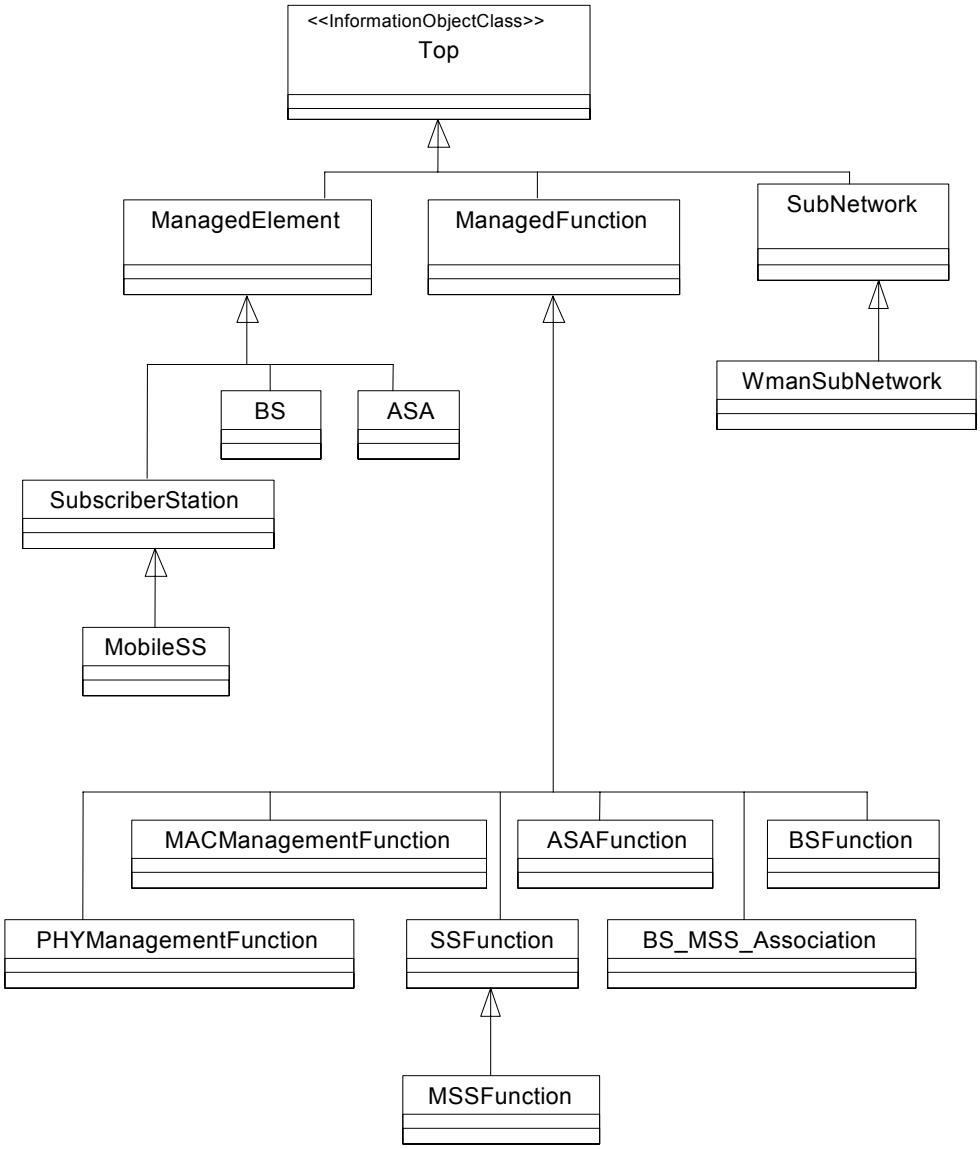

Figure 301—Inheritance Diagram

14.3.1.3 Information object classes definition

14.3.1.3.1 IOC BsFunction

14.3.1.3.1.1 Definition

This IOC represents a WMAN base station. For more information, see [zz]. It is derived from Managed-Function.

<Section Note: This table is just a template for reference.>

14.3.1.3.1.2 Attributes

Table 451—Attributes

Attribute name	Defined in	Visibility	Support Qualifier	Read Qualifier	Write Qualifier
BsFunctionId	--	+	M	M	--
objectClass	Top	+inherited	Minherited	Minherited	--inherited
objectInstance	Top	+inherited	Minherited	Minherited	--inherited
userLabel	ManagedFunction	+inherited	Minherited	Minherited	Minherited
aaa	--	+	O	M	--
bbb	--	+	O	M	--
yyy	--	+	O	M	--
zzz	--	+	O	M	--

14.3.1.3.2 IOC WmanSsFunction

14.3.1.3.2.1 Definition

This IOC represents a WMAN subscriber station. For more information, see [tbd]. It is derived from ManagedFunction.

14.3.1.3.2.2 Attributes

14.3.1.3.3 IOC xxx

14.3.1.3.4 IOC yyy

14.3.1.4 Information relationships definition

14.3.1.5 Notifications

14.3.1.6 Information attributes definition

Table 452—Attributes

Attribute name	Defined in	Visibility	Support Qualifier	Read Qualifier	Write Qualifier
SsFunctionId	--	+	M	M	--
objectClass	Top	+inherited	Minherited	Minherited	--inherited
objectInstance	Top	+inherited	Minherited	Minherited	--inherited
userLabel	ManagedFunction	+inherited	Minherited	Minherited	Minherited
ccc	--	+	O	M	--
ddd	--	+	O	M	--
www	--	+	O	M	--
xxx	--	+	O	M	--

14.3.1.6.1 Definition and legal values

Table 453—Definition and legal values

Attribute name	Definition	Legal Values
BsFunctionId	It contains 'name+value' that is the RDN, when naming an instance, of this object class containing this attribute.This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	--
SsFunctionId		--
ZzzId		--
aaa	tbd	tbd
bbb	tbd	tbd
ccc	tbd	tbd
ddd	tbd	tbd
objectClass	As defined in [zz]: An attribute which captures the name of the class from which the object instance is an occurrence of.	--

14.4 Architectural Aspects

This specification includes primitives that are exposed to upper layers in a consistent manner for use by control and management plane protocols in a network agnostic manner. The network that manages and controls an 802.16 air interface device is therefore abstracted as a Network Control and Management System (NCMS).

14.4.1 Network Reference Model

The Figure 3 describes a network reference model along with the interfaces that are within the scope of this specification. Multiple SS or MSS maybe attached to a BS. The SS communicate to the BS over the U interface using a Primary Management Connection or a Secondary Management Connection. MSS typically only utilize the Primary Management Connection over the U interface for management and related control functions.

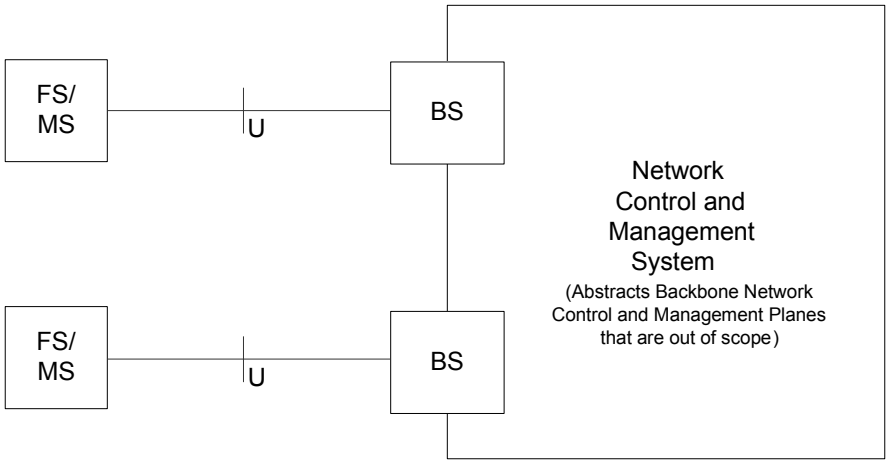

Figure 302—802.16g Network Reference Model

14.4.1.1 Network Control and Management System (NCMS)

This abstraction is detailed in Figure 4 to show the different functional entities that make up such a Network Control and Management System. These entities may be centrally located or distributed across the network. The exact functionality of these entities and their services is outside the scope of this specification but shown here for illustration purposes and to better enable the description of the management and control procedures.

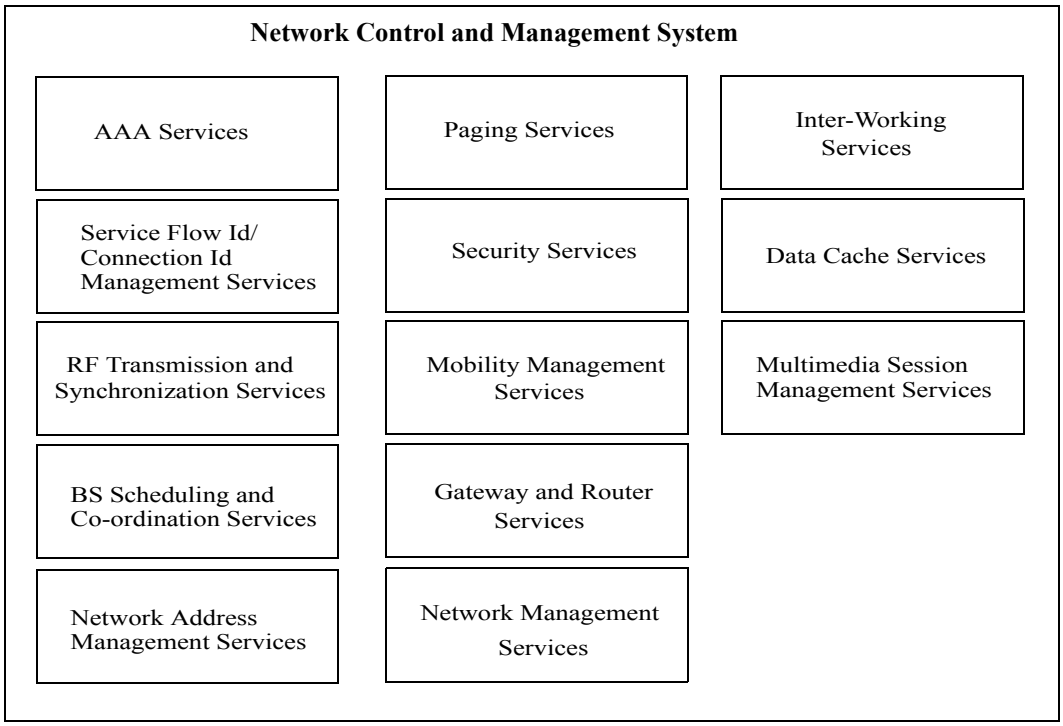

Figure 303—Illustration of the Network Control and Management System (Informational)

NCMS protocols are not defined in this specification, however information elements (IEs) and protocol primitives for these IEs are exposed using Service Access Points (SAP). This includes CS, MAC and PHY layer context information used by NCMS protocols to manage and control the air interface. Every BS is assumed to be part of an NCMS and therefore as shown in Figure 3.

14.4.1.1.1 SS/MSS and BS Interface

This U interface may be implemented using either a primary management connection or a secondary management connection.

14.4.1.1.2 BS and NCMS Interface

This interface is a set of Service Access Points (SAP) and is represented and in the Figure 5 below. It is decomposed in to two parts: the Management SAP used for Management primitives alone and the Control SAP is used for Control plane primitives that to support handovers, security context management, radio resource management, and low power operations (such as Idle mode and paging functions). The primary goal of such an interface is to ensure protocol separation.

These primitives do not define end to end protocol flows, but rather commands and indications for access to the Management and Control entities for the CS/MAC/PHY layers. Protocol procedures are defined using one or more of these primitives for performing distinct protocol functions on the air interface (eg. Paging, Handover etc.)

Management and Control entities are logical and may have SAPs between their protocol layers, however for simplicity they are not defined.

[Replace the figure 1 in section 1.4 with the one below]

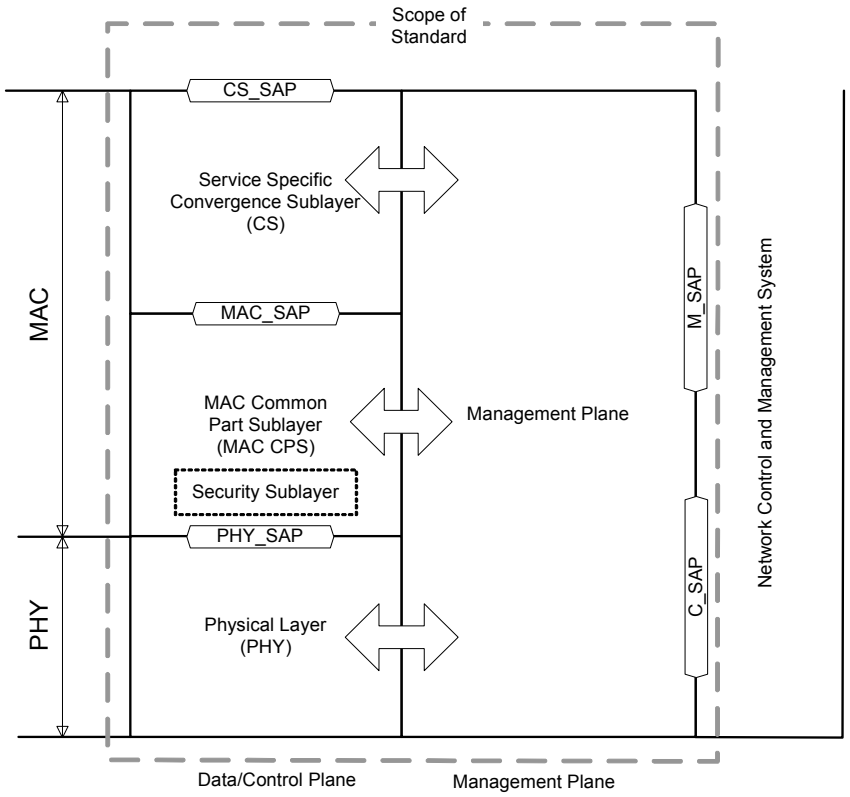

Figure 304—802.16g Protocol Architecture Model

14.4.1.1.2.1 Management SAP (M_SAP)

The Management SAP may include, but is not limited to primitives related to:

- System configuration
- Monitoring Statistics
- Notifications/Triggers

14.4.1.1.2.2 Control SAP (C_SAP)

The Control SAP may include, but is not limited to primitives related to:

- Handovers (e.g. notification of HO request from MS, etc.)
- Idle mode mobility management (e.g. Mobile entering idle mode)
- Subscriber and session management (e.g. Mobile requesting session setup)
- Radio resource management, etc.
- AAA server signaling (Eg. EAP payloads).

14.4.2 Management Interfaces

14.4.3 Information Service Models

14.5 Management Functions

14.5.1 Fault Management

14.5.1.1 Events/Logs

14.5.1.1.1 Persistance Requirements

14.5.1.2 Notification/Triggers

<Section Note: Notification for events and trigger functions associated with some events are described>

14.5.2 Configuration Management

14.5.2.1 Capability Management

<Section Note: Subscriber Basic Capabilities negotiation recommendations>

14.5.2.2 Basic RF Configuration

<Section Note: Procedures for setting and retrieving system information about frequency assignments for sectors, channel bandwidths, FFT sizes, Tx Power, etc. are described>

14.5.2.3 Basic MAC Configuration

<Section Note: Procedures for setting and retrieving MAC parameters like SDU size limits, PDU size limits, list of Service classes supported, scan list, packing, fragmentation, ARQ block sizes etc. are described>

14.5.2.4 BS Time Configuration

<Section Note: Procedures for setting and retrieving BS time information are described.>

14.5.3 Accounting Management

Accounting event can be detected for an MSS Network Entry. Since each MSS can have multiple connections at the same time, accounting event for each connection should be detected. Accounting for an MSS Network Entry is initiated when the MSS registers at the network and terminated when the MSS deregisters from the network. Similarly, accounting for a connection is initiated at the dynamic service addition (DSA) instant of the connection and terminated at the dynamic service deletion (DSD) instant of the connection.

14.5.3.1 Accounting Procedure

Accounting primitives consist of Accounting request and Accounting response, as shown in Figure 306 and Figure 306. Figure 305 represents accounting primitives initiated by a BS when it receives REG-REQ/RSP, DREG-REQ/RSP, DREG-CMD, DSA-REQ/RSP, or DSD-REQ/RSP. Figure 306 represents accounting primitives initiated by an NCMS.

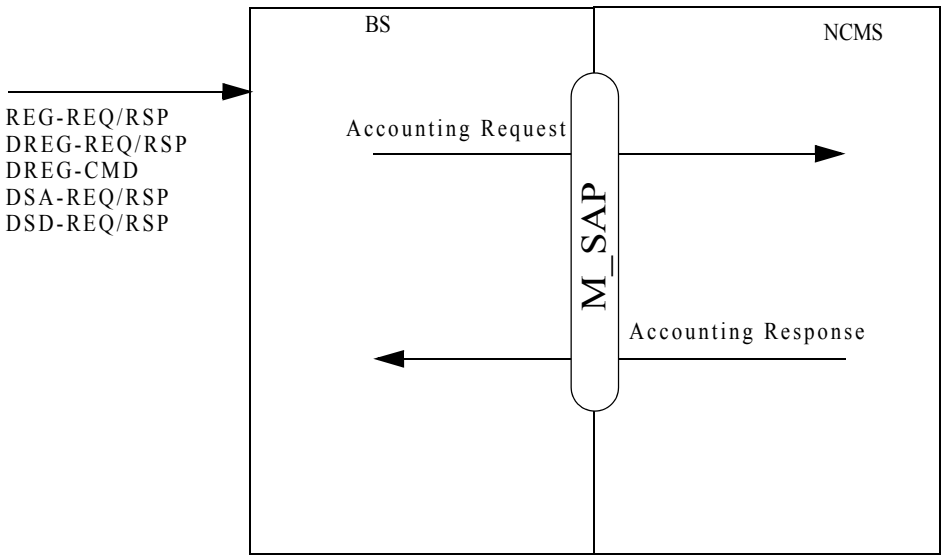

Figure 305—Accounting Primitive Initiated by a BS

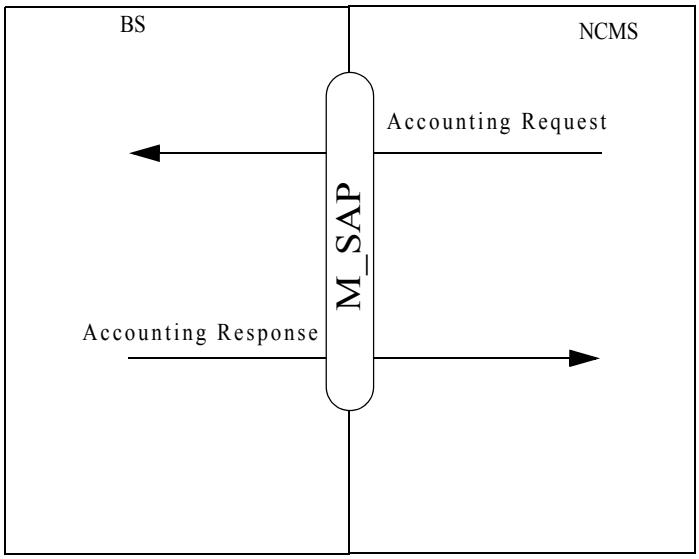

Figure 306—Accounting Primitive Initiated by an NCMS

14.5.3.2 Service Primitives for Accounting Management

14.5.3.2.1 Accounting request

14.5.3.2.1.1 Function

This primitive is issued by a BS to inform an NCMS of accounting event for MSS Network Entry after Registration request/response (REG-REQ/RSP) or Deregistration command (DREG-CMD) of an MSS. Also, it is issued by a BS to inform an NCMS of accounting event for connection after DSA or DSD procedure. On the other hand, this primitive can be issued by an NCMS depending on the policy of service provider.

14.5.3.2.1.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Accounting request
(
MSS MAC Address
Service Flow Identifier
Accounting Record Type
Accounting Record Number
Accounting Input Octets
Accounting Output Octets
Accounting Input Packets
Accounting Output Packets
Service Flow Information
)

MSS MAC Address
48-bit MAC address which will identify MSS

Service Flow identifier
32-bit service flow identifier which will identify service flows of an MSS

Accounting Record Type
The type of accounting record being sent and EVENT_RECORD, START_RECORD, INTERIM_RECORD, and STOP_RECORD are currently defined. An Event Record is used to indicate that a one-time event has occurred (meaning that the start and end of the event are simultaneous). A Start Record is used to initiate an accounting session and contains accounting information that is relevant to the initiation of the session. An Interim Record contains cumulative accounting information for an existing accounting session. A Stop Record is sent to terminate an accounting session and contains cumulative accounting information relevant to the existing session.

Accounting Record Number
Identifies accounting record within one session

Accounting Input Octets
The number of octets received from the MSS during the session

Accounting Output Octets
The number of octets sent to the MSS during the session

Accounting Input Packets
The number of packets received from the MSS during the session

Accounting Output Packets
The number of packets sent to the MSS during the session

Service Flow Information

Required QoS information of a service flow include traffic characteristics and a scheduling type such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter, and maximum latency

14.5.3.2.1.3 When generated

This primitive is generated at a BS when an MSS enters a network or terminates to access a network, or when an MSS starts or stops dynamic services. Also, this primitive can be generated at an NCMS to request accounting event from a BS.

14.5.3.2.1.4 Effect of receipt

If this primitive is generated by a BS, accounting event is sent to an NCMS. On the other hand, if this primitive is generated by an NCMS, the BS transfers gathered accounting event to the NCMS using Accounting response primitive.

14.5.3.2.2 Accounting response

14.5.3.2.2.1 Function

This primitive is issued by either an NCMS or a BS to respond to Accounting request.

14.5.3.2.2.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Accounting response
(
MSS MAC Address
Service Flow Identifier
Result Code
Accounting Record Type
Accounting Record Number
Accounting Input Octets
Accounting Output Octets
Accounting Input Packets
Accounting Output Packets
Service Flow Information
)

MSS MAC Address
48-bit MAC address which will identify MSS
Service Flow identifier
32-bit service flow identifier which will identify service flows of an MSS
Result Code
The result of Accounting request
Accounting Record Type
The type of accounting record being sent and EVENT_RECORD, START_RECORD, INTERIM_RECORD, and STOP_RECORD are currently defined. An Event Record is used to

indicate that a one-time event has occurred (meaning that the start and end of the event are simultaneous). A Start Record is used to initiate an accounting session and contains accounting information that is relevant to the initiation of the session. An Interim Record contains cumulative accounting information for an existing accounting session. A Stop Record is sent to terminate an accounting session and contains cumulative accounting information relevant to the existing session.

Accounting Record Number

Identifies accounting record within one session

Accounting Input Octets

The number of octets received from the MSS during the session

Accounting Output Octets

The number of octets sent to the MSS during the session

Accounting Input Packets

The number of packets received from the MSS during the session

Accounting Output Packets

The number of packets sent to the MSS during the session

Service Flow Information

Required QoS information of a service flow include traffic characteristics and a scheduling type such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter and maximum latency

14.5.3.2.2.3 When generated

This primitive is generated at either an NCMS or a BS to respond to Accounting request.

14.5.3.2.2.4 Effect of receipt

If an NCMS or a BS receives the Accounting response, it completes accounting procedure.

14.5.4 Performance Management

14.5.5 Security Management

14.5.5.1 EAP-based authentication procedure

When an MS try to initiate an EAP-based authentication or re-authentication procedure with a BS, it sends a PKMv2 EAP Start message. The BS informs of an NAS (Network Access Server) entity in NCMS as an EAP_start.request primitive. If the MS receives EAP-Request/Identity messages, then it sends the EAP-Response/Identity message with MN's identifier to the NAS entity. After the EAP-Response/Identity message, the EAP methods are negotiated between the MS and the AAA server and the EAP messages are exchanged several times. The EAP messages encapsulated are exchanged between the MS and the NAS entity. If the EAP authentication procedure is finished successfully and also yields an MSK (Master Session Key), the BS which does not know EAP protocols receives the MSK and a key lifetime from the EAP client entity as an EAP_Key_Notification.indication primitive. It is already shared between the AAA server and the MS through the EAP exchanges. The MSK is used for derivation for a PMK (Pair wise Master Key) and optional EIK (EAP Integrity Key).

Figure 307 shows EAP-based authentication procedure between a BS and an NAS entity in NCMS as follows

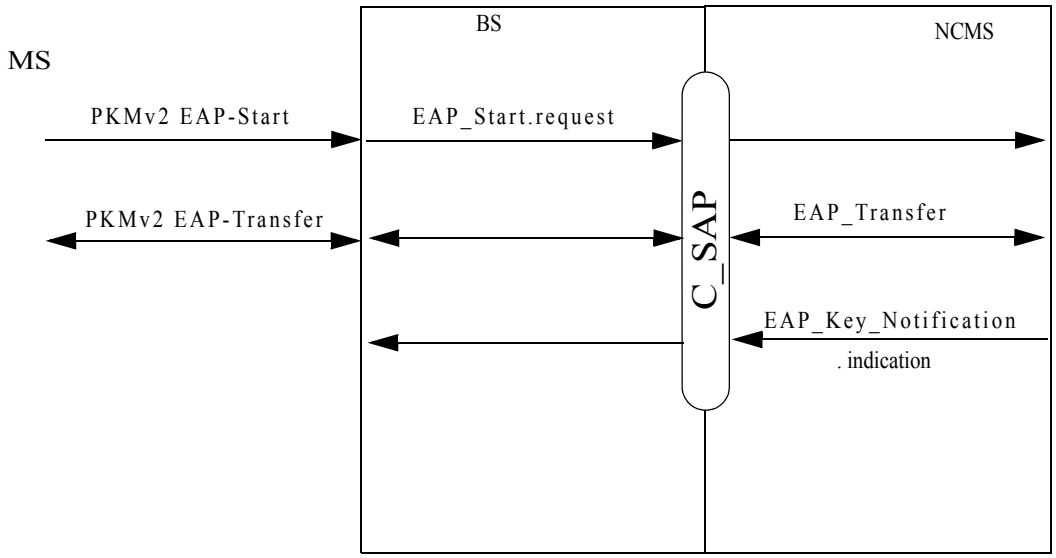

Figure 307—EAP based Authentication Procedure

14.5.5.1.1 Service Primitives

14.5.5.1.1.1 EAP_Start.request

14.5.5.1.1.1.1 Function

This primitive inform an AAA Client entity in NCMS that an MS is going to start EAP-based authentication.

14.5.5.1.1.1.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

EAP_Start.request
(
MS ID
)

MS ID
48-bit unique identifier used for user identification between BS and NCMS

14.5.5.1.1.1.3 When generated

This primitive is issued by a BS when a MS wants to initiate EAP-based authentication procedure.

14.5.5.1.1.1.4 Effect of receipt

EAP payloads are forwarded for the authentication between BS and NCMS entity.

14.5.5.1.1.2 EAP_Transfer

14.5.5.1.1.2.1 Function

After the EAP_start primitive, EAP payloads are exchanged between an MS and an NAS entity. The EAP payloads are encapsulated in the EAP Transfer because it is not interpreted in the MAC.

14.5.5.1.1.2.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

EAP_Transfer
(
MS ID
EAP Payload
)

MS ID
48-bit unique identifier used for user identification between BS and NCMS
EAP Payload
Contains the EAP authentication data

14.5.5.1.1.3 EAP_Key_Notification.indication

14.5.5.1.1.3.1 Function

A MS derives the key from the EAP payloads and the NCMS entity informs the BS of it when the EAP exchanges are successfully completed and yield the MSK.

14.5.5.1.1.3.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

EAP_Key_Notification.indication
(
MS ID
MSK
MSK Lifetime
)

MS ID
48-bit unique identifier used for user identification between BS and NCMS
MSK

MSK is the product of EAP exchanges. It is used for the derivation of PMK (Pair wise Master Key) and EIK.

MSK Lifetime

It may be transferred from the EAP method or may be set by a vendor.

14.5.5.1.1.3.3 When generated

This primitive is issued by a NCMS (a NAS entity) when the EAP exchange are successfully completed and yield the MSK.

14.5.5.1.1.3.4 Effect of receipt

The BS could derive a PMK and optional EIK from the MSK.

14.5.5.2 Authentication, Authorization and Accounting (AAA) Guidelines

<Section Note: Recommendations for utilizing EAP, RADIUS protocols>

14.5.5.3 Security Context and Key Management

<Section Note: Recommendations for establishment and management of Security Associations, Key establishment and caching policies.>

14.5.5.4 Security for Handoffs

<Section Note: Recommendations for Security context re-establishment during handoffs, key binding and key usage policies>

14.5.5.5 Protecting Management Messages

<Section Note: Recommendations for protecting management messages.>

14.5.6 Service Flow Management

14.5.6.1 BS Service Provisioning

<Section Note: Provisioning of the services on the BS are described. Ex: Setting and retrieval of Operator IDs, BS IDs etc. and type of convergence layers supported and their configuration parameters are described.>

14.5.6.2 SS/MSS Provisioning

<Section Note: Provisioning. Configuration and management for BS initiated connections and service flow creations for static and dynamic QoS>

14.5.6.3 SS/MS Connection Management

14.5.6.3.1 IPv4 Connection Management

There are two kinds of IP allocation method in the secondary management connection, DHCP (Dynamic Host Control Protocol) and MIP (Mobile IP).

First, for the IP allocation using DHCP, the DHCP protocol is employed in SS/MS and NCMS (a DHCP relay agent and a server). DHCP payloads are transported between SS/MS and BS, but BS forward them encapsulated. SS/MS sends a DHCPDISCOVER message in order to initiate IP allocation procedure. A SS/MS receives a DHCPOFFER message which has the information of DHCP server. The SS/MS requests an IP address allocation by sending a DHCPREQUEST message. Then a newly allocated IP address is provided by the DHCP server in a DHCPACK message. A Gateway address, DNS (Domain Name Server) addresses, and an IP address lease time are also represented.

Second, for the IP allocation using MIP, the MIP protocol is employed in MS and NCMS or a mobility agent (a Foreign Agent and/or a Home Agent). MIP payloads encapsulated also are forwarded between MS and BS. MIP procedure is started when a MS receives an Agent Advertisement message with information of a mobility agent. After that, the SS sends a MIP Registration Request message which includes a Home Agent address, a user NAI (Network Access Identifier) and so on. Then, the MS receives a MIP Registration Response message with successful Result-Code. If the MS forwards the MIP Registration Request message with no IP address, an allocated IP address is represented in the MIP Registration Response.

14.5.6.3.2 Service Primitives

14.5.6.3.2.1 DHCP_Transfer

14.5.6.3.2.1.1 Function

DHCP payloads are exchanged between an SS/MS and a DHCP Client entity. The DHCP payloads are encapsulated in the DHCP Transfer primitive because it is not interpreted in the BS.

14.5.6.3.2.1.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

DHCP_Transfer
(
MS/SS ID
DHCP Payload
)

MS/SS ID
48-bit unique identifier used for user identification between BS and NCMS
DHCP Payload
Contains the DHCP payload

14.5.6.3.2.2 MIP_Transfer

14.5.6.3.2.2.1 Function

MIP payloads are exchanged between an MS and an entity with functionalities of mobility agent in NCMS. The MIP payloads are encapsulated in the MIP Transfer primitive because it is not interpreted in the BS.

14.5.6.3.2.2.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

MIP_Transfer
(
MS ID
MIP Payload
)

MS ID
48-bit unique identifier used for user identification between BS and NCMS
MIP Payload
Contains the MIP payload

14.5.6.3.2.3 IP_Allocation_Notification.indication

14.5.6.3.2.3.1 Function

After MIP or DHCP exchanges are completed, the SS/MS gets a new allocated IP address. For the BS, NCMS sends a new allocated IP address for the SS/MS in IP_Allocation.indication primitive.

14.5.6.3.2.3.2 Semantics of the Service Primitives

The parameters of the primitives are as follows:

IP_Allocation_Notification.indication
{
MS ID
IP Address
}

MS ID
48-bit unique identifier used for user identification between BS and NCMS
IP Address
A new address allocated to the SS/MS using DHCP or MIP.

14.5.6.3.2.3.3 When generated

This primitive is issued by a NCMS (a DHCP client or a Mobility Agent) when the IP allocation procedure are successfully completed.

14.5.6.3.2.3.4 Effect of receipt

A newly allocated IP address is known to the BS.

14.5.6.4 QoS Management

The QoS Management Primitives are a set of primitives for supporting QoS management between BS and NCMS (access network). They are defined to support QoS service flows. A service flow ID is created and managed by the NCMS (or a network entity). A unique identifier of all SAPs is service flow ID because the service flow ID can only be identified in a network operator. The CID is only managed in MAC layer in a BS. MS ID in ASF request and CSF request is used to authorize the MS whether the QoS information is permitted.

Service flow application clients that interact with CS convergence layer should transform service flow information and CS parameter information to appropriate parameters of network protocol in network side and in reverse direction. How to convert specific QoS parameters between 802-16-Service-Flow and Network Flows is out of scope. Network side protocol modules such as RSVP, COPS (Common Open Policy Service) and SNMP (Simple Network Management Protocol) have better convert the specific QoS parameters between two sides. The service flow management primitives are designed as 2-way handshake style because resource reservation protocols in IETF and primitives at the 802.16 MAC SAP are designed as 2-way handshake style but service flow messages in IEEE 802.16-2004 is designed as 3-way handshake style to negotiate QoS requirements in a service flow.

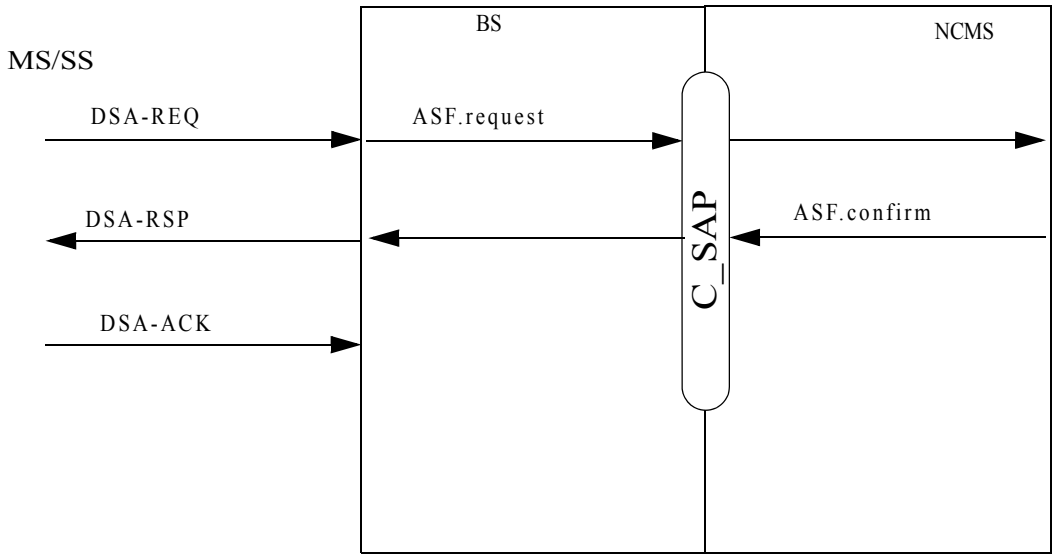

Figure 308—ASF request and ASF confirm primtives flow

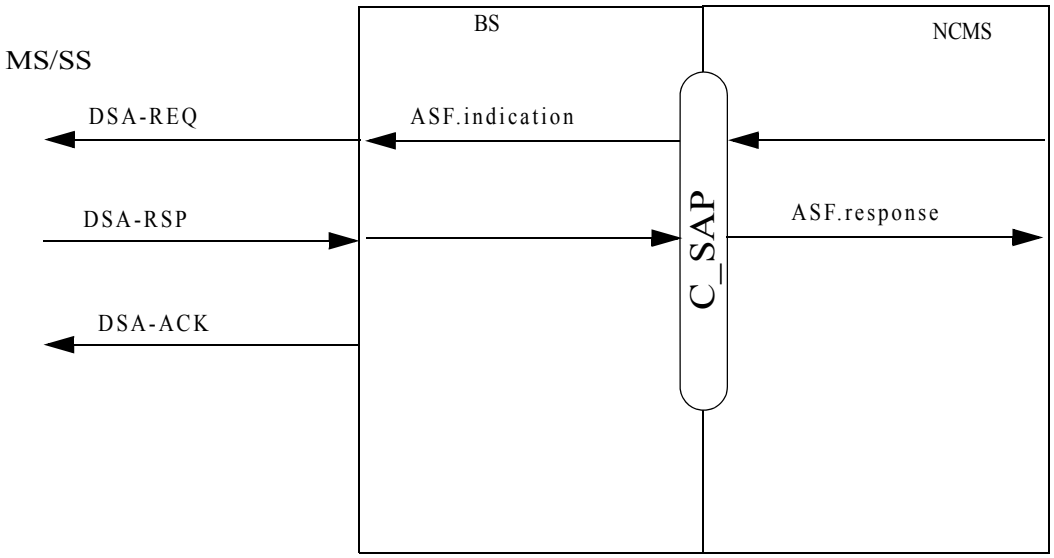

Figure 309—ASF indication and ASF response primtives flow

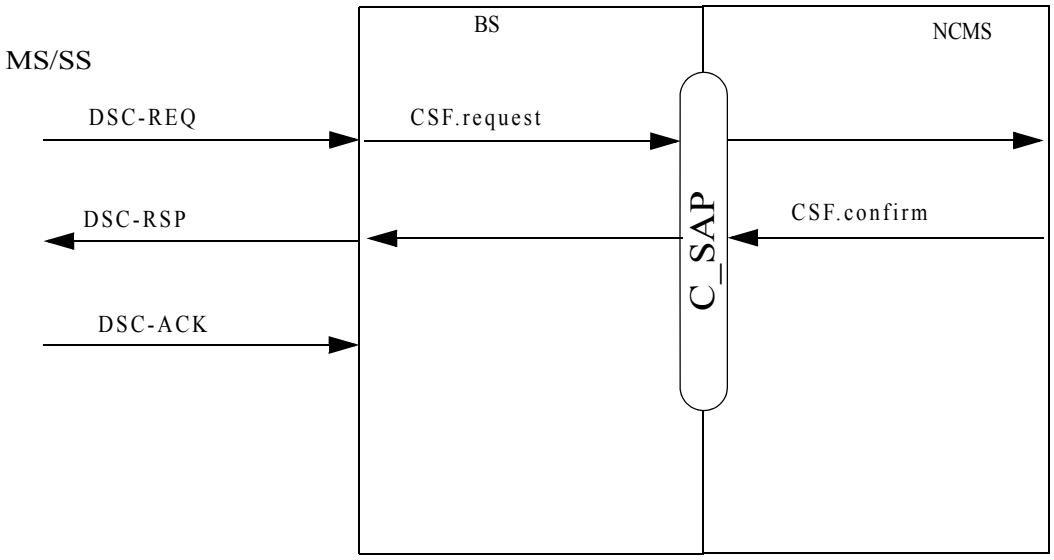

Figure 310—CSF request and CSF confirm primtives flow

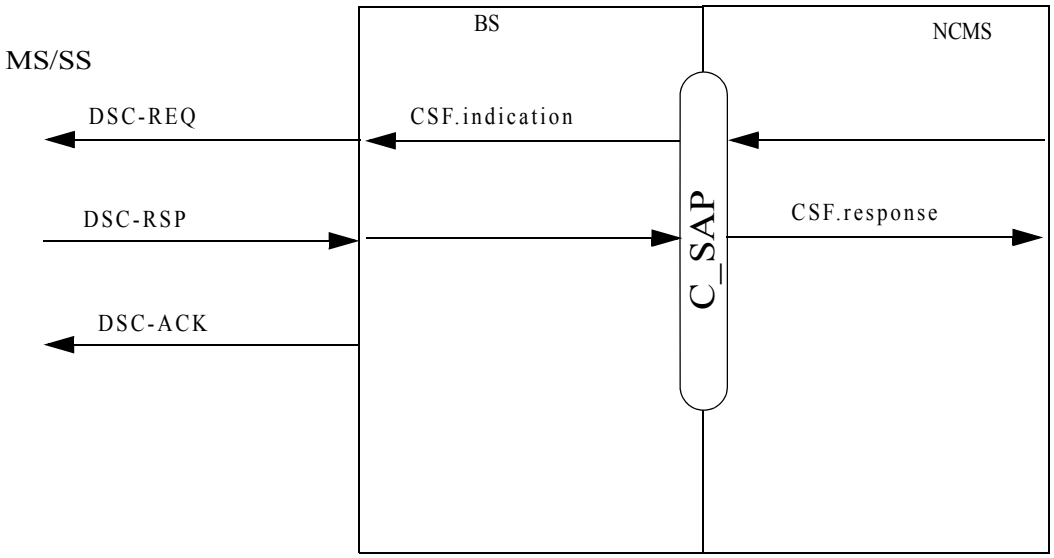

Figure 311—CSF indication and ASF response primtives flow

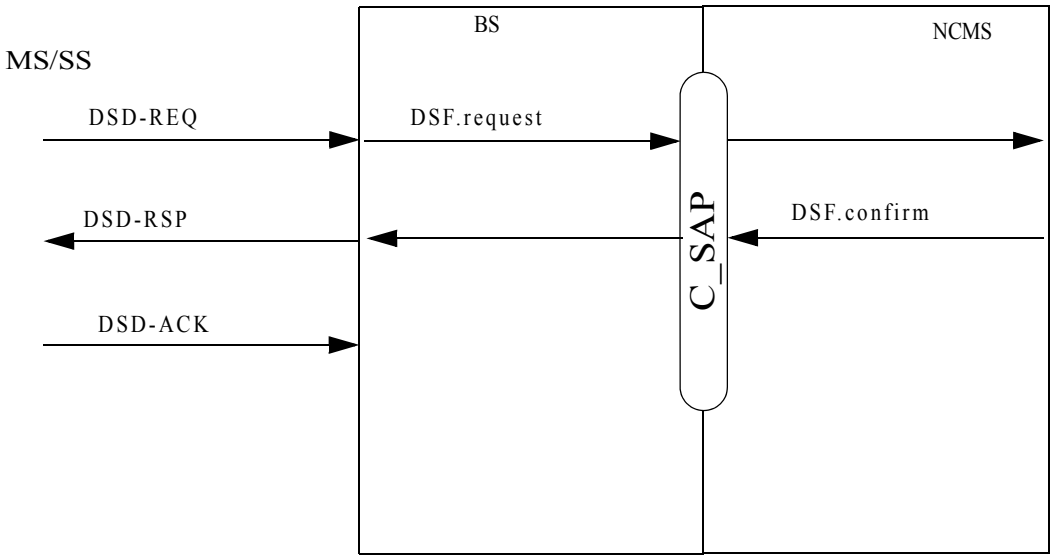

Figure 312—DSF request and DSF confirm primtives flow

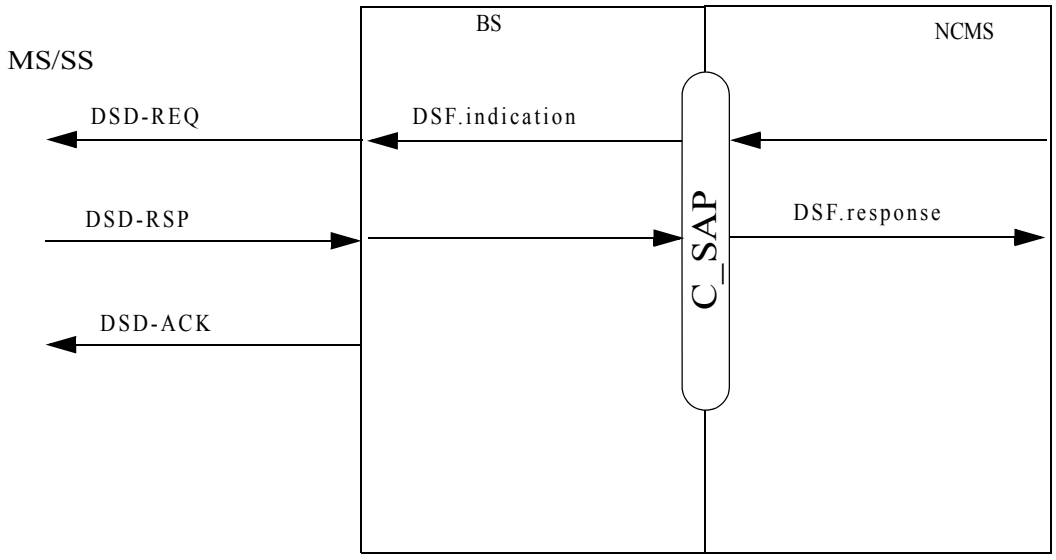

Figure 313—DSF indication and DSF response primtives flow

14.5.6.4.1 Add_Service_Flow.request (ASF.request)

14.5.6.4.1.1 Function

This primitive is used by a BS to inform an QoS information from an MS of the QoS management entity in NCMS.

14.5.6.4.1.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.request
(
Transaction ID
MS ID
Service flow descriptor
Service flow information
CS parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
MS ID
48-bit unique identifier used by MS. MS ID is used for user authorization
Service flow descriptor
Information regarding the attribute an uplink or downlink service flow
Service flow information
Required QoS information of a service flow include traffic characteristics and a scheduling type such as service class name, QoS parameter set type, maximum sustained traffic rate, max-

imum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter and maximum latency

CS parameter information

Required IP filter rules of a service flow such as packet classification rule and IPv6 flow label

14.5.6.4.1.3 When generated

This primitive is generated when a BS receives a DSA-REQ message.

14.5.6.4.1.4 Effect of receipt

The QoS management entity in NCMS shall respond to this primitive by sending Add_Service_Flow.confirm. The management entity for service flows checks the validity of the request from the point of view of its own resources. If the request is accepted, the QoS management entity in NCMS creates unique service flow ID for the request.

14.5.6.4.2 Add_Service_Flow.confirm (ASF.confirm)

14.5.6.4.2.1 Function

This primitive is used by the QoS management entity in NCMS to response the ASF.request from a BS. Service flow information in ASF response has approved QoS information if the ASF.request is accepted.

14.5.6.4.2.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.confirm
(
Transaction ID
MS ID
Service flow ID
Service flow descriptor
Service flow information
CS parameter information
Service flow error parameter information
)

Transaction ID

A unique sequential identifier of the transaction set by the BS

MS ID

48-bit unique identifier used by MS. MS ID is used for user identification

Service flow ID

Unique identifier to identify a service flow

Service flow descriptor

Information regarding the attribute an uplink or downlink service flow

Service flow information

Approved complete QoS information of a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter and maximum latency

CS parameter information

Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label

Service flow error parameter information
Failed reason and every specific failed QoS parameter if a ASF request is rejected

14.5.6.4.2.3 When generated

This primitive is generated when the QoS management entity in NCMS responds to Add_Service_Flow.request primitive.

14.5.6.4.2.4 Effect of receipt

This primitive informs the result of the service flow creation of a BS. A BS receiving the primitive shall transmit DSA-RSP message following the information provided by this message.

14.5.6.4.3 Add_Service_Flow.indication (ASF.indication)

14.5.6.4.3.1 Function

This primitive is used by the QoS management entity in NCMS to inform QoS information. Service flow information and service flow ID are included in ASF.indication of a BS.

14.5.6.4.3.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.confirm
(
Transaction ID
MS ID,
Service flow descriptor
Service flow ID
Service flow information
CS parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
MS ID
48-bit unique identifier used by MS.
Service flow descriptor
Information regarding the attribute an uplink or downlink service flow
Service flow ID
Unique identifier to identify a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter and maximum latency
Service flow information
Approved complete QoS information of a service flow
CS parameter information
Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label

14.5.6.4.3.3 When generated

This primitive is generated when the QoS management entity in NCMS informs QoS information of a BS.

14.5.6.4.3.4 Effect of receipt

A BS receiving the primitive shall transmit DSA-REQ message following the information provided by this message.

14.5.6.4.4 Add_Service_Flow.response (ASF.response)

14.5.6.4.4.1 Function

This primitive is used by a BS to respond the ASF.indication to the QoS management entity in NCMS.

14.5.6.4.4.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.request
(
Transaction ID
Service flow ID
Service flow descriptor
Service flow information
CS parameter information
Service flow error parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow
Service flow descriptor
Information regarding the attribute an uplink or downlink service flow
Service flow information
Approved complete QoS information of a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, service flow scheduling type, tolerate jitter and maximum latency
CS parameter information
Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label
Service flow error parameter information
Failed reason and every specific failed QoS parameter if a ASF request is rejected

14.5.6.4.4.3 When generated

This primitive is generated when a BS receives a DSA-RSP message.

14.5.6.4.4.4 Effect of receipt

This primitive informs the result of the service flow creation of the QoS management entity in NCMS.

14.5.6.4.5 Change_Service_Flow.request (CSF.request)

14.5.6.4.5.1 Function

This primitive is used by a BS to inform an QoS information from an MS of the QoS management entity in NCMS.

14.5.6.4.5.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Change_Service_Flow.request
(
Transaction ID
MS ID
Service flow ID
Service flow information
CS parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
MS ID
48-bit unique identifier used by MS. MS ID is used for user authorization
Service flow ID
Unique identifier to identify a service flow
Service flow information
Required QoS information of a service flow include traffic characteristics and a scheduling type such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, tolerate jitter and maximum latency
CS parameter information
Required IP filter rules of a service flow such as packet classification rule and IPv6 flow label

14.5.6.4.5.3 When generated

This primitive is generated when a BS receives a DSC-REQ message.

14.5.6.4.5.4 Effect of receipt

The QoS management entity in NCMS shall respond to this primitive by sending Change_Service_Flow.confirm. The management entity for service flows checks the validity of the request from the point of view of its own resources.

14.5.6.4.6 Change_Service_Flow.confirm (CSF.confirm)

14.5.6.4.6.1 Function

This primitive is used by the QoS management entity in NCMS to response the CSF.request from a MS. Service flow information in CSF response have approved QoS information if the CSF request is accepted.

14.5.6.4.6.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Change_Service_Flow.confirm
(
Transaction ID
Service flow ID
Service flow information
CS parameter information
Service flow error parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow
Service flow information
Approved complete QoS information of a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, tolerate jitter and maximum latency
CS parameter information
Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label
Service flow error parameter information
Failed reason and every specific failed QoS parameter if the request is rejected

14.5.6.4.6.3 When generated

This primitive is generated when the QoS management entity in NCMS responds to Change_Service_Flow.request primitive.

14.5.6.4.6.4 Effect of receipt

This primitive informs the result of the service flow modification of a BS. A BS receiving the primitive shall transmit DSC-RSP message following the information provided by this message.

14.5.6.4.7 Change_Service_Flow.indication (ASF.indication)

14.5.6.4.7.1 Function

This primitive is used by the QoS management entity in NCMS to inform QoS information. Service flow information is included in CSF.indication of a BS.

14.5.6.4.7.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.confirm
(
Transaction ID
MS ID,
Service flow ID
Service flow information
CS parameter information

)

Transaction ID
A unique sequential identifier of the transaction set by the BS
MS ID
48-bit unique identifier used by MS.
Service flow ID
Unique identifier to identify a service flow
Service flow information
Approved complete QoS information of a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, tolerate jitter and maximum latency
CS parameter information
Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label

14.5.6.4.7.3 When generated

This primitive is generated when the QoS management entity in NCMS informs QoS information of a BS.

14.5.6.4.7.4 Effect of receipt

A BS receiving the primitive shall transmit DSC-REQ message following the information provided by this message.

14.5.6.4.8 Change_Service_Flow.response (CSF.response)

14.5.6.4.8.1 Function

This primitive is used by a BS to respond the CSF.indication to the QoS management entity in NCMS.

14.5.6.4.8.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Change_Service_Flow.request
(
Transaction ID
Service flow ID
Service flow information
CS parameter information
Service flow error parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow
Service flow information
Approved complete QoS information of a service flow such as service class name, QoS parameter set type, maximum sustained traffic rate, maximum traffic burst, minimum reserved traffic rate, minimum tolerable traffic rate, tolerate jitter and maximum latency
CS parameter information
Approved IP filter rules of a service flow such as packet classification rule and IPv6 flow label

Service flow error parameter information
Failed reason and every specific failed QoS parameter if a CSF request is rejected

14.5.6.4.8.3 When generated

This primitive is generated when a BS receives a DSC-RSP message.

14.5.6.4.8.4 Effect of receipt

This primitive informs the result of the service flow creation of the QoS management entity in NCMS.

14.5.6.4.9 Delete_Service_Flow.request (DSF.request)

14.5.6.4.9.1 Function

This primitive is used by a BS to inform QoS information from an MS of the QoS management entity in NCMS.

14.5.6.4.9.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Change_Service_Flow.request
(
Transaction ID
Service flow ID
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow

14.5.6.4.9.3 When generated

This primitive is generated when a BS receives a DSD-REQ message.

14.5.6.4.9.4 Effect of receipt

The QoS management entity in NCMS shall respond to this primitive by sending Delete_Service_Flow.confirm. The management entity for service flows delete assigned resources for service flow ID.

14.5.6.4.10 Delete_Service_Flow.confirm (DSF.confirm)

14.5.6.4.10.1 Function

This primitive is used by the QoS management entity in NCMS to response the DSF.request from a MS.

14.5.6.4.10.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Delete_Service_Flow.confirm
(
Transaction ID
Service flow ID
Service flow error parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow
Service flow error parameter information
Failed reason and every specific failed QoS parameter if a DSF request is rejected

14.5.6.4.10.3 When generated

This primitive is generated when the QoS management entity in NCMS responds to Delete_Service_Flow.request primitive.

14.5.6.4.10.4 Effect of receipt

This primitive informs the result of the service flow deletion to a BS. A BS receiving the primitive shall transmit DSD-RSP message following the information provided by this message.

14.5.6.4.11 Delete_Service_Flow.indication (DSF.indication)

14.5.6.4.11.1 Function

This primitive is used by the QoS management entity in NCMS to inform QoS information. Service flow ID is included in DSF.indication of a BS.

14.5.6.4.11.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Add_Service_Flow.confirm
(
Transaction ID
Service flow ID
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow

14.5.6.4.11.3 When generated

This primitive is generated when the QoS management entity in NCMS informs QoS information of a BS.

14.5.6.4.11.4 Effect of receipt

A BS receiving the primitive shall transmit DSD-REQ message following the information provided by this message.

14.5.6.4.12 Delete_Service_Flow.response (DSF.response)

14.5.6.4.12.1 Function

This primitive is used by a BS to respond the DSF.indication to the QoS management entity in NCMS.

14.5.6.4.12.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Delete_Service_Flow.request
(
Transaction ID
Service flow ID
Service flow error parameter information
)

Transaction ID
A unique sequential identifier of the transaction set by the BS
Service flow ID
Unique identifier to identify a service flow
Service flow error parameter information
Failed reason and every specific failed QoS parameter if a DSF request is rejected

14.5.6.4.12.3 When generated

This primitive is generated when a BS receives a DSD-RSP message.

14.5.6.4.12.4 Effect of receipt

This primitive informs the result of the service flow deletion of the QoS management entity in NCMS. The QoS management entity in NCMS deletes assigned resources for service flow ID.

14.5.6.5 Managing Connection Resources

<Section Note: Managing constraints on the CID and SFID related resources. Recommendations on when CIDs could be recycled etc.>

14.5.6.6 Managing Multicast Broadcast Services

<Section Note: >

14.5.7 Subscriber Mode Management

The following informative subsection describes subscriber mode management.

14.5.7.1 Managing Device States

In Normal Operation, an MS transmits and receives packets to/from a BS. Currently, two subscriber modes are defined, i.e., Sleep and Idle Modes. Sleep Mode is intended to minimize an MS power usage and decrease usage of serving BS air interface resources by pre-negotiated periods of absence from the serving BS air interface. Idle Mode allows an MS to become periodically available for DL broadcast traffic without registration at a specific BS as the MS traverses an air link environment populated by multiple BSs, and thus, allows the MS to conserve power and operational resources.

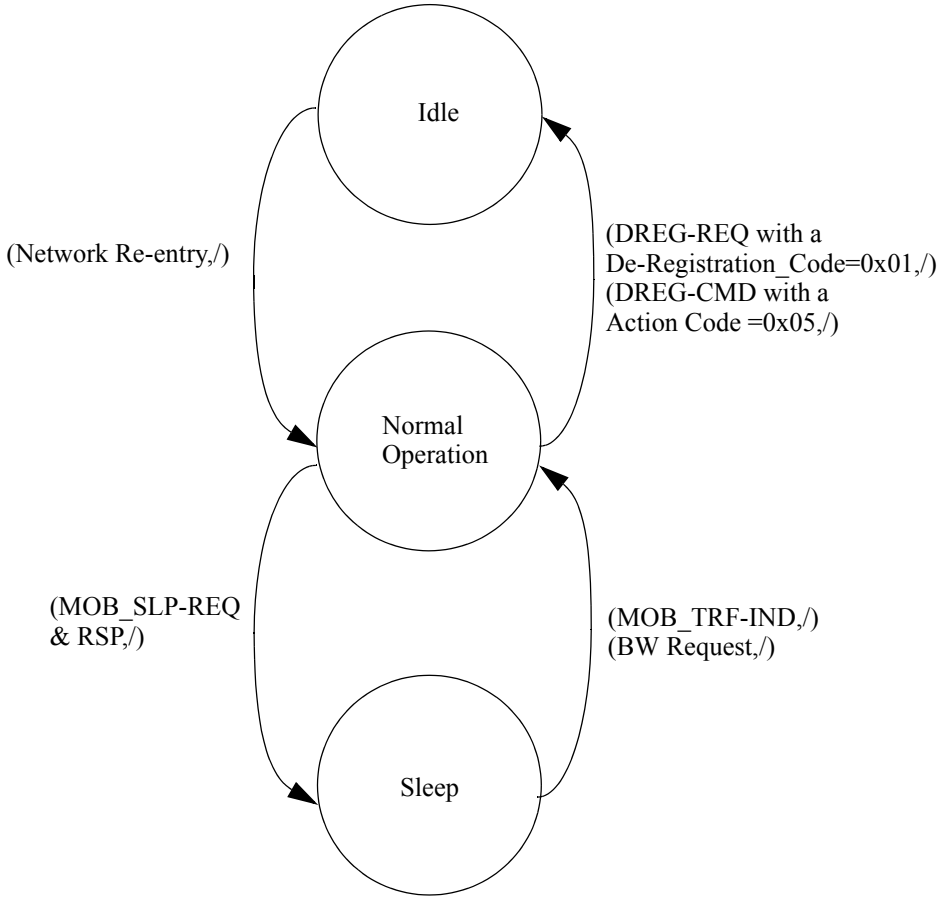

Figure 314—Subscriber Mode transition diagram at MS and BS

Sleep Mode operation is defined between an MS and a BS only, and an NCMS does not need to manage Sleep Mode of subscriber. Thus, both an MS and a BS manage all Normal Operation, Sleep Mode, and Idle Mode of subscriber. On the other hand, an NCMS manages Normal Operation and Idle Mode. In this contribution, Subscriber Mode transitions at an MS, a BS, and an NCMS are modeled and described, as shown in Figure 314 and Figure 315.

Figure 314 shows Subscriber Mode transition diagram at both an MS and a BS. Subscriber Mode at both an MS and a BS changes from Normal Operation to Idle Mode when the MS issues an MS De-registration

Request (DREG-REQ) message with De-Registration_Request_Code=0x01 or the BS issues an De-register Command (DREG-CMD) message with Action Code = 0x05. Then, the MS stays at Idle Mode and updates its location when the paging group changes. The Subscriber Mode returns back to Normal Operation from Idle Mode after completing Network re-entry. Transition from Normal Operation to Sleep Mode is performed after an MS successfully exchanges Sleep Request (MOB_SLP-REQ) and Sleep Response (MOB_SLP-RSP) messages with a BS. If there is any DL traffic toward an MS from a BS, MOB_TRF-IND is broadcast to the MS from the BS and Subscriber Mode of the MS and the BS changes from Sleep Mode to Normal Operation. If there is any UL traffic from an MS, Bandwidth Request (BW Request) is sent to the serving BS from the MS and Subscriber Mode of the MS and the BS changes from Sleep Mode to Normal Operation, too.

Figure 315 shows Subscriber Mode transition diagram at an NCMS with service primitives related with the Subscriber Mode transition. Subscriber Mode transition from Normal Operation to Idle Mode is performed by exchanging Idle_mode_initiation.request and Idle_mode_initiation.response between a BS and an NCMS after successful DREG-REQ message with De-Registration_Request _Code=0x01 or DREG-CMD message with Action Code = 0x05 between an MS and a BS, where Idle_mode_initiation.request and Idle_mode_initiation.response are defined in 14.5.11.1 and 14.5.11.2, respectively. Subscriber Mode transition from Idle Mode to Normal Operation is initiated after exchanging Paging_announce, Idle_ReEntry.indication, and Idle_ReEntry.confirmation between a BS and an NCMS, where Paging_announce, Idle_ReEntry.indication, and Idle_ReEntry. confirmation are defined in 14.5.11.3, 14.5.11.4, and 14.5.11.5, respectively.

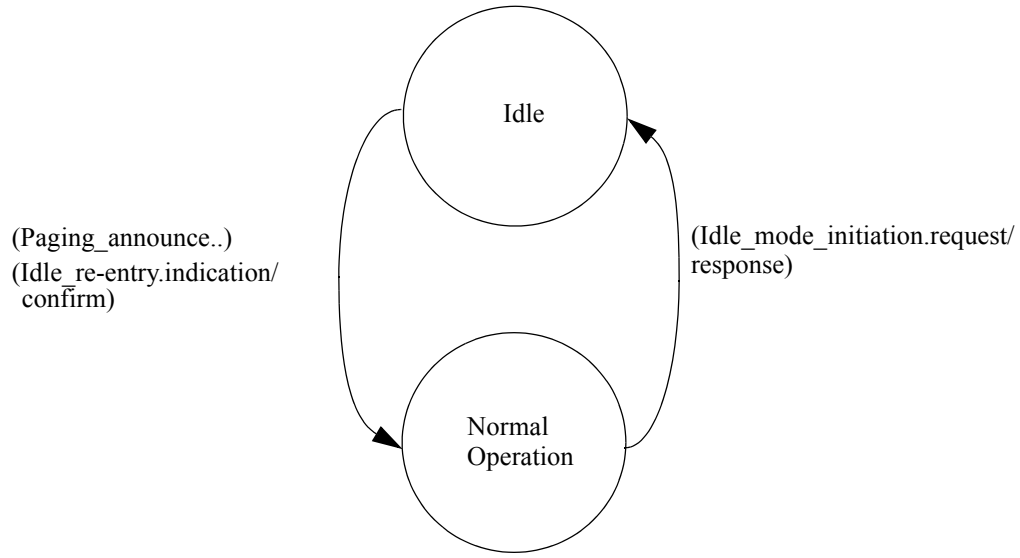

Figure 315—Subscriber Mode transition diagram at NCMS

14.5.8 Roaming Management

14.5.9 Mobility and Handover Management

14.5.9.1 Mobility Parameters

<Section Note: Requirements for different kinds of handoff (Hard-Handoff, FBSS, SHO). Thresholds etc.>

14.5.9.1.1 Handover Context for Connections

Handover context for connections is the set of information which is shared between the serving BS and the target BS for re-establishment of the transport connections during HO. HO context is consisted of the following information.

General MS Information
It is the information required to identify the MS. IP address and MAC address of the MS can be included in this information.

MS Capability Information
It is the information about MS capabilities which need to be negotiated with the serving BS at the initial network entry.

Security Information
It is the information negotiated during PKM procedure. If the MS and the target BS can derive the AK for them without the help of the serving BS, AK key may be excluded from this information.

Service Flow Information
It is the information negotiated during DSx-related procedure.

MAC state Information
It is the information used to maintain MAC state machine and to manage MAC PDU transmission.

For the re-establishment of connections at target BS during HO, serving BS shall provide target BS with the HO context through the mobility management entity in NCMS using HO primitives. If the target BS can not re-use some information in the HO context for restoring the former MAC state or re-establishing connections, the mobility management entity in NCMS may exclude the information from the shared HO context.

14.5.9.1.2 Neighbor BS List Management

14.5.9.1.2.1 Primitives for managing Neighbor BS List

####### 14.5.9.1.2.1.1 NBR_BS_Update.request

######## 14.5.9.1.2.1.1.1 Function

This primitive is issued by a mobility management entity in NCMS to inform BS of neighbor BS list and channel information for those neighbor BSs.

######## 14.5.9.1.2.1.1.2 Semantics of the service primitive

The parameters of the primitive are as follow:

NBR_BS_Update.request
(
Number of neighbor BSs,
List of neighbor BS information

)

Number of neighbor BSs

The number of the current active neighbor BSs

List of neighbor BS information

This parameter includes channel information for neighbor BSs. BS ID and UCD/DCD parameters per each neighbor BS may be included in this parameter

14.5.9.1.2.1.1.3 When generated

This primitive is generated when the mobility management entity in NCMS recognizes that initialization of BS is completed or there are some changes in neighbor BS list or in channel information of one of neighbor BSs.

14.5.9.1.2.1.1.4 Effect of receipt

A BS receiving NBR_BS_Update.request shall update internal information about neighbor BSs and adopt the information into subsequent MOB_NBR-ADV messages. The BS also shall response to this primitive by sending NBR_BS_update.response.

14.5.9.1.2.1.2 NBR_BS_Update.response

14.5.9.1.2.1.2.1 Function

This primitive is issued by BS to response to NBR_BS_Update.request.

14.5.9.1.2.1.2.2 Semantics of the service primitive

The parameters of the primitive are as follow:

NBR_BS_Update.response
(
Result
)

14.5.9.1.2.1.2.3 When generated

This primitive is generated when BS receives NBR_BS_Update.request.

14.5.9.1.2.1.2.4 Effect of receipt

The mobility management entity in NCMS shall inform the neighbor BS of the updating result.

14.5.9.1.2.1.3 NBR_BS_Update.indication

14.5.9.1.2.1.3.1 Function

This primitive is issued by BS to inform the mobility management entity in NCMS of changes in UCD and DCD.

14.5.9.1.2.1.3.2 Semantics of the service primitive

The parameters of the primitive are as follow:

NBR_BS_Update.indication
(
DCD configuration change count,
UCD configuration change count,
DCD parameters,
UCD parameters
)

14.5.9.1.2.1.3.3 When generated

This primitive is generated when one or more parameters in DCD and UCD are changed to inform mobility management entity of such changes.

14.5.9.1.2.1.3.4 Effect of receipt

If mobility management entity in NCMS receives this primitive, it shall inform neighbor BSs of those changes.

14.5.9.1.2.1.4 NBR_BS_Update.confirmation

14.5.9.1.2.1.4.1 Function

This primitive is issued by mobility management entity in NCMS to respond to NBR_BS_Update.indication.

14.5.9.1.2.1.4.2 Semantics of the service primitive

The parameters of the primitive are as follow:

NBR_BS_Update.confirmation
(
Result
)

14.5.9.1.2.1.4.3 When generated

This primitive is generated when mobility management entity receives NBR_BS_Update.indication.

14.5.9.1.2.1.4.4 Effect of receipt

If the value of result field in NBR_BS_Update.confirmation is not success, then BS shall retransmit NBR_BS_Update.indication within pre-defined number of times.

14.5.9.1.3 Connection Management during handover

14.5.9.2 Paging Management

14.5.9.2.1 Paging Group Management

14.5.9.2.1.1 Paging Group Management Procedure

The location information of an idle MS is managed by the unit of Paging Group in Paging Service of an NCMS, and paging messages are sent to all the BSs within the called MS's Paging Group. The NCMS should divide the whole service area into multiple Paging Groups and notify this Paging Group information to all the BSs within the service area, where a BS may be a member of one or more Paging Groups. In this contribution, we propose service primitive for Paging Group Action which is exchanged through Management Service Access Point (M-SAP) of Management Plane specified in IEEE 802.16g baseline document. Paging Group Action is performed by Paging Service of an NCMS, as shown in Fig. 2

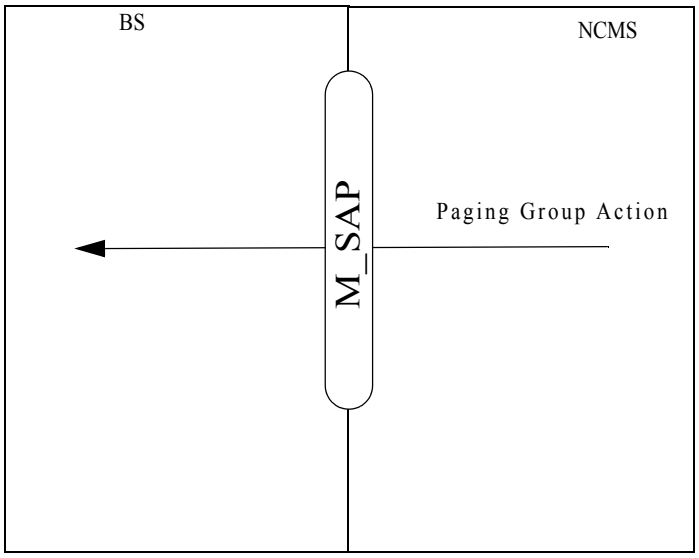

Figure 316—ASF indication and ASF response primtives flow

14.5.9.2.1.2 Service Primitive for Paging Group Management

14.5.9.2.1.2.1 Paging Group Action

14.5.9.2.1.2.1.1 Function

This primitive is issued by an NCMS to inform a BS of Paging Group ID(s) of the BS.

14.5.9.2.1.2.1.2 Semantics of the service primitive

The parameter of the primitive is as follows:

Paging Group Action
(
Paging Controller ID
Number of Paging Group IDs
Paging Group ID List
)

Paging Controller ID
The Paging Controller ID is a logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administering paging activity for the MS while in Idle Mode.

Number of Paging Group IDs
The number of Paging Group IDs in this primitive.

Paging Group ID List
List of Paging Group IDs of a BS (eg, Paging Group ID1, Paging Group ID2, … , Paging Group IDn)

14.5.9.2.1.2.1.3 When generated

This primitive is generated when an NCMS initializes or updates paging group configuration information and notifies the information to a BS.

14.5.9.2.1.2.1.4 Effect of receipt

When the BS receives this primitive, it updates its Paging Group ID information according to the delivered Paging Group ID List, and broadcasts the updated Paging Group ID information in MOB_NBR-ADV, DREG-CMD, MOB_PAG-ADV, DCD, RNG-RSP messages.

14.5.9.2.2 Paging Procedure

14.5.9.3 Location Management

14.5.9.3.1 Location Update Procedure

Location management of an MS is performed by mobility management service of an NCMS. An MS in idle mode performs Location Update in order to inform an NCMS of its current location information, i.e., paging group, and this information is used to page cells within paging group of the called MS when there is pending DL traffic toward the MS.

Location Update is performed if any of Location Update conditions is met and there are currently four Location Update conditions defined: Zone Update, Timer Update, Power Down Update, and MAC Hash Skip Threshold Update. In Zone Update, the MS shall perform Location Update process when the MS detects a change in paging group by comparing the paging group identifier, PG_ID, stored in the MS with that of transmitted by the preferred BS in the DCD message or MOB_PAG-ADV broadcasting message. In Timer Update, MS shall periodically perform Location Update process prior to the expiration of the idle mode timer. In Power Down Update, the MS shall attempt to complete a Location Update once as part of its orderly power down procedure. In MAC Hash Skip Threshold update, the MS shall perform Location Update process when the MS MAC hash skip counter exceeds MAC hash skip threshold.

All the above Location Updates are realized by Ranging request/response (RNG-REQ/RSP) message between an MS and a BS, and Location Update request and Location Update response service primitives are defined between a BS and an NCMS to perform Location Update.

Figure 317 shows service primitives for Location Update between a BS and an NCMS.

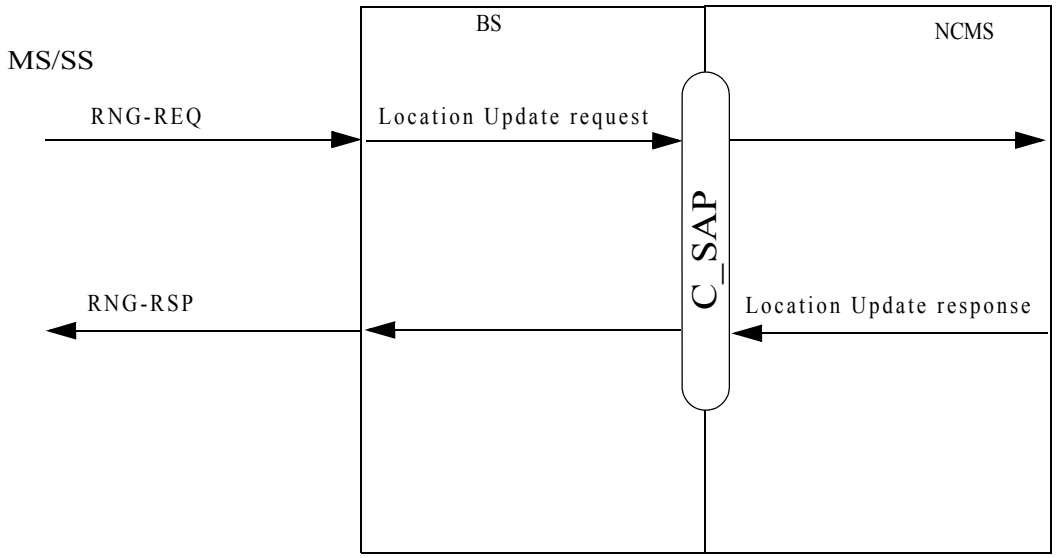

Figure 317— Location Update Primitives

14.5.9.3.2 Service Primitives for Location Update

14.5.9.3.2.1 Location Update request

14.5.9.3.2.1.1 Function

This primitive is issued by a BS to inform a management entity of Mobility Management Services in an NCMS that an MS requests to initiate Location Update.

14.5.9.3.2.1.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Location Update request
(
MS MAC Address
BS ID
Paging Controller ID
Paging Group ID
MAC Hash Skip Threshold
Power Down Indicator
)

MS MAC Address
48-bit MAC address which will identify MS
BS ID
Identifier of serving BS
Paging Controller ID
The Paging Controller ID is a logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administering paging activity for the MS while in Idle Mode.
Paging Group ID
One or more logical affiliation groupings of BS
MAC Hash Skip Threshold
Maximum number of successive MOB_PAG-ADV messages that may be sent from a BS without individual notification for an MS, including MAC address hash of an MS for which Action Code is 00, 'No Action Required'.
Power Down Indicator
Indicates the MS is currently attempting to perform Location Update due to power down.

14.5.9.3.2.1.3 When generated

This primitive is generated when the BS receives RNG-REQ message with Paging Controller ID and Ranging Purpose Indication with bit #1 set to 1, MAC Hash Skip Threshold, or Power Down Indicator.

14.5.9.3.2.1.4 Effect of receipt

This primitive shall be generated on BS side and a management entity of Mobility Management Services shall respond to this primitive by sending Location Update response.

14.5.9.3.2.2 Location Update response

14.5.9.3.2.2.1 Function

This primitive is issued by the NCMS to respond to Location Update request from the BS

14.5.9.3.2.2.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Location Update response
(
MS MAC Address
Location Update Result
Paging Information
Paging Controller ID
MAC Hash Skip Threshold
Power Down Response
)

MS MAC Address
48-bit MAC address which will identify MS
Location Update Result
Response to Location Update Request:
0b00=Failure of Idle Mode Location Update. The MS shall perform Network Re-entry from Idle Mode

0b01=Success of Idle Mode Location Update
0b10, 0b11: Reserved

Paging Information

New Paging Information assigned to MS. Paging Information shall only be included if Location Update Response=0x01 and if Paging Information has changed. The Paging Information TLV defines the Paging Group ID, PAGING_CYCLE and PAGING OFFSET parameters to be used by the MS in IDLE mode. PAGING_CYCLE is the cycle in which the paging message is transmitted within the paging group. PAGING OFFSET determines the frame within the cycle in which the paging message is transmitted and it must be smaller than PAGING CYCLE value. Paging Group ID specifies the paging group the MS is assigned to.

Paging Controller ID

Paging Controller ID is a logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administering paging activity for the MS while in Idle Mode. Paging Controller ID shall only be included if Location Update Response=0x01 and if Paging Controller ID has changed.

MAC Hash Skip Threshold

Maximum number of successive MOB_PAG-ADV messages that may be sent from a BS without individual notification for an MS, including MAC address hash of an MS for which Action Code for the MS is 00,'No Action Required'. If BS does not include this TLV item in the RNG-RSP message, any BS may omit MAC Address Hash of the MS with Action Code 00,'No Action Required' from any MOB_PAG-ADV message.

Power Down Response

Indicates the MS's Power Down Location Update result.
0x00= Failure of Power Down Information Update.
0x01= Success of Power Down Information Update.

14.5.9.3.2.2.3 When generated

This primitive is generated at an NCMS in order to request a BS to issue a RNG-RSP message.

14.5.9.3.2.2.4 Effect of receipt

A BS receiving Location Update response shall transmit RNG-RSP message with the appropriate parameters settings.

14.5.9.4 MSS Handover Management

<Section Note: How an MSS handles its handover functions>

14.5.9.5 Inter BS Handover Management

<Section Note: How a BS handles its handover functions with neighboring BSes>

14.5.9.6 Macro Diversity Management

<Section Note: How a BS along with the NCMS entities handles macro diversity>

14.5.9.7 Handover Control Protocol Procedures

14.5.9.7.1 HO Control Primitives

The HO Control Primitives are a set of primitives for supporting HO procedure between BS and NCMS. They are defined for access to the Mobility Control entity to support handovers.

14.5.9.7.1.1 HO request

This primitive is used by a serving BS to inform the mobility control entity in NCMS of an incoming HO request from an MSS. The following parameters are included in this primitive.

Serving BS ID
Base station unique identifier (Same number as that broadcasted on the DL-MAP message).
MS ID
48-bit unique identifier used by MS.
HO Type
Indication of HO types; HO or SHO/FBSS.
Mode
Various modes in Anchor BS update or Active Set Update.
Candidate target BS list
This is the list of BSes which are recommended for a target BS or an active BS by the MS. Additional HO quality information such as Service Level Prediction also can be included in this list.
Service flow Information
Information of all the service flows that have been established between the MS and the serving BS.

14.5.9.7.1.2 HO indication

This primitive is used by the mobility control entity in NCMS to inform target BSes of the pending HO. It delivers the following parameters.

Serving BS ID
Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
MSS ID
48-bit unique identifier used by MSS
HO Type
Indication of HO types; HO or SHO/FBSS
Mode
Various modes in Anchor BS update or Active Set Update
Service flow Information
Information of all the service flows that have been established between the MS and the serving BS
HO Quality Information
Information related with quality of HO procedure; Service Level Prediction, HO Optimization Flag, Arrival Time Difference, etc.

14.5.9.7.1.3 HO response

The Mobility Control entity in NCMS responds to the serving BS with the list of recommended target BSes. This primitive is always sent in reply to the HO request primitive.

The following parameters are included in this primitive.

MSS ID
48-bit unique identifier used by MSS
HO Type
Indication of HO types; HO or SHO/FBSS
Mode
Various modes in Anchor BS update or Active Set Update
Recommended target BS list
The list must be a subset of the candidate target BS list from the corresponding HO request. The recommended target BS list is to be delivered to the MSS in the MOB_BSHO-RSP. The BSes in the list may be the candidate target BSes for HO or an Anchor BS or Active BSes for SHO/FBSS according to the value of HO type and Mode. MS Access Information, Newly Allocation Information, and HO Quality Information can be included in this list

14.5.9.7.1.4 HO confirmation

This primitive is used by the target BS to responds to the HO indication primitive from the serving BS or the mobility control entity in NCMS. It delivers the following parameters.

Target BS ID
Base station unique identifier of the target BS
MSS ID
48-bit unique identifier used by MSS
Result Flag
HO Type
Indication of HO types; HO or SHO/FBSS
Mode
Various modes in Anchor BS update or Active Set Update
MSS Access Information
Information needed by MSS to access the target BS; HO ID, CQI CH Information, HO Authorization Policy Information
Newly Allocated Information
Newly allocated information for the MSS or each service flow; SAID, CID
HO Quality Information
Information related with quality of HO procedure; HO Optimization Flag, Service Level Prediction

14.5.9.7.1.5 HO start

In case of HO, this primitive is used to indicate the starting of the actual HO. In case of SHO/FBSS, it can be used to update Anchor BS or to add a new Active BS to the current Active set. Both of the serving BS and the mobility control entity in NCMS can use this primitive to inform the target BS or the mobility control entity in NCMS of the starting of the actual HO. The following parameters are included in this primitive.

MSS ID
48-bit unique identifier used by MS
HO Type
Indication of HO types; HO or SHO/FBSS
Mode
Various modes in Anchor BS update or Active Set Update
Target BS ID
Base station unique identifier to which the MS attempts the actual HO

14.5.9.7.1.6 HO cancel

In case of HO, this primitive indicates the cancellation of the pending HO. In case of SHO/FBSS, it can be used to cancel anchor BS update or Active set update, or to remove a target BS from the current active set. Both of the serving BS and the mobility control entity in NCMS can use this primitive. This primitive conveys the following parameters.

MSS ID
48-bit unique identifier used by MS
HO Type
Indication of HO type; HO and SHO/FBSS
Mode
It is valid for SHO/FBSS and cancels Anchor BS update or Active set update. In addition, it may indicate removal of the target BS from the current active set.

14.5.9.7.1.7 HO Directive

This primitive is generated by the Mobility Control entity in NCMS to induce the handover of a particular MSS. Transmission of MOB_BSHO-REQ message is triggered by this primitive.

MSS ID
48-bit unique identifier used by MSS
HO Type
Indication of HO types; HO or SHO/FBSS
Mode
Various modes in Anchor BS update or Active Set Update
Recommended target BS list
This is the list of recommended target BSes by the mobility control entity. The BSes in the list may be the candidate target BSes for HO or an Anchor BS or Active BSes for SHO/FBSS according to the value of HO type and Mode. MS Access Information, Newly Allocation Information, and HO Quality Information can be included in this list

14.5.9.7.1.8 Scanning.request

14.5.9.7.1.8.1 Function

This primitive is issued by the mobility management entity in NCMS to request radio signal information of MSs.

14.5.9.7.1.8.2 Semantics of the service primitive

The parameters of the primitive are as follow:

Scanning.request
(
Number of MS,
List of MS ID
)
Number of MS
Number of MSs
List of MS ID
The list of MS ID

14.5.9.7.1.8.3 When generated

This primitive is generated when the mobility management entity in NCMS decides that BS-initiated HO should be occurred because the BS is about to be overloaded.

14.5.9.7.1.8.4 Effect of receipt

The BS shall response to the scanning.request primitive using scanning.response primitive.

14.5.9.7.1.9 Scanning.response

14.5.9.7.1.9.1 Function

This primitive is issued by the BS to respond to scanning.request

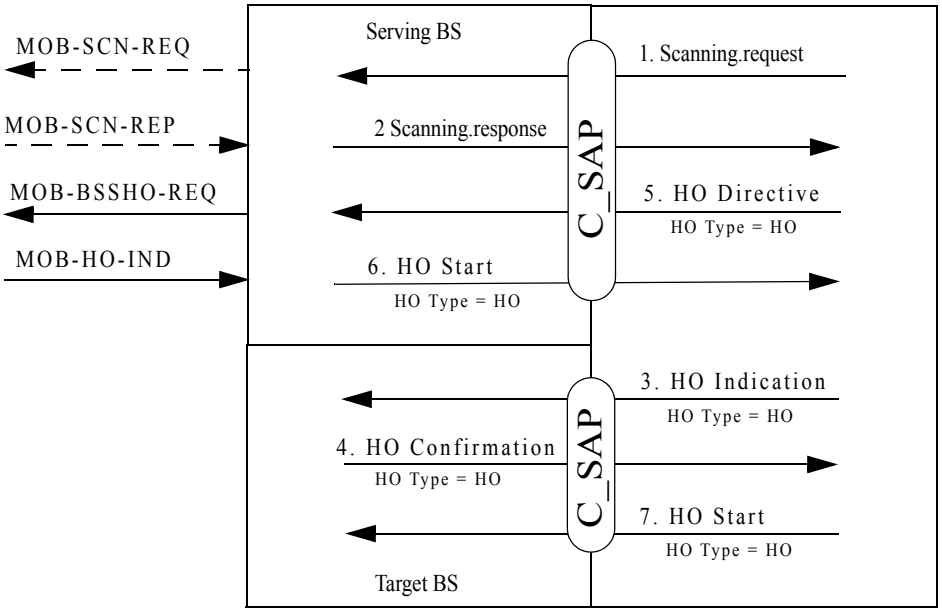

Figure 318—Example Primitive Flow of HO initiated by BS

14.5.9.7.1.9.2 Semantics of the service primitive

The parameters of the primitive are as follows:

Scanning.confirmation
(
Number of MS,
List of MS ID,

List of Signal information
)

Number of MS
Number of MSs
List of MS ID
The list of MS ID
List of Signal Information
TBD.

14.5.9.7.1.9.3 When generated

This primitive is generated when the receives scanning.request

14.5.9.7.1.9.4 Effect of receipt

The mobility management entity in NCMS may decide the specific MS and its potential target BS for BS-initiated HO based on the reported signal quality in the scanning.response primitive.

14.5.9.7.2 Hard Handoff Procedures

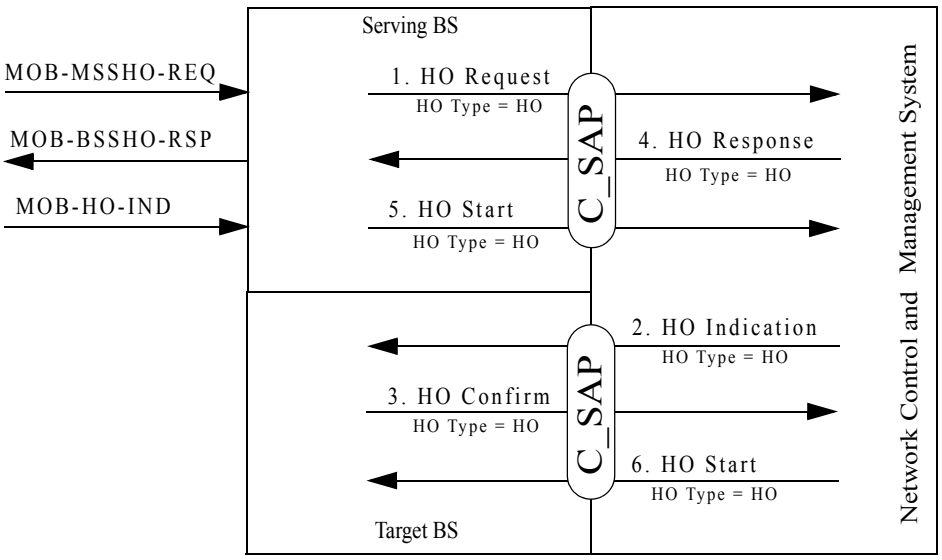

Figure 319—Example Primitive Flow of HO Initiated by MS

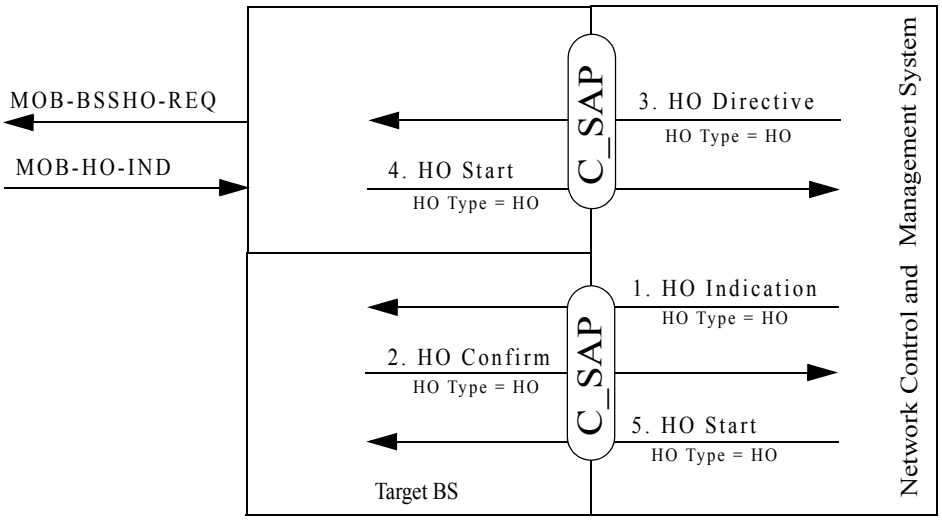

Figure 320—Example Primitive Flow of HO Initiated by BS

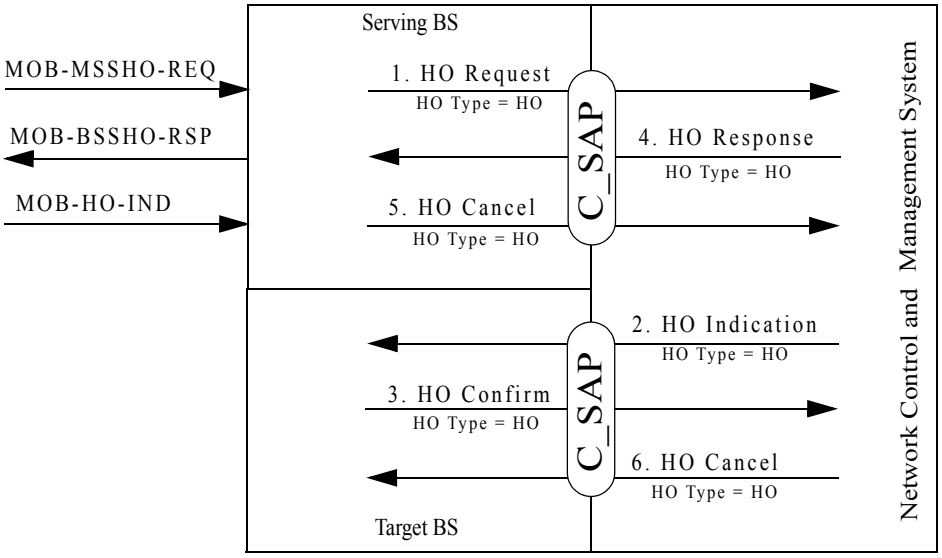

Figure 321—Example Primitive Flow of HO Cancel

14.5.9.7.3 Fast Base Station Switching Procedures

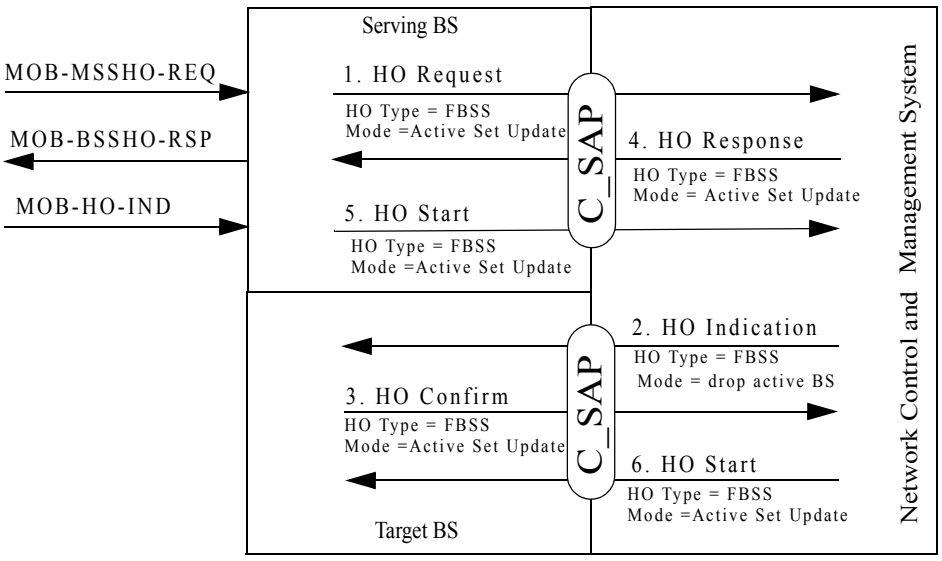

Figure 322—Example Primitive Flow of Active Set Update (Add)

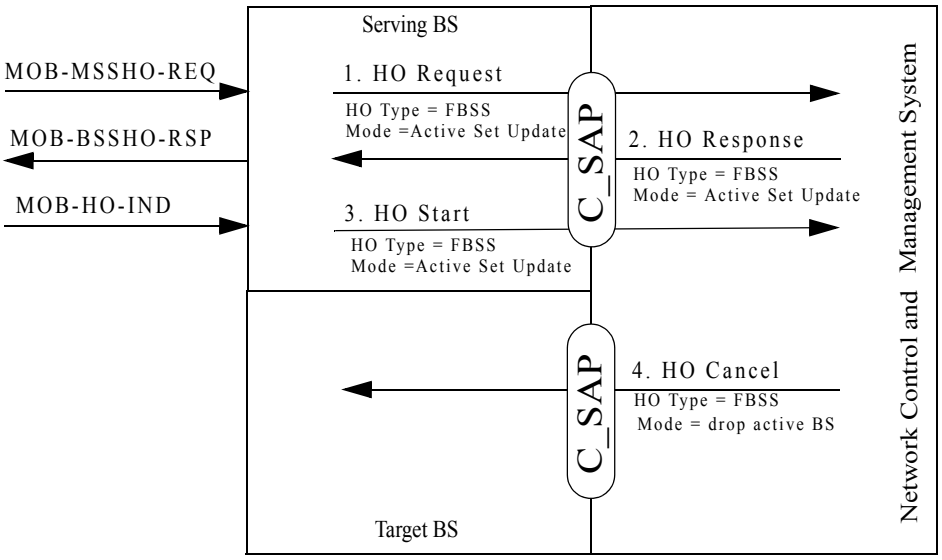

Figure 323—Example Primitive Flow of Active Set Update (Drop)

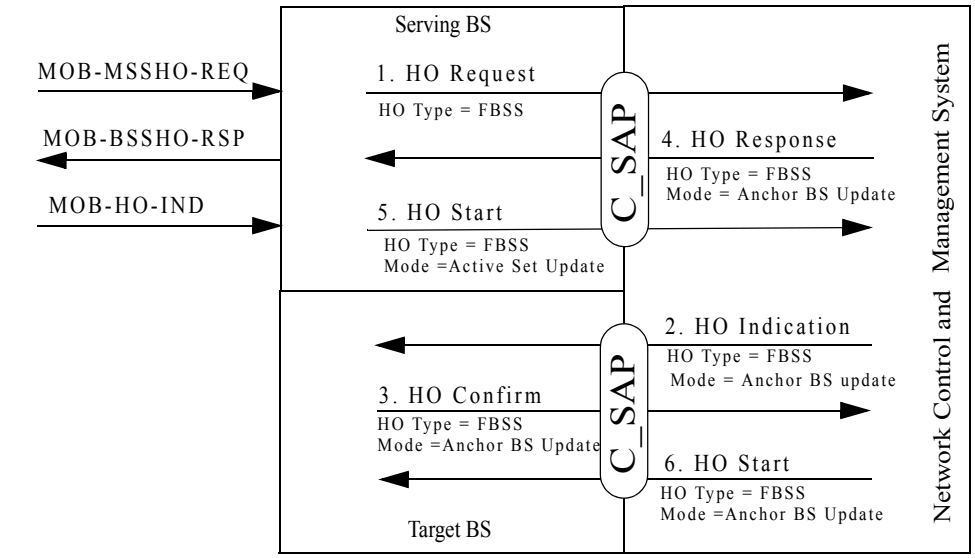

Figure 324—Example Primitive Flow of Anchor BS Update (Using MAC messages)

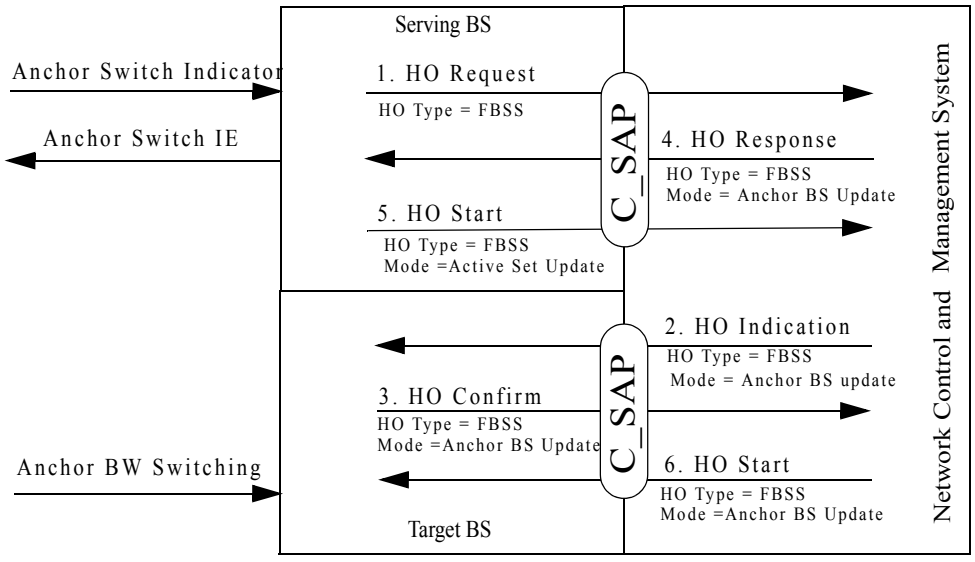

Figure 325—Example Primitive Flow of Anchor BS Update (Using selection feedback mechanism)

14.5.9.7.4 Soft Handoff Procedures

SHO procedures are the same as FBSS procedures except that the primitives may have different parameter values.

14.5.10 Backbone Messages

14.5.11 Interface SAP for Upper Layer Protocols

14.5.11.1 Idle_Mode_Initiation.request

14.5.11.1.1 Function

This primitive is issued by BS to inform a management entity of Paging Services in NCMS that an MS requests to initiate Idle Mode.

14.5.11.1.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Idle_Mode_Initiation.request
(
MS MAC Address
Paging_Cycle_Request
Idle Mode Retain Information
MAC Hash Skip Threshold
Service Flow parameters
Service and operational information
)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode

Paging_Cycle_Request
Paging Cycle requested by MS

Idle Mode Retain Information
MS request for Paging Controller retention of network re-entry related MAC management message and MS service and operational information to expedite future Network Re-entry from Idle Mode. (see 6.3.2.3.42.)

MAC Hash Skip Threshold
Maximum number of successive MOB_PAG-ADV messages that may be sent from a BS individual notification for an MS, including MS MAC Address Hash of an MS for which Action Code is 0b00, 'No Action Required'.

Service Flow parameters
Parameters for Service Flow which exists without actually being activated to carry traffic at MS Idle Mode Initialization, e.g. Paging Preference.

Service and operational information
MS service and operational information associated with MAC state machines, CS classifier information, etc.

14.5.11.1.3 When generated

This primitive is generated when a BS receives a DREG-REQ message with Deregistration_Request_Code=0x01, “request for MS De-Registration from serving BS and initiation of MS Idle Mode.

14.5.11.1.4 Effect of receipt

This primitive shall be generated on BS side and a management entity of Paging Services shall respond to this primitive by sending Idle_Mode_Initiation.response.

14.5.11.2 Idle_Mode_Initiation.response

14.5.11.2.1 Function

This primitive is issued by a management entity in Paging Services in NCMS to respond to Idle_Mode_Initiation.Request.

14.5.11.2.2 Semantics of the Service Primitive

The parameters of the primitives are as follows:

Idle_Mode_Initiation.response
(
Action code
MS MAC Address
Paging Information
Paging Controller ID
Idle Mode Retain Information
MAC Hash Skip Threshold
REQ-duration
)

Action code
Indicates the value of Action code to be included in DREQ-CMD message. (see Table 55.)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode

Paging Information
Paging Group ID, Paging Cycle, and Paging Offset parameters followed by MS in Idle Mode.

Paging Controller ID
A logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administrating paging activity for the MS while in Idle Mode. Paging Controller ID shall be set to BS ID when a BS is acting as Paging Controller.

Idle Mode Retain Information
MS request for Paging Controller retention of network re-entry related MAC management message and MS service and operational information to expedite future Network Re-entry from Idle Mode. (see 6.3.2.3.42.)

MAC Hash Skip Threshold
Maximum number of successive MOB_PAG-ADV messages that may be sent from a BS individual notification for an MS, including MS MAC Address Hash of an MS for which Action Code is 0b00, ‘No Action Required’.

REQ-duration
Waiting value for the DREG-REQ message re-transmission (measured in frames).

14.5.11.2.3 When generated

This primitive is generated to request a BS to issue a DREG-CMD message.

14.5.11.2.4 Effect of receipt

A BS receiving Idle_Mode_Initiation.response shall transmit DREG-CMD message with setting each field in accordance with the information elements in this primitive.

14.5.11.3 Paging_Announce

14.5.11.3.1 Function

This primitive is issued by a management entity of Paging Services in NCMS to request a BS to page an MS which is supposed to be in Idle Mode by transmitting MOB_PAG-ADV message including the MS MAC Address Hash and relevant Action Code.

14.5.11.3.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Paging_Announce
(
MS MAC Address
Paging Information
Action Code
)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode
Paging Information
Paging Group ID, Paging Cycle, and Paging Offset parameters followed by MS in Idle Mode.
Action Code
Action required for MS in Idle Mode (e.g. Network Re-entry, ranging for location update, and so on)

14.5.11.3.3 When generated

This primitive is generated by a management entity of Paging Services to request a BS to transmit BS Broadcast Paging message.

14.5.11.3.4 Effect of receipt

A BS receiving Paging_Announce shall transmit MOB_PAG-ADV message following the information provided by this primitive.

14.5.11.4 Idle_ReEntry.indication

14.5.11.4.1 Function

This primitive is issued by a BS to inform a management entity of Paging Services that the specified MS is attempting to re-enter network in response to paging.

14.5.11.4.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Idle_ReEntry.indication
(
MS MAC Address
Paging Information
Paging Controller ID
BS ID
)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode

Paging Information
Paging Group ID, Paging Cycle, and Paging Offset parameters followed used by MS in Idle Mode.

Paging Controller ID
A logical network identifier for the serving BS or other network entity retaining MS service and
operational information and/or administrating paging activity for the MS while in Idle Mode. Paging Controller ID shall be set to BS ID when a BS is acting as Paging Controller.

BS ID
A network identifier of the BS at which the MS is attempting to re-enter network

14.5.11.4.3 When generated

This primitive is generated by a BS when it receives a RNG-REQ message including Ranging Purpose Indication with setting bit #0 to 1 in combination with Paging Controller ID.

14.5.11.4.4 Effect of receipt

Idle_ReEntry.indication notifies a management entity of Paging Services that the specified MS is attempting to re-enter network through the specified BS in order to receive DL traffic. The management entity also checks MS service and operational information for the MS, and transmits Idle_ReEntry.confirmation in response to this primitive.

14.5.11.5 Idle_ReEntry.confirmation

14.5.11.5.1 Function

This primitive is issued by a management entity of Paging Services to confirm the MS Network Re-entry from Idle Mode and provides the BS at which the MS is attempting to re-enter network with service and operational information.

14.5.11.5.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Idle_ReEntry.confirmation
(
MS MAC Address
Service and operational information
)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode
Service and operational information
MS service and operational information associated with MAC state machines, CS classifier information, etc.

14.5.11.5.3 When generated

This primitive is generated by BS when a RNG-REQ message including Ranging Purpose Indication with setting bit #0 to 1 in combination with Paging Controller ID.

14.5.11.5.4 Effect of receipt

BS receiving Idle_ReEntry.confirmation transmits RNG-RSP message including HO Process Optimization which is based on the service and operational information in this primitive.

14.5.11.6 Idle_ReEntry_Complete

14.5.11.6.1 Function

This primitive is issued by a BS to inform a management entity of Paging Services that an MS has re-entered network successfully.

14.5.11.6.2 Semantics of the service primitive

The parameters of the primitives are as follows:

Idle_ReEntry.confirmation
(
MS MAC Address
Paging Controller ID
BS ID
)

MS MAC Address
48-bit MAC Address which will identify MS during Idle Mode
Paging Controller ID
A logical network identifier for the serving BS or other network entity retaining MS service and
operational information and/or administrating paging activity for the MS while in Idle Mode. Paging Controller ID shall be set to BS ID when a BS is acting as Paging Controller.
BS ID
A network identifier of the BS at which the MS is attempting to re-enter network

14.5.11.6.3 When generated

This primitive is generated by a BS when Network Re-entry process specified in 6.3.22.10 has been completed.

14.5.11.6.4 Effect of receipt

The buffered DL traffic is delivered to the serving BS and finally to MS.

14.5.12 Radio Resource Management

14.5.12.1 Radio Measurements and Reporting

The RRM Primitives are a set of primitives for supporting RRM procedures between BS and NCMS.

14.5.12.1.1 RRM Primitives

14.5.12.1.1.1 RRM Spare Capacity Request Primitive

The Radio Resource Controller (RRC) may use this primitive to request a BS to provide spare capacity information to the RRC. Note that the RRC may be located in another BS, or in a central entity in the NCMS.

RRM Type
Indication of RRM type: Spare Capacity Request
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
NCMS Node or BS unique identifier
Spare Capacity Report Type
Type of requested report profile. 1 for spare capacity report type 1. (Types > 1 reserved for future types)
Report Characteristics
Indicates whether report should be sent periodically, or event driven. Following events are possible:
- Completion of Network Entry
- Deregistration of MS
- Adding / changing / deleting connections
- MOB_MSHO-REQ received from MS
- MOB_SCAN-REPORT received from MS
- Association performed by MS
- MOB_HO-IND received by Serving BS
- Completion of network re-entry at Target BS after HO
- Report solicitation from RRC

14.5.12.1.1.2 Spare capacity report primitive

The BS may use this primitive to provide spare capacity information to the RRC, as requested by the RRC within the Spare Capacity Request Primitive.

RRM Type
Indication of RRM type: Spare Capacity Report
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
NCMS Node or BS unique identifier
Spare Capacity Report Type
Type of report profile = 1
Available Radio Resource
Percentage of reported average available subchannels and symbols resources per frame, as defined in section 14.5.13.3

14.5.12.1.1.3 PHY report request primitive

The Radio Resource Controller (RRC) may use this primitive to request a BS to provide a report of the link level quality for a specific MS.

RRM Type
Indication of RRM type: Physical Parameters Request
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
BS unique identifier
MS ID
48-bit unique identifier of the MS

14.5.12.1.1.4 RRM PHY report primitive

The BS may use this primitive to provide a report of the link level quality for a specific MS to the Radio Resource Controller (RRC).

RRM Type
Indication of RRM type: Physical Parameters Report
Sender NCMS Node ID
BS unique identifier
Target NCMS Node ID
NCMS Node or BS unique identifier
MS ID
48-bit unique identifier used by MS
Downlink Physical Service Level
Channel rate available for the MS calculated as a multiple of 1/32 of nominal bandwidth in the correspondent direction assuming 1 bit/Hz. For example, if DL channel bandwidth is 10 MHz, value PSL=4 means 4*1/32*10 Mbps = 1.25 Mbps. 1 PSL 96 (Number of sub channels in different OFDMA modes is multiple of 16 or 32; highest modulation (QAM64) provides 3 bits/Hz)
Downlink RSSI mean
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Downlink RSSI standard deviation
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Downlink CINR mean
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Downlink CINR standard deviation
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Uplink Physical Service Level
Channel rate available for the MS calculated as a multiple of 1/32 of nominal bandwidth in the correspondent direction assuming 1 bit/Hz. (see definition of Downlink Physical Service Level)
Uplink RSSI mean
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Uplink RSSI standard deviation
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Uplink CINR mean
As specified in 8.1.9 Channel quality measurements [802.16-2004].
Uplink CINR standard deviation
As specified in 8.1.9 Channel quality measurements [802.16-2004].

14.5.12.1.1.5 RRM Neighbor-BS Radio Resource Status Update primitive

This primitive can be used by RRC to inform a Serving BS about the list of Neighbor BS's which are potential HO Target Base Stations for any MS's being served by the SBS, including an information about their radio resource status

RRM Type
Indication of RRM type: Neighbor-BS Radio Resource Status Update
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
BS unique identifier
N NEIGHBORS
Number of neighbor BS's

For (j=0; j<N NEIGHBORS; j++) {

BS Identity
Unique identifier of BS
Available Radio Resource
Percentage of reported average available subchannels and symbols resources per frame, as defined in section 14.5.13.3
DCD Configuration Change Count
This represents the Neighbor BS current Downlink Channel Descriptor (DCD) configuration change count
UCD Configuration Change Count
This represents the Neighbor BS current Uplink Channel Descriptor (UCD) configuration change count
}

14.5.12.1.2 RRM Procedures

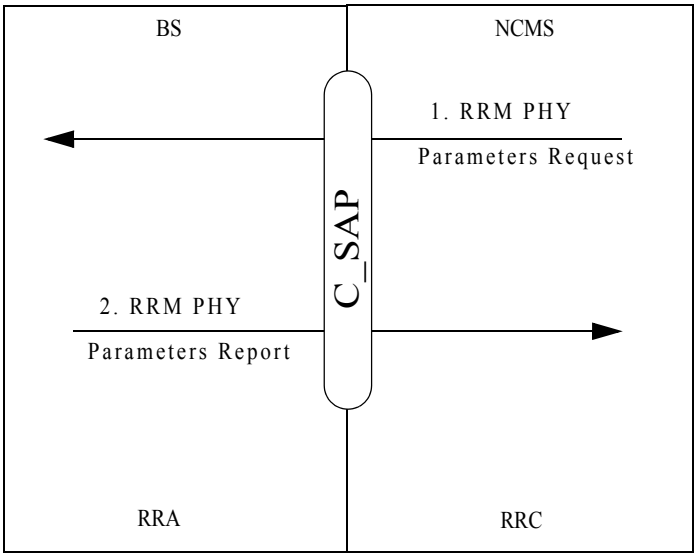

Figure 326—Example Primitive Flow of Physical Parameter Report

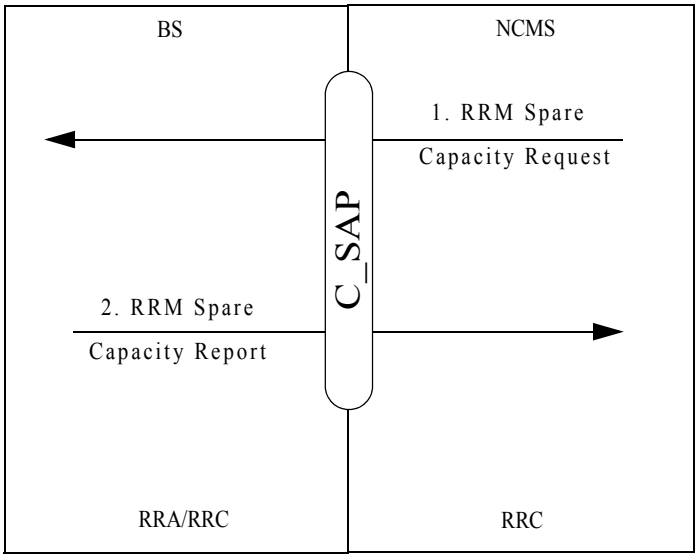

Figure 327—Example Primitive Flow of Spare capacity Report

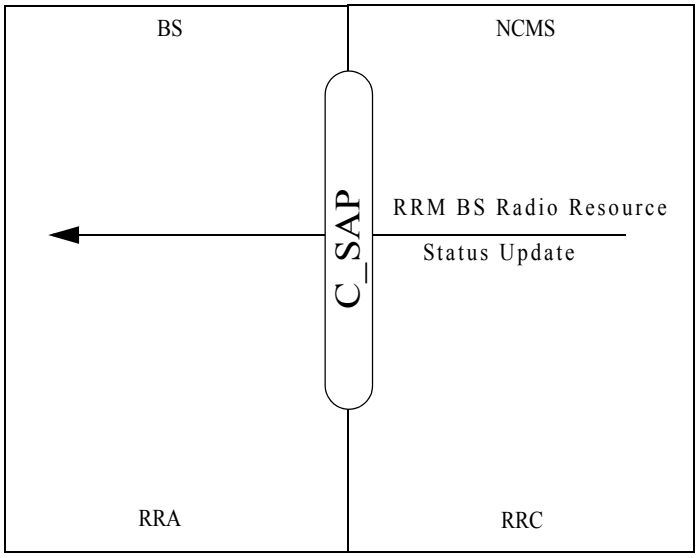

Figure 328—Example Primitive Flow of Radio Resource Status Update

14.5.12.2 Power Control Management

<Section Note: PHY Specific sections>

14.5.13 MAC Management Enhancements

14.5.13.1 Service Identity Broadcast

[Add the following entries to Table 14 in IEEE Standard 802.16-2004]

Table 454—MAC Management Messages

Type	Message name	Message description	Connection
201	SII	MAC management message	broadcast CID

14.5.13.1.1 Service Identity Information (SII) message

A BS may use the SII message to broadcast service identity information. The message may be broadcast periodically without solicitation or could be solicited by an (M)SS. This message is sent from the BS to all MSSs on a broadcast CID.

Table 455—Service Identity Information (SII) message format

Syntax	Size	Notes
SII_REQ () {		
Management message type = 201	8 bits	
TLV Encoded Information	Variable	TLV specific
}		

14.5.13.1.2 Service Information Identity (SII) TLV

It is a compound TLV that contains 1 or more service identity, and it is used in a broadcast SII message.

Table 456—Service Identity Information (SII) Compound TLV

Type	Length	Value
1	Variable	Compound

14.5.13.1.3 Service Identity TLV

The service identity can be represented as a 24-bit identity or NAI. The following TLVs are defined for each representation of the identity.

Table 457—Using 24-bit Identity

Type	Length	Value
2	3 bytes	24-bit Identifier

Table 458—Using NAI

Type	Length	Value
3	32 bytes	realm

14.5.13.2 Management Signaling Method

14.5.13.2.1 Management Signalling Messages

The following messages may be used to query and set the information elements (IE) on the SS by the BS. These messages shall only be used to query or set IEs that are indicated in the table A1. The table A1 explicitly indicates the type of operation that can be performed on a particular IE.

[Add the following entries as additions to the end of Table 14:]

Table 459—Management Signalling Messages

Type	Message name	Message description	Connection
202	QRY_IE_REQ	Query IE request	primary management
203	QRY_IE_RSP	Query IE response	primary management
204	SET_IE_REQ	Set IE request	primary management
205	SET_IE_RSP	Set IE response	primary management

Table 460—Information Elements for Query/Set Operations

Information Element (IE) Name	Description	Type of Operation = One of (Query Only, Set Only, Query and Set)
tbd	tbd	

14.5.13.2.1.1 Query IE Request message (QRY_IE_REQ)

BS uses the QRY_IE_REQ message to query information on the SS by describing by one or more IEs. The QRY_IE_REQ message is sent from the BS to the SS on the SS's primary management connection.

Table 461—Query IE Request (QRY_IE_REQ) Message Format

Syntax	Size	Notes
QRY_IE_REQ_Message_Format() {		
Management message type=202	8 bits	
Transaction id	8 bits	
Response timeout	8 bits	In units of 5 frames
TLV Encoded Information	variable	
}		

Parameters shall be as follows:

Transaction id
A unique sequential identifier of the transaction set by the initiator.
Response timeout
In units of 5 frames (by which the sender expects to receive a corresponding QRY_IE_RSP message)

The QRY_IE_REQ shall include the following parameters encoded as TLV Tuples:
HMAC Tuple (see 11.12)
The HMAC Tuple shall be the last attribute in the message.

The base station will serialize all the QRY_IE-REQ messages sent to the SS, waiting until the SS has responded, or a timeout has occurred before querying the SS again, or with more information. The BS may replay a message to override previously sent messages before the timeout has occurred. In this case the SS will not respond to the previous request instead will process the newly received message.

14.5.13.2.1.2 Query IE Response message (QRY_IE_RSP)

The QRY_IE_RSP message is sent by the SS in response to QRY_IE-REQ containing the results of the information elements sent in the corresponding QRY_IE-REQ. The QRY_IE_RSP message is sent from the SS to the BS on the SS's primary management CID.

Parameters shall be as follows:

Transaction id
A unique sequential identifier of the transaction set by the initiator.
RSP Status
Error encoding of the response status. Allowed values are:
0 – success
1 – Error Response timeout too short
2 – Error TLV

The QRY_IE_RSP shall include the following parameters encoded as TLV Tuples:

HMAC Tuple (see 11.12)

Table 462—Query IE Response(QRY_IE_RSP) message format

Syntax	Size	Notes
QRY_IE_RSP_Message_Format() {		
Management message type = 203	8 bits	
Transaction id	8 bits	
RSP Status	8 bits	Allowed values are: 0 – success 1 – Error Response timeout too short 2 – Error TLV
TLV Encoded Information	variable	
}		

The HMAC Tuple shall be the last attribute in the message.

14.5.13.2.1.3 Set IE Request message (SET_IE_REQ)

BS uses the SET_IE_REQ message to set information on the SS describing by one or more IEs. SS uses the SET_IE_REQ message to notify or alert the BS of an event or error condition. The SET_IE_REQ message is sent from the BS to the SS or from the SS to the BS on the SS's primary management CID.

Parameters shall be as follows:

Transaction id

A unique sequential identifier of the transaction set by the initiator.

Response timeout

Number of frames x 5 by which the sender expects to receive a corresponding SET_IE_RSP message with either a success or error RSP Status. If this value is set to 0, the sender does not require a response and the receiver will not issue one.

The SET_IE_REQ shall include the following parameters encoded as TLV Tuples:

HMAC Tuple (see 11.12)

The HMAC Tuple shall be the last attribute in the message.

14.5.13.2.1.4 Set IE Response message (SET_IE_RSP)

The SET_IE_RSP message is sent by the SS in response to SET_IE-REQ containing the results of the operation in the corresponding QRY_IE-REQ.

The SET_IE_RSP message is sent from the SS to the BS on the SS's primary management CID.

Table 463—Set IE Request (SET_IE_REQ) message format

Syntax	Size	Notes
SET_IE_REQ_Message_Format() {		
Management message type = 204	8 bits	
Transaction id	8 bits	
Response timeout	8 bits	Number of frames x 5 by which the sender expects to receive a corresponding SET_IE_RSP message with either a success or error RSP Status. If this value is set to 0, the sender does not require a response and the receiver will not issue one.
TLV Encoded Information	variable	
}		

Table 464—Set IE Reponse (SET_IE_RSP) message format

Syntax	Size	Notes
SET_IE_RSP_Message_Format() {		
Management message type = 204	8 bits	
Transaction ID	16 bits	
RSP Status	8 bits	Allowed values are: 0 – success 1 – Error Response timeout too short 2 – TLV set Operation Error
TLV Encoded Information	variable	
}		

Parameters shall be as follows:

Transaction id
A unique sequential identifier of the transaction set by the initiator.

RSP Status
Error encoding of the response status. Allowed values are:

0 – success
1 – Error Response timeout too short
2 –TLV set operation Error

The SET_IE_RSP shall include the following parameters encoded as TLV Tuples:

HMAC Tuple (see 11.12)
The HMAC Tuple shall be the last attribute in the message.

The base station will serialize all the SET_IE-REQ messages sent to the MSS, waiting until the MSS has responded, or a timeout has occurred before configuring the MSS again, or with additional settings. In case a timeout has occurred

14.5.13.3 BS Radio Resource Advertising

[Apply the following modification to table 108f]

Table 108f—MOB_NBR-ADV message format

Syntax	Size (bits)	Note
Skip-optional-fields bitmap	8	Bit [0]: if set to 1, omit Operator ID field Bit [1]: if set to 1, omit NBR BS ID field Bit [2]: if set to 1, omit HO process optimization field Bit [3]: if set to 1, omit QoS related fields Bit [4]: if set to 1, omit 802.16g related fields Bit [~~4~~5]-[7]: reserved

[Add the following entries in the table 108f, immediately above the row "DCD Configuration Change Count"]

[Add the following text after table 108f]

DL/UL Available Radio Resource:

Table 108f—MOB_NBR-ADV message format

Syntax	Size (bits)	Note
if (Skip-optional-fields-[4]=0) {		
Skip-802.16g-fields bitmap	8	Bit [0]: if set to 1, omit Radio Resource related fields Bit [1]-[7]: reserved
if (Skip-802.16g-fields-[0]=0) {		
DL Available Radio Resource	8	Percentage of available radio resource DL 0x00 : 0% 0x01 : 1%, ..., 0x64 : 100% 0x65 – 0xFE : reserved, 0xFF indicates no information available
UL Available Radio Resource	8	Percentage of available radio resource UL 0x00 : 0% 0x01 : 1%, ..., 0x64 : 100% 0x65 – 0xFE : reserved, 0xFF indicates no information available
}		
}		

Available Radio Resource indicator shall indicate the average percentage of available physical radio resources for DL/UL where averaging shall take place over a time interval which shall be defined by configuration. Available physical radio resources shall be defined as the set of subchannels and symbols within a radio frame, which are not used by any non-best-effort service flow class.

Appendix 1

<Section Note: Discussion on Spanning Tree>

Annex F: IRP Solution Sets for Management (Informative)

Annex G: Network Topologies (Informative)

This annex provides two types of network topologies without precluding other typical topologies.

G.1 Full distributed network

Figure 329 is a diagram of the typical full distributed network.

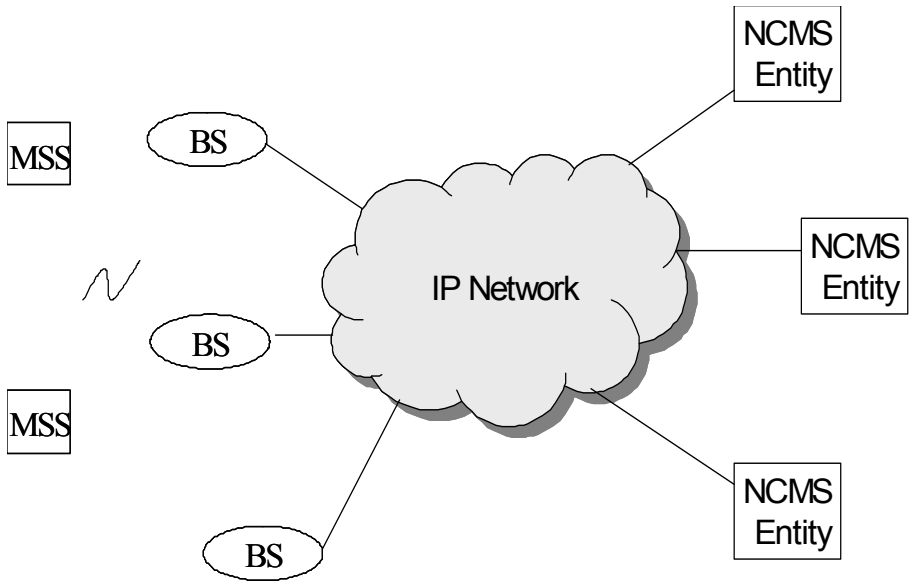

Figure 329—Distributed network

In a full distributed network, BS connects to IP network directly. NCMS is implemented as several network elements, each of the elements is also connects to IP network directly. Some NCMS functions, such as gateway and router service, are embedded in BS.

G.2 Centralized network

802.16's network can also be deployed as cellular system does now. Figure 7 is a diagram of the typical centralized network, which is similar to 3G core network.

<Section Note: Figure 7 TBD>