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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
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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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Management Plane Procedures and Services

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]

IRP - Integration Reference Point

NRM - Network Reference Model

MIB - Management Information Base

[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 1—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.

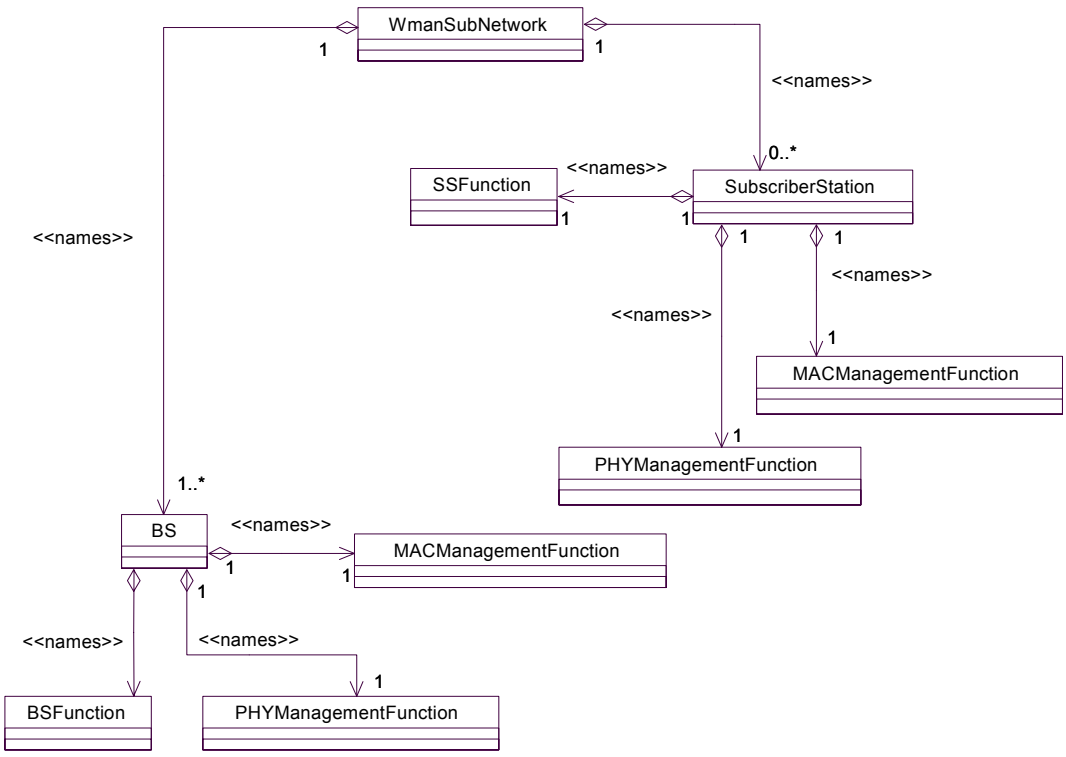

Figure 1—Containment and Naming Diagram

14.3.1.2.2 Inheritance

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

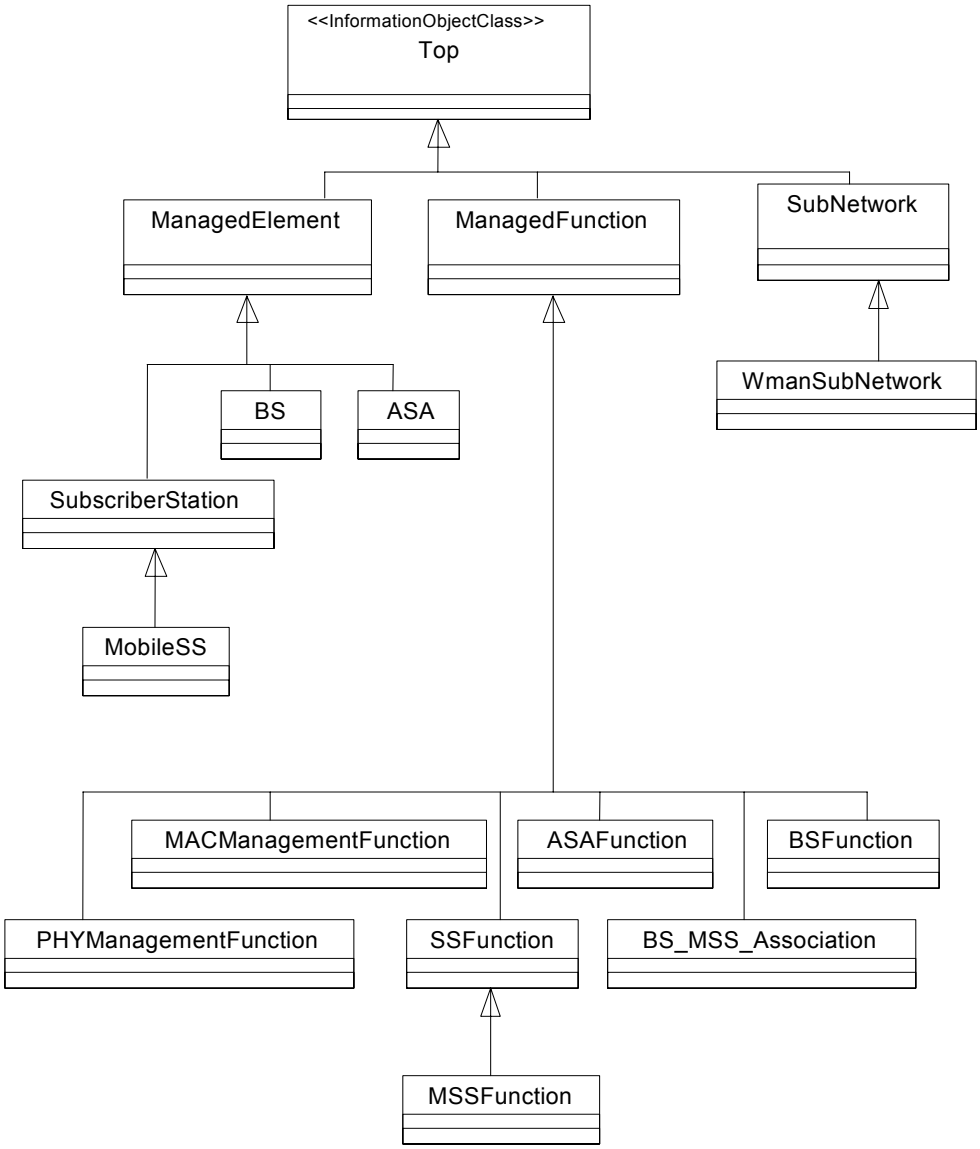

Figure 2—Inheritance Diagram

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 2—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 3—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 4—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.

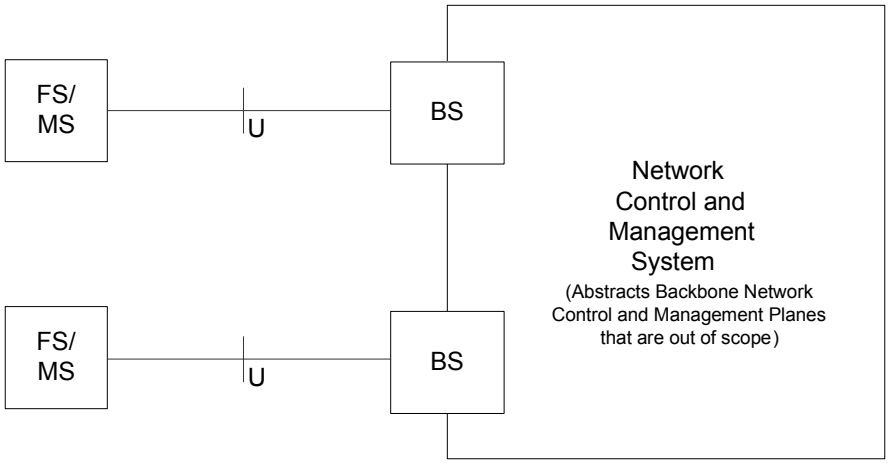

Figure 3—802.16g Network Reference Model

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.

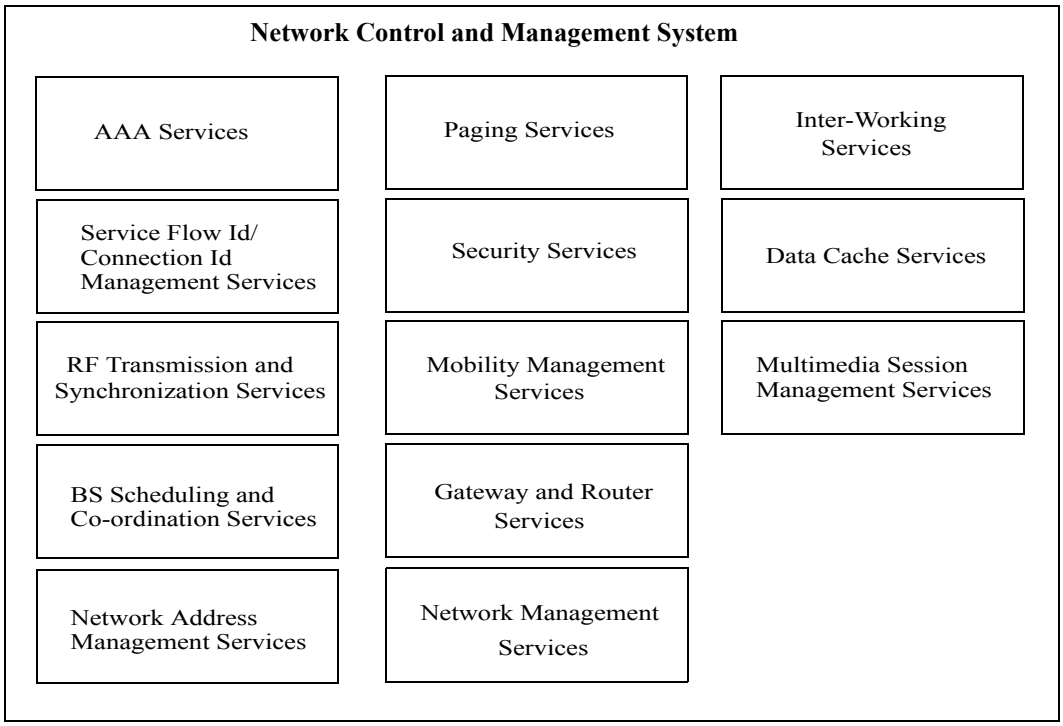

Figure 4—Illustration of the Network Control and Management System (Informational)

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]

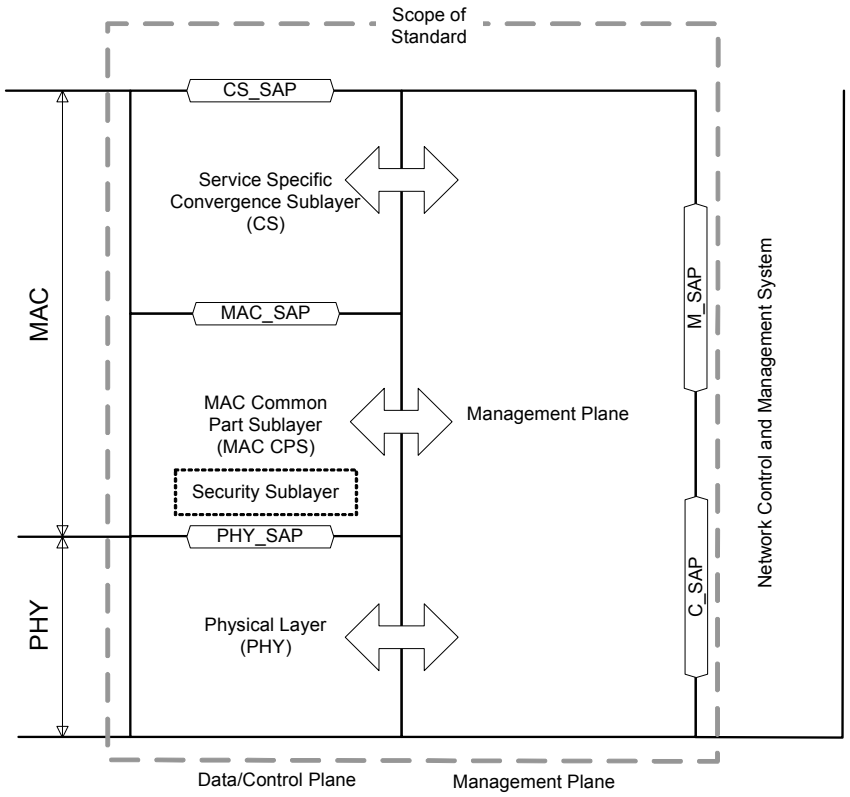

Figure 5—802.16g Protocol Architecture Model

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

14.5.4 Performance Management

14.5.5 Security Management

14.5.5.1 Authentication, Authorization and Accounting (AAA) Guidelines

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

14.5.5.2 Security Context and Key Management

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

14.5.5.3 Security for Handoffs

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

14.5.5.4 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/MSS Connection Management

<Section Note: Recommendations for utilizing DHCP protocol>

14.5.6.4 QoS Management

<Section Note: CID and SFID Management, Managing Bandwidth Requests and Grants. QoS Mapping for 802.16-Service-Flows to Network-Flows >

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

14.5.7.1 Managing Device States

<Section Note: Idle Mode, Sleep Mode, Active Mode>

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

14.5.9.1.2 Neighbor List Management

14.5.9.1.3 Connection Management during handover

14.5.9.2 Paging Management

14.5.9.2.1 Paging Procedure

14.5.9.3 Location Management

14.5.9.3.1 Location Update Procedure

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

14.5.9.7.2 Hard Handoff Procedures

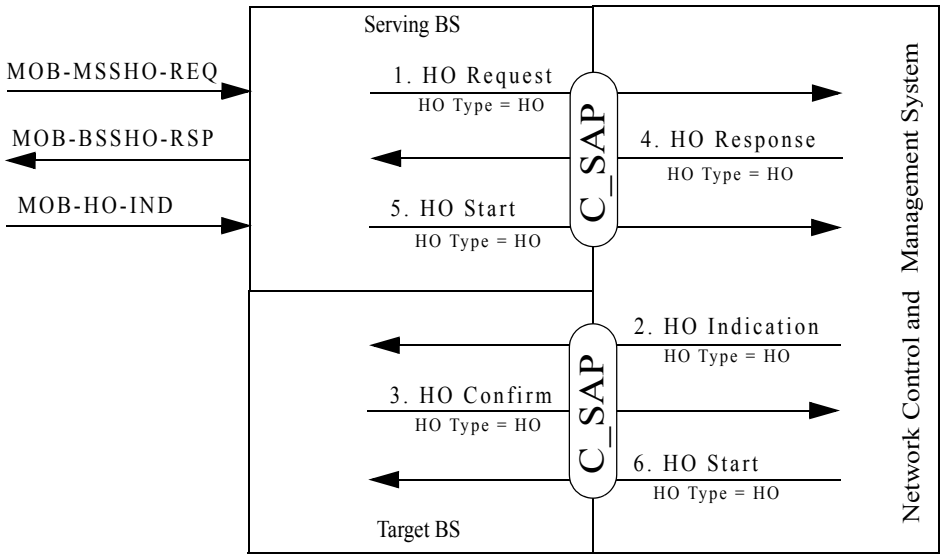

Figure 6—Example Primitive Flow of HO Initiated by MS

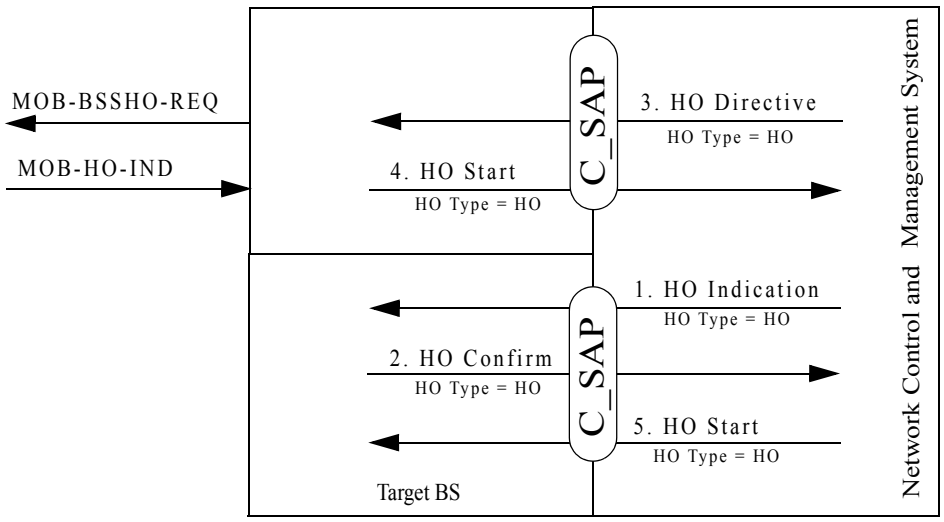

Figure 7—Example Primitive Flow of HO Initiated by BS

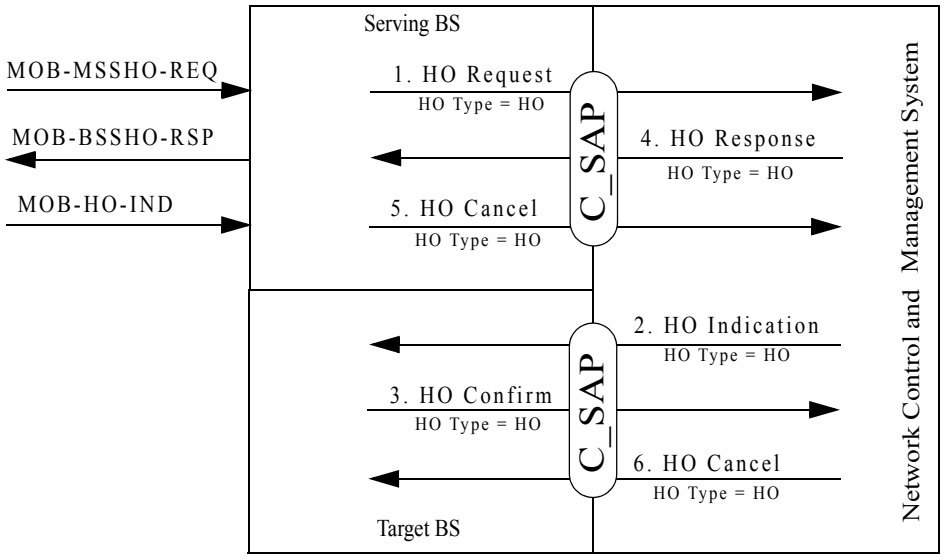

Figure 8—Example Primitive Flow of HO Cancel

14.5.9.7.3 Fast Base Station Switching Procedures

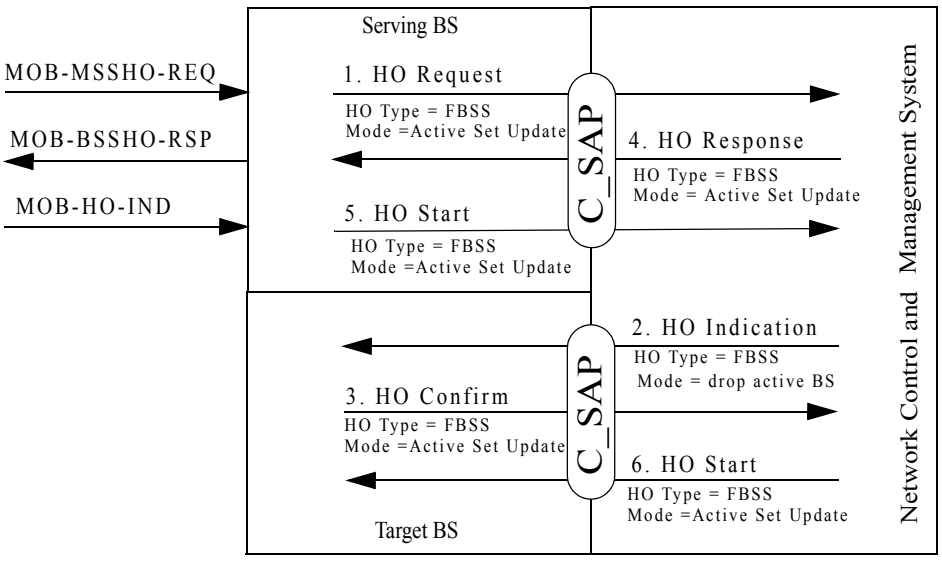

Figure 9—Example Primitive Flow of Active Set Update (Add)

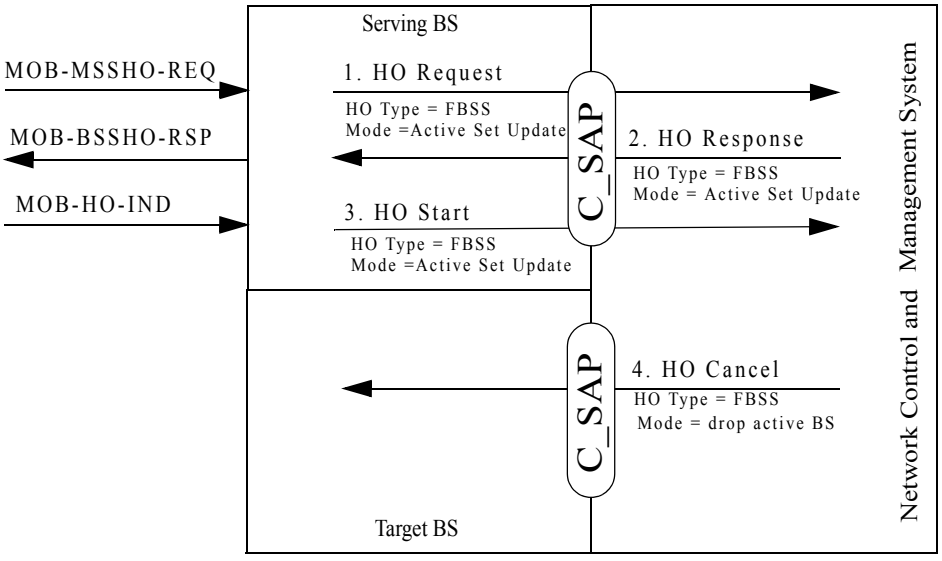

Figure 10—Example Primitive Flow of Active Set Update (Drop)

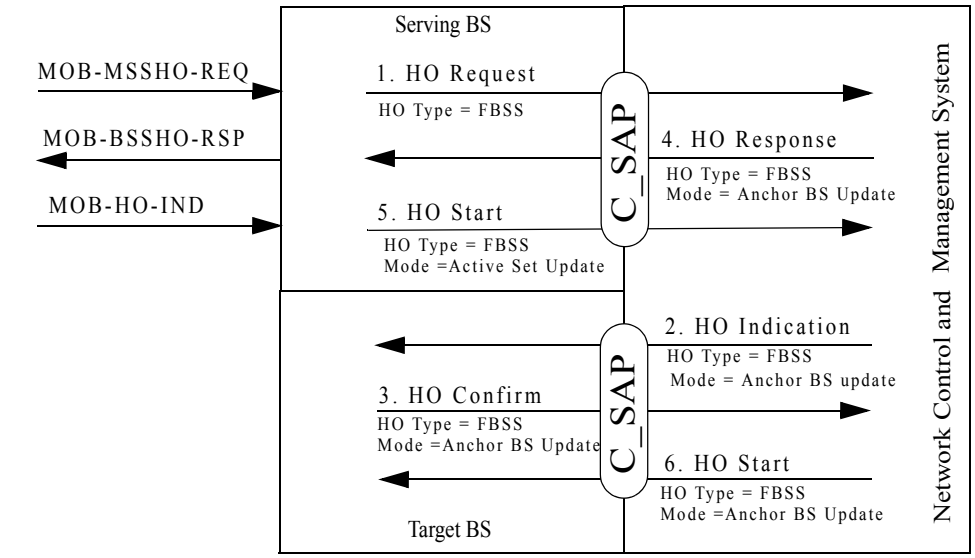

Figure 11—Example Primitive Flow of Anchor BS Update (Using MAC messages)

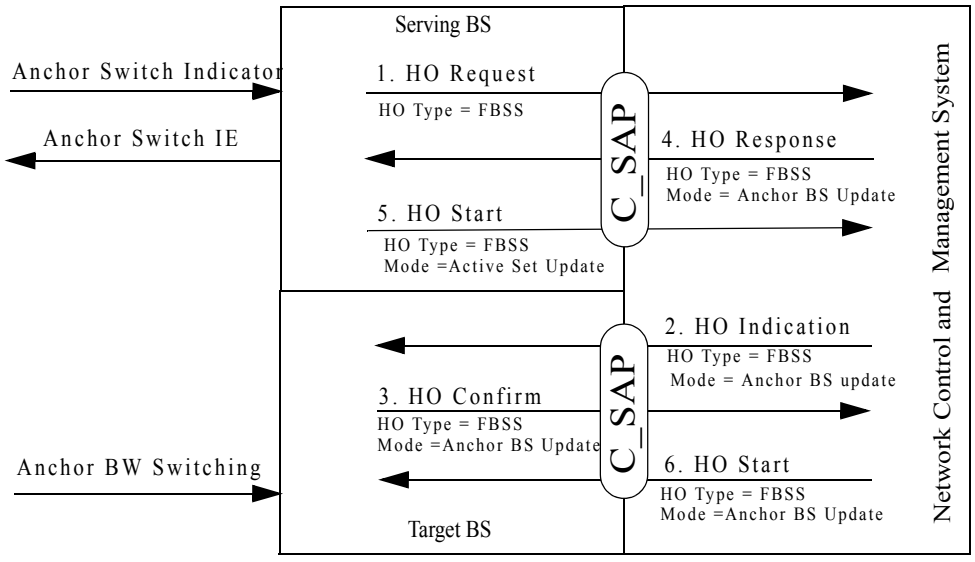

Figure 12—Example Primitive Flow of Anchor BS Update (Using selection feedback mechanism)

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 Measurement and Reporting

<Section Note: PHY Specific sections for SS/MSS and BS Radio Measurements>

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 14—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 15—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 16—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 17—Using 24-bit Identity

Type	Length	Value
2	3 bytes	24-bit Identifier

Table 18—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:]

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 19—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 20—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	

Table 21—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.

Table 22—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	
}		

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)

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.

Table 23—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	
}		

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 24—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

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 13 is a diagram of the typical full distributed network.

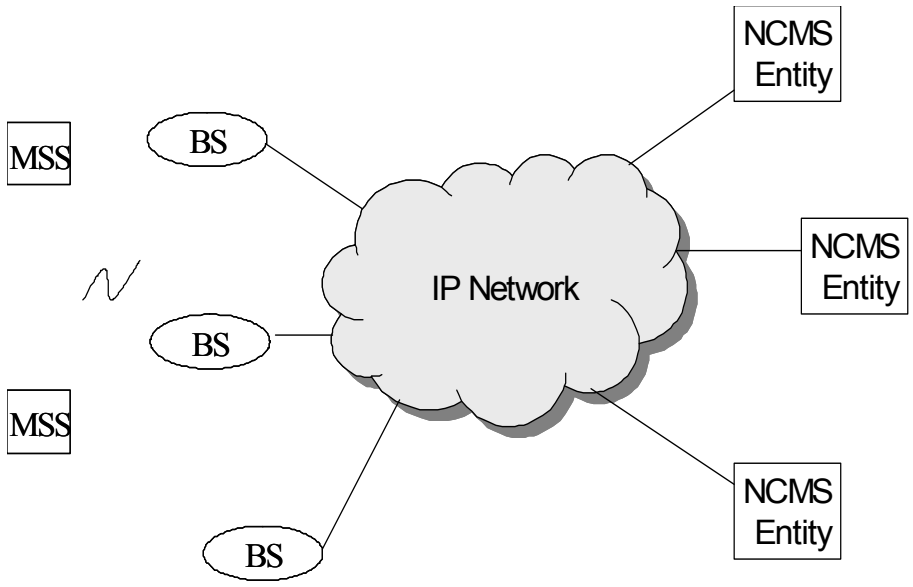

Figure 13—Distributed network

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>