Designing wimax femtocell networks computer science essay

Business, Accounting

The construct of femtocell is an built-in portion of the telecommunication industry ‘ s attempts to supply high throughput, high quality services into the users ‘ place. In contrast to conventional cell types which are well-planned by the operators, femtocell base Stationss are supposed to be installed by clients themselves, similar to a WiFi entree point.

Unlike WiFi nevertheless, femtocells operate chiefly in accredited sets, such that operators are in control of the wireless interface. This brings new challenges every bit good as chances for femtocell design ; these include sophisticated mobility and intervention direction, increased dependability, every bit good as deployment in a plug-and-play mode. Extensive advancement in femtocell design has been made in Advanced WiMAX late, which is associated with the IEEE 802. 16m update in 2011. This study gives an overview and update on fresh constructs and mechanisms for femtocell support in the air interface and web architecture which have been adopted into the IEEE 802. 16m specification and the WiMAX Forum web specifications.

1.

Introduction

The monolithic addition in demand for wireless information traffic has created chances for new web architectures integrating multi-tier base Stationss with diverse sizes. Support for small-sized low-power base Stationss (BS) such as femtocell BSs is deriving impulse in cellular systems, because of their possible advantages such as low cost deployments, traffic offloading from macrocells, and the capableness to present services to

mobile Stationss which require big sums of informations [1, 2, 3] . Femtocells will be supported by following coevals cellular systems, such as Advanced WiMAX systems. Advanced WiMAX, which will supply up to 1Gbit/s extremum throughput with the IEEE 802. 16m [1] update in 2011, is one of the campaigner engineerings for the on-going International Mobile Telecommunications (IMT) -Advanced programme for the 4th coevals (4G) of nomadic radio broadband entree.

IEEE 802. 16m defines the Wireless Metropolitan Area Networks (WirelessMAN) -Advanced Air Interface as an amendment to the sanctioned IEEE 802. 16-2009 specification [4] with the intent of heightening public presentation such that IMT Advanced demands are fulfilled. In Advanced WiMAX, femtocell support is one of the solutions to supply high public presentation services even in indoor scenarios. In Advanced WiMAX, a femtocell BS, or WiMAX Femtocell Access Point (WFAP) , is a low power BS that is intended to supply in house/SOHO coverage. With conventional macro or micro cells, indoor coverage is disputing and expensive to accomplish due to the high incursion losingss of most edifices. WFAPs are normally self-deployed by the clients inside their premises, and connected to the wireless entree web (RAN) of the service supplier via available broadband connexions like DSL or fiber-to-the-home (FTTH) .

The self-deployment of WFAPs has effects on the demands for operation and direction. The WFAP must be able to respond, in a extremely flexible mode, to different intervention state of affairss, since neither the location nor the wireless extension environment can be predicted in progress. Furthermore,

the clients are in physical control of the WFAP significance that they can exchange it on or off any clip. Other factors like undependable backhaul connexions must besides be considered. Sing these scenarios, some of the proficient challenges and demands can be identified as follows [5] ,- Tight integrating into the bing WiMAX architecture for support of seamless mobility betweenmacrocells and WFAPs, low-complexity web synchronism and localisation.- Advanced intervention extenuation techniques to vouch quality of service and coverage in macrocells every bit good as femtocells.- Entree control for different groups of endorsers every bit good as energy efficient acknowledgment of entree regulations by the nomadic station (MS) .- Support for increased dependability and independent reaction on irregular web or WFAP conditions.

To plan WFAPs capable of run intoing these challenges and demands, standardisation attempts are being made in both IEEE 802. 16 and WiMAX Forum. IEEE 802. 16 Task Group “ m ” (TGm) defines the air interface support for femtocells. IEEE 802.

16m is expected to be completed by the terminal of 2010, and scheduled for concluding blessing as a proficient criterion in the first one-fourth of 2011. In analogue, the WiMAX Forum Network Working Group (NWG) is driving the development of specifications for femtocell solutions in the entree and nucleus web. A high degree description of some of the engineerings to back up WFAPs are in [1] and [2] , but were non yet technically specified in the corresponding working groups at the clip of composing. As IEEE 802. 16m is near to completion, a important figure of proficient inside informations have

been discussed, evaluated, and eventually adopted into the specification. This study provides a elaborate update on these recent developments in the standardisation procedure for femtocell design in Advanced WiMAX. In the following subdivision we describe how WFAPs are integrated into the WiMAX web architecture.

The Advanced Air Interface support for mobility in WFAPs, intervention extenuation, WFAP dependability, and WFAP low responsibility manner, are introduced in the 2nd subdivision, which is chiefly based on the most recent attempts in IEEE 802. 16m. The study is concluded with some sum uping observations.

2. NETWORK ARCHITECTURE FOR WIMAX FEMTOCELLS

Figure 1 shows the general WiMAX web architecture with extra support for femtocells. In the undermentioned subdivision, the chief functional entities are described.

2. 1. GENERAL WIMAX NETWORK ARCHITECTURE

The NSP (Network Service Provider) provides IP informations services to WiMAX endorsers, while the NAP (Network Access Provider) provides WiMAX wireless entree services to one or more NSP.

A WiMAX operator may have both NSP and NAP. A macro NAP contains one or more macro ASNs. A macro ASN is composed of an ASN Gateway and one or more Bachelor of sciences to supply nomadic Internet services to endorsers. The ASN Gateway serves as the portal to an ASN by aggregating

BS control plane and informations plane traffic to be transferred to the CSN (Connectivity Service Network) . An NSP contains the CSN which is composed of the AAA entity (Authentication, Authorization, and Accounting) and the HA (Home Agent) to supply a set of web maps (e.

g. roaming, mobility, subscription profile, subscriber charge) that are needed to function each WiMAX endorser.

2. 2. NETWORK ARCHITECTURE TO SUPPORT WIMAX FEMTOCELL

For the support of femtocells, a Femto NAP and a Femto NSP are introduced. Additionally, SON (Self-Organizing Networks) maps are added. Femto NAP: A Femto NAP contains one or more Femto ASNs to supply short scope wireless entree services to femtocell endorsers.

When a WFAP is booted, it foremost communicates with the Bootstrap Server to download the initial constellation information, including the IP reference of the Security GW. The WFAP and the Security GW authenticate each other and make a secure IPSec tunnel. The Femto Gateway acts as the portal to a Femto ASN that transfers both control and carrier informations between MS and CSN, and command informations between WFAP and Femto NSP. Femto NSP: The Femto NSP manages and controls entities in the Femto ASN. The AAA map performs hallmark and mandate of the WFAP. The direction waiter implements direction plane protocols and processs to supply OAM & A ; P (Operation, Administration, Maintenance & A ; Provisioning) maps to entities in the Femto ASN.

OAM & A ; P enables the mechanization of web operations and concern procedures that are critical to WiMAX Femtocell deployment. WFAP direction includes mistake direction, constellation direction, public presentation direction, and security direction. SON Functions to Support Femtocell: SON maps can be divided into self-configuration and selfoptimization. Due to the big figure of WFAPs expected, self-configuration is chiefly intended to enable auto-configuration and avoid truck axial rotations. However, since femtocell deployments are non planned by operators, it is really of import that the constellation (e.

g. wireless parametric quantities puting) should take its neighbours into history by non adding intervention to the users. The radio environment alterations dynamically, as WFAPs can be powered on and off at any clip.

Self-optimization provides a mechanism to roll up measurings from MS and all right melody system parametric quantities sporadically in order achieve optimal system capacity, coverage, and public presentation. Therefore, the SON waiter needs to interact with SON clients non merely in the Femto ASN but besides in the macro ASN. The information elements exchanged between the SON waiter and SON clients will be conducted on the direction plane. Therefore, they will be transported utilizing the same direction plane protocols as defined in the femtocell direction specification.

WFAP: For proper integrating into the operators RAN, the WFAP enters the low-level formatting province before going operational. In this province, it performs processs such as fond regard to the operators ‘ web, constellation

of wireless interface parametric quantities, time/frequency synchronism and web topology acquisition. After successfully finishing low-level formatting, the WFAP is integrated into the RAN and operates usually.

In operational province, normal and low-duty operation manners are supported. In low-duty manner, the WFAP reduces radio interface activity in order to cut down energy ingestion and intervention to neighbouring cells. The low responsibility manner will be discussed in more item in a separate subdivision. Figure 1: WiMAX web architecture

2. 3.

Air INTERFACE SUPPORT FOR WIMAX FEMTOCELLS

The IEEE 802. 16m bill of exchange specification provides support for the operation of WFAPs and the integrating of WFAPs in macrocell webs to supply functionality such as entree control, web topology acquisition, mobility support, intervention extenuation, dependability, and WFAP low responsibility manner. In the undermentioned subdivision, these characteristics are introduced in more proficient item.

2. 4.

FEMTOCELL ACCESS CONTROL

For the typical usage instance of WFAPs as a “ private base station ” , entree control schemes must be supported. A Closed Subscriber Group (CSG) incorporating a list of endorsers restricts entree to WFAPs or certain service degrees. IEEE 802. 16m defines three manners for WFAP entree ; these are:

CSG-Closed WFAPs are accessible entirely to members of the CSG, except for exigency services. CSG-Open or intercrossed WFAPs grant CSG members discriminatory entree. However, endorsers which are non listed can still entree the WFAP at a lower precedence. OSG (Open Subscriber Group) WFAPs are accessible by any MS much like a normal macro BS. For efficient designation of subscriptions and handiness of WFAPs, a femto-enabled MS can keep a CSG whitelist, incorporating a set of WFAPs and matching properties like geographical location or covering macrocell identifiers.

To avoid big CSG whitelists, a CSG identifier (CSGID) is defined which describes a group of WFAPs within the same CSG. The CSGID can be derived straight without any extra information from the planetary unique BS identifier (BSID) of the WFAP.

3. NETWORK TOPOLOGY ACQUISITION

Knowledge of the web topology is critical for efficient intervention extenuation and mobility direction between macrocells and WFAPs and among WFAPs. Both macrocells and WFAPs have to be cognizant if a WFAP enters or leaves the environment, therefore altering intervention and mobility conditions.

Furthermore, MSs can execute cell seeking and handovers in a more efficient manner if the type and the entree policies of the WFAPs in connexion scope are known beforehand. IEEE 802. 16m supports MS-assisted web topology acquisition, but the WFAPs can besides scan the wireless environment to happen neighbour or sheathing cells.

Figure 2 shows some attacks for web topology acquisition.

3. 1. MS acquisition of WFAP topology

IEEE 802.

16m adopts an energy-efficient two-step scanning method for the MS to place adjacent WFAPs, and farther to expeditiously place whether an MS is allowed to entree the WFAP. Identified WFAPs and their properties can so be reported to covering macrocells and neighbouring WFAPs. Base station types are differentiated by the frame preamble sequence, which is unambiguously mapped to an IDcell identifier. The entire figure of preamble sequences is partitioned into subsets to distinguish between BS types. To do the scanning and possible web entry efficient, the set of IDcells is partitioned into sets for macro and non-macro cells, where the latter set is farther partitioned into private (farther partitioned into CSG-closed and CSG-open) and public cells (farther partitioned into pico and relay) . The two-step scanning method works as follows. In the first measure, an MS scans the frame preamble sequence to find the BS type.

However, the figure of WFAPs within the coverage country of a macrocell may good transcend the figure of available IDcell identifiers, such that the individuality of a WFAP may non be resolved unambiguously. To work out this WFAP ambiguity job, the MS decodes in the 2nd measure the sporadically broadcasted superframe heading (SFH) to obtain the alone BSID identifier. Note that to salvage battery energy, the 2nd measure is merely performed if needfully. In the 2nd measure, the MS can besides

deduce the CSGID of the WFAP, and comparison with its local CSG whitelist to find whether the detected WFAP is an accessible cell for the MS.

3.

2. WFAP acquisition of neighbouring cells

The WFAP can get the web topology from the backhaul, from the coverage MSs, or by active scanning. The WFAP can scan and mensurate its neighboring cells, such as covering macrocells, or other nearby WFAPs, for intervention direction and to help the cell (rhenium) choice of the MS. The WFAP in this manner acts like an MS. However, in TDD (clip division semidetached house) systems, the WFAP can non convey frame preambles and SFH during scanning. Hence, the WFAP broadcasts a SON-ADV (SON advertizement) message which includes the timing information of the scanning interval, in which the WFAP scans the other cells, while its ain preambles and SFH may non be available for the MS in its coverage to scan. This message prevents the MS from scanning a WFAP which is non available for scanning.

Figure 2: Network topology acquisition

4. FEMTOCELL MOBILITY MANAGEMENT

Femtocell webs, particularly in the instance of dense deployments, are disputing for mobility and hand-over maps due to the big figure of little cells with different entree types. Particular focal point must be set on cell scanning maps to avoid high energy ingestion on the MS side. Besides,

seamless hand-over must be supported to avoid QoS debasements. Figure 3 shows some optimized mobility direction support in IEEE 802. 16m.

4. 1. Optimized MS scanning of WFAPs

Macrocell BSs and WFAPs can assist MSs in the procedure of scanning for WFAPs by conveying information on the WFAP web topology. This is achieved by broadcast, unicast, and request-response message exchanges.

Specifically, a macrocell BS can air information on OSG WFAPs in their coverage country like bearer frequences or IDcell dividers to cut down the scanning clip for MSs. Furthermore, after successful association of an MS to the macrocell web, a macrocell BS can convey a list of accessible adjacent WFAPs. An Multiple sclerosis may besides explicitly bespeak a list of accessible WFAPs.

An MS may bespeak extra scanning chances from a BS by directing a message including the detected IDcell index and bearer frequence information. Upon response of the message, the BS can react with list of accessible neighbour WFAPs. Scaning of closed-subscriber group WFAPs should be avoided every bit far every bit possible every bit long as the endorser is non authorized. Therefore, the MS may supply CSGIDs of CSG whitelists to the current helping base station to obtain direction on how and when to scan, these instructions may include a list of WFAP BSIDs which are associated with the requested CSGIDs. Furthermore, information on the location of WFAPs is besides exploited. The CSG whitelist may include

location information of CSG WFAPs, such as GPS info or sheathing macrocell BSID.

The web may besides teach (by directing a message, which may include a list of allowable WFAPs nearby the MS) the MS to scan WFAPs based on location information available at the web.

4. 2 Handover support for WFAPs

Handovers between macrocells and WFAPs every bit good as inter-WFAP handovers should be on the one manus transparent and seamless for high QoS, on the other manus user penchants must be considered. For illustration, endorsers may prefer their place WFAPs even if the signal strength of the WFAPs is lower than that of next macrocell BSs.

To this terminal, the WirelessMAN-Advanced Air Interface defines handover and scanning trigger conditions, and mark BS precedences for femtocells based on the BS type. Trigger conditions can be defined such that an unwanted handover from a place WFAP to the macrocell web is avoided, or frailty versa handovers to WFAPs are preferred. In add-on, the web can teach the MS on how to prioritise the cell (rhenium) choice. For illustration, the web or the functioning BS can direct the MS a message that includes a prioritized list of the campaigner mark base Stationss. Figure 3: Optimized handover strategy

5.

INTERFERENCE MANAGEMENT

Since WFAPs are overlaid by macrocells, intervention occurs non merely in the grade of WFAPs, but besides across grades, i. e. between WFAPs and macrocells. Advanced intervention direction is hence important for feasible operation of femtocell webs, particularly in dense-deployment scenarios. Several factors need to be considered, such as whether the WFAP and sheathing macrocell use the same frequence, whether multiple frequence bearers are available, whether intervention direction is applied to command channel or informations channel or both, and whether the interfered MS is in affiliated or in idle manner. In order to supply seamless connectivity and high QoS to mobile Stationss, the WirelessMAN-Advanced Air Interface supports advanced intervention direction methods with a set of engineerings aiming different scenarios.

The intent is to accomplish efficient inter-cell intervention extenuation with acceptable complexness in an optimized mode. Advanced intervention direction crosses multiple beds, such as physical bed (e. g. , power control, bearer alteration) , MAC bed (e. g. , signaling, messages, resource direction such as resource reserve) , web bed (e. g.

, security, SON server coordination) , and other higher beds (e. g. nomadic station QoS demand and provisioning) .

Some of these engineerings are described below: Resource Reservation and Blocking – A CSG WFAP may go a strong beginning of intervention for non-

member MSs which are associated to a nearby macrocell. In this instance, the WFAP blocks a wireless resource part (i. e.

a time/frequency divider of the wireless frame) entirely for non-member MSs for communicating with the macrocell BS. Power control – A CSG WFAP adjusts the transmit power to cut down intervention at non-member MSs. For illustration, the transmit power may be reduced to fulfill the lower limit QoS demands of its member MSs if the WFAP is strongly interfering non-member MS (s) . The power degree may be restored once more to supply better QoS to its member MSs every bit shortly as the non-member MS left the coverage country of the WFAP. Coordinated Fractional Frequency Reuse (FFR) – Both WFAP and macrocells coordinate their frequence dividers and the associated power degrees over the frequence dividers.

Frequency bearer alteration -The WFAP can alter to another frequence bearer with less intervention if there are more than one frequence bearers available. Spatial coordinated beamforming – If beamforming is supported by the WFAP, the WFAP and/or the macrocell can organize their aerial precoding weights to avoid or extenuate intervention. Femtocell-macrocell coordinated manus off strategy – A CSG WFAP can manus off some of its member MSs to a nearby macrocell so that the WFAP can set wireless resources (for illustration by agencies of power control or wireless resource reserve) to cut down intervention to non-member MSs served by the macrocell. The timing of the resource accommodation can be adaptively set to suit the QoS demands from both the WFAP member MSs and the non-member MSs.

Femtocell type alteration under service understanding – If required, a CSG WFAP can temporarily alter its endorser type (e.

g. from CSG-Closed to CSG-Open) if it strongly interferes with a non-member MS, such that the MS can hand-over to the now CSG-Open WFAP. The endorser type is restored every bit shortly as the non-member MS leaves the coverage country of the WFAP. Figure 4: Two-step intervention direction in instance a CSG-closed WFAP generates high intervention at a non-member MS. One of the biggest jobs for the operation of heterogenous macrocell/WFAP deployments is the creative activity of coverage holes for macrocell users by CSG-closed WFAPs. If a nomadic station is non a member of the subscriber group of a CSG-closed WFAP, the standard signal power is experienced as intervention. This may take to serve debasement and in the worst instance to connexion loss – i. e.

a coverage hole is created. To work out this job, IEEE 802. 16m defines a two-step solution as shown in Figure 4: Measure 1: After scanning, an MS detects that the lone BS with acceptable signal quality is a CSG-closed WFAP where the MS is non listed as member. Normally, a non-member MS should non seek to entree the CSG-closed WFAP [3] . However in the exceeding instance of a coverage hole generated by the CSGclosed WFAP, the non-member MS can signal the coverage hole state of affairs to the WFAP by agencies of a reserved CDMA runing codification. Measure 2: The WFAP can advise the macrocell and a web entity such as a SON waiter to bespeakcoordinated intervention extenuation.

It has to be noted that the co-ordinated intervention direction non merely means the non-member MS served by the macrocell BS will acquire coveted QoS, but besides the WFAP attempts to vouch its member MSs desired QoS. Depending on the scenario, intervention extenuation attacks such as resource reserve, power control, FFR, or beam-forming can be applied. The two-step attack can be used in a general instance when MS is connected with macrocell, where in Step 1 the MS can describe the intervention to the macro BS, while in Step 2 the macro BS can organize with the interfering WFAP via the backhaul web and so the intervention extenuation attacks can be applied.

5. 1 WFAP SERVICE RELIABILITY

Since WFAP BSs are under physical control of the clients, normal operation may be interrupted for assorted grounds.

Typical illustrations are loss of power support or backhaul connectivity jobs. Besides, operators may schedule care times and web topology reacquisition or intervention extenuation processs. However, service continuity should be maintained every bit much as possible in these instances. IEEE 802.

16m introduces characteristics for increased dependability and uninterrupted service to the MS (see Figure 5) should such scenarios arise. Figure 5: Illustration of WFAP dependability designAs a basic regulation, the WFAP will seek to inform the web and MSs in instance of any service breaks. On the air interface, this is done by agencies of a sporadically broadcasted message. The message encodes the ground for the unavailable clip, relevant system

parametric quantities like transmit power decrease and frequence allotment index, and finally the continuance of the air interface absence, if known beforehand. Additionally, a list of recommended BSs for the MS to handover can be included.

The message is broadcasted until the WFAP disables the air interface. This allows the MS to originate a hand-over to a BS based on the recommended list or to any antecedently cached neighbour BS list of its penchant. Alternatively, the WFAP can teach the MS to handover to otherBSs before a scheduled unavailable clip is due. For optimized web re-entry to a WFAP which becomes available once more, the WFAP may hive away MAC context information of the served MSs (e. g. basic capablenesss, security capablenesss, etc.

) . If the WFAP recovers from failure of backhaul, or power down, or reconfiguration or it regains some resources from intervention coordination, it may inform the web or advise the current functioning BS of the MS through the backhaul web interface. Based on the cell types of the current helping BS and the WFAP and the associated mobility direction policy, the current helping BS may so originate a handover back to the WFAP, where the cured WFAP is prioritized.

5. 2.

WFAP OPERATION IN LOW DUTY MODE

A fresh optional operational manner, denoted as Low Duty Mode (LDM) was introduced into IEEE 802. 16m in order to cut down intervention and energy

ingestion in femtocell deployments. The rule of the LDM is to cut down air interface activity every bit much as possible by conveying on the air interface merely if it is required. To this terminal, default LDM patterns dwelling of available intervals (AI) and unavailable intervals (UAI) are defined which enables a form of activity and inaction for the WFAP. The UAI allows disenabling or exchanging off of certain parts of WFAP hardware constituents such as the sender concatenation. Another possibility is to utilize UAIs for scanning and measuring of the wireless environment in order to better intervention extenuation or for synchronism to the macrocell web. During an AI, the WFAP is available for any sort of transmittal merely every bit in normal operation province besides being guaranteed to be available for scanning by the AMSs. The LDM is designed with two basic paradigms: First, a WFAP may come in LDM merely in instance there is no active MS attached.

This regulation is established in order to avoid complex signaling and possible QoS debasement at the user side. Second, the impact on the operation of the MS should be minimized in order to maintain execution costs low. The Default LDM form is either pre-provisioned, unicasted during web entry or may be broadcasted, such that MSs have the necessary information on when the WFAP is available, for illustration for bespeaking bandwidth. The WFAP switches back to normal manner on expressed petition from the backhaul web or implicitly by having any triggering of informations activity from the MSs.

An AI will be scheduled by the WFAP whenever there is an operational demand for it. Therefore, the ensuing AI form at the WFAP is the

superposition of the Default LDM form and any extra AIs necessary for normal MS operation. This is illustrated in Figure 6. Note that for intervention extenuation, it is desirable to cut down the transmission clip of the LDM every bit much as possible, for illustration by alining paging and LDM Default Patterns. Figure 6: WFAP operation in low responsibility manner

6. Summary

The femtocell construct is supported in Advanced WiMAX for low cost deployment, high throughput and high quality of service in indoor scenarios. Recent standardisation activities in IEEE 802.

16m and the WiMAX Forum, the proficient inside informations for the following coevals WiMAX femtocell design have been defined. Advanced WiMAX introduces advanced solutions for femtocell support into the WiMAX web architecture and the WirelessMAN-Advanced Air Interface. This study highlighted the challenges and design rules of Advanced WiMAX Femtocells. The characteristics and mechanisms which solve the alone jobs of deploying and runing femtocell webs have been illustrated. These include web topology acquisition, enhanced mobility direction, coordinated intervention direction, increased service dependability, and operation of Low Duty Mode.