Femtocell Geo-location Challenge

DSL Approach as Solution

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***Abstract*— Femtocell or Home eNode cell in LTE is a home base station that anticipated to be deployed in very large numbers with fully automated manner .Femtocell provides enhanced coverage for in - building cellular services. The enhanced data rates enable new multimedia services which in turn generate new revenue. However, with all the convenience such device can provide, locating the user's geographic location represents a great deal of challenge for law enforcement and operators alike. In this work we propose a simple and direct approach that does not require any changes in the network or in the femtocell standard design by exploiting the connection between the femtocell and the network operator through the DSL backhaul. Result shows the proposed approach has achieved successfully the goal of locating the geographic location of the femtocell user precisely.**

***Index Terms*—Femtocell, femtocell geolocation, LTE security.**

I. INTRODUCTION

Femtocell also commonly known as home base station (HeNB) is a cellular network access point that connects standard mobile devices to mobile operator network using residential DSL, cable broadband connections, optical fibers or wireless last-mile technologies. The femtocell unit incorporates the functionality of a typical base station (Node-B in UMTS).The coverage of femtocell is between 20-30 meter. Femtocell exterior and connection is looks like a Wi-Fi access point as shown in Fig. 1 that describes the general connection of femtocell [1]. It is estimated 2.3 million femtocells have already been deployed globally while expected to reach nearly 50 million by 2014 [2]. Femtocells along with Wi-Fi offloading are expected to carry over 60% of all global data traffic by 2015 [2]. However, there is serious challenge that can affect the use of femtocell commercially if the automatic configuration feature is used especially in the 4th generation broadband LTE where currently all the configuration are done manually. The challenge we talking about is *locating the exact geographic location* of the femtocell's user for technical and security reasons. Femtocell and macrocell base stations have similar requirements in terms of timing information and location. Important requirements such verification, emergency caller location identification and law e-nforcement are needed in accurate real-time [3].Thus it is mandatory for femtocells to have the ability of reporting their location to the management system associated with location management. This report must be sent prior starting transmitting and whenever the femtocell location changed .In the literature there are various techniques used for the purpose of femtocell's user locating [4, 8]:

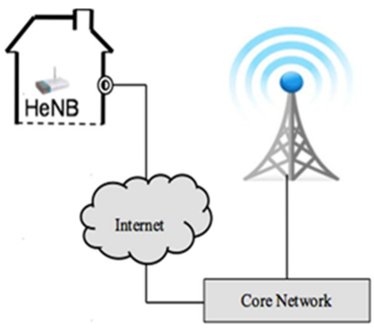

Fig.1.Example of femtocell connections architecture

- Self-reporting by femtocell customer: normally femtocell registered to a specific customer address. That address is the first clue of the expected location. This address might be sufficient to some extents in case customers provide clear and trusted information, however information supplied by customers not always accurate and trusted.
- GPS: typically GPS signal delivers very good and accurate location for outdoor navigation application, unfortunately it is not the case with indoor application, such as femtocell where the only solution to overcome the problem of signal degradation is to place femtocell close to windows or by deploying external GPS antenna and that not practical for many cases.
- Radio Frequency Identification (RFID) tags: using a reader device with electronic tags and radio waves, R-

FID is able to transfer data between the reader device and the electronic tags attached to a device. If during the process of site preparation that usually includes providing backhaul connectivity ,power and also adding as addition define a site by marking it with an RFID tag, the signature of the site's RFID tag can be acquired by the Network Elements .Moreover, the RFID reader can be deployed with a built-in or temporarily attached RFID reader. Due to its requirement for only close range signals reception, this method (RFID) particularly adequate for the case of indoor deployment [5].Yet one of the main challenges for this method is to place the tag in a such way that insure no wrong site identifier be read. This is especially challenging in compartments with co-located sites. The usage of machine-readable identifiers solves the transcription problem but introduces complexity at other points in the process [9, 10].

- Broadband port identity: One method demonstrates its reliability, i.e. the Broadband Port Identity [6]. The broadband operator can locates a femtocell physically via knowledge of the local exchange or network port from which service is accessed. This approach produces a very good degree of confidence in the location and is directly available in the case of an integrated operator who is delivering both the fixed and wireless portions of the service. In the case of separate operators the approach will require either a commercial agreement between the relevant operators or a regulatory compulsion on the fixed operator. Such regulatory and arrangements are already being proposed in many parts of the world to enable support for emergency call location by VoIP services, with all broadband operators contributing location details of broadband subscribers to a central database [1]. Given all of these techniques, it should be possible for femtocells to report their location with a high likelihood and good precision in the majority of cases femtocells connect to the mobile operator's network facilities via a standard consumer broadband connection, such as DSL, cable or fiber. In the presented approach we exploit this notion by using the geographical location that can be invoked from customer's DSL, cable or fiber. Thus fixed geographical information can be used to overcome the problem of locating user's exact geographic location. In this work we chose DSL as fixed broadband connection due the popularity of DSL among service providers.

III .PROPOSED SOLUTION

The Companies responsible of installing the fixed connections in buildings such as DSL ports, these companies have their own records for the location's full address and their installed equipment details as well. DSL switch rack or what so called Digital Loop Carrier (DLC) carries the DSL service through the telephone company equipment to the internet by using a DSL Access Multiplexer (DSLAM). Each DLC has its own unique ID number or code which if combined with the port number provides unique combination and it will be easy to know the exact femtocell's geographic location and other femtocell details. Fig. 2[7] shows the connection details of DSL that connects the customer's house with the local central office. The idea of our approach is to use the information collected by the company who installed the DSL ports. These information usually include port number, DLC ID …etc. For the case of LTE these information uploaded to the Operation Administration and Maintenance (OAM) database. Once the femtocell turned-on it sends its port number and DLC ID by using standard protocols specified by the operator. Next the OAM compares these information with OAM's database and finally in the case of matching the OAM's allows the process of initialization for the new femtocell to be continued. With this process there is no hazard form illegal use of unregistered device also the full address of the femtocell device and its owner is ensured especially these information is carried and obtained by the company itself and not by the users.

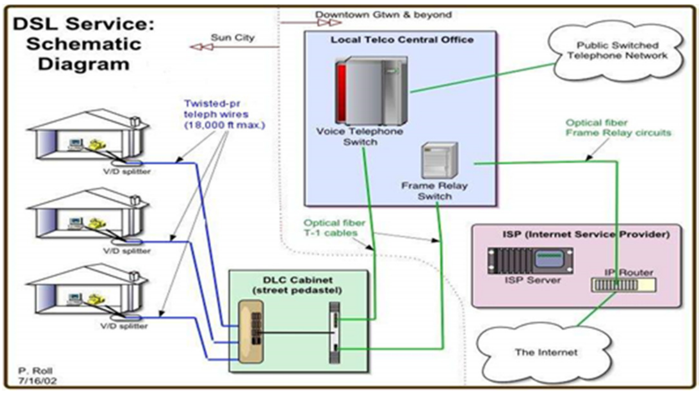

Fig.2. DSL schematic diagram

II. SIMULATION AND SCENARIO

The used simulation in this work is Matlab simulator .Simulation parameters are shown in Table I. The simulator connected to Microsoft Excel to simulate OAM's database where the database contains the ports numbers and their information. Fig. 3 demonstrates the scenario where a multiple DSLAMs assumed to be connected to the OAM and a new turned-on femtocell acknowledged the OAM about its status, in addition there is another information carried out by the new turned-on femtocell .However this information is beyond the focus of this work. Next, the OAM takes the received port number and DLC ID that serve this port to compare them with its database trying to find a match where if the information matched, then the OAM allows the process of femtocell initialization to continue, otherwise the process will be intervened and a report is sent to a terminal monitored by human to be alerted for further action. In this scenario we used 4 DCLs each with 100 ports that means we have 400 ports where 100 of them are not registered in the OAM's database. The purpose of doing so is to check the reliability of the system in case of unregistered port number and DLC ID try to initiate a connection with the network.

TABLE I: SIMULATION PARAMTER

DLC ID	The ID of connected DLC
Port No.	The ID number of DSL port connected to the serving DLC
Building address	Costumer's address
Floor No.	Floor number where the port existed
Owner Name	Recorded name for the femtocell's owner

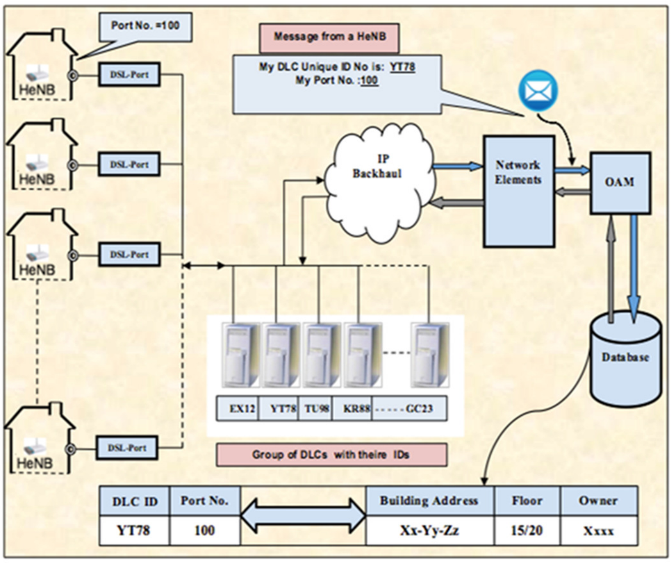

Fig.3. A scenario for the proposed approach

III. RESULTS AND DISCUSSION

After running the simulation scenario as described in Fig. 3, a 400 femtocells attempt to initiate a connection with core network. The simulation generated output report as shown in Table II where the approach and the simulation managed to block the unregistered femtocells and allow the registered once with full information to continue their process successfully and seamlessly .The simulation has ran for several times to ensure reliability .The result shows that our proposed approach is app- -licable and doesn't need any changes in the main design of the LTE standard.

TABLE II: OUTPUT RESLUTS

Request from a new femtocell			OAM	
	DLC ID	***Port No.***	***Decision***	***Details***
1	YT78	100	Approved	Matched
2	YT78	101	Approved	Matched
3	YT78	102	Blocked	No information
.	…..	…….	…….	…….
399	EX12	95	Blocked	No information
400	KR88	7	Approved	Matched

IV . CONCLUSTION

After running the proposed approach managed successfully to provide a simple and reliable way to locate the exact geographical location of the femtocell user. Also, the proposed approach can save large network resources when comparing with other approaches regardless of their lack of robustness, they need to consume large amount of network resources and also require changes in the standard design of network / femtocell or both. Finally, the proposed approach does achieve its objectives successfully and precisely in locating the femtocell user and block any untrusted user. In addition to its simplicity the approach uses only the basic information available in the network.

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