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Ultra Dense Networks and mm Wave Phased Arrays in 5G Technology

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***Abstract* - 5G technology stands for fifth generation of mobile technology. From generation 1G to 5G this world has seen a number of improvements along with improved performance with every passing day. The fifth generation network provides affordable broadband wireless connectivity (very high speed). The Ultra-Dense network in 5G provides high efficiency device localizations. It provides unprecedented opportunities to create an advance localization system that meets demands of the future location based services. Here we preset technical labors to obtain location information in an Network Eccentric Manner that provides better benefits to compared to existing Radio Networks. In mm wave phased arrays new parameters for the evolution are introduced in mobile terminals also the Hand Effect on the phased array in mobile terminal at 15 GHz is also investigated.**

Keywords: 5G Architecture, Cloud computing, Ultra Dense Networks, mm Wave phased array, Antenna array, Hand Effect

I. Introduction

Wireless communication is started in early 1970's. In the next four decades, a mobile wireless technology has evolved from 1G to 5G. Fifth generation technology offers very high bandwidth that user never experienced before. The fifth generation technologies offers various new advanced features which makes more powerful and huge demand in the future. Fifth generation is based on 4G technologies. The fifth generation supports LAS-CDMA (Large Area Synchronized Code-Division Multiple Access),OFDM(Orthogonal Frequency-Division Multiplexing), MCCDMA(Multi-Carrier Code Division Multiple Access), UWB (Ultra Wide Band). The deployment of future 5GUltra Dense small cell networks provides unprecedented opportunities to create advanced localization system that needs demands of future location-based services and functionalities. The mm wave phased arrays in mobile terminals for 5G communication is evaluated .Furthermore ,the Hand Effect on the phased array in terminal at 15 GHz is also evaluated.

II. 5G Architecture

Fifth generation mobile system model is all-IP based model network interoperability. The all-IP network (AIPN) is capable to fulfill increasing demands of the cellular communication market. It is common platform for all radio technologies. The AIPN uses packet switching and its continuous evolution provides optimized performance and cost and .In fifth generation network architecture consists of a user terminal and a number of independent, autonomous radio access technologies (RAT). In 5G network architecture mobile applications based on all-IP and services such as Mobile portal, Mobile commerce, Mobile health care, Mobile government, Mobile banking and others are offered via Cloud computing resources. Cloud computing allows consumers to use application without installation and access their personal data at any computer with internet access. CCR links the Reconfigurable Multi Technology Core(RMTC) with Remote reconfiguration data from RRD attached to reconfiguration data models(RDM). The main challenge for a RMTC is to deal with increasing different radio access technology. The core is convergence of nanotechnology, cloud computing and radio, and based on all-IP platform. Core changes its communication functions depending on status of the network and/or user demands. RMTC is connected to different radio access technologies ranging from 2G/GERAN to 3G/UTRAN and 4G/EUTRAN in addition to 802.11x WLAN and 802.16x WMAN.

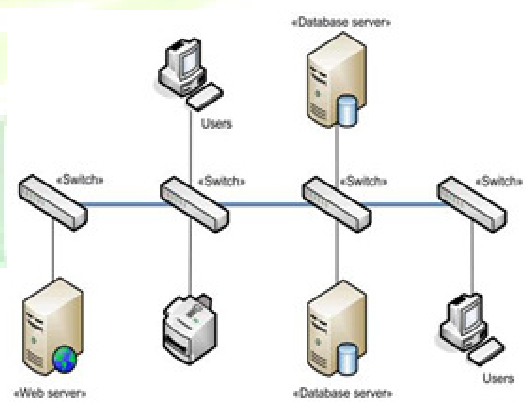

Fig 1: 5G Architecture

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A. Cloud Computing

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Hence, Cloud computing is a technology that uses the internet and central remote server to maintain data and application. In 5G networks, this central remote server could be content provider. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with internet access. The same concept is going to be used in multi-core technology where the user tries to access his private account from a global content provider through cloud computing.

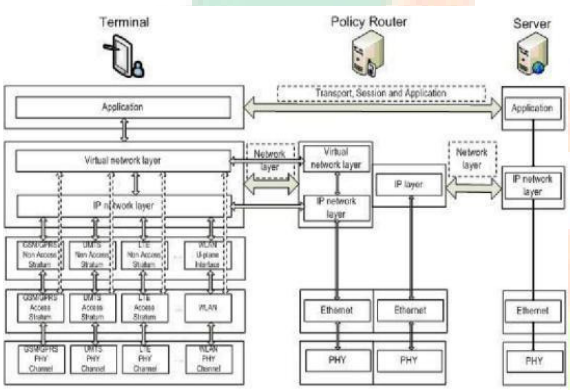

Fig 2: Proposed Architecture

B. 5G Ultra Dense Networks

It is envisioned that future 5G networks will consists of access nodes (ANS) deployed with a very high spatial density. The overall concept of Ultra-Dense small cell networks results in new opportunities and challenges to develop and provide localization in 5G networks which have many novel features compared to existing radio technologies. The observed time difference of arrival (OTDOA) techniques used in Long Term Evolution (LTE) provides and accuracy of few tens of meters, while commercial global navigation system (GNSSs) have an accuracy of 5m and WLAN fingerprinting results in an accuracy of 3-4m.In addition to enhanced accuracy, 5G localization techniques can offer improvements in terms of UN power consumption when utilizing network-centric localization based on frequently transmitted uplink pilot signals. It should be noted that localization does not need any dedicated uplink pilots that are in any case transmitted for a channel estimation purposes. Consequently, the power consumption are expected to be very low. It is an important feature of 5G. In fact, Future 5G UNs are expected to have improvements in energy efficiency in the order of 10x-100x. Thus Network-Centric Localization services in Ultra-Dense networks can run in the background, and be able to provide high-accuracy location information at any time.

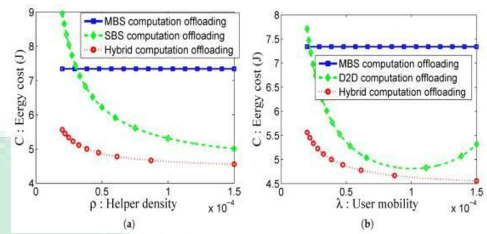

Fig 3: Density vs Energy cost and mobility

C. mm Wave Phased Array In 5G

Due to shortage of the frequency spectrum below 6GHz, the mm wave (10 to 300 GHz) band has been seen for the fifth generation mobile communications. However from friis formula, we can see the free space path loss will be much higher in mm wave band than current mobile networks due to shorter wave length. Consequently, antenna gains of both in base station and mobile terminals needs to be increased to compensate the higher path loss without consuming anymore power.

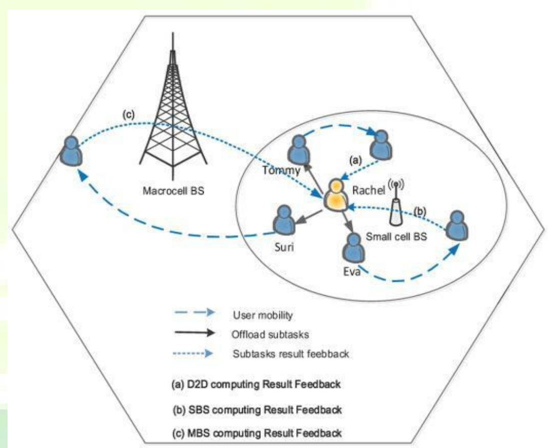

Fig 4: Antenna array in mobile terminal with 2 sub arrays

The antenna arrays can be implemented in terminals to achieve the high gain. However, high gain directly translates into a narrow bandwidth, which will reduce space coverage of terminal antenna and increases the possibilities of poor links. As beam steering of phased arrays have a limited scanned angular range. The total scan pattern of a four element antenna array in a mobile terminal with continuous phase shifts.

III. Antenna Arrays

In this study, the phased array is composed by eight notch antenna and separated slightly less than 15 GHz in a 6

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inch terminal. All array elements are located in a row and on the top of mobile terminal. Each four element compose a sub array and a phase progression that is independent of adjacent sub array. Thus beams can be steered separately, making the pattern diversity feasible. Furthermore, we bring up the coverage efficiency to quantify the space coverage of the phased array, which is defined as ratio between covered area and the total area. The covered area can be defined as total scan pattern coverage with respect to a threshold gain level. The total area includes whole surrounding sphere and the threshold gain will depend on the path loss, transmitting/receiving power.

IV. HAND EFFECT

The Hand effect is always a critical issue for mobile terminals. In order to simulate the Hand effect, the dielectric property of human hand at 15GHz must be selected carefully. The skin depth of electrical field at 15 GHz on human skin is around 2mm, and the skin of palm is the thickest part on the human body which can be as thick as 2mm. The skin layer plays an important role in Hand Effect at 15 GHz. In our study, for simplicity a homogeneous hand phantom with skin material is used for simulation. The permittivity of skin at 15 GHz is set to 26.40 and the loss tangent to 0.63.

Here, three user cases are studied. They are single handed gripping, the dual hand hold gripping the single finger touching.

Fig 5: Single Handed Gripping

In single handed gripping, coverage efficiency and total scanned patterns of sub array 1 and sub array 2 are almost same in the free space. The Hand effect at 15 GHz is lower comparing to a current cellular frequency, reason is that effective distance hand and antennas are longer due to shorter wavelength. In dual handed gripping coverage efficiencies of sub array 1and sub array 2 are presented. Unlike, the single hand case both sub array show a dramatic degrading of coverage efficiency, which is most likely an effect of close proximity of index finger.

Fig 6: Dual Handed Mode Gripping

Fig 7: Single Finger Touching

Furthermore, the wavelength is relatively small at 15 GHz, which makes hand can only effect their array propagation when it is proximate to array. Therefore, we designed an extreme case that one of the sub arrays is totally blocked by the index finger. In single finger touching case, when maximum gain requirement is larger than 1, the coverage efficiency of sub array 1 decreased rapidly, and its total scanned pattern is totally changed by the finger. However, the sub array 2 is not almost affected by hand phantom. In this case, the diversity technology can be used to select the best sub arrays in terms of signal to noise ratio (SNR).

V. CONCLUSION

Thus in this paper, the evolution of various wireless technologies has been sorted out and justified with architecture. The depth analysis of properties that makes 5G Ultra-Dense small cell networks very well-suited for network-centric UN localization, tracking and location prediction. We have shown that future 5G Ultra-Dense small cell network deployments provides unprecedented opportunities to create an advanced localization system that needs network of location-based services. The latest study of mm wave phased array in mobile terminals for 5G communications is provided. The total scan pattern and coverage efficiency are presented with phased array in mobile terminal. Also, the Hand effect on the array antenna at 15 GHz is investigated.

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