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Computer Techniques Solution for Cellular Network Challenges

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ABSTRACT

Communication is an essential part of the human experience, as humanity evolves, technology evolving too, impacting the way communicative aspect of our lives functions. we hear many acronym nowadays from here and there like IoT, M2M, Cloudmobile and so on, cellular communications is the seed for all, there is many research on that growing fields, In this paper we will display what other did in cellular communication from 2007-2012, to determine, challenges and future trends, also the role of computer techniques on solving such challenges will be given too. The paper try to answer such question like: What is the open research area (or challenges) of cellular communication? Are Computer techniques represent good solution for cellular challenges? What is the computer algorithms used to solve those challenges.

Key words : Cellular Network, Cellular Challenges, Data Mining ,
Optimization Network Planning.

INTRODUCTION

Cellular communication is a result of interacting many disciplines such as computer science, electronic engineering, radio communications and manufactures, to identify challenges and researcher effort on such field. We could notice three main component for cellular communication:

Cellular device
Cellular network (equipment and planning)
Computer algorithm

Accordingly each component had its effect in developing cellular communication, research in each components face many challenges, Fig(1) shows challenges in each component, throughout this paper we will explain each and mention research effort that had been done. Literature found in this research mainly from IEEE, In this survey we arranged literatures in three sections, the first one review the cellular devices (section II), cellular network planning and manipulation challenges (section III), fourth section mainly deals with computer mining and optimizing algorithms, section V represent conclusion, mentioning in each section the scientific effort done, challenges, and solution.

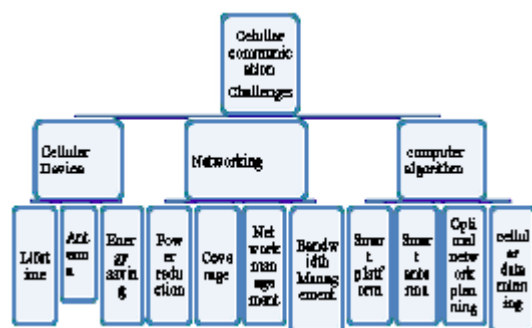


Fig. 1 : Cellular communication challenges

Cellular device Challenges

Last 5 years notice remarkable development in cellular utilities, 4G was dream now it's fact, new utilities and more resources could be possible accessed over our cellular device. Through our literature reviewing to papers and articles (mainly within 2010-2012) we could say that main challenges facing cellular Network could be divided into::

Cellular Lifetimes

Those challenges could be divided into software and hardware challenges, in mobile devices software could be in application program (and middleware) such application monitor power conception and reduce it according to device parameter, an interest reading could be found in^{1,2,3,4,9}, or, operating system or platforms, smart os play important role in optimal management of mobile phone resources, papers in^{5,6,11} proposed energy saving mobile operating system.

Energy saving challenges

Energy saving has been an important and challenging issue because all mobile stations (M|S) are operating with limited battery. User expectations towards their mobile devices are rising, and functionality is increasing. Accordingly, available energy is made a scarce resource, L.JORGUSESKI et al in⁷ studied energy saving in wireless access network, he discussed previous research in energy saving (dated back to 2007), mentioned that dynamic base station switching on/off has significant potential for energy reduction, using SON for dynamically switching on/off cells also they called for green wireless communication as a source for base station energy, also advance

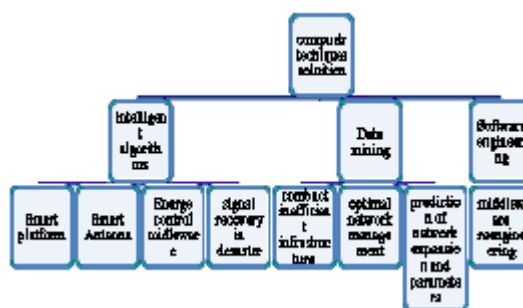


Fig. 2 : Computers techniques used in cellular communications

signal processing and circuit design, improvement of power amplifier, in⁸ Li-Der adaptively adjusted IEEE802.16e energy saving parameters for mobile station extend batteries lives. Paper in¹⁰ also discuss this issue, While¹² explain many future trends and usage of green wireless solution.

Antenna challenges

The main design challenges of mobile phone antenna are the requirements of small size, built-in structure, multi systems in multi bands, and moreover the need for a nice appearance meeting all standards and requirements such as specific absorption rates (SARs), hearing aid compatibility (HAC), over the air (OTA), and reduction of pollution. Z.Ying et al in¹³ displaying an overview of some important antenna designs and progress in mobile phones in the last 15 years, recent development on new antenna technology for LTE and compact multiple-input-multiple-output (MIMO) terminals were presented too.

Cellular network planning and manipulations which involves :

Power reduction

Improving power amplifiers through modulation techniques is a good solution to reduced energy because most power consume in amplifier, see¹⁴ while¹⁵ discuss green networking by reduce power consumption and RF pollution drastically this was achieved by intelligent adaptive antenna along with A_SDMA, self-organization aided network sharing is a good energy saving combinations this was presented in^{16,17} used M2M for energy reduction, in¹⁸ the researchers achieved power saving for M2M devices and for RAN, they proposed power saving in Device side by sleep

state ,removing of unnecessary M2M activities , for RAN. Green base station could be found in¹⁹

Coverage, antenna challenges

To resolve challenging related to coverage strength within low cost 3GPP since 2005 started to studying M2M , many recent studied started which aimed at efficiently deploying and overcoming M2M issues. Paper in²⁰ provided mechanism to lessen coverage interference of femtocell, good literature review about femto cell deployment were presented too. Another solution for coverage and antenna is smart antenna, cost effective solutions for many implications and challenges in cellular antenna , it is low cost (it consist of digital signal processors (DSPs), general-purpose processors (and ASICs), and software-based signal-processing techniques . R. Jan in²¹ explain two type of smart antenna : switched beam and adaptive array systems, he displayed benefits of smart antenna usage as less RF pollution.

To overcome cell edge coverage problem, reduced call drop , relays are used to maintain strength signal , LTE-A deployed Relay nodes(RN), to improve link qualities of cell edge user equipment's (UEs). LTE-A replaces BT by eNB node. Paper in²² proposed using relays deployed prediction-based handover (PH) scheme to allow eNBs to make potential handover decisions within the UE's reporting period .

Bandwidth management challenges

Bandwidth managements have many challenges and demand, many attempts have been done to get higher data rates and improve bandwidth. 3GPP proposed spectrum aggregation technology (which is also called carrier aggregation in LTE-advance standardization) it aggregates several carriers into one wider channel. In 2010 Wie et al²³ gives a brief discussion on bandwidth management concentrating on spectrum aggregation, the paper also listed challenges on spectrum aggregation, showing that LTE-advance represent the solution for such challenges on that area. S. Kumar²⁴ apply data mining concept to maintain good QoS, by making BS able to communicated with all MS within its macro cell area for control information exchange.

Network managements

To overcome challenges in network planning the trends where towards intelligent resource management mechanism , researchers on that fields either develop new intelligent mechanism or adopt hybrid one from the pre-existing mechanism and adaptively changing the parameters. LTE had great effort in self-healing, the remarkable work start in 2009 by proposing the use of intelligent resource management mechanism with fuzzy reinforcement presented in²⁵ , changing source parameter keeping fuzzy model paper in²⁶ proofed that this could reduced load on the network. Network self healing used in²⁷ by optimizing neighbour cells coverage with antenna reconfiguration and power compensation resulting in filling the coverage gap,²⁸ used SON for energy consumption, network efficient usage and fault recovery. Cell-edge performance can be tremendously improved with the deployment of low power relay nodes within a cell network, Carrier aggregation can make use of spectrum very efficiently by aggregating multiple carrier with the help of Orthogonal Division Multiple access scheme for more about those LTE-Advanced solution refer to ²⁹.

Using Computer techniques In cellular communication

In cellular communications each mobile user is associated with Home Location Register (HLR) which stores up-to date location of the mobile users. These logs accumulate as large database, in which data mining technique is applied to understand data mining techniques and challenges refer to^{30,31} where good literature review presented. Data Mining (DM) have been used as a cost effective methods to solve cellular communication challenges, to observe researcher effort on that field and facilitating reviewing the literature, we grouped DM solution into following :

Prediction user behaviour

Papers collected under that headlines are mainly used call detail record to extract user behaviour which is an important for BI, Social group , network planning and other applications . paper in^{32,33,34} investigate using of data mining in prediction of potential Prepaid churners, good literature review for using data mining in user

behaviour prediction could be found in³⁵.

Infrastructure

Compacting inefficient infrastructure is another challenges of cellular communication ,many countries suffer from that, so using computer technology which is less cost than industrial technology represent acceptable solution, this could be done by overcomes failure specially during hand over failure, where efficient transaction processing is required, data mining could successfully reduce transaction time during failure , this was done in^{36,37} , multi agent data mining used in³⁶ for recover handover failure , to overcome the inefficient infrastructure of mobile phone in Ethiopian, M. Yigzaw³⁸ tried to do so by ranking customer according to probability of paying bill (fraud). Resource constraints (limited power, CPU capacity and storage, communication bandwidth) in Wireless network were resolved through Distributed Data mining (DDM) this finding detailed in³⁹ . Back to cellular network planning, predicting optimal network configuration is a hot topic , in that field we could notice efforts of , R. P. Kumar⁴⁰ and W. J. Singh⁴¹ , Kumar Predicted base station and noisy level in busy hours , using data mining, in other hand, W.J. Singh presented optimal algorithm for cell site location such that, number of base stations (N) is minimum while coverage is maximum.

Mining platform

Software company's realize the important of employing intelligent algorithms and DM in cellular network operating system, nowadays DM platforms and toolbox available under windows or Linux, those systems could be used easily ,but which of them is better ?How to choice one over other?⁴² Answering such question, User friendly Map which shows result of clustering depending on spatial data presented In 2010 by J.Wang⁴³ the application was web based thus it introduced a platform any one could access and used.

Emergency response

In the area of mobile GIS and geospatial web service ,there are two trends : Mobile GIS spatial data infrastructure and SDI , those trends are in Disaster management that required providing instant data for different institutions.

Integrating mobile services with geographical information (e.g. GIS), could offer great help in such situation. in⁴⁴ architecture integrate mobile geospatial with OGC-Complaint was presented, it provide information regarding service , and maps for user. Time is an urgent element in emergency response, W. He et al⁴⁵ try to minimize time required to response in emergency situation by developing approach for real time data mining process. After tsunami an increasing research trends to prediction of disaster , for that reasons H.Y. Kung ⁴⁶ implement Real time Mobile Flow Disaster Forecast System (RM(DF)2,as a three-tier architecture consisting of mobile appliances, intelligent situation-aware agents and decision support servers based on the wireless/mobile Internet communications.

Business Intelligent (BI)

That group witnessed fast development , most DM technique could easily adopt to work with BI , paper⁴⁷ present good literature review about what had been done from the late of 90's till 2010 in BI, paper⁴⁸ presented marketing management strategy , compares marketing effectiveness before and after using clustering for CM company. Papers that Handled other applications of DM in BI are^{49, 50, 51, 52} those papers presented novel methods , which lead us the conclude (as many other researchers indicates that) the problem of developing algorithm for mobile environments is novel.

CONCLUSION

From the above reviews for literature we conclude that, there is many unsolved challenges in cellular communication which need researchers effort, challenges and solutions that papers offers were:

Life time (for cellular devices and network component such as base station)

Solution is by using smart middleware and platform for optimal controlling hardware technology, for network base station eNode is a promised solution thus LTE-advance adopt it .

Energy consumption

For mobile devices- smart platform control energy of the device and help in maintain battery,

M2M charging, could be applied to cellular devices as well as base station and other energy consume network parameter ,also using green energy resource should be spread and developed, so more research is demand.

Antenna, coverage and modulation challenges

Smart antenna using intelligent algorithms as well as self organising network SON is a promising solution to such challenges. SON depends on integrate hardware technology (for cellular devices and network equipments) with software component (computer science techniques) it is the future that solves many challenges.

Infrastructure

Many country have inefficient communication infrastructure, the challenges is how to combat such infrastructure, it could be done simply using computer techniques, how to make communication infrastructure developed with

reasonable cost ?, this could done via more software solution .

As the main focuses of that reviews is to indicated the role of computer techniques in solving cellular communications challenges, Fig (2) depicted those techniques and area of applications, computers techniques that used to solve challenges and implications of evolving cellular network , are :

Intelligent algorithms (smart platform ,middleware and decision support)

Data Mining (which include soft computing as well):(network planning , infrastructure, optimal network planning and maintaining)

Software engineering: (platform and middleware development and M2M by employing software from other machine nearby to reused)

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