Review on Self Organization in Next Generation Mobile Network

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ABSTRACT
This paper is the review of Self organization in future mobile network. As for now self organization is being applied to autonomic computer, or wireless network but presently self organization in mobile network is the emerging field with lot of research direction in various field related to mobile communication. In this paper a brief introduction of the term self organization and SON is presented. Also paper contains the weakness of existing system with increasing complexity. Key objectives for the deployment of self organization in system are to ensure excellent coverage and capacity with reduced interference. Deployment of SON also reduces capital operating expenditure as it eliminates the need of skilled labour. SON is mainly classified in three type's viz. self configuration, self optimization and self healing which covers almost all parameters and function related to mobile communication. Lastly it concludes with few research directions and *the areas which need more research work to be done.*

Keywords
SON, eNB, OPEX, self configuration, self optimization, self healing.

1. INTRODUCTION
In recent past years, mobile telecommunication industry has experienced tremendous changes and it will continue to evolve in coming generation. Cellular communication system has to bear tremendous pressure owing to rapid growth in bandwidth hungry application such as video, multimedia file sharing etc. in coming future. Capacity of cellular network to support these applications has to meet in a cost effective way as users may not be comfortable in paying higher bills for better and improved services. But there is a trade-off between providing improved services and minimizing operating expenditure because in cellular system major cost is associated with the operation and maintenance of network.

Cellular network consist of large number of distributed equipment and complicated system throughout the country. Operation and maintenance of such a complicated cellular system is difficult and require large no. of skilled labour in each and every regional office around the clock.

The requirement to meet the needs of both users as well as operators in cost effective way require to add some intelligence named as *self organization (SO*) [1].

1.1 Reasons for developing Self organization

1. In future cellular networks, number of nodes will be too large to meet the requirement of all users in term of capacity, quality of service (QoS) and energy efficiency. Ultimately it is going to affect regular configuration, operation and maintenance of cellular network by classic manual approach.
2. The increased complexity of cellular network wills prone to large number of errors if manual approach is employed.
3. There are always faults in network and it has to be rectified soon. In manual approach, human error will lead to long recovery and fault correction time resulting in suboptimal service or no service at all.
4. SO can also reduce the operating and maintenance expenditure (OPEX) as it will reduce the need of skilled labour required for configuration, maintenance and recovery of system.

2. SON OVERVIEW
Self organization can be defined in various ways, it is an intelligence that is capable of taking decision. SON can be defined as the network that continuously monitor, and if it encounters any change in the system it will make intelligent moves to reduce those changes which are undesired.

Figure 2.1 illustrate Self Organizing system. Self organized mobile network consists mainly of three phases *viz.*

1. Planning:

   Planning phase deals with the location and interconnection of all base station, devices and different network equipment, related parameters etc.

2. Configuration:

   This phase deal with the configuration of base station during the development of network system. Or it may be required whenever there is a need to extend or upgrade the network. In SON, network is made such that after equipment installation it provides means of detecting equipment and downloading software as per need and also testing various equipment.

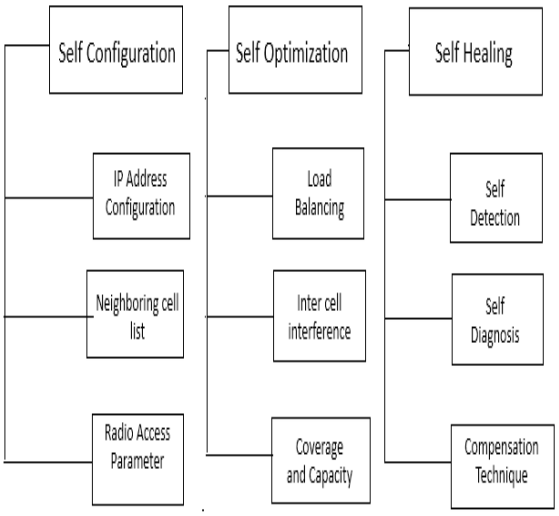

Fig.1 Self Organizing Network

3. Operation:

   In these phase, network optimization, monitoring and maintenance is done. In a view to have an efficient system, there should be continuous monitoring of system for any faults and optimize system parameters.

3. SELF CONFIGURATION

Configuration of base station and interconnection is required after installation process. Configuration may also be required if there is some fault in the system, or system need to be upgraded, also when there is degrade in performance of the system. In future cellular system there should be some intelligence which perform all this task more efficiently compared to manual configuration which require skilled labour in large number. F. Parodi et Al. has presented self configuration of future LTE system. In this paper problems associated with autonomous setup of new node is projected. Node should self configure their IP address, radio access parameter, neighbor cell list [3].

As the new node is deployed, it will scan its neighbour cell and generates neighbour cell list. From this list it will select a sponsor node. New node will make connection with the configuration server using this sponsor node. Once a connection is made new node will start downloading all software from configuration server and IP addresses too [4]. The node will then be in a full operation mode. Initial location dependent Radio access parameters are obtained from the current setting of the sponsor node [1].

Frequency allocation is one radio access parameter in self configuration of future cellular network. For the deployment of relays, pico cells determining the MAC layer (Media Access Control) frequency channel that causes least interference to existing nodes and which still provides enough bandwidth to achieve the desired throughput is still an open research issue [1]. The decentralized medium access protocol proposed in [5] shows that the proposed MAC protocol is capable of operating in the worst case scenario of no frequency and eNB location planning [1].

Propagation parameter configuration is another radio access parameter. Network performance is highly affected by antenna parameters, their gain and power. Although omnidirectional and sectorised antenna are best suited in today's cellular system because of fixed radiation pattern yet there should be the deployment of smart antenna in future cellular system which is capable of reconfiguring their radiation pattern. Provisions for this are obtained by MIMO techniques. Azimuth and tilt angle of antenna is most important parameter as it determines the direction of propagation of signal and controls the interference capacity of system. There may be electrical tilt or mechanical tilt. Electrical tilting provide better performance compared to mechanical tilting in terms of interference. While the performance is comparable if noise parameter is considered [6]. Few research in self configuration can be obtained in papers [7], [8], and [9].

Self configuration of future cellular system in this way would require increased signaling with the centralized server and its complexity would increase with the number of nodes making it less scalable [1].

4. SELF OPTIMIZATION

Every base station contains hundreds of configuration parameters that control various aspects of the cell site. Each of these can be altered to change network behavior, based on observations of both the base station itself, and measurements at the mobile station or handset. One of the first SON features establishes neighbor relations automatically (ANR), while others optimize random access parameters or mobility robustness in terms of handover oscillations. A very illustrative use case is the automatic switch-off of a percent of base stations during the night hours. The neighboring base station would then re-configure their parameters in order to keep the entire area covered by signal. In case of a sudden growth in connectivity demand for any reason, the "sleeping" base stations "wake up" almost instantaneously. This mechanism leads to significant energy savings for operators.

4.1 Reasons for self-optimizing networks

One of the major elements within SON optimization techniques that can be used. As the environment for the base station, eNB may change after installation and configuration, there is a need to continue to optimize the operation on a regular basis.

Some of the reasons for a change in the environment may be:

1. Change in propagation characteristics: SON optimization of the network can help take out the effects of any changes to the propagation conditions. These could arise from new buildings going up, or coming down etc. Even changes resulting from leaves falling in autumn can have a significant effect.
2. Change in traffic patterns: As time progresses usage patterns may change. This could result from increased concentrations of users, from new housing, changes resulting from more people being on holiday, schools being on vacation, or any one of many hundreds of reasons. These can result in further optimization being required to re-asses the best operational characteristics for the base station, eNB.
3. Change in deployments: There could be many reasons for the change in deployments in the area. Other base stations, eNBs could have been optimized and changed their characteristics, alternatively new base stations may have been deployed and their operation could affect that of others.

These reasons all mean that help for the maximum efficiency of self optimizing.

4.2 Areas for cellular network optimization

There are many areas of cellular networks that can be optimized. Some cellular network optimization schemes operate on elements of the network. Other schemes may adopt to optimize the cellular network as a whole. However for the sake of looking at cellular network optimization there are two main areas that can be considered:

1. Air interface Core network

   These element of the network may be optimized separately, or many newer networks are combining these functions to enable a far greater level of flexibility to be obtained in optimization and "healing" when problems occur.

2. Self Optimizing Networks

   With network optimization now playing a major element of many networks, a form of network optimization known as Self-Optimizing Networks (SON) is growing feature in network planning and optimization. Standards bodies, equipment representatives and mobile operators are now working to set the standards for self optimizing networks.

Self optimizing networks, SON are seen as a key feature of the evolving cellular network architectures and as a result they are seen as a key feature in the next generation networks.

4.3 Self-optimizing network functionality:

There are a number of areas where self-optimization of the network is undertaken.

a) Mobility robustness optimization

b) Mobility load balancing and traffic steering

c) Energy saving

d) Coverage and capacity optimization

e) RACH optimization

5. SELF HEALING

Faults and failure are very often in Wireless cellular system. The reason for this may be some natural disaster, improper function of any component etc. And this failures are software or hardware related and require personnel round the clock.

In present time, if there is fault in the system alarm will trigger and this are mainly determined by centralized O and M software. As the size and complexity of system is ever increasing, even with reliable hardware and software there are certain faults that are not cleared remotely and require personnel. To clear such failures and faults engineers are mobilized to cell site for fault compensation. This process could take days or weeks for problem recovery. Even in some cases, there are faults which are not even detected or determined by OnM until and unless a customer lodged a complaint and will lead to end user experience suboptimal service level or no service at all. If not given proper service, users may switch to competing network operator. Hence fault management also called as troubleshooting (TS) is a key aspect of cellular system in a competitive environment.

In future cellular system this process has to be improved by incorporating self-healing process. In this process fault if occurred in any node due to any natural calamity or any other breakdown will be out of service using the flow given by Aliu et al. fault is automatically detected and diagnosed and proper compensation technique will be given. Aliu et al. has presented a general self healing flow which is categorized in monitoring, diagnosis, and compensation.

1. Self Detection

   Cell outage means dip in the performance operation of system. In future, cellular system must employ intelligent detection scheme so that outage can be cleared remotely. This will reduce the manual effort as well as time. Faults may be in the piece of equipment or it can be interference or coverage problem etc. When alarm is triggered, it should be correctly diagnosed. In [10] Bayesian approach is used for automated diagnosis of fault in UMTS networks. Expert system built according to this Bayesian approach have many advantages compared to other techniques used in other application for diagnosis. Bayesian network efficiently model the uncertainty inherent to human reasoning [11].

2. Self Compensation

   Self Compensation action to be taken is largely dependent over the type of fault encountered in system. Compensation action involve reconfiguration or optimization that is by changing the antenna tilt or increasing power level for proper coverage. To achieve this there is need to continuously monitor the system for any error or fault and as soon as the fault is occurred alarm will be triggered. Depending over the type of faults proper compensation action is taken. It is desired to produce the simulation results to show that the compensation action is halted when the fault is being cleared.

6. FUTURE WORK

Self organization in future cellular network is very effective and must be employed in cellular system so as to make system much more reliable even if the network is complex. But still there is lot to do to make cellular network with Self organization intelligence realistic. As in self configuration, newly deployed node generate cell list from neighbouring node and download all software. While allocating frequency to newly deployed node it should have enough bandwidth with least interference. Tilt angle and power of node is also one of the challenging issue. In self-healing whenever a fault occur alarm will trigger and fault diagnosis is done by system itself. Here the main issue is there is need to continuously monitoring the system even if there is no fault. This will consume energy hence there should way in which system is monitored after some interval which will save energy. Again when the appropriate compensation technique is generated and fault is recovered the process should be halted.

7. CONCLUSION

Self organization in future mobile network is powerful technique which in future going to decrease operating capital and personnel even with increased complexity. In this paper, we presented the requirement and benefits of employing self organization in future cellular network. Although there is large number of paper on self organizing network yet there is areas in which lot has to be done before deployment of SON in cellular system. Also we have presented SO network in three different categories *viz.* self organization, self optimization and self-healing and related parameters with it. Lastly areas in which more research need to be done is discussed.

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