SON coordination with priorities for separation of Parameter Regulation

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Abstract. Self organizing network (SON) is a concept which automates the constant monitoring of service and network performance and analyses the data for making decisions. There may be different SON functions running among which there may be conflicts/dependencies which are minimized by a process known as SON coordination. With SON coordination, there are chances of a particular SON function to use mainly other SON key performance metrics (KPI) along with its own KPI so that its target metrics is not achieved ultimately. This happens mostly for SON functions which are correlated i.e. one function leads to negative impact on the other. In order to address this issue, it is proposed that such SON functions are given priorities for defined time which is fixed based on the target metrics and are implemented accordingly. After that fixed time, principle of separation of parameter regulation is applied so that the target metrics for both the SON functions will be achieved with minimal deviation which will be set prior so that the network service performance is maintained at user acceptance level. Separation of parameter regulation can be applied to a particular SON by enforcing it to use only its own KPI to achieve target metrics. This approach is illustrated in this paper with a use case in detail.

Keywords: SON coordination, SON function, Separation of Parameter regulation.

1. Introduction

After the start of transition from 3G to 4G, there has been an enormous increase in the amount of data traffic. To handle this, a large number of base stations are required for a data centric network. But the problem arises in the management of huge number of base stations so that optimal capacity and coverage can be provided. Also the increasing data traffic creates congestion in the network with dropping revenues. In order to resolve these issues and address diversified services and operations, a change is required in the way the network capacity and coverage is planned and managed so that there is reduction in OPEX and manual efforts. This change can be achieved by a concept called Self Organizing Networks (SON). 4G is the first technology to use this SON technology. Before the evolution of 4G, the configuration, optimization of NodeBs and healing of the network was carried out manually with the help of some tools as shown in Fig 1.

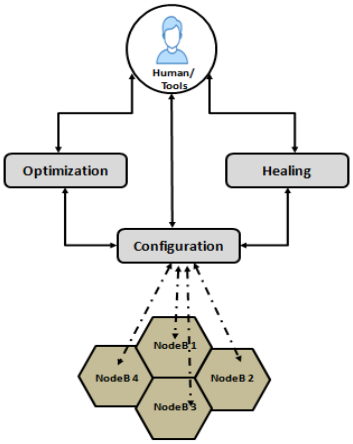

Fig.1. Manual efforts of optimizing network parameters in NodeBs

With the introduction of SON, these manual efforts are reduced by performing functions- configuration, optimization and healing of network automatically by using SON automation tool as shown in Fig 2. Here the network performance is monitored and various appropriate parameters are controlled automatically in eNodeBs.

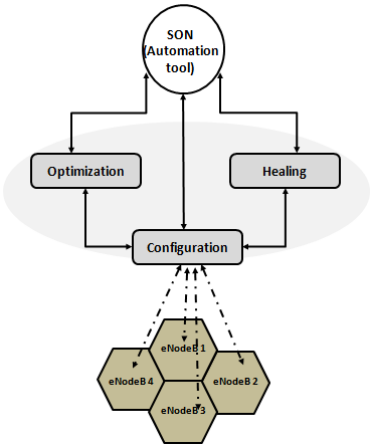

Fig.2. Eliminating Human efforts with SON

The self organising networks for LTE and Heterogeneous networks is explained in [7]. There are number of different SON functions running in the network. So, there are chances of conflicts/dependencies. The occurrence of such SON conflicts and their consequences are minimized by a process known as SON coordination as shown in Fig 8. In[10] also, an outline is given for a conflict free implementation of multiple SON functions. [9] also can be referred to get more understanding on how SON coordination helps us to prevent conflicts among SON functions is explained. One SON coordination method must not exclude the other. Some SON functions are dependent on each other i.e. one can lead to negative impact on the other dependent SON function.

In such cases, separation of Parameter regulation helps us to achieve target metrics by maintaining the SON functions to be independent as explained in [1]. Immediately, by doing so, there are chances of one SON function to be affected by the other which is explained clearly in the use case later in this paper. Since many SON functions are running in the network, there are chances of many SON functions being affected as mentioned. This issue laid roots for the motivaton of the concept proposed in this paper. To address this issue, it is proposed that priorities can be set for such kind of SON functions for fixed time by defining minimal deviation for target metrics in the SON coordinator. Post that, separation of parameter regulation principle(explained in [1]) can be applied.

This decision is taken by SON coordinator to achieve the target performance and stability requirements. With this principle, the SON function uses only its own KPI metrics to control appropriate parameter which is independent of the KPI metrics of others. Hence, the target metrics of both the SON functions can be achieved while maintaining stability and the required service performance but with acceptable minimal deviation. This is called SON coordination with priorities for Separation of Parameter regulation. Refer to [8] also just to get more understanding in which an algorithm is proposed for the cell outage compensation in sef organizing networks and simulation is done to access performance effects.

The background of the technologies involved in this paper is clearly drafted in section 2. The introduction to SON, its elements and architectures are clearly explained in sub-section 2.1. The SON coordination and its functionality using figure is described in sub-section 2.2. The proposed concept of assigning priorities in SON coordination using the principle of Separation of Parameter regulation is explained in section 3 along with the illustration example in sub-section 3.1. The conclusions and future scope of the proposal of this paper are included in section 4.

2. Background

2.1 **Self Organizing Network (SON)**

It is a technology that is designed to automate the planning, management, configuration, optimization and healing of radio access networks. It simplifies the management of multi technology, multi-vendor network. It helps in faster deployment and rollout of the network by minimizing human efforts. Using this technology, the performance metrics of the service in the network are being monitored such as outage time, energy consumption, emission power of antenna, antenna tilt, QOS parameters etc. It performs analysis on these metrics and takes decision accordingly to control certain parameters of the network in order to maintain optimal coverage and capacity in each cell. It automates the subsequent tuning of these parameters in the network cell. SON has mainly three elements as shown in Fig 3.

Self-configuration process. The process through which the deployed nodes are configured automatically with the configuration that is necessary for system operation. This provides the dynamic plug-and-play configuration of newly deployed eNodeBs. The eNodeB configures the Physical Cell Identity (PCI), Cell global ID (CGID), transmission frequency and power by itself leading to faster cell planning and rollout.

Eg: Automated Configuration of PCI, Automatic neighbour relations (ANR)

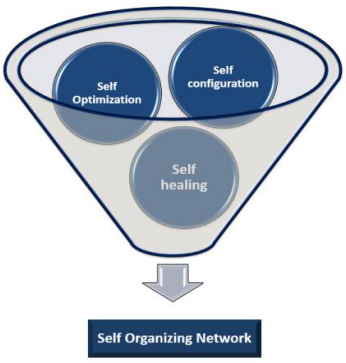

Fig.3. Elements of SON

Self-optimization process. The User equipment (UE) & eNodeB service and performance measurements are collected from the network and are used to auto-tune the appropriate parameters to optimized values in the network.

Eg: 1) Coverage and Capacity Optimization
2) Energy Savings
3) Mobility Robustness Optimization
4) Mobility Load balancing optimization

Self-healing process. This process is triggered by the alarms generated for each detected faults in the fault management system. It is used to solve or mitigate the faults by triggering appropriate recovery actions.

Eg: Cell outage detection / Cell Outage Recovery.

There are three types of SON architecture.

1. **Centralized SON**-all SON functions are stored and executed from centralized OAM system[2] and [3]. The architecture is as shown in Fig 4. Itf-N is the north bound interface from network elements,eNodeBs and OAM (SON) systems.

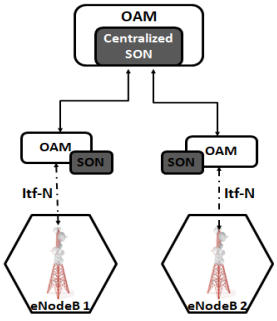

Fig .4. Centralized SON

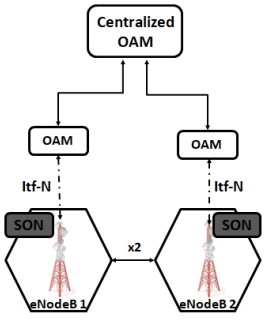

Fig.5. Distributed SON

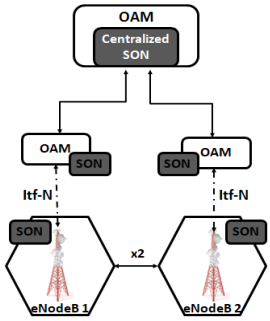

Fig.6. Hybrid SON

2. **Distributed SON**-all SON optimization algorithms are implemented at relatively low level i.e. at eNodeBs (Also refer [2] and [3]). .The architecture is as shown in Fig 5. x2 is the interface between eNodeBs.

3. **Hybrid SON**-Some optimization algorithms are implemented at eNodeB level and part of them which are complex are executed from OAM systems [2] and [3]. The architecture is as shown in Fig 6.

2.2 **SON coordination**

With the introduction of SON, there are potentially large number of SON functions running in the network. These SON functions perform network management actions automatically based on network behaviour metrics collected. There are chances of multiple SON functions being performed simultaneously which requires coordination such that there will not be conflicts or dependencies among them.

By deploying SON coordination in the network, these functions are monitored and altered to avoid/ mitigate conflicts in the network. SON coordination resolves the conflicts by performing the functions mentioned in the Fig 7.

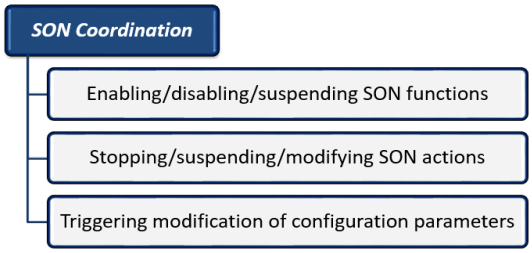

Fig.7. Functions of SON coordination

In order to avoid problems in the network, all SON functions are to be designed such that they are able to deal with the possible actions taken by the SON coordination function in order not to worsen the problems in the network.

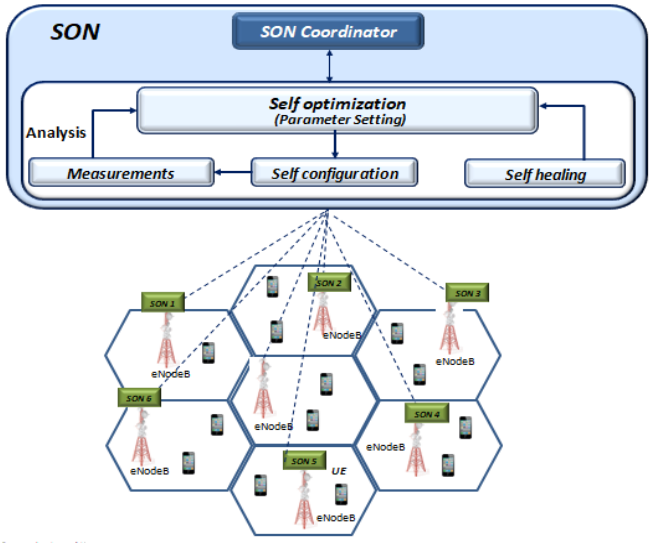

Fig.8. SON coordination

As shown in Fig 8, the parameter measurements are received from the network and are analyzed. Self optimization set the optimum values for these parameters and self configured accordingly in the network automatically. Self healing is done to mitigate faults in the network. These activities are performed for different SONs in the network which are coordinated by SON coordinator through self configuration, self optimization and self healing processes.

3. SON coordination with Priorities for Separation of Parameter Regulation

SON coordination helps us to handle multiple SON functions simultaneously. This may lead a particular SON function not to achieve its defined target metrics by considering other SON metrics. In such cases, separation of parameter regulation principle as mentioned in [1] can be applied to that particular SON function to forcefully use its own KPI and control respective parameters accordingly to achieve its target. Refer Fig 9. Here cell A compromises its target metrics by considering cell B KPI. So separation of parameter regulation is applied to the SON function in Cell A. But the SON function in Cell B may not achieve its target metrics.

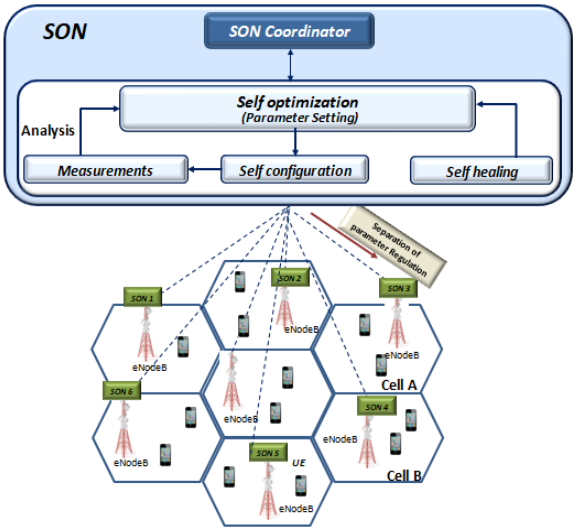

Fig. 9. SON coordination with Separation of Parameter Regulation

Whenever there is chance of such kind of conflict between SON functions, it is proposed that priorities to be given initially for some defined fixed time so that one of the SON functions(which is given high priority) achieves its target metrics with minimal acceptable deviation. Then applying the principle of separation of Parameter Regulation [1] to the other SON function helps us to achieve its target metrics too.

Instead of performing only one SON function by compromising the target metrics of another, priorities being fixed for some defined time then applying separation of Parameter regulation helps us to achieve both SON target metrics with minimal acceptable deviation. This overall approach helps in resolving conflicts in an easier and simplest way just by configuring SON coordinator to achieve the required target metrics.

3.1 **Illustration**

Let us consider two cells A and B as shown in the Fig 10 in which cell A has Cell Outage Compensation (COC) SON and cell B has Energy Saving Management (ESM) SON. Here cell B is configured to take coverage of cell A when cell A is in outage. In this scenario, a conflict could arise between COC and ESM.

When cell A is in outage, the SON function COC will try to compensate the cell A outage by re-configuring the RF configuration of the compensating cell B like transmitting power, antenna tilt. Since cell B should be in Energy saving state, it is difficult to compensate for cell A outage at the same time.

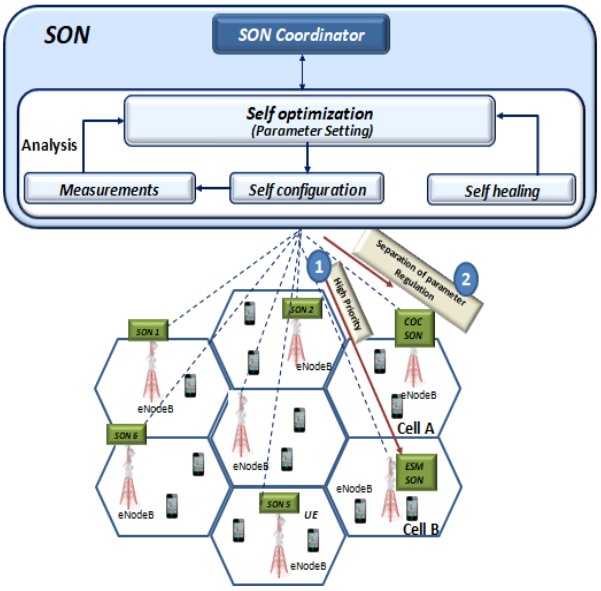

Fig. 10. SON coordination with Priorities for Separation of Parameter Regulation

Resolution. Using coordination mechanism, SON 1 COC mainly considers cell B ESM SON KPI which keeps cell B to be in energy saving state. Refer [1] for the similar use case and [2] for outputs. Here SON 1 outage target cannot be achieved. By fixing priorities for these SON functions with high priority for ESM for fixed amount of time, cell B is in Energy saving state. This fixed time is set so that it maintains the energy consumption target metric with acceptable deviation by maintaining network service performance at the user acceptance level. Soon after this time, separation of parameter regulation principle is applied to COC SON to forcefully use only its own KPI to achieve its target metric.

By doing so, COC SON concentrates only on its statistics and tries to achieve the target outage time percentage. With the proposed approach, the target metrics for both Cell A and cell B SON functions could be achieved with defined acceptable minimal deviations by controlling appropriate parameters like Outage time(cell A) and Energy consumption(cell B). The cell B may go into the energy saving state after the cell A outage is recovered.

4. Conclusions and future scope

The proposed approach of prioritizing SON function for separation of parameter regulation resolves the conflicts among SON functions and helps to achieve the target metrics of all SON functions. This helps in the faster deployment and roll out of the network. It improves the network performance and user experience. It helps to provide the optimal coverage and capacity of a network. It reduces the Operational Expenditure (OPEX) due to reduction in installation costs and manual efforts. It also reduces Capital Expenditure (CAPEX) due to optimized usage of eNodeBs. By means of task automation, human intervention can be reduced and operational efficiency can be increased.

The upcoming 5G network needs high number of base stations to handle an exponential increase in the data traffic which clogged up the network while not leading to proportional increase in the revenue.. There is difficulty in managing this large number of base stations while maintaining optimal coverage and capacity. In such cases, the proposed method of assigning SON priorities in SON coordination using separation of parameter regulation principle helps to maintain them so easily and simply by monitoring and controlling certain parameter metrics in the network/cells automatically while providing all the cells optimal coverage and good performance metrics . It reduces the manual burden and thereby complexity in maintenance while providing better user experience. The proposed principle can be implemented more in distributed networks which helps us to achieve a more future proof and reliable solution.

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