Jio SON

Self Organizing Network

A Distributed Approach to Automate Networks

Part of Jio's complete End-to-End 5G product offering

Solution for Controlled, Self-Organized, Scalable & Reliable Network

3GPP Release 16 Compliant

Overview

The development of cellular technology will be directly proportional to the increasing requirement in various aspects, such as the speed of data transmission (velocity), data variations (variety), and data storage media (volume). In relation to that, the demand for increased capacity and coverage becomes a necessity because users access the networks using the same resources by utilizing resource sharing mechanism. Self-organizing network (SON) is an automation technology designed to make the planning, configuration, management, optimization and healing of mobile radio access networks simpler and faster. Self Organizing Network (SON) is one of the solutions to make the system more efficient with guaranteed Quality of Experiment (QoE). Big Data is leveraged in the network analytics as a reference for decision-making activities in the network automation process. Detecting problems starts with data collection and analysis of possible network problems. The SON has the capability of full awareness of current status and the ongoing changes, the ability to do necessary analysis to determine optimal network parameter values, and the ability to implement the network adjustment, and thus minimize the human intervention as much as possible, and also to provide network maintenance in an optimal and timely fashion. A Self-Organizing Network is an automated adaptive network, capable of performing a set of functions with the minimum human intervention. It reduces OPEX, as some functions are automatized and may only require minimum human intervention, and, also, reduces CAPEX, as a better usage of the resources can be done and, therefore, the service may improve without the need of deploying more infrastructures. The next generation SON should have the capability of full awareness of current status and the ongoing changes, the ability to do necessary analysis to determine optimal network parameter values and the ability to implement the network adjustment , and thus minimize the human intervention as much as possible.

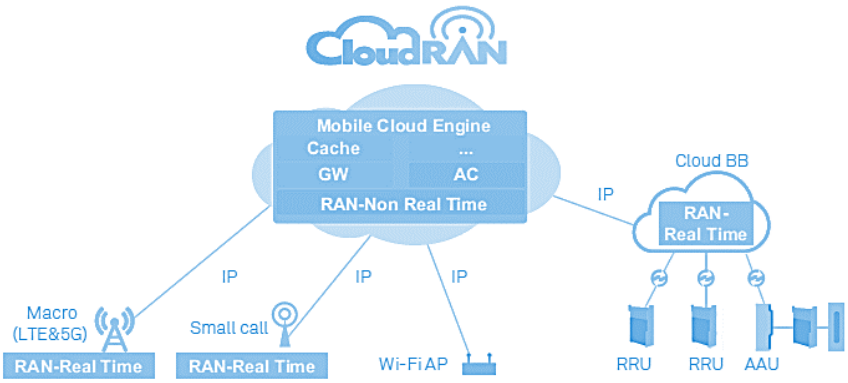
Well-designed and efficient of network performance by continuously finding improvement patterns that may not be easily distinguishable to an expert. This is done so via the modification of various network parameters and by using rollback algorithms. These operations can be performed efficiently due to the availability of rich statistical models on Key Performance Indicators (KPI), their dependencies on one another and their interactions with each other. However, SON functions need to be specifically tuned to each individual network. Correct parameters need to be used which comply with the existing network policies.

Objectives of SON

The main purpose of the next generation SON should be greatly improve the O &M efficiency and help the operators to keep the pace with the complexity of fast evolving wireless networks.

Enabling Cloud RAN

The cloud-computing based Mobile Cloud Engine will provide automatic scaling capabilities, making it possible to quickly respond to service and network changes. The guiding principle in designing of the MCE is that it must be able to predict the service growth accurately or trigger a resource allocation at the right time. The next generation SON combined with the new, cloud-based architecture, will be able to address such challenge by automatically monitoring network load, and even predicting network load based on historical service statistics.

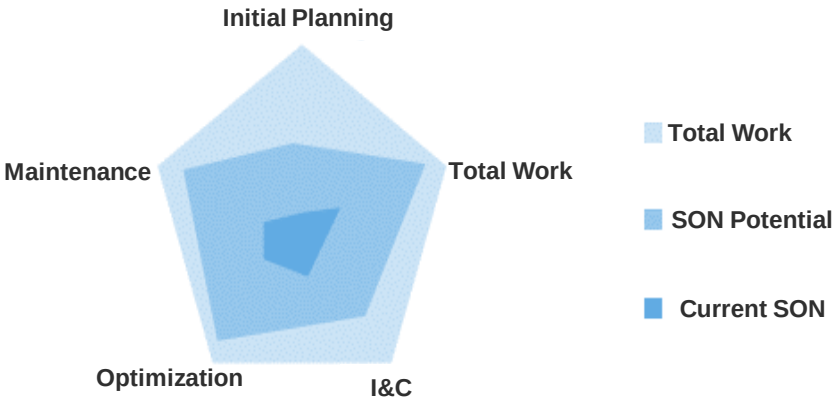


Improving O&M efficiency

This improved user experience will be enabled by the introduction of new radio transmission technologies that will increase the spectrum efficiency and offer higher data rates. However, this will come at the cost of increased network complexity due to the following:

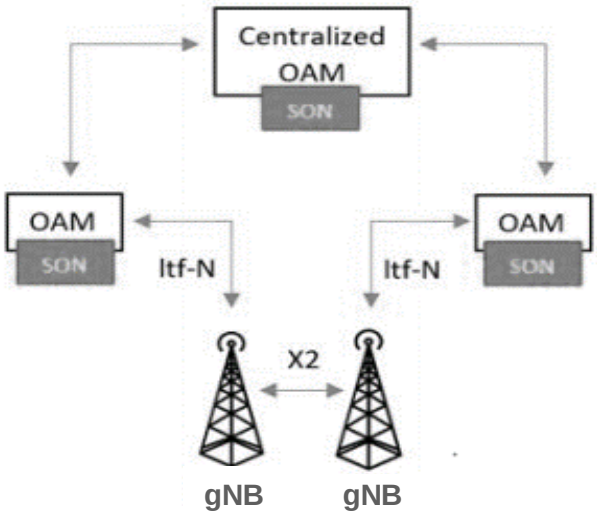
Automating the O&M Tasks

Wireless network O&M tasks can be divided into five stages: 1) Initial planning: deciding the high level network design, including site selection and base station type selection. 2) Detail design: defining the detailed site configurations and RF features. 3) Installation &Commissioning (I&C): implementation and verification of the designs. 4) Optimization: optimization of legacy or new networks periodically. 5) Maintenance: maintenance of network and equipment



SON Architecture

In order to address the inter-operability in multi-vendor scenarios, SON solutions shall be based on standardized interfaces but the detailed implementation of SON functions is vendor specific.



In a centralized SON architecture, the algorithms are executed at the network management level. As depicted in the above figure, the SON functions are located in the O&M system, in the core network. Commands, requests and parameter settings data flow from the network management level to the network elements, while measurement data and reports flow in the opposite direction. The main benefit of this approach is that the SON algorithms can take information from all parts of the network into consideration. Centralized SON solutions give the operator more control over the network as all information and control are available at the network management level.

Some of the key SON functions include PnP, auto call-P-test, Minimization of Drive Testing (MDT).

Plug and Play Deployment

PnP deployment takes advantage of DHCP procedures, allowing gNodeBs to connect to the OSS and to update software and configurations automatically.

Auto Call-P Test

The auto call P-test function helps operators complete various call procedure tests for each new site or cell, which ensures that sites and cells run automatically.

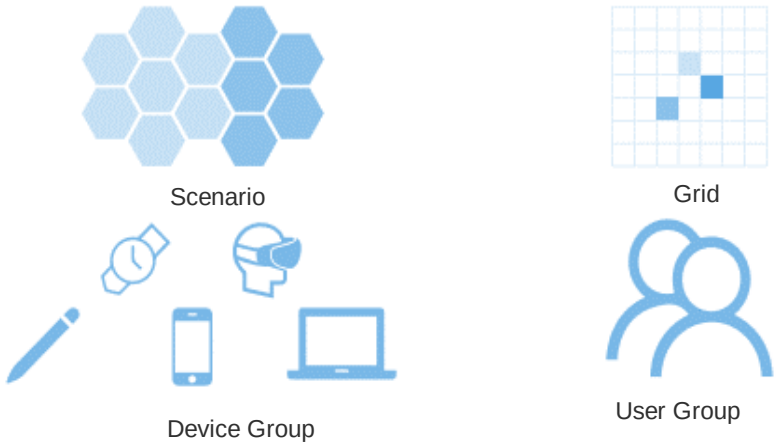
Minimization of Drive Testing

The MDT enables UEs to automatically collect network measurement data. With MDT, UEs can collect measurement data from locations that cannot be visited in traditional drive tests (eg. indoor locations).

Multidimensional Accurate Self-Optimization is another key feature of SON. From the geographic area point of view, wireless networks can be divided into following categories:

- Cluster of cells, intended to serve a specific coverage scenario, such as indoor coverage, stadium, highway etc.
- Individual cells are the smallest units with unique RF parameters.
- Sub-cell size units organized, usually referred to as grids. The level of grid granularity is not necessarily well defined; sometimes it refers to a relative location within a cell.

Additionally, a network can be divided from the user perspective into various groups, such as groups by device (eg. iPhone, Android etc.) or service (VoLTE, IoTetc.)



Capabilities

- Automatic configuration of initial radio/transport parameters
- Automatic data alignment for neighbor nodes (realized for LTE via standardized Automatic Neighbor Relation (ANR) management)
- Automatic connectivity establishment
- Self-test
- Automatic inventory control
- Automatic authentication and SW download
- Automates the load balancing
- Automatic handover parameter optimization

Key Principles of Self Organizing Networks

Self-Organizing Networks are defined as a set of use cases covering all aspects of network operation from network planning to maintenance activities. These use cases express high-level requirements for future networks and are based on the paradigm that network should self-organize and manage its resources so that optimal network quality and performance is achieved.

Self Configuration

The Self-configuration SON is a collection of algorithms that aims at reducing the amount of human intervention in the overall installation process. This will result in faster network deployment and reduced costs for the operator in addition to a more integral inventory management system that is less prone to human errors. Self-configuration is a broad concept which involves several distinct functions that are covered through specific SON features, such as automatic software management, self test, Physical Cell ID Configuration (PCI), and Automatic Neighbor Relations (ANR). The self-configuration actions will take place after the gNB is physically installed, plugged to the power line and to the transport link. When it is powered on, the gNB will boot and perform a self test, followed by a set of self-discovery functions, which include the detection of the transport type, tower-mounted amplifier (TMA), antenna, antenna cable length and auto-adjustment of the receiver-path.

Self Healing

Self-healing is a collection of SON procedures which detects problems and solves or mitigates these to avoid user impact and to significantly reduce maintenance costs. Self-healing is triggered by alarms generated by the faulty network elements. If it finds alarms that it might be able to correct or minimize the effects of, it gathers more necessary correlated information, does deep analysis, and then trigger the appropriate actions. Fault management should be simplified and automated via information correlation mechanisms. Operators will be responsible for definition of correlation rules and corrective actions to specific faults but the fault correction itself will be autonomous. Self-healing covers use cases such as cell outage detection and compensation via automated root cause analysis and such corrective actions as routing traffic to nearby cells.

Features

- ANR Addition –- Neighbor cells addition and removal with the support of UE measurements for gNodeBs.
- LTE ANR Addition & Removal - Neighbor cells addition and removal with the support of UE measurements for eNodeBs.
- PCI Collision Resolution – New value will be assigned by SON, if the Physical Cell Identity of two gNodeBs (source and target) are same.
- PCI Confusion Resolution - New value will be assigned by SON, if the Physical Cell Identity of two neighbor gNodeBs against single source gNodeB, are same.
- Enrich CLI – The requirement for Enrich CLI is when 2CLIs may require:

a) Fetch Running neighbor list from ODSC via SON CLI

b) Display Neighbor list available in SON database against source gNB via SON CLI

Cloud Native Deployment Support

Support for deployment in any private or public cloud environment as virtualised or containerized function (e.g. Google Cloud, Microsoft Azure, Amazon EC2, Openstack, Docker).

Self Optimization

SON self-optimization functions are aiming at maintaining network quality and performance with a minimum of manual intervention from the operator. Self-optimization functions monitors and analyzes performance data and automatically triggers optimization action on affected network element(s) when necessary. Self-optimizing SON functions make it possible to introduce new automatic processes that are too fast, and/or too complex to be implemented manually. This will improve the network performance by making the network more dynamic and adaptable to varying traffic conditions and improve the user experience. The aim of self-optimization is to fine-tune initial parameters and dynamically recalculate these parameters in case of network and traffic changes.

The main use cases of the Self Optimization process are mentioned below:

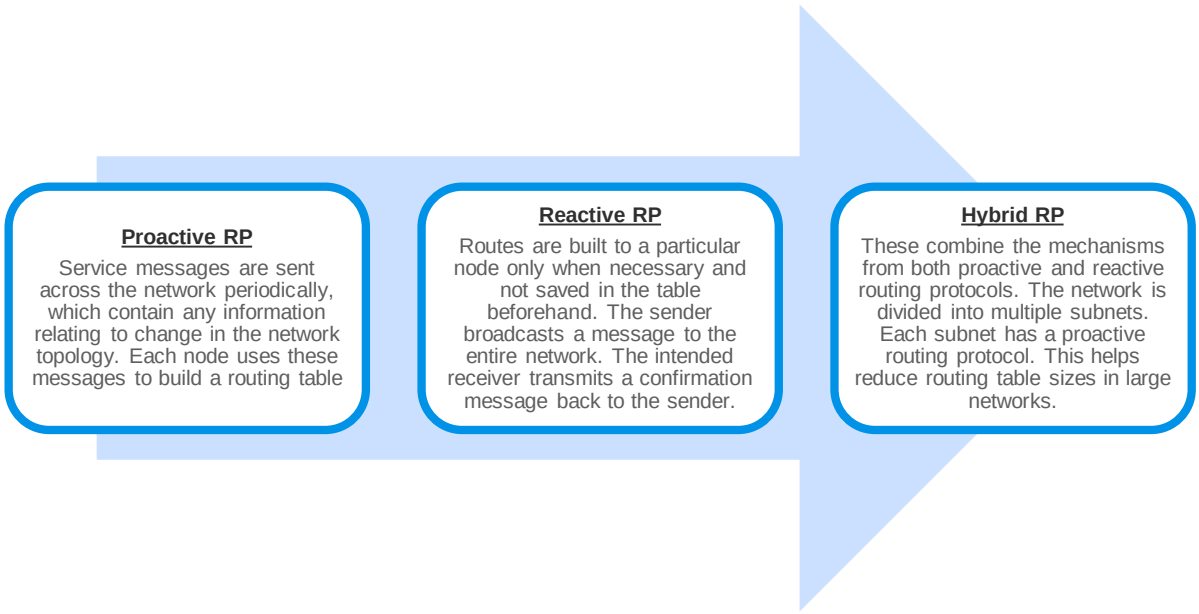
- ❑ Automatic neighbor relation
- ❑ Energy savings
- ❑ Interference reduction
- ❑ Mobility robustness optimization
- ❑ Coverage and capacity optimization
- ❑ Random access channel optimization
- ❑ Physical cell ID Automatic Configuration

Benefits

- Reduced installation time and cost
- Reduced OPEX due to reductions in manual efforts in connection with monitoring, optimizing, diagnosing, and healing of the network
- Significant reduction in time
- Reduced CAPEX due to more optimized use of network elements and spectrum
- Improved user experience
- Improved network performance
- Provides a customer-centric network
- Reduces time-to-market for network projects
- Increases the return on infrastructure investments
- Improves O&M efficiency
- Increased number of RAN features and parameter

Routing Protocols in SON

Based on the working, SON routing protocols can be broadly classified into three different types:



Key Features

Automatic Neighbour Relations (ANR) Management

Neighbour planning is realized at eNodeB. A neighbour relation is information that a neighbour cell is a neighbour to an eNB. Each eNB holds a table of detected neighbour cells which are used in connection with handovers. Updating automatic neighbour relations (ANR) is a continuous activity that may be more intense during network expansion, but is still a time consuming task in mature networks. The task is multiplied with several layers of cells when having several networks to manage. With LTE, one more layer of cells is added; thus, optimization of neighbour relations may be more complex. Due to the size of the neighbouring relation tables in radio networks, it is a huge task to maintain the neighbour relations manually. Neighbour cell relations are therefore an obvious area for automation, and ANR is one of the most important features for SON and is implemented at eNB rollout.

Related Products

- Jio Converged MANO Solution
- Jio Hybrid Policy Control Solution
- Jio Business TAS
- Jio Converged TAS
- Jio Converged IP Short Message Gateway
- Jio Element Management System
- Jio Adaptive Troubleshooting, Operations & management (ATOM)
- Jio Blockchain Platform

PCI-Collision and PCI Confusion Detection and Resolution: PCI is a locally defined identifier for eNBs with a restricted range (up to 504 values) and must be reused throughout the network. The PCI numbering of eNBs must locally be unique so that the UEs may be able to communicate and possible perform handovers. The goal of PCI configuration is to set the PCI of a newly introduced cell. The PCI is contained in the SCH (synchronization channel) for user equipment (UE) to synchronize with the cell on the downlink. When a new eNB is established, it needs to select PCIs for all the cells it supports. Since the PCI parameters have a restricted value range, the same value needs to be assigned to multiple cells throughout the network and must be configured collision free, that is, the configured PCI needs to be different from the values configured in all the neighbouring cells.The PCI automatic configuration was one of the first SON functions to be standardized by 3GPP. The self-configuration feature seems to be quite mature and all of the main vendors have this function implemented in their eNBs. Some vendors report tests with 100% handover success rate in networks where new eNB are introduced and the Automatic PCI Optimization are applied. The physical cell ID configuration is a SON function that is implemented at eNB rollout.

InterCell Interference Coordination (ICIC): The main idea behind inter-cell interference coordination (ICIC) is to coordinate transmissions in different cells in such a way that the inter-cell interference and/or the effect of it is reduced. With the currently proposed solutions this is achieved by letting each cell omit using some of the spectrum resources (frequency/time slots/power) in order to reduce interference. Omitting to use spectrum resources implies that some capacity is lost, so the gains obtained by operating in an environment with less interference must more than compensate for this loss. The most important gain that can be achieved by ICIC is the ability to provide a more homogeneous service to users located in different regions of the network, especially by improving the cell-edge performance. The nature and severity of inter-cell interference depends on the cell types involved, basically: macro-macro, macro-pico, and macro-femto cell interference.

Cell Database Management: Cell Database contains the physical parameters of gNB like gNB ID, PCI, RSI, IP etc. This enables the self configuration of Node. This is supported for ODSC, IDSC and Macro cell interference.

gNodeB Software Upgrade: gNodeB Software Upgrade Management includes Software Upgrade, Rollback, Software Upgrade Cancellation, and Postpone like features are also supported. This feature provides the remote software upgrade of all the modules of ODSC like L1 , CU/DU , OAM etc.. Software upgrade as well as downgrade to lower release can be done via it.

Mobility Robustness Optimisation: Mobility robustness optimization (MRO) is a solution for automatic detection and correction of errors in the mobility configuration. The main objective of mobility robustness optimization is the reduction of the number of HO-related radio link failures. Mobility robustness optimization (MRO) encompasses the automated optimization of parameters affecting active mode and idle mode handovers (HOs) to ensure good end-user quality and performance, while considering possible competing interactions with other SON features such as automatic neighbour relations (ANR) and mobility load balancing (MLB).

Mobility Load Balancing Optimisation: The objective of mobility load balancing (MLB) is to intelligently spread user traffic across the system's radio resources in order to optimize system capacity while maintaining quality end-user experience and performance. Additionally, MLB can be used to shape the system load according to operator policy, or to empty lightly loaded cells which can then be turned off in order to save energy. The automation of this minimizes human intervention in the network management and optimization tasks.

Cell Outage: This SON function has two basic components, namely, cell outage detection (COD) and cell outage compensation (COC)

COD uses a collection of evidence and information to determine if a particular cell is not working correctly. Detection also includes the simple case where OAM is aware of the fault. However, in the case of complete eNB failure, OAM will be unable to communicate with the eNB to determine whether its cell is in service.
The goal of COC is to determine and set network parameters and mitigate the effect of cell outages and thereby minimize the network performance degradation when a cell is in outage. This is done by automatic adjustment of network parameters in order to optimise coverage and performance, and meet operator's deployment requirements based on coverage and other KPIs.

GNB Runtime Configuration Changes: This feature provides the feasibility of parameters configuration dynamically.

Cell Lock, Unlock, Shutdown etc.: This feature is to stop the cell radiation or if operator wants to disable the cell temporarily.

Current Cell State: This feature allows operator to see the current state of the cell whether the cell is up and running or cell is down.

Hard and Soft Reboot via Jio SON: This feature allows an operator to do hard reboot or soft reboot remotely in case of any failure.

Linux ETH Packet Capture: Used to replicate data between active and standby SONs

FAPI Packet Capture: This feature enables the FAPI (interface between L1 and L2) packets capture using the command line interface.

DPDK Packet Capture: Enables the DPDK interface packets capture using the command line interface.

Get Registered gNodeB Detail: This command provides the the detail of connected gNB in the Jio SON server. It provides the SAP IDs,serial number and gNB ID

Initialize Cell DB Data: If there is any update in cell DB data then using this command SON server takes the latest data base for its operation

List All Registered gNodeB: This command provides the the list of connected gNBs in the Jio SON server. It provides the SAP IDs, serial number and gNB ID.

CRUD operations on Cell DB Data for a given Range: Used to add, update and delete cell DB Data for a given range.

Bulk Software Upgrade:It is used to Start Bulk Software Upgrade where input is taken from an Excel File. Also, the Bulk Software Upgrade Status can be fetched.

Import Cell DB Data: It is used to import Cell DB Data from Database.

Import Registered Index Data: It is used to import Registered Index Data from Database.

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Summary

As complexity of networks and OPEX reduction pressures grow, concepts related to Self-Organizing Networks are regarded by operators as the key technology requirement. The manual work associated with network operation needs to be significantly reduced and the network itself should be capable to self-configure and continuously self-optimize in response to network and traffic changes. As the demand for mobile communication is steadily increasing, this will lead to an increased complexity in radio access network. It is therefore important to develop SON solutions for heterogeneous access technologies.

Hardware Information

The solution can be deployed on variety of hardware including RAC based or chassis-based servers. Below is the list of preferred HW providers.

Dell PowerEdge R640, R740 RACK Servers

HP DL 360 Gen 10 RACK Servers

Dell PowerEdge M1000e Enclosures with MX740/840 Servers

HP ProLiant C7000 Enclosures with BL460 Gen 10 Servers

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