

Issues in Self Organizing Network (SON)

Purple Petal Edu Hub

Self Organizing Network (SON)

- A **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.
- In simple words: A self-organized network is a kind of wireless network that can be deployed instantly and provide easy network communication without the support of pre-established network infrastructures, such as base stations. This network architecture brings promise of much better mobility and communication capacity

Functional Overview

Three classes of key functions figure prominently in SON.

- 1. Self-configuration** comprises all tasks necessary to automate the deployment and authorizing of networks and the configuration of parameters. Network elements operate autonomously, running setup routines, authenticating and connecting to the network.
- 2. Self-optimization** serves to improve or recoup network quality by tuning and adapting the network parameters. It involves balancing loads among neighbouring cells.
- 3. Self-healing** : Includes a set of key functions designed to cope with major service outages, including detection, root cause analysis. Auto-restart and other automatic alarm features afford the network operator even more quick-response options.

Self-planning combines configuration and optimization capabilities to dynamically re-compute parts of the network, the aim being to improve parameters affecting service quality

Self-configuration

Plug and play
Automated setup
and configuration

Self-planning

Self-optimization

Auto tune
Real-time network
optimization

**Dynamic
re-planning**

Self-healing

Auto repair
Fast, autonomous
failure mitigation



To secure a self organizing network, we consider the following attributes:

Availability, Confidentiality, Integrity and Authentication.

- To ensure that the message delivered has not been modified, a technique called diversity coding can be used. The basic idea is to transmit redundant information through additional routes for error detection and correction without message retransmission. Thus even if one route is compromised, the other routes can be used to get the correct information across.

Research Papers:

➤ **Self Organizing Wireless Sensor Network**

In this paper, a set of algorithms for self-organization of wireless sensor networks, in which there is large number of static nodes with highly constrained energy resources , was presented. The protocols further support slow mobility by a subset of the nodes, energy-efficient routing, and formation of ad hoc sub-networks for carrying out cooperative signal processing functions among a set of the nodes.

The algorithms exploit

1. abundant bandwidth
2. energy utilization
3. network scalability
4. formation of ad hoc sub-networks.

Drawbacks:

1. Minimum energy required for network formation could not be decided
2. The extent to which the algorithms can efficiently deal with more extensive mobility in the nodes and the targets.

➤ **Self-Organizing Networks (SON) in 3GPP LTE, 2008**

As every mobile network, LTE (Long Term Evolution) system also needs to be managed. There is a trend to simplify the management by auto-configuration and auto-optimization. However, the complexity of LTE system also place new demands on the Operations and Maintenances of the network. Self-Organizing Networks (SON) is seen as one of the promising area for an operator to save operational expenditures. SON is therefore currently discussed in 3GPP standardisation. **This paper provides some background on SON principles, introduces different architectures that are considered and describes some exemplary procedures.**

Need of SON in 3GPP Long Term Evolution system:

1. The number and structure of network parameters have become large and complex.
2. The rapidly expanding number of Base Stations needs to be configured and managed with the least possible human interaction.
3. Increasing capacity of the network

➤ **Benefits of Self-Organizing Networks (SON) for Mobile Operators, Telenor, Research and Future Studies, 2012**

Self-Organizing Networks (SON) is a collection of functions for automatic configuration, optimization, diagnosing and healing of cellular networks. It is considered to be a necessity in future mobile networks and operations due to the increased cost pressure. **The main drivers are essentially to reduce**

1. CAPEX (Cost Affective Expenditure)
2. OPEX (Operational Expenditure)

which would otherwise increase dramatically due to increased number of network parameters and rapidly increasing numbers of base stations in the network **Mobile networks are getting more complex to configure, optimize and maintain. Many SON functions will give cost savings and performance .**



- **Self-Organizing Network with Intelligent Relaying (SONIR)**

A software SONIR (Self-Organizing Network with Intelligent Relaying), in **MATLAB**, was developed, which implemented an end-to-end multi-hop, capable of dealing with mobility of nodes. Different methods for clustering, mobility management, routing were implemented. These methods work on different OSI layers. The main goal is to be able to visualize such a system as a whole in order to see the end-to-end performance as well as solve the possible issues that arise with it.

➤ **Self-Organizing Networks (SON) in 3GPP: Release 11** **– The Benefits of SON in Long Term Evolution**

This paper is an update of the paper published in 2011, *Self-Optimizing Networks: The Benefits of SON in LTE*, that addressed the rationale for SON and the description of SON features in 3GPP Releases 8, 9 and 10. This paper also focuses on the SON use cases that play an important role in the **operation of multi-vendor Heterogeneous Networks** comprising of macro and metro cells. Various architecture options and tradeoffs as it relates to the implementation of SON use cases for multi-vendor HetNets (Heterogeneous Networks) , are described.

Heterogeneous Network: A **heterogeneous network** is a **network** connecting **computers** and other devices with different **operating systems** and/or **protocols**.

For example, a wireless network which provides a service through a **wireless LAN** and is able to maintain the service when switching to a **cellular network** is called a wireless heterogeneous network.

➤ **Self-Organizing Network (SON)**

- Introducing the Nokia Siemens Networks

The self-organizing network is a cellular network in which the tasks of configuring, operating, and optimizing are largely automated. Radio access elements account for a large share of cellular networks' installation, deployment, and maintenance costs. The two benefits of SON are:

Enhances network quality

Cuts operational expenditure (OPEX)

➤ **Routing protocols overview and design issues for self-organized network**

A self-organized network is a kind of wireless network that can be deployed instantly and provide easy network communication without the support of pre-established network infrastructures, such as base stations. This network architecture brings promise of much better mobility and communication capacity. Various routing protocols have been presented. This paper gives a detailed study of whether each of them works and whether there is a superior one that can function successfully under all kinds of situations.

Design issues of Self Organizing Networks:

The issues in designing of the Self Organized Networks include the available bandwidth (which is large, compared to the per hop data rate) and available energy (which is small).

Main Problems/ Challenges

There are lot of technical issues involved in the creation of an ad hoc network and then making it self organizing. Configuration, discovery, routing, security are some of the key issues. Further, power and processing capabilities are scarce resources in mobile device, thus making protocols design even more complex.

The main issues discusses here, are:

1. Configuration
2. Discovery
3. Routing
4. Co-operation Incentive
5. Security

Challenges associated with a self organizing network.

Configuration

Most of today's networks are relatively static. They involve a large management cost to be setup and maintained. Further, if the node moves to a new location this configuration has to be changes. This technique though workable, is highly inefficient for a frequently changing network.

Discovery

Discovery is a very important aspect of making an ad hoc network self organizing. Discovery deals with two issues:

- The discovery of the node itself within the network.
- The discovery of the services available to the node once it has placed itself in the network.

The simplest way a node can discover itself is by using a Global Positioning System (GPS). The GPS can provide the node with its location and then it can start looking for nodes in its zone

Routing

Routing is one of the fundamental operations of a network. There are a lot of routing protocols proposed to work with ad hoc networks

Broadly speaking routing protocols are classified into two :

1. Proactive Protocols

2. Reactive Protocols

➤ **Proactive:** These types of protocols constantly evaluate the routes within the network so that when a packet needs to be forwarded the route is already known. E.g. Open Shortest Path First (OSPF), Wireless Routing Protocol (WRP), Destination-Sequenced Distance-Vector (DSDV).

➤ **Reactive:** This type of protocols determines the route on demand. E.g. Temporally-Ordered Routing Algorithm (TORA), Ad hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR).

Cooperation Incentive

Self organizing network are highly cooperative, since each node of the network acts as an autonomous network elements and provides all the services themselves. Since providing service to the network does not provide any direct advantage to the users of such a node, they may just consume services and not provide any.

- So mechanisms are required to encourage end-users to let their node act as a relay, and keep their terminal turned on and not tamper with them.
- Further such a mechanism should also discourage end-users from overloading the network, in particular limit the number of long distance communications.

Security

Security issues like legitimacy of the users, confidentiality and integrity of information in self organizing networks are similar to that of conventional networks. But this type of network has more complex issues as listed below:

- The medium used is wireless, thus it becomes easier to eavesdrop.
- These networks do not have a centralized monitoring or management point.
- The network configuration changes dynamically owing to the dynamic nature of the network.
- Mobile devices have a limited processing capacity and battery life, so any kind of solution has to take these factors into account.



Conclusion

The design of self organizing networks as we have seen involves the resolution of lot of complex issues. In this survey , some of these issues ranging from configuration to security, have been discussed. Some of the possible approaches that can be adopted to resolve them, have also been outlined.



Future Scope

The potential benefits like ease of use, robustness and overall efficiency of such networks warrant further research till they can be commercially realizable.