# A Study of Star, Mesh and Cluster Network Topologies

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***ABSTRACT:*** *In wireless network systems various topologies need to understand. These topologies include star, mesh, cluster and a few more. Among them it is found that the cluster-based topology is more significant over the other existing types. We have analysed the several types and discuss the features in this paper.*

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## 1. Introduction

Wireless sensor networks (WSN) appear to be a subdivision of wireless networks without infrastructure, where there are higher requirements to the size of the sensor nodes and the optimization of the activity time of each of them aiming at energy saving.

WSN are networks with decentralized structure in which the information is wirelessly transmitted, mainly through radio or optical connection and there are higher requirements to the size and the duration of the nodes.

The nodes main tasks in WSN are detection and reporting of different parameters as temperature, illumination, humidity, radiation etc. The collection of the wanted information from a certain district could take months and years. For this task fulfillment nodes functionality is divided into three groups [3], each of them is subject to optimization:

- Environment connection
- Computing and processing
- Communication

**Environment connection** includes the environment factors and their values detection, as well as discovering neighboring nodes and their coordinates determination. This functionality is fulfilled in two modes – normal and that of reduced consumption.

**Computing and processing** in the nodes are connected with analyzing, calculating and summarizing of the information. For this purpose different kinds of microcontrollers are used.

For communications between nodes there are routing algorithms and protocols, which depend on the architecture of the

network. They could be classified into two main groups according to their logical structure: data-centric, hierarchical and location-based.

Wireless sensor networks are preferred when the infrastructure building is difficult, unprofitable; the network is of a temporary use etc.

The listed features of WSN lead to certain requirements: low energy consumption (due to the use of restricted autonomous power supply); small sensor sizes; security and protection of the transmitted information and so on.

**2. WSN Topologies**

Most often nodes are randomly scattered, as the location and the connections between them determine the network topology.

Tree main types of topologies have been established in practice:
Star

Mesh

Cluster/tree

Nodes in these main topologies could be divided into two main classes: Full Function Devices-FFD (Router node) and Reduced Function Devices-RFD (End node).

FFD support full set of functions and could play the role of a coordinator of network CN (Gateway) or of a common device. At the same time RFD can be used as common devices. They have got smaller memory, computational resource and smaller energy consumption [1].

**2.1. Star Topology**

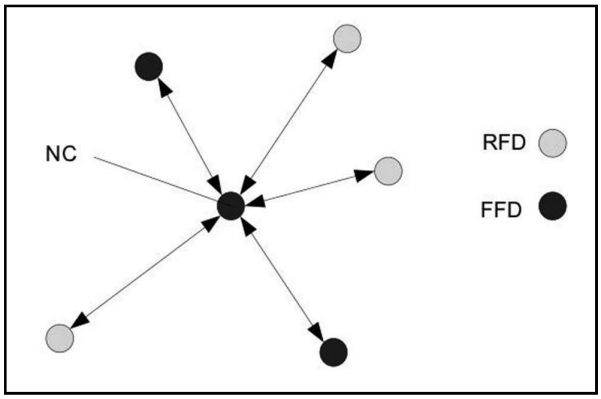


Figure 1. Star topology

In star topology devices could be FFD or RFD. They function as terminal devices and communicate directly with CN [5].

This is the simplest topology. Its name is connected with the spatial location of the end nodes around the coordinator node.

CN is a specialized device for quick date exchange, but it can also be a personal or pocket computer (PDA).Its purpose is to manage the work of the end devices, to exchange data with them and to relay the collected date to other networks.

Star topologies are Single-Hope Systems, which means that data from the transmitter is transferred to the receiver with one hop. Their structure is point-to-multipoint type.

The main advantage of these networks is that they have the lowest energy consumption. The perimeter covered by the network is equal only to the range of the end nodes, which is a disadvantage.

Besides their reliability is not big – the disruption of the connection between the sensor nodes and the network coordinator, due to malfunction for instance, could not be compensated. It is recommended that these networks should have up to 30 nodes and cover an area with a radius of 100 meters [2].

**2.2. Mesh Topology**

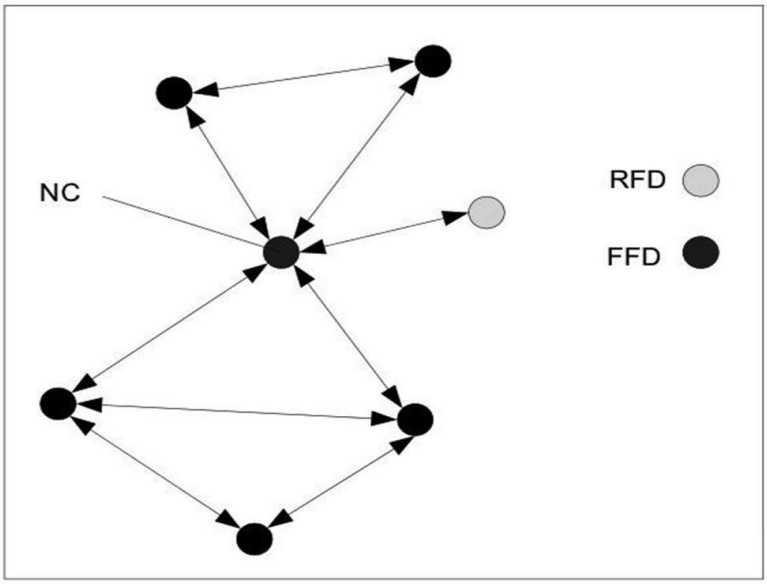


Figure 2. Mesh topology

In Mesh topology (figure 2) all the devices should be FFD, as an exception is made only for the most distant ones. In this case communication with CN could also be implemented with transition of the packages across multiple nodes, which indicates that these types of networks are Multi-Hop Systems [4].

Furthermore several routs are possible between any two nodes, as the network software chooses the shortest one of them. This means reduction of the energy being consumed, due to the well known fact that the necessary radiated power is proportional to the square of the distance. Furthermore for consumption restriction the work algorithm of WSN ensures a precise synchronization of data exchange – the transmitting node sends a control package for the switching on of the receiver of the receiving node. It reacts quickly, accepts the data and switches off instantly.

With the appearance of a damaged node (Router node) or large distortions through the rout, another one is automatically found, and for this reason these are Self-Healing Networks. With switching on and off of the devices to the network and presence of moving nodes in it (as it is with GSM networks) it also changes routs, which makes it Self-Configuring Network too. Self-Configuring allows the network to recognize automatically and involve in action each new node.

Network structure is called Point-to-Point-to-Point, Peer-to- Peer. Unlike WSN star topology, where all the management is concentrated in the CN node, here it is distributed between all nodes and therefore this network type is with Distributed Control.

Apart from the much better communications in mesh topology there is a possibility for covering a significantly larger area compared to star topology.

Another advantage is the facilitated check of nodes functionality and network as a whole by means of specialized diagnostic device or a computer. The fast and easy installation and starting of such a WSN should be noted as well.

### 2.3. Cluster Topology

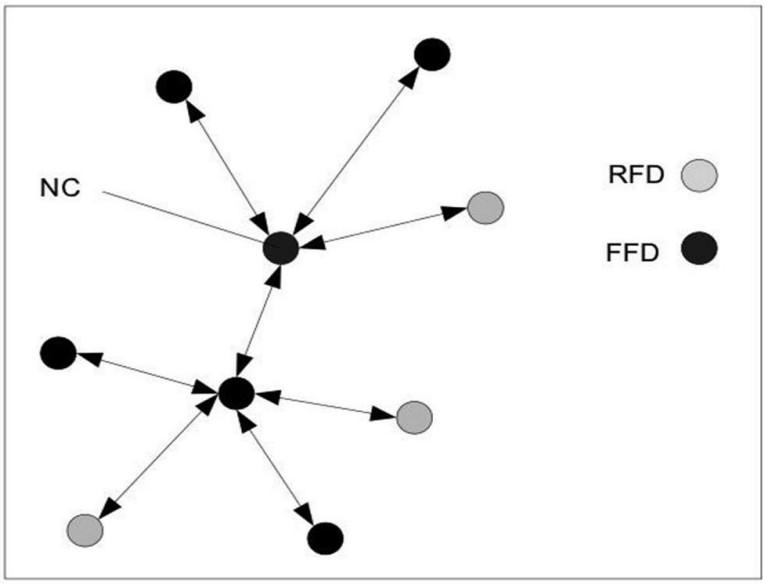


Figure 3. Cluster topology

In cluster topology (figure 3) groups of nodes that communicate only with one FFD, called cluster-head, are differentiated.

The head has more energy, memory and computational resource. There is also a possibility for collecting (aggregating) more information with buffering the packets in the memory and calculating the collected data. After that it transmits in multi-steps (via the other heads) only the information that is approximated and updated without surpluses to the base station.

In this network types each cluster could work at different frequencies compared to the neighboring cluster and in this way collisions could be avoided and network communication quality can be improved.

Each cluster can use different keys for data encryption and in this way network becomes more protected.

In cluster approach scalability as well as network productivity could be improved.

There is self-organizing here as well, i.e. nodes find their neighbors by their own and are individuated in groups (clusters) with a central node (head). This happens without participation of centralized management of BS. For clusters life prolonging and consequently of network as a whole, protocols are used in which change of the heads in the group is laid.

Schedules awake-asleep are used for receiving and transmitting the information, i.e. switching on and off of the transmitter and the receiver. Transmission is accomplished only when there is a change of parameters of the reported by the sensor information

## 3. Conclusion

From what has been written up to now several important conclusions could be made.

Firstly it should be noted that Wireless sensor networks quickly find their application in different areas of surrounding life. Rational methods for increasing of their energy efficiency, duration, safety and so on are looked for.

In building wireless sensor networks with cluster topology energy efficiency is significantly improved because transmitted data to the final user is reduced many times. In this way of connecting network has high communication quality and high safety degree that makes it hardly vulnerable to external attacks.

All this prolongs network's life and makes it attractive for construction and utilization

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