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Smart Sensor Network using IoT Technologies

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Abstract: -During the modern times where we live in an environment surrounded by sensors which are designed to collect information on the basis of changes happening around them which are then processed to function in a way which eases our life. However, keeping all sensors in active state at all times keeps them operating at maximum performance which reduces their lifetime before which they need a replacement or a recharge; in a large network, the number of nodes is very high and therefore, it is nearly impossible to recharge then hence they are usually replaced. Here, we propose a system where a limited number of sensors will be kept in active state which will constantly sense the changes around them and after detecting an intrusive change, other remaining nodes will be sent a signal to turn themselves to active state. This type of system network design will ensure that the sensing load is equally distributed among all of nodes consisting in a network equally and most of the nodes are kept on standby mode to ensure maximum use of limited power supply of the nodes or sensors.

Index Terms: Sensor network, IoT nodes, Aloha Protocol, LoRa and LoRaWAN technologies, NB-IoT, efficiency, cluster of nodes, large sensor network.

1.INTRODUCTION:

Most of the times we use an advanced technology such as sensors or other automated technology which can work up to a great extent without human intervention. These type of devices helps in solving and saving a lot of human force and time involved which can be used in other productive ways but the other side of the coin often ignored is the efficiency in which these devices work. Since in more than half of these type of devices the main source of power is direct electricity,we often oversee how much power they are drawing compared to old and traditional devices, even if they are battery based which are made to be recharged after a regular intervals, their efficiency can be further improved to make the device work for even a longer period of time. In case of huge connected networks of interconnected nodes, the power consumption which can be reduced can impact a lot on the life of nodes before which they need a replacement or require a recharge. Consider a building for example here with over twenty floor and security sensors being installed in it like sound sensor, movement sensor, IR sensor and other different type of smart sensors which can detect an intrusion activity or a possible theft during the night times or whenever the owner of the building is not occupying it and need it's place to be kept secure and intact till he comes back and resumes his work. Same type of example can be applied to a normal home considering of only one or two floor but similar type of sensors being installed in the house to maintain the security against theft or intrusion. Usually, these nodes can detect an activity in their surrounding and alert the user and local authorities for support but more interestingly, these nodes form a network which can be used further to reduce the power consumption by these nodes on individual level. Consider a group of five IR sensor nodes to detect any intrusion in a corridor, now, instead of keeping five sensors in an active for the complete night for say, six hours, only one or two alternate sensors can be kept on to detect a speck of activity, these one or two sensors can be tweaked to detect even a more finer activity and once they detect any activity all other sensors will be turned to confirm or validate the intrusion and upon that, notify the local authorities and alert the owner.

Same set of scenario can be thought with other type of sensors like sound sensor or a larger group of network where different type of sensors can be coupled and only a few of them can remain in the active state to detect the first activity and after successfully detecting that all other sensors can be turned on to further validate it or take further actions on the report.

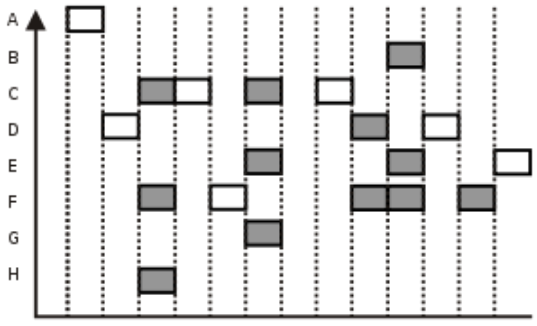
To achieve this type of networking where nodes can function according to the sensory behavior of other connected nodes, we can use technologies such as LoRa or LoRaWan where LoRaWAN is an extended version of the already existing LoRa technology. Low Power Wide Area Networking enables IoT devices including small nodes and central sync nodes to communicate, the reason behind the mainstream use of LoRa and LoRaWAN popularity is that supports a wide range of communication and networking settings such as cluster head or central base head LoRa/LoRaWAN has open source software support.

Moreover, to support a wide operating range, LoRa supports a number of communication settings based on physical layer parameters that can be modified and changed based on the needs, such as spreading factor (SF) which tells about the range in which the nodes and network will be spread, Bandwidth (BW) which tells about the operating frequency in which data and information will be transferred, transmission power(TP) which tells about the power consumption technique and algorithm , and code rate (CR). A simple LoRaWAN network con-

Sists of a protocols and gateways which define the network communication settings, other LoRa nodes, and a central server. However, a complex LoRaWAN network may comprise of multiple protocols and gateways. Usually, LoRa nodes form a network formation in a star topology to reduce the response times between nodes, and the gateway is connected to the server.

A simple Aloha protocol is used for information exchange and packet transmission in LoRaWAN networks. ALOHA is a system for coordinating and arbitrating access to a shared communication Networks channel. The original system used for ground based radio broadcasting, but the system has been implemented in satellite communication systems.

A shared communication system like ALOHA requires a method of handling collisions that occur when two or more systems attempt to transmit on the channel at the same time. In the ALOHA system, a node transmits whenever data is available to send. If another node transmits at the same time, a collision occurs, and the frames that were transmitted are lost. However, a node can listen to broadcasts on the medium, even its own, determine whether the frames were transmitted.



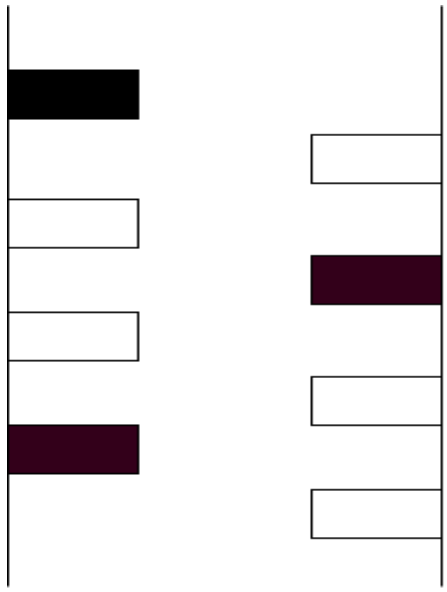
Slotted ALOHA protocol (shaded slots indicate collision)

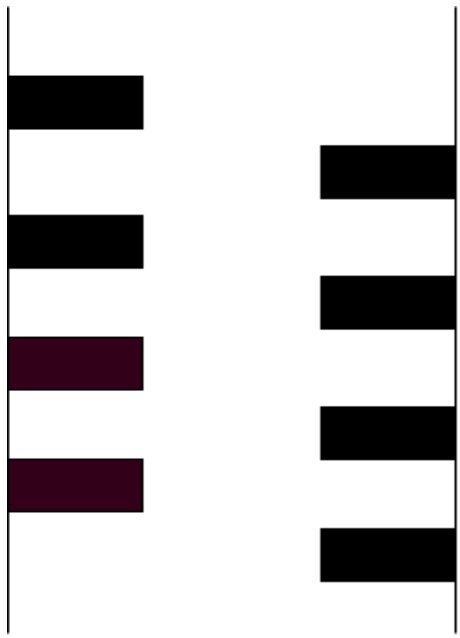
Aloha means "Hello". Aloha is a multiple access protocol at the data link layer and proposes how multiple terminals access the medium without interference or collision. The Slotted Aloha protocol involves dividing the time interval into discrete slots and each slot interval corresponds to the time period of one frame. This method requires synchronization between the sending nodes to prevent collisions. Before deploying a physical network in real world, network designers typically evaluate and simulate a particular network design, protocol parameters and different applications using a network simulator such as NS2 etc. A network simulator is a relatively inexpensive tool for design testing and evaluation, and it also gives an early overview into different aspects that can be critical regions a network design performance and needs some improvement. LoRaSim is currently the most widely used LoRa/LoRaWAN simulator. Physical application and network deployments consists of multiple IoT applications and areas, such as smart metering, smart parking, and street lighting and other methodologies in the smart city domain, all this using a single LoRaWAN network. Different IoT applications generate heterogeneous data and have variable quality of service requirements. Therefore, to safely operate the study of such multi-application use cases, we an extended version of LoRaSim is used that can simulate a LoRaWAN running multiple applications. Other methodologies include RPMA; For Internet of Things Machine to Machine

Communication, Random Phase Multiple Access is a method that is low power wide area channel. RPMA employs Direct Sequence Spread Spectrum for multiple accesses. In order to find clear signal at both device and network level, RPMA self modulates. This technology enables battery efficiency and maximum coverage unlike traditional cellular technologies. There is a special connection protocol deployed which pings the device, and device sends back which is used to check the status of device, after that the data is received and then connection is safely terminated to save battery life. Most of the IoT and M2M connections require high battery life and low quality if service dependency. Or, we can also use Narrowband – Internet of Things (NB-IoT); which is the latest way of communication that allows the transmission of small chunks of data for longer period of time to maximize the operation time of these small and almost irreplaceable nodes to remote places. NB-IoT technology falls into the category of Low Power WAN that is developed to handle wide range of services and devices of IoT. In deep coverage areas NB-IoT helps to significantly improve system capacity, power consumption of end-devices and spectrum capacity. It supports a longer battery life of years for a variety of use cases. This technology is specially designed to meet increasing demand for extended coverage like rural or indoor areas with ultra low device complexity. The cost of NB-IoT s comparable to GPRS/GSM. It is expected that the cost may decrease with increase in demand of the technology. Also that it is very simple than GPRS and GSM. It can be said that NB-IoT may coexist with 2G, 3G and $g networks of mobile if it is supported with all major equipment and chipset. All the mobiles network privacy and security features like authentication, integrity, authorization, confidentiality, device identification is advantageous to NB IoT as well.

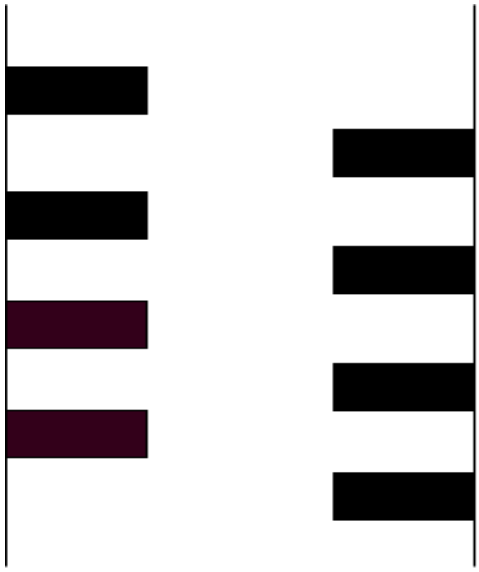
In the above diagram, the blocks represent the different kinds on nodes and the two parallel lines represent the boundaries, here, all nodes are turned off.

Here, all of the nodes deployed in the sensor network are in active state, i.e., turned on.





Here, the alternate or only few of the nodes are turned on to



active state which will detect the changes in the environment and upon that, they will act and turn they neighboring nodes from sleep state to active state.

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