A Comprehensive Survey on Wireless Sensor Networks

Pawnesh Kumar Pandey
Computer science and Engineering
ITM University, Gwalior
Gwalior, India

Kapil Sharma
Computer science and Engineering
ITM University, Gwalior
Gwalior, India

ABSTRACT: The purpose of this paper is to provide a summary of wireless sensor networks (WSNs). WSN has developed as one of the maximum encouraging technologies aimed at the prospect**.** WSN, a component of prevalent computing, is currently being utilized proceeding a big scale to observe real-time ecological status. Sensor nodes (SNs) may communicate done least distance by wireless medium & unite to achieving a single job. WSNs have developed one of the significant areas in the networking field. It is as sensors as related to others are cheaper, capable, smaller& adaptable. Paper offers a synopsis of WSN. This paper discussed the structure of WSN, Security Protocols, Storage management & application of WSN.

Keywords: WSN, security protocol, WSN structure, LEAP.

I. INTRODUCTION

A SENSOR NW is an assortment of a big no. of wireless sensing nodes that are spatially detached into a sensor field. SNs performance as information originators & NW transmits, and they may sense (measure), procedure information, & communicate by additional SNs. end-users of information or managers may before be up to create explanations and reply towards events into a specific atmosphere [1, 2, 3]. Wireless SNs are very small & most cost-effective. They may measure ecological circumstances or additional constraints comprising air quality, sound, temperature, humidity, &pressure& send that data towards a general base towards be managed properly

A WSN must be able to arrange a small no. of nodes that may be assembled & organized aimed at a common determination. WSN applications comprise, they are not limited to restricted area monitoring, rescue operations, disaster detection, intelligent cultivation& accurate, health care& medical, environmentally friendly heart buildings, object tracking, and traffic control. Instances of environmental monitoring & object tracking are towards monitor underground mines aimed at some trends towards confirming security and location of miners at every time. Organization of WSN at a lower cost than wired NW they may dynamically acclimatize towards variations into the environment in which they are organized & aggressively respond towards NW occasional variations. Important parts that create a WSN are;

- Sensor component
- Processor component
- Power source component
- Transceiver Actuators, analog to digital converters (ADC) and observer scan be added reliant on application.

Fig. 1 demonstrates many components that create a wireless SN.

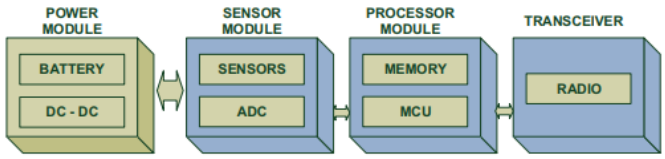

Fig.1 A structure of a WSN Node

Due to rapid development in the field of Information Technology (IT) & Integrated Circuit (IC), the improvement of cheap & compact SNs has evolved. WSN is an integral part of IoT; This environment creates billions of tools to share data to improve user control. WSN has many sensor nodes arranged in an ad hoc manner to monitor and interact with the whole world. Each sensor node has four components: sensor, microcontroller, power supply, and transceiver. In the sensing unit, sensors measure physical parameters like temperature, pressure, humidity, vibration, digit stick signal, infrared and vehicle speed in the real world (Estrin et al., 1997). The Interactive Value Processing Unit Process transmits the Single Base or Communication Unit to the Base Station (BS) via Intermediate Nodes (Anastasi et al, 2009). WSN is usually used to monitor real-time monitoring and applications such as military monitoring, agriculture, disaster management, health care, industrial automation and inventory control (Sohraby et al., 2007). WSN is generally organized in areas where human intervention is hard or incredible. [4]

II. WSN NETWORK STRUCTURE

Each SN has a sensing field that may understand events & objects in that range in WSN. Also, every node may communicate by additional nodes into the communication range of this node via the wireless node. Figure 1 demonstrates an assortment of sensors disseminated across an NW area for monitoring events, for example, event E in fig. Data collected after this event is transported towards BS by Multihop communication. BS sends NW information towards an application server on the Internet.

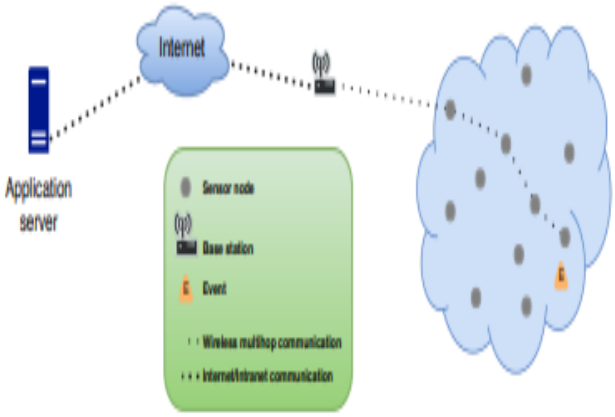

Fig. 2 A wireless sensor network

There are 2kinds of Wireless Sensor Networks [5] in unstructured and structured WSNs. Usually, structured WSN has low SNs& it is easy to manage. SNs are used decisively, that is, they determine the location of every node in advance. In indefinite WSNs, several sensors are organized provisionally. So, it is more difficult to deal with ensuing WSN. Control of WSN may be classified as decentralized, centralized or distributed control presented into Figure 2. By centralized control, NW has a global perception in a node & define seven if the node is active or not, that is node must be active or not. Nodes are distributed into groups, & every group has a central node with decentralized control. Interaction among nodes among every group defines the function of every node. In distribution control, there is no central control node, and every node relate by each other aimed at NW-wide decision-making, for example, describes an active node to cover the NW area.

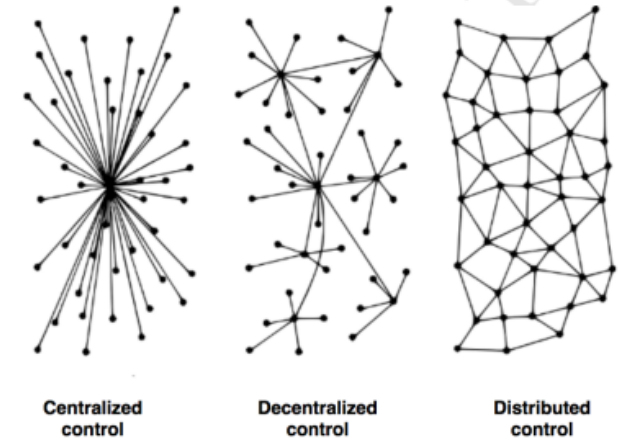

Fig. 3 Different control types for WSNs.

III. SECURITY PROTOCOLS FOR WSN

Adrian Perrig et. al. [6] suggested SPINS (Security Protocols into sensor NWs) protocol which is a suite of 2 protocols aimed at wireless sensor networks specifically SNEP & 3TESLA. SNEP concentrations proceeding integrity, data confidentiality & authentication although 3TESLA concentrations on authentication aimed at broadcast.

a) SNEP

SNEP (Secure NW Encryption Protocol) utilizes a common counter aimed at its operation, at end of a sender & at end of 2nd receiver. This converts plain text into a counter mode (CTR) with block ciphers to the ciphertext in SNEP. It utilizes a message authentication code (MAC) to gain integrity & authentication. The sender computes Mac & adds towards the original message. While the recipient accepts the message, it calculates Mac &associates it towards established mac, which will receive a message or reject message uncertainty it matches the message.

b) 3TESLA

Certified Broadcasting needs an asymmetric cryptographic system, which has a great computational and storage above, creating WSN unrealistic by with this system. This symmetry in 3TESLA presents a delayed key introduction. A base station (BS) utilizes a secret key to certify a packet by calculating a mac in the packet. Store packet into buffer up to a node accepts a packet by BS after it accepts the packet. While node accepts key, it utilizes the key to validate the packet. Key to key chain created by Public Key F is one of the keys in the Mac key. It calculates Key K through with Ki=F(Ki+1)

c) TINYSEC

TINYSEC is a link-layer security protocol (LLSP) that delivers every service delivered through SNEP. Key variance among TINYSEC & SNEP is that counter doesn't utilize TINYSEC aimed at cryptographic handling. TINYSEC has 2 flavors: TINYSEC-Auth& TINYSEC-AE. TINYSEC-AE offers encryption & authentication. Simply TINYSEC-provides authentic authentication. It utilizes cyber block chaining aimed at encryption & authentication.

d) MiniSec

Minic is a network layer protocol that uses less power. It utilizes Offset Codebook (OCB) mode to delivering encryption on packets. MiniSec has 2 operating modes that is MiniSec-U & MiniSec-B. Now Minsk-U is a unique mode & Minsk-B is a broadcast mode. MiniSeq-B &MiniSeq-U counter is different in how to use it.

e) LEAP

LEAP (Localized Encryption and Authentication Protocol) is a main exclusive protocol aimed at wireless sensor networks. LEAP is intended to delivering authentication & confidentiality. [6]

IV. ROUTING IN WSN

Sensory, computational power, communication capability & power are classified in a sensory element node. These nodes can communicate with each other to find data directly or with additional intermediate nodes. So, high sensory element performances as a router in every node NW in NW. In the Direct Communication Path Protocol, every sensing element may communicate directly by node &BS. BS may communicate by end-user directly or by certain remaining NW. The topology of sensing element NW often variations. In the case of direct communication, the distance among sensing element nodes &BS is very good, then sensors consume energy & developed inactive. An additional method, knowledge leads towards BS by an intermediate node, hence saving node energy. The routing protocol (RP) may be a protocol that says how router interconnects by each other, scattering data that permits to choose routes among any 2 nodes in NW, & route selection by routing algos does. [8] Dynamic routing agrees on routing tables on routers, since available routes may revolution. In the case of wireless

sensing element NWs, dynamic routing is generally utilized as nodes change their location & die at any instant. Therefore, disadvantages & advantages of wireless sensing component NW may be précised as ensues:

- NW setups are composite.
- Ideally aimed at non-reachable places as across mountains, ocean, deep forests or rural areas.[9]

V. STORAGE MANAGEMENT IN WSN

The storage management sensor is an expanse of NW analysis that is starting towards attracting the consideration of researchers. Aimed at storage management, information-composed through sensors is not communicated towards the sink aimed at a restricted period. In some applications, data must be stored concisely on NW until the sink is stored. So, in addition to storage energy, it develops a primary source, which defines scheduling & coverage of NW. Trends that encourage essential aimed at storage management have conversed device aspects& several resource limits that may move planning of storage management methods in sensor NW [10]. Also, storage management is distributed into various modules: (1) system help aimed at storage management; (2) Cooperative purchase; (3) Collections. A purchase management method must be a balance of consequent aims:

- Minimize Size of stored data:

As sensors have classified storage accessible towards them, reducing dimensions of data that need to retain ends up into developed exposure since NW will remain to store information aimed at protracted periods & develops further economic uncertainty data size is short [11].

- Minimize Energy Consumption:

The maximum sensors area unit is battery-powered and subsequently, energy might be an occasional resource, therefore storage management could be energy effective.

- Maximize data Retention or Coverage:

Combined data is the main objective of NW. Uncertainty storage is precious, data re-allocation must be useful proficiently to confirm coverage aimed at novel information. Management protocol ought to design towards recollect applicable data at an adequate quality level.

VI. APPLICATIONS OF WSN

WSNs are comprising of a big no. of SNs by restricted-energy resources. The main objective of the WSN is to gather data precisely & economically [12]. Development of WSN was moved through applications for example target tracking, crime investigation, greenhouse monitoring, aircraft control [13], & marine environment monitoring [14]. WSN has extensive kind of applications like medical and agriculture applications, industrial applications and so more. Some of them are the following:

- Health care observation
- Area observation
- Forest fire detection
- Environmental or Earth sensing
- Machine health observation
- Landslide detection
- Structural Health observation
- Water quality observation
- Data logging

VII. LITERATURE REVIEW

B. Liu et al. [15] Paper node suggest an RBF-based cross-application energy savings system aimed at WSNs towards control node energy consumption. Calculation of cluster center is built proceeding neural network (NN) radial base function with K-means clustering self-adjusted algo. Arrange & improve at Least Mean Square algo (LMSA) into Cluster Center Wet Matrix towards recognizing data fusion. Outcomes of simulation test display that when some rounds consumption of node may be significantly decreased. WSN node processing is controlled & it is hard to change its power. But a practical point is how to decrease energy consumption efficiently.

F. Jiet al. [16] This paper focuses on the issues of localization of distributed nodes in the conventional WSN. A following particle swarm optimization (PSO) developed node localization method is proposed to support the least square vector regression model.

S. Kumar et al. [17] Clustering is one of the most significant jobs in WSN, in which nodes are selected as of any node like a cluster head (CH), whereas CH sustains the main function & accomplishes others. In WSN, the detection of malicious nodes is a significant job, therefore malicious nodes may not ever be CHs. Furthermore, when no. of malicious nodes escalations, the likelihood of malicious nodes becoming a CH escalation. To identify malicious node &towards select high potential node aimed at CH, we mention that PSO based malicious node detection &CH selection methods.

M. Tayet al. [18] In this study, the most frequent clustering algos into literature are included 7 these algos are compared based on certain metrics. As a result of the comparison, advantages and disadvantages of clustering algorithms are indicated. Wireless Sensor Networks (WSN) always need energy as a part of the areas they are used to. Therefore, they must use their energy most efficiently. One of the most important roles in ensuring energy efficiency for the WSN is creating clusters between sensor nodes. Choosing the most appropriate sensor node as Cluster Head (CH) among the clustered sensors according to the predetermined criteria decreases the energy consumption.

A. A. Shaikhet al. [19] suggest a clustering algo with spatial correlation, which is altered after additional clustering algos in this paper. Groups are focused on a set of SNs using specific reads, namely, it is enough to report single readings after complete group, which decreases energy consumption & escalations NW life. Among a set of nodes, a node was designated such a CH with the centroid technique. SN was selected such CH at the shortest distance as of cluster centroid point. So, with spatial correlation, clustering may decrease residual energy, increase NW performance, increase NW life, & reduce network traffic.

VIII. CONCLUSION

This survey accessible an overview of WSNs. research in WSNs is most dynamic, and there are high prospects concerning applications and business probable of sensor NWs. Wireless

Sensor Network is a capable prospect technology & currently utilized in a range of applications that needs least human involvement. Survey defined Structure, generations, Routing & storage management of WSNs. Applications areas of WSNs are similarly defined in this paper.

REFERENCES

[1] K. Akkaya, M. Younis, A survey on routing protocols for wireless sensor networks, Ad Hoc Netw. 3 (3) (2005) 325–349., pp. 871–872.

[2] K. Sohrabi, D. Minoli, T. Znati, Wireless Sensor Networks, 2007. EBSE, 2007.

[3] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, Wireless sensor networks: a survey, Comput. Network. 38 (4) (2002) 393–422.

[4] A.M. Zungeru, L.-M. Ang, K.P. Seng, Classical and swarm intelligence based routing protocols for wireless sensor networks: a survey and comparison, J. Netw. Comput. Appl. 35 (5) (2012) 1508–1536.

[5] H. M. Ammari, A. Shout, F. Mustapha, Sensing coverage in threedimensional space: A survey, Handbook of Research on Advanced Wireless Sensor Network Applications, Protocols, and Architectures (2016).

[6] Adrian Perrig, Robert Szewczyk, David Culler, and J.D.Tygar, "SPINS: Security protocols for sensor networks", In 7th Annual ACM International Conf on Mobile Computing and Networks-MobiCom 2001, July 2001.

[7] Sushruta Mishra, Hiren Thakkar, " Features of WSN and Data Aggregation Techniques in WSN: A Survey," International Journal of Engineering and Innovative Technology (IJEIT) Vol. 1, Issue 4, pp:264-273, April 2012.

[8] ParulBakaraniya, Sheetal Mehta, "Features of wsn and various routing techniques for wsn: a survey," International Journal of Research in Engineering and Technology, Vol. 1, Issue 3, pp: 349- 354, Nov-2012.

[9] Liu Yong-Min, Wu Shu-Ci, Nian Xiao-Hong, " The Architecture and Characteristics of Wireless Sensor Network," International Conference on Computer Technology and Development, ICCTD '09, Kota Kinabalu, 13-15 Nov. 2009, pp: 561 – 565.

[10] T. A. Almeida, Gao Weimin, Zhu Lingzhi, "Distributed Data Storage in Wireless Sensor Networks," International Journal of Database Theory and Application, Vol.8, No.4, pp.179-182, 2015.

[11] A.K. Luha, T. Vengattraman, M. Sathya, "RAHTAP Algorithm for Congestion Control in Wireless Sensor Network," International Journal of Advanced Research in Computer and Communication Engineering, Vol 3, Issue 4, pp: 6250-6255, April 2014.

[12] H. Bagci, A. Yazici, "An energy-aware fuzzy approach to unequal clustering in wireless sensor networks," Applied Soft Computing, Vol. 13, No. 4, pp: 1741-1749, April 2013.

[13] IstvanMatijevics, "Advantages of wireless sensor networks in a greenhouse environment," 7th International Symposium on Intelligent Systems and Informatics, SISY '09, IEEE, Subotica, 25- 26 Sept. 2009, pp: 155 – 159.

[14] R.K. Yedavalli, R. K. Belapurkar, "Application of wireless sensor networks to aircraft control and health management systems, " Journal of Control Theory and Applications, Vol. 9, No. 1, pp: 28- 33, 2011.

[15] B. Liu, "An Energy Consumption Control Scheme Based on Radial Basis Function in Wireless Sensor Networks," *2019 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS)*, Changsha, China, 2019, pp. 161-164

[16] F. Ji, J. Tian, Y. Xu, H. Rong, X. Mu and Y. Wang, "A wireless sensor network localization algorithm based on particle swarm optimization aided least square support vector machine," *2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC)*, Chengdu, China, 2019, pp. 2290-2293.

[17] S. Kumar and S. Mehfuz, "A PSO Based Malicious Node Detection and Energy Efficient Clustering in Wireless Sensor Network," *2019 6th International Conference on Signal Processing and Integrated Networks (SPIN)*, Noida, India, 2019, pp. 859-863.

[18] M. Tay and A. Senturk, "Energy-Aware Clustering Algorithms Used in Wireless Sensor Networks," *2019 Scientific Meeting on Electrical-Electronics & Biomedical Engineering and Computer Science (EBBT)*, Istanbul, Turkey, 2019, pp. 1-4.

[19] A. A. Shaikh and D. J. Pete, "Spatial Correlation and Centroid Based Clustering in Wireless Sensor Network," *2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA)*, Pune, India, 2018, pp. 1-5.

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