Improved QoS by Clustering Identically Modulated WSN Nodes using Reprogrammable High Speed Architecture

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ABSTRACT
A technique for grouping different modulation schemes in a nodal management network (by clustering identically modulated nodes) is presented in this paper. The modulation tracking scheme localizes a specific node (allocated with a unique, but dynamically varying modulation scheme). The clustering mechanism to group the identical nodes exists intrinsically. The proposed modulation identification scheme and clustering mechanism are implemented using high speed architectures and the performance of the proposed approach is validated for multiple modulation scenarios.

Keywords: Modulation identification, Clustering, High speed architecture, reconfigurable i/o interfaces.

1. INTRODUCTION
In this paper, a generic framework is constructed for grouping similar nodes in a network. The framework provides an appropriate abstraction of specific detection mechanisms, and models the unique properties of modulation techniques. Based on the framework, different modulation schemes can coexist. The proposed work assures that corresponding nodes can collude at will. The results show that, this work is optimal in the sense that it identifies the largest number of corresponding nodes with minimal false positives. Grouping of various nodes into clusters has been vital to support some design objectives like scalability, energy saving, etc. Clustering aims at discovering groups and identifying the corresponding nodes. Clustering techniques for wireless communication proposed in the literature can be generally classified based on the overall network architectural and operation model and the objective of the node grouping process include the desired count and properties of the generated clusters.

In the clustering process, there are no predefined classes and no examples that would show what kind of desirable relations should be valid among the data (unsupervised process) [8,19]. On the other hand, classification is a procedure of assigning a data item to a predefined set of categories. Clustering produces initial categories in which values of a data set are further classified during the classification process.

Previous works [1,2] have tried to develop intelligent receivers that are capable of identifying the incoming modulation scheme and reconfigure themselves accordingly. However, these architectures support only a very limited number of constellations, thus limiting both generality and performance [13-15]. For nodal management in a network, modulation identification and clustering mechanism are employed. In a communication network, several nodes are connected together randomly. While transmitting data to the receiver, the modulation selector selects the appropriate modulation scheme. At the receiver, a modulation tracker tracks and recovers the data sent by the transmitter. The modulation tracking scheme is also used to identify a specific node allocated with a unique but dynamically varying modulation scheme. The parameters used to identify the modulation include Signal Strength and Average response time. On completion of modulation tracking performance, clustering mechanism is performed. This can be adapted by identifying the identical nodes in the network, where the node address can differ from each other. The nodes with varying node address in a communication network are classified as active node and idle node. The active node undergoes node scanning process before transmission of data. The identical nodes which perform same type of modulation are clustered together and handled [16].

2. RELATED WORK
In this section, literature survey of various published clustering algorithms for wireless networks is presented. The observed parameters include efficient utilization of communication bandwidth within the clusters, avoiding redundant message transfer between the nodes, localizing energy efficient route setup within the clusters, reduction in energy consumption, etc. [1], [2] made an analysis that reliable routing of packets from nodes to its base station is the most important task for the networks. Routing in wireless networks is bit more complex than other wired networks. The conventional routing protocols cannot be used due to its battery powered nodes. To support scalability, energy efficiency and efficient routing, nodes are often grouped into non-overlapping clusters. The survey of different distributed clustering algorithms (adaptive clustering algorithms) based on some metrics such as cluster count, cluster stability, cluster head mobility, cluster head role, clustering objective and cluster head selection is done. [3] proposed an adaptive digital receiver architecture suitable for Software Defined Radio systems. This receiver is prepared to handle modulation schemes whose symbols belong to a linear, two dimensional signal space (such as M-PSK or M-QAM). It is capable of identifying key signal parameters (e.g., symbol rate and constellation) and, in an autonomous way, modifies its operation accordingly. Four aspects of self reconfiguration are addressed: baseband filtering, symbol synchronization, carrier synchronization and constellation recognition. The performance of the receiver is evaluated based on simulation results, and several usage scenarios for the proposed architecture are envisaged. [4] described that nodes may be part of several paths, and therefore nodes closer to the sinks may consume higher amounts of energy. This fact is the chief motivation, where modulation scaling over the nodes with more energy is performed in order to increase the lifetime of the nodes having lower energy reserves. Simulation results showed typical values of path lifetime expectancy of 50 to 120 percent higher than comparable power-aware methods.

[5] Chosen a time-interleaved architecture, with four FLASH channels each running at 1 GHz using offset clocks. The

desired resolution was achieved through careful device sizing in the preamplifier and comparators rather than relying on complex calibration schemes. Testing at the full designed speed was not possible due to problems with the on-chip test interface but these have been identified. They demonstrated the problem of high-speed data conversion for digital UWB receivers tractable in CMOS within a reasonable power budget. [6] Considered that nodes are often grouped into disjoint and mostly non-overlapping clusters to support scalability. They presented a taxonomy and general classification of published clustering schemes for different clustering algorithms. Comparison was done based on the clustering algorithms for the metrics such as convergence rate, cluster stability, cluster overlapping, location awareness and support for node mobility.

The focus of this paper is to achieve high information assurance for wireless network applications. Several approaches have been proposed to detect and tolerate false information from corresponding nodes through sampling and redundancy. But they lack mechanisms to accurately identify corresponding nodes and perform various modulations, which is the focus of this paper.

3. PROPOSED SCHEME

The clustering of the nodes is performed in the following stages:

Step 1: To classify a group of transmitting nodes into “Active” and “Idle” groups, as shown in figure 1.

Step 2: Among given range of Node address, identify whether the nodes is live

Step 3: Perform”Node scanning”.

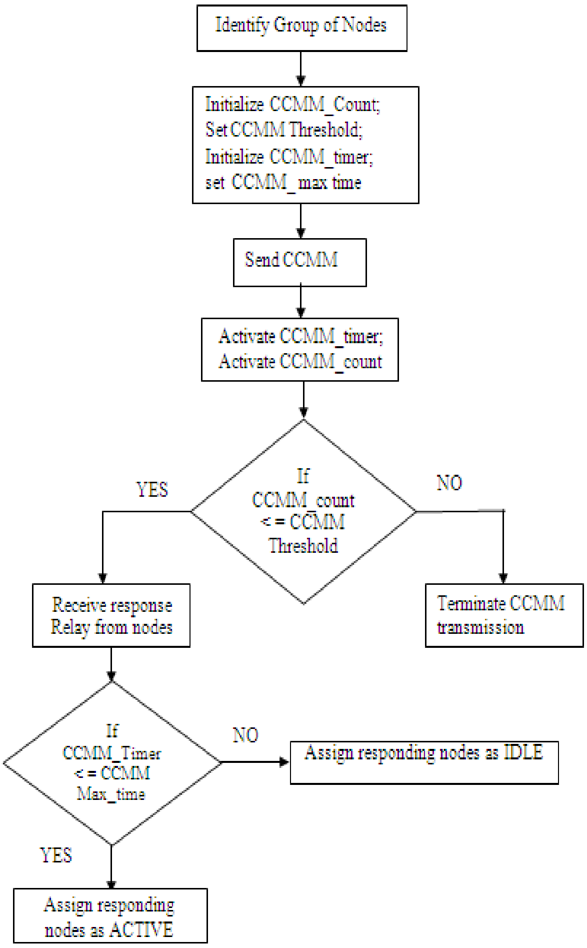

Fig. 1 Flow chart for node address identification

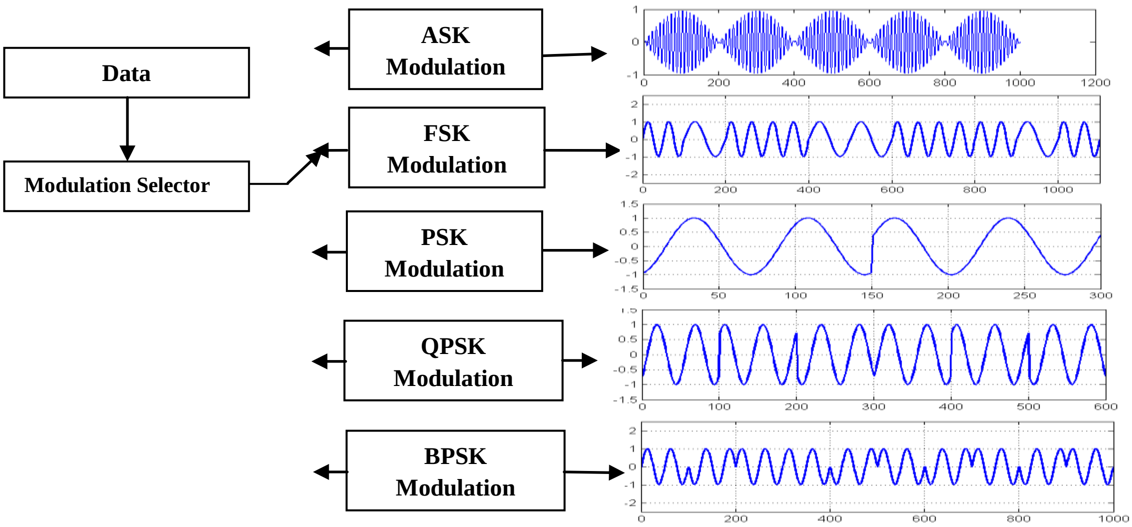

Fig. 2 Block diagram of transmitter

Note: CCMM-Communication and Control Message Management

4. EXPERIMENTAL SETUP

When a data is to be transmitted over the wireless network, the modulator selector selects the appropriate modulation scheme from the different kinds of modulations so as to maintain uniform signal to noise ratio and compensates channel effects [18].

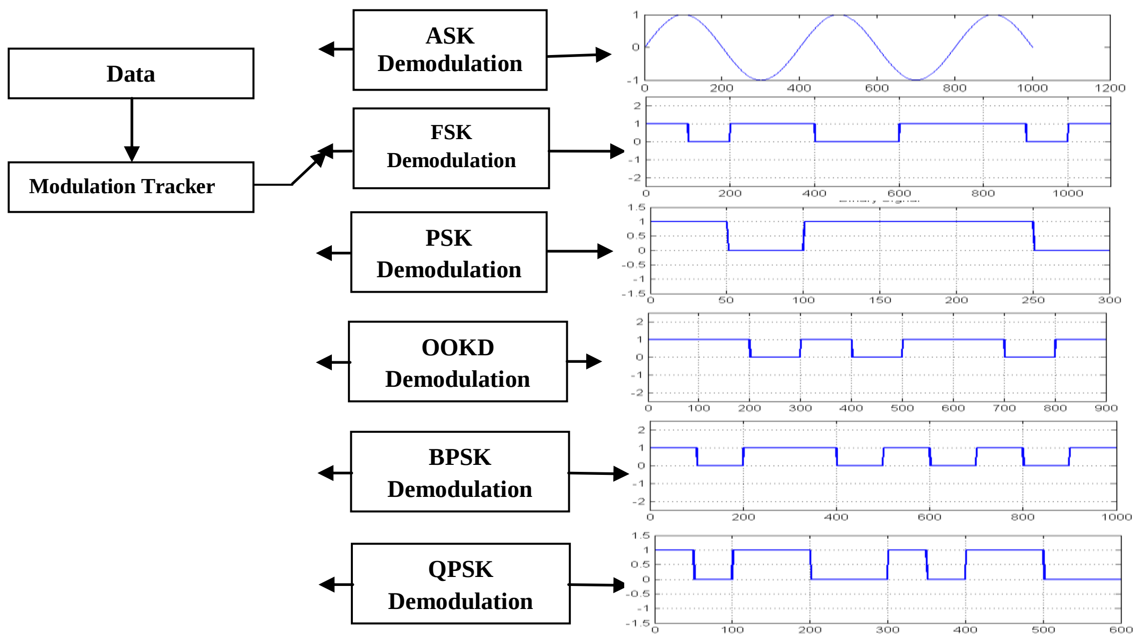

Fig. 3 Block diagram of Receiver

Such as ASK modulation, FSK modulation, PSK modulation, QPSK modulation and BPSK modulation. Individual data can choose their own appropriate modulation best suited for transmission through wireless medium. The data must be transmitted error-free and at low signal to noise ratio with acceptable signal strength.

When a data is to be received over the wireless network, the modulator tracker selects the appropriate demodulation scheme from the different kinds of demodulations such as ASK, FSK, PSK, QPSK and BPSK. The error free data received by the receiver

4.1 REAL TIME STUDY

In the chosen communication network, the data is to be transmitted through the nodes in an optimal pathway [17]. Based on the performance of the different modulation scheme, the lane can differ and travel accordingly. The experimental setup consists of fifty nodes, with hardware set up compatible for Zedex board with Matlab/GUI support with Linux OS. High speed links for interconnects with user programmable modulation schemes for a wide range of channel modeling is also supported. The data can be modulated in one of the possible six modulation schemes namely (i) ASK, (ii) FSK, (iii) PSK, (iv) OOKD, (v).QPSK, (vi) BPSK. Figure 4 shows the eight communication nodes clustered together based on identical modulation scheme. The optimal path through which the data is transferred from S1 to S2 is also shown i.e., S1→S4→ S6→ S7→ S3→ S8→ S5→ S2. The path is chosen

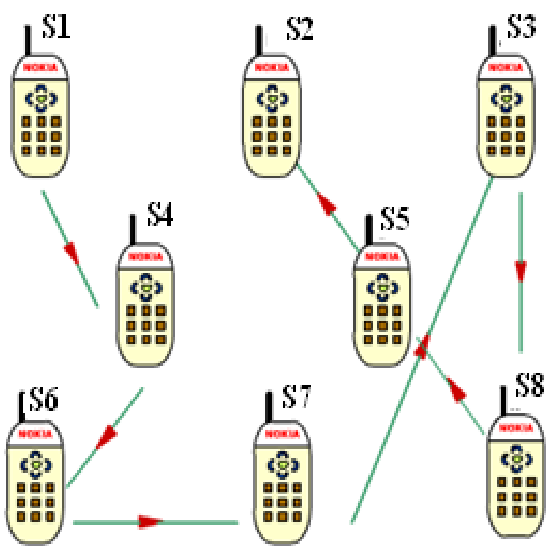

Fig. 4 Connectivity between all mobile nodes

5. RESULTS AND DISCUSSION

Case (i)

Based on the connectivity of various nodes in a communication network, they are clustered according to the modulation schemes performed. While transmission, the active node alone sends data to the receiver. The modulation selector envelopes all the carried signals and selects any one of the specialized modulation schemes such as ASK, FSK, PSK, QPSK and BPSK etc., The node with different node address provides the average response time and they are clustered in accordance to the various modulations performed. For study, 22 nodes are used (S1 to S22) and they perform different modulations depending on the channel conditions. For example the nodes that undergo ASK modulations are S1, S2, S3, S4, S5, S6, S7, S8, S10, S15, S17, S18, S19, S20 and S22 and are clustered together and named as node label A. Then the two identical nodes S9 and S11 performs FSK modulation are clustered together and named as node label B. Nodes S14 and S16 performs PSK modulation are clustered and named as label C. Nodes S12 and S13 performs QPSK modulation are clustered and named as label D. Node S21 alone performs BPSK modulation and named as label E. The individual and Partitioned Nodes details are shown in table 3, table 4 and figure 5.

Table 3 Node ID's Modulation type table

Node Address	Avg. Res. Time	Losses	Modulation Type	Nodes
172.16.15.70	0.00 ms	0.00%	ASK Modulation	S1
172.16.15.71	0.00 ms	0.00%	ASK Modulation	S2
172.16.15.119	0.00 ms	0.00%	ASK Modulation	S3
172.16.15.121	0.00 ms	0.00%	ASK Modulation	S4
172.16.15.144	0.00 ms	0.00%	ASK Modulation	S5
172.16.15.150	0.00 ms	0.00%	ASK Modulation	S6
172.16.15.151	0.00 ms	0.00%	ASK Modulation	S7
172.16.15.154	0.00 ms	0.00%	ASK Modulation	S8
172.16.15.179	0.50 ms	0.00%	FSK Modulation	S9
172.16.15.186	0.00 ms	0.00%	ASK Modulation	S10
172.16.15.193	0.50 ms	0.00%	FSK Modulation	S11
172.16.15.194	1.50 ms	0.00%	QPSK Modulation	S12
172.16.15.195	1.50 ms	0.00%	QPSK Modulation	S13
172.16.15.198	1.00 ms	0.00%	PSK Modulation	S14
172.16.15.200	0.00 ms	0.00%	ASK Modulation	S15
172.16.15.201	1.00 ms	0.00%	ASK Modulation	S16
172.16.15.203	0.00 ms	0.00%	PSK Modulation	S17
172.16.15.212	0.00 ms	0.00%	ASK Modulation	S18
172.16.15.249	0.00 ms	0.00%	ASK Modulation	S19
172.16.15.251	0.00 ms	0.00%	ASK Modulation	S20
172.16.15.253	3.00 ms	0.00%	ASK Modulation	S21
172.16.15.254	0.00 ms	0.00%	BPSK Modulation	S22

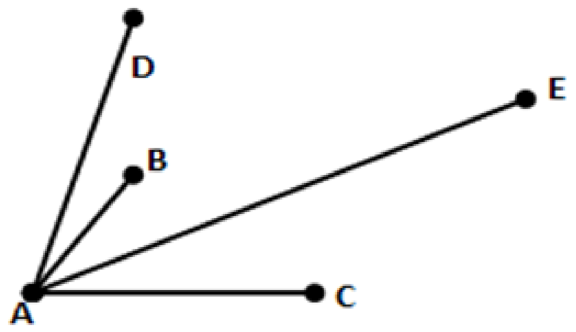

Fig. 5 Clustered Nodes after first scan (based on similar modulation type)

Table 4 Partitioned Nodes Clustered together

Node Label	Nodes
A	S1,S2,S3,S4,S5,S6,S7,S8,S10,S15,S16,S18,S19,S20,S21
B	S9,S11
C	S14,S17
D	S12,S13
E	S22

A: ASK; B: FSK; C: PSK; D: QPSK; E: BPSK;

Case (ii)

Table 5 Node ID's modulation type table

Node Address	Avg. Res. Time	Losses	Modulation Type	Nodes
172.16.15.70	0.00 ms	0.00%	ASK Modulation	S1
172.16.15.71	0.00 ms	0.00%	QPSK Modulation	S2
172.16.15.119	0.00 ms	0.00%	BPSK Modulation	S3
172.16.15.121	0.00 ms	0.00%	PSK Modulation	S4
172.16.15.144	0.00 ms	0.00%	ASK Modulation	S5
172.16.15.150	0.00 ms	0.00%	ASK Modulation	S6
172.16.15.151	0.00 ms	0.00%	FSK Modulation	S7
172.16.15.154	0.00 ms	0.00%	ASK Modulation	S8
172.16.15.179	0.50 ms	0.00%	FSK Modulation	S9
172.16.15.186	0.00 ms	0.00%	ASK Modulation	S10
172.16.15.193	0.50 ms	0.00%	FSK Modulation	S11
172.16.15.194	1.50 ms	0.00%	FSK Modulation	S12
172.16.15.195	1.50 ms	0.00%	PSK Modulation	S13
172.16.15.198	1.00 ms	0.00%	ASK Modulation	S14
172.16.15.200	0.00 ms	0.00%	FSK Modulation	S15
172.16.15.201	1.00 ms	0.00%	ASK Modulation	S16
172.16.15.203	0.00 ms	0.00%	ASK Modulation	S17
172.16.15.212	0.00 ms	0.00%	FSK Modulation	S18
172.16.15.249	0.00 ms	0.00%	PSK Modulation	S19
172.16.15.251	0.00 ms	0.00%	FSK Modulation	S20
172.16.15.253	3.00 ms	0.00%	ASK Modulation	S21
172.16.15.254	0.00 ms	0.00%	OOKD Modulation	S22

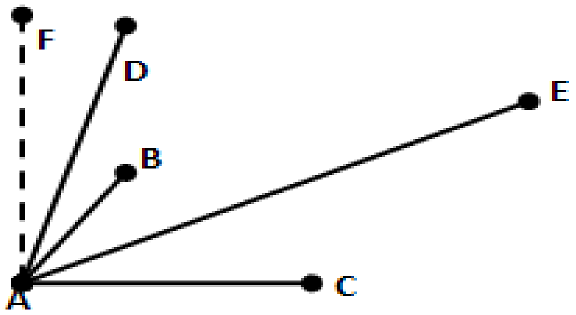

Fig. 6 Clustered Nodes after second scan

Table 7 Host Nodes Clustered Together (2nd Scan)

Node Label	Nodes
A	S1,S5,S6,S8,S10,S14,S16,S17,S21
B	S7,S9,S11,S12,S15,S18,S20
C	S4,S13,S19
D	S22
E	S3
F	S2

A: ASK, B: FSK, C: PSK, D: OOKD, E: BPSK, F: QPSK

6. CONCLUSION

The node management provides overall trustworthiness in the network by the appropriate selection of modulation scheme as the corresponding nodes are clustered together. The results show that such an optimal modulation scheme can lead to the effective transmission of data over the complete wireless network. The work is ideally suited for designing MIMO system with high speed reconfigurable I/O interfaces. Performance metrics suited for clustered MIMO systems is also presented. Our work deliberates in precise identification of corresponding active nodes in the cluster and on authenticating multiple modulation scenarios. Our future work concentrates in a more specific analysis and implementation of various clustering algorithms under different modulations.

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7. REFERENCES

[1]. S.R.Boselin Prabhu, "A Survey of Adaptive Distributed Clustering Algorithms for Wireless Sensor Networks", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.2, No.4, pp.165-176, India, November 2011

[2]. Mary Mathews , Min Song, Sachin Shettyc, Frederic D. McKenzied, "An Anomaly-based Algorithm to Detect Compromised Nodes in Wireless Sensor Networks", 8th ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing(SNPD 2007),Vol.1, pp273-278, 2007

[3]. Rachsuda Jiamthapthaksin, Christoph F. Eick, and Vadeerat Rinsurongkawong, "An Architecture and Algorithms for Multi-Run Clustering", IEEE Symposium on Computational Intelligence and Data Mining, CIDM 2009, Vol.1, pp.306-313, Nashville, TN, USA, April 2, 2009.

[4]. Henrique C. Miranda, Pedro C. Pinto, Sérgio B. Silva, "A self-reconfigurable Receiver Architecture for Software Radio Systems". Radio and Wireless conference, RAWCON'03, pp.241-244, August 2003.

[5]. Raúl Malavia Marín, "A pragmatic Approach to Modulation Scaling Based Power Saving for Maximum Communication Path Lifetime in Wireless Sensor Networks", Thesis of Master of science of Electronics, Norwegian University of Science and Technology, June 2008

[6]. Hai Xu, Hee-Jun Kim and Won-Sup Chung, "Experimental Identification Method for Small-Signal Analysis of Smart Power ICS", IEEE Transactions n industrial electronics, Vol. 57, No. 6, pp.2142-2150, June 2010.

[7]. Lin Xu, Noam Ophir, Michael Menard, Ryan Kin Wah Lau, Amy C. Turner-Foster, Mark A. Foster, Michal Lipson, Alexander L. Gaeta, and Keren Bergman, "Simultaneous wavelength conversion of ASK and DPSK signals based on four-wave-mixing in dispersion engineered silicon waveguides "OPTICS EXPRESS", Vol. 19, No. 13, pp.12172-12179, June 2011

[8]. Ameer Ahmed Abbasi a, Mohamed Younis, "A survey on clustering algorithms for wireless sensor networks" Published by Elsevier Computer Communications, Vol.30,pp. 2826–2841, June 2007

[9]. Puneet Prashant Newaskar, "High-Speed Data Conversion for Digital Ultra-Wideband Radio Receivers" Submitted to the requirements for the degree of Master of Science in Electrical Engineering and Computer Science at the Massachusetts institute of technology, June 2003

[10]. Parul Agarwal,M. Afshar Alam, Ranjit Biswas, "Issues, Challenges and Tools of Clustering Algorithms", International Journal of Computer Science Issues, (IJCSI) Vol. 8, Issue 3, No. 2,pp.523-528, May 2011

[11]. CH.Nagarjuna Reddy, Mrs. B.R.Sujatha "TDOA Computation Using Multicarrier Modulation for Sensor Networks", International Journal of Computer Science & Communication Networks, Vol 1(1),pp. 85-90, September-October 2011

[12]. Liang CHEN, Jun'an LU, "Cluster synchronization in a complex Dynamical network with two Non identical clusters", Jnl. Syst Sci & Complexity, Springer Science/ Business Media, LLC, pp. 20-33. 2008

[13]. Matthew J. Sottile Ronald G. Minnich, Supermon: "A high-speed cluster monitoring system", IEEE International Conference on Cluster Computing, pp.39-46, 2002.

[14]. S.B. Kotsiantis, P. E. Pintelas, "Recent Advances in Clustering: A Brief Survey", Journal of WSEAS Transactions on Information Science and Applications, pp.73-81, 2004

[15]. Daniel Bielefeld, Gernot Fabeck, Rudolf Mathar, "Power allocation and node clustering for Distributed detection in IR-UWB sensor networks", VTC fall-2009, IEEE,Vol-1,pp.978-982

[16]. Jakob R. Olesen, Jorge Cordero H., and Yifeng Zeng, "Auto-Clustering Using Particle Swarm Optimization and Bacterial Foraging" Springer-Verlag Berlin Heidelberg, pp. 69–83, 2009.

[17]. Jyotirmoy Karjee, HS Jamadagni, "Data accuracy model for distributed clustering algorithm based on spatial data correlation in wireless sensor networks", Computer Science and Telecommunications, pp.13-27, October 2012

[18]. Jeffrey Dean and Sanjay Ghemawat, "MapReduce: Simplified data processing on large clusters", Journal of Communications of the ACM, pp.107-113, Jan 2008.

[19]. Yan Li, Li Lao & Jun-Hong Cui, "SDC: A Distributed Clustering Protocol ", International Journal of Computer Networks, (IJCN), Vol.2:pp.205-226, 2011

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