Statistical Analysis and Control of Atmospheric Parameters Using Wireless Sensor Network for Human Comfort

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Abstract - *In any closed environment containing humans, a safe atmosphere is critical requirement. Temperature, light and humidity determine comfort in such closed environments like malls, meeting halls, industrial workplaces, etc. Departures from satisfactory conditions can reduce efficiency and may have harmful health effects. In this paper the atmospheric parameters will be monitored and controlled by the wireless sensor nodes and statistical analysis of collected data will be performed at centralized coordinator.*

The system consists of a Wireless Sensors Network including a centralized coordinator and two sensor nodes. Centralized coordinator collects the information from all other nodes and sends it to the monitoring PC where real time data can be viewed and data storage can be done. Sensor nodes communicate with centralized node using Zigbee which is low cost and ultra low power consumption standard for wireless radio networks in monitoring and control fields. Sensor nodes collect the local data and take the control action accordingly. Relays connected to the two wireless sensor nodes are used to turn on lights, ceiling fans and exhaust fans thus maintaining healthy atmospheric conditions.

Key Words: Wireless Sensors Network, Zigbee, Control action, Healthy atmospheric conditions.

1. INTRODUCTION

There are many fatal accidents due to suffocation in crowds. Small children and senior citizens suffer a lot in such unhealthy situations. Maintaining healthy and safe environment at all public places where crowds are possible is a crucial requirement. In closed environments for example like queues of devotees in queue building of temple; in festival of ramnavmi or holidays the people visiting the temple reaches in lakhs. When so many people come together the CO_2 exhaled and the temperature level rises to a level causing suffocation. This atmosphere can be maintained safe by maintaining proper ventilation by using ceiling or exhaust fans and proper lighting conditions. The closed environments like malls, meeting halls, airports, etc are quite large in size hence the sensing systems are to be placed at several locations and accordingly decisions for different locations will differ according to the crowd. This is possible by using Wireless Sensor Network and a central coordinator system.

Temperature, light and humidity determine comfort in such closed environments like malls, meeting halls, industrial workplaces, etc. The World Health Organisation recommends a maximum of 24 degrees Celsius for working in comfort. Humidity is the amount of moisture in the air; at saturation point the relative humidity is 100%. Low levels of humidity can exacerbate respiratory and skin conditions. There may be a build up of static electricity in dry air leading to electrostatic shocks. There is no specific legislation dealing with humidity. Generally the relative humidity should be between 40% and 70%. If there is a problem with humidity it tends to be because it is too low and the air feels 'dry'. Fresh air is need respiration, to dilute and remove impurities and odours and to dissipate excess heat. Legislation requires that every enclosed workplace has effective and suitable ventilation, which provides a sufficient quantity of fresh or purified air. In many cases windows or other openings will provide sufficient ventilation. If they do not mechanical ventilation systems may have to be used. Replacement air should be as free of impurities as possible. Lighting should be sufficient to enable to work, use facilities and move about safely and without eye strain and other ill health effects. Legislation requires that every workplace has suitable and sufficient lighting and it shall, as far as it is reasonable practicable, be by natural lighting [1].

Departures from satisfactory conditions can reduce efficiency and may have harmful health effects. In this dissertation the atmospheric parameters will be monitored and controlled by the wireless sensor nodes and statistical analysis is performed at centralized coordinator. Statistical analysis provides us with data in

form of bar graphs about the particular location; the information is stored in text file and can be utilized for renovations, reconstructions and study.

2. LITERATURE REVIEW

Kollam & Shree in their IEEE paper named "Zigbee wireless sensor network for better interactive industrial automation" explained how industrial workplace atmosphere is monitored and controlled using WSN consisting intelligent sensor nodes connected to ARM 7 controller and centralized coordinator connected to ARM 9 controller [3]. In another IEEE paper by Yang Li,Ji Maorong,Gao Zhenru & ZhangWeiping named "Design of Home Automation System Based on Zigbee Wireless Sensor Network" they introduce zigbee technology in home automation system based on CC2430 chip and through experiment WSN is proved feasible and practical [4].

The paper by P.Naresh Kumar, Dr. N.S Murthy Sharma, Mr. M.S.Madhan Mohan & Mr. Dhana Raj named "Design and implementation of arm intelligent monitoring system using zigbee", explained the research method of laboratory intelligent monitoring system based on Zigbee is elaborated, and the hardware design and software design is discussed.Sensors controlling board collect the data to web server through Zigbee networks. These sensors automatically monitor the local environmental data and external material intrusion in the laboratory. Users can control the equipment in the lab through a web browser which is cross platform. The simulation results indicate that design of system is safe and convenient from local management of environmental data in laboratories [5].

G. V. Satyanarayana & S. D. Mazaruddin in their paper named "Wireless Sensor Based Remote Monitoring System for Agriculture Using ZigBee and GPS", proposed to design, develop and implement a wireless sensor network connected to a central node using ZigBee, which in turn is connected to a Central Monitoring Station (CMS) through General Packet Radio Service (GPRS) or Global System for Mobile (GSM) technologies. This system is expected to help farmers in evaluating soil conditions and act accordingly [6]. The system also obtains Global Positionting System (GPS) parameters related to the field and sends them to a central monitoring station. This system is expected to help farmers in evaluating soil conditions and act accordingly. Minal Nikose, Pratibha Mishra & Avinash Agrawal in their paper named "A Review On Industrial Automation By Zigbee Based Wireless Remote Controller", proposes a review on remote control system of smart appliances based on Zigbee wireless sensor network [7]. Status of the home appliances can be queried and controlled through the remote controller. The proposed work presents the design and implementation of a novel wireless sensor network based home security system with a modular self-reconfigurable remote controller.

Ashenafi Lambebo & Sasan Haghani in their paper "A Wireless Sensor Network for Environmental Monitoring of Greenhouse Gases" provides a detailed study and implementation of a WSN for real time and continuous environmental monitoring of greenhouse gases. A tree-topology WSN consisting of two sensor nodes and a base station was successfully built and tested using open source and inexpensive hardware to measure the concentration level of several greenhouse gases [8]. The sensor nodes consisted of carbon monoxide sensor, a carbon dioxide sensor, a methane sensor, a temperature sensor, a GPS module and a ZigBee wireless transmitter packaged together. The GPS module was added to give information about the location of the sensors. The base stations consisted of an Arduino Uno micro-controller and a ZigBee receiver that can collect data from the various sensors and submit to a sink base station where data can be stored and processed. A website was developed where the captured data can be continuously monitored and displayed in real time. Wireless sensor networks (WSN) are gaining the ground in all sectors of life; from homes to factories, from traffic control to environmental and habitat monitoring. Monitoring seems to be the key word. Wireless systems can take control actions too and in this way they compete with existing process automation systems or with conventional home automation.

Prof. Pravin R. Lakhe in their article "Wireless Sensor Network Using Zigbee" describes features of the Zigbee standard that is great solution for wireless sensor networks. ZigBee is a specification for a suite of high level communication protocols. Zigbee is a typical wireless communication technology. ZigBee uses low rate, low-power digital radios based on an IEEE 802 standard for personal area networks. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs (Wireless personal area network), such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking [9].

Nisha Ashok Somani and Yask Patel in their paper, " Zigbee a low power wireless technology for industrial application", say that the great potential of Wireless Sensor Network is being seen in industrial, consumer and commercial application. The wireless technology is becoming one of the most prominent areas of research. This paper focuses on the most widely used transceiver standard in Wireless Sensor Networks, a ZigBee technology. ZigBee over IEEE 802.15.4 defines specifications for low data rate WPAN (LR-WPAN) to support low power monitoring and controlling devices. This paper presents a Zigbee wireless standard, IEEE 802.15.4specification, ZigBee device types, the protocol stack architecture and its applications [10].

D.D.Chaudhary, S.P.Nayse and L.M.Waghmare, in their paper "Application of Wireless Sensor Networks for Greenhouse Parameter Control in Precision Agriculture", have proposed and analyse the use of Programmable

System on Chip Technology (PSoC) as a part of Wireless Sensor Networks (WSN) to monitor and control various parameter of green house. It is particularly crucial to analyse the methods which can effectively manage the proper environment. The use of wireless sensor network for the large area is now becoming popular in green house technology of precision agriculture. The parameters of green house to be control are increasing day by day so that it may cause the data traffic and congestion in the future. So that, the wireless sensors derived from PSoC technology with high-bandwidth spectrum or cognitive radio technology may be the proper solution for smooth data traffic and remote control of green house from long distance. With the use of green house concept, the farmer can produce different crops in different climates and various seasons. In proposed design of the green house, the farmer can easily keep the desired crop's environment conditions [11].

A paper discusses use of WSN for interactive industrial automation. Many papers discuss about atmospheric parameters control for agriculture or greenhouse. It also provides with the best technology like Zigbee for communication in the designed WSN. There are no papers discussing about atmospheric parameters control for human safety and comfort. In crowded closed environments it causes suffocation and other ill health effects. Therefore it encourages the use of WSN for human comfort by controlling the atmospheric parameters. The technologies and methods which are in use for agriculture and greenhouses are being utilized for human safety and comfort by making the corresponding changes.

3. HARDWARE AND SOFTWARE DESIGN

3.1 Block Diagram and Description

The system consists of centralized coordinator and sensor nodes. The sensor node collects the local data and the Zigbee module at the centralized coordinator collects the information from all other nodes and sends it to the monitoring PC where statistical analysis of data is done and its displayed in form of bar graphs as well as data is stored in text file. The communication between sensor nodes and centralized node is performed using Zigbee which is low cost and ultra low power consumption standard for wireless radio networks in monitoring and control fields. Relays connected to the sensor nodes are used to turn on lights, ceiling fans and exhaust fans thus maintaining healthy atmospheric conditions.

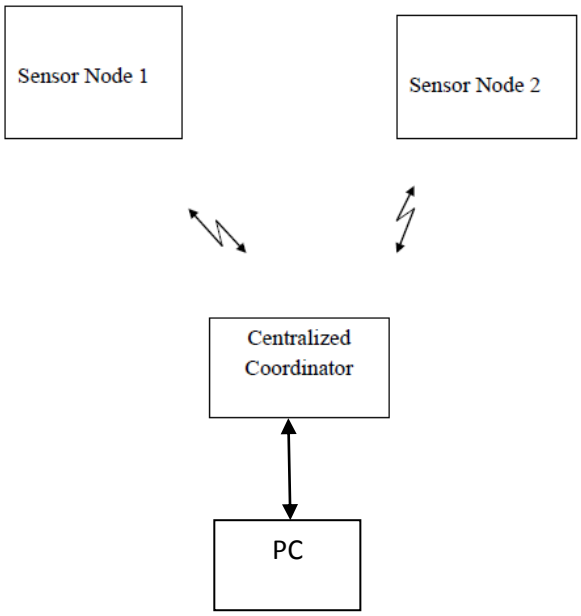


Figure 1: System Block Diagram

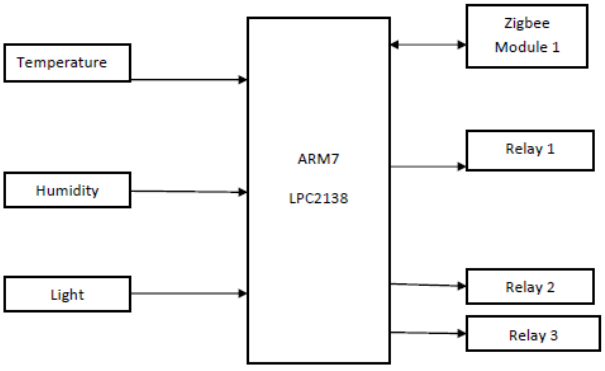
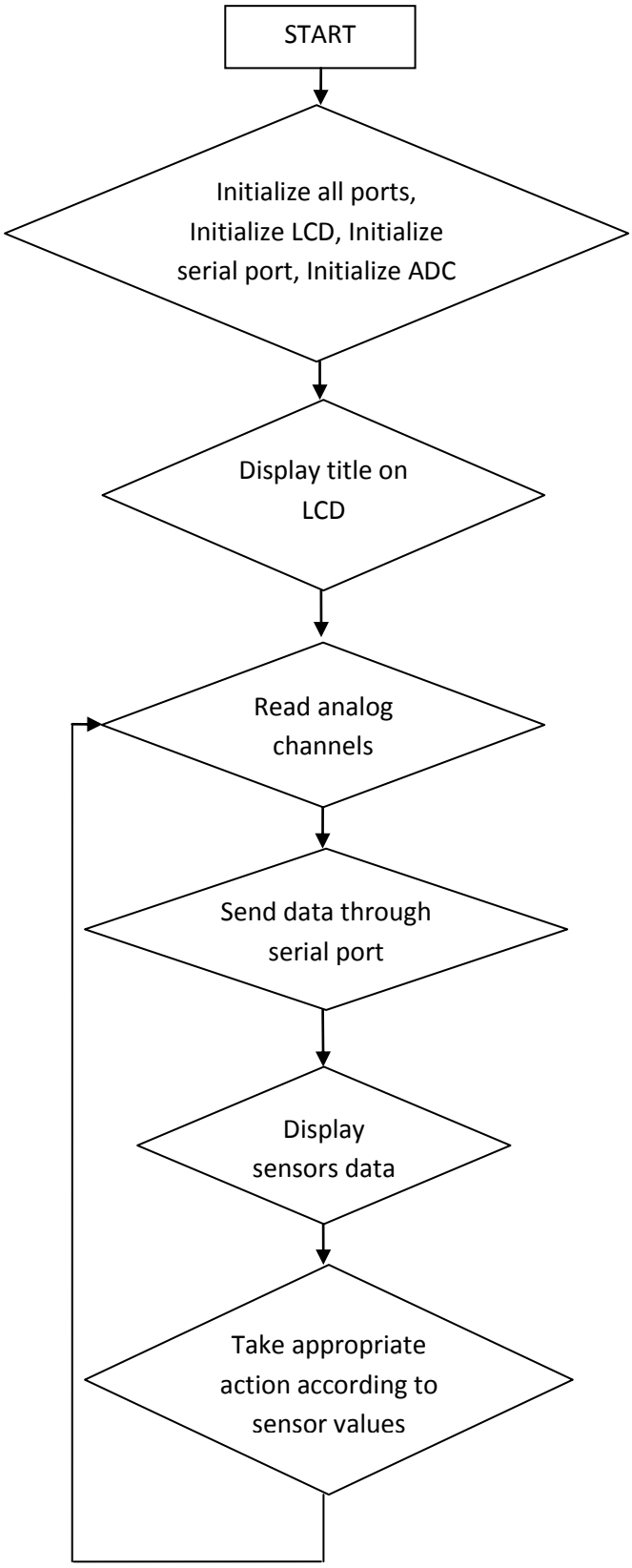


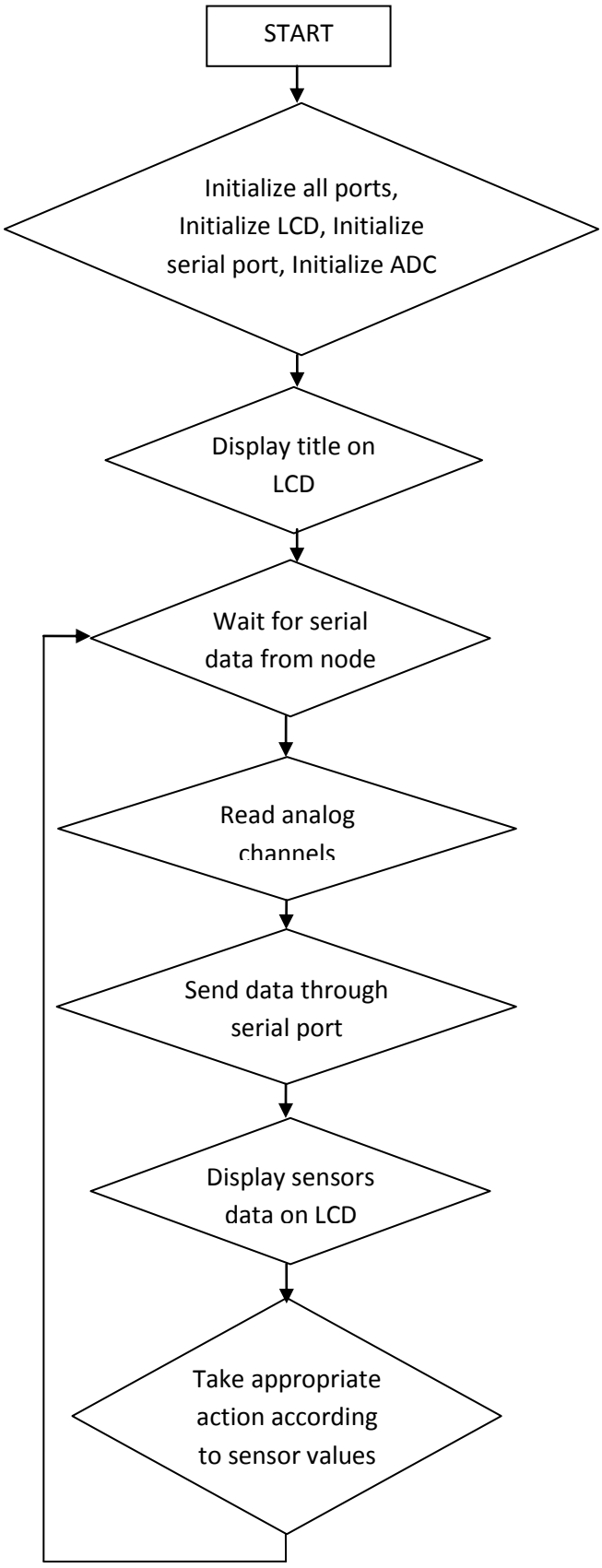
Figure 2:. Sensor node block diagram

3.2 Software Design

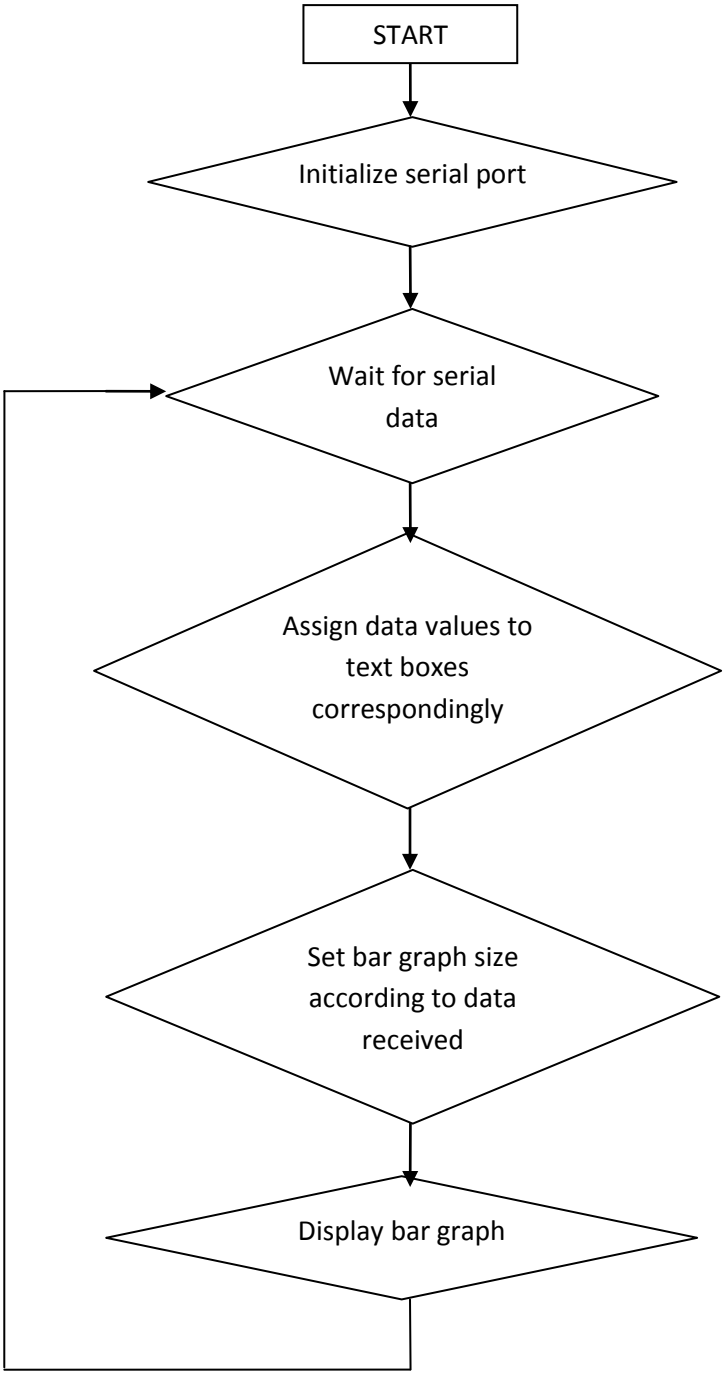
3.2.1 Flow chart of sensor node 1 program



3.2.2 Flow chart of sensor node 2 program



3.2.3 Flow chart of program in visual basic for statistical data analysis



4. EXPERIMENTATION AND RESULTS

Following results are obtained by simulating environment around the sensor nodes:

Table 1:.Result Table

Atmospheric parameters			Relays		
Light	Temperature	Humidity	Light	Ceiling fan	Exhaust fan
14%	37ºC	32%	ON	ON	OFF
65%	36ºC	33%	OFF	ON	OFF
51%	40ºC	72%	OFF	ON	ON
43%	18ºC	48%	OFF	OFF	OFF

Statistical analysis of data is performed and it is displayed in form of bar graphs as shown below:

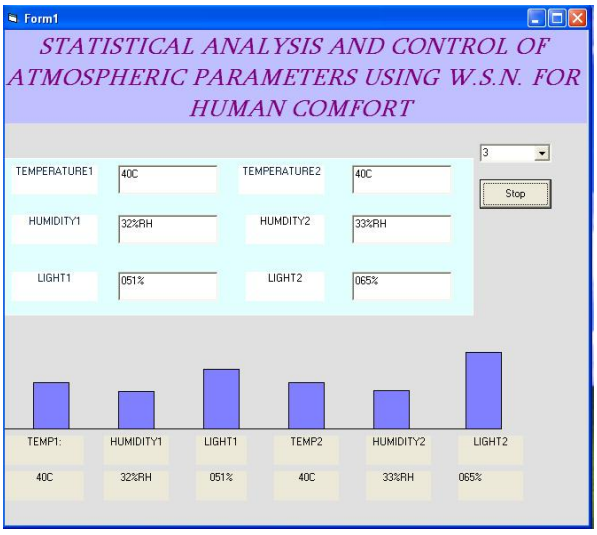


Figure 4: Bar graph display

The data is stored in a text file for further reference and record.

5. CONCLUSION

In this paper the atmospheric parameters of closed environment will be monitored and controlled by the wireless sensor nodes and statistical analysis is performed at centralized coordinator. The system will periodically monitor the environmental parameters (light, temperature, and humidity) of any closed environment using sensor nodes deployed at different locations. The environment at different

locations varies according to the crowd. The control actions will be taken by maintaining temperature below 24º C, humidity below 55% and light above 40%.The sensor nodes will collect the gathered information at centralized coordinator using zigbee modules; where the centralized coordinator will perform statistical analysis on data which is displayed in form of bar graphs and stored for further references. The system will intelligently monitor and control the atmospheric conditions in closed environments containing humans to maintain safe, comfortable and healthy environment for people.

The advantages of system are given below:

- Real-time data can be accessed from the remote site and analyzed and a real-time reaction taken upon it.
- Closed loop control ability (automation).
- Negative weather conditions do not affect the health of people.
- Sensor nodes are small in size and weight and require no wiring which means that they are easy to install in most locations and applications.
- Easy and brief deployment in the desired environment.
- Simple to use.
- Extremely versatile.
- Low maintenance.

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