Chapter 8
Cross-Layer Cooperative Protocol for Industrial Wireless Sensor Network: Cross-Layer Cooperative Protocol for IWSN

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ABSTRACT

Robustness and reliability are two essential network parameters to be given priority in Industrial Wireless Sensor Network. But at the same time it is difficult to achieve gain in these performance metrics. Since in industries these networks are used for monitoring, control and automation processes, therefore, it also requires robust communication with minimum delay. Considering the need of high QoS in Industrial WSN, protocols and standards were developed to fulfil the requirement of reliable data communication in harsh environment. In year 2007, HART community designed a Wireless HART standard for efficient industrial communication. This standard gain high reputation soon after its implementation and still being used as a universal solution for industries. In 2009, another standard ISA100.11a was developed, it also gives promised results but fails to eliminate WHART. Both these standards are still competing in industry and the results of these standards are more reliable in comparison to other wireless industrial protocols that exists.

INTRODUCTION

Background

With the growing use of wireless technology for industrial communication, the need for the productive and reliable protocol also comes in demand. Wireless networks reduces the cost of network management and improves the QoS over wired network (Al-Yamin, Harb, & Abduljauwad, 2013). But still these networks

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have some limitations which are needed to be resolved. Considering the challenges of industrial communication, protocol design with reliable and robust routing is required. Also the data communication of sensor and actuator nodes must be secure for reliable data transmission. Several methods, protocols and standards have been proposed for reliable industrial communication; however, the two standards are being used globally for wireless communication in industry. These two standards, WHART (Anna, Hekland, Petersen & Doyle, 2008) and ISA100.11a, uses proactive routing strategy and different frequency hopping techniques to maintain the network's performance. Also to overcome the issues of link breaking; graph table of mesh network are used. These standards are being used parallel to each other but none of these has eliminated the need of another in industry. Although, they have improved the performance of wireless system in industry through many factors, but they also have some drawbacks and limitations. This must be catered to further enhance the network performance. Some general solutions and protocol design are presented in this research work to eliminate the issues of communication over radio link in harsh environment. Methods proposed can be incorporated in several protocols to enhance and signify the network performance more efficiently.

Motivation and Need

Most of the industrial wireless communication are used for automation processes and controlling application. These control and monitoring mechanisms in industrial environment requires robust and secure data transmission in order to perform correct action accordingly. The delivery of false information or data may cause system to perform in an inadequate manner in such environment. Therefore, reliable and secure transmission of data is essential in industrial wireless sensor network. The atmosphere in industry causes hindrance for communication over radio link. Different industrial environments have different causes for data loss, collision and path disconnectivity. Some of these most common factors are vibration, noise, corrosion and extreme temperatures. Most of the nodes in wireless industrial network also malfunction due to corrosion and therefore does not transmit data accurately. Nodes present on field are also effected by weather changes such as rain, snow, humidity and high temperature, this increases the rate of collision and data loss in network which further degrade the network performance. Therefore the protocol design is required to maintain the network efficiency and improves network gains under challenging environment.

Problem Description

Challenges over radio link in industrial environment varies with the network topology and nodes density. Nodes in the industrial network suffered from extreme atmospheric condition and noise. Data on communication link may be lost or get erroneous in such harsh environment. In order to secure; data transmission over communication link protocol design must route the data on active and secure link. Dynamic network behavior that includes the variable data rata, node density and network traffic also deteriorate the performance of network. Communication protocol must adapt the network changes to transmit data with maximum throughput. These factors also consume more network resources; and reduces the network life time. Efficient management of power resources in therefore necessary to maximize the network life. Mobility of sensor nodes in wireless network is also a factor which degrades the network efficiency. These mobile nodes frequently break the communication link and increases the rate of packet loss. In order to improve the network performance metric in such networks; routing scheme and

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