

Chapter 26

Middleware Systems for Sensor Network: A Study on Different Middleware Systems

Nova Ahmed

North South University, Bangladesh

ABSTRACT

The middleware is a very important component in the wireless sensor network system. It has major challenges that are generic for any distributed systems as well as specific ones that are inherent to the physical nature of WSN systems due to the resource constraint nature. The author classifies WSN middleware systems as Event Based Middleware, System Abstraction Based Middleware, Application and Network Aware System, and Query Based Systems to gain a better understanding of such systems.

INTRODUCTION

Wireless sensor networks are gaining significant interest in recent years. The flexibility of sensor nodes to connect, communicate and compute opens up opportunities for many interesting applications ranging from monitoring of static, semi-static and dynamic environments. Researchers are able to gain insight from environments that are unreachable otherwise such as monitoring of animals in

migration or situation in a battle field (Liu & Martonosi, 2003; Zebranet, 2004).

The wide varieties of applications require a proper management system of sensor nodes that are able to meet diverse set of characteristics. The application requirements comprise of real time query support, accuracy of sensor data, ability to support changes in sensor network system (eg, node failure or battery shortage), resource management etc.

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Middleware systems that are designed specifically for sensor network systems are similar to middleware systems for other distributed, heterogeneous components – on top of the basic requirements, wireless sensor network middleware systems must take into account the resource limited sensor node characteristics. The middleware system must ensure efficient resource management ensuring maximum lifetime of the system.

We have looked at various wireless sensor network middleware systems and classified them according to the interactions among system components and operational strategies. We have taken a close look at each classes as well as the middleware systems supporting individual class. We emphasize at the variations and requirements of applications. We consulted existing classification schemes as discussed in various literatures and surveys [Molla, M.M. and Ahamed, S.I., (2006), Hadim S. and Moamed N. (2006), Henricksen K. and Robinson R., (2006), Tubaishat, M. and Madria, S., (2003)] and created an extensive study that includes current and state of the art middleware systems.

We classify WSN middleware systems as Event Based Middleware, System Abstraction Based Middleware, Application and Network Aware System and Query Based Systems. Event based middleware are middleware systems allow events to trigger various system specific actions as it is implemented in systems like Impala (Liu & Martonosi, 2003; Zebranet, 2004) and DSWare (Li, Son, & Stankovic, 2004). System abstraction allows the middleware to hide specific details of the underlying sensor system for application development with lower degree of complexity, such as SENSORD/Stat (Sashima et al., 2008), Sensation (Hasiotis et al., 2005), Mate (Levis & Culler, 2002; Levis, Gay, & Culler, 2004), Magnet (Barr et al., 2002) and RF²ID (Ahmed et al., 2007). Examples of query processing middleware are TinyDB (Madden et al., 2005), SINA (Shen, Srisathapornphat, & Jaikao, 2001) and Cougar (Johannes, Gehrke, & Seshadri, 2001) where

query processing is inherent in the middleware system design. Application aware systems make desing and operational decisions based on sensor network applications. Examples of such systems are MiLan (Heinzelman et al., 2004), Middleware to Support Sensor, Agilla [Fok, Roman, & Lu, 2009), EnviroTrack (Abdelzaher et al., 2004) and AutoSec (Han & Venkatasubramanian, 2001). Classifying and discussing individual WSN middleware system provides insight to existing systems as well as future directions for WSN deployment and development.

We present the chapter in the following order, first we discuss examples of sensor network applications to present the importance of study on sensor network middleware systems, we follow the discussion by classifying the middleware systems for WSN in subsequent section, we discuss the contrast among various middleware classes after that and then we conclude our chapter.

WSN APPLICATIONS

We present various WSN applications as our motivation towards the study on various WSN middleware systems. The main category incorporates various monitoring schemes using sensor networks

Wildlife Behavior Monitoring

Wireless sensor nodes can be used to automate the study of mobile animals that would be difficult to study manually. For example, the ZebraNet (Liu & Martonosi, 2003; Zebranet, 2004) project attaches sensor nodes on wildlife like Zebras to study their migration behavior. The study places sensor nodes on Zebras at the Mpala Research Center at the Sweet Water Reserve in central Kenya. The study enables interdisciplinary approach to take a close look at wildlife which are of interest to behavior researchers as well as researchers conducting sensor network studies.

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