2012 IEEE/ACM Third International Conference on Cyber-Physical Systems

Poster Abstract: Involving A Sensor Network System in Core Datacenter Management Functions

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I. Introduction

In the recent decade, datacenters have emerged to play an increasingly important role in cloud-based computing systems. It is shown that wireless sensor networks (sensornets) can provide fine-grained measurement and flexible coverage for the datacenter platform, and help achieve better control and energy efficiency [1]–[3]. In these applications, sensor nodes are only passive information receivers, and the use has so far been limited to auxiliary functions as an intelligent replacement of the traditional wired and embedded sensors.

We argue that the combined computational and networking capability of a sensor network enables it to interact with server clusters in a much more sophisticated way and perform essential functions in the datacenter system. We design a technology to incorporating the sensornet as a core part of the datacenter system and improve datacenter management and operations. The sensornet can be easily deployed in a cluster, with sensor nodes attached in an ad hoc manner to the compute servers, and provide key system functions including reprogramming, supplementary authentication, and network signaling. The datacenter administrator can manage a large number of servers through the multihop sensor network, verify the participating servers to be legitimate entities within the datacenter, and improve performance through a low-bandwidth but intelligent wireless network.

Our initial results have shown that the system eliminates some of the security problems present in current LAN network based datacenter management system; and that the sensornet provides good physical authentication function without introducing long delays in cluster-wide operations.

II. Design

The system comprises a number of inexpensive Telos Revision B nodes, and this inexpensive and autonomous network performs several important system functions, such as distributing control commands and triggering system-wide operations, in the private and short-distance wireless communication network. Moreover, the sensornet conducts supplementary physical authentication designed to enhance the security level of the datacenter system. Figure 1 shows a configuration of a small-scale system.

Traditional authentication algorithms provide strong cryptological guarantees but fall short of assuring the physical presence of the authorized entity. This makes it necessary to incur additional operational measures to protect the system, and leaves an Internet-connected system always potentially vulnerable to unknown exploits. We enhance the security of the datacenter using coarse-grained but unforgeable physical properties collected by a sensor network. Specifically, the system examines wireless signals and estimates the locations of the communicating entities, building on prior research work on localization in sensor networks. The location information can be estimated by the relationship between RSSI and physical distance. Although such localization is coarse-grained, it is sufficient to authenticate the control mote and verify it is located within an area inside the datacenter with high confidence. The datacenter administrator can use this network to complement conventional datacenter management system.

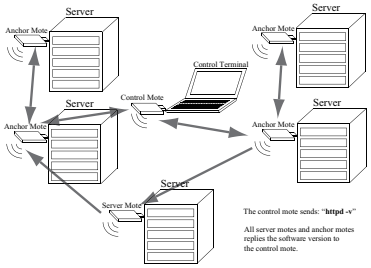

Figure 1. The Minimum System Architecture

III. Prototype

We have implemented the sensor network system using Telos Revision B sensor nodes and TinyOS 2.1.1. Control interfaces are developed to facilitate system information gathering and command distribution. Experiments show that the delay in a small-scale system is less than 300ms, and the delay does not accumulate much when the system scales up. The localization algorithm employed by the system can authenticate the control mote with meter-level precision.

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978-0-7695-4695-7/12 $26.00 © 2012 IEEE
DOI 10.1109/ICCPS.2012.52