Inspired Social Spider Behavior for Secure Wireless Sensor Networks

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ABSTRACT

Last year’s biologically inspired systems had received a great interest. Behavior of social insects, DNA computation, artificial neural networks, evolutionary computation, and artificial immune systems are some of the interests which can be highlighted. Wireless sensor networks have no clear line of defense and no fixed infrastructure; therefore, the known security techniques used for cabled networks might not work perfectly. While wireless sensor networks, node misbehavior can cause the packet dropping, packet modification, packet misrouting, selfish node behavior, and so on. A biologically-inspired algorithm for detecting misbehaving nodes in a wireless sensor network is presented. Such an algorithm, inspired by the behavior of some social spiders from Congo, a specially their strategy to collaborate for detecting an intrusion in their web.

Keywords: Biologically Inspired Systems, Misbehavior Detection, Secure Wireless Sensor Networks, Security Attacks, Wireless Sensor Network

INTRODUCTION

Security in wireless sensor networks (Michiardi & Molva, 2003) is of serious concern because of several established reasons, as follows: Vulnerabilities resulting from radio communications involves eavesdropping and spoofing of MAC address, lack of infrastructure makes it impossible to assign well-defined roles such as trusted third parties and key management servers, lack of dedicated routers and servers hamper the performance of basic networking operations such as packet forwarding and routing because of malicious network behavior or lack of cooperation.

In the last years, we have witnessed unprecedented growth of the wireless sensor networks. The tremendous size and complexity that is
associated with any large-scale, distributed system is pushing the limits of our ability to manage this type of network, or even to fully understand its behavior. It has been a great research challenge to and an effective means to influence its future, and to address a number of important issues facing the wireless sensor networks, such as overall system security, routing scalability, effective mobility support for large numbers of moving components, and the various demands put on the network by the ever-increasing number of new applications and devices.

Although the wireless sensor network is perhaps the world’s newest large-scale, complex system, it is certainly not the first or the only one. Certainly the oldest large-scale, complex systems are biological. Biological systems have been evolving over billions of years, adapting to an ever-changing environment. They share several fundamental properties with the wireless sensor networks, such as the absence of centralized control, increasing complexity as the system grows in size, and the interaction of a large number of individual, self-governing components, etc. Despite their disparate origins, it is easy to draw analogies between these two systems.

Though drawing parallels between computer systems and biology is not a new idea (Visconti & Tahayori, 2009), the unprecedented complexity and scale of modern networks demands investigation from a different angle. As many researchers have argued (Kephart & Chess, 2003; Barbaoglu et al., 2006; Carreras, Miorandi, & Chlamtac, 2007; Meisel, Pappasb, & Zhanga, 2010), there is a great opportunity to find solutions in biology that can be applied to problems in networking. In Figure 1, each topic is categorized by the biological field or fields that inspired it and the computer network research to which it applies.

### NETWORK SYSTEMS INSPIRED BY INSECT COLONIES

Social insects, such as ants and bees, form large-scale and highly organized colonies. Such insect colonies are decentralized as the coordination/communication between individual insects is local rather than global. In a large-scale insect colony, when individual insects with a set of very simple behavioral rules interact, intelligent group behaviors emerge from these local interactions. For example, an ant colony may contain millions of worker ants, yet through local interactions, the labor of nest repair, enlargement, and defense is efficiently distributed (Bourke & Franks, 1995).

Similarly, a bee colony that consists of thousands of honeybees coordinates its activities through local interactions to efficiently collect nectar, pollen, and water. The coordinated group behavior of social insects arising from local interactions, known as swarm intelligence, relies on direct and indirect types of interactions. Direct interactions are straightforward mechanisms, and allow insects to communicate through direct contact (e.g., by exchanging food

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**Figure 1. Possible security research topics map against bio-inspired research field**

![Possible security research topics map against bio-inspired research field](image)
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