
Secured Adaptive Routing in Mobile Ad Hoc Networks with Artificial Immune System

¹V.Sherine Vargheese, ²G.Jayasudha, ³V.Dhivya

Kailash Women's College.

Abstract: Wireless devices and the increase of computing and storage resources are increasing in supporting mobile computing techniques. Particularly, ad hoc networks can potentially connect different wireless devices. The infrastructure less and the dynamic nature of Mobile Ad hoc Network (MANET) demands new set of networking strategies to be implemented in order to provide efficient end-to-end communication. The entire network is mobile and the individual terminals are allowed to move freely. The nodes may be located in or on airplanes, ships, trucks, cars, even on people or very small devices. Routing is a big problem in Mobile ad hoc networks. Many protocols have been proposed to increase efficiency and security of traditional protocols in Mobile ad-hoc networks (MANET), but they are all facing the problem of computation overhead which leads to impracticability. Though adaptive routing minimizes the problem of efficiency, it doesn't cover the secure issues. A possible reason for node misbehavior is faulty hardware or software. Another reason is that to save its battery power. In such a condition, battery replacement may not be possible. Each node depends on small low-capacity batteries as energy sources and cannot expect replacement when operating in hostile and remote regions. Centralized and distributed scheduling algorithms. This could bring in a significantly throughput improvement with the variation of node density such as link failure ratio, packet arrival rate, retransmission threshold. To enhance efficiency and security for misbehaving node detection integrate security mechanism based on Artificial Immune System (AIS) with adaptive routing strategy. In initial phase, the detection systems learns about the normal behavior of the nodes with respect to the DSR protocol and in second phase detection and classification are done to prevent unauthorized access to the data transmitted.

Keywords: Mobile Ad Hoc Networks (MANET), Adaptive Routing, High throughput, Node misbehavior, Attacks, Security.

Reference to this paper should be made as follows: ¹Sherine Vargheese, ²G.Jayasudha, ³V.Dhivya (2015) 'Secured Adaptive Routing in Mobile Ad Hoc Networks with Artificial Immune System', *International Journal of Inventions in Computer Science and Engineering*, Volume 2 Issue 9 Oct 2015.

1 Introduction

The main objective of this paper is to develop a secured environment for detecting malicious nodes in a heterogeneous wireless sensor network (HWSN). Here a probability model is used to analyse the best redundancy level, using path redundancy and source redundancy. In order to improve the method here using heterogeneous node for multipath routing. It using packet droppers with IDS (Intrusion detection system) for tolerance purpose. Packet droppers are common attacks that can be launched by an adversary to disrupt communication in wireless sensor networks. Many schemes have been proposed to mitigate the attacks but none can effectively and efficiently identify the intruders. To address the problem, a simple yet effective scheme is proposed, which can identify misbehaving forwarders that drop or modify packets. In a wireless sensor network, sensor nodes monitor the environment, detect events of interest, produce data and collaborate in forwarding the data towards a sink, which could be a gateway, base station, storage node or querying user.

A sensor network is often deployed in an unattended and hostile environment to perform the monitoring and data collection tasks. When it is deployed in such an environment, it lacks physical protection and is subject to node compromise. After compromising one or multiple

sensor nodes, an adversary may launch various attacks to disrupt the in network communication. Among these attacks, two common ones are dropping packets and modifying packets, i.e., compromised nodes drop or modify the packets that they are supposed to forward. The key concept is that this redundancy management is to exploit the tradeoff between the energy consumption with the gain in reliability, timeless and security to maximize the system useful lifetime. Formulating the tradeoff as an optimization problem for dynamically determining the best redundancy level to apply to multipath routing for intrusion tolerance so that the query response success probability is maximized while prolonging the useful lifetime. Here it is considering the optimization problem for the case in which a voting-based distributed intrusion detection algorithm is applying to detect and evict malicious nodes in heterogeneous wireless sensor network.

To deal with packet droppers, a widely adopted counter measure is multipath forwarding, in which each packet is forwarded along multiple redundant paths and hence packet dropping in some but not all of these paths can be tolerated. This scheme introduces high extra communication overhead. Another category of counter measures is to monitor the behaviour of forwarding nodes. These schemes are subject to high energy cost incurred by the promiscuous operating mode of wireless interface. To deal with packet

modifiers, most of existing counter measures are to filter modified messages within a certain number of hops. Without identifying packet droppers and modifiers, these counter measures cannot fully solve the packet modification problems because the compromised nodes can continue attacking the network without being caught. To identify packet modifiers, Yet all recently proposed a probabilistic nested marking (PNM) scheme to identify packet modifiers with a certain probability. However, the PNM scheme cannot be used together with the false packet filtering schemes, because the filtering schemes will drop the modified packets which should be used by the PNM scheme as evidences to inter packet modifiers. This degrades the efficiency of deploying the PNM scheme.

Secure data transmission is a critical issue for wireless sensor networks (WSNs). Clustering is an effective and practical way to enhance the system performance of WSNs. Here it is a study of a secure data transmission for cluster-based WSNs (CWSNs), where the clusters are formed dynamically and periodically. We propose two Secure and Efficient data Transmission (SET) protocols for CWSNs, called SET-IBS and SET-IBOOS, by using the Identity-Based digital Signature (IBS) scheme and the Identity-Based Online/Offline digital signature (IBOOS) scheme, respectively. In SET-IBS, security relies on the hardness of the Hellman problem in the pairing domain. SET-IBOOS further reduces the computational overhead for protocol security, which is crucial for WSNs, while its security relies on the hardness of the discrete logarithm problem. We show the feasibility of the SET-IBS and SET-IBOOS protocols with respect to the security requirements and security analysis against various attacks. The calculations and simulations are provided to illustrate the efficiency of the proposed protocols. The results show that, the proposed protocols have better performance than the existing secure protocols for CWSNs, in terms of security overhead and energy consumption. It has been proposed in order to reduce the computation and storage costs to authenticate the encrypted sensed data, by applying digital signatures to message packets, which are efficient in communication and applying the key management for security. The proposed protocols paring parameters are distributed and preloaded in all sensor nodes by the BS initially.

II. Multipath Routing

Wireless sensor networks are usually deployed for gathering data from unattended or hostile environment. Several application specific sensor network data gathering protocols have been proposed in research literatures. However, most of the proposed algorithms have given little attention to the related security issues. In this paper we have explored general security threats in wireless sensor network and made an extensive study to categorize available data gathering protocols and analyse possible security threats on them. Due to limitations of sensor devices, the networks exposed to various kinds of attacks and conventional defences against these attacks are not suitable due to the resource constrained

nature of these kinds of networks. Therefore, security in WSNs is a challenging task due to inheritance limitations of sensors and it becomes a good topic for researchers. In this paper we focus at secure routing protocols in wireless sensor networks and surveyed nineteen papers which focusing on this matter. We represent problems and methodologies which are used in order to address the problems.

Advantages in communication technology allow us to build the networks where large numbers of low power and inexpensive sensor devices are integrated in the physical environment and operating together over a wireless media. There are a lot of its application in industry, military and health. In some applications such as intruder detection systems in military, detection of unusual behaviour or failures in a manufacturing process or detection of forest fires, the infrequency of occurrence of specific events has been detected via wireless sensor network (WSN). In the some other WSN applications such as monitoring temperature, humidity and lighting in office buildings, data gathered and reported in the specific periods of time. In some applications scenarios the process of gathering and reporting environment data had been asked through the base, or sink. In some cases border surveillance, WSN may be used in order to track of specific objects in the environment.

III. Set Protocol

The set protocol module, Secure and efficient data Transmission (SET) protocol for CWSNs. The SET-IBOOS protocol is designed with the same purpose and scenarios for CWSNs with higher efficiency. The proposed SET-IBOOS operates similarly to the previous SETIBS, which has a protocol initialization prior to the network deployment and operates in rounds during communication. We first introduce the protocol initialization, then describe the key management of the protocol by using the IBOOS scheme, and the protocol operations afterwards.

IV. Key Management For Security

This module, the key cryptographies used in the protocol to achieve secure data transmission, which consist of symmetric and asymmetric key based security.

V. Neighbourhood Authentication T

his module is used for secure access and data transmission to nearby sensor nodes, by authenticating with each other. Here, "limited" means the probability of neighbourhood authentication, where only the nodes with the shared pairwise key can authenticate each other.

VI. Background And Motivation

Cluster based data transmission in WSNs, has been investigated by researches in order to achieve the network

scalability and management, which maximizes node lifetime and reduce bandwidth consumption by using local collaboration among sensor nodes. In a cluster based WSN(CWSN), every cluster has a leader sensor node, regarded as cluster-head(CH). A CH aggregates the data collected by the leaf nodes(non-CH sensor nodes) in its cluster, and sends the aggregation to the base station(BS). The LEACH(Low Energy Adaptive Clustering Hierarchy) protocol presented by Heinzelman et al. It is a widely known and effective one to reduce and balance the total energy consumption for CWSNs. In order to prevent quick energy consumption of the set of CHs, LEACH randomly rotates CHs among all sensor nodes in the network, in rounds. LEACH achieves improvements in terms of network lifetime. Following the idea of LEACH, a number of protocols have been presented such as APTEEN and PEACH, which use similar concepts of LEACH. In this paper for convenience, we call this sort of cluster based protocols as LEACH like protocols. Researchers have been widely studying CWSNs in the last decade in the literature, however, the implementation of the cluster based architecture in the real world is rather complicated.

Adding security to LEACH like protocols is challenging, because they dynamically, randomly and periodically rearrange the network's clusters and data links. Therefore, providing steady long-lasting node-to-node trust relationships and common key distributions are inadequate for LEACH like protocols (most existing solutions are provided for distributed WSNs, but not for CWSNs). There are some secure data transmission protocols based on LEACH like protocols, such as SECLEACH, GS-LEACH and RLEACH. Most of them, however, apply the symmetric key management for security, which suffers from a so called orphan node problem. This problem occurs when a node does not share a pair wise key with others in its preloaded key ring, in order to mitigate the storage cost of symmetric keys, and the key ring is not sufficient for the node to share pair wise symmetric keys with all of the nodes in a network. In such a case, it cannot participate in any cluster, and therefore, has to elect itself as a CH. Furthermore, the orphan node problem reduces the possibility of a node joining a CH, when the number of alive nodes owning pair wise keys decreases after a long term operation of the network. Since the more CHs elected by themselves, the more overall energy consumed of the network, the orphan node problem increases the overhead of transmission and system energy consumption by raising the number of CHs. Even in the case that a sensor node does share a pair wise key with a distant CH but not a nearby CH, it requires comparatively high energy to transmit data to the distant CH. The feasibility of the asymmetric key management has been shown in WSNs recently, which compensates the shortage from applying the symmetric key management for security. Digital signature is one of the most critical security services offered by cryptography in asymmetric key management systems, where the binding between the public key and the identification of the signer is obtained via a digital certificate. The Identity-Based digital signature(IFS)

scheme, based on the difficulty of factoring integers from Identity Based Cryptography(IBC), is to derive an entity's public key from its identity information, e.g., from its name or ID number. Recently, the concept of IBS has been developed as a key management in WSNs for security. Carman first combined the benefits of IBS and key predistribution set into WSNs, and some papers appeared in recent years. The IBOOS scheme has been proposed in order to reduce the computation and storage costs of signature processing. A general method for constructing online/offline signature schemes was introduced by even at all. The IBOOS scheme could be effective for the key management in WSNs. Specifically, the offline phase is to be executed during communication. Some IBOOS schemes are designed for WSNs afterwards. The offline signature in these schemes, however, is precompiled by a third party and lacks reusability, thus they are not suitable for CWSNs.

VII. Proposed Methodology

An identity (ID)-based signature scheme allows any pair of users to communicate securely and to verify each other's signatures without exchanging public key certificates. The proposed new ID based signature scheme that allows batch verification of multiple signatures. Using the new scheme, the signature size is reduced into almost half and efficiently verify multiple signatures. The verification cost of k signatures by a single signer is one signature verification plus k elliptic curve addition and k hashing. When a new signature by a different signer is added, additional verification cost is almost a half of that of ordinary verification of a single signature with minimal security loss.

If there is an attacker who can forge a set of signatures to pass batch verification, then the computational Diffie-Hellman problem (CDHP) is used to solve such problem. Batch verification was devised to improve the efficiency of verification process for multiple signatures.

Proposed Technique Description: An ID-Based Signature

This scheme consists of four algorithms: Setup, Extract, Signing and Verification.

Setup

Given a GDH group G and its generator P , pick a random $s \in \mathbb{Z}/\mathbb{Z}$ and set $P_{pub} = sP$. Choose two hash functions $H1 : \{0, 1\}^* \times G \rightarrow (\mathbb{Z}/\mathbb{Z})^*$ and $H2 : \{0, 1\}^* \rightarrow G^*$. The system parameter is $(P, P_{pub}, H1, H2)$. The master key is s .

Extract

Given an identity ID , the algorithm computes $QID = H2(ID)$ and $DID = sH2(ID)$ and outputs DID as a private key of the identity ID corresponding to $QID = H2(ID)$.

Signing

Given a secret key DID and a message m , pick a random number $r \in \mathbb{Z}'\mathbb{Z}$ and output a signature $\sigma = (U, V)$ where $U = rP$, $h = H1(m,U)$, and $V = rQID+hDID$.

Verification

Given a signature $\sigma = (U, V)$ of a message m for an identity ID, compute $h = H1(m,U)$. The signature is accepted if and only if $(P,QID,U + hPpub, V)$ is a valid Diffie-Hellman tuple

Aes Aggregate Verification

A forger is given a target public key for which a forged signature should be made. While each secret key of users is chosen independently in the traditional public key system, all secret keys of users are mutually related in ID-based system. In fact, they are produced from one secret key of the whole system. Hence in ID-based setting it is reasonable not to give specific ID but a system parameter to a forger.

K-Aggregate Forger Of A Chosen ID:

A forger succeeds if he can produce a set of k signatures which pass the aggregate verification. This type of forger is known as k -aggregate forger of a chosen ID.

K-Aggregate Forger Of A Given ID:

A forger produces a set of k signatures one of which has the signer with the given ID, then this type of forger is called a k -aggregate forger of a given ID.

VII. Conclusion

In this paper, the data transmission issues and the security issues in CWSNs. The deficiency of the symmetric key management for secure data transmission has been discussed. We then presented two secure and efficient data transmission protocols respectively for CWSNs, SET-IBS and SET-IBOOS. In the evaluation section, we provided feasibility of the proposed SET-IBS and SET-IBOOS with respect to the security requirements and analysis against routing attacks. SET-IBS and SET-IBOOS are efficient in communication and applying the ID based crypto-system, which achieves security requirements in CWSNs, as well as solved the orphan node problem in the secure transmission protocols with the symmetric key management. Lastly, the comparison in the calculation and simulation results show that, the proposed SET-IBS and SET-IBOOS protocols have better performance than existing secure protocols for CWSNs. With respect to both computation and communication costs, we pointed out the merits that, using SET-IBOOS with less auxiliary security overhead is preferred for secure data transmission in CWSNs.

References

- [1] Y. Yang, C. Zhong, Y. Sun, and J. Yang, "Network coding based reliable disjoint and braided multipath routing for sensor networks", *J. Netw. comput. Appl.*, vol. 33, no. 4, pp. 422-432, 2010
- [2] R. Machado, N. Ansari, G. Wang, and S. Tekinay, "Adaptive density control in heterogeneous wireless sensor networks with and without power management", *IET commun.*, vol. 4, no. 7, pp. 758-767, 2010
- [3] E. Stavrou and A. Pitsillides, "A survey on secure multipath routing protocols in WSNs", *Comput. New.*, vol. 54, no. 13, pp. 2215-2238, 2010
- [4] T. Shu, M. Krunz, and S. Liu, "Secured data collection in wireless sensor networks using randomized dispersive routes", *IEEE Trans. Mobile Comput.*, vol. 9, no. 7, pp. 941-954, 2010
- [5] Y. Lan, L. Lei, and G. Fuxiang, "A multipath secure routing protocol based on malicious node detection", in *Proc. 2009 Chinese control Decision Conf.*, pp. 4323-4328
- [6] Y. Zhou, Y. Fang, and Y. Zhang, "Securing wireless sensor networks: a survey", *IEEE Commun. surveys & Tutorials*, vol. 10, no. 3, pp. 6-28, 2008
- [7] D. Somasundaram and R. Marimuthu, "A multipath reliable routing for detection and isolation of malicious nodes in MANET", in *Proc. 2008 Int. Conf. Computing, Commun. Netw.*, pp. 1-8
- [8] H. Su and X. Zhang, "Network lifetime optimization for heterogeneous sensor networks with mixed communication modes," in *Proc. 2007 IEEE Wireless Commun. Netw. conf.*, pp. 3158-3163
- [9] H. Su and X. Zhang, "Network lifetime optimization for heterogeneous sensor networks with mixed communication modes," in *Proc. 2007 IEEE Wireless Commun. Netw. Conf.*, pp. 3158-3163.
- [10] I. Slama, B. Jouaber, and D. Zeghlache, "Optimal power management scheme for heterogeneous wireless sensor networks: lifetime maximization under QoS and energy constraints," in *Proc. 2007 Int. Conf. Netw. Services*, pp. 69-69.
- [11] R. Machado, N. Ansari, G. Wang, and S. Tekinay, "Adaptive density control in heterogeneous wireless sensor networks with and without power management," *IET Commun.*, vol. 4, no. 7, pp. 758-767, 2010.
- [12] E. Stavrou and A. Pitsillides, "A survey on secure multipath routing protocols in WSNs," *Comput. Netw.*, vol. 54, no. 13, pp. 2215-2238, 2010.
- [13] T. Shu, M. Krunz, and S. Liu, "Secure data collection in wireless sensor networks using randomized dispersive routes," *IEEE Trans. Mobile Comput.*, vol. 9, no. 7, pp. 941-954, 2010.
- [14] Y. X. Jiang and B. H. Zhao, "A secure routing protocol with malicious nodes detecting and diagnosing mechanism for wireless sensor networks," in *Proc. 2007 IEEE Asia-Pacific Service Comput. Conf.*, pp. 49-55.

- [15] C. Karlof and D. Wagner, "Secure routing in wireless sensor networks: attacks and countermeasures," in Proc. 2003 IEEE Int. Workshop Sensor Netw. Protocols Appl., pp. 113–127.
- [16] B. Deb, S. Bhatnagar, and B. Nath, "ReInForM: reliable information forwarding using multiple paths in sensor networks," in Proc. 2003 IEEE Conf. Local Computer Netw., pp. 406–415.
- [17] H. Lu, J. Li, and H. Kameda, "A Secure Routing Protocol for Cluster-Based WSNs Using ID- Based Digital Signature," in Proc. IEEE GLOBECOM, 2010.
- [18] S. Even, O. Goldreich, and S. Micali, "On-Line/Off-Line Digital Signatures," in Lect. Notes. Comput. Sc. - CRYPTO, 1990.
- [19] S. Xu, Y. Mu, and W. Susilo, "Online/Offline Signatures and Multisignatures for AODV and DSR Routing Security," in Lect. Notes. Comput. Sc. - Inf. Secur. Privacy, 2006.
- [20] C.-K. Chu, J. K. Liu, J. Zhou et al., "Practical ID-based encryption for wireless sensor network," in Proc. ACM ASIACCS, 2010.
- [21] C. Karlof and D. Wagner, "Secure routing in wireless sensor networks: attacks and counter measures," *Ad Hoc Networks*, vol. 1, no. 2-3, 2003.
- [22] F. Hess, "Efficient Identity Based Signature Schemes Based on Pairings," in Lect. Notes. Comput. Sc. - SAC, 2003.
- [23] J. Liu and J. Zhou, "An Efficient Identity-Based Online/Offline Encryption Scheme," in Lect. Notes. Comput. Sc. - Appl. Crypto. Netw. Secur., 2009.
- [24] J. J. Rotman, *An Introduction to the Theory of Groups*. Springer-Verlag; 4th edition, 1994.
- [25] K. S. McCurley, "The discrete Logarithm Problem," in Proc. Symp. Appl. Math., Prog. Com. Sc., 1990, vol. 42.
- [26] W. Diffie and M. Hellman, "New directions in cryptography," *IEEE Trans. Inf. Theory*, vol. 22, no. 6, 1976.
- [27] D. Boneh, I. Mironov, and V. Shoup, "A Secure Signature Scheme from Bilinear Maps," in Lect. Notes. Comput. Sc. - CT-RSA, 2003.
- [28] P. Barreto, H. Kim, B. Lynn et al., "Efficient Algorithms for Pairing-Based Cryptosystems," in Lect. Notes. Comput. Sc. - CRYPTO, 2002.
- [29] C. Castelluccia, E. Mykletun and G. Tsudik, "Efficient aggregation of encrypted data in wireless sensor networks," in Proc. MobiQuitous, 2005.
- [30] H. Lu, J. Li, and G. Wang, "A Novel Energy Efficient Routing Algorithm for Hierarchically Clustered Wireless Sensor Networks," in Proc. FCST, 2009