

Hop by Hop Message Authentication and Source Privacy in Wireless Sensor Networks

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Abstract:

Message authentication is one of the most effective ways to thwart unauthorized and corrupted messages from being forwarded in wireless sensor networks (WSNs). For this reason, many message authentication schemes have been developed, based on either symmetric-key cryptosystems or public-key cryptosystems. Most of them, however, have the limitations of high computational and communication overhead in addition to lack of scalability and resilience to node compromise attacks. To address these issues, a polynomial-based scheme was recently introduced. However, this scheme and its extensions all have the weakness of a built-in threshold determined by the degree of the polynomial: when the number of messages transmitted is larger than this threshold, the adversary can fully recover the polynomial. In this paper, we propose a scalable authentication scheme based on elliptic curve cryptography (ECC). While enabling intermediate nodes authentication, our proposed scheme allows any node to transmit an unlimited number of messages without suffering the threshold problem. In addition, our scheme can also provide message source privacy. Both theoretical analysis and simulation results demonstrate that our proposed scheme is more efficient than the polynomial-based approach in terms of computational and communication overhead under comparable security levels while providing message source privacy.

Introduction

1. Towards Resilient Geographic Routing in WSNs
In this paper, we consider the security of geographical forwarding (GF) – a class of algorithms widely used in ad hoc and sensor networks. In GF, neighbors exchange their location information, and node forwards packets to the destination by picking a neighbor that moves the packet closer to the destination. There are a number of attacks that are possible on geographic forwarding. One of the attacks is predicated on misbehaving nodes falsifying their location information. The first contribution of the paper is to propose a location verification algorithm that addresses this problem. The second contribution of the paper is to propose approaches for route authentication and trust-based route selection to defeat attacks on the network. We discuss the Proposed approaches in detail, outlining possible attacks and defenses against them.

2. On Optimal Information Capture by Energy-Constrained Mobile Sensors

A mobile sensor is used to cover a number of points of interest (PoIs) where dynamic events appear and disappear according to given random processes. The sensor, of sensing range r , visits the PoIs in a cyclic schedule and gains information about any event that falls within its range. We consider the temporal dimension of the sensing as given by a utility function which specifies how much information is gained about an event as a function of the cumulative sensing or observation time. It has been shown in [1] that for Step and Exponential utility functions, the quality of monitoring (QoM), i.e., the fraction of information

captured about all events, increases as the speed of the sensor increases. This work, however, does not consider the energy of motion, which is an important constraint for mobile sensor coverage. In this paper, we analyze the expected information captured per unit of energy consumption (IPE) as a function of the event type, the event dynamics, and the speed of the mobile sensor. Our analysis uses a realistic energy model of motion, and it allows the sensor speed to be optimized for information capture. We present extensively simulation results to verify and illustrate the analytical results.

3. Security Solutions for Wireless Sensor Networks

This paper describes security solutions for collecting and processing data in Wireless Sensor Networks (WSNs). Adequate security capabilities for medium and large scale WSNs are a hard but necessary goal to achieve to prepare these networks for the market. The paper includes an overview on security and reliability challenges for WSNs, and introduces a toolbox concept to support such a framework.

Existing system

In existing system, we propose a scalable authentication scheme based on elliptic curve cryptography (ECC). While enabling intermediate nodes authentication, our scheme allows any node to transmit an unlimited number of messages without suffering the threshold problem. We develop a source anonymous message authentication code (SAMAC) on elliptic curves that can provide unconditional source anonymity through hop by hop message authentication process. In order to evaluate the existing message authentication, SAMAC act as resilience to active and passive attack. In the existing system, symmetric key and hash based authentication schemes were proposed for WSNs. In these schemes, each symmetric authentication key is shared by a group of sensor nodes. An intruder can compromise the key by capturing a single sensor node. Therefore, these schemes are not resilient to node compromise attacks. Another type of symmetric-key scheme requires

synchronization among nodes. These schemes, including TESLA and its variants, can also provide message sender authentication. However, this scheme requires initial time synchronization, which is not easy to be implemented in large scale WSNs. In addition, they also introduce delay in message authentication, and the delay increases as the network scales up.

A secret polynomial based message authentication scheme was introduced in the existing system. This scheme offers information-theoretic security with ideas similar to a threshold secret sharing, where the threshold is determined by the degree of the polynomial. When the number of messages transmitted is below the threshold, the scheme enables the intermediate node to verify the authenticity of the message through polynomial evaluation. However, when the number of messages transmitted is larger than the threshold, the polynomial can be fully recovered and the system is completely broken. To increase the threshold and the complexity for the intruder to reconstruct the secret polynomial, a random noise, also called a perturbation factor, was added to the polynomial in the existing system to thwart the adversary from computing the coefficient of the polynomial. However, the added perturbation factor can be completely removed using error-correcting code techniques.

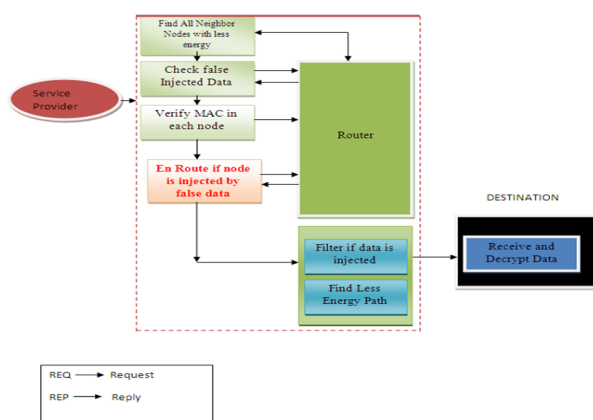
For the public-key based approach, each message is transmitted along with the digital signature of the message generated using the sender's private key. Every intermediate forwarder and the final receiver can authenticate the message using the sender's public key. The recent progress on elliptic curve cryptography (ECC) shows that the public-key schemes can be more advantageous in terms of memory usage, message complexity, and security resilience, since public-key based approaches have a simple and clean key management. The existing anonymous communication protocols are largely stemmed from either mix net or DC-net. A mix net provides anonymity via packet re-shuffling through a

set of mix servers (with at least one being trusted). In a mix net, a sender encrypts an outgoing message, and the ID of the recipient, using the public key of the mix. The mix accumulates a batch of encrypted messages, decrypts and reorders these messages, and forwards them to the recipients. Since mix net-like protocols rely on the statistical properties of the background traffic, they cannot provide provable anonymity. DC-net is an anonymous multi-party computation scheme. Some pairs of the participants are required to share secret keys. DC-net provides perfect (information-theoretic) sender anonymity without requiring trusted servers. However, in DC-net, only one user can send at a time, so it takes additional bandwidth to handle collision and contention.

Proposed system

The proposed system concentrates on providing high privacy to the message authentication. In addition to hop by hop message authentication, key exchange mechanism is enhanced through diffie Hellman key exchange algorithm. The source node encrypts the data using the public key of receiver node, and then transmits the data. After receiver receiving the data, it needs a private key for decrypting data. So the receiver request key server to produce a private key, the key server authenticates the receiver access through key authentication. It is very hard for the malicious node to get a key from key server.

System Architecture



Modules description

Node Deployment

The mobile nodes are designed and configured dynamically, designed to employ across the network, the nodes are set according to the X, Y, Z dimension, which the nodes have the direct transmission range to all other nodes.

SAMA Message authentication

The message receiver should be able to verify whether a received message is sent by the node that is claimed or by a node in a particular group. In other words, the adversaries cannot pretend to be an innocent node and inject fake messages into the network without being detected.

Hop-by-hop message authentication

Every forwarder on the routing path should be able to verify the authenticity and integrity of the messages upon reception. This can be done through the verification of public key. ACK is replied to previous hop node if authentication is successful.

COMPROMISED NODE DETECTION PROCESS

If a message is received by the sink node, the message source is hidden in an AS. Since the SAMA scheme guarantees that the message integrity is unhampered, when a bad or meaningless message is received by the sink node, the source node is viewed as compromised. If the compromised source node only transmits one message, it would be very difficult for the node to be identified without additional network traffic information. However, when a compromised node transmits more than one message, the sink node can narrow the possible compromised nodes down to a very small set.

Key server management

Key server is a certificate authority server, which is responsible for message authentication. The key server verifies the information and authenticates the user. This could be a kind of data encryption and decryption

process. This is achieved through diffie hellman key exchange algorithm.

Algorithm

```

for each location l do                               /* initialize the belief */
    Bel(L0 = l) ← P(L0 = l)                          (17)
end for

forever do
    if new sensory input sT is received do
        αT ← 0
        for each location l do                       /* apply the perception model */
            Bel(LT = l) ← P(sT | l) · Bel(LT-1 = l)  (18)
            αT ← αT + Bel(LT = l)                    (19)
        end for
        for each location l do                       /* normalize the belief */
            Bel(LT = l) ← αT-1 · Bel(LT = l)        (20)
        end for
    end if

    if an odometry reading aT is received do
        for each location l do                       /* apply the motion model */
            Bel(LT = l) ← ∫ P(l | l', aT) · Bel(LT-1 = l') dl'  (21)
        end for
    end if
end forever

```

Tab. 1. The Markov localization algorithm

Steps for Sha1 Algorithm

SHA1 can be accessed through a Generic class called Message Digest.

- 1). Generate a Message Digest object using get instance method of Sha1.
- 2). Call the Digest () Method: Performs SHA1 algorithm on the current input message and returns the message digest as a byte array.
- 3). Give the Input as a File which u want's a mac to be generated.
- 4). Read the Output to the Big integer variable which is used to translate a byte array containing the two's-complement binary representation of a BigInteger into a BigInteger.

Screen Shots



Fig 1: Source

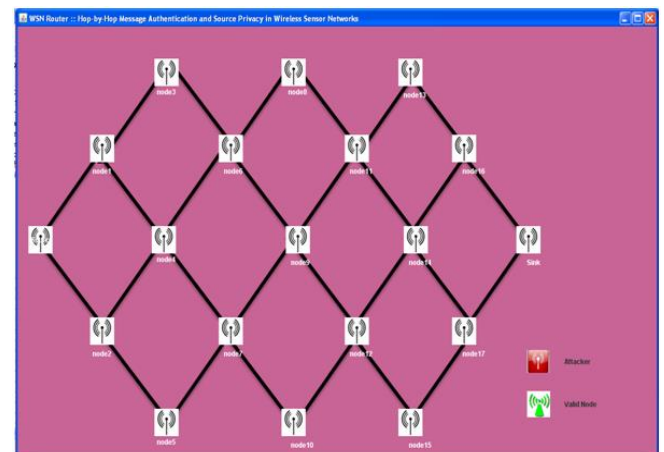


Fig 2: Router

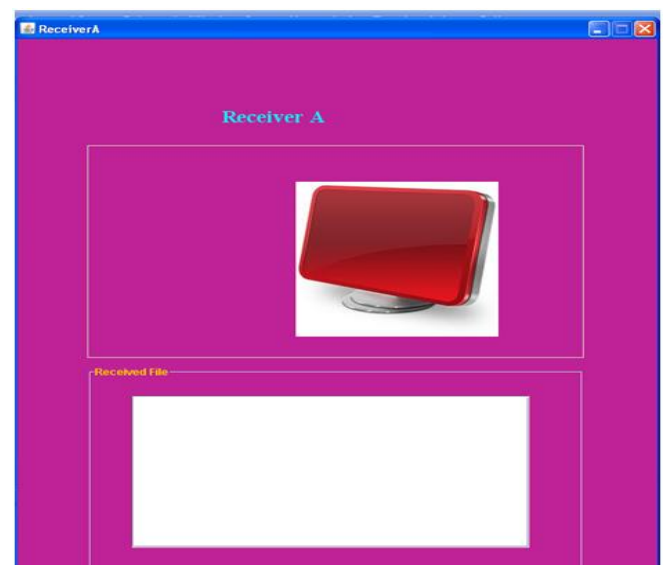


Fig 3: Receiver A



Fig 4: Receiver B

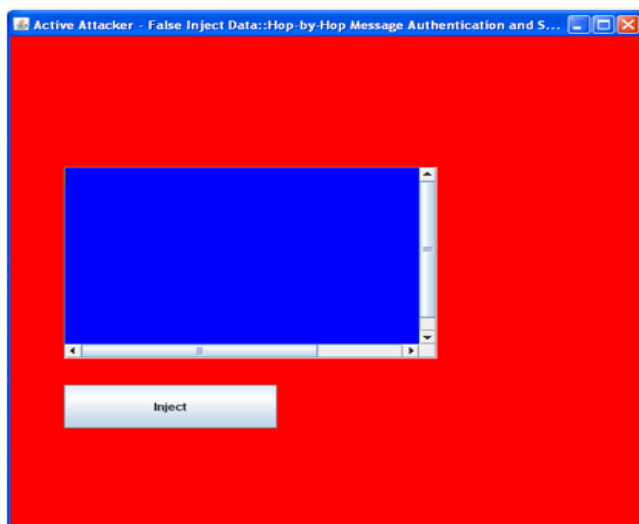


Fig 5: Active attacker

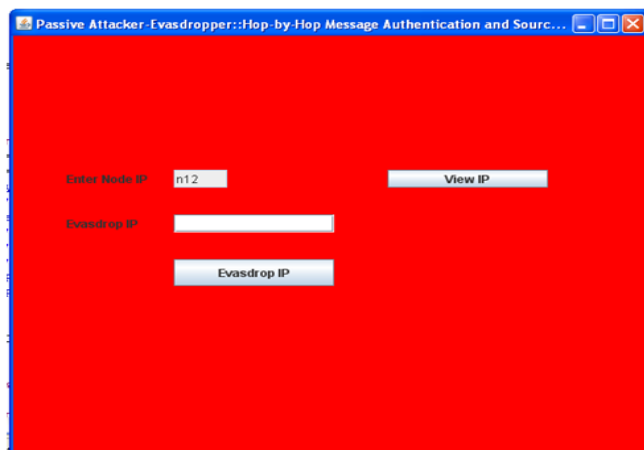


Fig 6: Passive attacker

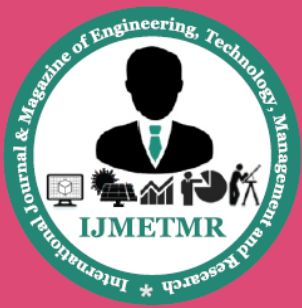
CONCLUSION

In this paper, we first proposed a novel and efficient source anonymous message authentication scheme (SAMA) based on elliptic curve cryptography (ECC). While ensuring message sender privacy, SAMA can be applied to any message to provide message content authenticity. To provide hop-by-hop message authentication without the weakness of the builtin threshold of the polynomial-based scheme, we then propose a hop-by-hop message authentication scheme based on the SAMA. When applied to WSNs with fixed sink nodes, we also discussed possible techniques for compromised node identification. We compared our proposed scheme with the bivariate polynomial-based scheme through simulations using ns-2 and TelosB. Both theoretical and simulation results show that, in comparable scenarios, our proposed scheme is more efficient than the bivariate polynomial-based scheme in terms of computational overhead, energy consumption, delivery ratio, message delay, and memory consumption.

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