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# Efficient Anonymous Certificateless Multi-Receiver Signcryption Scheme without Bilinear Pairings

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**ABSTRACT** Certificateless multi-receiver encryption/signcryption (CLME/CLMS) has become a research hotspot in the field of information security. Almost all of the existing CLME/CLMS schemes are constructed based on the bilinear pairing computation, a time-consuming operation, which makes their computational efficiency relatively low. Although there are some CLME schemes constructed on scalar point multiplications on elliptic curve cryptography (ECC) instead of the bilinear pairing computation, too many scalar point multiplications involved still lead to the low computational efficiency. Therefore, there is still room for CLME/CLMS schemes in efficiency. Motivated by these concerns, an efficient anonymous certificateless multi-receiver signcryption scheme is proposed with its security proved under the random oracle model. The proposed scheme is improved largely in computational efficiency by the idea that it is designed based on scalar point multiplications on ECC instead of the bilinear pairing and the number of scalar point multiplications on ECC is reduced as small as possible.

**INDEX TERMS** Certificateless cryptography; Computational efficiency; Elliptic curve cryptography; Multi-receiver signcryption.

## I. INTRODUCTION

Multi-receiver encryption/signcryption has been considered as an effective and promising way to achieve one-to-many secure communication. The first identity-based multi-receiver encryption (MIBE) scheme was brought forward by Baek *et al.* [1] in 2005. Afterwards, in order to ensure the ciphertext's validity, combining MIBE with Zheng's signcryption [2], Duan *et al.* [3] proposed the first multi-receiver identity-based signcryption (MIBS) scheme and gave the unforgeability security model at the same time. Since then, a large number of MIBS schemes [4]-[9], which are suitable for network conferences, paid-TV system and ad-hoc networks, have been proposed.

With the penetration of the Internet in all aspects of our daily life, people are increasingly focusing on their own privacy. For example, when watching a paid-TV program, people may not want others to know the specific program that they are watching, which belongs to their own privacy. Based on this practical need, introducing the receiver anonymity to MIBE, Fan *et al.* [10] put forward the first

anonymous MIBE scheme by utilizing Lagrange interpolating polynomial. Unfortunately, both Wang *et al.* [11] and Chien [12] later prove that Fan *et al.*'s scheme fails to achieve the receiver anonymity as they have claimed. Afterwards, a new anonymous MIBS scheme was proposed by Pang *et al.* [13], in which the concept of decryption fairness is used to describe the characterization and enhancement of the receiver anonymity, but the receiver anonymity is not achieved due to the use of Lagrange interpolating polynomial, either. To truly achieve the receiver anonymity, in 2014, Tseng *et al.* [14] proposed another anonymous MIBE scheme, in which the receiver anonymity is realized by a modular large prime polynomial and the method is considered as one of the most effective ways to achieve the receiver anonymity so far. Nevertheless, there exists the terrible phenomenon that the number of the involved bilinear pairing operations grows linearly with the number of receivers in Tseng *et al.*'s scheme, which leads to it extremely low in computational efficiency. To further improve efficiency, security and performance, there are a few

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### **Table of Contents Efficient Certificateless Anonymous Multi Receiver**

1. Understanding the eBook Efficient Certificateless Anonymous Multi Receiver
  - The Rise of Digital Reading Efficient Certificateless Anonymous Multi Receiver
  - Advantages of eBooks Over Traditional Books
2. Identifying Efficient Certificateless Anonymous Multi Receiver
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Efficient Certificateless Anonymous Multi Receiver
  - User-Friendly Interface
4. Exploring eBook Recommendations from Efficient Certificateless Anonymous Multi Receiver
  - Personalized Recommendations
  - Efficient Certificateless Anonymous Multi Receiver User Reviews and Ratings
  - Efficient Certificateless Anonymous Multi Receiver and Bestseller Lists

5. Accessing Efficient Certificateless Anonymous Multi Receiver Free and Paid eBooks
  - Efficient Certificateless Anonymous Multi Receiver Public Domain eBooks
  - Efficient Certificateless Anonymous Multi Receiver eBook Subscription Services
  - Efficient Certificateless Anonymous Multi Receiver Budget-Friendly Options
6. Navigating Efficient Certificateless Anonymous Multi Receiver eBook Formats
  - ePub, PDF, MOBI, and More
  - Efficient Certificateless Anonymous Multi Receiver Compatibility with Devices
  - Efficient Certificateless Anonymous Multi Receiver Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Efficient Certificateless Anonymous Multi Receiver
  - Highlighting and Note-Taking Efficient Certificateless Anonymous Multi Receiver
  - Interactive Elements Efficient Certificateless Anonymous Multi Receiver
8. Staying Engaged with Efficient Certificateless Anonymous Multi Receiver
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Efficient Certificateless Anonymous Multi Receiver
9. Balancing eBooks and Physical Books Efficient Certificateless Anonymous Multi Receiver
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Efficient Certificateless Anonymous Multi Receiver
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Efficient Certificateless Anonymous Multi Receiver
  - Setting Reading Goals Efficient Certificateless Anonymous Multi Receiver
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Efficient Certificateless Anonymous Multi Receiver
  - Fact-Checking eBook Content of Efficient Certificateless Anonymous Multi Receiver
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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