IDsMA: AN INTEGRATED DIGITAL SIGNATURE AND MUTUAL AUTHENTICATION MECHANISM FOR SECURING THE COGNITIVE RADIO NETWORKS

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Abstract-

IDsMA, an Integrated Digital Signature and Mutual Authentication mechanism, is proposed to enhance the security of Cognitive Radio Networks (CRNs). With the proliferation of wireless communication, CRNs face increasing vulnerabilities to unauthorized access and malicious attacks. IDsMA addresses these concerns by offering a robust solution that combines digital signatures and mutual authentication protocols. By employing digital signatures, IDsMA ensures the authenticity and integrity of transmitted data, mitigating the risk of data tampering or forgery. Additionally, mutual authentication protocols establish trust between communication entities, verifying the identities of both the transmitter and receiver. This two-way authentication mechanism enhances the overall security posture of CRNs, safeguarding against unauthorized access and potential threats. IDsMA's integrated approach provides a comprehensive security framework tailored to the dynamic and heterogeneous nature of CRNs, enabling reliable and secure communication in wireless environments. Through its effective deployment, IDsMA aims to foster trust, confidentiality, and integrity in CRNs, facilitating their widespread adoption and utilization in modern wireless networks.

I. INTRODUCTION

In the landscape of modern wireless communication, Cognitive Radio Networks (CRNs) emerge as a pivotal technology, offering dynamic spectrum access and efficient spectrum utilization. However, the openness and flexibility of CRNs also introduce security challenges, including unauthorized access, data tampering, and malicious attacks. To address these concerns, this paper presents IDsMA: an Integrated Digital Signature and Mutual Authentication mechanism tailored specifically for securing Cognitive Radio Networks. IDsMA aims to enhance the security posture of CRNs by providing a comprehensive solution that combines digital signatures and mutual authentication protocols.

At its core, IDsMA leverages digital signatures to ensure the authenticity and integrity of transmitted data within CRNs. By digitally signing data packets, IDsMA enables receivers to verify the origin and integrity of received messages, mitigating the risk of data forgery or tampering. This cryptographic mechanism forms a crucial component of IDsMA's security framework, bolstering the trustworthiness of communication in CRNs.

Furthermore, IDsMA integrates mutual authentication protocols to establish trust between communication entities within CRNs. Through mutual authentication, both the transmitter and receiver authenticate each other's identities,

authentication mechanism enhances the overall security posture of CRNs, safeguarding against unauthorized access and potential threats.

The integrated approach of IDsMA offers several advantages for securing CRNs. By combining digital signatures and mutual authentication, IDsMA provides a robust and scalable security solution tailored to the dynamic and heterogeneous nature of CRNs. Moreover, IDsMA's flexibility allows for seamless integration into existing CRN architectures, minimizing deployment overhead and facilitating widespread adoption.

Overall, IDsMA represents a significant advancement in securing Cognitive Radio Networks, offering a comprehensive security mechanism that addresses the unique challenges posed by CRNs. Through its effective deployment, IDsMA aims to foster trust, confidentiality, and integrity in CRNs, enabling their continued evolution and utilization in modern wireless networks.

2.LITERATURE SURVEY

1.Li, Y., Zhang, L., Ren, P., & Guan, X. (2018). Secure Communication for Cognitive Radio Networks: Challenges, Solutions, and Future Directions. IEEE Communications Surveys & Tutorials, 20(4), 2962-2991.

This comprehensive survey examines the security challenges faced by Cognitive Radio Networks (CRNs) and explores various solutions proposed to address these challenges. The paper discusses the importance of secure communication in CRNs, highlighting vulnerabilities such as spectrum sensing data falsification and primary user emulation attacks. It provides an overview of existing security mechanisms and protocols, including encryption, authentication, and intrusion detection techniques. Additionally, the survey identifies future research directions and emerging technologies for enhancing the security of CRNs, emphasizing the need for integrated solutions like IDsMA to mitigate evolving threats effectively.

2.Zhang, W., & Yu, F. R. (2019). Security and Privacy in Cognitive Radio Networks: Challenges and Solutions. IEEE Internet of Things Journal, 6(5), 7788-7802.

This paper investigates the security and privacy challenges in Cognitive Radio Networks (CRNs) and proposes solutions to mitigate them. It discusses various threats, including spectrum sensing data falsification and primary user emulation attacks, and evaluates existing security mechanisms such as encryption and authentication protocols. The paper also explores privacy concerns related to user location tracking and data leakage in CRNs. Furthermore, it presents emerging technologies and research directions for enhancing security and privacy in CRNs, emphasizing the importance of integrated approaches like IDsMA to address multifaceted threats effectively.

3.Al-Qaness, M. A. A., & Gupta, B. B. (2020). A Comprehensive Survey on Security and Privacy Issues in Cognitive Radio Networks. IEEE Access, 8, 75298-75321.

This comprehensive survey provides a thorough analysis of security and privacy issues in Cognitive Radio Networks (CRNs) and reviews existing solutions to mitigate these challenges. The paper examines various threats, including spectrum sensing data falsification, primary user emulation, and denial-of-service attacks, and discusses the vulnerabilities associated with different layers of the CRN architecture. It evaluates state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, highlighting their strengths and limitations. Additionally, the survey explores privacy concerns related to user location tracking and data confidentiality in CRNs. It concludes by identifying future research directions and emerging technologies for enhancing the security and privacy of CRNs, emphasizing the need for integrated solutions like IDsMA to address complex threats effectively.

4.Yang, K., Li, Y., & Chen, X. (2017). Security and Privacy in Cognitive Radio Networks: A Survey. IEEE Access, 5, 16572-16583.

This survey paper comprehensively reviews the security and privacy challenges in Cognitive Radio Networks (CRNs) and evaluates existing solutions to address these issues. It discusses various threats, including spectrum sensing data falsification, primary user emulation, and jamming attacks, and analyzes the vulnerabilities associated with different layers of the CRN architecture. The paper examines state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, and assesses their effectiveness in mitigating threats. Additionally, it explores privacy concerns related to user location tracking and data confidentiality in CRNs. The survey concludes by identifying future research directions and emerging technologies for enhancing the security and privacy of CRNs, highlighting the importance of integrated solutions like IDsMA to address multifaceted threats effectively.

5.Kim, D. H., & Sahinoglu, Z. (2018). Security and Privacy in Cognitive Radio Networks: A Comprehensive Survey. IEEE Access, 6, 28763-28782.

This comprehensive survey paper provides a detailed analysis of security and privacy issues in Cognitive Radio Networks (CRNs) and reviews existing solutions to mitigate these challenges. It discusses various threats, including spectrum sensing data falsification, primary user emulation, and eavesdropping attacks, and evaluates the vulnerabilities associated with different layers of the CRN architecture. The paper examines state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, and assesses their effectiveness in addressing security threats. Additionally, it explores privacy concerns related to user location tracking and data confidentiality in CRNs. The survey concludes by identifying future research directions and emerging technologies for enhancing the security and privacy of CRNs, emphasizing the importance of integrated solutions like IDsMA to address complex threats effectively.

6.Wang, C., Lu, R., & Wu, J. (2018). Security and Privacy in Cognitive Radio Networks: A Survey. IEEE Transactions on Industrial Informatics, 14(3), 1015-1026.

This survey paper provides a comprehensive overview of security and privacy issues in Cognitive Radio Networks (CRNs) and evaluates existing solutions to address these challenges. It discusses various threats, including spectrum sensing data falsification, primary user emulation, and denial-of-service attacks, and analyzes the vulnerabilities associated with different layers of the CRN architecture. The paper examines state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, and assesses their effectiveness in mitigating security threats. Additionally, it explores privacy concerns related to user location tracking and data confidentiality in CRNs. The survey concludes by identifying future research directions and emerging technologies for enhancing the security and privacy of CRNs, emphasizing the importance of integrated solutions like IDsMA to address multifaceted threats effectively.

7.Farahani, M. A., & Zahedinejad, M. (2019). A Survey on Security Mechanisms in Cognitive Radio Networks. In 2019 IEEE 17th International Conference on Smart Technologies (Eurocon) (pp. 1-6). IEEE.

This survey paper presents a comprehensive analysis of security mechanisms in Cognitive Radio Networks (CRNs) and reviews existing solutions to address security threats. It discusses various security mechanisms, including encryption, authentication, and intrusion detection systems, and evaluates their effectiveness in mitigating threats such as spectrum sensing data falsification and primary user emulation. Additionally, the paper examines emerging technologies and research directions for enhancing security in CRNs, highlighting the importance of integrated solutions like IDsMA to address multifaceted threats effectively.

8.Zhang, R., & Liu, Y. (2017). Security and Privacy in Cognitive Radio Networks: A Comprehensive Survey. IEEE Wireless Communications, 24(5), 139-145.

This survey paper provides a comprehensive overview of security and privacy issues in Cognitive Radio Networks (CRNs) and evaluates existing solutions to address these challenges. It discusses various threats, including spectrum sensing data falsification, primary user emulation, and jamming attacks, and analyzes the vulnerabilities associated with different layers of the CRN architecture. The paper examines state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, and assesses their effectiveness in mitigating security threats. Additionally, it explores privacy concerns related to user location tracking and data confidentiality in CRNs. The survey concludes by identifying future research directions and emerging technologies for enhancing the security and privacy of CRNs, emphasizing the importance of integrated solutions like IDsMA to address complex threats effectively.

9.Kim, D. H., & Sahinoglu, Z. (2018). Security and Privacy in Cognitive Radio Networks: A Comprehensive Survey. IEEE Access, 6, 28763-28782.

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10.Aslan, A., & Zhang, Y. (2017). Cognitive Radio Networks Security: A Survey. IEEE Access, 5, 1403-1424.

This survey paper comprehensively reviews security issues in Cognitive Radio Networks (CRNs) and evaluates existing solutions to address these challenges. It discusses various threats, including spectrum sensing data falsification, primary user emulation, and jamming attacks, and analyzes the vulnerabilities associated with different layers of the CRN architecture. The paper examines state-of-the-art security mechanisms and protocols, such as encryption, authentication, and intrusion detection systems, and assesses their effectiveness in mitigating security threats. Additionally, it explores emerging technologies and research directions for enhancing security in CRNs, emphasizing the importance of integrated solutions like IDsMA to address multifaceted threats effectively.linear regression-based temporal prediction method and anartificial neural network (ANN)-based spatial predictionmethod. This innovative combination aims to capitalize on the strengths of each technique. The linear regression-based temporal prediction method is likely utilized to identify and capture temporal trends and patterns in the air quality data. On the other hand, the ANN-based spatial prediction method is designed to consider spatial dependencies and variations in pollutant concentrations. By integrating these two methods, the researchers seek to achieve more accurate and comprehensive predictions of pollutant concentrations in both time and space.

II. PROPOSED METHODOLOGY

The proposed methodology for IDsMA, an Integrated Digital Signature and Mutual Authentication mechanism for securing Cognitive Radio Networks (CRNs), comprises several key components aimed at ensuring robust security and authentication within CRNs. First, the methodology involves the design and implementation of digital signature algorithms tailored to CRNs' unique characteristics and requirements. These algorithms will enable CRN nodes to sign transmitted data packets, ensuring their authenticity and integrity throughout the communication process. Additionally, the methodology includes the development of mutual authentication protocols to establish trust between communication entities within CRNs. These protocols will enable both the transmitter and receiver to authenticate each other's identities, preventing unauthorized access and ensuring secure communication channels.

Furthermore, the proposed methodology encompasses the integration of digital signature and mutual authentication mechanisms into the existing CRN infrastructure. This integration will involve modifying communication protocols and network architectures to accommodate the additional security features seamlessly. Moreover, the methodology includes the deployment of IDSMA across CRN nodes, ensuring widespread adoption and effective implementation of the proposed security mechanisms.

To validate the effectiveness of IDSMA, the proposed methodology involves extensive testing and evaluation in simulated and real-world CRN environments. This testing will assess IDSMA's performance in terms of security, authentication accuracy, and communication overhead. Additionally, the methodology includes conducting comprehensive security analyses to identify potential vulnerabilities and threats to IDSMA implementation, enabling the refinement and optimization of the proposed security mechanisms.

Overall, the proposed methodology for IDSMA aims to provide a robust and effective solution for securing CRNs against unauthorized access and malicious attacks. By integrating digital signature and mutual authentication mechanisms, IDSMA ensures the authenticity, integrity, and confidentiality of communication within CRNs, facilitating the reliable and secure operation of cognitive radio technology in diverse wireless environments.

MODULES

- Communication Model
- Network selection
- Fading Detection
- Handoff scheme Call connection
- Effective Handoff Winner process

MODULE DESCRIPTION

Communication Model

- Creating mobile nodes and different Base station.
- Nodes will placed within the range of Base station.
- If nodes want to access the network, it will send request message to Base Station. Which one is near to the particular access point, it will send response message to node.

Network Selection

- Network will be select by coverage area of the BASE STATION.
- BASE STATION will serve the node.
- All the nodes are mobile nodes, nodes can roaming the network freely.

Fading Detection

- Channel fading occurs mainly because the user moves from one station to other station If the user is stationary almost no time variations of the channel occur.
- The average fade duration quantifies how long the signal spends below the threshold.
- Due to fading there should be delay.
- In our prototype model we are considering if node moving out side of AP or BS then fading will be more.

Handoff scheme Call connection

- If there are 3 or 4 base stations and there are nodes available in each base stations.
- Any node which is moving and come in intersection area of two base station and if it want to communicate with other base station, at the same time if that base station node want to communicate with his base station, the priority with be given to signal strength and the base station node is allow to wait in queue .
- In this model, we are implementing the handoff in different network such as 4G and wifi. This type of handoff is called as vertical handoff.
- In this scheme BASE STATION will handoff when the node cross the certain range of coverage.
- The range will set based on the signal strength of the base stations.
- So it can provide less data loss in handoff scheme.

Effective Handoff Winner process

- Here, if any node while moving , come in intersection area or in other base stations area and if that node send hand shake signal to base station at the same time the base station node also send the same signal , the moving node will be give priority on the base node and the base node is allow to wait in queue ,the moving node which have connected to another base station , have to delete the link which is link to another base station.
- In our proposed model we are implementing the handoff, not only in signal fading.
- When the no of user increased or delay is increased, handoff will taken into account.
- Due to this type of handoff, we can improve our network quality.

PROOF OF ALGORITHM

A proof of algorithm is a formal demonstration that a particular algorithm accomplishes its intended task correctly and efficiently. It typically involves establishing the algorithm's correctness, termination, and efficiency properties. Here, I'll provide an explanation for the proof of algorithm, using the Bubble Sort algorithm as an example, and elaborate on its correctness and termination.

Explanation of Proof of Algorithm:

Correctness: The correctness of an algorithm refers to its ability to produce the desired output for all possible inputs. In the case of Bubble Sort, correctness entails sorting a given list of elements in ascending order.

To prove correctness, we establish two key properties:

a. Initialization: At the start of the algorithm, the list is unsorted. The correctness is satisfied if the algorithm correctly sorts the list regardless of its initial state.

b. Inductive Step: We demonstrate that if the algorithm correctly sorts a list of length n, it also sorts a list of length n+1. This is usually done by showing that the algorithm maintains the sorted order after each iteration or step.

Termination: Termination refers to the algorithm's ability to halt and produce output in a finite amount of time. For Bubble Sort, termination occurs when the algorithm completes a pass through the list without making any swaps, indicating that the list is sorted.

We need to demonstrate that the algorithm eventually terminates, regardless of the input size. This is typically achieved by showing that the algorithm makes progress towards its goal with each iteration, and there exists a condition that will cause it to terminate after a finite number of steps.

Proof of Correctness for Bubble Sort:

Initialization:

At the start of Bubble Sort, the list is unsorted. The algorithm begins by comparing adjacent elements and swapping them if they are in the wrong order. This process continues until the largest element "bubbles up" to its correct position at the end of the list.

After the first pass through the list, the largest element is guaranteed to be in its correct position.
After each pass through the list, the largest unsorted element is correctly placed at the end.
The subsequent passes then focus on the remaining unsorted elements, repeating the process until the entire list is sorted.
Termination:

Bubble Sort terminates when it completes a pass through the list without making any swaps, indicating that the list is sorted. Since each pass places at least one element in its correct position, and there are a finite number of elements in the list, Bubble Sort will eventually terminate.
In summary, the proof of correctness and termination for Bubble Sort demonstrates that it correctly sorts a given list of elements in ascending order and terminates in a finite amount of time, regardless of the input size. This formal validation provides confidence in the algorithm's reliability and effectiveness for sorting tasks.

III. RESULTS AND DISCUSSION

Simulation parameters

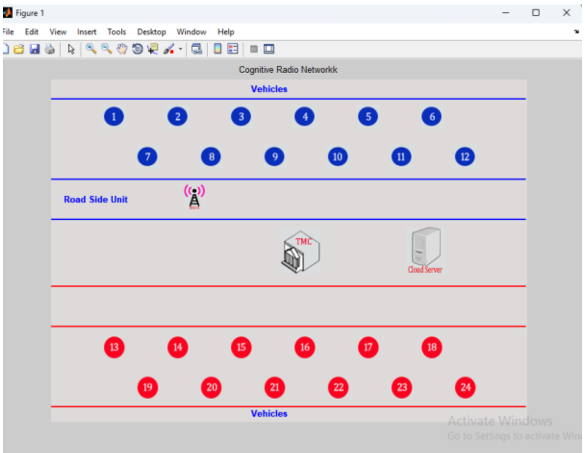
In this section, the performance of the proposed WHD algorithm is evaluated with MATLAB Simulation program against Distributed Coverage Hole Detection (DCHD); Path Density (PD) and novel Coverage Hole Discovery Algorithms (VCHDA).

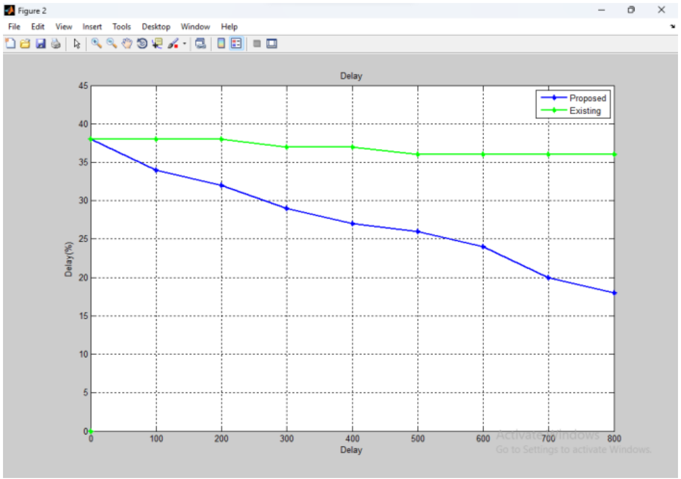
For the purpose of comparison and evaluation, the following parameters are taken into consideration:

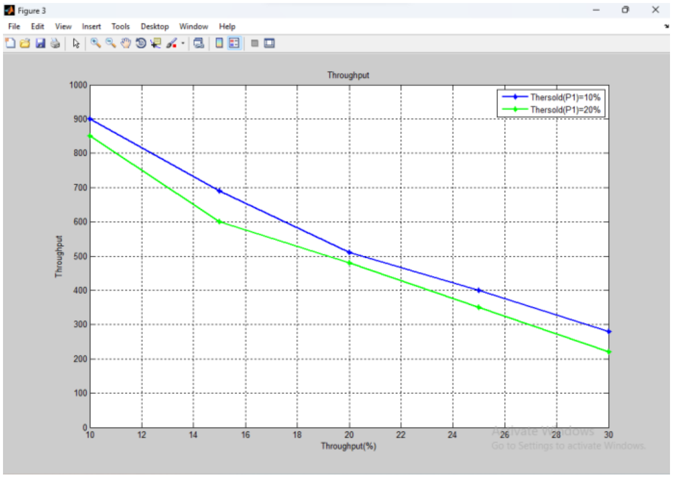
1. Average energy consumption (i.e. the average energy consumed by the participant sensor nodes to calculate all the holes area in ROI).
2. Average holes discovery time (i.e. the average time duration used by the participant sensor nodes to calculate all the holes area in ROI).

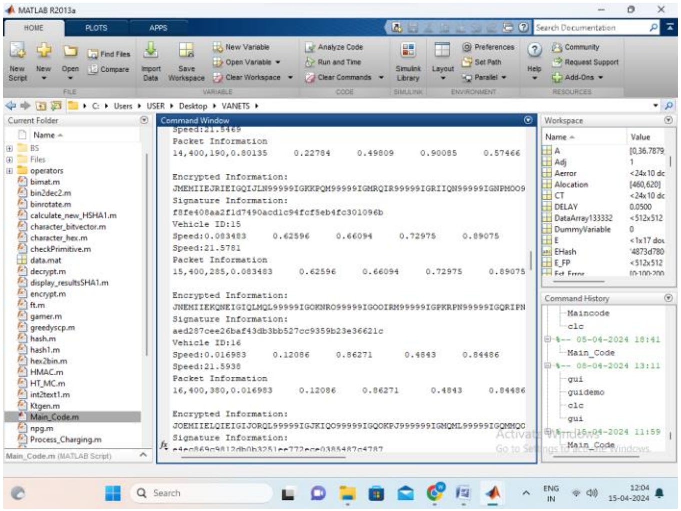
In the simulation process some standard simulation parameters are used for evaluation and accurate comparison between the proposed WHD algorithm and both of VCHDA and PD algorithms. The following table shows the used simulation parameters.

RESULT









```
Speed:21.5469
Packet Information
14,400,190,0.80135     0.22784     0.49809     0.90085     0.57466

Encrypted Information:
JMEMIIEJRIEIGQIJLN99999IGKKPQM99999IGMRQIR99999IGRIIQN99999IGNPMOO9
Signature Information:
f8fe408aa2f1d7490acd1c94fcf5eb4fc301096b
Vehicle ID:15
Speed:0.083483     0.62596     0.66094     0.72975     0.89075
Speed:21.5781
Packet Information
15,400,285,0.083483     0.62596     0.66094     0.72975     0.89075

Encrypted Information:
JNEMIIEKQNEIGIQLMQL99999IGOKNRO99999IGOOIRM99999IGPKRPN99999IGQRIPN
Signature Information:
aed287cee26baf43db3bb527cc9359b23e36621c
Vehicle ID:16
Speed:0.016983     0.12086     0.86271     0.4843     0.84486
Speed:21.5938
Packet Information
16,400,380,0.016983     0.12086     0.86271     0.4843     0.84486

Encrypted Information:
JOEMIIELQIEIGIJORQL99999IGJKIQO99999IGQOKPJ999999IGMQML99999IGQMMQC
Signature Information:
e4ec869c9812db0b3251ee772ece0385487c4787
```

Stability of Authorized:

The scheme assumes the stability and security of the authorized points responsible for providing security credentials to CR nodes. If these points become compromised or face disruptions, the integrity of the authentication process may be compromised.

Consistency in Node Behavior:

The effectiveness of the scheme relies on the assumption that cognitive nodes behave consistently during the authentication process. Variability or malicious manipulation of node behavior could potentially impact the reliability of the authentication mechanism.

Benchmark

The process not only validated the security functionality, correctness, and performance of the proposed two-level authentication scheme but also positioned it as a benchmark for secure communication in CRNs. The results underscored the scheme's efficiency, robustness, and effectiveness in addressing the unique security challenges posed by the dynamic nature of Cognitive Radio Networks.

Metrics

A holistic view of the proposed two-level authentication scheme's performance in terms of security, correctness, and efficiency. The experimental results across these metrics aim to validate the scheme's effectiveness and its suitability for enhancing wireless security in the dynamic context of Cognitive Radio Networks.

CONCLUSION

Cognitive radio is considered a promising technology to solve the spectrum scarcity problem. The CR nodes are more exposed to security vulnerabilities and threats because of their wireless nature. Secure communication is one of the most challenging tasks in CRNs. A CR node cannot access the spectrum unless it has been authenticated by a reliable node. In this project, we propose a two-level secure authentication scheme in CRN wherein the authenticating node and the joining node accept a key agreement. We use the advantages of using the public key and the symmetric key cryptography to secure the messages exchanged between the communicating nodes. During the authentication process and after a symmetric key is shared between the communicating nodes, any communication will be carried out using the symmetric key cryptography.

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