A Literature Survey on Security Challenges in VANETs

Ahmad Yusri Dak, Saadiah Yahya, and Murizah Kassim

***Abstract*—This paper presented a literature survey on security challenges in Vehicle Ad-hoc Networks (VANETs). Many researches on Mobile Ad-Hoc Networks (MANETs) have been done where VANETs routing protocol has taken as a new protocol exist in the network. This protocol or system allows cars to talk to each other where a wireless device sends information to nearby vehicles. More and more technique using VANETs also has been published but yet no comparison has been made between them to look further on the security issues. This research discussed the security issues such as confidentiality, authenticity, integrity, availability and non-repudiation aimed to secure communication between vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I). It discussed and analyzed literature on the possible security attacks from 13 researchers that address security and privacy concern in VANETs. Statistics on the relationship between security services versus the technique to encounter the possible attacks is tabulated. Five security services with security attacks and techniques also have been presented. This paper can serve as a reference in building the new technique for VANETs.**

***Index Terms*—Vehicle ad-hoc networks (VANETs), mobile ad-hoc networks (MANETs), security, technique.**

I. Introduction

Vehicular networks are emerging as a new promising field of wireless technology which aims to deploy vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) for safety and non-safety applications. It provides the ability of vehicle to communicate among nearby vehicle and road-side unit (RSUs) as shown in Figure 1. When RSU receives a message from vehicle, it authenticates the message to ensure no malicious message. The Autonomous Server (AS) is responsible for security related issues between vehicle and RSU. Based on wireless fundamental concepts, Wireless Ad-Hoc Network (WANET) has many categories such as wireless mesh networks, wireless sensor networks and Mobile Ad-Hoc Networks (MANETs) as shown in Figure 2. VANETs is a subset of MANETs with a unique characteristic of dynamic nature or node mobility, frequent exchange information, real time processing, self-organizing, infrastructure less nature, low volatility and distance. It is considered the first commercial vehicles of MANETs. In VANETs, security and privacy are identified as major challenge.

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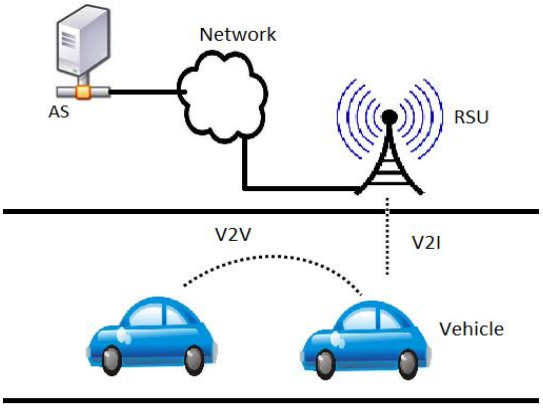

Fig. 1. V2V and V2I communication.

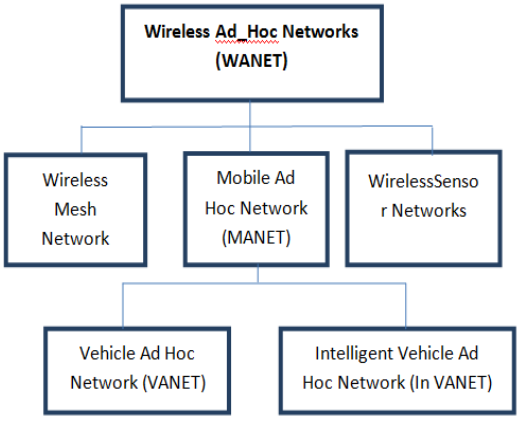

Fig. 2. Structure of WANETs.

This research discusses the security issues such as confidentiality, authenticity, integrity, availability and non-repudiation aim to secure communication between V2V and V2I. The privacy issues are concerned with protecting and disclosing driver's personal information such as name, location, plate number and many more. This paper has discussed and analyzed the possible of security attacks from 13 researchers that address security and privacy concern in VANETs. The analysis concludes that a research gap in the area of security in VANETs. In Section 3, a study on the relationship between securities services versus the technique proposed to encounter the possible attacks is presented

II. Possible Attacks in VANETs

There are a numbers of possible attacks in VANETs. The purpose of these attacks is to create problem for users to access the system or phising some information. Derived are some definition of attacks.

A. Sybil Attacks

Sybil attack is the creation of multiple fake nodes broadcasting false information. In Sybil attack, a vehicle

install with On Board Unit(OBU) sends multiple copies of messages to other vehicle and each message contains a different fabricated identity. The problem arises when malicious vehicle is able to pretend as multiple vehicle and reinforce false data. There are several technique proposed to encounter Sybil attack in VANETs such as statistical and probability, signal strength and session keys [1]-[6]. However, each of these schemes has advantageous and disadvantageous due to dynamic characteristics, weather conditions and system design. One of the interesting method proposed by [1] and [4] are based on statistical and probability algorithm integrated with signal strength as an input data. The different between received signal strength and estimate signal strength is claimed by positionaire calculated. It is analysed by AS using statistical and probability algorithm. A framework to detect Sybil attacks in nodes has been proposed using Certificate Authority (CA) [2], [3]. Two main steps involve in the proses are system initialization and attacks detection where public key and private key are used during system initialization to sign in the message.

B. Node Impersonation

Node impersonation is an attempt by a node to send modified version of message and claims that the message comes from originator for the unknown purpose. An algorithm technique to detect and isolate node impersonation using greedy algorithm that is Detection of Malicious Vehicle(DMV) and Outlier Detection algorithm has been proposed to overcome this problem [7]-[9]. The schemes used RSU to detect and observe an abnormal behaviour of nodes. The proposed scheme increases the trust value of the node if the vehicle is trusted. The identity(ID) of the vehicle will be reported to the relevant Certificate Authority (CA) as malicious if distrust value is higher than threshold value.

C. Sending False Information

Sending False Information can be described as sending the wrong and fake information purposely by one node to another to create chaos scenarios. This scenario may create misinterpretation of the actual scenario. False information is sent by attackers to vehicle for selfish reasons. For example, attacker might send false report on congestion, accident or road block in order to clear the road. A scheme has been proposed to detect the compromised nodes that may misbehave using different kinds of technique [2], [3], [5], [7], [10]-[12]. One of the schemes is a group signature which relies on password access. It can be applied to sign message so that when another vehicle receives a message, it only check the authentication of the message. However, this scheme is not practical since group members always will change frequently especially in a city networks.

D. ID Disclosure

The nodes are able to disclose the identity in the network and track the location of the target nodes. Observer monitors the target nodes and sends a virus to the neighbours of the target nodes. When the neighbours of the attacker are attacked by virus, then they take the ID of the target nodes as well as target's nodes current location [2][3][7][10]. A technique to deal with privacy preserving scheme such as identity disclosure has been proposed to prevent vehicle from being tracked by identifying keys that are used. Al-Hawi et al.[10] is used pseudonyms as an exchange mechanism to encrypt and hide vehicle's unique identity such as driver's name, plate number and location. The pseudonyms used the Public Key Infrastructure to sign the message and this make it difficult to track.

E. DoS and DDoS Attack

The attacker attacks the communication medium or network's nodes to cause the channel or some problem to networks or nodes. The vehicle is unable to access the networks and result in devastation and overtiredness of the nodes and network's resources. None of the reseachers are focusing on DoS and DDoS attack in VANETs as up to date.

III. Security Services in MANET

Security is an important issue for ad hoc networks, especially for security sensitive applications. To secure an ad hoc network, we need to consider the following attributes as criteria to measure security which include availability, confidentiality, integrity, authentication and non-repudiation.

A. Availability

The availability deals with network services for all nodes comprises of bandwidth and connectivity[13]. In order to encounter the availability issues, prevention and detection technique using group signature scheme has been introduced[10]. The scheme is focusing on availability of exchanging the messages between vehicles and RSUs. When the attack causes network unavailability, the proposed technique still survives due to interconnection using public and private keys between RSUs and vehicles.

B. Confidentiality

Confidentiality ensures that classified information in the network can never disclosed to unidentified entities[14]. It also prevents unauthorized access to confidential information such as name, plate number and location. The most popular technique, pseudonyms are used to preserved privacy in vehicular networks [2][3]. Each vehicle node will have multiple key pairs with encryption. Messages are encrypted or signed using different pseudo and these pseudo has not linked to the vehicle node but relevant authority has access to it. Vehicle need to obtain new pseudo from RSUs before the earlier pseudo expires.

C. Authentication

Authentication is the verification of the identity between vehicles and RSUs and the validation of integrity of the information exchange. Additionally, it ensure that all vehicles are the right vehicle to communicate within network. Public or private keys with CA are proposed to establish connection between vehicles, RSUs and AS [8], [12]. On the other hand, password is used to access to the RSUs and AS as authentication method [10].

D. Integrity

Data integrity is the assurance that the data received by nodes, RSUs and AS is the same as what has been generated during the exchanges of the message. In order to protect the integrity of the message, digital signature which is integrated with password access are used [10].

E. Non-Repudiation

Ensures that sending and receiving parties cannot deny ever sending and receiving the message such as accident messages. In certain fields, non-repudiation is called auditability whereby RSUs and vehicles can prove have been receive and sent respectively.

IV. Analysis of Attacks

Listed in Table I, Table II and Table III are analysis of attacks based on previous researches. Based on the statistics four most attacks have been identified as listed in Table I.

TABLE I: Analysis of Security Attacks in VANETs.

Authors	Sybil Attacks	Node Imper'	Sending False Info'	ID Disc'
Daeinabi A. and Rahbar A.G.,2011 [8]		√		
Li and Joshi, 2009 [9]		√		
Xiao B et al, 2006 [1]	√			
Zhou T. et al, 2011 [2]	√		√	√
Zhou T et al,2010 [3]	√		√	√
W.W.Neng et al, 2008 [7]			√	√
Grover J. et al, 2010 [4]	√			
Hao Y. et all, 2011 [5]	√		√	
Mainak G. et al, 2009 [10]			√	√
Park S. et al, 2009 [6]	√			
Al-Hawi F. et al, 2010 [11]		√		√
G. Mainak et al, 2009 [12]			√	

V. Conclusion

This paper has briefly introduced Vehicular Ad Hoc Networks and challenges associated with security attacks and security services. It also deeply dig out the security gap for DoS and DDoS that never been explorer previously as in Table I. Various techniques has been identified and discussed by researchers to solve security issues as depicted in Table II and Table III. Five security services with security attacks and techniques has been analysed and tabulated in Table IV according to its security problem.

TABLE II: Analysis of Security Services in VANETs on Availability and Authenticity.

Problem statement	Availability		Authenticity	
		Technique		Technique
Daeinabi A. and Rahbar A.G.,2011 [8]			√	Threshold value & CA
Li and Joshi, 2009 [9]			√	Outlier detection algorithm
Xiao B et al, 2006 [1]			√	
Zhou T. et al, 2011 [2]			√	CA/PKC
Zhou T et al,2010 [3]			√	PKC
W.W.Neng et al, 2008 [7]			√	CA/ Symmetric crypto
Grover J. et al, 2010 [4]			√	CA/ Symmetric Crypto
Hao Y. et all, 2011 [5]			√	CA/ digital signature
Mainak G. et al, 2009 [10]	√	Group Signature		Digital signature – secret signing key
Park S. et al, 2009 [6]			√	Digital certificates
G. Mainak et al, 2009 [12]			√	Digital Certificate

TABLE III: Analysis of Security Services in VANETs on Confidential, Integrity and Non-Repudiation.

Problem statement	Confidentiality (Privacy)		Integrity		Non-repudiation	
		Technique		Technique		Technique
Zhou T. et al, 2011 [2]	√	Pseudonyms				
Zhou T et al,2010 [3]	√	Pseudonyms				
W.W.Neng et al, 2008 [7]	√	Session keys				
Grover J. et al, 2010 [4]	√	Session keys: Pairwise & group keys.			√	Digital Signature with sequence number
Hao Y. et all, 2011 [5]	√	Group signature/ private key				
Mainak G. et al, 2009 [10]	√	Group public key	√	Digital signature with password		
Park S. et al, 2009 [6]	√	Timestamp				
Al-Hawi F. et al, 2010 [11]	√	Pseudonyms			√	ID Based signature

TABLE IV: Secure Routing Protocol.

Security Problem	Security attacks	Technique
Availability	Interruption	Group Signature
Authentication	Fabrication	Certificate Authority(CA)
Integrity	Modification	Digital Signature with password
Confidentiality	Interception	Encryption and decryption
Non-repudiation		Sequence number, Digital Signature

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