https://dx.doi.org/10.22161/ijaems.4.3.12 *ISSN: 2454-1311*

Automated Sensing System for Monitoring Road Surface Condition Using Fog Computing

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Abstract— *The principle point of this task is to build up an Intelligent Monitoring System used to screen the Road Surface Condition using Fog Computing that increases the road safety. Multiple solutions have been proposed which make use of mobile sensing, more specifically contemporary applications and architectures that are used in both crowd sensing and vehicle based sensing. Nonetheless, these initiatives have not been without challenges that range from mobility support, location awareness, low latency as well as geo-distribution. As a result, a new term has been coined for this novel paradigm, called, fog computing.*

Keywords—Certificateless aggregate signcryption (CLASC), fog computing, road surface condition monitoring system, security.

I. INTRODUCTION

1.1 Overview of the Project

Great attention has been directed toward road surface condition monitoring in the recent past. As a matter of fact, this activity is of critical importance in transportation infrastructure management. In response, multiple solutions have been proposed which make use of mobile sensing, more specifically contemporary applications and architectures that are used in both crowd sensing and vehicle-based sensing. This has allowed for automated control as well as analysis of road surface quality. These innovations have thus encouraged and showed the importance of cloud to provide reliable transport services to clients. Nonetheless, these initiatives have not been without challenges that range from mobility support, locational awareness, low latency, as well as geo-distribution. As a result, a new term has been coined for this novel paradigm, called, fog computing. In this paper, we propose a privacy-preserving protocol for enhancing security in vehicular crowd sensing based road surface condition monitoring system using fog computing. At the onset, this paper proposes a certificate less aggregate signcryption scheme that is highly efficient.

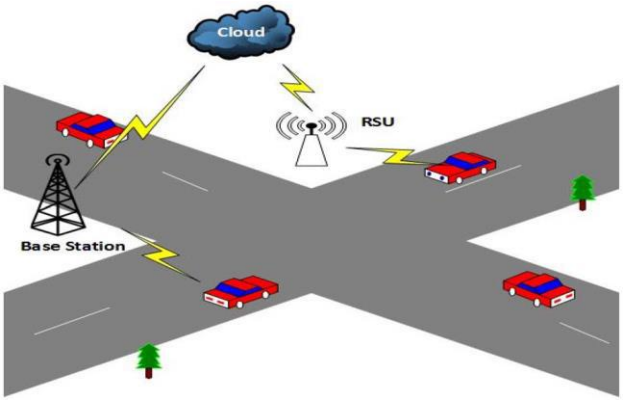

Fig.1: Cloud-based Architecture

On the basis of the proposed scheme, a data transmission protocol for monitoring road surface conditions is designed with security aspects such as information confidentiality, mutual authenticity, integrity, privacy, as well as anonymity. In analyzing the system, the ability of the proposed protocol to achieve the set objectives and exercise higher efficiency with respect to computational and communication abilities in comparison to existing systems is also considered.

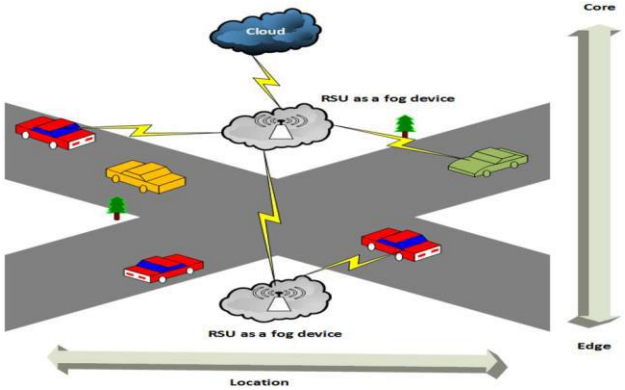

Fig.2: Fog-based Architecture

1.2 Existing System

The condition of road surfaces is considered as a major indicator of the quality of roads. As a matter of fact, classification of a road as either safe or dangerous, more often than not take into consideration the surface condition of the road. Conventionally, parameters such as potholes, bumps and slipperiness are considered as the distinguishing features of the quality of road surfaces.

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Thus systems for monitoring road conditions are critical to the improvement of safety in roads, lowering accident rates and protection of vehicles from getting damaged as a result of poor surface road conditions. Using advanced vehicular technologies especially vehicular communication combined with sensing technologies, road anomalies can be easily identified and dealt with. This is achieved using an advanced system for monitoring road surface condition.

1.3 Proposed System

We propose a Road surface Condition Monitoring System Using Fog Computing which consists of traditional OBU(On board Unit) and RSU as Fog Node. In General OBU is Responsible to monitor the road condition and forward the content to the cloud. While uploading the information to the cloud OBU must encrypt the information by using Signcryption. Control center is responsible for key generation to the OBU as well as rsu . OBU will encrypt the information by using the key provided by the control center and forward the information to the Fog cloud i.e.(RSU). Fog Node is Responsible to Verifying the truthfulness of an message and forward the information to the cloud . The Cloud will maintain the data whenever request received cloud process the data and provide the corresponding request.

II. PROPOSED ALGORITHM AND EQUATIONS

The proposed CLASC scheme is composed by the following six algorithms.

2.1 Setup

Given the security parameters *k*, and this algorithm is performed by the KGC as follows.

a) Chooses a cyclic additive group G of prime order q on elliptic curve, and P is an arbitrary generator of G.

b) Chooses a cyclic multiplicative group G_T of the same order q and a bilinear map ê: $G \times G \rightarrow G_T$.

c) Randomly selects a master private key $s \in Z_q^*$and compute the master public key $P_{pub} = sP$.

d) Selects four secure hash functions H_1: $\{0, 1\}^* \rightarrow Z_q^*$, $H_2 : \{0, 1\}^* \rightarrow \{0, 1\}^n$ here n is the bit-length of plaintexts, $H_3 : \{0, 1\}^* \rightarrow G$ and H_4: $Z_q^* \rightarrow G$.

e) Publishes the system parameter params = $(G, G_T , ê, P, q, P_{pub}, H_1, H_2, H_3, H_4)$ and the master private key s will be kept secure by the KGC.

2.2 Key-Generation

This algorithm is interactively performed by the user ID_i and KGC as follows.

a) The user ID_i randomly chooses $x_i \in Z_q^*$ as the secret value and computes a partial public key $Y_{ib} = x_i P$.

b) The user sends its identity and partial public key (ID_i, Y_{ib}) to the KGC.

c) The KGC then randomly selects $y_i \in Z_q^*$and compute another partial public key for the user $Y_{ia} = y_i P$, so the full public key for the user is (Y_{ib}, Y_{ia}).

d) The KGC computes the partial private key $D_i = y_i + s * Q_i$where $Q_i = H_1 (ID_i)$, and D_i is sent securely to the user ID_i.

e) The user ID_i judges the validity of the partial private key by checking $D_i P = Y_{ia} + P_{pub} H_1 (IDi)$.

Notably, these procedures finish three different algorithms which are: 1) *set-secret-value*; 2) *partial-privatekey-extract*; and 3) *set-public-key* of the proposed scheme. These algorithms generate public key (Y_{ib}, Y_{ia}) that is kept in the public tree by the KGC, and the full private key (x_i, D_i) is kept secret by the user.

2.3 Signcrypt

This algorithm is performed by a sender ID_i to signcrypt the message m_i with ID_R as a receiver. ID_i performs the algorithm as follows.

a) ID*i* randomly selects $r \in Z_q^*$ and compute $T_i = rP$.

b) Compute $Z_b = rY_{rb}$.

c) Compute $Z_a = r(Y_{ra} + P_{pub}\ Q_i)$.

d) Compute $h_a = H_2\ (ID_R||Y_{ra}||Y_{rb}||\Delta||T_i||Z_b||Z_a)$.

e) Compute $K_i = h_a \oplus m_i$.

f) Compute $h_b = H_3(ID_R||Y_{ra}||Y_{rb}||\Delta||T_i|K_i||Q_i|$ $|Y_{ib}||Y_{ia})$.

g) Compute $h_c = H_4\ (\Delta)$.

h) Compute $\alpha_i = D_i h_c + r h_b + x_i h_c$.

i) Return the ciphertext $C_i = (T_i, K_i, \alpha_i)$.

2.4 Aggregate

This algorithm is performed by aggregator signcryption generator on the receiver ID_R as follows.

a) Compute $\alpha = \sum_{i=1}^{n} \alpha_i$

b) This algorithm outputs the aggregate ciphertexts $C = (T_1 \ldots T_n, K_1 \ldots K_n, \alpha)$.

2.5 Aggregate-Verify

This algorithm is run by a receiver ID_R and computes the following.

a) $h_b = H_3\ (ID_R||Y_{ra}||Y_{rb}||\Delta||T_i||Z_b'||Q_i||Y_{ib}||Y_{ia})$, for $i = 1, \ldots, n$.

b) $h_c = H_4\ (\Delta)$.

c) Verify $ê(\alpha, P) = ê(\sum_{i=1}^{n} Y_{ia} + P_{pub} Q_i, h_c) ê$ $(\sum_{i=1}^{n} Ti, h_b) ê(\sum_{i=1}^{n} Y_{ib}, h_c)$.

If the above equation holds, this algorithm outputs true otherwise false.

2.6 Aggregate-Unsigncrypt

If the output of Aggregate-Verify algorithm is true, this algorithm is performed by the receiver ID_R as follows.

a) Compute $Z_b' = x_r T_i$.

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b) Compute $Z'_a = D_r T_i$.
c) Compute $h'_a = H_2\ (\mathrm{ID}_R \| Y_{ra} \| Y_{rb} \| \Delta \| T_i \| Z'_b \| Z'_a)$.
d) Compute $m'_i = K_i \oplus h'_a$.
e) This algorithm outputs $\{mi\}_{i=1}^{n}$.

2.7 Correctness of the Signatures

$$\hat{e}(\alpha, P) = \hat{e}\left(\sum_{i=1}^{n} \alpha_i, P\right)$$

$$= \hat{e}\left(\sum_{i=1}^{n} (D_i h_c + r h_b + x_i h_c), P\right)$$

$$= \hat{e}\left(\sum_{i=1}^{n} D_i h_c, P\right) \hat{e}\left(\sum_{i=1}^{n} rP, h_b\right) \hat{e}\left(\sum_{i=1}^{n} x_i P, h_c\right)$$

$$= \hat{e}\left(\sum_{i=1}^{n} D_i P, h_c\right) \hat{e}\left(\sum_{i=1}^{n} T_i, h_b\right) \hat{e}\left(\sum_{i=1}^{n} Y_{ib}, h_c\right)$$

$$= \hat{e}\left(\sum_{i=1}^{n} (Y_{ia} + P_{\mathrm{pub}} Q_i, h_c)\right)$$

$$\times\ \hat{e}\left(\sum_{i=1}^{n} Ti, h_b\right) \hat{e}\left(\sum_{i=1}^{n} Y_{ib}, h_c\right)$$

2.8 Correctness of the Decryption

$m'_i = K_i \oplus h'_a$
$= H_2\ (Q_i \| Y_{ia} \| Y_{ib} \| \Delta \| Ti \| Z_b \| Z_a) \oplus\ m_i \oplus h'_a$
$= h_a \oplus\ m_i \oplus h'_a$
$= m_i$.

III. RESULTS AND DISCUSSION

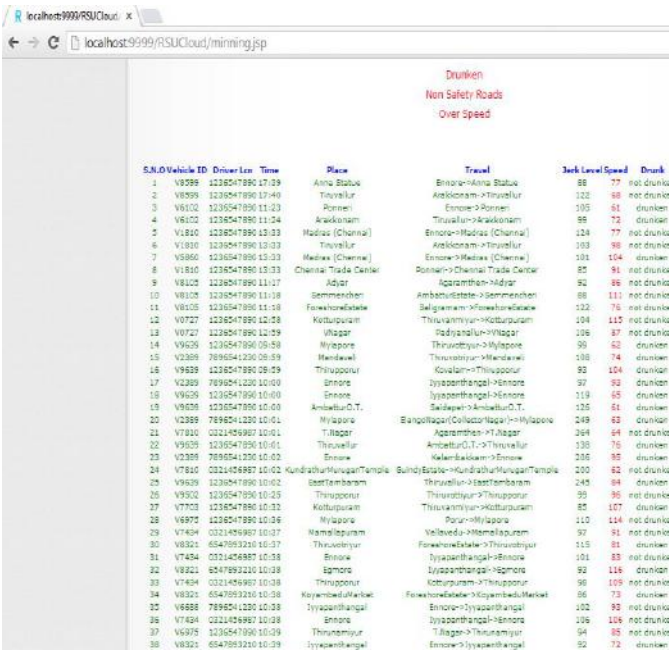

Fig.3: Vehicle data set

Fig 3 shows the data set of the vehicles. This data set contains the sensed information such as Jerk Level, Speed and Safety between the source and destination. These information are useful for the mobile users who requests the safe route. Fig 4 shows the best and safe route between source and destination and additionally it displays the Public Transport for the requested route.

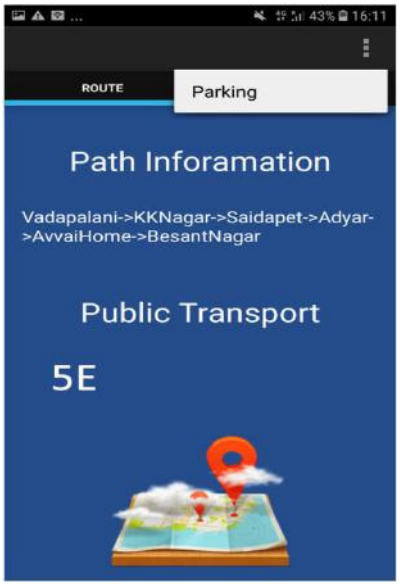

Fig.4: Dipslaying Best Route

Fig 4 displays the best route in map. It points the best intermediate route between source and destination. As it points the places, it will be very comfortable for the mobile users to travel easily and safely.

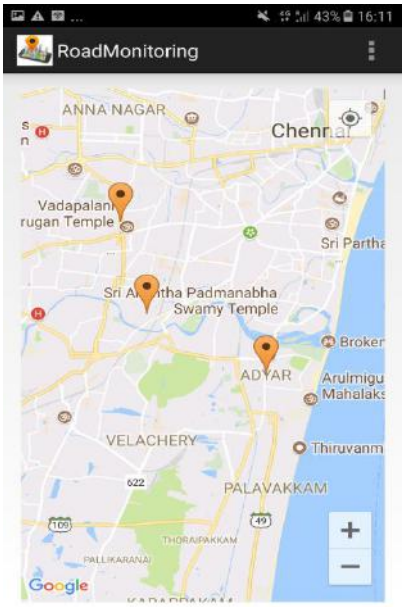

Fig.5: Route in map

Fig 5 displays the additional information to the mobile users such as the number of restaurants, petrol bunks, hospitals.

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Fig.6: Additional Information

IV. CONCLUSION

We propose a new efficient CLASC scheme . We then designed a privacy preserving vehicular crowd sensing Road Surface Condition monitoring system using fog computing based on the proposed CLASC scheme. In addition, the proposed privacy-preserving protocol meets the security requirements such as data confidentiality and integrity, mutual authentication, anonymity, and key escrow resilience. Extensive comparisons of computational cost and communication overhead show that the proposed scheme can achieve much better efficiency than the existing schemes.

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