Introduction

Solution Concept

Construction

Conclusions

Local Self -Organization with Strong Privacy Protection

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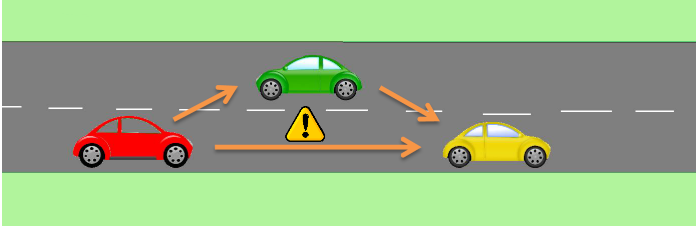
Tianjin, China

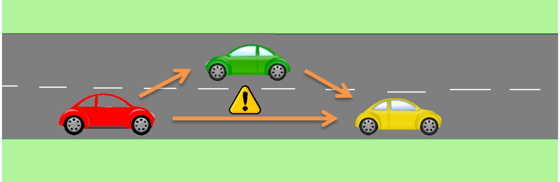
Vehicular Ad Hoc Networks (VANET)



Applications

- Virtual brake lights
- Traffic information systems
- Virtual traffic lights
- and many more...

Authentication in VANET



Threats for Authentication to VANET

- Seclusiveness - sending fraudulent signals or forging on-board Units (Virtual Vehicle). Only a legal manufacturer can issue new On-Boar Units.

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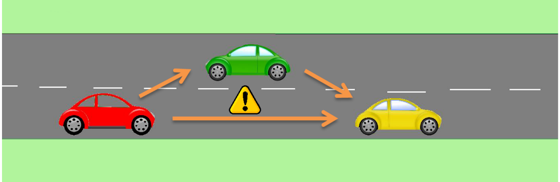

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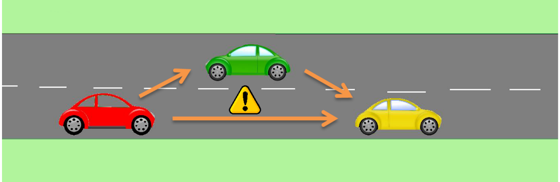

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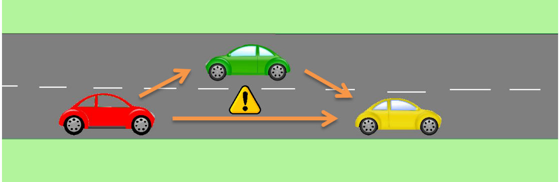

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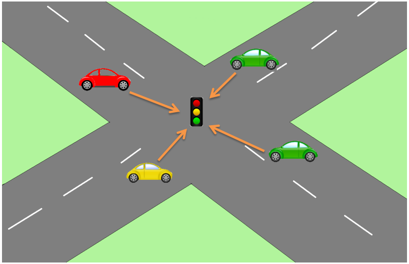
- Accountability - Deanonymization in case of misbehaviour and undeniability of ones actions.

Local Self -Organization (Virtual Traffic Lights)



Goal: Establish an ordering of vehicles.

- Participants should not have any advantage above others.
- Clone detection.

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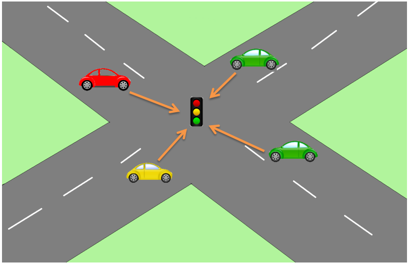

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Existing solutions (Leader election)

Run a leader election protocol → The leader decides the ordering → requires Honest Majority.

2-D Traceable Domain Signature - Concept

Consider n participating vehicles on a crossroad at location `location` at time `time`.

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  - the secret key has a valid certificate - seclusiveness

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Example

1. Sort the pseudonyms lexicographically and hash: $seed \leftarrow H(nym_0||nym_1||..nym_{n-1}||location||time)$.

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Unlinkability of pseudonyms - Decisional Diffie-Hellman

$(H(\texttt{location-1}) \cdot H(\texttt{time}))^{sk} = (h_1 \cdot H(\texttt{time}))^{sk}$ and
$(H(\texttt{location-2}) \cdot H(\texttt{time}))^{sk} = (h_2 \cdot H(\texttt{time}))^{sk}$

Adding Deanonymisation and Tracing Capabilities

Deanonymization/Opening

- The signature contains also an encryption of the users identity: $ID \leftarrow \hat{h}^{sk}$.

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- The Tracing Authority will know if a vehicle appears in different locations at the same time.

Construction Background - Pointcheval-Sanders Signatures

- Setup(1^λ): Generate bilinear groups $BG = (q, \mathbb{G}_1, \mathbb{G}_2, \mathbb{G}_T, e)$, where q is the group order and $e : \mathbb{G}_1 \times \mathbb{G}_2 \to \mathbb{G}_T$ is a type-3 pairing.

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- Verify(pk, σ, M): Check that $e(A, \tilde{X} \cdot \tilde{Y}^m) = e(B, \tilde{g})$.

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We use so called Signatures of Knowledge.
Example:

$$SoK\{(\alpha, \beta) : X = g^{\alpha} \wedge Y = g^{\beta} \cdot h^{\alpha}\}(M)$$

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Putting Things Together

- Setup
  1. Run $BG = (q, \mathbb{G}_1, \mathbb{G}_2, \mathbb{G}_T, e) \leftarrow \mathrm{Setup}_{RS}$,

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The issue protocol does not reveal u, to the Issuer.

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Given signatures (C_1, C_2, nym, π) and (C'_1, C'_2, nym', π'):

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Given a signature (C_1, C_2, nym, π):

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- A vehicle needs to store only single key to produce multiple pseudonyms.

Questions?