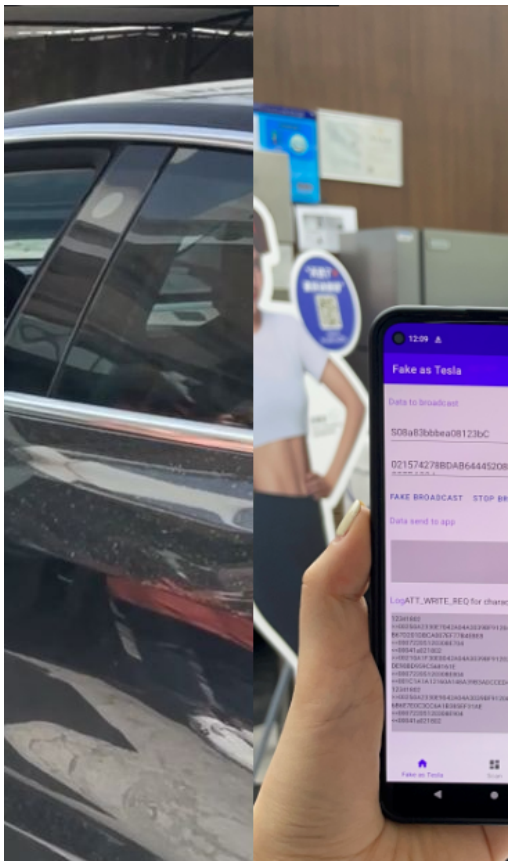

Security Lab

jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

Is Phone

Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures

Key Secure

Compromising Keyless Entry for Tesla Model 3

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

Exploit: Authentication Bypass by Spoofing

Data: 2022-03-06

Exploit Authors: Kun Jiang, Xinyi Xie, Rui Dai, Jun Lu

Affected Product: Tesla Mode 3
Version: Tesla Model 3: V11, Tesla Mobile App: V4.23 (test on Motorola Edge S Android 11)
CVE: CVE-2022-37709

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Kun Jiang, Xinyi Xie, Rui Dai

Introduction

The Tesla app has a feature called Phone Key that turns a smartphone into a key. Locking and unlocking even starting Model 3 with your phone key is conveniently hands-free. As

you approach, your phone's Bluetooth signal is detected and doors unlock. Further, you can start and drive the car without ever taking the phone out of a pocket. However, this passive entry and start feature are not secure enough. Authentication can be bypassed by spoofing. It allows attackers to open a door and drive the car away by leveraging access to a

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Kun Jiang, Xinyi Xie, Rui Dai

legitimate Phone Key.

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How does it work?

The phone key communicates with Model 3 using Bluetooth in plain. The Bluetooth Phone Key reconnects to the Model 3 depending on the vehicle's MAC address

only. Since the MAC address of the car is static, an adversary can fake the Model 3 easily. The Phone Key will reconnect to the device with the specific MAC automatically. In this case, the adversary forwards the messages to both sides as an intermediary. Model 3 authenticates the key by two attestations. The Phone generates the second attestation

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

based on a token from the vehicle. According to our experiments, the update of the token is not related to the connection status and happens over hours. It allows the adversary to complete the attack with one attack device. The adversary needs to approach the owner and the Model 3 in turn to forward messages. By spoofing the Phone key and the vehicle, the

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jiangkun@fmsh.com.cn

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attack device can bypass the authentication. Finally, the Model 3 unlocks the door and can be started.

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

More Technical Description

Here is a more detailed explanation of the exploit:
The Phone Key and Model 3 will generate a

shared secret by `ECDH`. The shared key is used to authenticate attestations. The attestations are calculated by `AES-GCM`.

1. Get the MAC address **BD_ADDR** of the Model 3 according to advertisements broadcasting.
2. Change the MAC address of the attack device same as Model 3
3. Approach the owner to

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get the first attestation **A**.

4. Approach Model 3 to get the token **G**
5. Approach the owner to get two attestations **A', B**
6. Back to the vehicle. The vehicle unlocks.

The figure below shows the entire process of exploiting the vulnerabilities.

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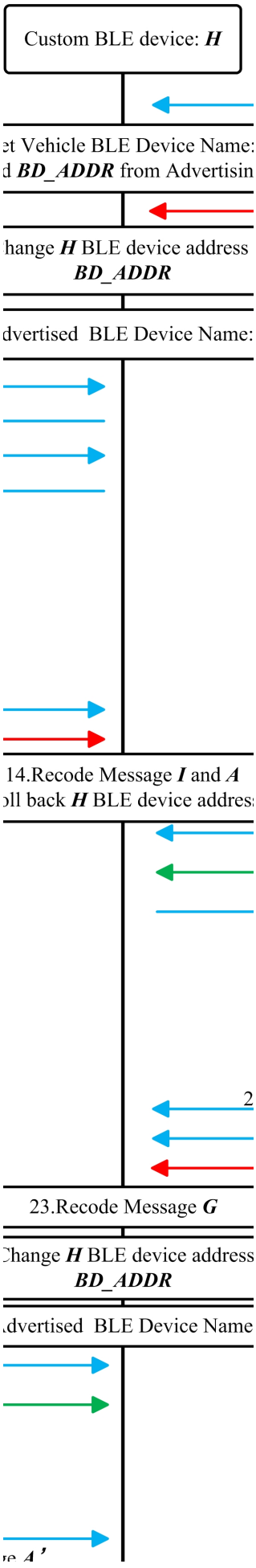

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jiangkun@fmsh.com.cn

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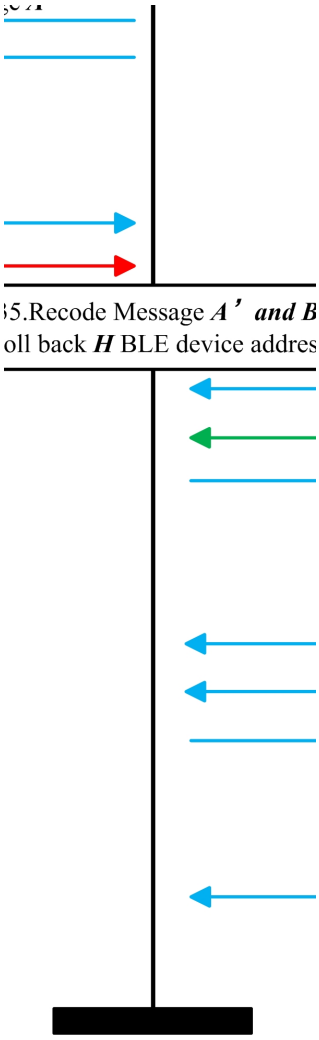
Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures



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jiangkun@fmsh.com.cn

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Impact and Demo

1. *The whole process is out of the awareness of the car owner. People can drive your car without your permission.*
2. *Because the token G remains fixed for several hours, the attacker*

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures

has plenty of time to complete the Man in the Middle Attack. The parking lot near Starbucks or supermarkets appears to be a great place to perform the attack.

3. *Since most of the communicatic*

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jiangkun@fmsh.com.cn

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data on the Bluetooth channel is in plaintext, it is easy for an attacker to replay some fixed data, such as request commands and vehicle status information.

4. *Any devices that support*

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Kun Jiang, Xinyi Xie, Rui Dai

> *BLE 5 can exploit this vulnerability to complete the attack.*

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jiangkun@fmsh.com.cn

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Our results show that attackers can break into Tesla Model 3 and drive it away in one minute without the awareness of the car owner. It brings into question the security of Passive Keyless

Entry and Start (PKES) and Bluetooth implementations in security-critical applications.

We created an app named TesMla for Android device to conduct the attack.
You can check the demo vedio for attack on the **Youtube**.
More information for the app is on the **Github**.

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Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures

Possible countermea

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jiangkun@fmsh.com.cn

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1 on PIN 2 Drive	**BLE encryption** Tesla can enable secure BLE communication. The communication between end devices will be protected by this session key

Car owners can enable this multi-factor authentication countermeasure. It allows owners to program a

personal identification number. This feature forces the owner to enter these numbers into the screen to drive the car.

key. Enabling BLE encryption will improve the difficulty of the analysis.

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jiangkun@fmsh.com.cn

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Token frequently

Tesla can update

ToF-based secure ranging

The UWB

update the token every time the Model 3 establishes a BLE connection. The adversary has to use two attack devices connecting to the Phone Key and Model 3 utilizes the ToF technique to measure the distance. Messages of measurement or synchronization require encryption or signature by a trusted module, Secure Element (SE) for example.

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jiangkun@fmsh.com.cn

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3 simultaneously. To a certain degree, refreshing the token fast enough will reduce the attack window.

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures

Tesla has been notified over 6 months ago (March/2022) and has not replied yet.

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jiangkun@fmsh.com.cn

Kun Jiang, Xinyi Xie, Rui Dai

Introduction

How does it work

More technical description

Impact and demo

Possible countermeasures