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Man in the contacts

and secure messengers: the ultimate spear-phishing weapon?

Laureline DAVID / Jérémy MATOS

Man in the contacts

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About the authors

Both based in French speaking Switzerland

Laureline DAVID

- Freelance consultant
- HEIG-VD graduate in Security Engineering
- https://ltouroumov.ch/

Jérémy MATOS

- Former developer of security solutions
- OWASP Geneva co-chapter leader
- Threat modeling aficionado
- Appsec consultant at my own company: Securing Apps
- https://www.securingapps.com/
- @SecuringApps

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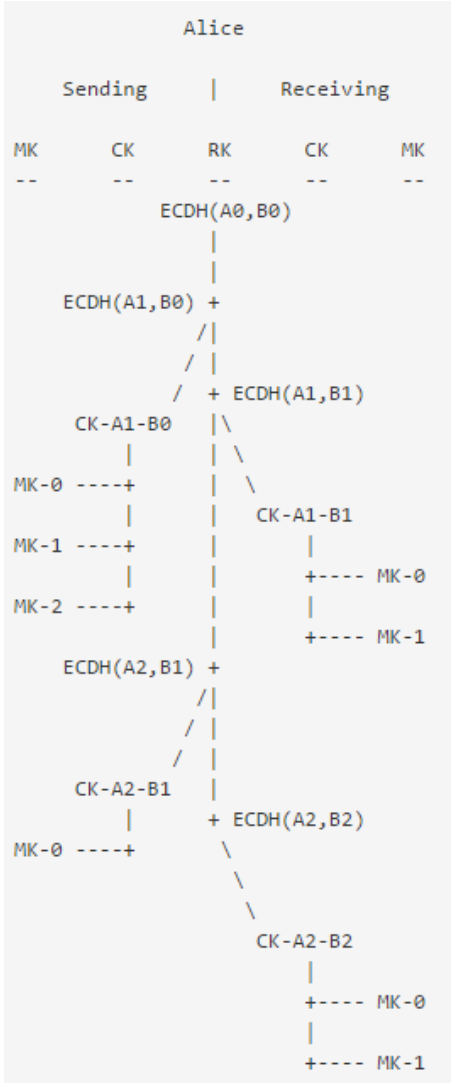
Introduction

Popular messaging apps switched to end-to-end encryption

- Great communication around it
- Privacy is now a requirement
- Debates at the government level to ask for backdoors: going dark ? Terrorists ?
- Increased feeling that those applications are unbreakable

Super crypto. But wait …

- Advanced ratcheting in Signal protocol: looks like an obvious flaw won't be here ➔
- But how messaging apps authenticate myself ?
  - No explicit identifier
  - Provisioning done by SMS
  - Link to device/phone number
- And my contacts ? Get them automatically from my address book



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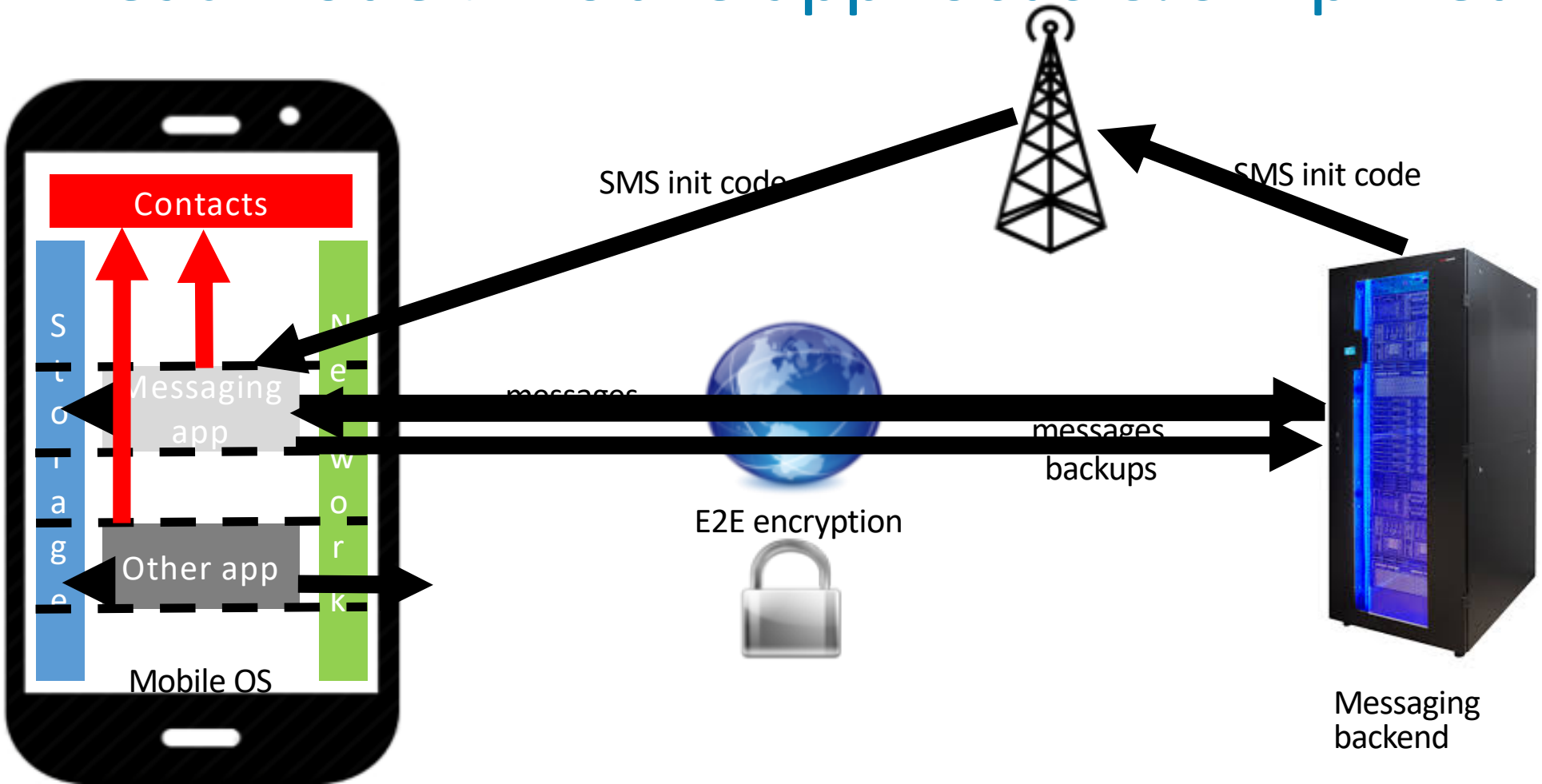
Threat model: mobile app focus & simplified



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Accessing contacts

Easy to read/modify/create contacts

- There is an API for that
- Android example ➔

```
private boolean updateContactName(String phone, String newName) {
    ArrayList<ContentProviderOperation> ops = new ArrayList<ContentProviderOperation>();

    ops.add(ContentProviderOperation.newUpdate(ContactsContract.Data.CONTENT_URI)
            .withSelection(ContactsContract.CommonDataKinds.Phone.NUMBER + "=?", new String[]{String.valueOf(phone)})
            .withValue(ContactsContract.CommonDataKinds.StructuredName.DISPLAY_NAME, newName)
            .build());
    try {
        getContentResolver().applyBatch(ContactsContract.AUTHORITY, ops);
        return true;
    } catch (Exception e) {
        Log.e("oups","aie",e);
    }
    return false;
}
```

Shared data structure accessible in read/write

- Only restricted by permissions ➔
- And it contains authentication data in clear

```
<uses-permission android:name="android.permission.READ_CONTACTS" />
<uses-permission android:name="android.permission.WRITE_CONTACTS" />
```

There is room for a **side channel attack : Man in the contacts**

- Does not require a rooted device

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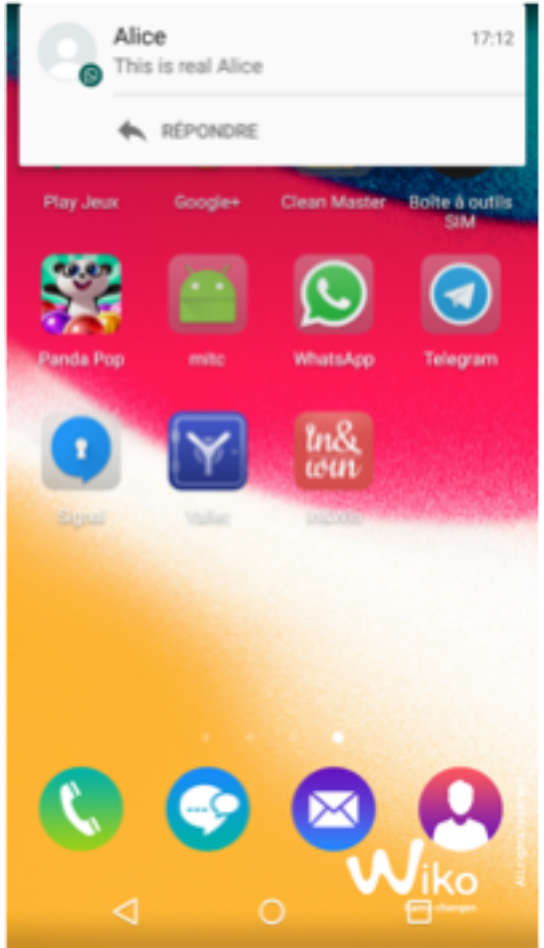
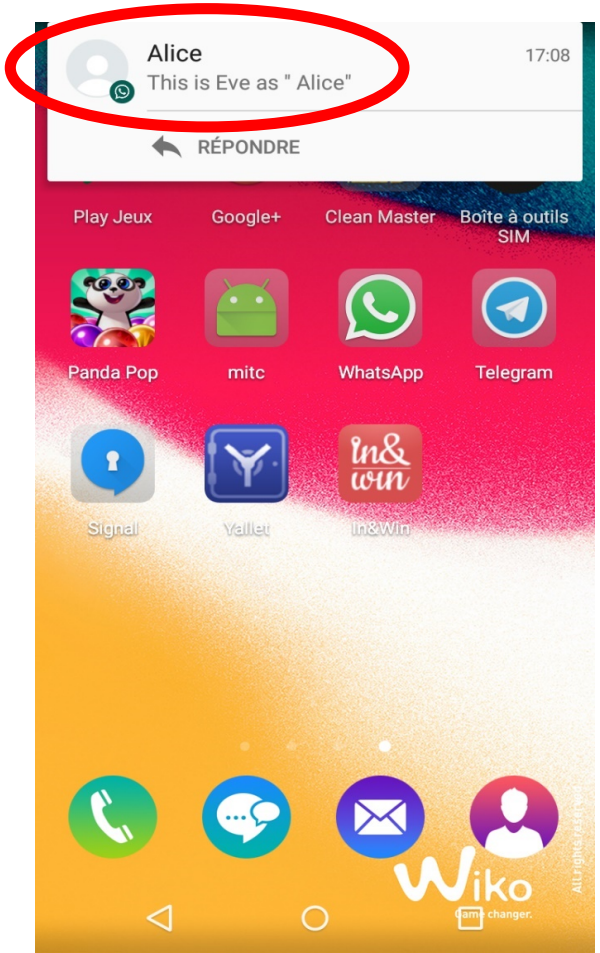
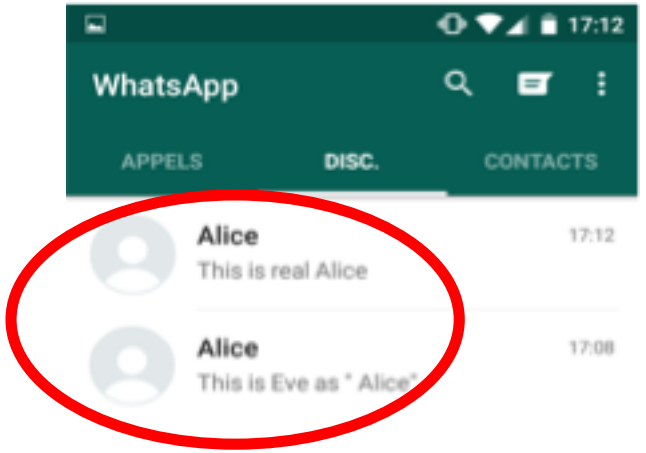
Let’s create a new contact called “ Alice”







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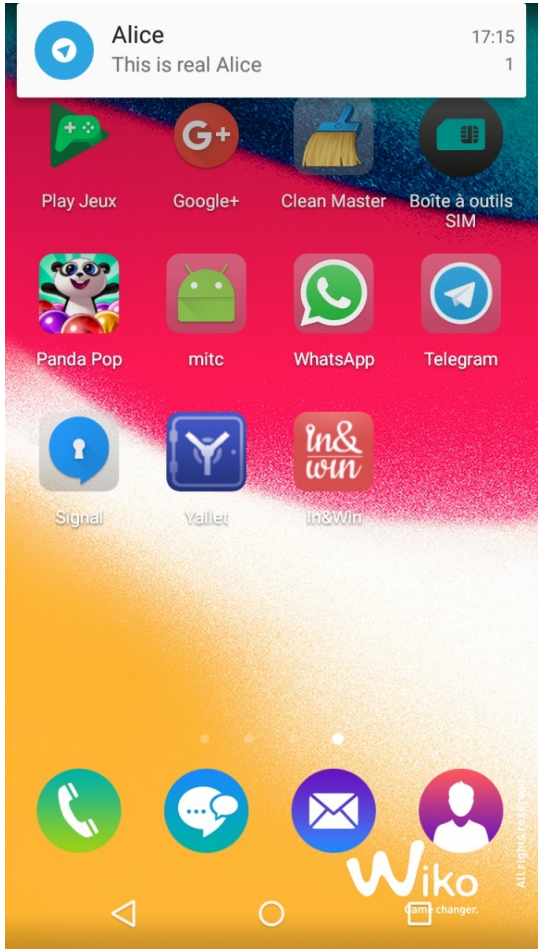

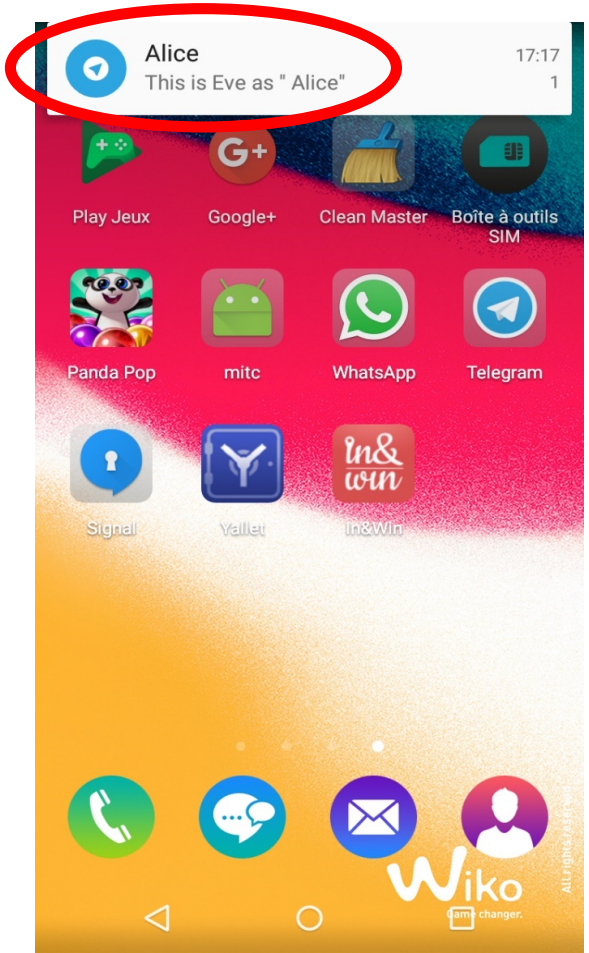

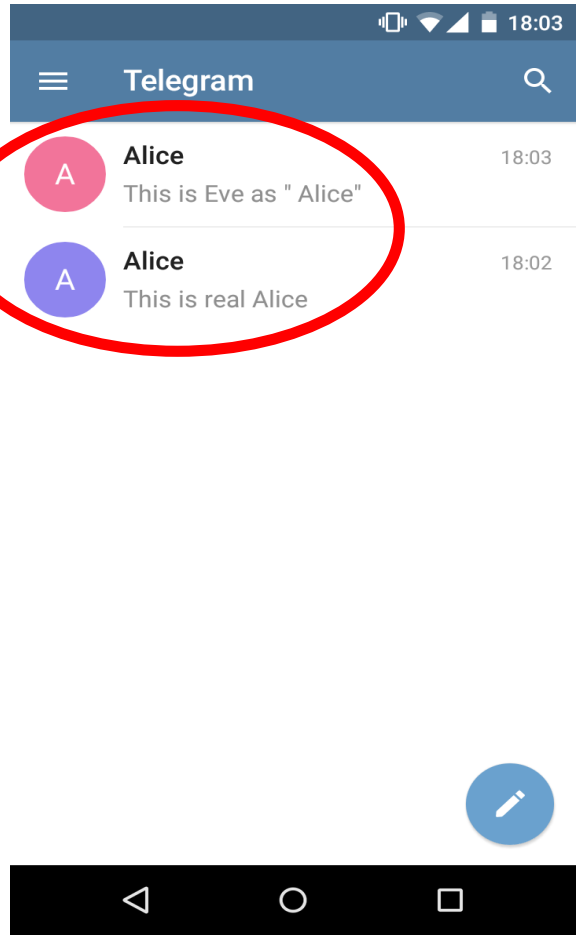

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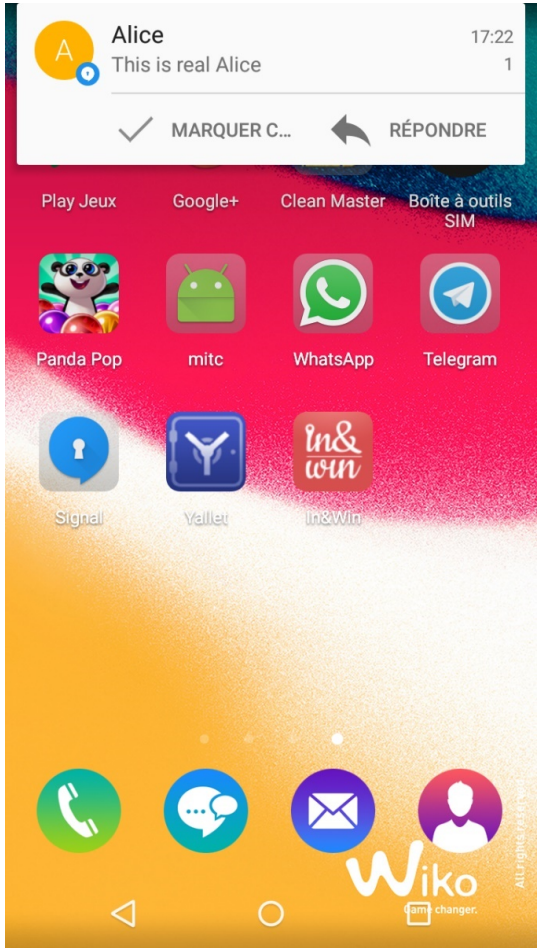
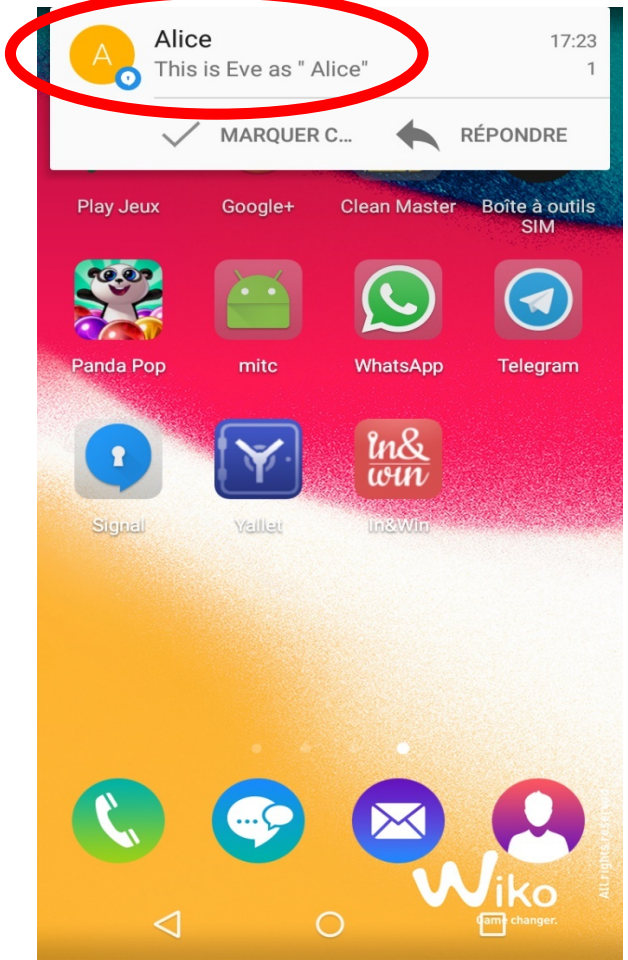
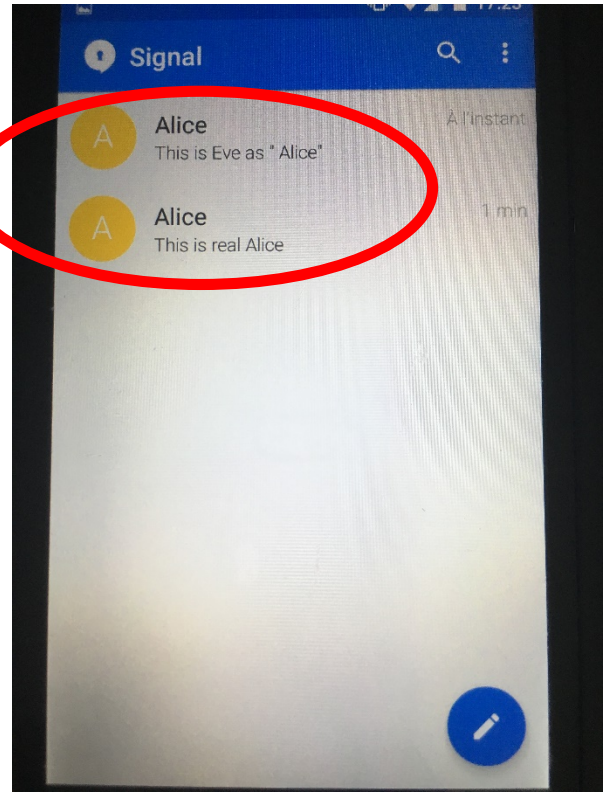
Let’s create a new contact called “ Alice”







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Why does it work ?

- **Design error** from a security point of view: phone number as implicit identifier is a poor choice
- **Abusing Trust On First Use** (TOFU): new contact = new key = accepted by default
- **Same old trick of invisible characters**
- **End user/mobile not really included in the threat model**
  - Focus on protecting network/backend (e.g. from government agencies)
  - Side channel attack with some social engineering out of scope
  - E.g. Formal security analysis of Signal protocol: https://eprint.iacr.org/2016/1013.pdf

  Signal specifies a mandatory method for participants to verify each other's identity keys through an out-of-band channel, but most implementations do not require such verification to take place before messaging can occur

- **Bonus:** messengers store their own identifiers in the contacts

  ➔ we can know from another application if WhatsApp, Telegram or Signal is installed despite sandboxing

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Risk assessment

- Simple evaluation: risk = easiness of attack * user impact
- **Difficulty of attack: Low to Medium**
  - Technical: Low
    - Easy to access contacts via code
    - Not a problem to get MITC application approved for publication
  - Logistics: Medium
    - One phone number is enough
    - But need to convince many users to install the application
- **User impact: High**
  - Thousands of users can be spied via those 3 famous messengers

Difficulty to attack	Low business impact	Medium business impact	High business impact
Low	Low	Medium	Very High
Medium	Low	Medium	High
High	Low	Low	Medium

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Vendors feedback

Telegram

security@telegram.org = /dev/null

WhatsApp (Facebook)

*We appreciate your report. **Ultimately** an attacker with **malware** installed on a device is going to be able to alter data on the device itself. In your examples for **WhatsApp conversations remained properly bound to the phone number that the messages were sent to**. Beyond that, WhatsApp allows people to set local aliases for contacts and to view the number associated with a specific message thread at any point. Given that, we don't feel that this behavior poses a significant risk and **we do not plan to make any changes here**. Please **let us know if you feel we've misunderstood something here**!*

Signal (Moxie Marlinspike)

*Hey Jeremy, saw your support email about "man in the contacts." This, like all interception techniques, is **what safety numbers are for. Signal users would be notified that the safety numbers for their contact have changed**, and be asked to verify them. A successful MITM attack would need to find a way to intercept communication without triggering that notice.*

---

*Hey Jeremy, **Signal is not designed to protect your device against malware**. Thanks for getting in touch, good luck with everything.*

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Implementing Man in the contacts in practice

Bachelor thesis of Laureline

1. Android game: a social version of Rock, Paper, Scissors

- Available on Google PlayStore at https://play.google.com/store/apps/details?id=com.tricktrap.rps
- Approved without any issue on July 2017

  Biggest challenge: contact API is a total mess

2. The Command-and-Control server

- Python based
- Overview of its web interface

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Spear-phishing in action

- Convince Alice to download the social game
- When Alice starts game, C&C server controlled by Eve is notified that a secure messenger is installed and now listens for contact orders.
- Eve asks C&C server to create “ Bob” in Alice’s phone.
- Eve send a malicious link to Alice as “ Bob” via secure messenger.

  Alice clicks on it because she knows well Bob and it is a super secure messenger.
- **Backend servers cannot filter dangerous content because by design they can’t read the messages**.

- NB: Desktop versions of those secure messengers are more and more popular

Live demonstration

- **Any volunteer ?**

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Open sourcing the tool

Source code of Android game available at https://github.com/ltouroumov/rockpaperspam-client

Source code of Command-and-Control server is available at https://github.com/ltouroumov/rockpaperspam-server

Don’t hesitate to share those links

Vendors may now better understand that it can be a real-life issue.

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Next attack to implement: Man in the Middle

- Convince Alice and Bob to download the social game
- When Alice and Bob start the game, Eve notices they have a secure messenger installed
- Eve asks C&C server to create “ Alice” in Bob’s phone and “ Bob” in Alice’s phone
- Eve sends as “ Alice” via secure messenger an introduction message to Bob.

  Bob is thinking he is talking to real Alice.
- Eve forwards as “ Bob” the answer of Bob to Alice.

  Alice is convinced it is the real Bob because it’s really his words.
- Alice answers to ” Bob”, who is in fact Eve. Eve can now forward the message to Bob as “ Alice”.

  Bob is also convinced. ➔ We now have a full Man in the Middle

- **Alice and Bob are using E2E encrypted communications but they are talking to the wrong contact without noticing**

Possible mitigations

End users

- Avoid installing applications requesting contact permissions.

  But this is the case for secure messengers ….

Mobile OS

- Sandbox contact information
- Be stricter on write operations to address book

Secure messengers

- Give up implicit trust on contact information:

  require users to manually add people they are talking to
- Or **raise user awareness when a conversation is starting with a brand new contact**:

  make it clear in U.I. this an unusual situation, e.g. with a danger sign

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Conclusion

E2E encryption cannot guarantee privacy if you're not sure who you are talking to

- Beware of messages showing good cryptography is used because it can bring a false sense of security

Security model around contacts if far too open for sensitive apps

- If the design of your solution includes access to contacts, start with a threat modeling session

Tool open sourced to demonstrate secure messengers should not be trusted blindly

- Their great security reputation can be used against them for a successful social engineering attack
- By design dangerous messages cannot be filtered