Introducing Man In The Contacts attack to trick encrypted messaging apps

Defcon Crypto Village

05/08/2016 – Jérémy MATOS

whois securingapps

- Developer background
- French who spent last 10 years working in Switzerland on security products and solutions
  - Focus on mobile since 2010
- Now software security consultant at my own company

http://www.securingapps.com

- Provide services to build security in software
  - Mobile
  - Web
  - Cloud
  - Internet Of Things

@SecuringApps

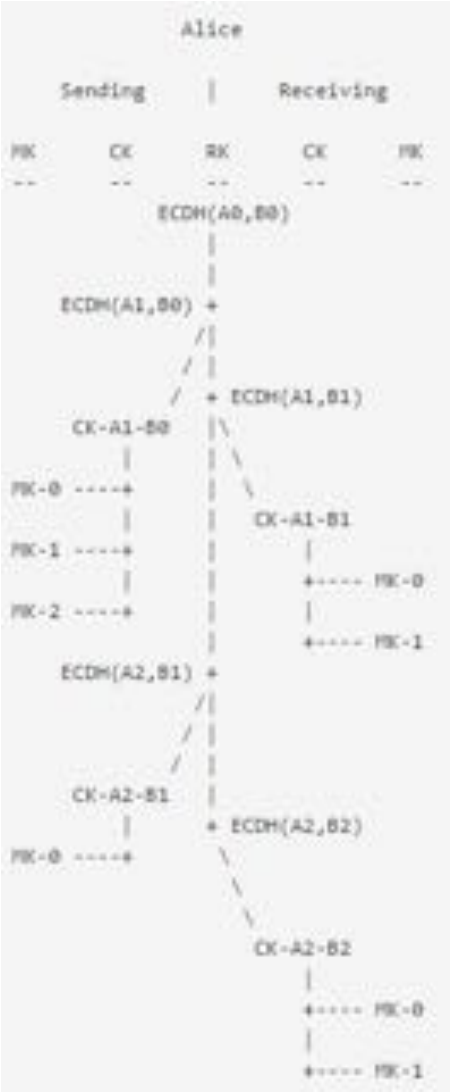
Introduction

- Popular messaging apps recently switched to End-to-End encryption
  - Great communication around it
  - Privacy now is a requirement
  - Thank you @moxie
- Debates at the government level to ask for backdoors
  - Going dark ?
  - Used by terrorists ?
- Increased feeling that those applications are unbreakable

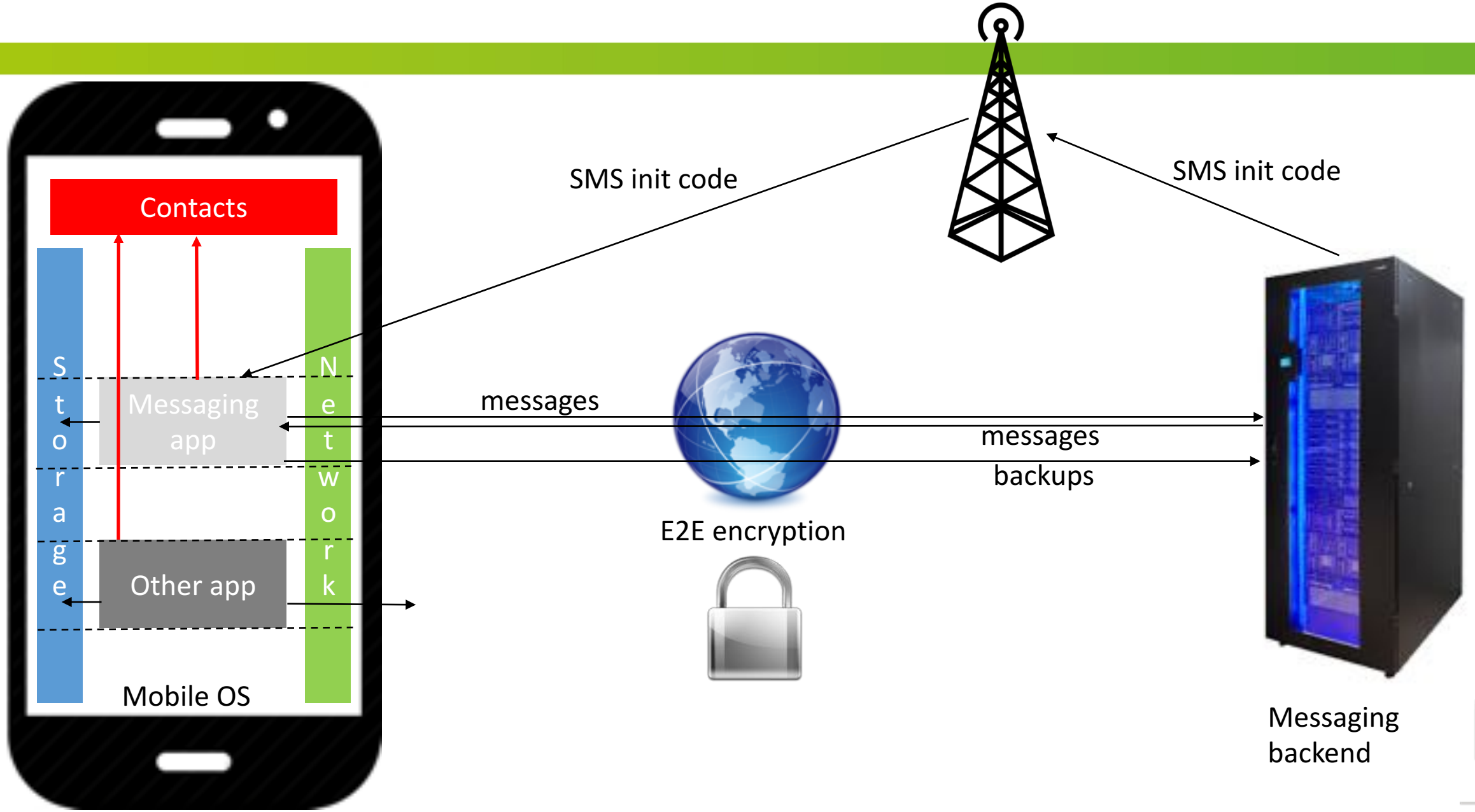
Super crypto. But wait ….

- Advanced ratcheting in Signal Protocol →
- Looks like an obvious flaw won't be there

- But how messaging apps authenticate myself ?
  - No explicit identifier
  - Provisioning done via SMS
  - Link to device/phone number
  - And when I change phone number ?
- And my contacts ?
  - Get them from my address book
  - No manual contact import (e.g. Skype)



Threat model: mobile focus & simplified



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
  - Not requiring a rooted device

Introducing Alice, Bob and Eve

- Convention: Alice on the left, Bob on the right, Eve in the center
- **Devices not rooted**, latest OS updates available
- Installed apps: latest version (31st July 2016) of **WhatsApp**, **Telegram** and **Signal**

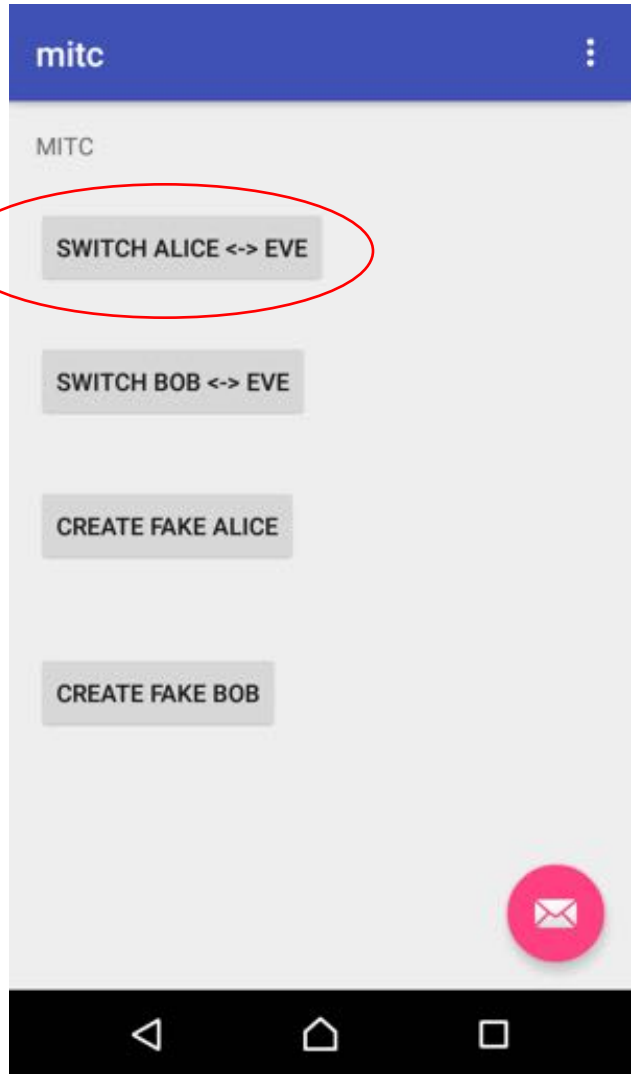
Alice
+33 X XX XX XX 60
Android 5.0

Eve
+41 XX XXX XX 21
iOs 9.3

Bob
+41 XX XXX XX 66
Android 5.1

Old joke: swap contacts

- Install MITC app on Bob's device
- Start a conversation between Alice and Bob
- Swap Alice and Eve phone numbers on Bob's device
- See what happens



Bob

Old joke: swap contacts

- WhatsApp 1

- Bob starts a conversion with Alice
- Alice answers

Bob

Old joke: swap contacts

- WhatsApp 2
- Eve triggers contact swap via remote MITC app on Bob's device
- Eve sends «This is eve» to Bob
- Notification received as Alice
- But new conversation

Bob

Old joke: swap contacts

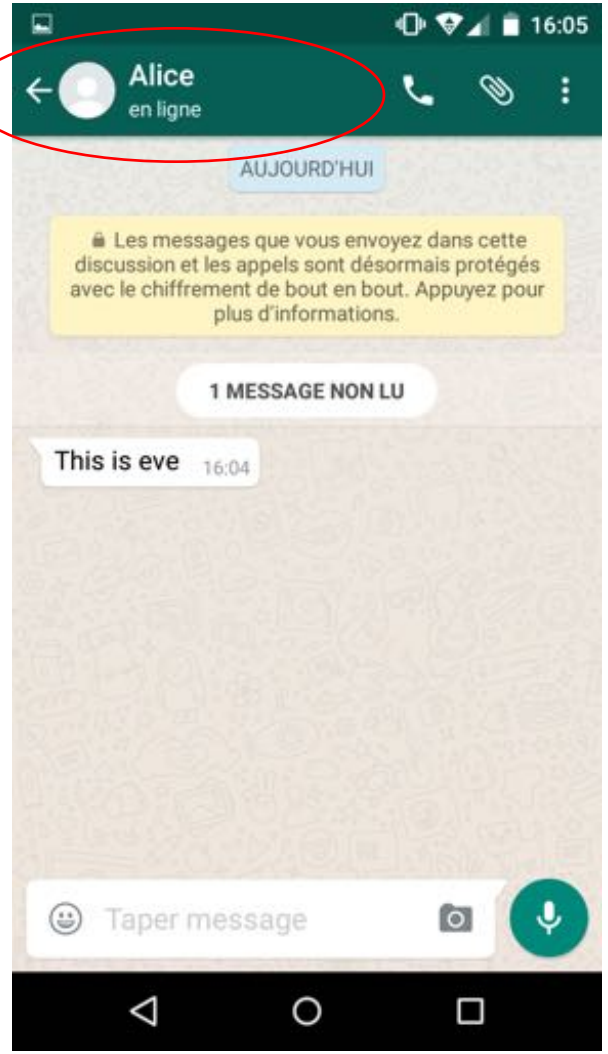
- WhatsApp 3
- Ignore notification
- Conversation of Alice now displayed as Eve

Bob

Old joke: swap contacts

- WhatsApp 4

- Accept notification
- Eve triggered a new conversation
- But displayed as Alice



Bob

Old joke: swap contacts

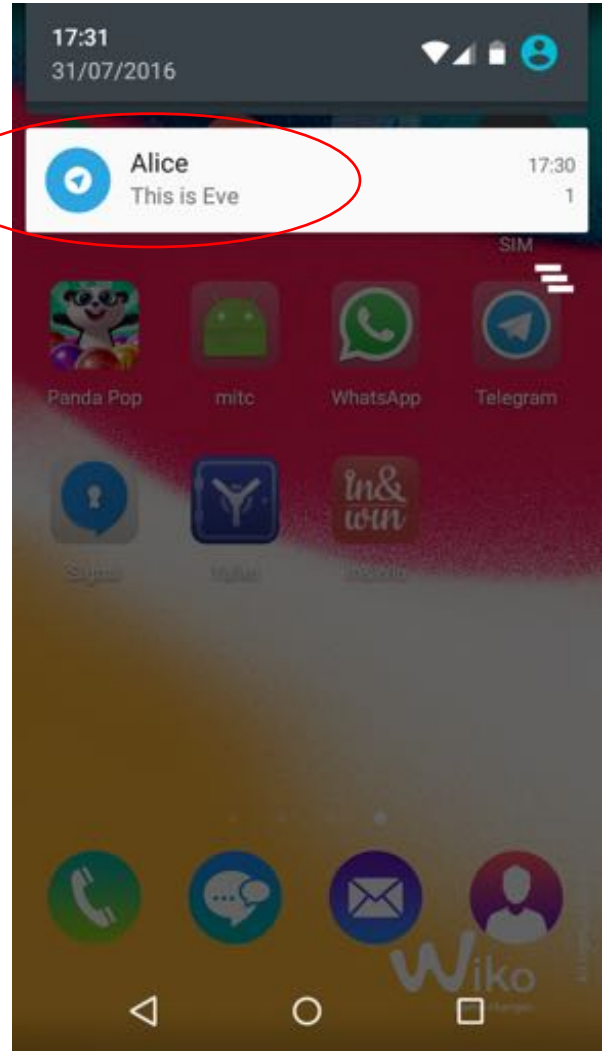
- Telegram 1

- Bob starts a conversion with Alice
- Alice answers

Bob

Old joke: swap contacts

- Telegram 2
- Eve triggers contact swap via remote MITC app on Bob's device
- Eve sends «This is Eve» to Bob
- Notification received as Alice
- But new conversation



Bob

Old joke: swap contacts

- Telegram 3

- Accept notification
- Eve triggered a new conversation
- But displayed as Alice

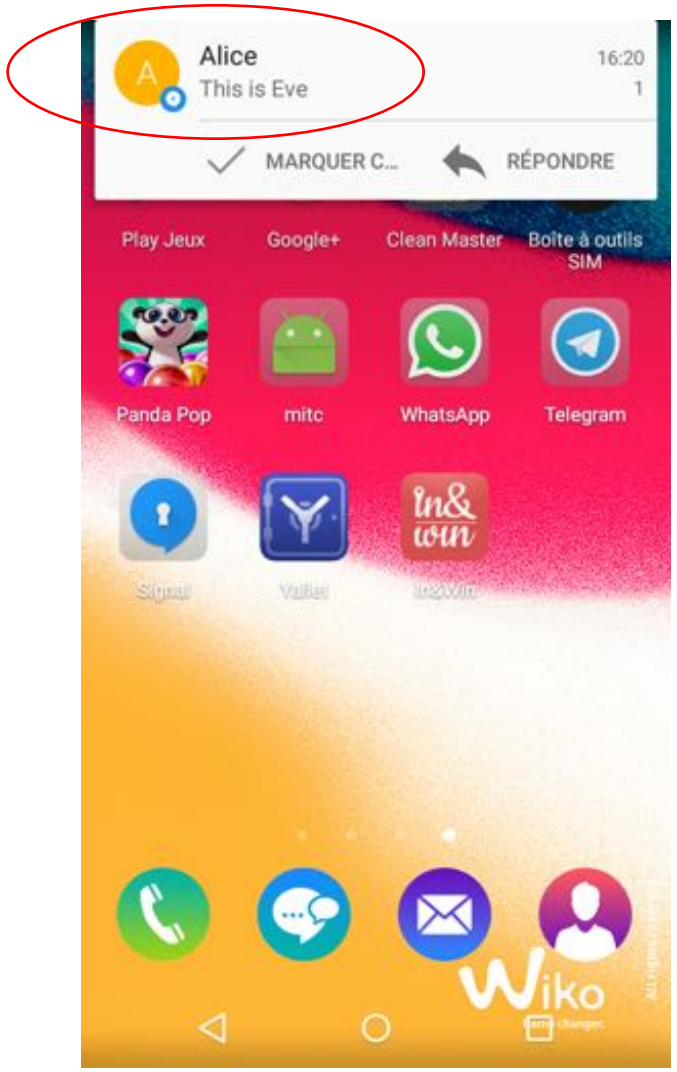
- NB: If you change the name of Alice, in the future notifications and conversations will still be under the name of Alice

Bob

Old joke: swap contacts

- Signal 1 & 2

- Screenshots refused by Android app
- But same behaviour than WhatsApp

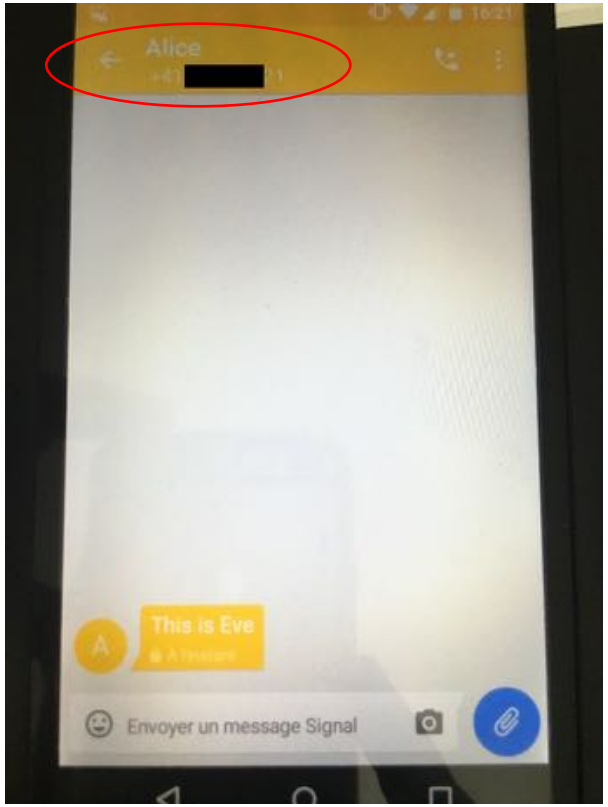


Bob

Old joke: swap contacts

- Signal 3

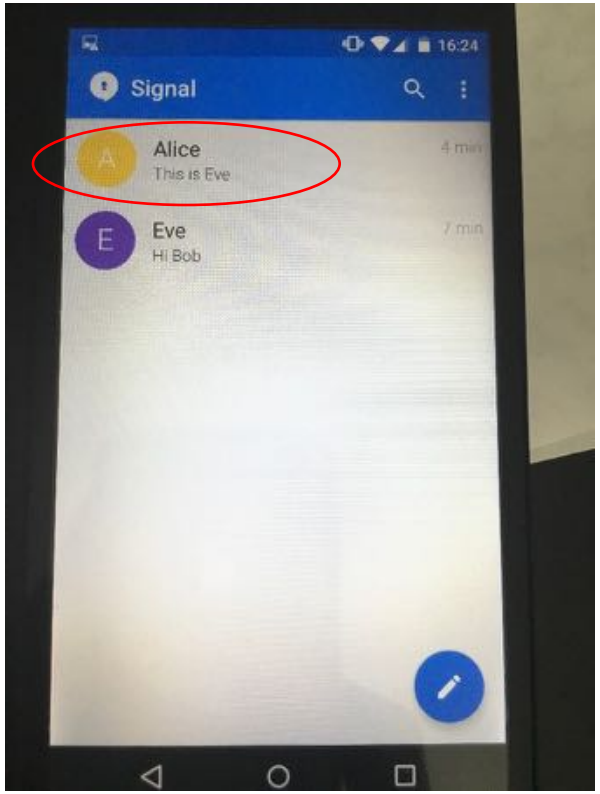
- Accept notification
- Eve triggered a new conversation
- Displayed as Alice
- But phone number also displayed



Bob

Old joke: swap contacts

- Signal 4
- Not the case in the main view

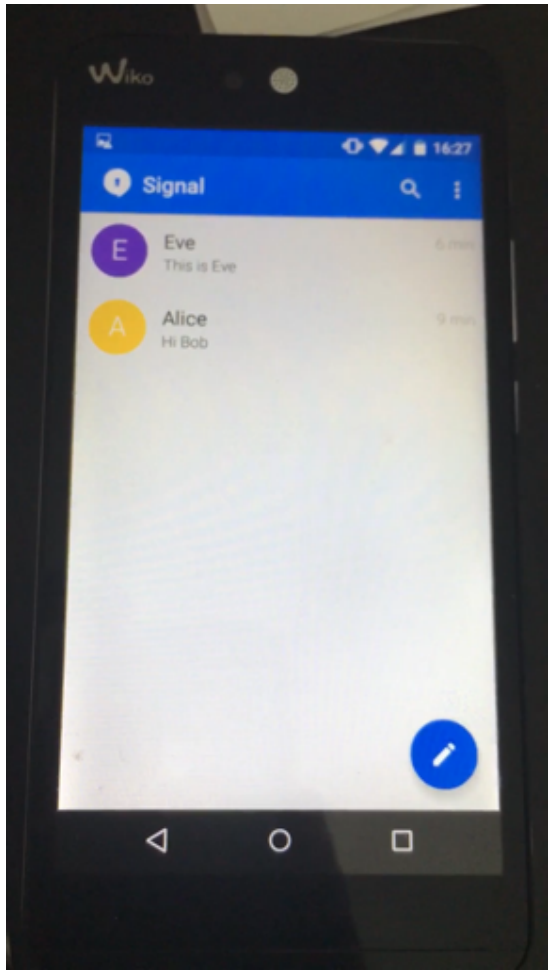


Bob

Old joke: swap contacts

- Signal 5

- Stay in this view
- Switch back contacts with MITC app
- Nothing happens for a while
- And then main view updated
  => contact sync process



Bob

Swap contacts results

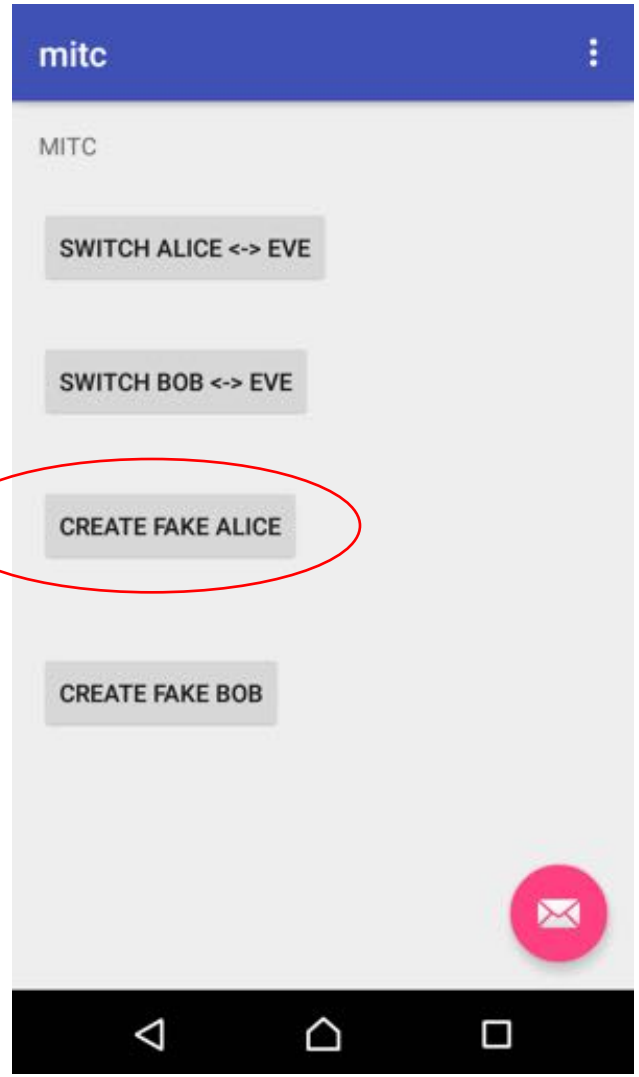
- Can't be used to trick Bob within an existing conversation
- But produces a notification and a new conversation that may seem legitimate to Bob

- Different behaviors depending on the app
  - Name in the notification vs name in the conversation
  - Name configured by the sender vs contact name as seen by receiver
  - Contact sync time

- Not discrete in case Alice and Bob have a phone call or send a message

Nasty trick: contact with similar name

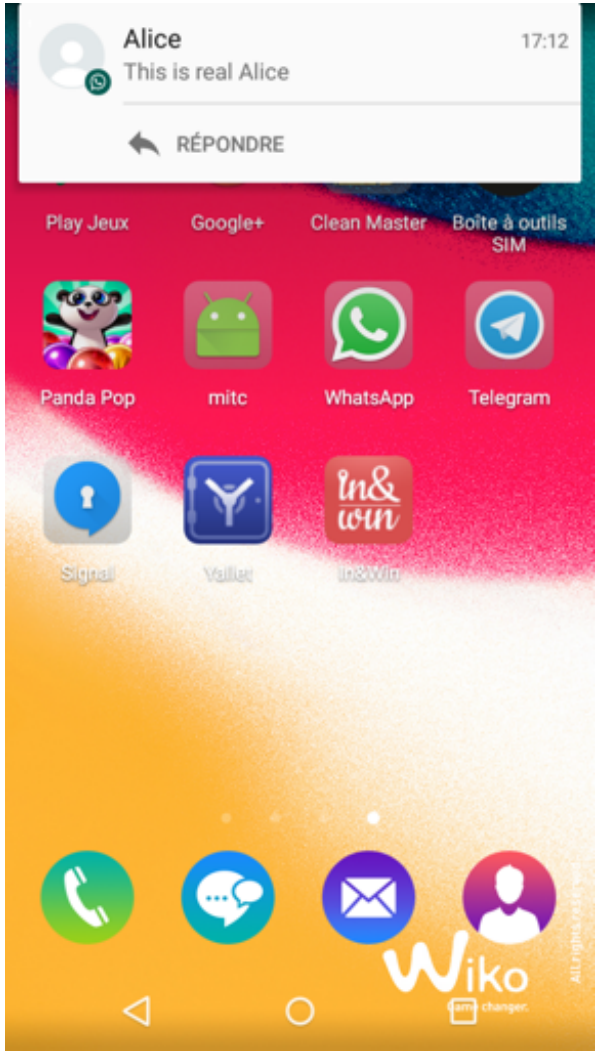
- Start a conversation between Alice and Bob
- Create a contact name **« Alice»** on Bob's device with Eve's phone number
- See how the **whitespace** in front of Alice gets displayed



Bob

Nasty trick: contact with similar name

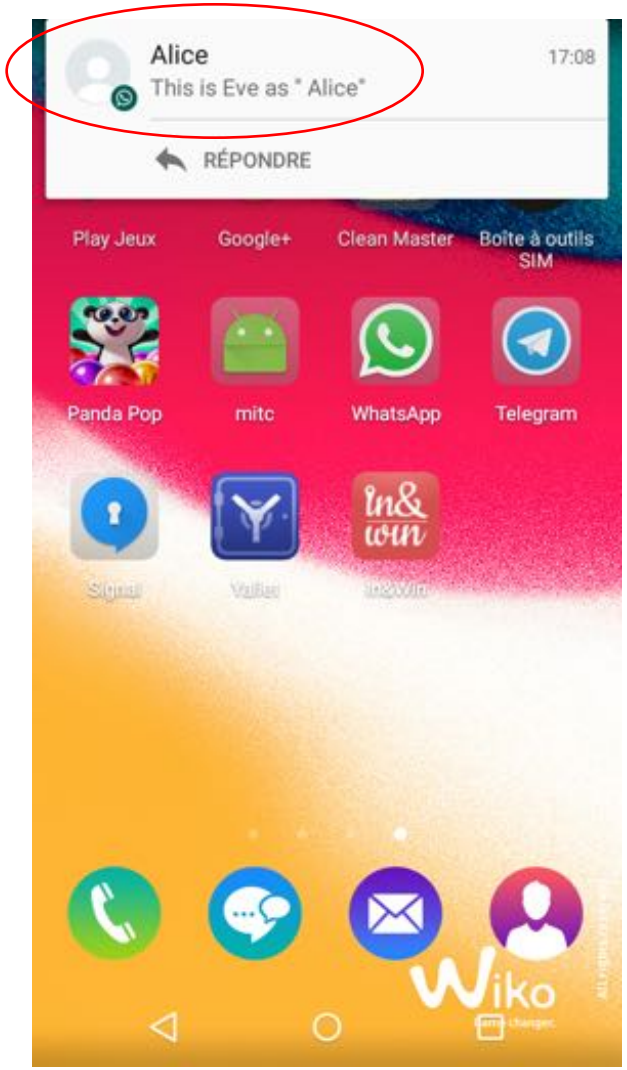
- WhatsApp 1
- Alice starts a conversion with Bob



Bob

Nasty trick: contact with similar name

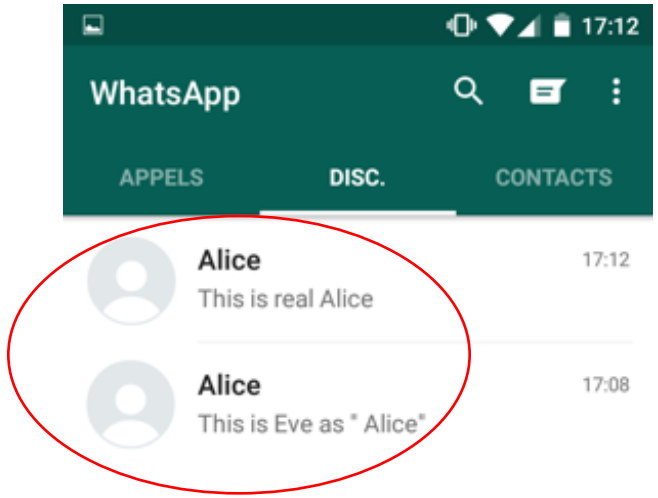
- WhatsApp 2
- Eve starts a conversion with Bob



Bob

Nasty trick: contact with similar name

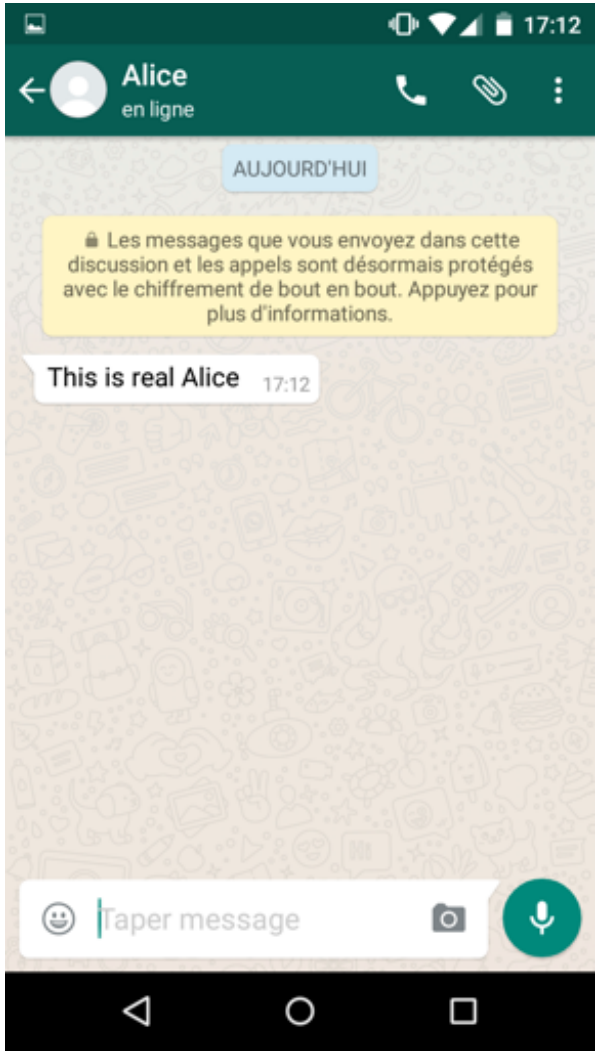
- WhatsApp 3
- Main view



Bob

Nasty trick: contact with similar name

- WhatsApp 4
- Conversation with real Alice



Bob

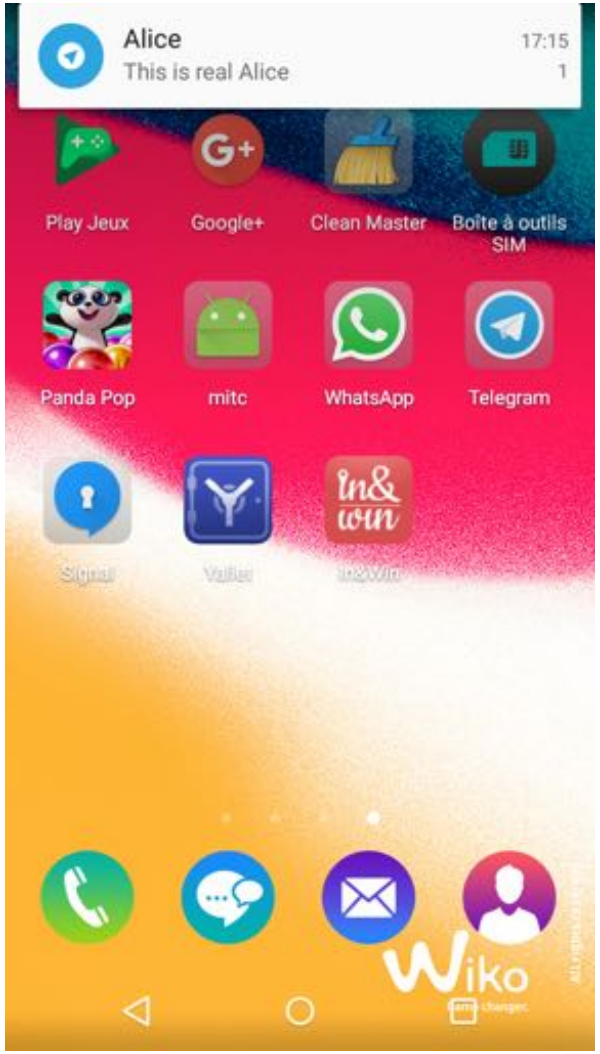
Nasty trick: contact with similar name

- WhatsApp 5
- Conversation with Eve as « Alice»

Bob

Nasty trick: contact with similar name

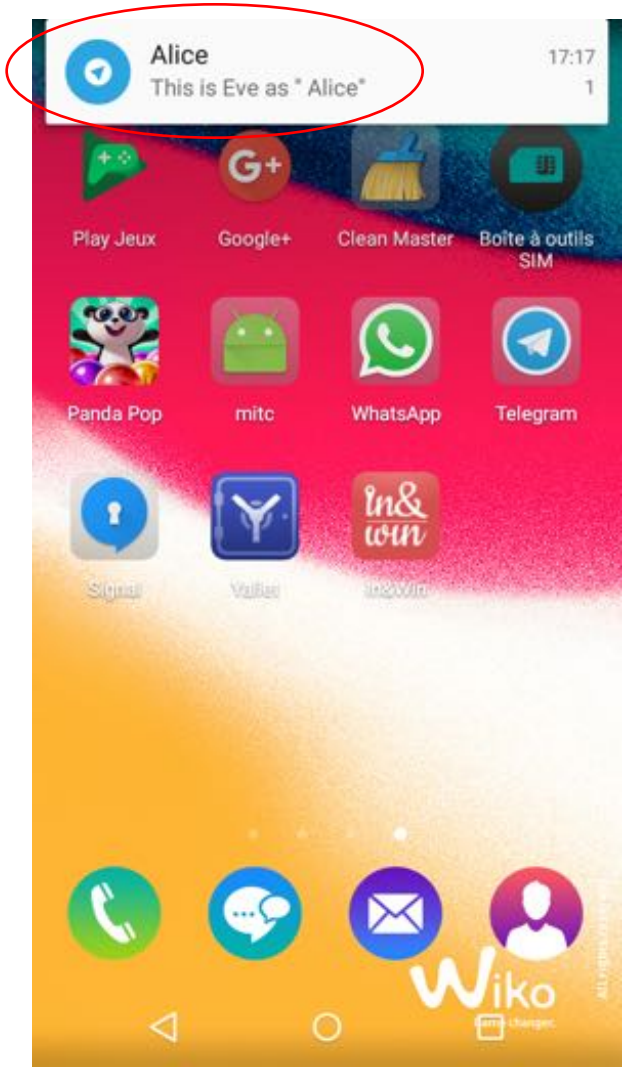
- Telegram 1
- Alice starts a conversion with Bob



Bob

Nasty trick: contact with similar name

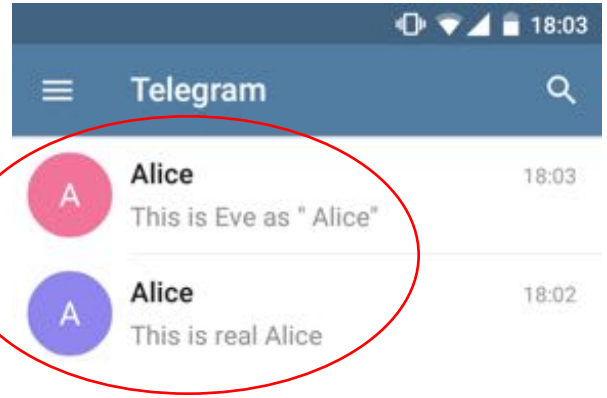
- Telegram 2
- Eve starts a conversion with Bob



Bob

Nasty trick: contact with similar name

- Telegram 3
- Main view



Bob

Nasty trick: contact with similar name

- Telegram 4
- Conversation with real Alice

Bob

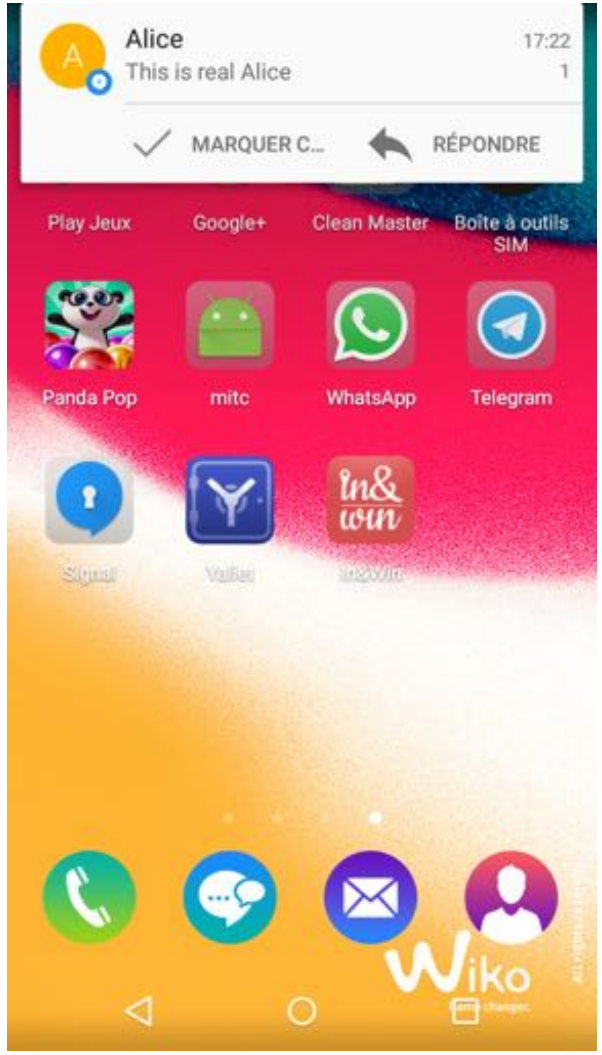
Nasty trick: contact with similar name

- Telegram 5
- Conversation with Eve as « Alice»

Bob

Nasty trick: contact with similar name

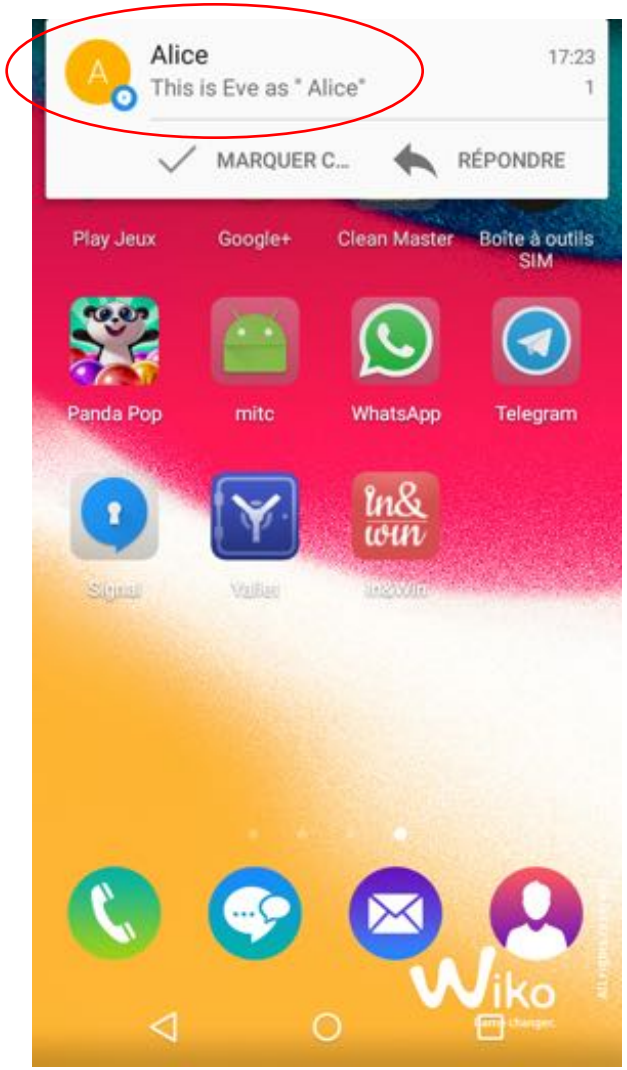
- Signal 1
- Alice starts a conversion with Bob



Bob

Nasty trick: contact with similar name

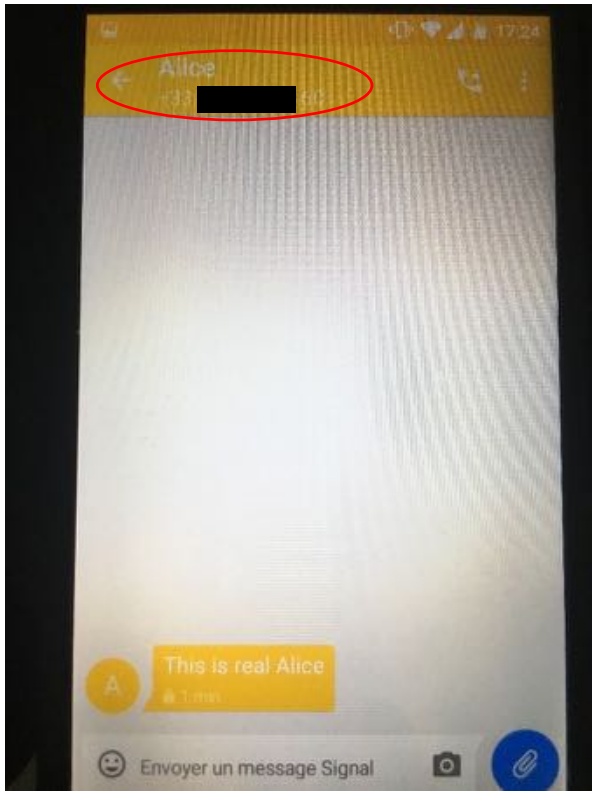
- Signal 2
- Eve starts a conversion with Bob



Bob

Nasty trick: contact with similar name

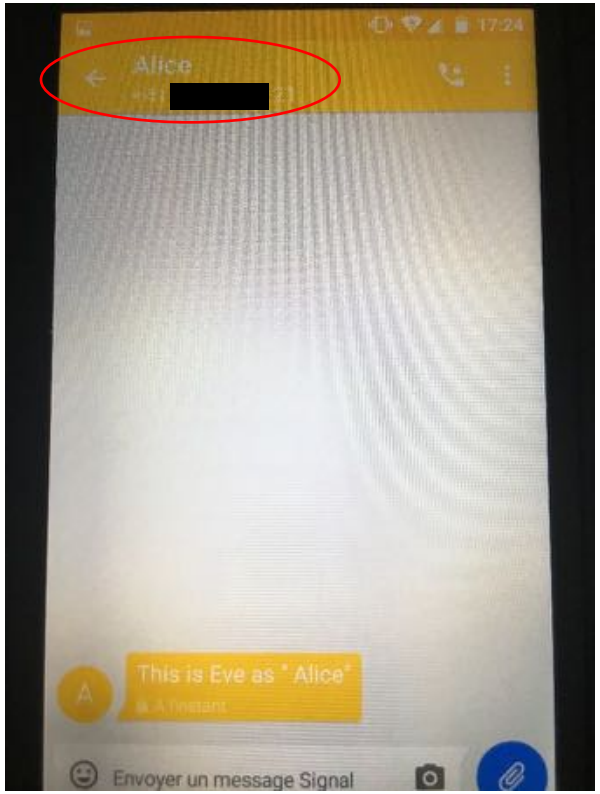
- Signal 4
- Conversation with real Alice



Bob

Nasty trick: contact with similar name

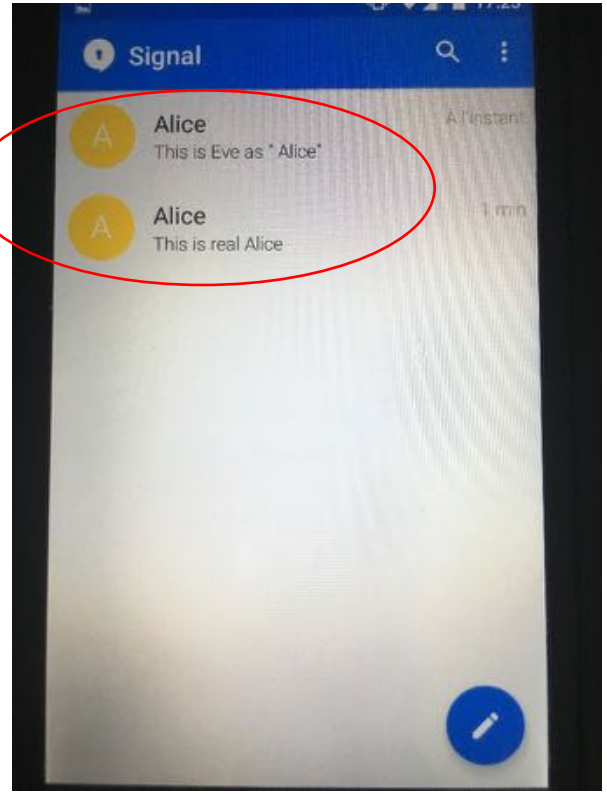
- Signal 5
- Conversation with Eve as « Alice»



Bob

Nasty trick: contact with similar name

- Signal 3
- Main view



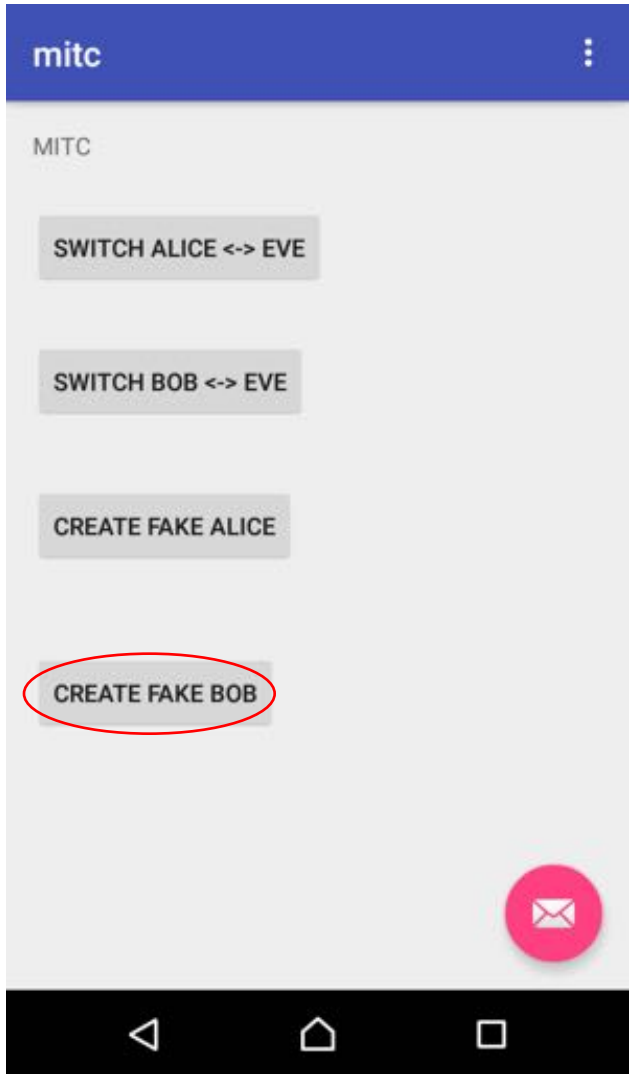
Bob

Contact with similar name results

- Creating « Alice» in addition to Alice is far more discrete
  - Phone call/SMS OK with real contact
  - Whitespace prefix is not visible in messaging apps
  - Requires a new contact, but MITC app can delete/recreate « Alice» as often as needed
- Yet after a few messages, Bob can guess it is not really Alice speaking to him

- **Let's suppose Alice also installed the MITC app**
  - because it's very popular
  - or MITC app sends her a SMS recommending to do so because it found her in Bob's contacts

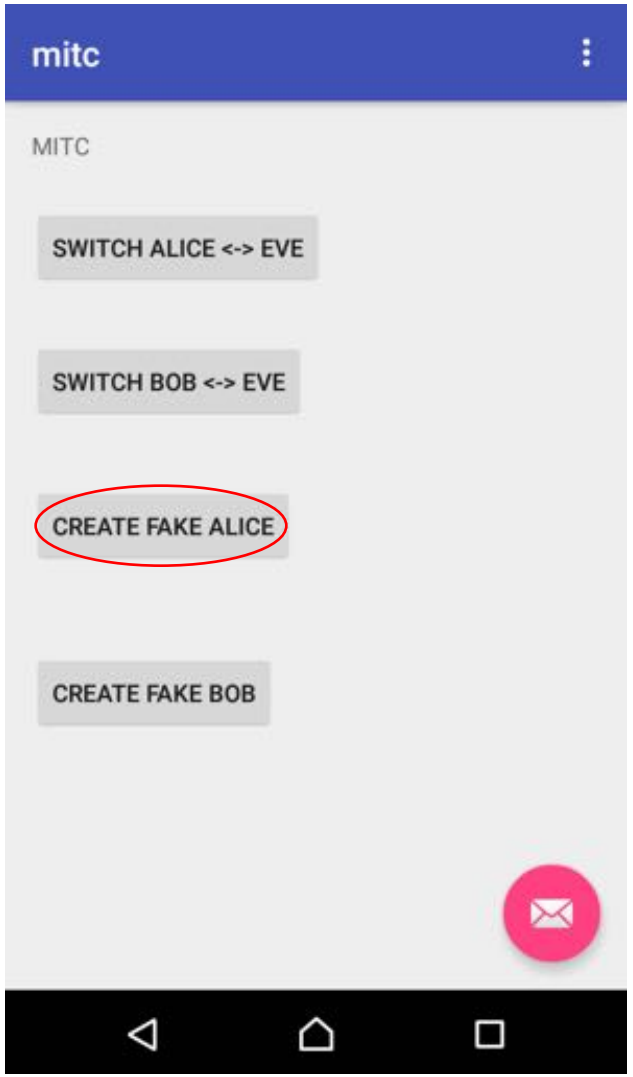
Man In The Middle: init phase



Alice

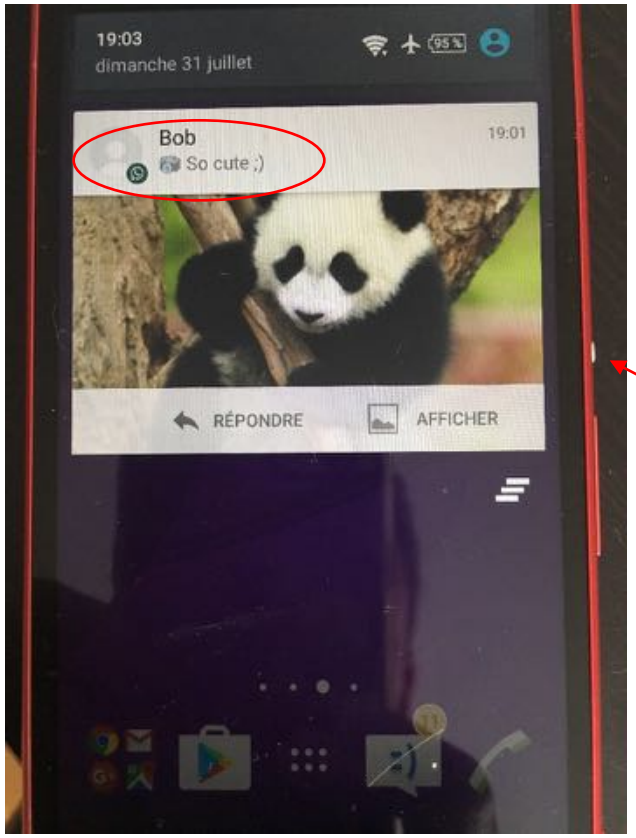
- 1. Have MITC deployed on the devices of Alice and Bob
- 2. Login as Eve to **web version of messaging app**
- 3. Create « Alice» and « Bob» with Eve's phone number via MITC app

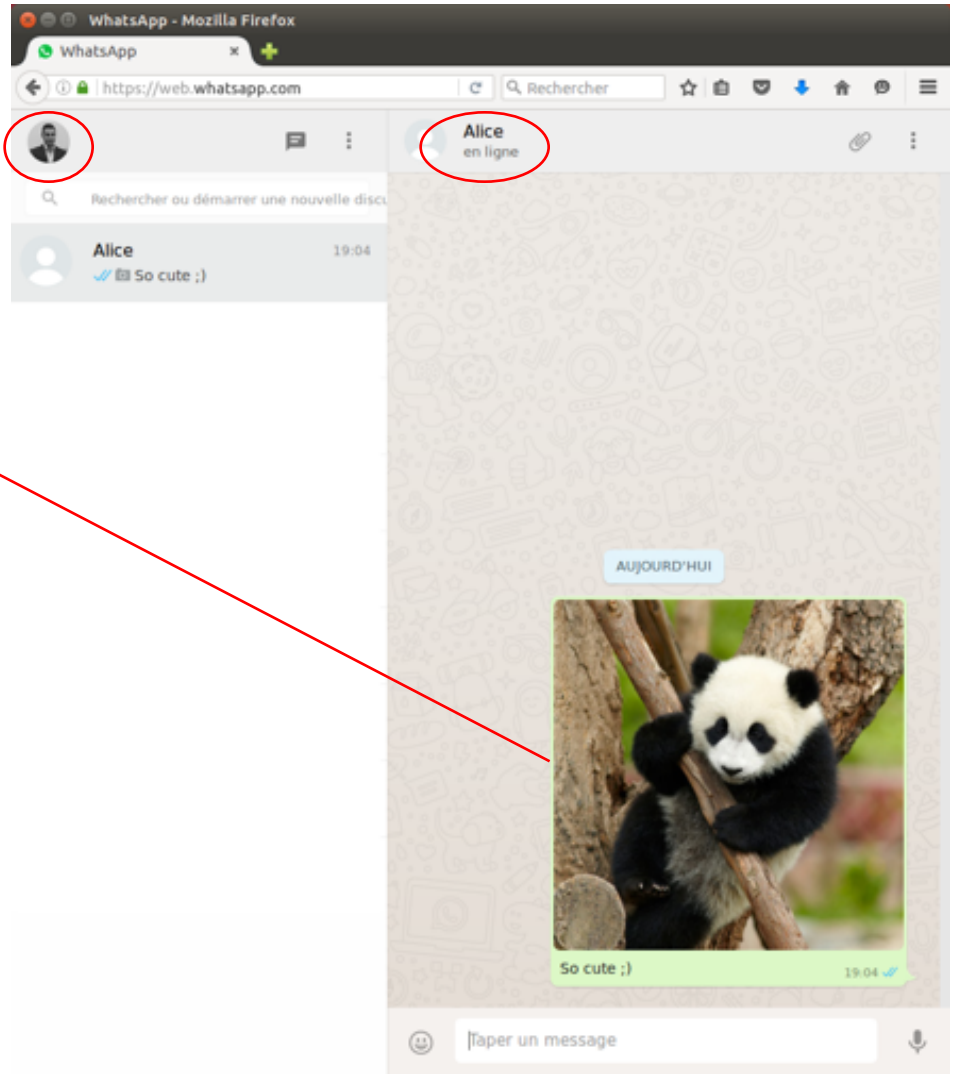
Eve



Bob

Man In The Middle: provoke discussion 1



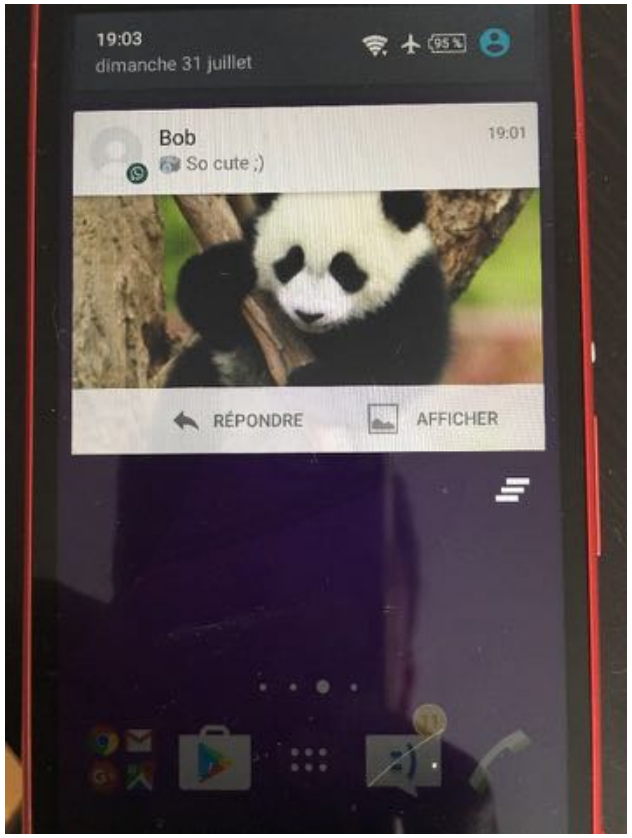


Alice

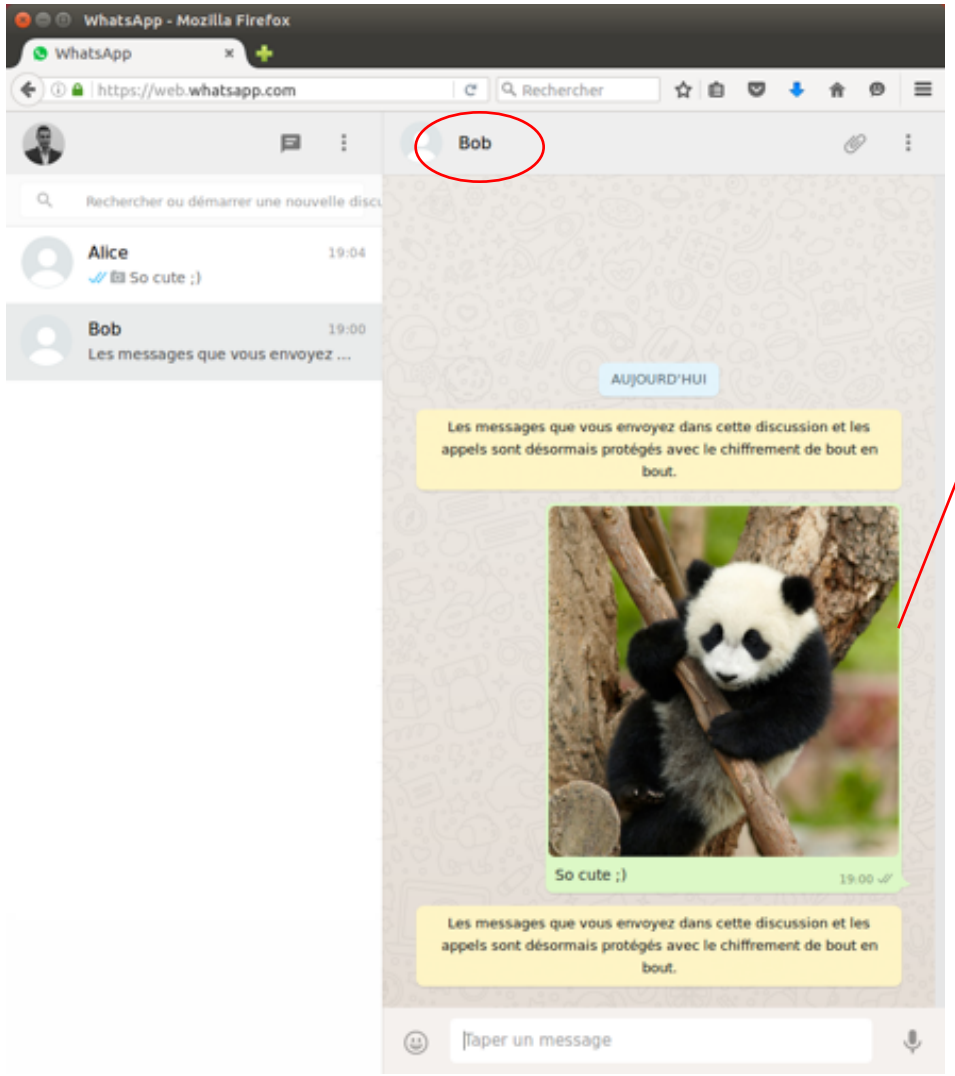
Eve

Bob

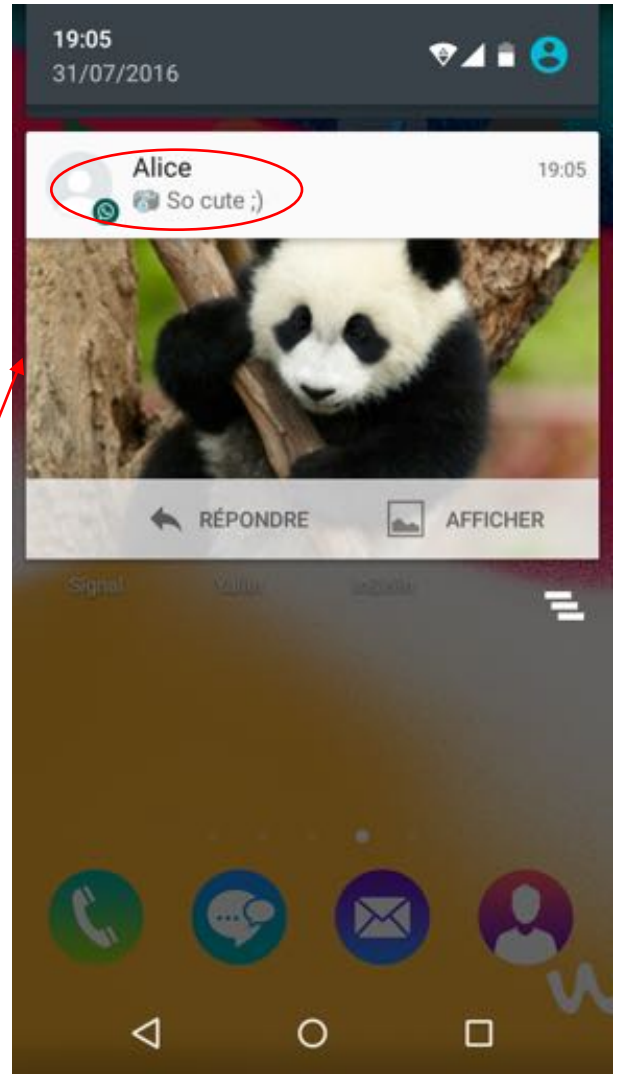
Man In The Middle: provoke discussion 2



Alice

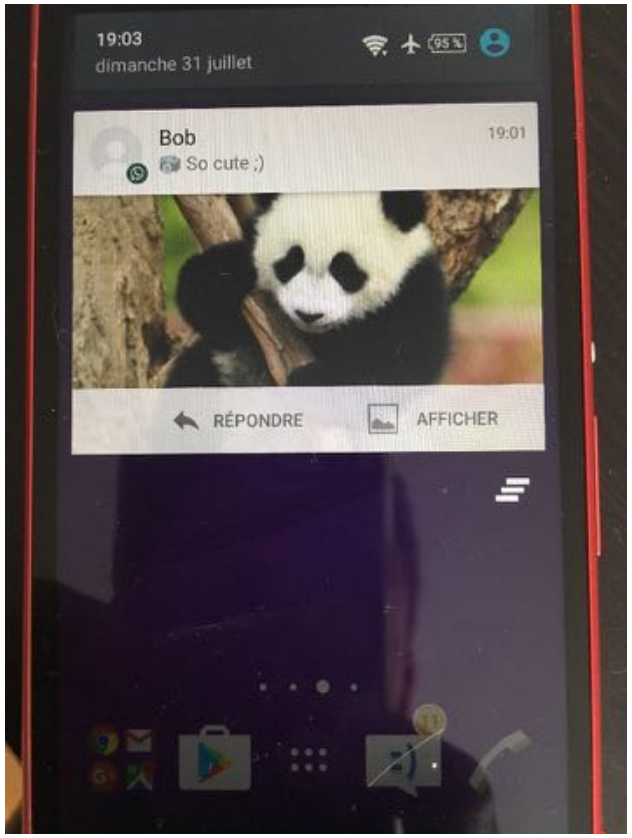


Eve

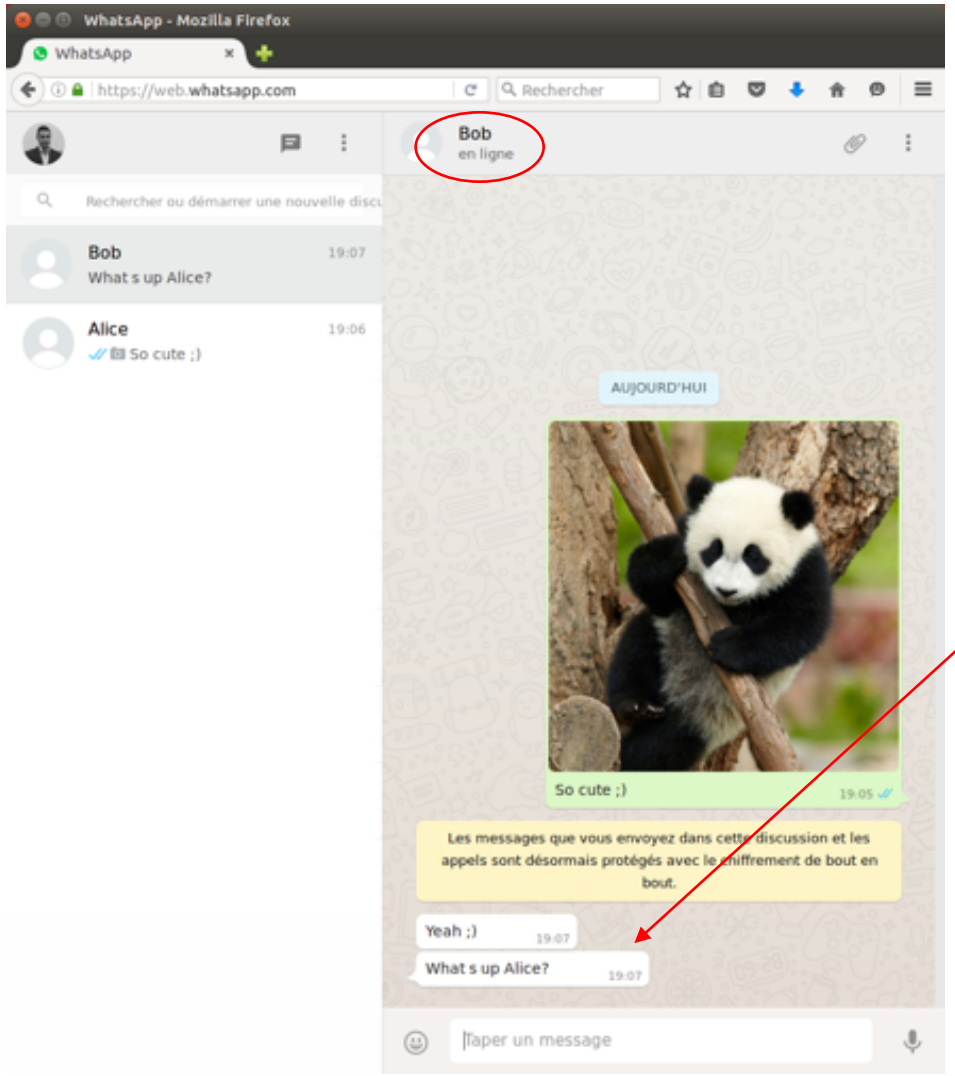


Bob

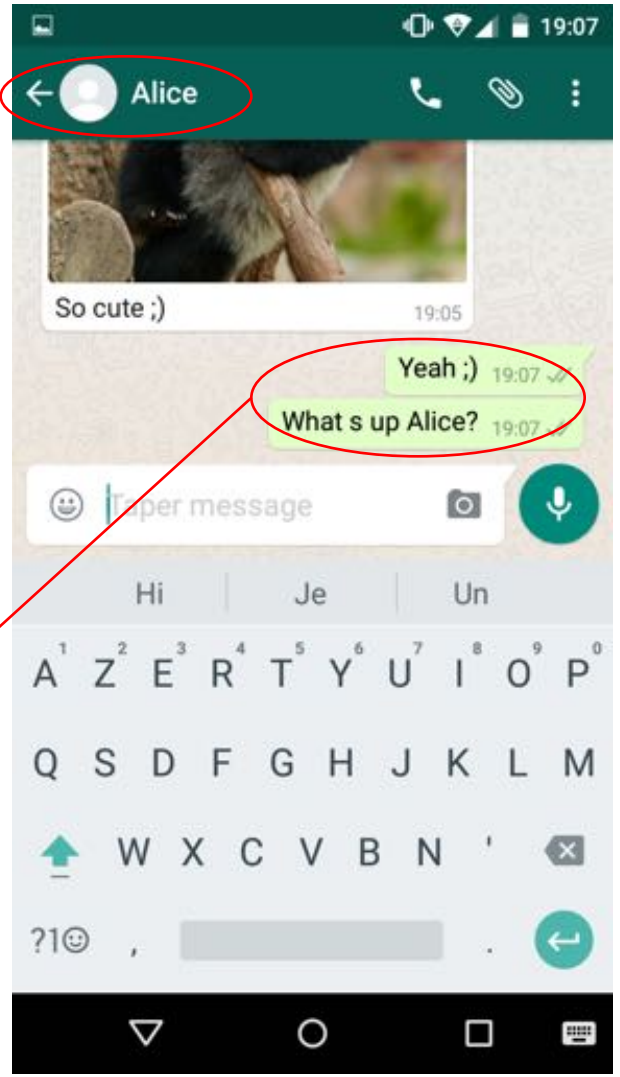
Man In The Middle: discussion 1



Alice

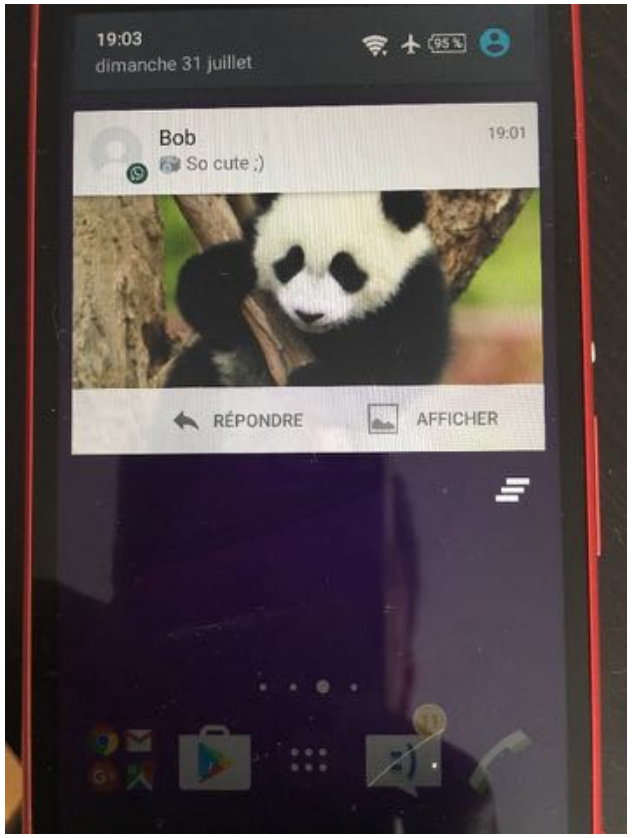


Eve

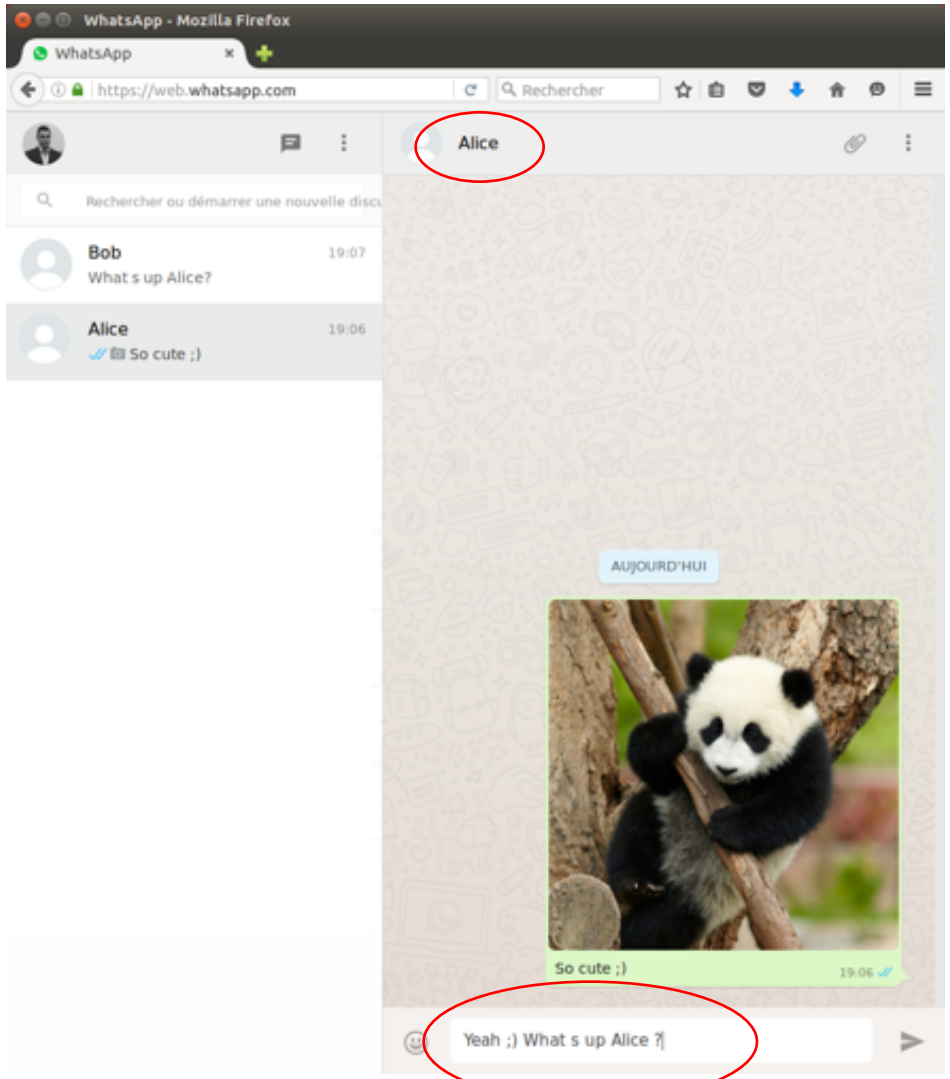


Bob

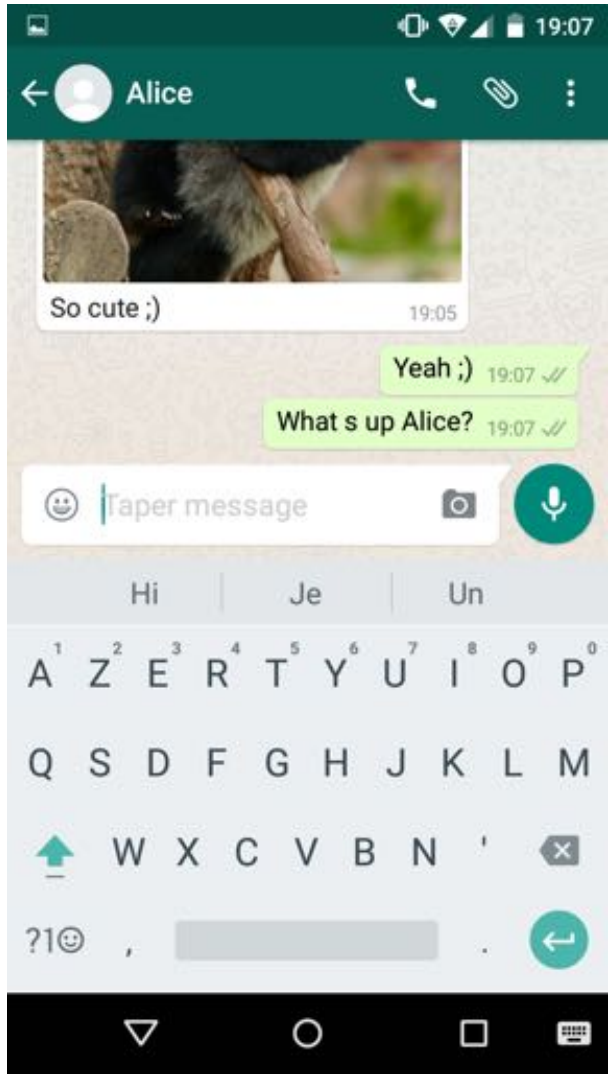
Man In The Middle: discussion 2



Alice

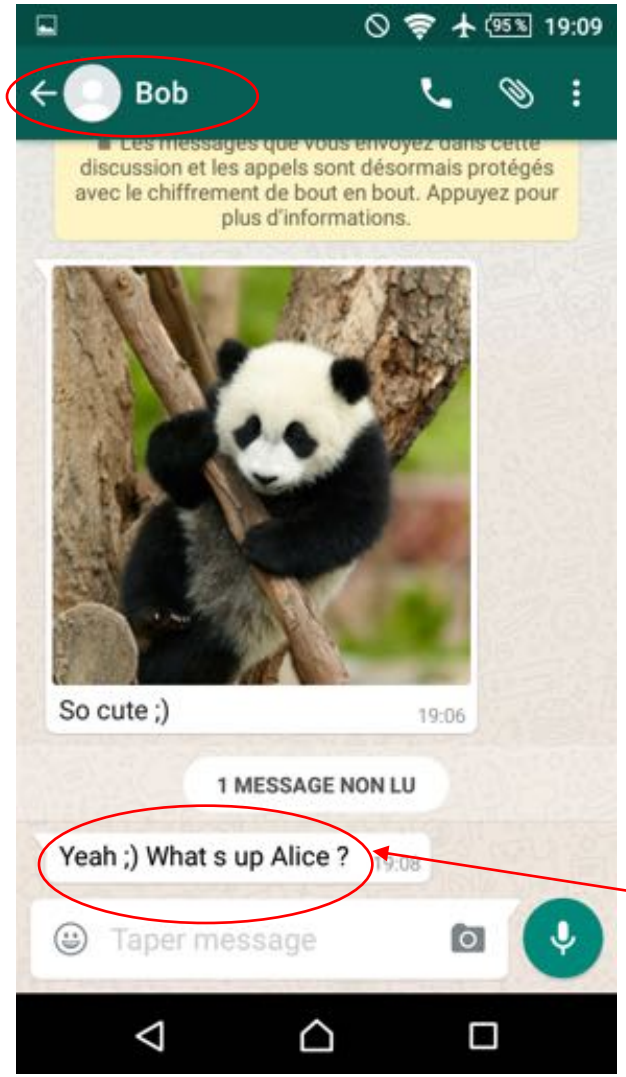


Eve

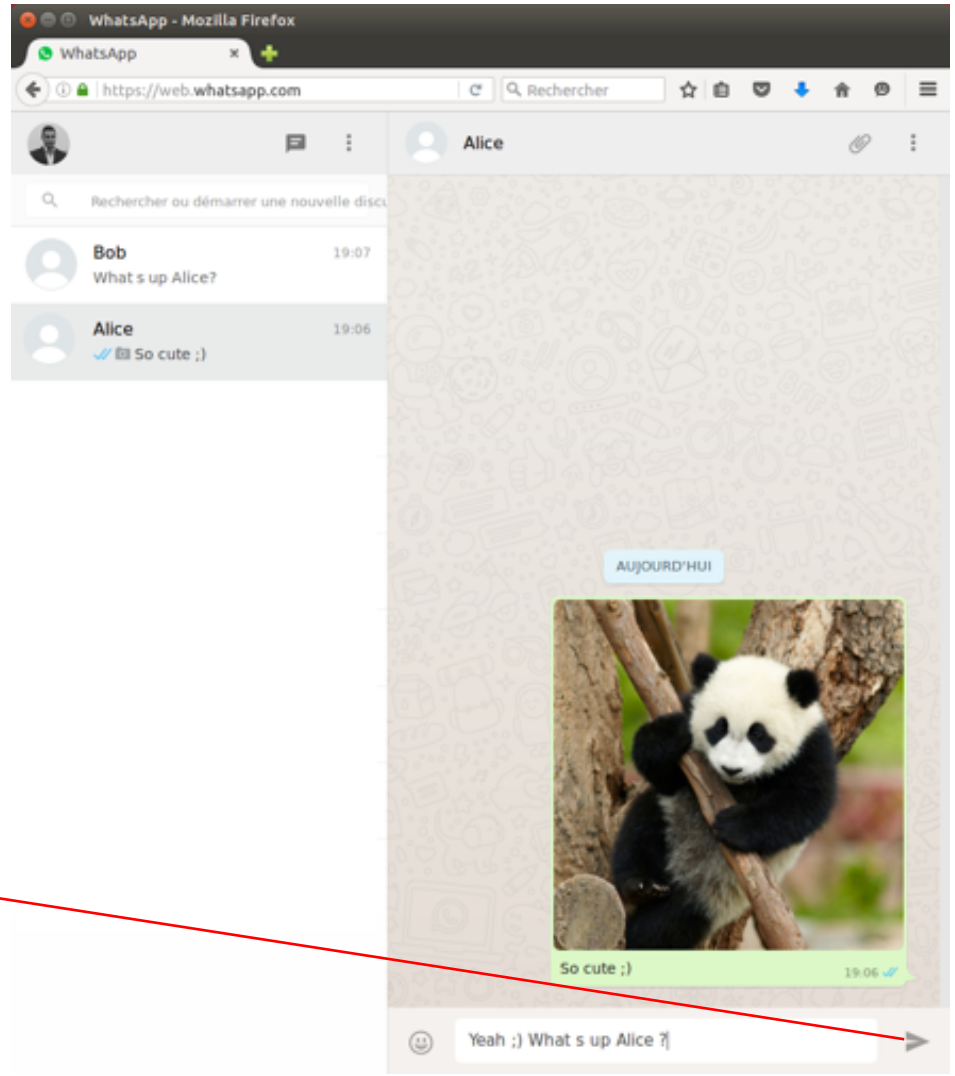


Bob

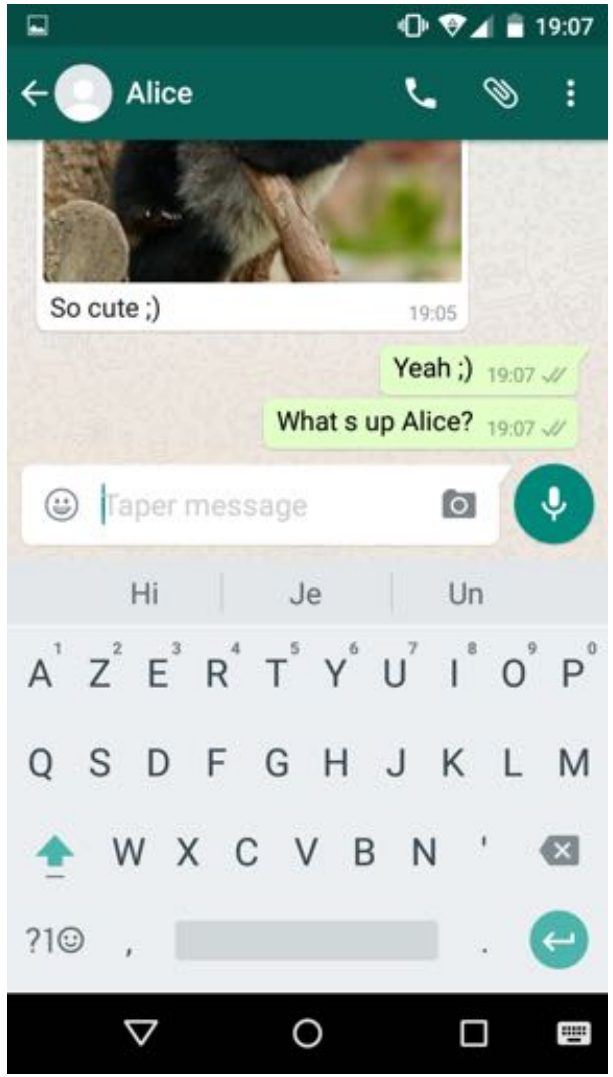
Man In The Middle: discussion 3



Alice

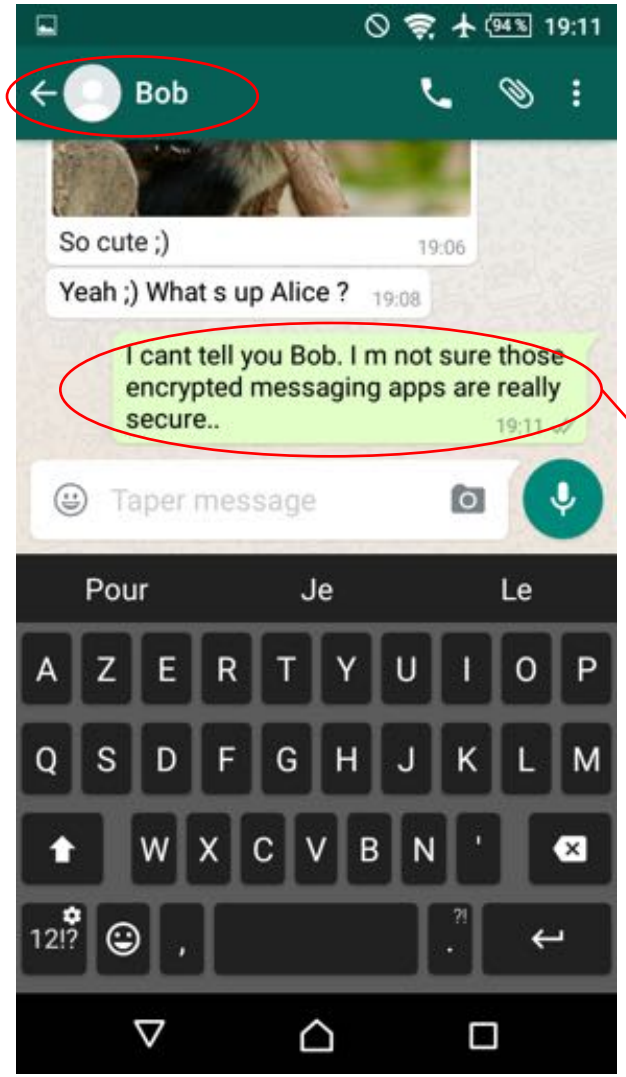


Eve

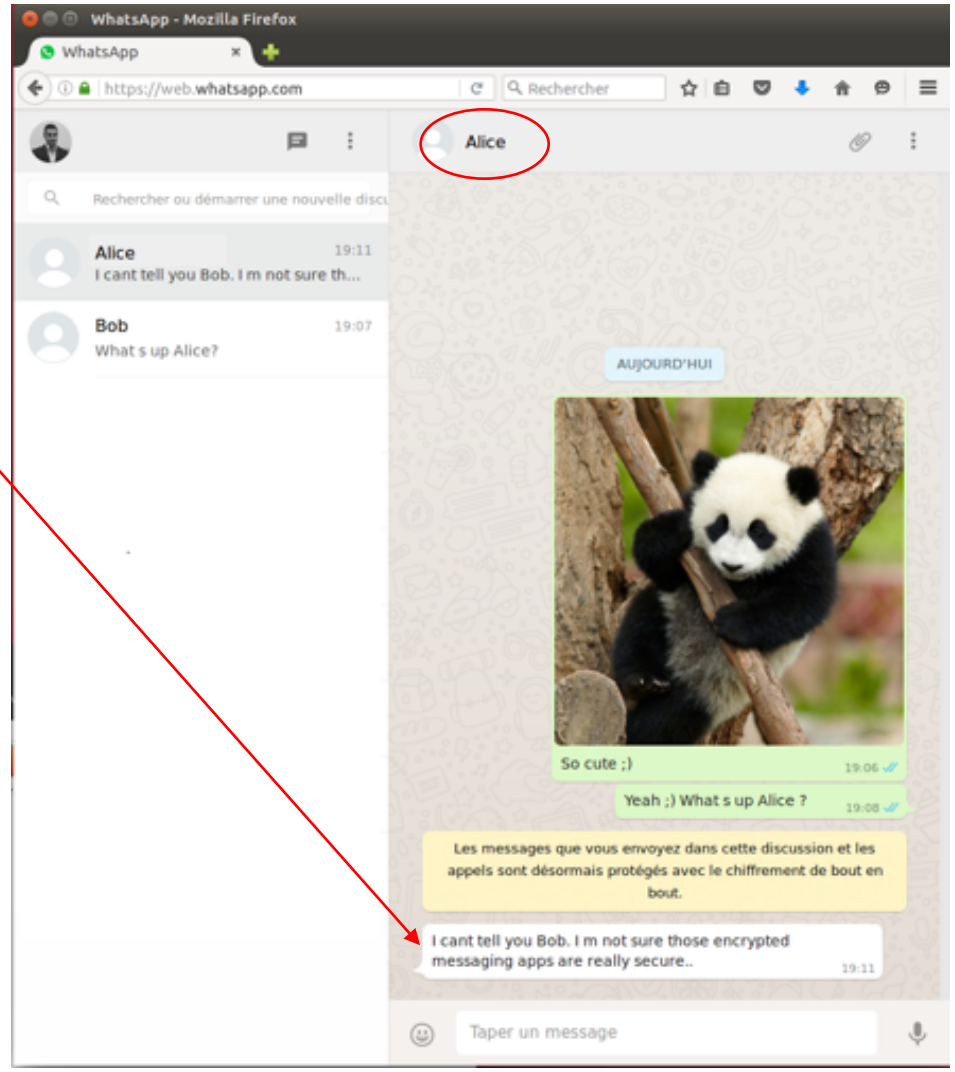


Bob

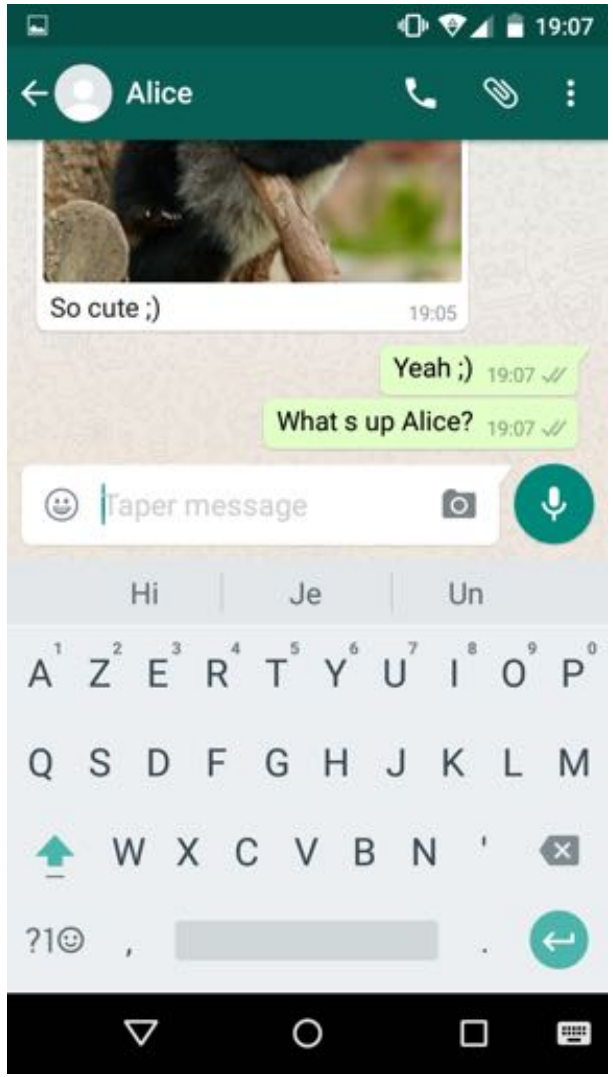
Man In The Middle: discussion 4



Alice



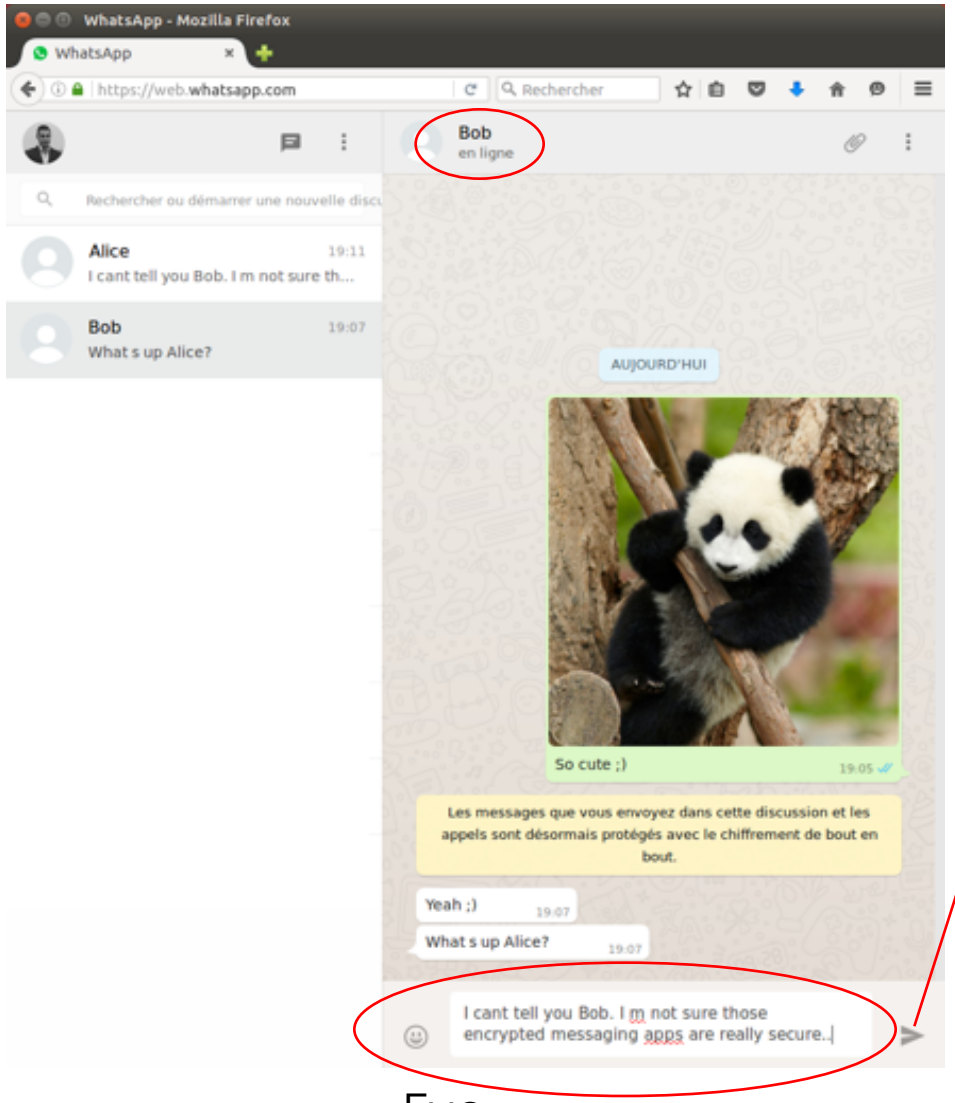
Eve



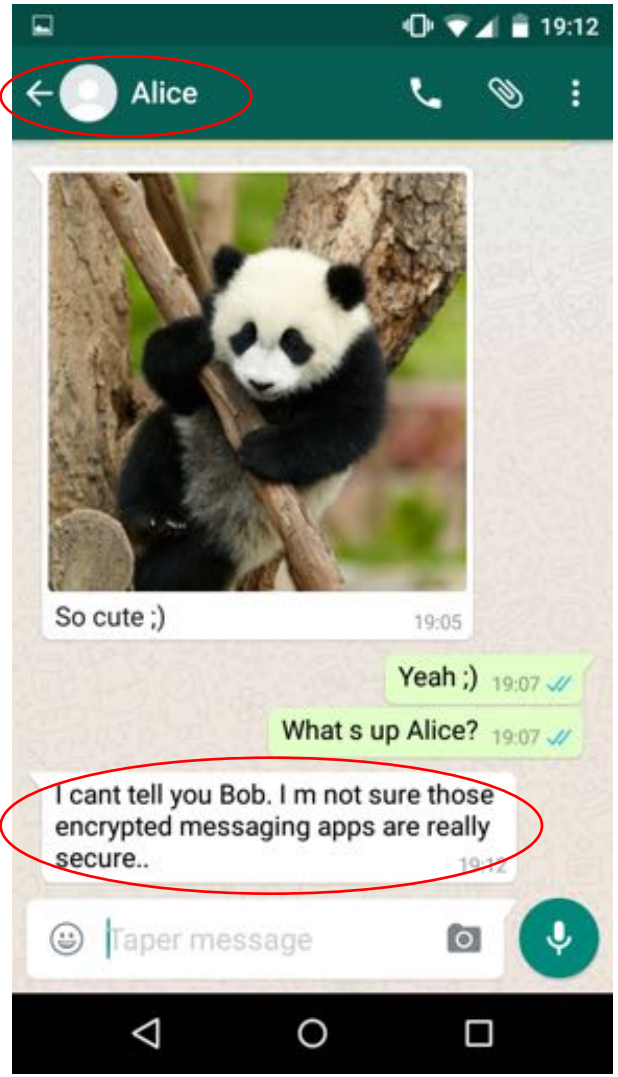
Bob

Man In The Middle: discussion 5

Alice



Eve



Bob

Man In The Middle results

- WhatsApp
  - **Possible to share a real conversation between Bob and Alice via Eve**
  - Only need to switch to a new conversation by forcing a chat
  - Later conversations will likely continue in this session (UI easiest path)
- Telegram: same results (web version also available), as long as the new contacts are used for the first time
- Signal: same results
  - Web version requires Android phone to login
  - Phone number always displayed below contact name

Risk assessment

- Simple evaluation: risk = easiness of attack * user impact
- Difficulty of attack: Low-Medium
  - Technically: Low
    - Easy to access contacts via code
    - Not a problem to get MITC application approved for publication
  - Logistics : Medium
    - One phone number is enough
    - Need to convince many users to install the MITC application
    - But « Ponzi scheme » possible by using the contact information
- Impact: High
  - Thousands of users can be spied

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

Countermeasures ?

- Messaging app
  - Display phone number + educate users
  - Give up the implicit trust on contacts
  - Deal with contacts the old way
    - Provide an explicit identifier + authentifier
    - Manually approve contacts to be added
- Mobile OS
  - Stronger restrictions for accessing contacts
  - Notifications when contacts are created/modified
- End user
  - Check your contacts
  - Beware of new conversations
  - Avoid installing applications asking for modify contacts permission

Conclusion

- **E2E can't guarantee privacy if you're not sure who you're talking to**
  - Beware of messages displaying good cryptography is used because it can bring a false sense of security
- **Security model around contacts is far too open** for sensitive apps
- **Authenticating the other party is an absolute necessity**
  - But it's a difficult task, particularly the provisioning processes
  - And even more to make it user friendly
    - **The end user must be in the loop** to detect suspicious activity
    - If it's too complex, secure features won't be used
    - A significant part of end users will install crappy apps, accept anything and not care about security warnings
- If the design of your solution includes access to contacts, start a threat modeling session

Thank you !

Any question ?

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