Information Assurance

CSE 365

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About me

- Not Dr. Crandall
- Antonio Espinoza
- Filling in today
- Dr. Crandall will be going over the syllabus on Tuesday
- Post Doctoral researcher at Bio-Design
- Former graduate student of Dr. Crandall

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Today

- Brief cryptography preview.
- Cover the analysis of end-to-end encryption in the LINE messaging application.

Section 1

Cryptography preview

Cryptography

You will be exploring cryptography in more detail early this semester.

Cryptography

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- Derived from Greek, meaning “secret writing”.
- Art/science of concealing the meaning behind messages with codes(*encryption*).
- Cryptanalysis is the breaking of such codes.

Encryption

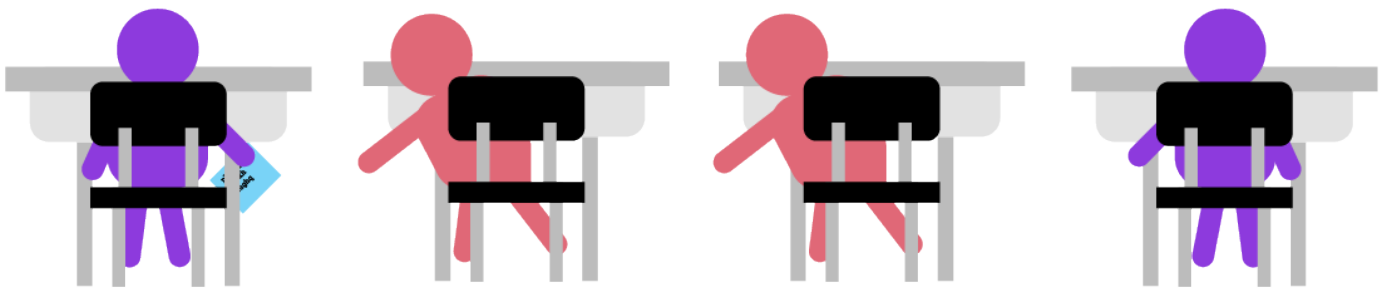
- Symmetric
  - Both parties have the same key
  - ***AES***[1], DES, Blowfish...
- Asymmetric
  - Both parties have different keys
  - Public and pivate keys for each participant.
  - ***Diffie-Hellman***, RSA...

[1] Military grade encryption usually refers to AES.

MAC

- Method Authentication Codes.
  - Not to be confused with Media Access Control from networking (ac:9c:bf:28:d7:b9)
- Makes sure the message has not been altered (integrity).

MAC [2]



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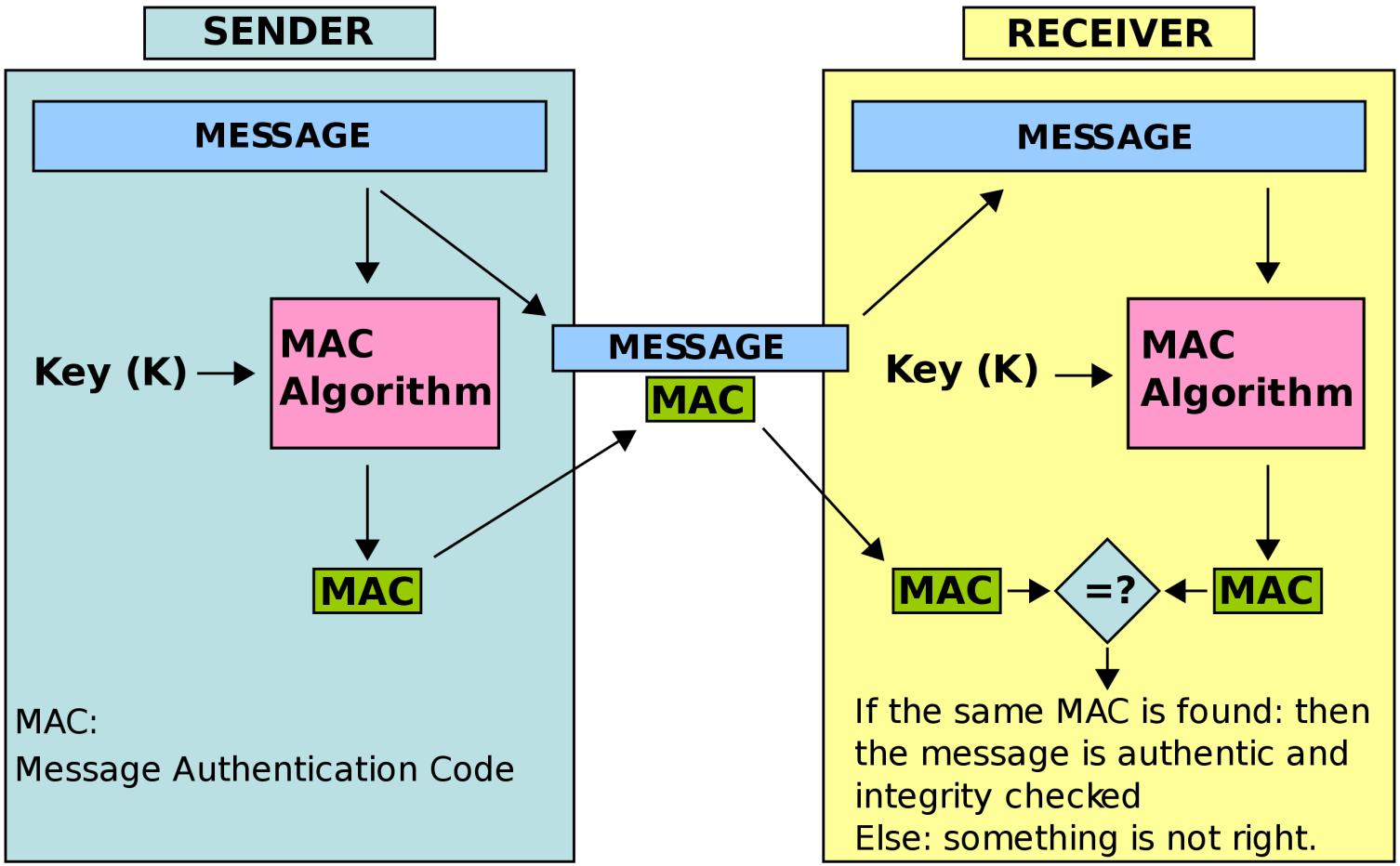
[2]Image from: https://ssd.eff.org/

MAC [3]



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[3] Image from: https://en.wikipedia.org/wiki/Message_authentication_code

End-to-end encryption

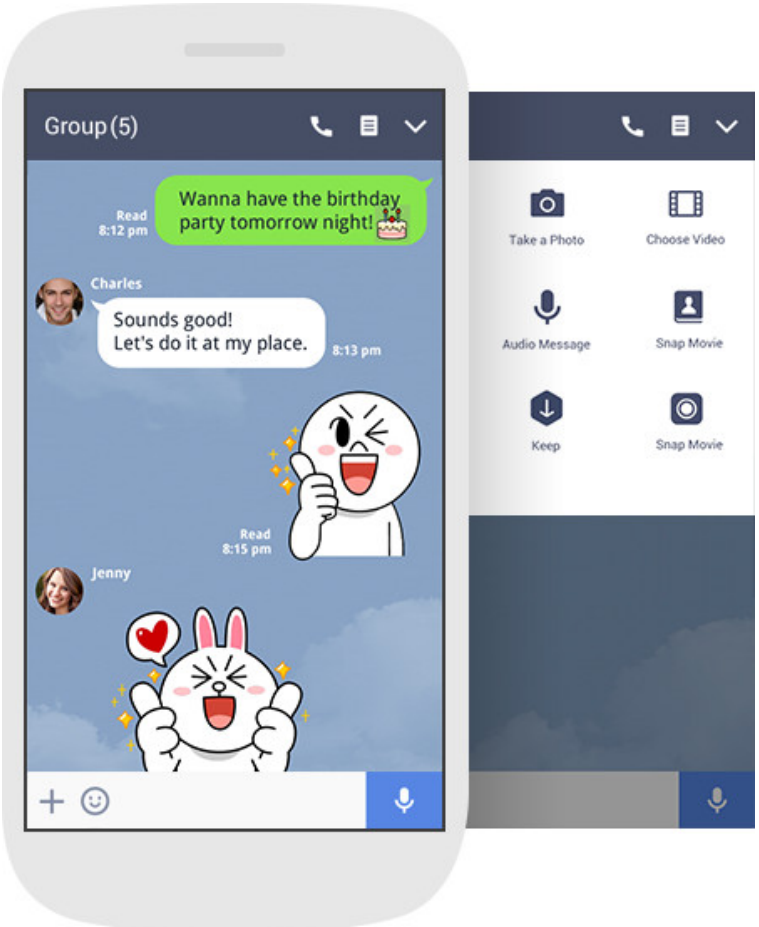
- System where only the parties communicating can decrypt messages.
- Examples?
  - Signal, telegram, wire, WhatsApp, Viber...
- Why E2EE?
- Uses?

Section 2

Analysis of end-to-end encryption in the LINE messaging application

LINE messaging application

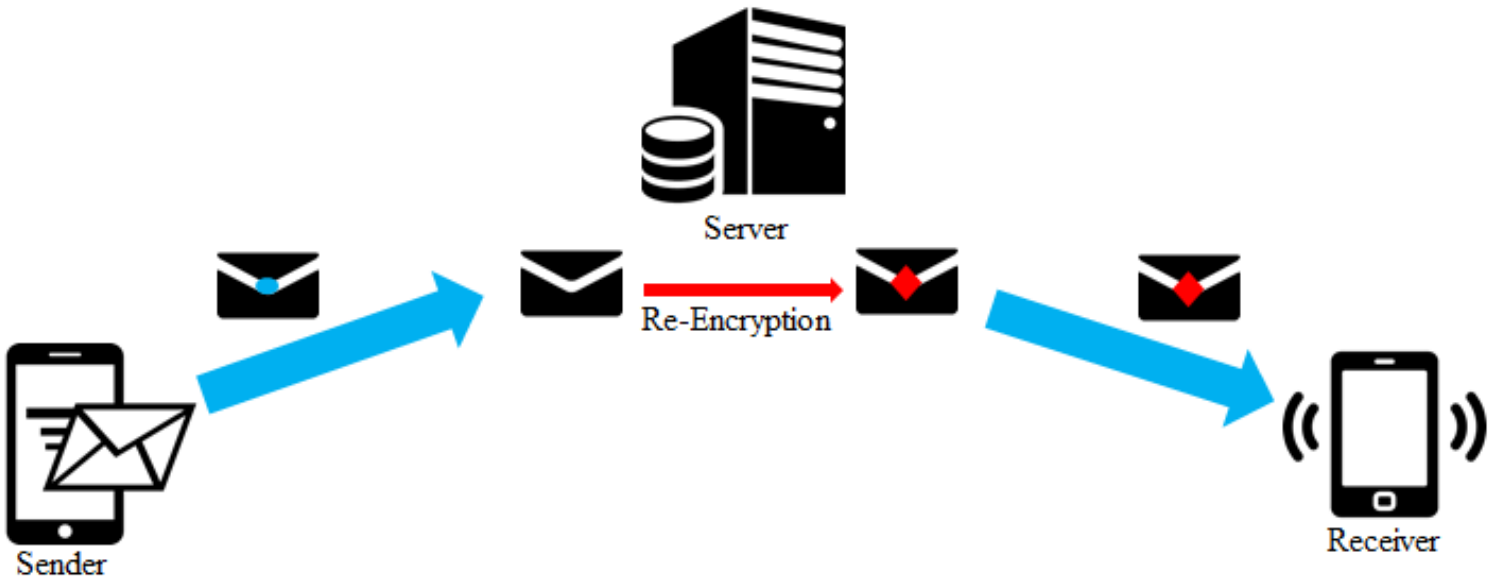
What is LINE? LINE is a Japanese chat application with over 200 million monthly active users.



About LINE

- In 2014 released a "Hidden Chat" feature.
  - "1-to-1 chat"
  - "sent in a secure state"
  - Basically disappearing messages
- In 2015 they released "Letter Sealing".
  - AKA End-to-end Encryption (E2EE)
- In 2016 Letter sealing became the default.
- Everything presented is from 2017 applying to LINE 6.7.1.

LINE pre letter sealing [4]



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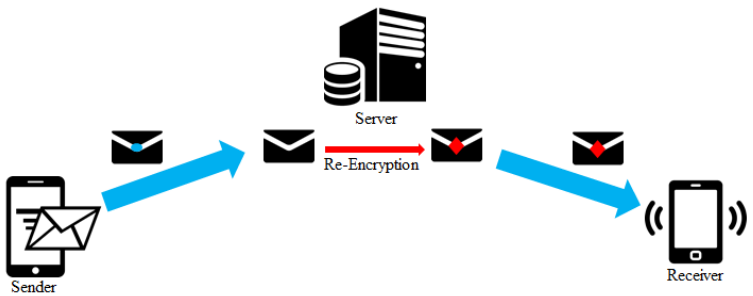
[4] Line images from https://engineering.linecorp.com/en/blog/detail/65/

LINE pre letter sealing

- Issues?
- Who can read the decrypted message?
- How would you fix this?



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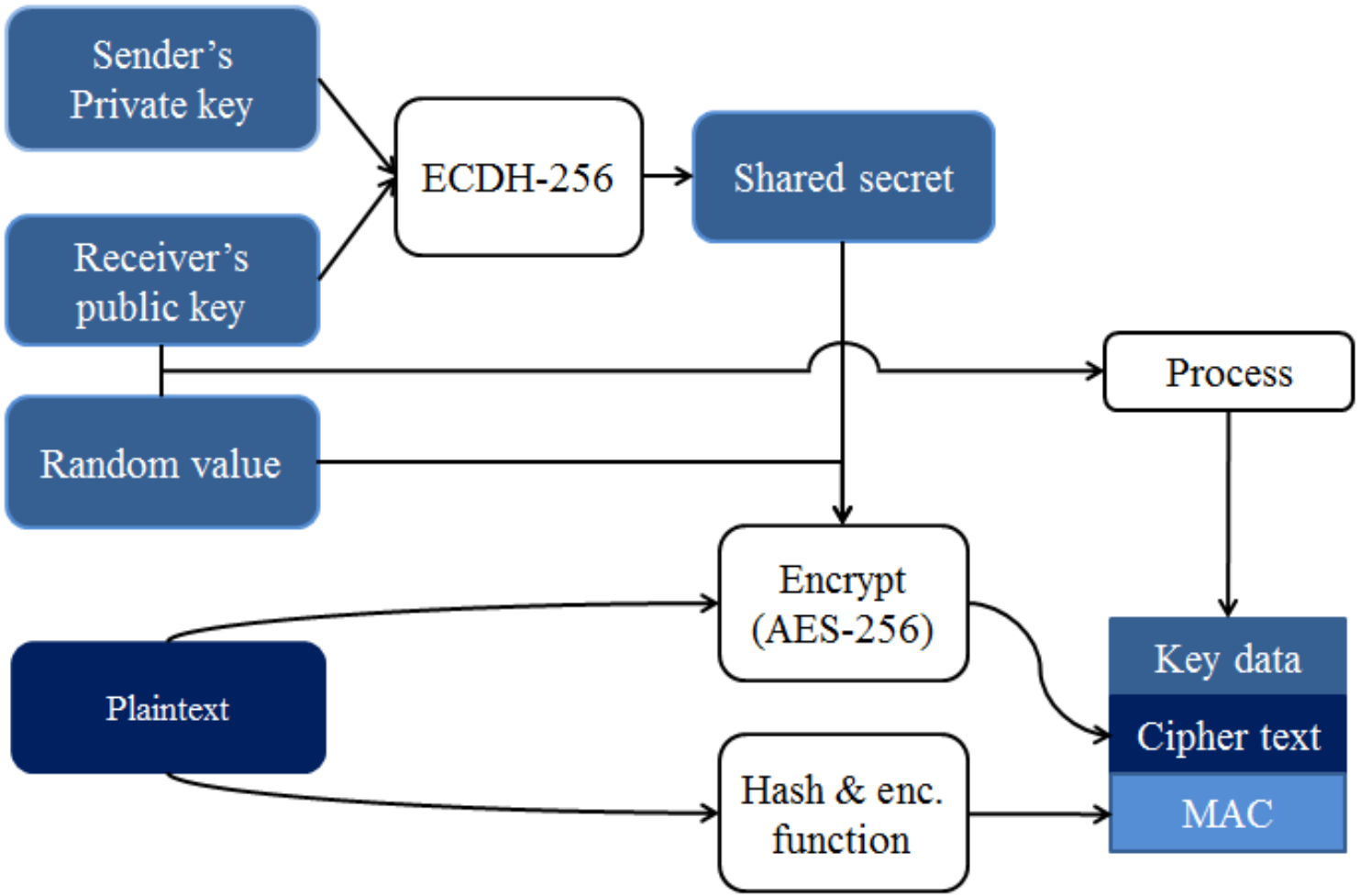
LINE sealing process



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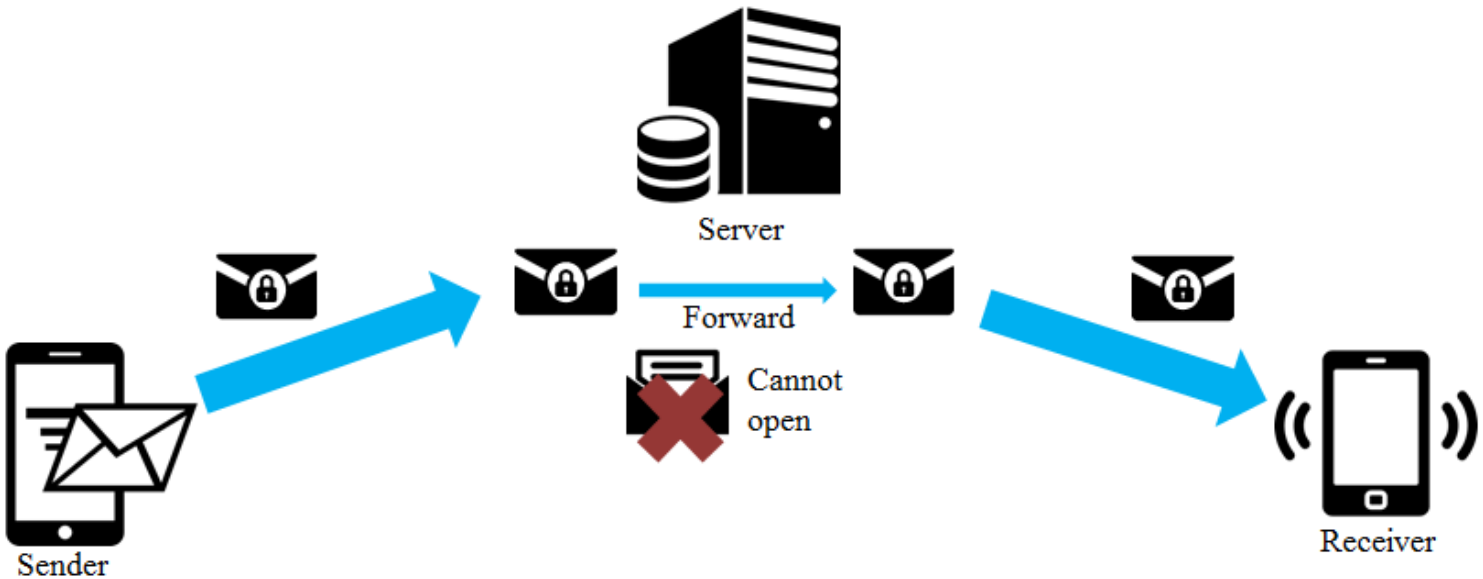
LINE letter sealing



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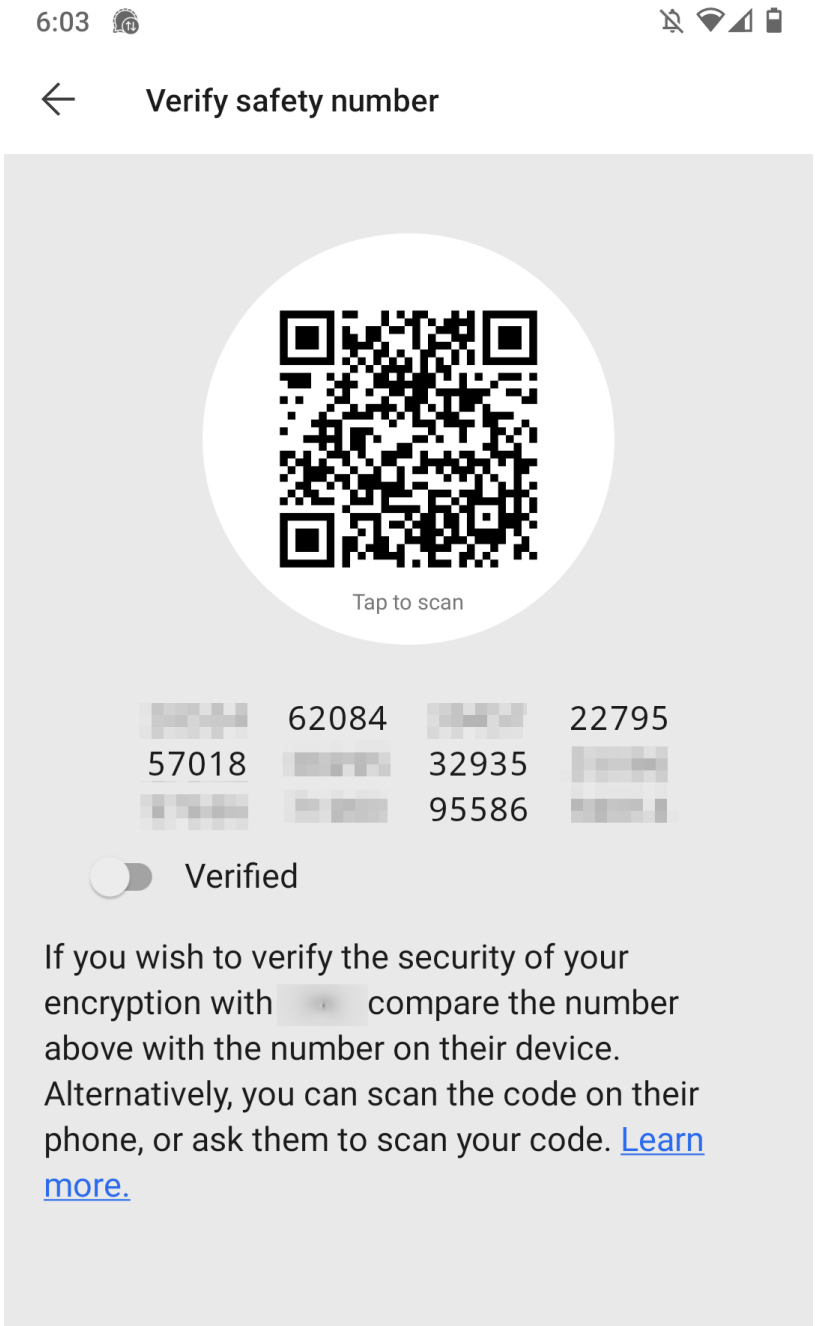
LINE letter sealing



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Devil in the details

- Don't need to know the mathematical underpinnings of cryptography to exploit its incorrect use.
- Do have to know how to correctly select values and the implications behind design decisions.
- For example:
  - It's not enough to use a password, you have to use a good password, not "abc123" .
- The following issues were found while reverse engineering the LINE app[5]

[5] I was reading **Cryptography Engineering** at the time.

Line issues

- Lack of end-to-end forward secrecy
- Replay attack (possible due to MAC issues)

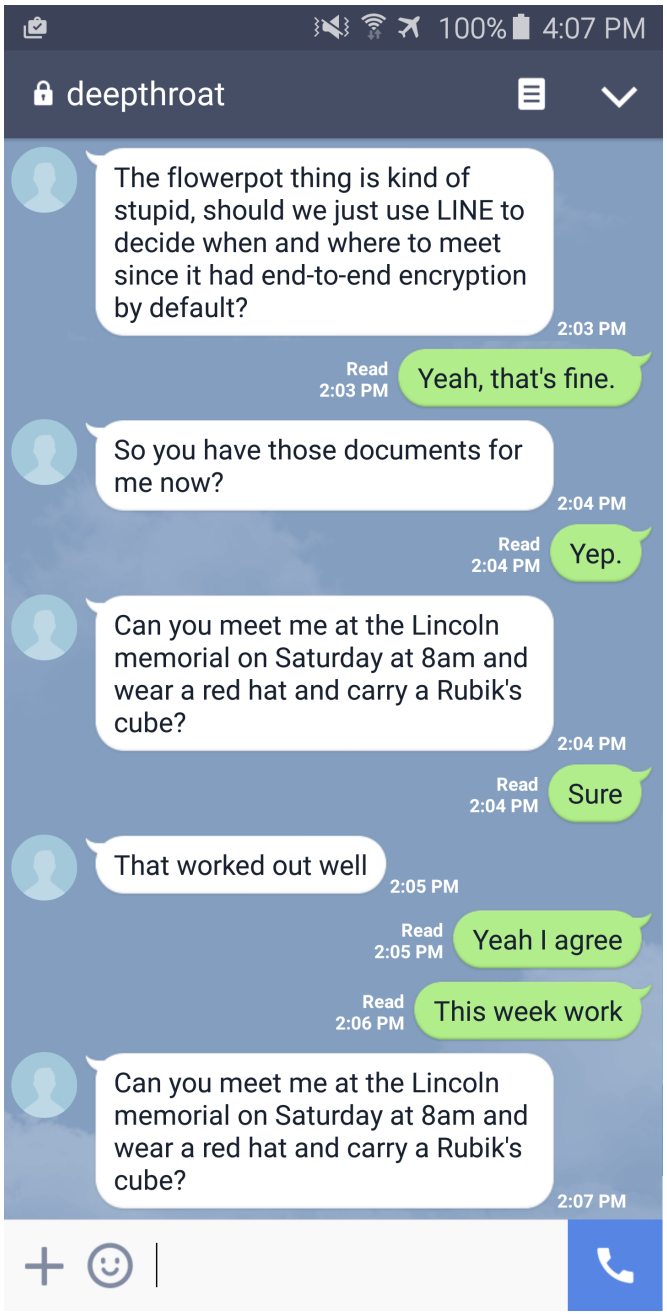
Forward secrecy

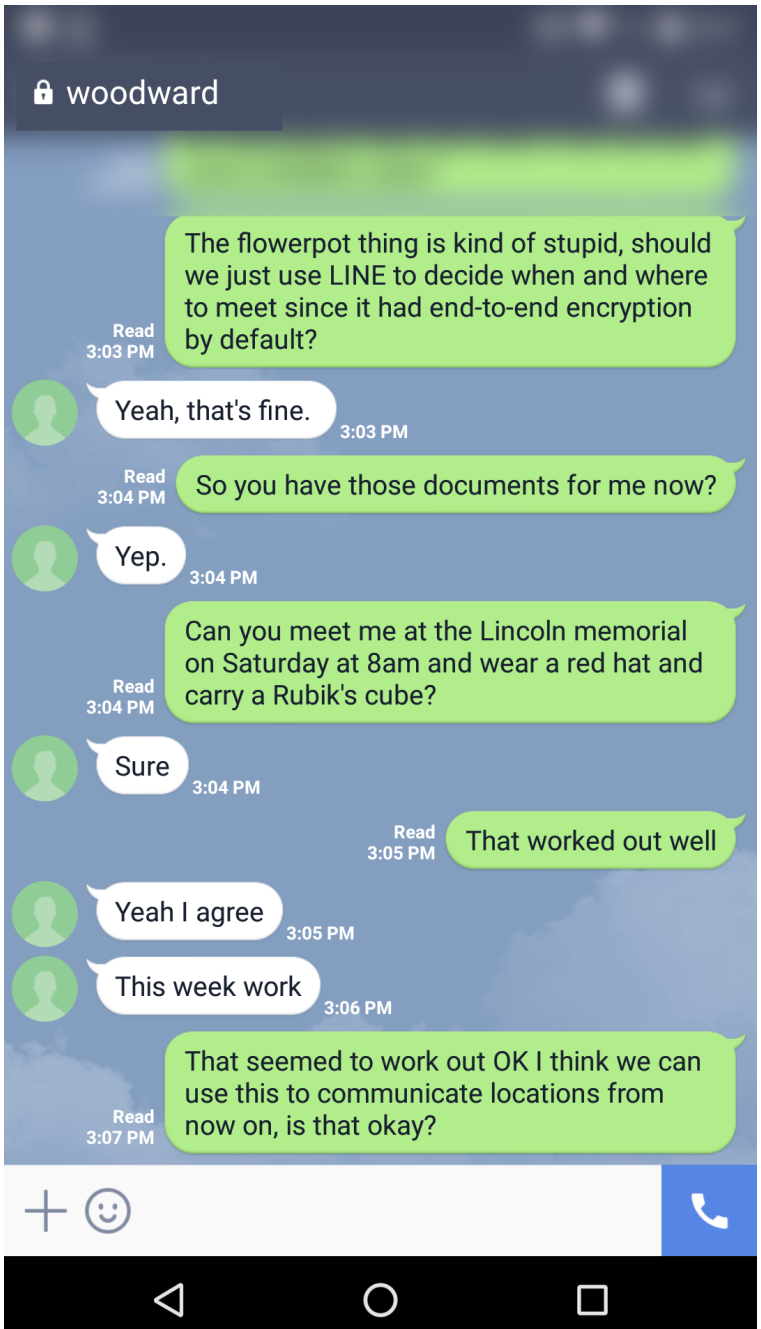
- Forward secrecy is a property of an encryption system that removes an attacker's ability to decrypt past messages even if one or more users' private keys are compromised.
- LINE had forward secrecy from the client to server, but not end-to-end.
- Implications?
  - Adversary can record traffic data and once a key is compromised past conversations can be read.

Replay attack

- A replay attack is an attack where an adversary records messages between two parties and can later replay any of those messages to either party member.
- The attacker does not know the key of either sender or receiver.
- The attacker may not know what the message decrypts to.

Replay attack

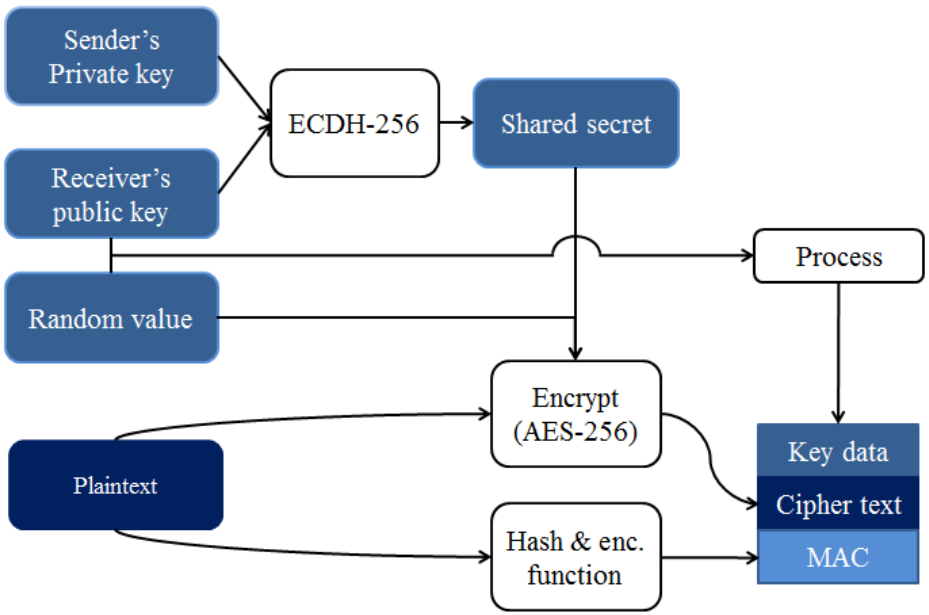




Replay details

Attacker needs 3 things

- Salt “Random value”
- Encrypted message “Cipher text”
- LEGY HMAC function “Hash & enc function”



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Tools

- The tools I used to do reversing of LINE.
- Other helpful tools:
  - wireshark
  - tcpdump
  - python

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