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# Passwords suck

- Good ones are hard to remember
- Difficult to have a different one for every site
- They can be intercepted, stolen from the client, stolen from the server, etc.
- What can we do to improve on passwords?

# Factors of Authentication

1. Something you know
  - Password
2. Something you have
  - Phone, RSA token, etc
3. Something you are
  - Finger prints, Iris scan, DNA, etc.

# Example

- When I log into my insurance site I am asked for a username and password
  - How many factors is that?
- After I log in I am asked to provide a “PIN”
  - Now how many factors have I used now?
- If I’m coming from an “unfamiliar computer” I am asked a secret question like: “What is the model of your first car?”
  - Now how many factors?

1 factor the whole time

- Only things I know

## Example 2

- When I log into Gmail I am asked for my username and password
- Then I am asked for my “Google Authenticator code”
- I pull out my phone, check the code which changes every 30 seconds, and enter that in
- How many factors have I used?

2 factors!

- Something I know (password)
- Something I have (phone)

# How Google Authenticator Works

- Google Authenticator implements TOTP security tokens from RFC6238 in a mobile app
- Provides a 6 digit one-time password for login
- Requires a shared secret for setup
- Conforms to specification so other sites can use the Google Auth app
  - Coinbase
  - Lastpass



No Service



2:23 PM



# Google™ Authenticator



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wileyc@acme.com



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msmart@control.gov



Edit

Legal Information



# Under the Hood - Overview

- Web application generates an 80-bit secret key for each user
  - Served as 16 character base32 string or QR code
- Client Creates an HMAC-SHA1 using the secret key
  - The message HMAC-ed (hashed) can be:
    - The number of 30 second periods having elapsed since the Unix epoch (number of seconds since Thursday January 1, 1970)
    - The counter that is incremented with each new code
- A portion of the HMAC is converted to a 6 digit code

# Under the Hood

## Pseudocode for Time OTP [\[edit\]](#)

```
function GoogleAuthenticatorCode(string secret)
  key := base32decode(secret)
  message := floor(current Unix time / 30)
  hash := HMAC-SHA1(key, message)
  offset := value of last nibble of hash
  truncatedHash := hash[offset..offset+3] //4 bytes starting at the offset
  Set the first bit of truncatedHash to zero //remove the most significant bit
  code := truncatedHash mod 1000000
  pad code with 0 until length of code is 6
  return code
```

Can you think of any possible issues?

# Possible Issues

- Shared Secret
  - Server could be compromised
  - Requires a cryptographically secure seed
- Clock Skew/Drift
  - Clock on phone and clock on server drift apart
  - To compensate the window for a valid code can be increased, but that makes the window of opportunity for compromise larger
  - More to keep track of and worry about server side
- Window of Opportunity
  - A dedicated attacker might still have ~30 seconds

A clever 2FA system from Twitter

# Twitter's 2FA

- Consists of 2 parts
  - Online
    - Similar to other 2FA with slight twist
  - Backup codes
    - Inspired by S/KEY

# Online 2FA

- 2 RSA 2048bit keys are generated (public and private)
- Public is given to Twitter and stored on their servers
- Private is stored on the phone
- When you log in the servers send a “challenge” (random secret) to the phone
- If the user approves the phone signs the random secret with the private key and sends it back
- The server then verifies the signature, and issues a session token to the client logging in
- No clock to worry about



# Backup Codes

- A random key is generated by the phone
- The key is hashed 10,000 times
- The 10,000x hash is kept on the server
- The key is then hashed 9,999 times and written down
- If the user needs to log in they can provide the 9,999 iteration hash, which is then hashed once, and compared to the 10,000x hash on the server
- If they match then they must have the secret
- A new 9,998x hash is given to the user to be written down
- The 9,999x hash is stored on the server

What is a digital service that everyone here has access to?

Hint: it's an old service that mimics a similar service in the outside world

Email

# Square Cash

- When you sign up you are given a temporary URL sent to your email
- When you follow that link you enter your debit card
- On the back-end the debit card and your email are now “linked”
- Assumptions
  - Only someone with access to the email would be able to follow the URL
  - Only someone with the debit card would be able to fill out the form located at the URL
  - Therefore we can assume that the owner of the card and the owner of the email account are the same person

# Square Cash

- When I want to send money I simply
  - send an email to the person I want to send money to
  - CC pay@square.com and put the amount in the subject line
- If they have an account the money is transferred (charge to me and refund to them)
- If they don't have an account they are sent a signup link to link their email to their debit card

# Square Cash

- No typical account signup
- No additional username and password
- If 2FA is setup on the email account then it is also setup on the Square account
- When you forget a password you use your access to the email to recover it, so why not just use access to your email as your password to begin with

# Resources

- <https://blog.twitter.com/2013/login-verification-on-twitter-for-iphone-and-android>
- [https://en.wikipedia.org/wiki/Google Authenticator](https://en.wikipedia.org/wiki/Google_Authenticator)