A Comparative Usability Study of Two-Factor Authentication

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Two Factor (2F) Authentication

Website/Service

Possession
- Token
- Phone
- Smart Card

Knowledge
- password
- PIN
- Pattern

Inherence
- Fingerprint
- Retina
- Palm

A. Adams and M. A. Sasse. Users are not the enemy. 1999
Two Factor vs One Factor

More secure

Less usable
Slower
Unfamiliar

N. Gunson et al. User perceptions of security and usability of 1F and 2F in automated telephone banking, 2011
D. D. Strouble et al. Productivity and usability effects of using a two-factor security system, 2009
This Presentation

Observations
- Large offering of two factor solutions
- Lack of metrics to measure 2F usability

Problem
- Is there a difference in usability among 2F?

Contributions
- Comparative usability study
- Pre-study interview
- Explorative quantitative study
Pre-Study Interviews

Goal
Understand popular 2F in use, context and motivations

Participant Recruitment
Mailing lists and social media (Google+ and Facebook)
Announced paid interviews for user study on authentication
Online screening survey to know more about potential participants
9 out of 29 mostly from Silicon Valley, familiar with 2F
Findings

Adoption

- Security token
- SMS or email
- Smartphone app

Motivation

- Forced to
- Incentivized
- Wanted to

- “I use 2F to obtain higher limits on online banking transactions”
- “I use 2F to avoid getting hacked”

Context

- Work
- Personal
- Financial
"An artisan must first sharpen his tools if he is to do his work well."
Confucius

QUANTITATIVE SURVEY
Quantitative Survey

Two main challenges
  How to recruit participants?
  What questions to ask?

Existing usability metrics
  SUS - System Usability Scale (10 questions)
  QUIS - Questionnaire for User Interface Satisfaction (27 questions)
  PUEU - Perceived Usefulness and Ease of Use (12 questions)
  CSUQ - Computer System Usability Questionnaire (19 questions)
  ...

Software focused, not for 2F technologies
Usability Questions

- Quick
- Helpful
- Concentration
- User Friendly
- Not Enjoy
- Convenient
- Reuse
- Enjoy
- Need Instruction
- Secure
- Frustrating
- Trust
- Easy
- Match


User Distribution

Online survey

219 participants from Mechanical Turk

SUS and 15 other questions on usability

<table>
<thead>
<tr>
<th>Group</th>
<th>2F Technologies Used</th>
<th># of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Token</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Email/SMS</td>
<td>77</td>
</tr>
<tr>
<td>3</td>
<td>App</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Token &amp; Email/SMS</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>Token &amp; App</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Email/SMS &amp; App</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>All three</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>219</td>
</tr>
</tbody>
</table>
Adoption

SMS/Email is the most popular 2F (89.95%)
App (45.20%)
Token (24.20%)

Context

\[ X^2(4, 582) = 65.18, p < .0001 \]
Results

Motivations

Forced  Incentive  Voluntary

App 37.57%  9.25%  53.18%
Email/SMS 43.52%  11.65%  44.48%
Token 44.90%  19.73%  35.37%

$\chi^2(4, 775) = 14.68, p < .0001$
Results
Exploratory Factor Analysis

Quick  Helpful  Concentration
Not Enjoy  User Friendly  Stressful
Convenient  Enjoy  Need Instruction
Reuse  Secure  Frustrating  Trust
Easy  Match


# Results

**Exploratory Factor Analysis**

<table>
<thead>
<tr>
<th>Ease of Use</th>
<th>Cognitive Efforts</th>
<th>Trustworthiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick</td>
<td>Need Instruction</td>
<td>Trust</td>
</tr>
<tr>
<td>Convenient</td>
<td>Concentration</td>
<td>Helpful</td>
</tr>
<tr>
<td>Enjoy</td>
<td>Stressful</td>
<td>Secure</td>
</tr>
<tr>
<td>Reuse</td>
<td>Match</td>
<td></td>
</tr>
<tr>
<td>Not Enjoy</td>
<td>Frustrating</td>
<td></td>
</tr>
<tr>
<td>User Friendly</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>32%</th>
<th>15%</th>
<th>14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Explained</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14%
Usability Comparison

- Token
- Email/SMS
- App

Graph showing usability comparison across SUS, Ease of Use, Cog. Efforts, and Trustworthiness.
Usability Comparison

MANOVA analysis (groups 4, 6 & 7)

DV: Ease of use, Cognitive Efforts and Trustworthiness
IV: Technology (2F technologies used)
Covariates: Age and gender

Results

No main effect of Technology
Some usability differences w.r.t age and gender:

Email/SMS and Token users (group 4)
The elderly (Md=3) need more Cognitive Efforts than the young (Md=2, p=0.003)

Email/SMS and App users (group 6)
The elderly (Md=5.5) find that 2F are less trustworthy than the young (Md=6, p=.0007)

Users of all 3 technologies (group 7)
Females (Md=2.75) need more Cognitive Efforts than males (Md=2.0, p=.001)
Conclusion

Main results

Different 2F technologies are preferred in different contexts
Did not find usability difference among three 2F technologies
Identified two additional dimensions of 2F usability: Cognitive Efforts and Trustworthiness

Future work

Larger variety of 2F technologies and participants
Develop a usability scale for 2F technologies
BACKUP
Methodology

Interviews

1 on 1 meeting, $10 Amazon Gift Card compensation

Questions

1. Which 2F have you used? (Adoption)
2. How does 2F work? (Understanding)
3. Why do you use 2F? (Motivation)
4. Recall last time you used 2F? (Familiarity)
5. What issues do you have with 2F? (Comments)

PIN from a paper/card
Digital certificate
RSA token code
Verisign token code
Paypal token code
Google Authenticator
PIN received by SMS/email
USB token
Smartcard
Participants’ Profile

Selected 9/29 from survey

Most of them from silicon valley
Only participants familiar with 2F
Age: 21 to 49
Gender: 5 males, 4 females
Education: High school to PhD
Security: 5/9 background in computer security