A Comparative Usability Study of Key Management in Secure Email

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Motivation

- How does an IBE-based email system fare against a well implemented PGP-based email system?
- Two outcomes
    - Research results
    - A research platform

IBE—Identity-Based Encryption
PGP—Pretty Good Privacy

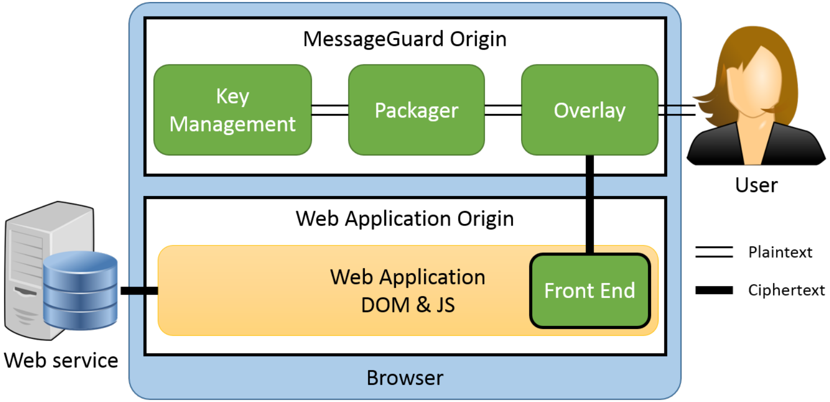
MessageGuard:
A Research Platform For Securing the Web

The Web

- Much of today’s software is on the Web
- Strong push for moving desktop software to the cloud
  - Software-as-a-Service (SaaS)
- Pros
  - Cheap
  - Scalable
  - Resilient
- Cons
  - Limited ability to configure
  - No control of own data

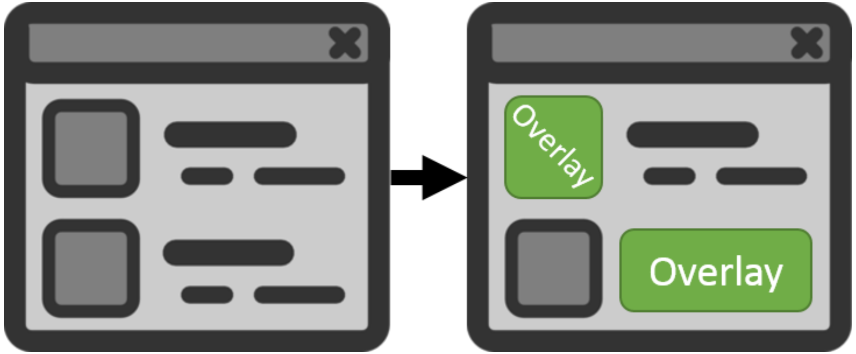
MessageGuard

- Retrofit websites/SaaS products to add security
  - Add end-to-end encryption
  - Verify signatures of content
- Does not require cooperation by the website/SaaS product
- Strong isolation from the underlying application



Afanasyev et al. *Content-Based Security for the Web*. NSPW 2016. ACM, 2016.
SaaS—Software as a Service

Security Overlays



- Replace portions of the interface with overlays
  - iFrame
- Author and view secure content in the overlay
- Visually seamless

Research Platform

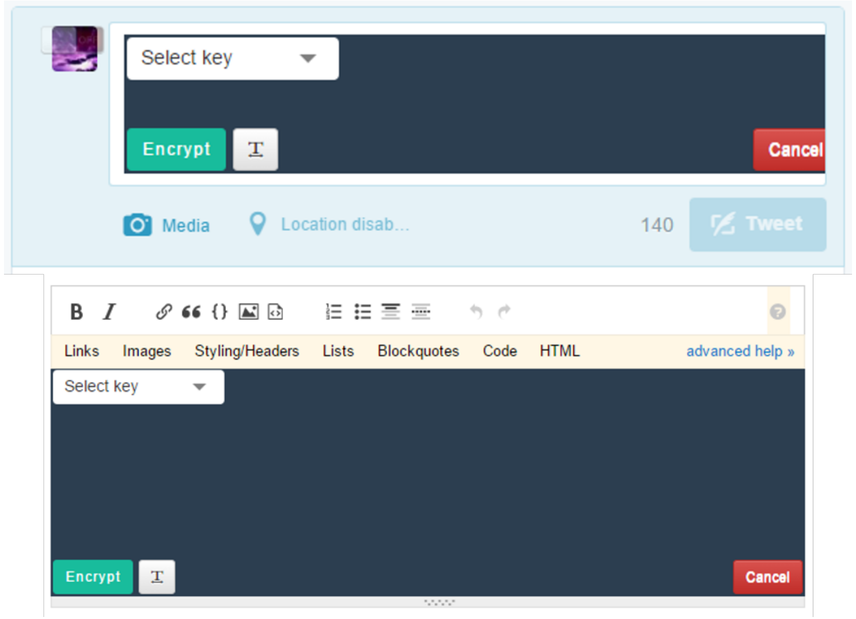
Framework

- Easy-to-modify
  - Pluggable
- Universal
  - Most websites
  - Desktop and mobile
- Fast

Benefits

- Accelerate the creation of functional prototypes
  - Simplifies creating prototypes for A/B testing
- Provides an easy way to share research results

Example Systems



- Private Facebook Chat
  - Robinson et al., 2012
- Pwm 2.0
  - Ruoti et al., 2016
- Short-lived keys
  - Monson et al., 2018
- This work

Robison et al. *Private Facebook Chat*. SocialCom 2012.
Ruoti et al. *Private Webmail 2.0: Simple and Easy-to-Use Secure Email*. UIST 2016.
Monson et al. *A Usability Study of Secure Email Deletion*. EuroUSEC 2018.

Research Opportunities

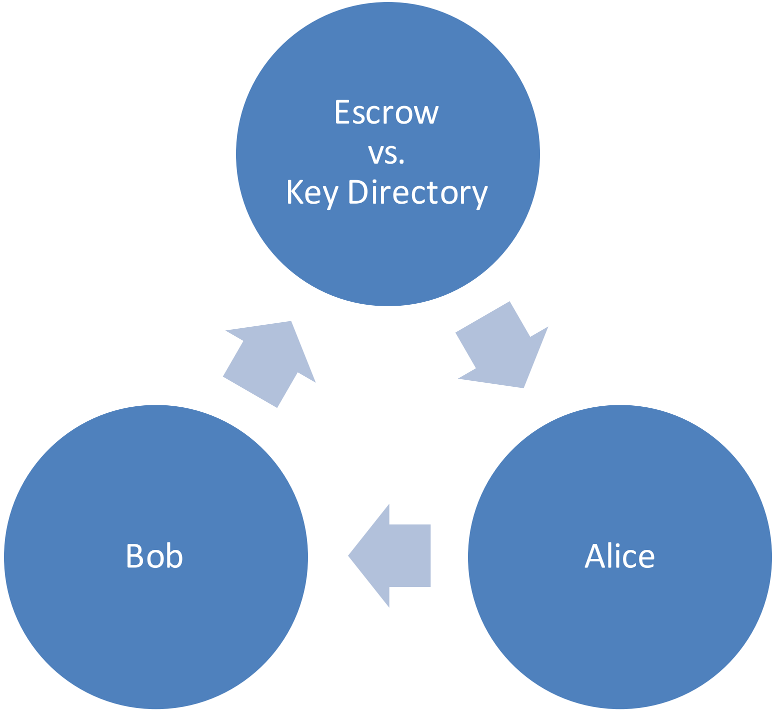
- Security researchers
  - Easily conduct usability studies
  - Key management
  - Messaging protocols
- Usability researchers
  - Test fully-implemented systems
  - Trustworthy interfaces
  - Avoiding mistakes

Available now at
https://messageguard.io

Comparing Key Management in Secure Email

IBE vs. PGP

- IBE consistently outperforms PGP
- Reasons to questions this gap
  - Poorly designed PGP systems
  - Emergence of public key directories (PKD)
- Prior work is insufficient to answer this question


Escrow
vs.
Key Directory

Bob

Alice

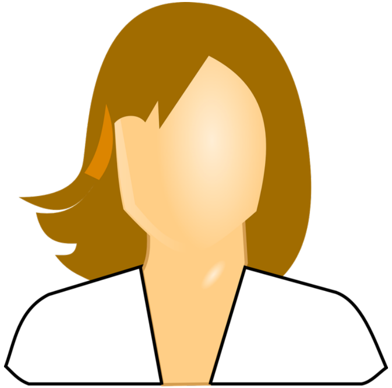
Study Design

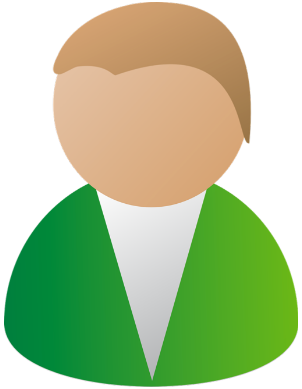
- Use MessageGuard to create email prototypes that differ only in key management
  - IBE, PKD, and Passwords
- Leverage standard metrics
- Use a two-person study methodology

IBE—Identity-Based Encryption
PKD—Public Key Directory

Two-Person Methodology

- Two roles
  - Johnny—initiator
  - Jane—initiated
- Simple task
  - Helping with taxes
- Within-subject



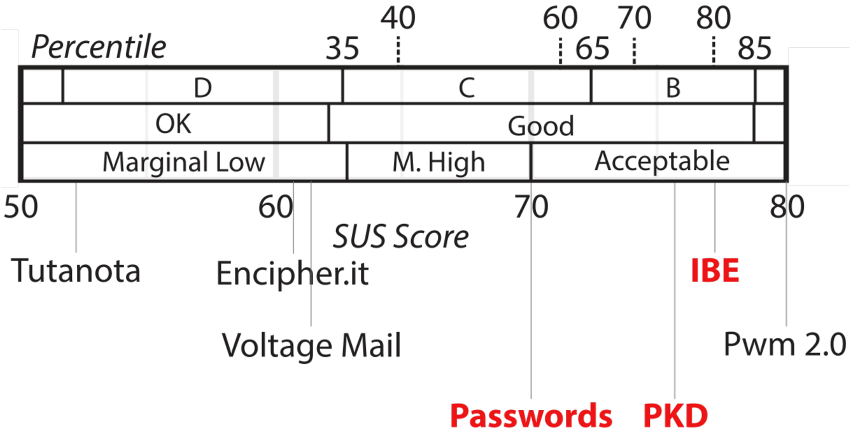


Demographics

- 94 total participants
  - Largest secure email study
- 50/50 gender split
- Most were undergraduate students
  - Attempted to recruit non-students, but failed
  - Not all were from our university

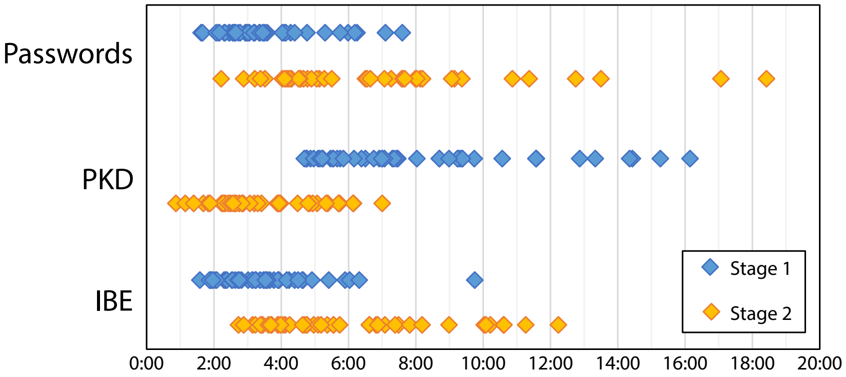
Results—Perceived Usasbility

- IBE and PKD performed similarly
- Passwords performed the worst
- MessageGuard-based systems outperformed other similar systems



IBE—Identity-Based Encryption
PKD—Public Key Directory
Ruoti et al. *Private Webmail 2.0: Simple and Easy-to-Use Secure Email*. UIST 2016.

Results—Time



- No difference in overall time
- PKD takes longer to send first encrypted email
- *"I am more motivated (i.e., I can more readily see the need) to install the app if the encrypted message is already sitting there in my inbox. Also, the fewer emails I have to send/receive the better."*

Results—Other

- Understanding
  - IBE and PKD performed poorly
  - Passwords were intuitive
- Favorite System
  - Split between the three
  - Changed with understanding

- Passwords
  - Why not just use the out-of-band channel for communication?
  - *“It was way lame that I had to call him because I might as well have just given him the info that way. . . . If I'm gonna communicate with them through email, it's because I want to do it through email, not through a phone call.”*

IBE—Identity-Based Encryption
PKD—Public Key Directory

Limitations

- Impossible to remove all confounding factors
- Laboratory study
- Focused on first-time use
- Non-representative demographic

SUMMARY

Summary

- MessageGuard is a research platform for securing the Web and SaaS
  - Many interesting research questions to be explored
- Compared the usability of key management in secure email
  - Gap between IBE and PKD is minimal
- Data and code available at https://messageguard.io/

SaaS—Software-as-a-Service
IBE—Identity-Based Encryption
PKD—Public Key Directory

Thank you