# A closer look at SQRL

## Agenda

- SQRL introduction
- Related work
- SQRL design details
- Research questions
- Research method
- Research findings
- Conclusion

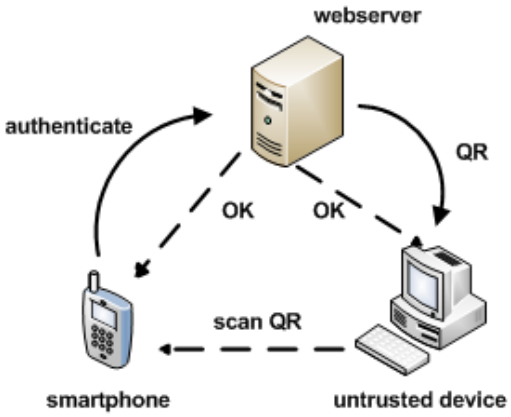
# A closer look at SQRL

## SQRL introduction: trigger

## Secure Quick Reliable Login


# A closer look at SQRL

## SQRL introduction: how it works




**QR-scanning**


**QR-tapping**


**QR-clicking**

# A closer look at SQRL

## SQRL introduction: design goals

- ✓ SSO
- ✓ 2FA
- ✓ out-of-band (OOB) authentication
- ✓ no secret(s) exchange
- ✓ anonymity
- ✓ no (additional) TTP
- ✓ low friction deployment

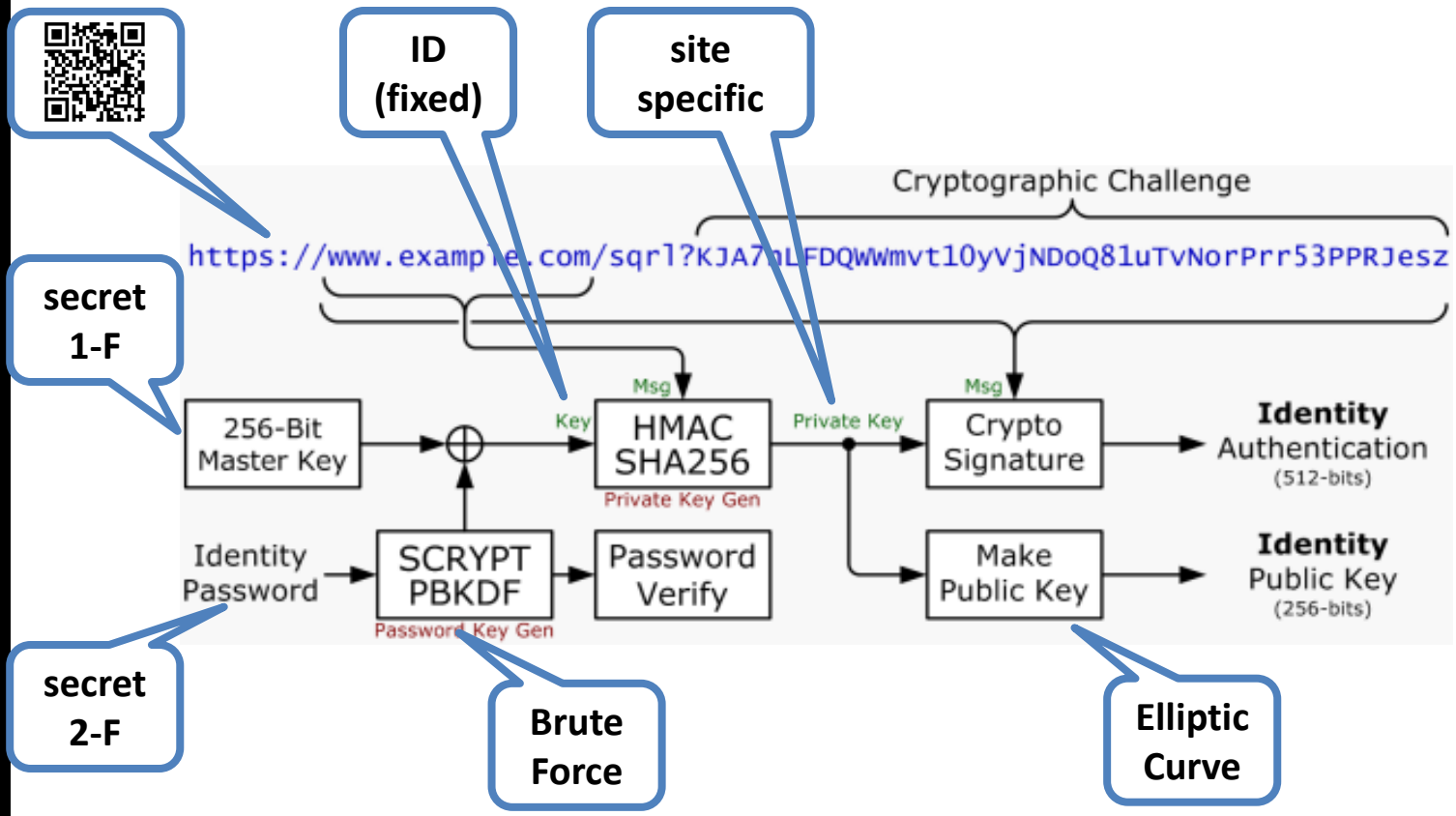
# A closer look at SQRL

## Related work: SSO

- Open standards
  - OpenID
  - TiQR

# A closer look at SQRL

## SQRL design details: crypto



# A closer look at SQRL

## SQRL design details: more crypto

**Compromised ID ?**

- **ID revocation support**
- **proves ID ownership**
- **uses additional keys**
  - **Lock (disable)**
  - **Unlock (enable/change)**

# A closer look at SQRL

## SQRL design details: messages

client (laptop) — server

enrolment request →

← QR (URL enrolment + challenge)

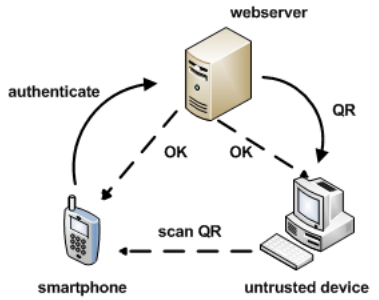
(SQRL-app) smartphone
- extract site's domain name
- generate site-specific private key
- sign extracted QR data

response
- signed extracted QR data
- public key

→ authentication handler

← OK

← OK (laptop)



# A closer look at SQRL

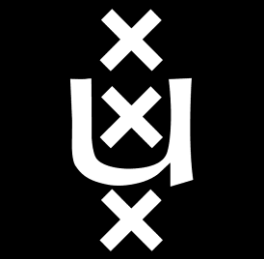
## Research questions

- ***How does SQRL improve authentication security compared to related solutions?***
  - ***What does SQRL offer to both parties?***
  - ***What constraints must be met to guaranty this behaviour?***
- ***What additional features are relevant to extend deployability?***
- ***What attacks remain feasible and what countermeasures are to be considered?***

# A closer look at SQRL

## Research method: attacks

- Attacks exploit vulnerabilities
- Causes of vulnerabilities
  - design errors
  - implementation errors
  - user mistakes



# A closer look at SQRL

## Research method: attacks

- Attacks exploit vulnerabilities
- Causes of vulnerabilities
  - design:
    - uses TLS
      - covers MiTM
      - covers eavesdropping
    - uses HMAC
      - no reverse operation
    - uses scrypt
      - covers brute-force

# A closer look at SQRL

## Research method: attacks

- Attacks exploit vulnerabilities
- Causes of vulnerabilities
  - design errors
  - implementation errors
    - no current (mature) app/server

# A closer look at SQRL

## Research method: attacks

- Attacks exploit vulnerabilities
- Causes of vulnerabilities
  - design errors
  - implementation errors
  - user mistakes

# A closer look at SQRL

# Research method: attacks

## SQRL user interaction

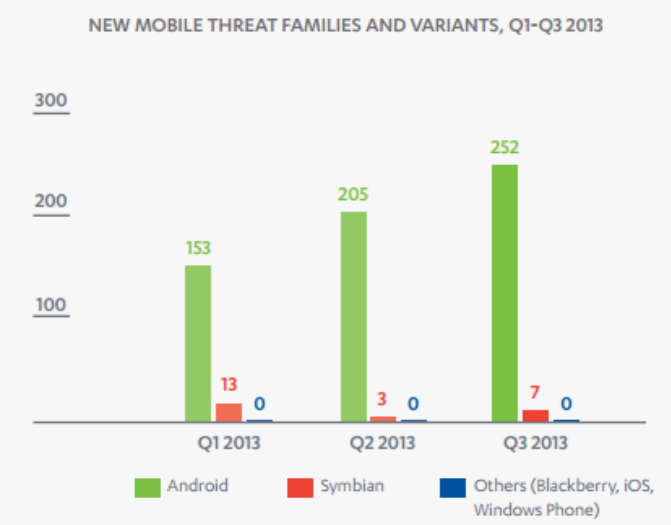
- SQRL-app installation
- SQRL Identity password generation & use
- SQRL Master Key backup & restore
- SQRL (Un)lock Key backup & restore

## SQRL design dependencies

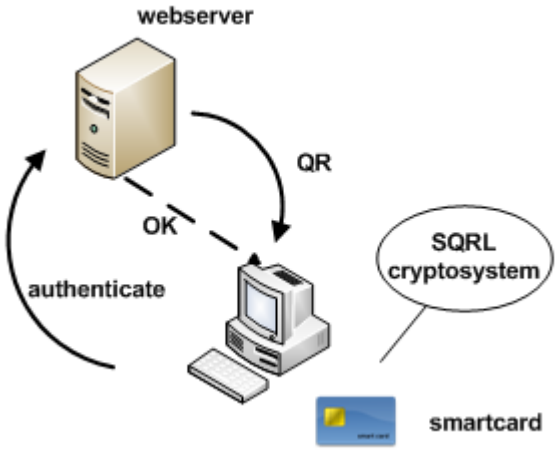
- Responsible users
  - No malware installed
  - No shoulder surfing
  - Master Key safely stored (QR on paper)
  - (Un)lock Key safely stored (QR on paper)

# A closer look at SQRL

## Research findings: attacks



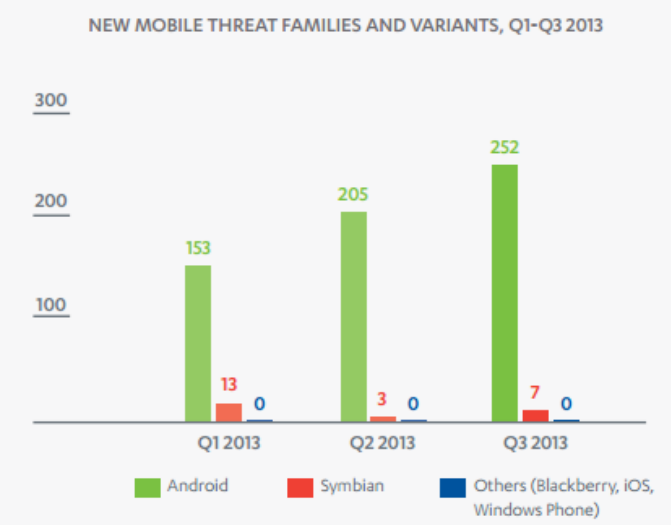

**Malware needs to be addressed**

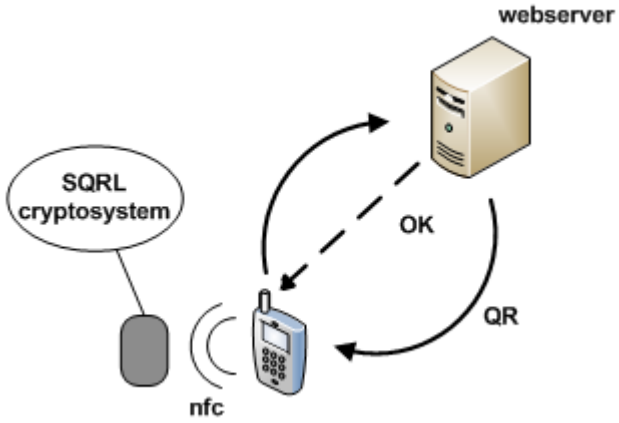



**Crypto in crypto-chip**

# A closer look at SQRL

## Research findings: attacks



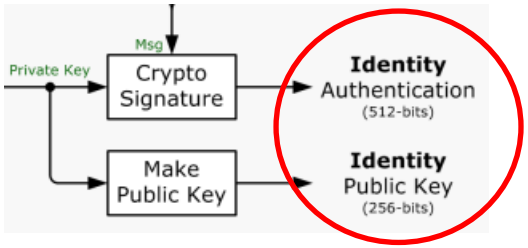

**Malware needs to be addressed**

**Crypto in nfc-chip**

# A closer look at SQRL

## Research findings: research question 2

- *What additional features are relevant to extend deployability?*




- **Site-specific key-pairs**


**-E-mail**
**-Membership**
**-Registration**

# A closer look at SQRL

## Research findings: research question 1

***How does SQRL improve authentication security compared to related solutions?***

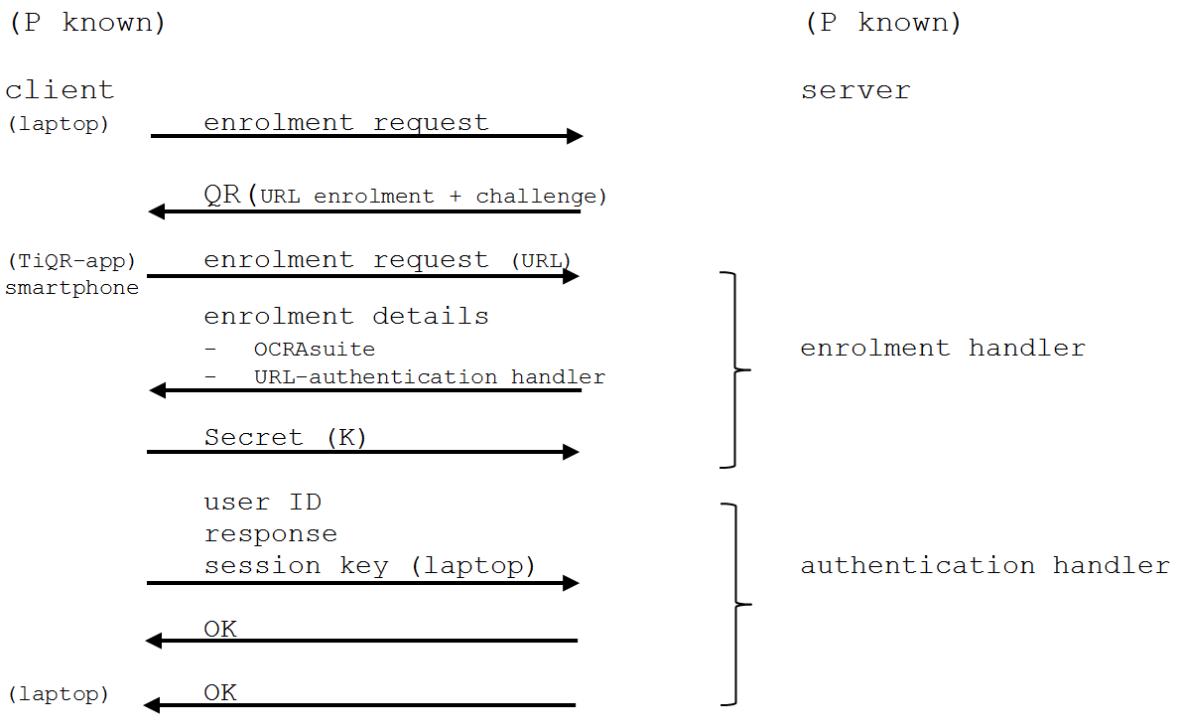
- *What does SQRL offer to both parties?*
- *What constraints must be met to guaranty this behaviour?*

**SSO**
**2FA**
**out-of-band (OOB) authentication**
**no secret(s) exchange**
**anonymity**
**no (aditional) TTP**
**ID revocation facility**

# A closer look at SQRL

## Related work: SSO-Open standards

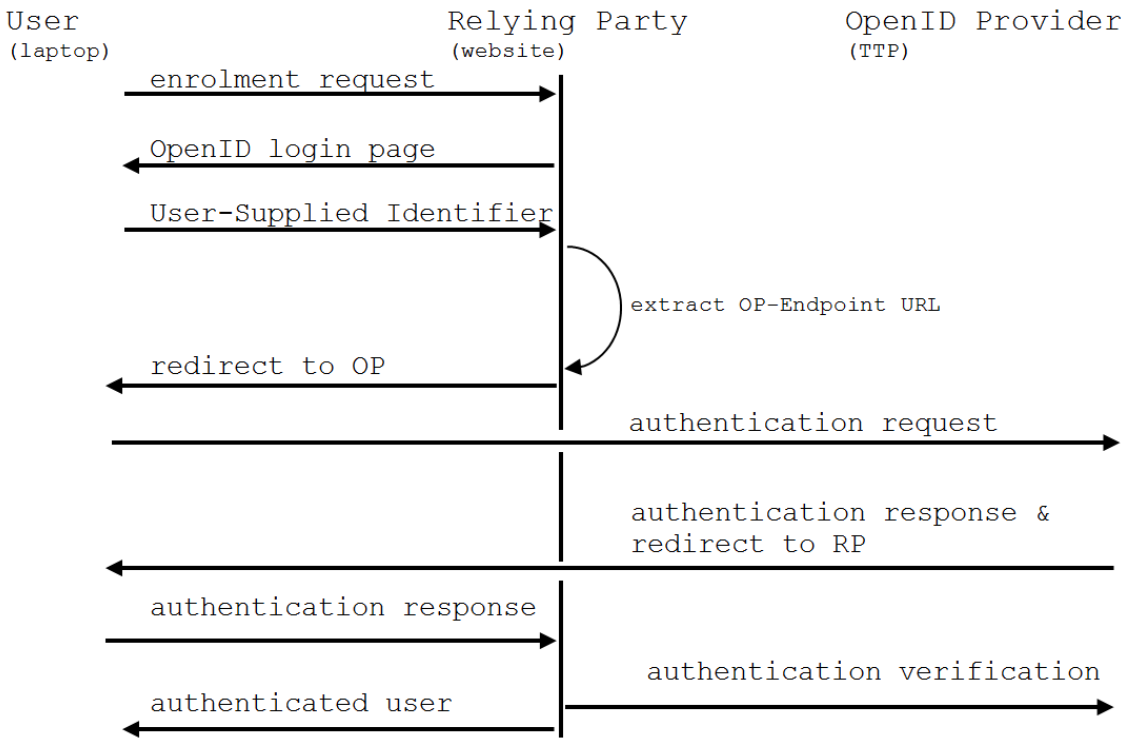
- **SURFnet**
- **OCRA (OATH Challenge Response Algorithm)** `RFC6287`



# A closer look at SQRL

## Related work: SSO-Open standards

- **OpenID Authentication 2.0**
- **Support of algorithms (not prescribed)**



# A closer look at SQRL

## Related work: SSO-Open standards


| | TiQR | OpenID | SQRL |
|---|---|---|---|
| SSO | ✓ (?) | ✓ | ✓ |
| 2FA | ✓ | ? | ✓ |
| OOB | ✓ | ? | ✓ |
| No secret(s) exchange | X | ? | ✓ |
| Anonymity | ✓ (?) | ? | ✓ |
| No (additional) TTP | ✓ | X | ✓ |
| Low Friction Deploy | ✓ | ✓ | ✓ |
| ID revocation | X | ? | ✓ |

# A closer look at SQRL

## Research findings: research question 1

*How does SQRL improve authentication security compared to related solutions?*

- ***What does SQRL offer to both parties?***
- *What constraints must be met to guaranty this behaviour?*

**User:**

- **SSO**
- **2FA security**
- **anonymity**
- **no cross-site coupling of ID's**
- **ID revocation support**

**Website:**

- **authenticated identity**
- **alongside alternative solutions**

# A closer look at SQRL

## Research findings: research question 1

*How does SQRL improve authentication security compared to related solutions?*

- *What does SQRL offer to both parties?*
- ***What constraints must be met to guaranty this behaviour?***

  - **HTTP over TLS**
  - **user responsibility/awareness**

# A closer look at SQRL

# Conclusion

**SQRL is**

- **open**
- **no new technology**
- **a combination of Best Practices**
- **unique in its offered properties**
- **not operational yet**

**SQRL depends on**

- **responsible users**

**SQRL needs**

- **additional secret protection**

# A closer look at SQRL

## Questions