F3ildCrypt: End-to-End Protection of Sensitive Information in Web Services

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Motivation

- Identity-related information is valuable
- You must provide such information when using an online merchant
- This information is vulnerable to disclosure at many points
- Can we protect this information end-to-end without revealing details of the logical corporate architecture?

Outline

1 Introduction

2 Related work

3 Architecture

4 Evaluation

5 Conclusion

Introduction

- Users have to trust online merchants:
- Merchant is not malicious
- Merchant site is maintained by diligent sysadmins
- Merchant will protect always sensitive information

SOA trust

- In Service Oriented Architectures, users have to trust:
- Merchant *and peer SOAs* are not malicious
- Merchant *and peer SOAs* are maintained by diligent sysadmins
- Merchant *and peer SOAs* will always protect sensitive information

Data in transit

- In this work, we focus on data in transit
- We protect the data from the web browser to the back-end database

Example

- XXX: Diagram showing web browser, merchant, and SOA doing credit-card transactions. Even with SSL, only protected from web browser to merchant.

Pair-wise key distribution

- Generate and distribute a key for each potential target host in the SOA pipeline.
- Naive – doesn't work! XXX

Proxy re-encryption

For all plaintext P, Alice $\langle pk_A, sk_A \rangle$, Bob $\langle pk_B, sk_B \rangle$:

$$pk_B(p) = rk_{A \to B}(pk_A(P))$$

- [Blaze et al., 1998]
- [Ateniese et al., 2005]

W3bCrypt

- Introduced end-to-end encryption in web pipelines
- Firefox plugin for application-level crypto
- Requires disclosure of corporate network details

Architecture

- Design goals
- F3ieldCrypt architecture
- Example session

Network model

- SOA-style network
- Each SOA may have multiple child SOAs
- SOAs wish to prevent disclosure of logical architecture and peering

Threat model

- XXX

Design goals

- End-to-end protection of XML fields – even across SOA boundaries
- Confidentiality of logical architecture of each SOA must be respected

Do not provide protection against compromise or failure of entities with legitimate access to sensitive information.

F3ieldCrypt architecture

- Each SOA s publishes a public key pk_{E_s}
- Browser b generates plaintext P
- b sends $C = pk_{E_s}(P)$
- At s, proxy re-encrypt C to internal hosts and child SOAs 0...n

Key generation

- Key pair $\langle pk_{E_s}, sk_{E_s} \rangle$ generated at the external-key holder
- Public keys of applications $pk_{I_0} ... pk_{I_n}$ are collected
- Used in conjunction with sk_{E_s} to generate $rk_{E \rightarrow I_0} ... rk_{E \rightarrow I_n}$

F3ieldCrypt architecture (cont.)

- By proxy re-encryption:

$$pk_{I_j}(P) = rk_{E \to I_j}(pk_E(P))$$

- Keys $rk_{E \to I_0} ... rk_{E \to I_n}$ stored at proxy re-encryption engine

Proxy re-encryption engine

- Fields arrive at PRE encrypted under pk_{E_s}
- Each field f is re-encrypted under $pk_{E \rightarrow I_j}$
- The mapping $f \longrightarrow j$ is determined from a XACML policy

Client policy and crypto engines

Web clients receive a re-cryptography engine and a policy engine.

- Policy engine uses a XACML policy to determine which fields to encrypt
- Re-crypto engine encrypts XML fields as directed by the policy engine.

Architecture summary

- XXX: insert image

Implementation

- Java-based Re-crypto engine based on JHU-MIT Proxy Re-cryptography Library for each web client
- Python-based XML proxy for each internal application to store keys and unwrap XML
- XML gateway at the SOA stores the re-encryption engine

Testbed servers

Dell PowerEdge 2650 Servers

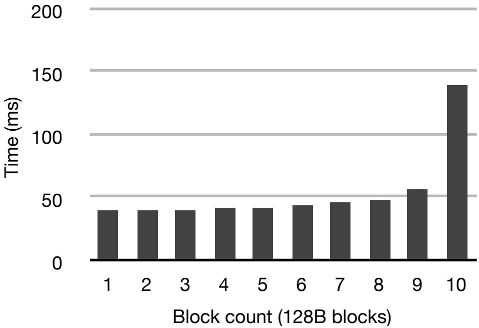
- 2.0GHz Intel Zeon processor, 1GB RAM, Gigabit Ethernet
- OpenBSD 4.2
- OpenBSD PF firewall, Apache 1.3.29, PHP 4.4.1, MySQL 5.0.45

Testbed client

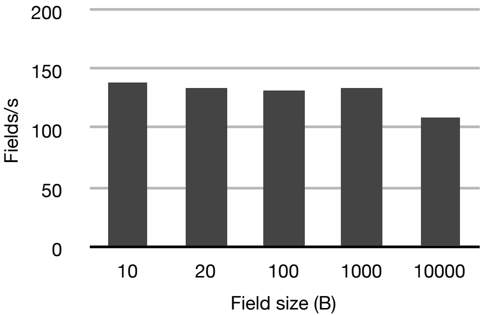
Macbook Pro

- 2.4 GHz Intel Core 2 Duo, 2GB RAM, Gigabit Ethernet
- OS X 10.5.2, Darwin kernel 9.2.2, Mozilla Firefox 2.0.0.13

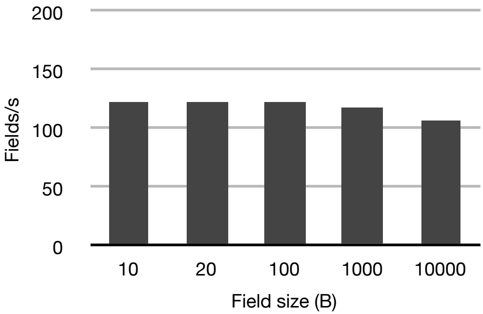
Block encryption on the client



Re-encryption rate at an XML gateway



Decryption rate at an XML proxy



Conclusion

- End-to-end protection to users and SOAs
- XXX

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Divertible protocols and atomic proxy cryptography.
In *Proceedings of Eurocrypt '98*, pages 127–144, 1998.

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