Secure Data Preservers for Web Services

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Joint work with
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Users Entrust Web Services with Their Data

TigerDirect.com
SHOP BY PHONE 1-800-800-8300

Credit card number

WebMD
Better information. Better health.

Health records

E*TRADE

Trading strategy

bing

Web click logs

Users Entrust Web Services with Their Data

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WebMD®

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Health records

- How their data will be used
- What parts will be shared
- With whom they will be shared

Exposure of Sensitive Data

- dataloss.db lists 400 data loss incidents in 2009; on average exposed half-a-million customer records

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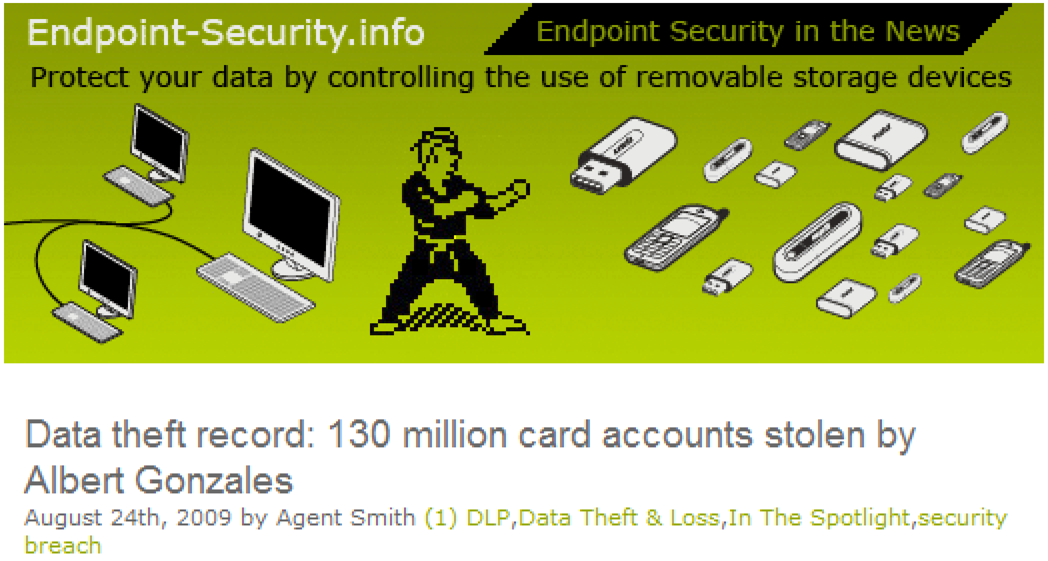
Endpoint-Security.info
Endpoint Security in the News
Protect your data by controlling the use of removable storage devices

Data theft record: 130 million card accounts stolen by Albert Gonzales

August 24th, 2009 by Agent Smith (1) DLP,Data Theft & Loss,In The Spotlight,security breach

Exposure of Sensitive Data

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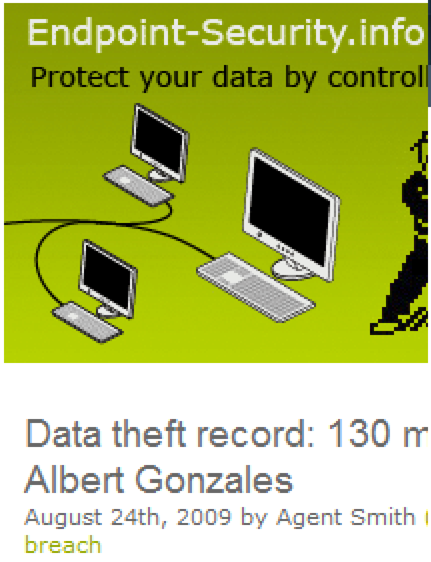

Data theft record: 130 m
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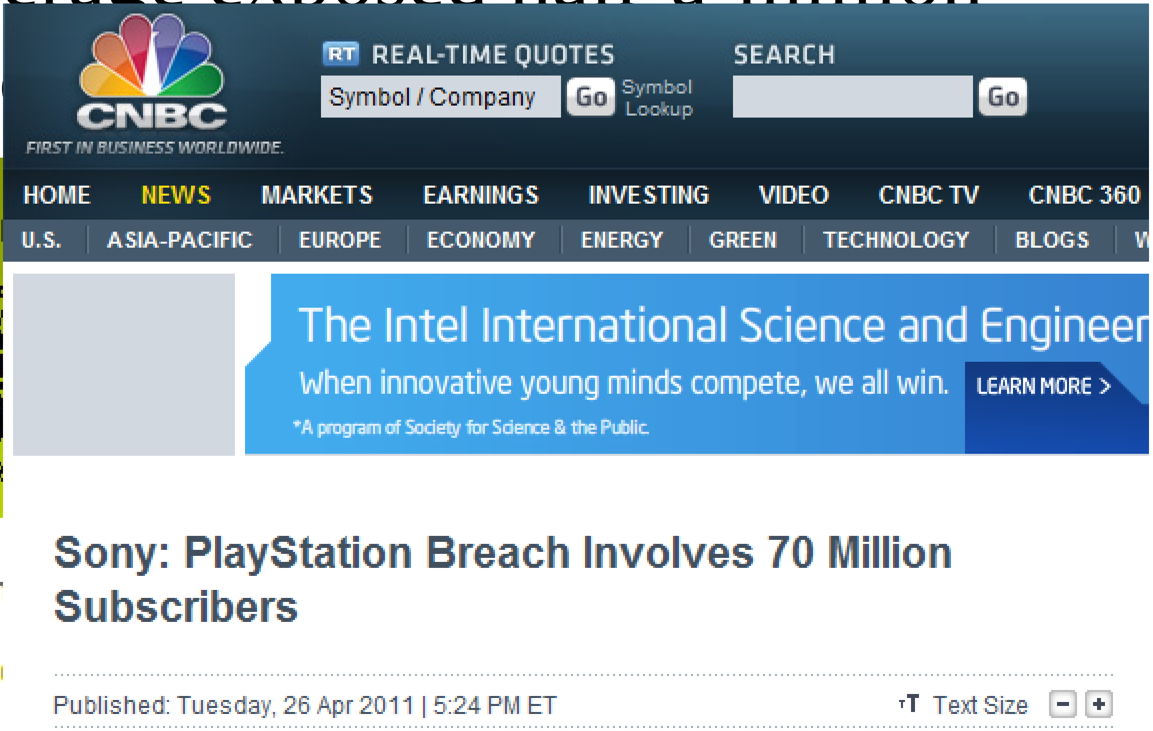
breach



Sony: PlayStation Breach Involves 70 Million Subscribers

Published: Tuesday, 26 Apr 2011 | 5:24 PM ET

Exacerbated by Giving Up Data Usage Control

Individuals

Health records

WebMD

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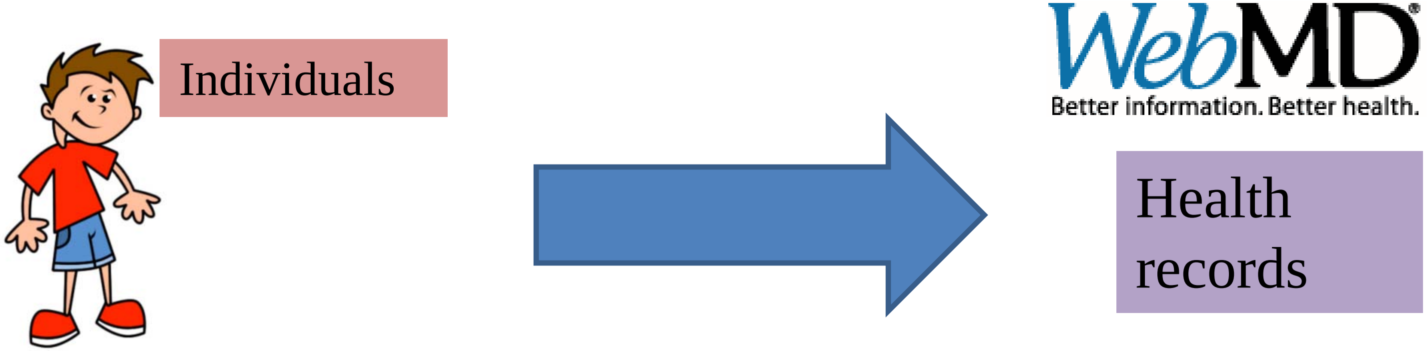
Exacerbated by Giving Up Data Usage Control



Individuals

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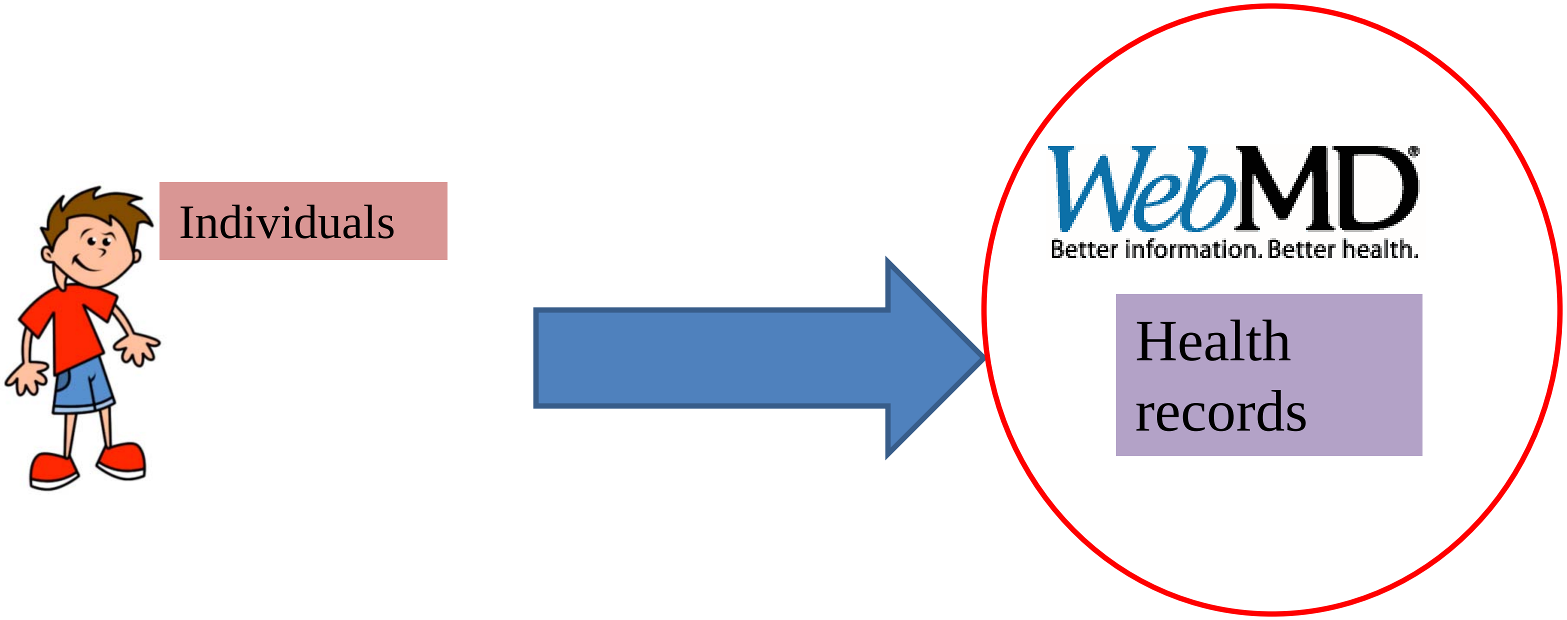
Exacerbated by Giving Up Data Usage Control



Individuals

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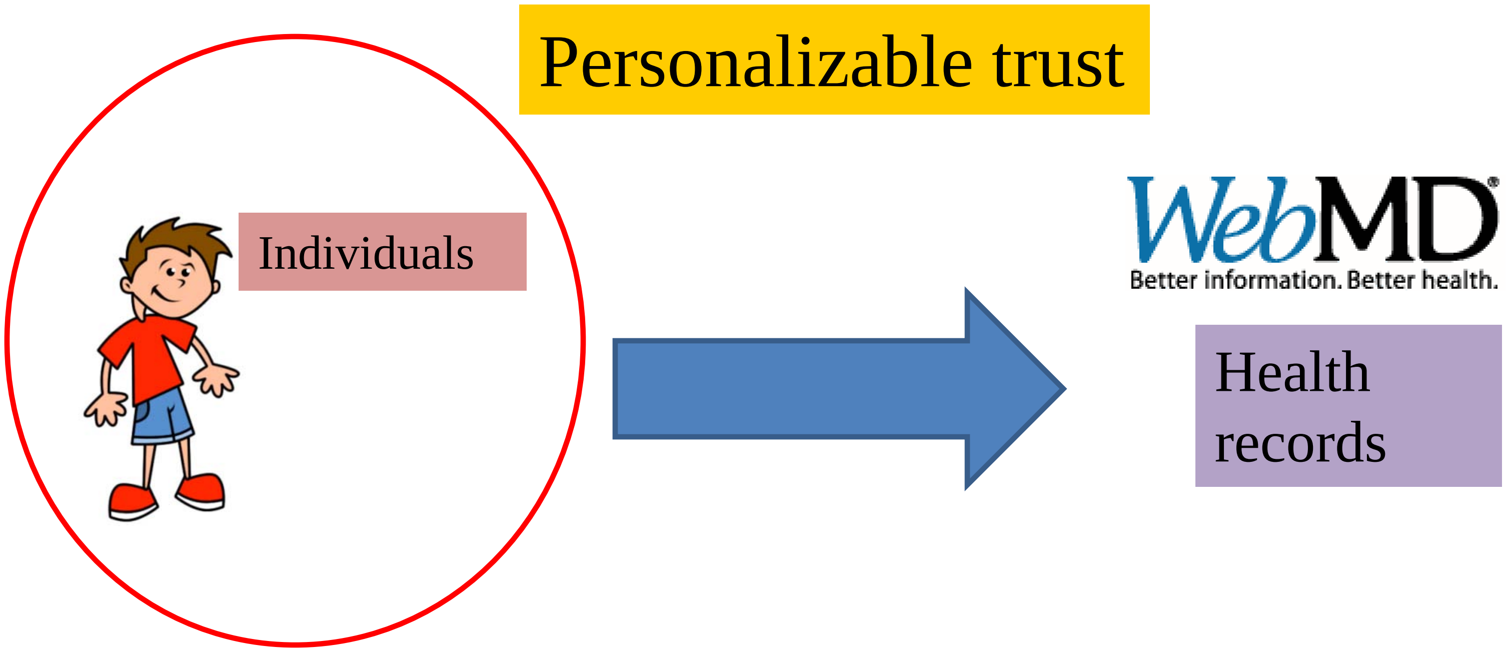
Give Control Back to Users



Personalizable trust

Individuals

Health records

- How their data will be used
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Roadmap

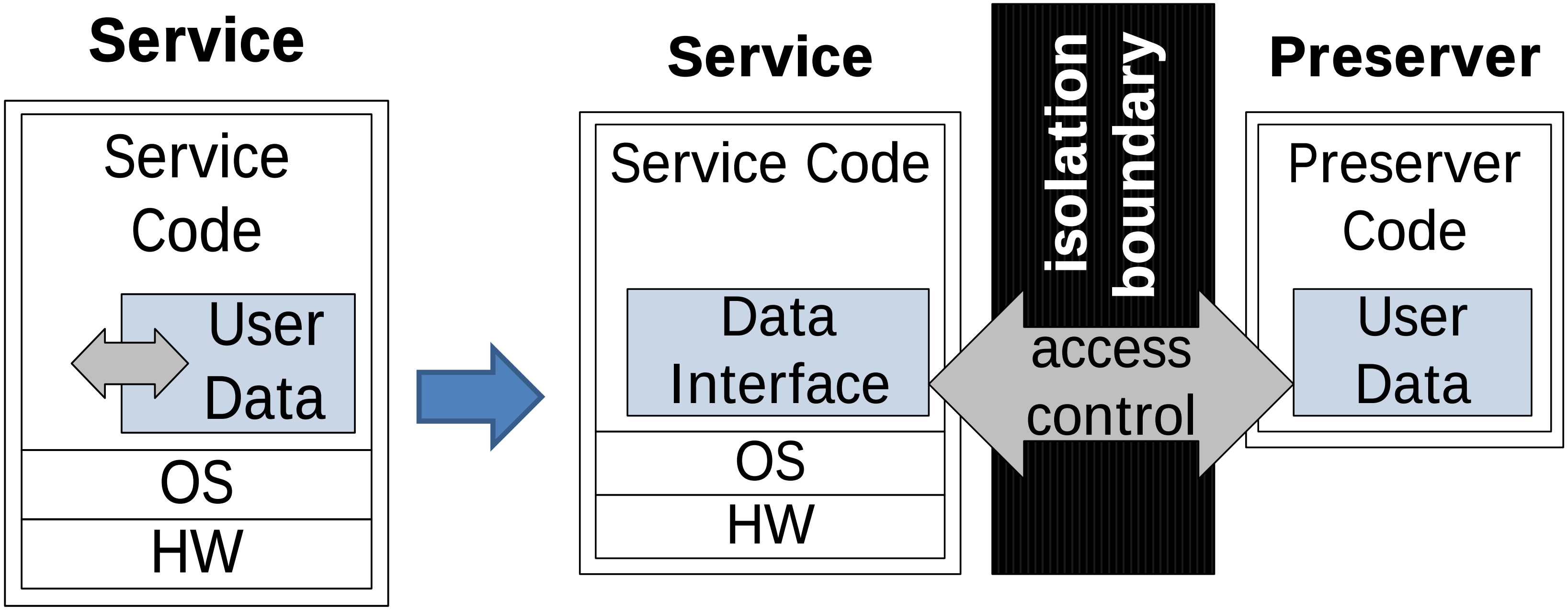
- Motivation
- Secure Data Preserver
- Design
- Evaluation

Our Approach

- Entrusting raw data violates least privilege

- Encapsulate sensitive data and enforce well-defined interface for service to access data

Secure Data Preserver (SDaP)

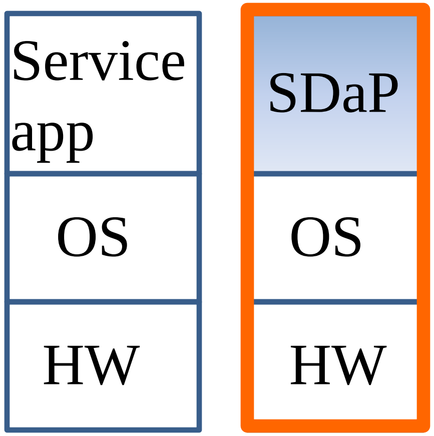


(a) Service + User Data

(b) Service + Preserver

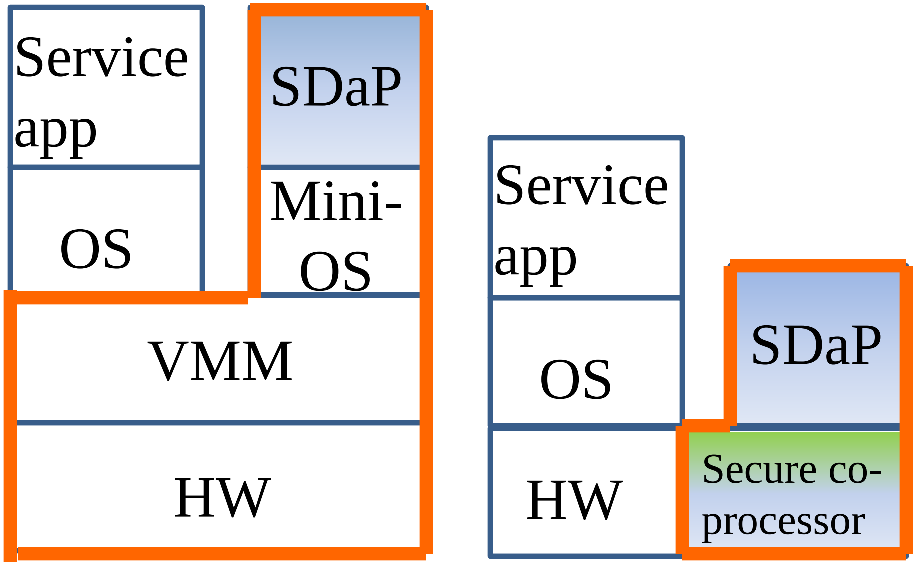
Preserver Deployment Scenarios

Trusted third party or client



Faulty service app
Faulty service operator

Co-location



Faulty service app

Faulty service app
Faulty service operator

What Apps Are Suitable?

- Sensitive query
  - User provides sensitive query, service provides data stream
  - E.g., Trading, Health
- Analytics on sensitive data
  - Service performs data mining on user’s sensitive data
  - E.g., Targeted advertising, Recommendation
- Proxy
  - User provides credentials to another service

What Apps Are Suitable?

- Sensitive query
  - User provides sensitive query, service provides data

* Limitation

Data-centric service reading and updating users' data at fine granularity

- E.g., Docs, Social networking apps

- Proxy
  - User provides credentials to another service

Roadmap

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Preserver Design Goals

- Simple Interface
- Flexible deployment
- Fine-grained use policy
- Trust but mitigate risk

Preserver Operational View

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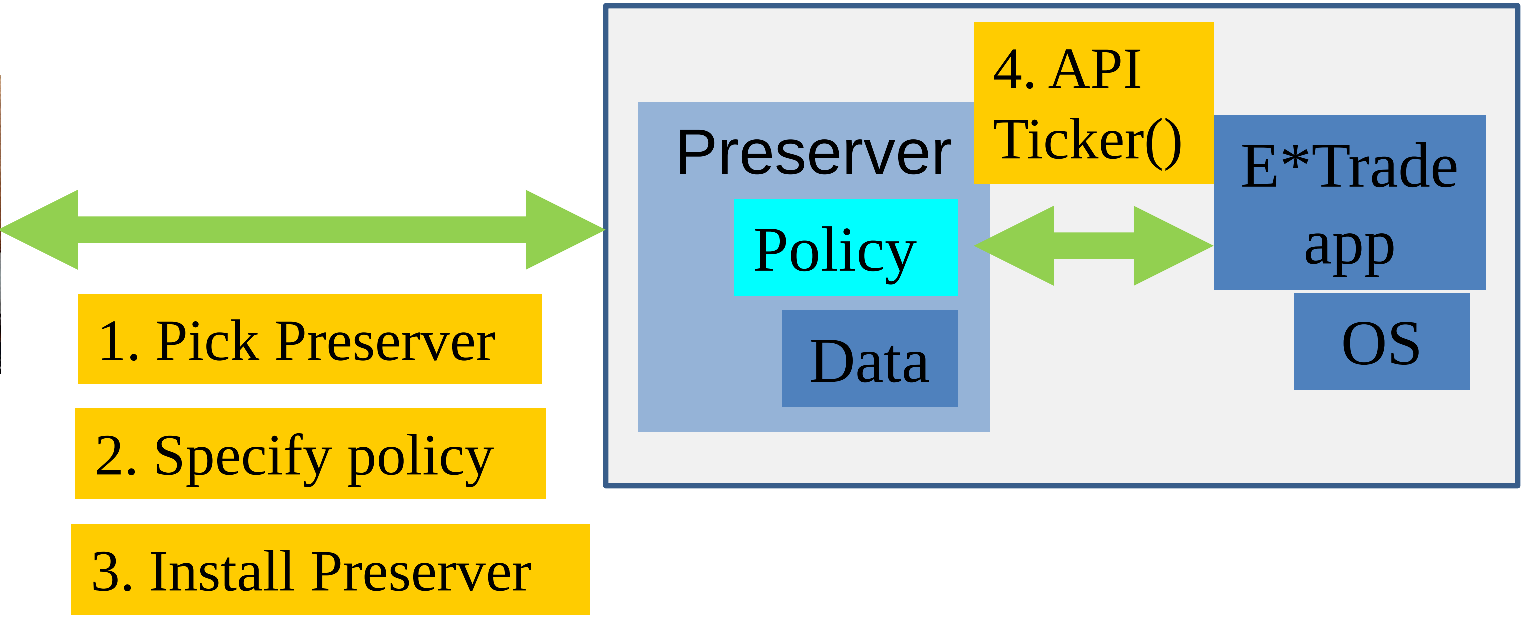


1. Pick Preserver

2. Specify policy

3. Install Preserver

4. API Ticker()

Preserver

Policy

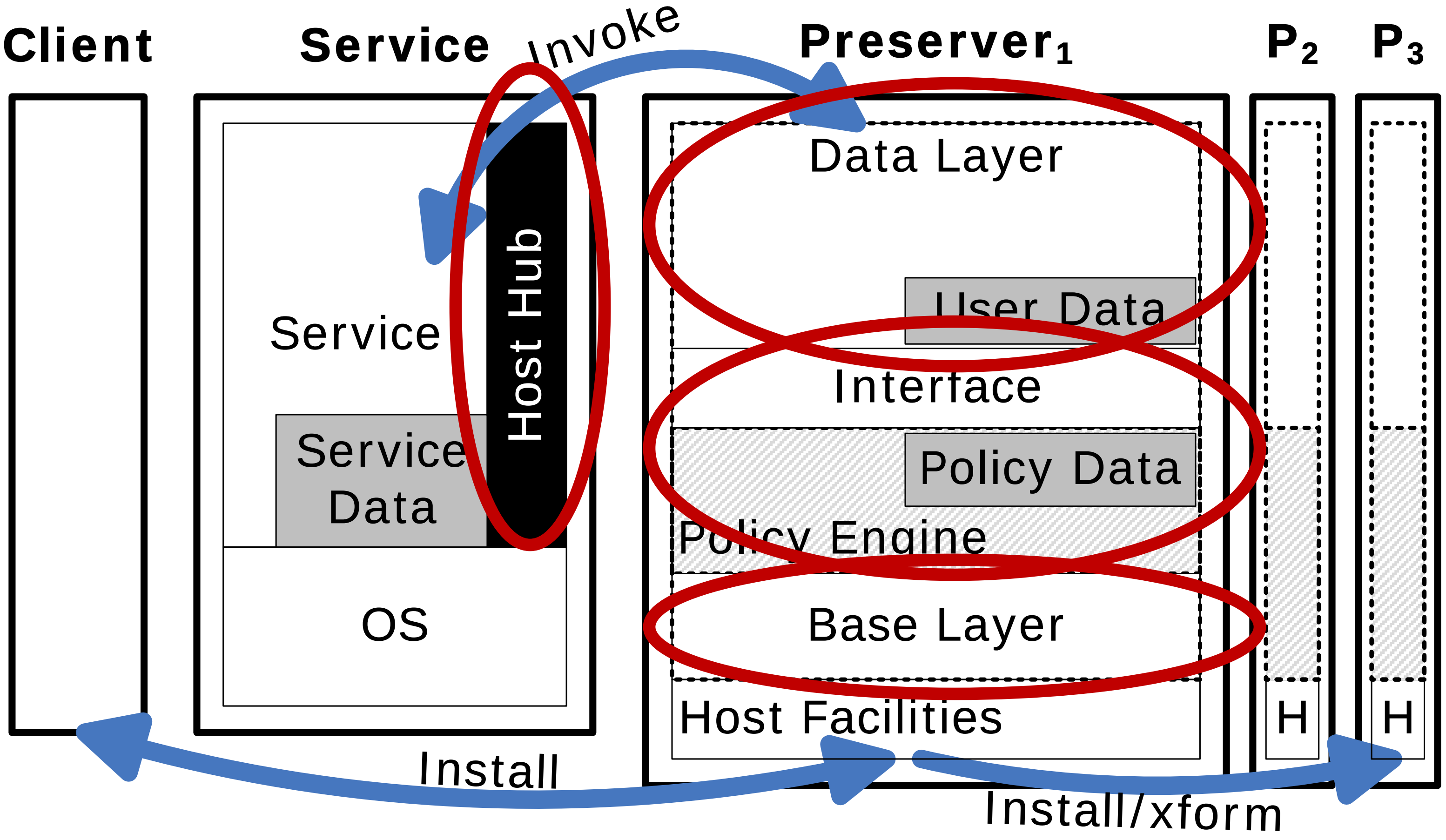
Data

E*Trade app

OS

Preserver Architecture

Hosting Invocation Transformation



Preserver Hosting

- Which services can host users’ preservers
- Hosting policy
  - – Declarative language based on SecPAL

1. *alice* SAYS CanHost(M) IF OwnsMachine(*amazon*, M)

- Hosting mechanism
  - – Hosting protocol based on Diffie-Hellman protocol

Preserver Hosting

- Which services can host users’ preservers
- Hosting policy
  - Declarative language based on SecPAL

2. *alice* SAYS CanHost(M) IF TrustedService(S), OwnsMachine(S,M), HasCoprocessor(M)

- Hosting mechanism
  - Hosting protocol based on Diffie-Hellman protocol

Preserver Hosting

- Which services can host users' preservers
- Hosting policy
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3. *alice* SAYS *amazon* CANSAY TrustedService(S)

- Hosting mechanism
  - Hosting protocol based on Diffie-Hellman protocol

Preserver Invocation

- Constrain interface invocation parameters with SecPAL
- Two kinds: stateless, stateful

1. *alice* SAYS CanInvoke(*amazon*, A) IF LessThan(A, 50)

- Transfer of invocation policies: exo-leasing

Preserver Invocation

- Constrain interface invocation parameters with SecPAL
- Two kinds: stateless, stateful

2. *alice* SAYS CanInvoke(*doubleclick*,A) IF
LessThan(A,Limit), Between(Time,”01/01/10”,”01/31/10”)
STATE (Limit=50,Update(Limit,A))

- Transfer of invocation policies: exo-leasing

Preserver Invocation

- Constrain interface invocation parameters with SecPAL
- Two kinds: stateless, stateful

3. *alice* SAYS *amazon* CANSAY CanInvoke(S,A) IF LessThan(A,Limit) STATE (Limit=50,Update(Limit,A))

- Transfer of invocation policies: exo-leasing

Preserver Transformation

- Filtering: retain a subset of data
  - E.g., only the web history in the last six months

- Aggregation: merging of raw data from mutually trusting users of a service
  - E.g., ad-click history of users

Roadmap

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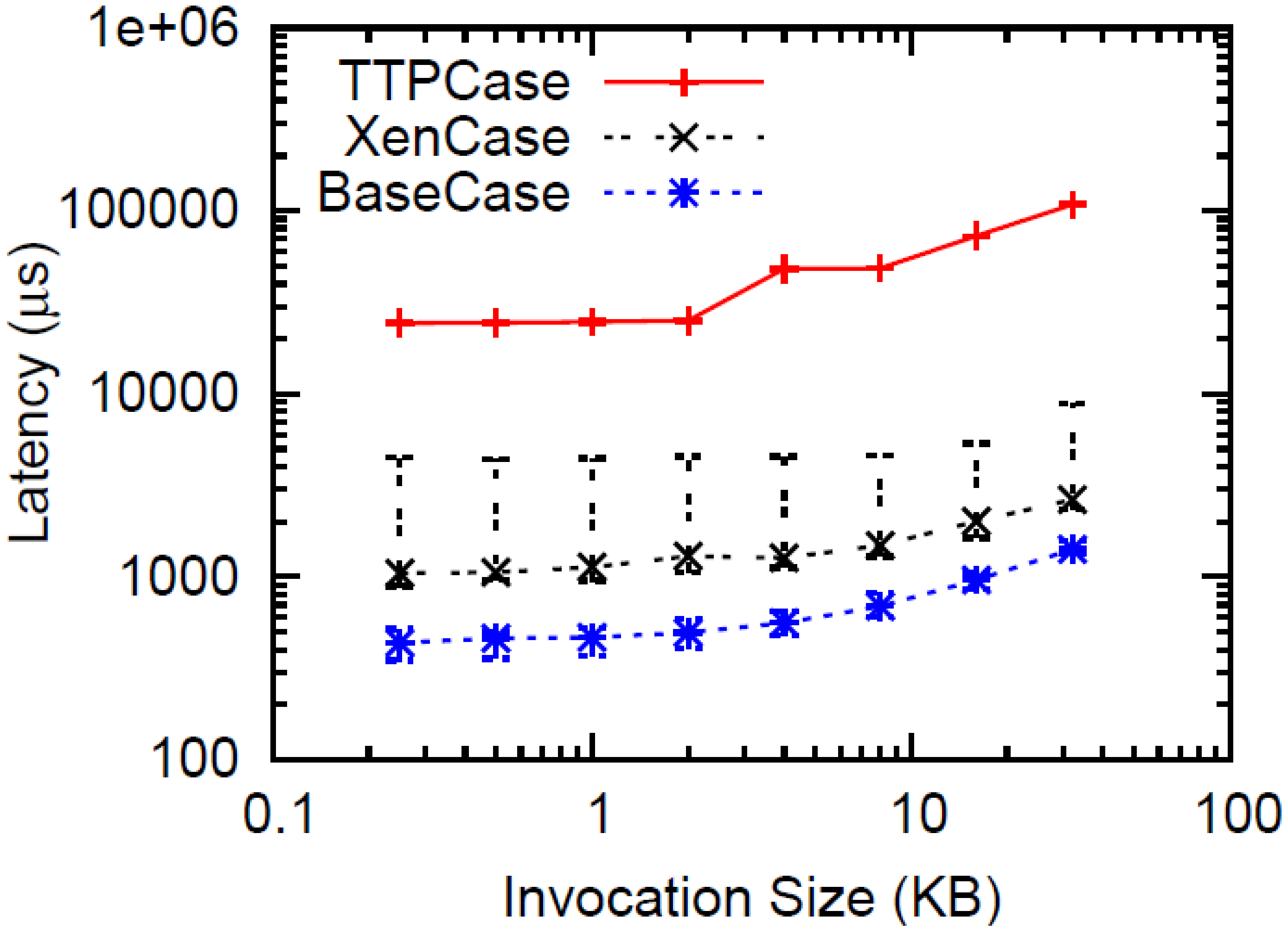
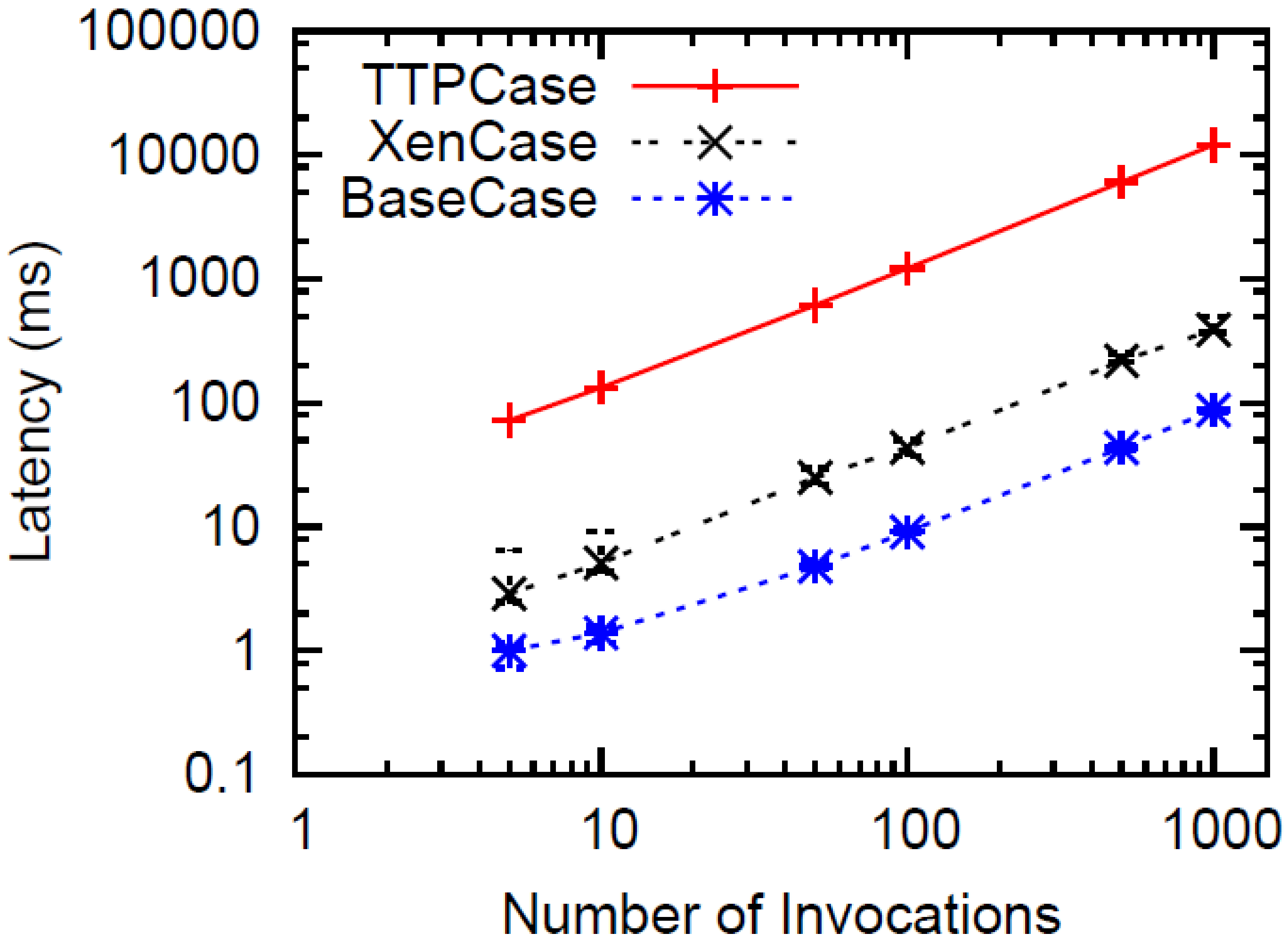
Evaluation

- Deployment options:
  - TTP, client, Xen-based co-location
- Three sample preservers:
  - Stock trading, targeted advertising, credit card xact
- Main results:
  - Cost of preserver
  - Comparison of deployment options
  - Security analysis: LS2-based theoretical analysis, Trusted Computing Base (TCB) comparison

Cost of Basic Invocation (Latency)



Cost of Stock Trading (Latency)



Discussion

- Find appropriate interfaces, verify them
- Easy refactoring
  - Even automated
- Apps with rich interfaces
  - Information flow control

Related Work

- Wilhelm’s mobile agent
- CLAMP
- BSTORE
- Decentralized privacy frameworks
- Information flow control

Conclusion

- Rearchitect web services around the principle of giving data usage control back to users

- Secure Data Preserver achieves this goal via data encapsulation and interface-based access control

Thank you!

Q & A