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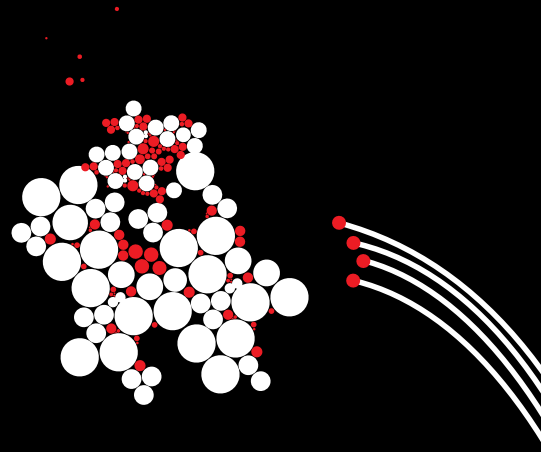
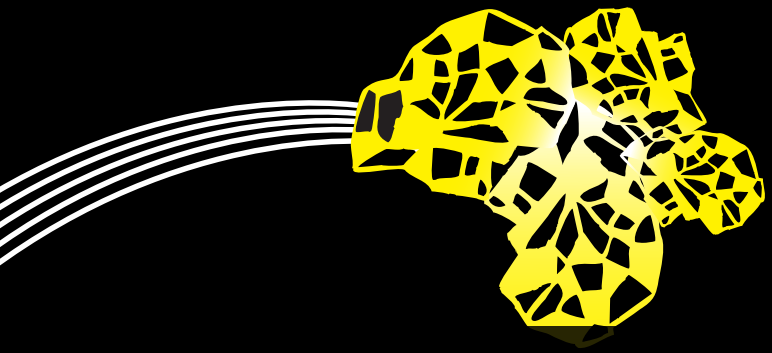


Multi-client Predicate-only Encryption for Conjunctive Equality Tests

Tim van de Kamp Andreas Peter Maarten Everts Willem Jonker



16th International Conference on Cryptology And Network Security, 2017

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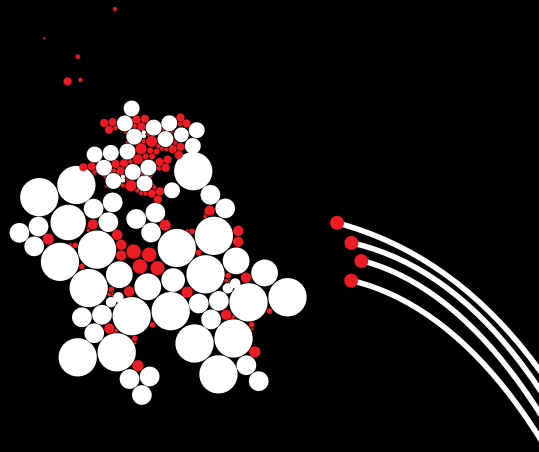
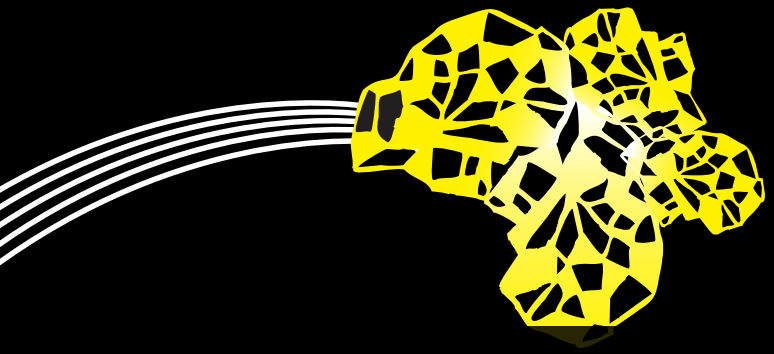


Monitoring over Encrypted Data

Tim van de Kamp **Andreas Peter** **Maarten Everts** **Willem Jonker**



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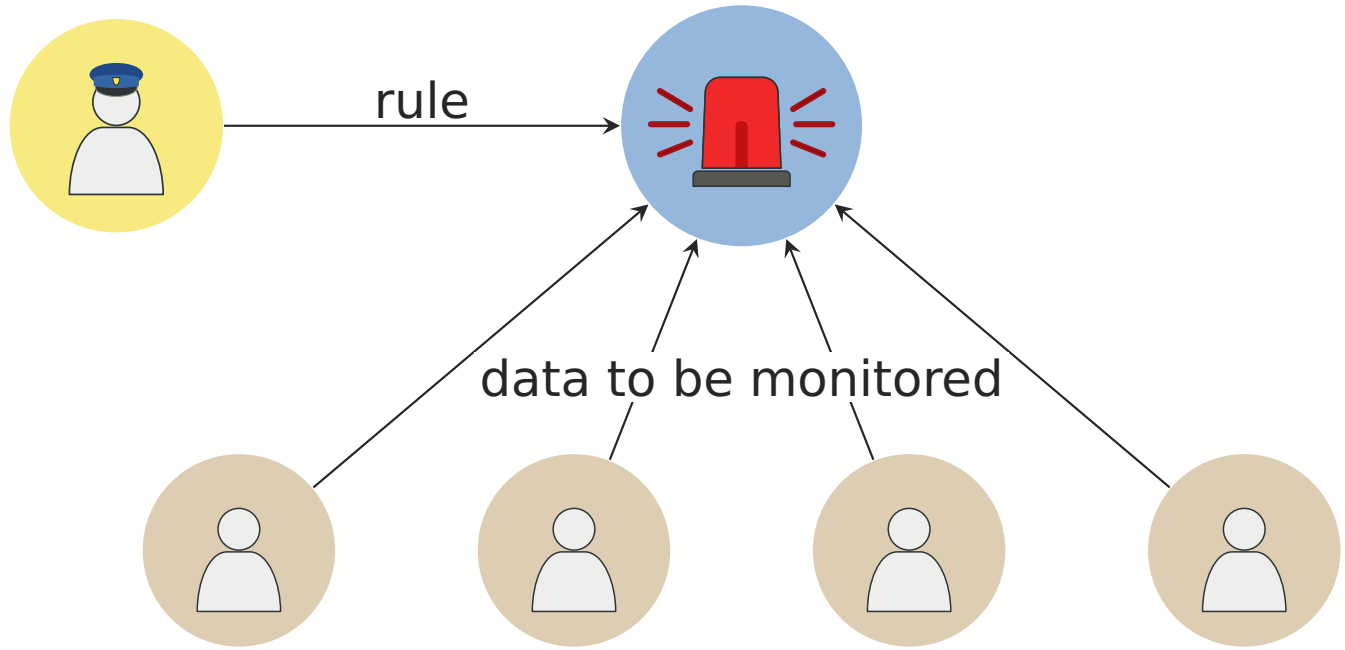
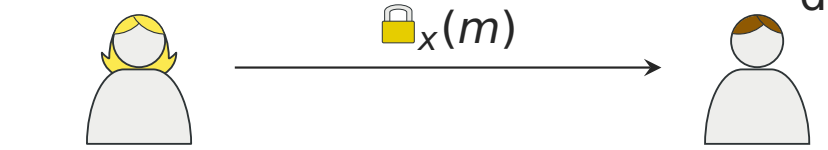
This Talk: Monitoring over Encrypted Data



Monitoring of sensitive data using sensitive monitoring rules.

Background: Predicate Encryption



decryption $\begin{cases} m & \text{if } f_y(x) = \text{TRUE} \\ \perp & \text{if } f_y(x) = \text{FALSE} \end{cases}$

message: m
label: x

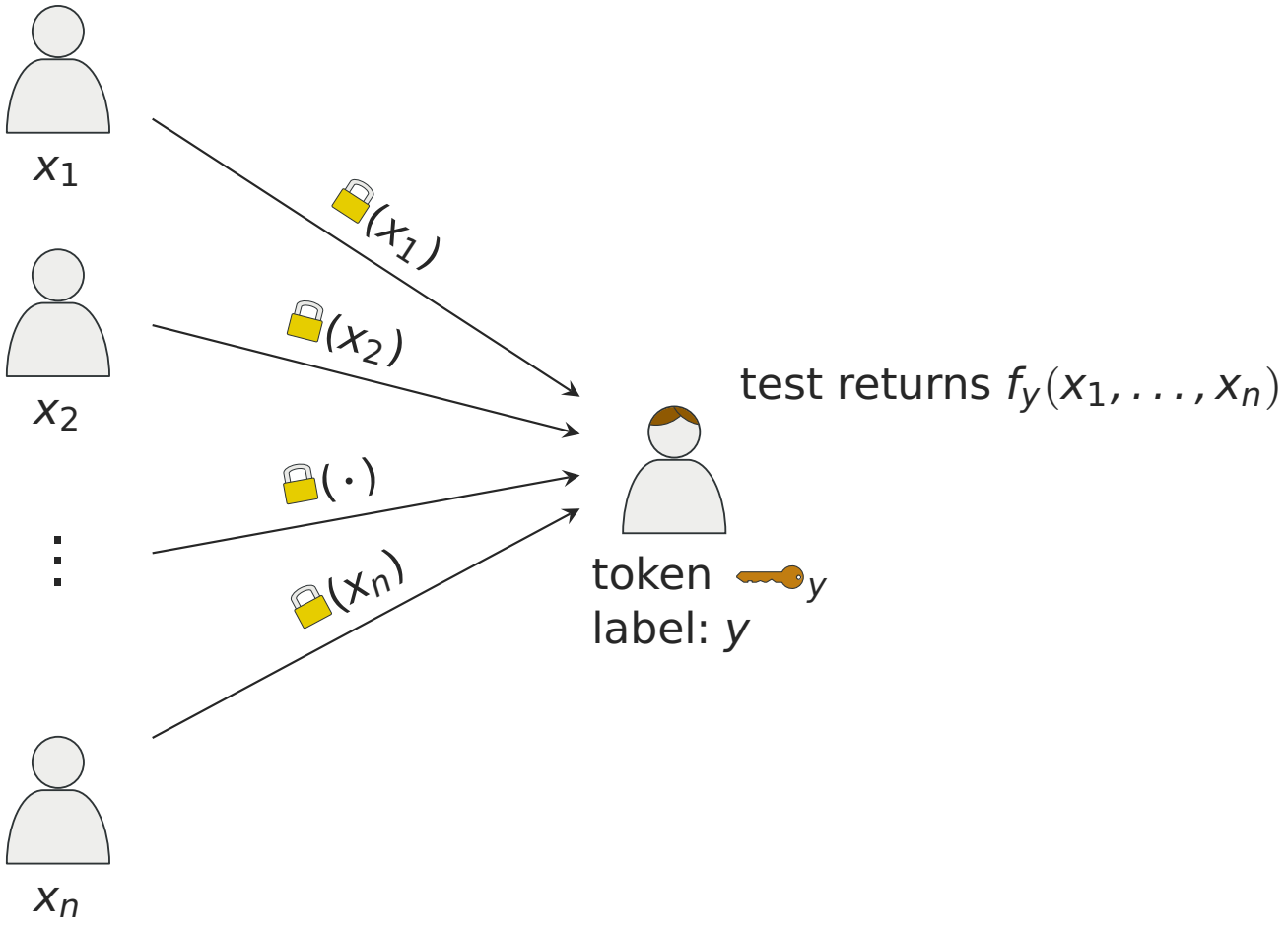
decryption key $_y$
label: y

Predicate encryption for relation $R(x, y)$.

Examples

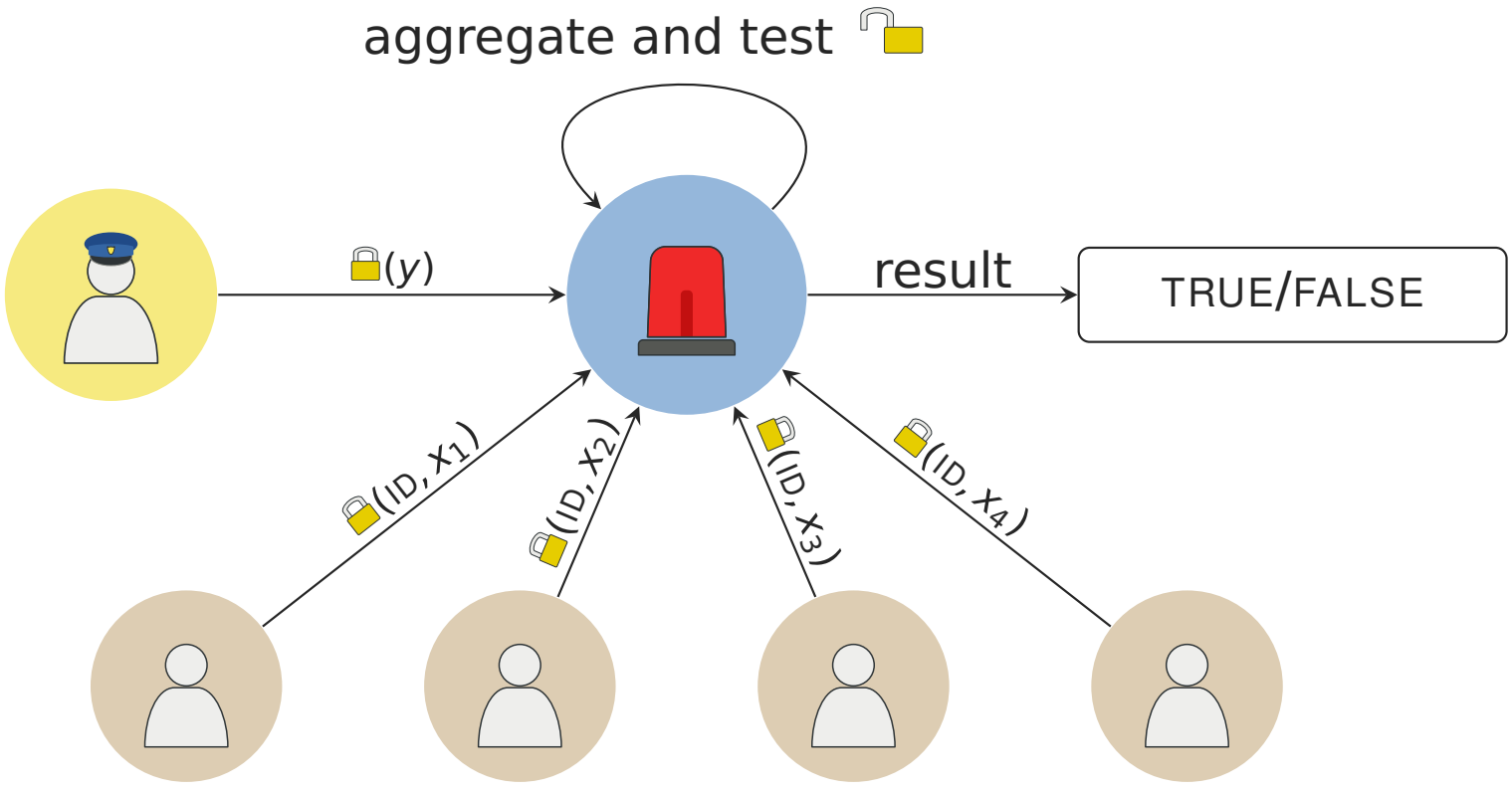
- Identity-based encryption
- Attribute-based encryption
- Hidden vector encryption
- Inner-product predicate encryption

Multi-client Predicate-only Encryption – Concept

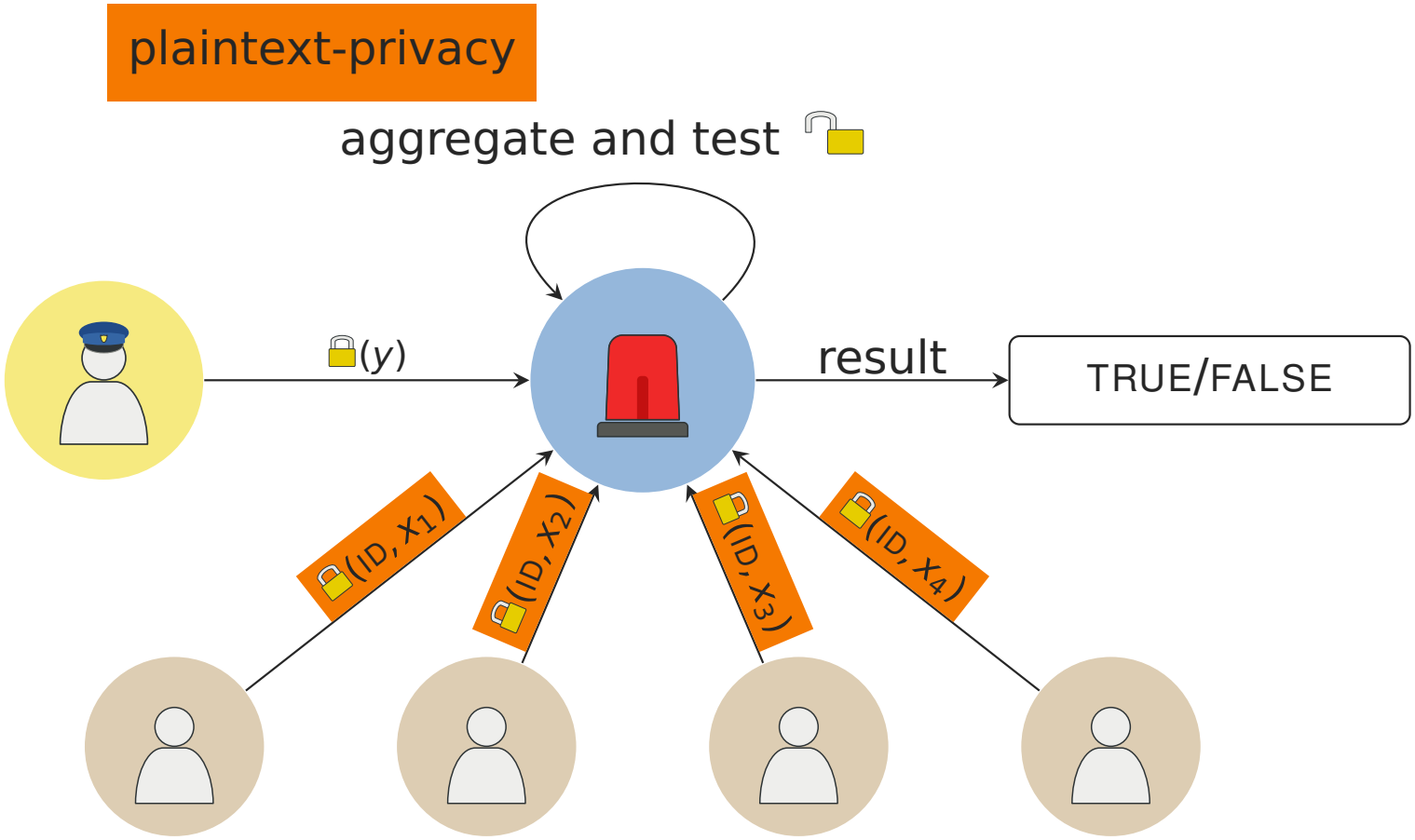


Multi-client predicate-only encryption for relation $R(x_1, \ldots, x_n, y)$.

Multi-client Predicate-only Encryption – Security



Multi-client Predicate-only Encryption – Security



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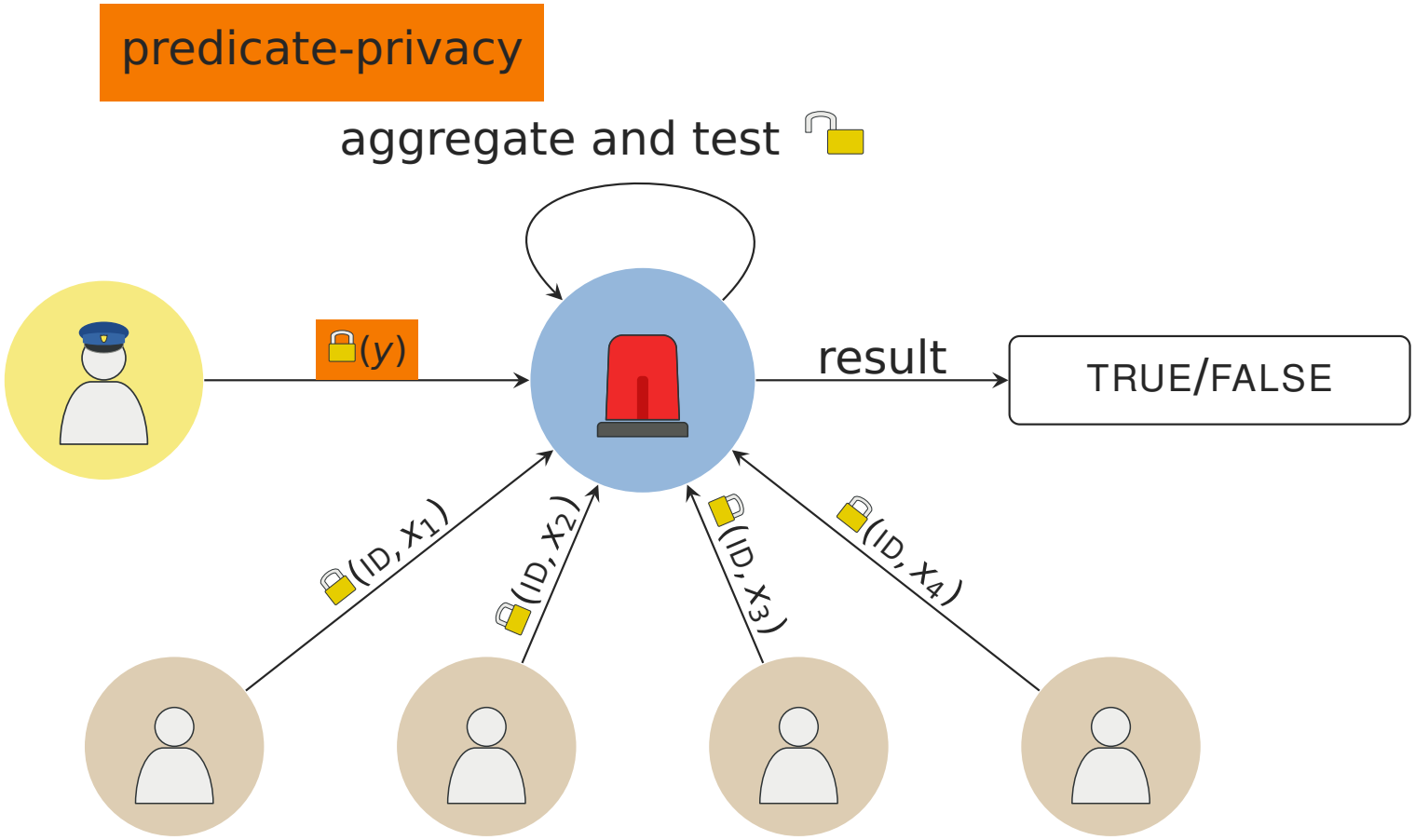

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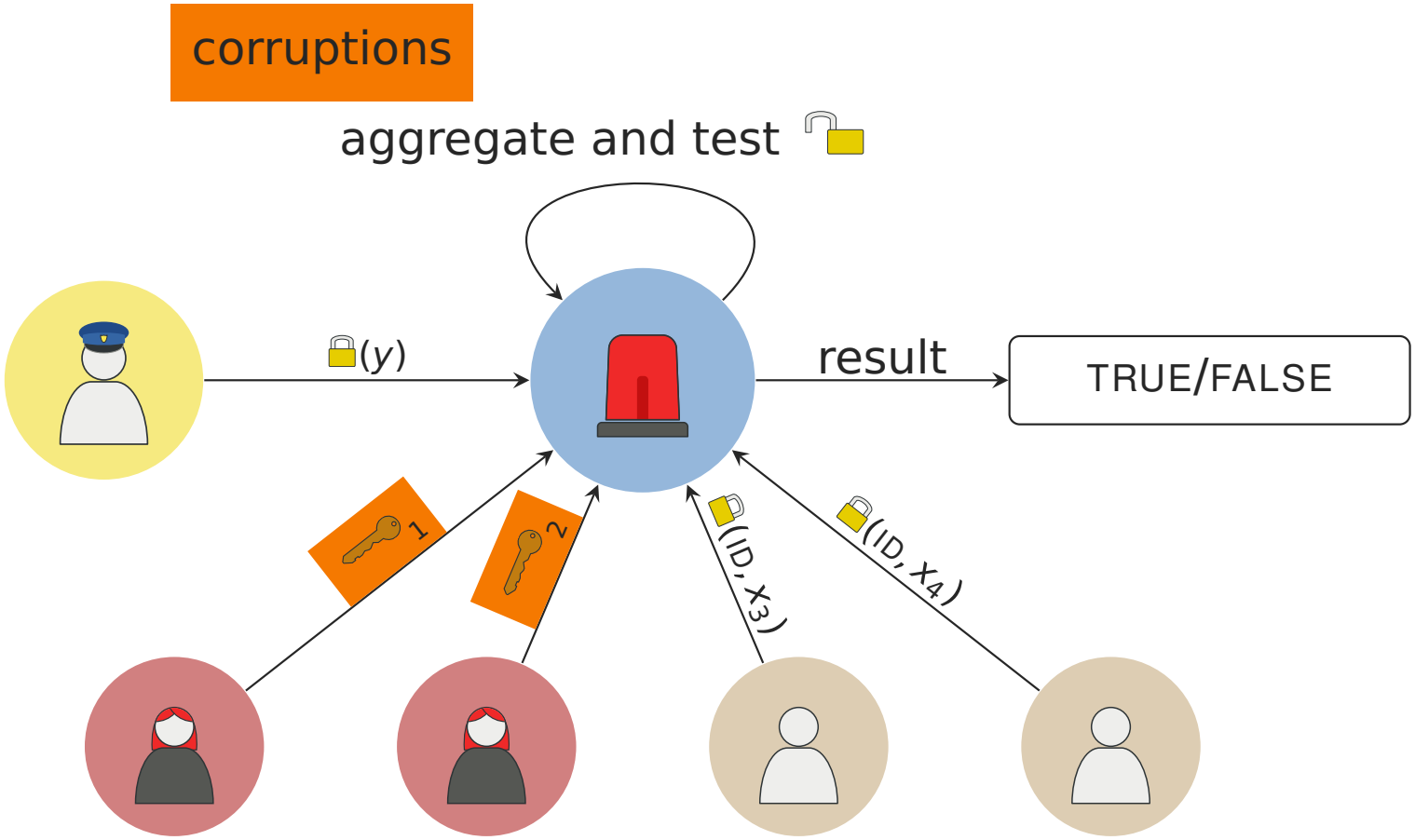
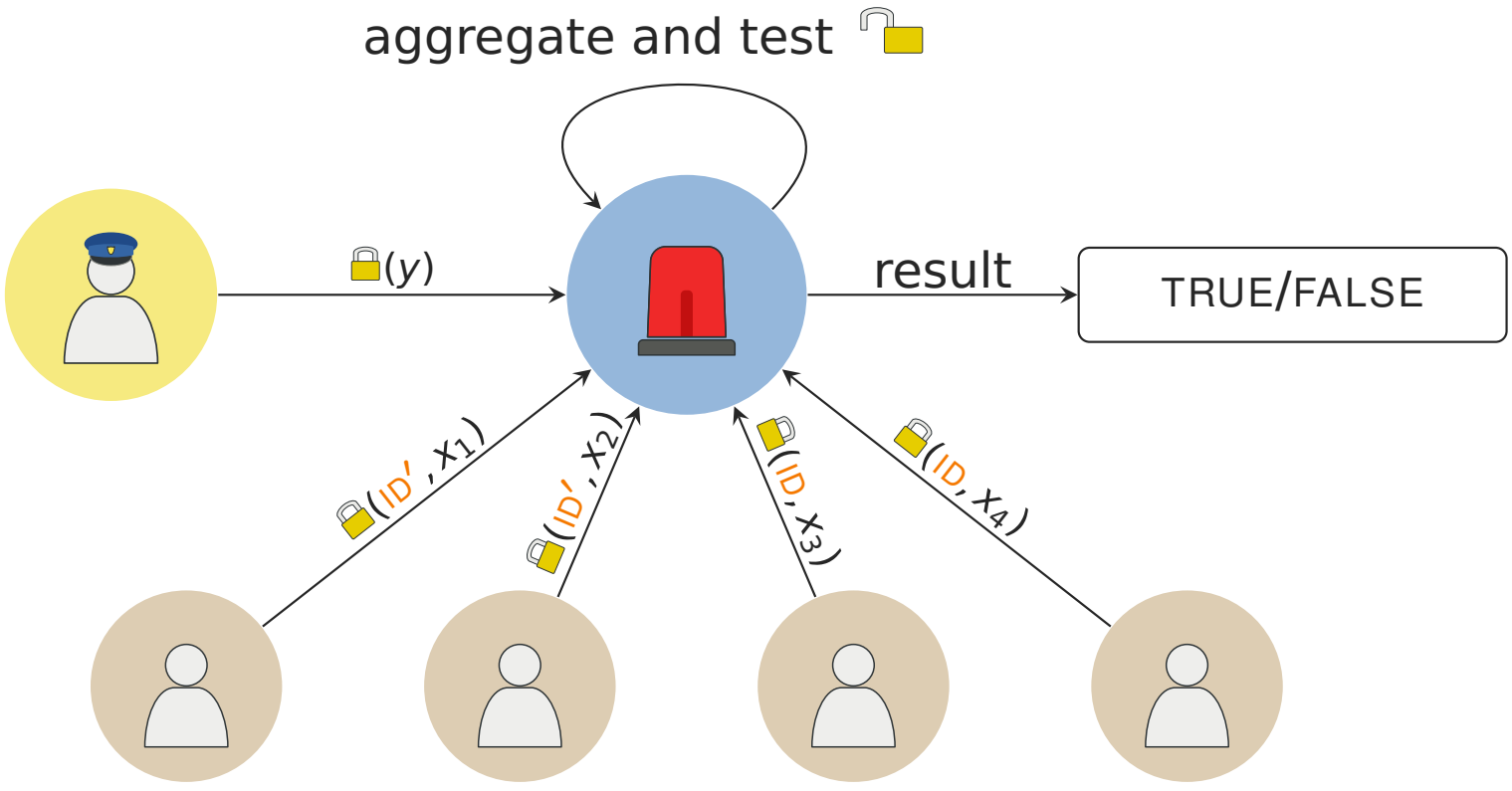
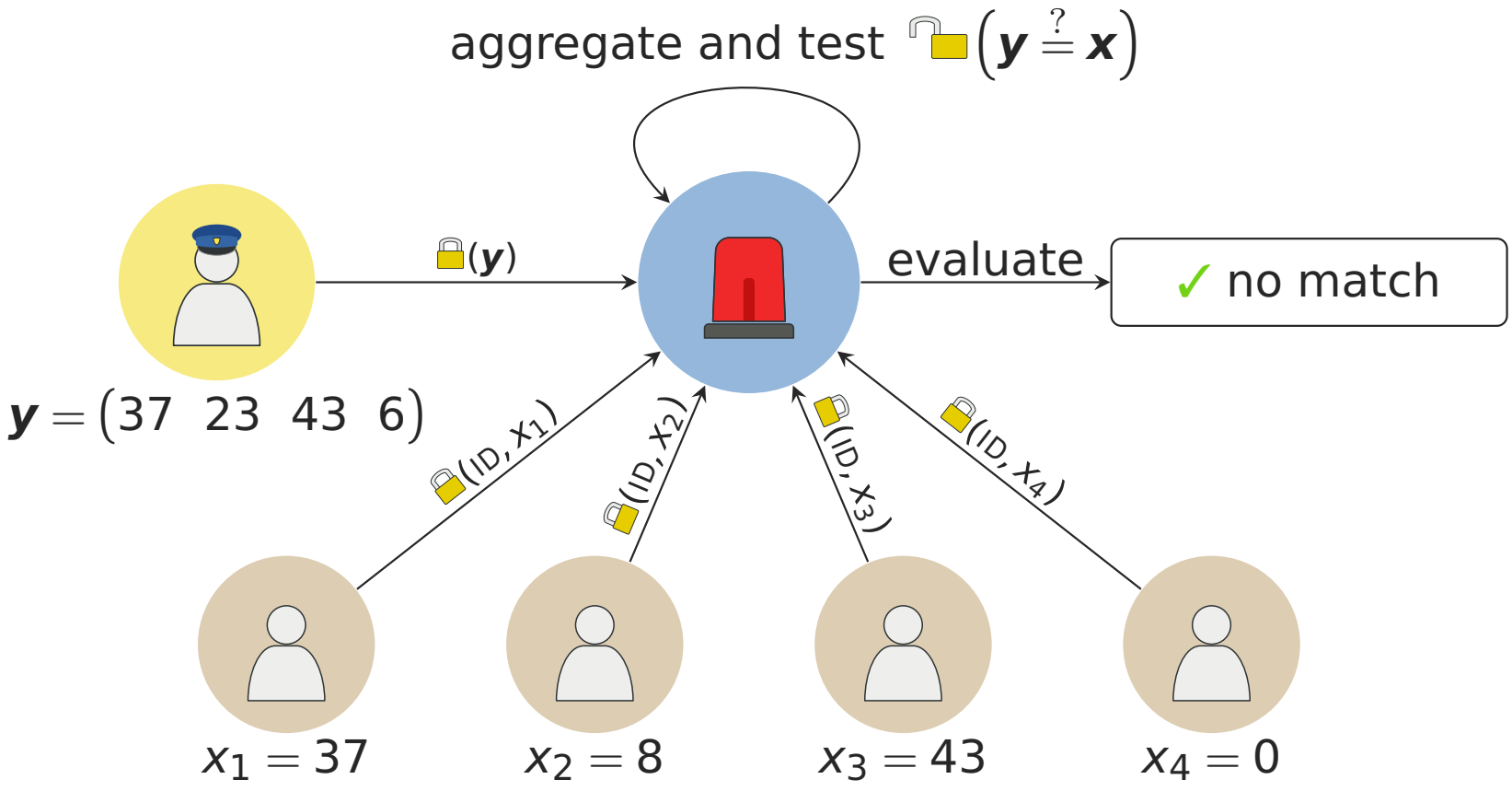


Multi-client Predicate-only Encryption – Security

mix-and-match attacks prevention



Construction: Schematic Overview



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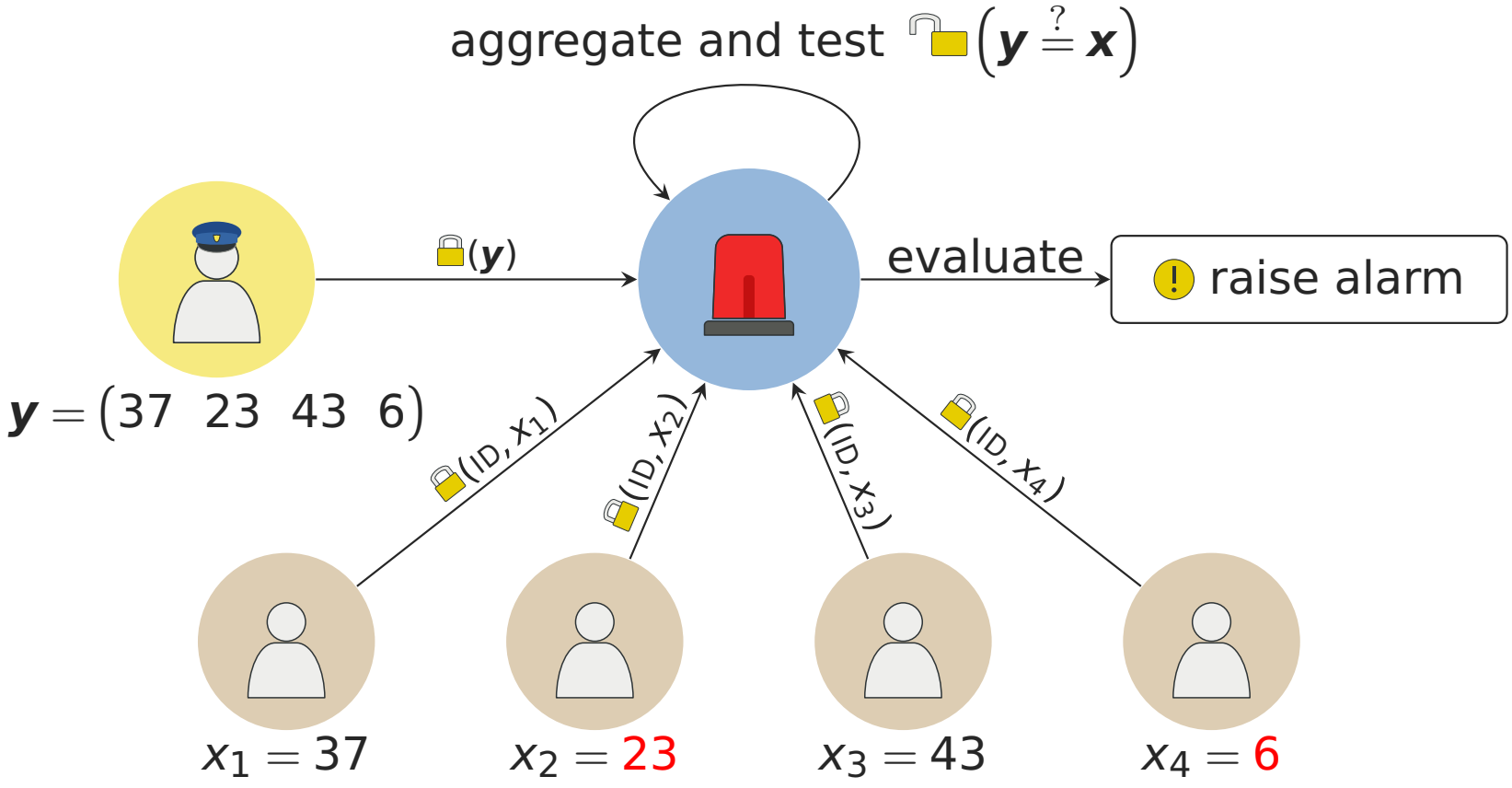

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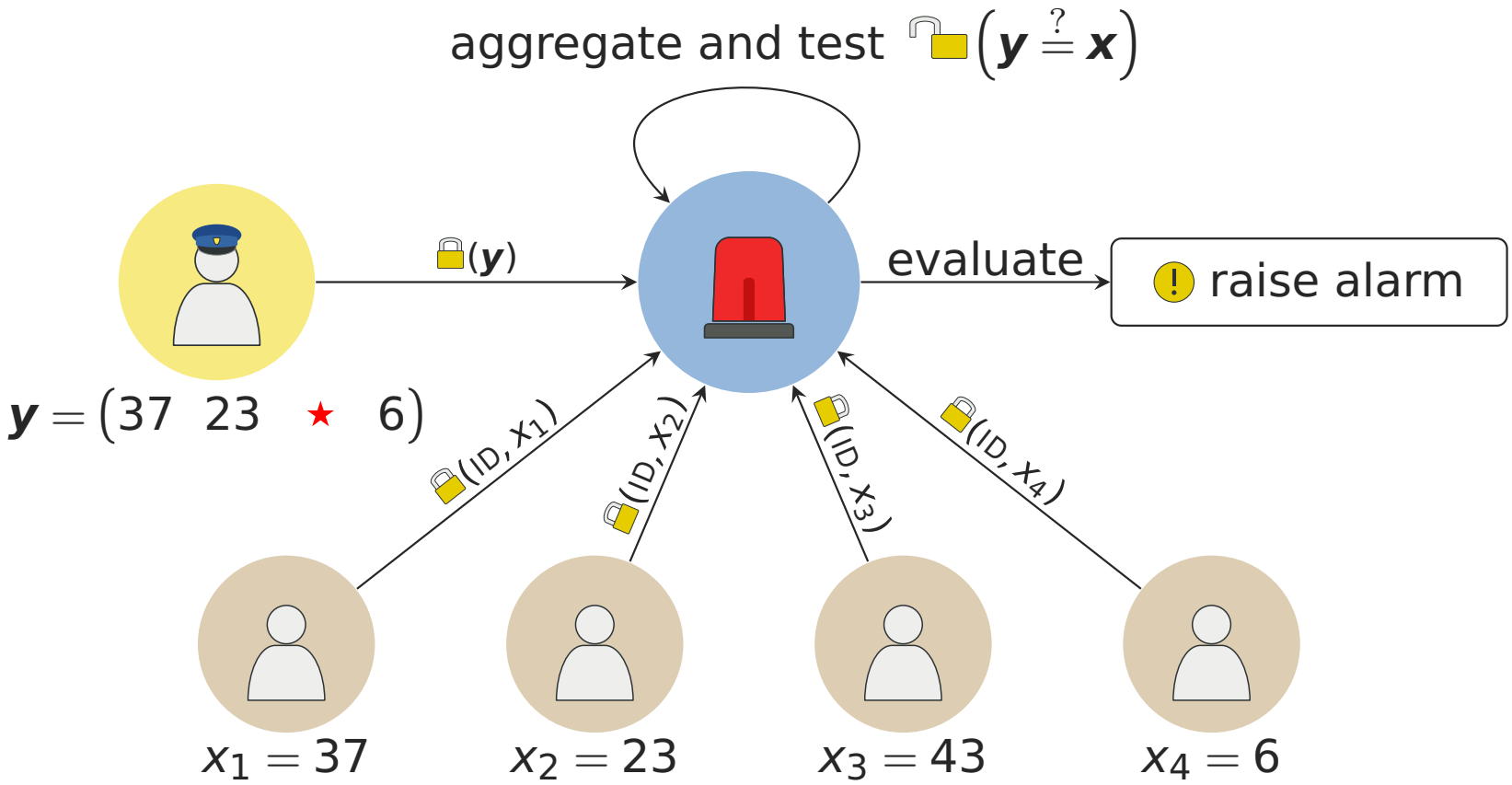

Construction: Simplified & Highlights

Setup(1^λ)

- prime-order asymmetric pairing $e\colon \mathbb{G}_1 \times \mathbb{G}_2 \to \mathbb{G}_T$
- hash function $H\colon \{0,1\}^* \to \mathbb{G}_1$
- $\mathsf{usk}_i = ({g_1}^{\alpha_i}, \quad)$
- $\mathsf{msk} = \left\{({g_2}^{\alpha_i}, \quad)\right\}_{i\in[n]}$

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Encrypt($\mathsf{usk}_i, \mathsf{ID}, x_i$)

$$\mathsf{ct}_i = \left(\quad , g_1^{r_i}, g_1^{\alpha_i x_i r_i} \quad \right)$$

GenToken($\mathsf{msk}, \boldsymbol{y}$)

$$\mathsf{tk}_{\boldsymbol{y}} = \left(\left\{ g_2^{u_i}, g_2^{\alpha_i y_i u_i} \right\}_{i\in[n]}, \quad \right)$$

Test($\mathsf{tk}_{\boldsymbol{y}}, \{\mathsf{ct}_i\}_{i\in[n]}$)

$$\prod_{i\in[n]} e\left(g_1^{\alpha_i x_i r_i} \quad , g_2^{u_i}\right) \stackrel{?}{=} \prod_{i\in[n]} e\left(g_1^{r_i}, g_2^{\alpha_i y_i u_i}\right)$$

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Encrypt(usk_i, ID, x_i)

$\mathsf{ct}_i = \left(H(\mathsf{ID}), g_1^{r_i}, g_1^{\alpha_i x_i r_i} H(\mathsf{ID})^{\delta_i}\right)$

GenToken(msk, $\boldsymbol{y}$)

$$\mathsf{tk}_{\boldsymbol{y}} = \left(\left\{g_2^{u_i}, g_2^{\alpha_i y_i u_i}\right\}_{i\in[n]}, \prod_{i\in[n]} (g_2^{\delta_i})^{u_i} \right)$$

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$$\prod_{i\in[n]} e\left(g_1^{\alpha_i x_i r_i} H(\mathsf{ID})^{\delta_i}, g_2^{u_i}\right) \stackrel{?}{=} \prod_{i\in[n]} e\left(g_1^{r_i}, g_2^{\alpha_i y_i u_i}\right) e\left(H(\mathsf{ID}), \prod_{i\in[n]} (g_2^{\delta_i})^{u_i}\right)$$

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Encrypt($\mathsf{usk}_i, \mathsf{ID}, x_i$)

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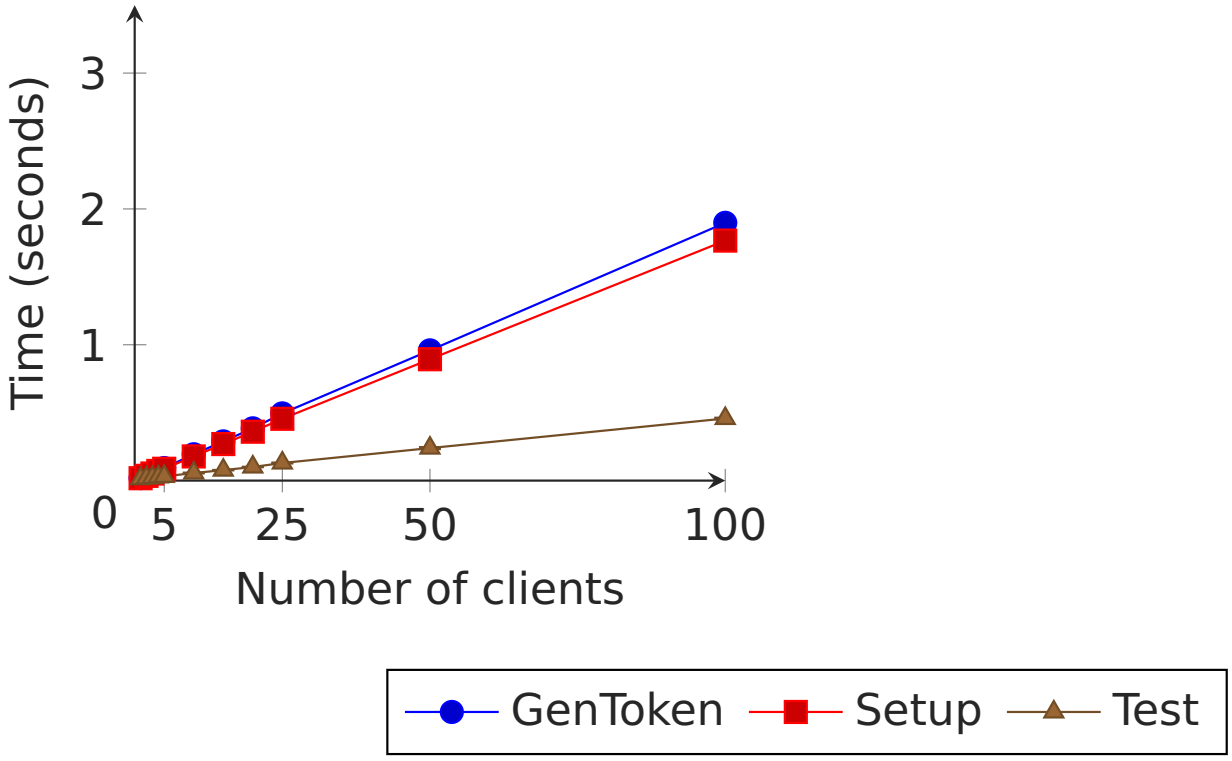
Evaluation

Proof-of-concept implementation in Go [CRIPTIM].

MNT-159 curve

Encrypt (single client): 2.6 ms



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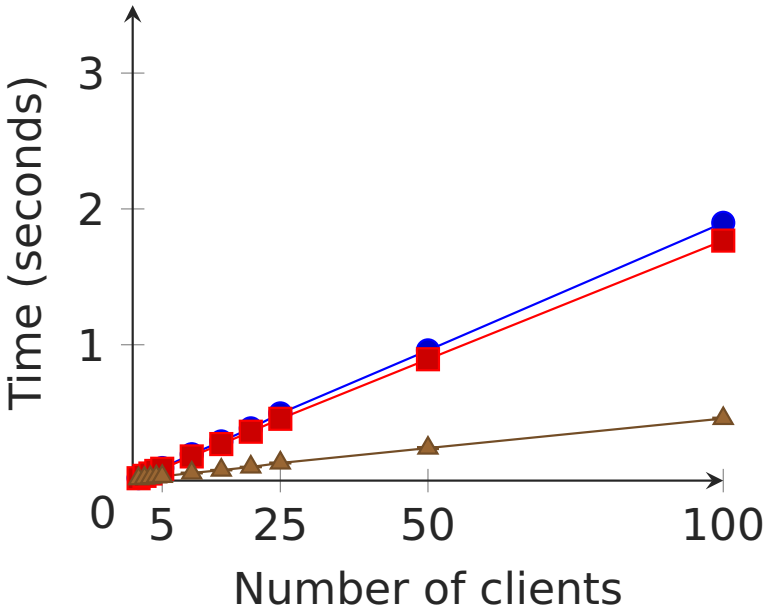
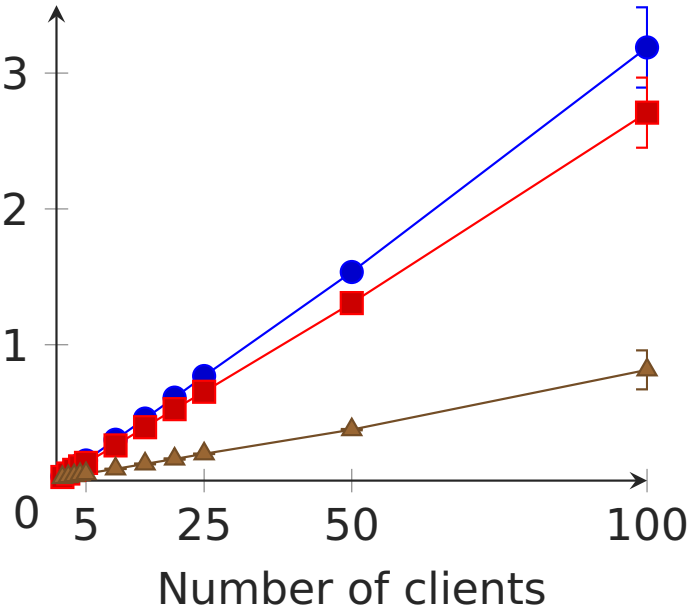
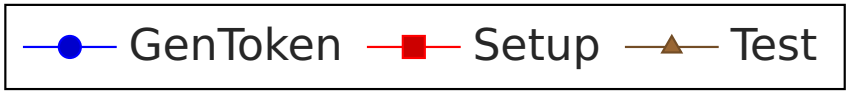


MNT-224 curve
Encrypt (single client): 4.4 ms





Summary

- Monitoring over encrypted data
- Defined multi-client predicate-only encryption
- Simple and efficient construction for conjunctive equality tests

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Interested?

Contact: t.r.vandekamp@utwente.nl

References

[CRIPTIM] *Implementations of Private Information Sharing Schemes*. CRIPTIM consortium. URL: https://github.com/CRIPTIM/.