

Optimistic Fair Priced Oblivious Transfer

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IBBT

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Priced Oblivious Transfer: Definition



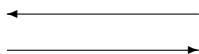
Vendor

$(m_1, \dots, m_N), (p_1, \dots, p_N)$



Buyer

$\tau \in \{1, \dots, N\}$
 m_τ



Properties:

- \mathcal{V} does not learn τ .
- \mathcal{B} does not get any information about other messages.
- \mathcal{B} pays price p_τ .

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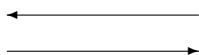
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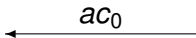


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Prepaid Mechanism

- \mathcal{B} makes an initial deposit to \mathcal{V} .
- At each purchase, the price is debited from the deposit.
- \mathcal{V} learns neither the price nor the deposit.

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Priced Oblivious Transfer: Security

Previous Work

Half-Simulation secure schemes [AIR01, Tob03].

- Vulnerable under attack in [DNO08].

UC-secure scheme [RKP09].

- Inefficient.

Efficient Full-Simulation Secure POT

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Usually, e-commerce protocols are analyzed to prove their fairness [Kre04].

- Non privacy-preserving protocols [EGL85, Gol83].
- Privacy-preserving protocols that provide buyers' anonymity [RR01].

However, no fair POT scheme has been proposed.

- Malicious \mathcal{V} can claim \mathcal{B} ran out of funds.
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Fair POT

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- 1 Efficient Priced Oblivious Transfer
 - Construction
 - Comparison with Previous Work

- 2 Optimistic Fair POT
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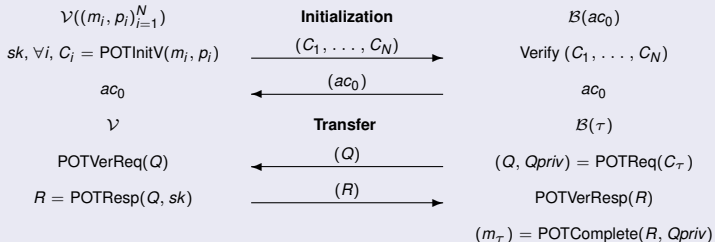
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Overview

Our POT scheme is based on the OT scheme of [CNS07] and thus follows an assisted decryption approach.

Generic POT scheme



Details: Initialization

\mathcal{V} computes the ciphertexts (C_1, \dots, C_N) .

- Computes bilinear map setup $(p, \mathbb{G}, \mathbb{G}_t, e, g)$.
- Pick secret key $h \in \mathbb{G}$.
- Ciphertext $C_i = (A_i = g^{1/(x+p_i)}, B_i = e(h, A_i) \cdot m_i, p_i)$.

\mathcal{B} verifies each A_i and makes the initial deposit ac_0 .

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Transfer phase “j”: Request

\mathcal{B} computes a request (POTReq) for item τ :

- \mathcal{B} picks $v \leftarrow \mathbb{Z}_p$ and blinds $V = A_\tau^v$, computes a commitment C_j to new deposit value $ac_{j-1} - p_\tau$ and a proof that:
 - She possesses a signature on price p_τ .
 - C_j commits to $ac_{j-1} - p_\tau$.
 - C_j commits to a non-negative value [CCS08].

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Transfer phase “j”: Response

\mathcal{V} verifies request (POTVerReq) and computes a response (POTResp):

- $W = e(h, V)$.
- and a proof that secret key h was used to compute W .

\mathcal{B} verifies response (POTVerResp) and obtains the message (POTComplete):

- $m_\tau = B_\tau / (W^{1/v}) = \left(\frac{m_\tau \cdot e(A_j, h)}{e(h, A_j^{1/v})} \right)$

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Comparison with Previous Work

UC Secure vs Our Scheme

	[RKP09]	Our Scheme
UC	Yes	No
Standard Model	Yes	Yes
Static Corruptions	Yes	Yes
CRS	Yes	No
Assumptions	DLIN, TDH, HSDH	SDH, BDHE
Efficient	No	Yes

Efficiency

Given the upper bound of the deposit $D = d^a$.

Communication Efficiency

	[RKP09]	Our Scheme
Ciph	$(12N + 3d + 11) \cdot \mathbb{G} + \mathbb{Z}_p $	$(2N + 2d + 2) \cdot \mathbb{G} + (N + 1) \cdot \mathbb{Z}_p + 2 \cdot \mathbb{G}_t $
Req	$(86 + 30a) \cdot \mathbb{G} $	$(a + 7) \cdot \mathbb{G} + (2a + 7) \cdot \mathbb{Z}_p + (a + 1) \cdot \mathbb{G}_t $
Resp	$28 \cdot \mathbb{G} $	$3 \cdot \mathbb{G}_t + \mathbb{Z}_p $

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Definition

Transformation that turns any secure POT scheme into an Optimistic Fair POT scheme.

Properties:

- Third party \mathcal{A} to resolve disputes.
- \mathcal{A} is only involved in case of dispute (optimistic).
- \mathcal{A} must be neutral to guarantee fairness.
- Privacy-properties of POT are guaranteed (even if \mathcal{A} is corrupted).
 - \mathcal{A} and \mathcal{V} cannot learn τ .
 - \mathcal{A} and \mathcal{B} cannot learn non-purchased messages.
- Without harming efficiency.

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Verifiably Encrypted Signatures

A VES scheme consists of algorithms

- $\text{Kg}(1^\kappa)$, $\text{Sign}(sk, m)$ and $\text{Vf}(pk, \sigma, m)$.
- $\text{AdjKg}(1^\kappa)$ output a key pair (ask, apk) for \mathcal{A} .
- $\text{Create}(sk, apk, m)$ computes a VES ω .
- $\text{VesVf}(pk, apk, \omega, m)$ verifies a VES ω .
- $\text{Adj}(pk, ask, apk, \omega, m)$ extracts σ form ω .

Properties:

- Unforgeability.
- Opacity.

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Protocol based on VES

Non privacy-preserving e-commerce protocol based on VES:

- \mathcal{B} requests an item and sends a VES.
- \mathcal{V} sends the item.
- \mathcal{B} reveals a valid signature.
- If \mathcal{B} does not reveal it, \mathcal{V} complains.
 - \mathcal{A} verifies \mathcal{V} fulfills delivery.
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OFPOT based on VES

- In non-privacy preserving protocols, \mathcal{A} can easily verify whether \mathcal{V} fulfills delivery.
- In POT \mathcal{A} can learn neither m_1, \dots, m_N nor τ .
- However, correctness of requests and responses can be publicly verified.
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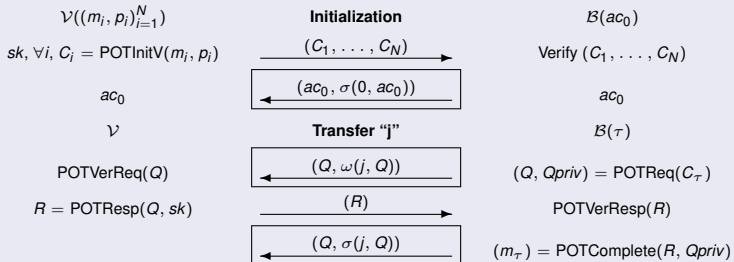
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OFPOT based on VES: construction

Generic OFPOT scheme



OFPOT based on VES: disputes

\mathcal{V} complains:

- \mathcal{V} sends request $Q, \omega(j, Q)$ and response R to \mathcal{A} .
- \mathcal{A} verifies request and response.
- \mathcal{A} sends R to \mathcal{B} and reveals $\sigma(j, Q)$ to \mathcal{V} .

\mathcal{B} complains:

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