PAYMENT PROJECT

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National Research Centre on
Privacy, Harm Reduction
and Adversarial Influence
Online

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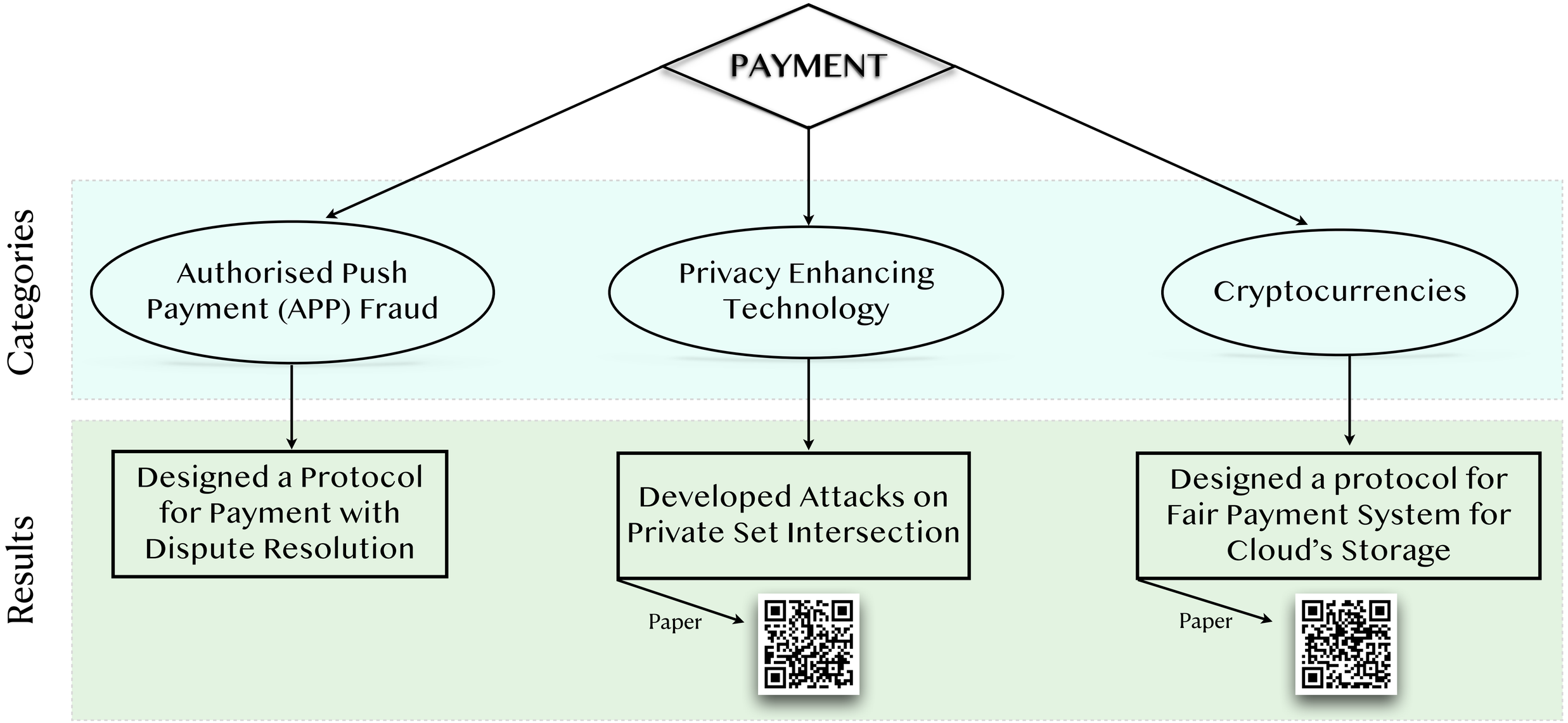
Progress so far

REPHRAIN
Protecting citizens online



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Authorised Push Payment (APP) Fraud

Background

- ‘’Authorised Push Payment” (APP) fraud:
  - Definition: An APP fraud is a type of cyber-crime where a fraudster tricks a victim into making an authorised online payment into an account controlled by the fraudster.
  - It is called “authorised” because the victim authorises the payment.
  - The APP fraud has various variants, such as:
    - romance
    - investment
    - CEO
    - invoice

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Authorised Push Payment (APP) Fraud

Background

- The amount of money lost due to APP frauds is substantial
    - Only in the first half of 2021, a total of £355 million was lost to APP frauds.
- APP fraud is a global issue.
    - According to the **FBI**'s report, victims of APP frauds reported at least a total of $419 million losses, in 2020.
    - Recently, **Interpol** warned its member countries about a concerning variant of APP fraud called investment fraud via dating software.

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Authorised Push Payment (APP) Fraud

Problem

- Although the UK's regulators (unlike other countries) have provided specific guidelines to financial institutes to prevent APP frauds occurrence and improve victims' protection, these guidelines are:
    - ambiguous
    - open to interpretation
- Also, there exists no mechanism in place via which honest victims can prove their innocence.

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Authorised Push Payment (APP) Fraud

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Our Solution

- To protect victims of APP frauds, we proposed:
  1. **Formal Definition:** we put forward the notion of "Payment with Dispute Resolution" (PwDR):
     - Identified a PwDR scheme's core security properties:
       1. security against a malicious victim.
       2. security against a malicious bank.
       3. privacy.
     - formally defined the PwDR scheme.

Security Game

$$\texttt{keyGen}(1^\lambda) \rightarrow (sk, pk)$$
$$\texttt{bankInit}(1^\lambda) \rightarrow (T, pp, \boldsymbol{l})$$
$$\mathcal{A}(1^\lambda, T, pp, \boldsymbol{l}) \rightarrow \hat{m}_1^{(\mathcal{C})}$$
$$\texttt{insertNewPayee}(\hat{m}_1^{(\mathcal{C})}, \boldsymbol{l}) \rightarrow \hat{\boldsymbol{l}}$$
$$\texttt{genWarning}(T, \hat{\boldsymbol{l}}, \text{aux}) \rightarrow \hat{m}_1^{(\mathcal{B})}$$
$$\mathcal{A}(T, \hat{\boldsymbol{l}}, \hat{m}_1^{(\mathcal{B})}) \rightarrow \hat{m}_2^{(\mathcal{C})}$$
$$\texttt{makePayment}(T, \hat{m}_2^{(\mathcal{C})}) \rightarrow \hat{m}_2^{(\mathcal{B})}$$
$$\mathcal{A}(\hat{m}_1^{(\mathcal{B})}, \hat{m}_2^{(\mathcal{B})}, T, pk) \rightarrow (\hat{z}, \hat{\ddot{\pi}})$$
$$\forall j, j \in [n]:$$
$$\left(\texttt{verComplaint}(\hat{z}, \hat{\ddot{\pi}}, g, \hat{\boldsymbol{m}}, \hat{\boldsymbol{l}}, j, sk_{\mathcal{D}}, aux, pp) \rightarrow \hat{\boldsymbol{w}}_j\right)$$
$$\texttt{resDispute}(T_2, \hat{\boldsymbol{w}}, pp) \rightarrow \boldsymbol{v} = [v_1, ..., v_4]$$

Adversary's wining probability

$$\Pr\left[\begin{array}{l} \left((m_1^{(\mathcal{B})} = warning) \wedge (\sum_{j=1}^{n} w_{1,j} \geq e)\right) \\ \vee\left((\sum_{j=1}^{n} w_{1,j} < e) \wedge (v_1 = 1)\right) \\ \vee\left((\texttt{checkWarning}(m_1^{(\mathcal{B})}) = 1) \wedge (\sum_{j=1}^{n} w_{2,j} \geq e)\right) \\ \vee\left((\sum_{j=1}^{n} w_{2,j} < e) \wedge (v_2 = 1)\right) \\ \vee\left(u \notin Q \wedge \texttt{Sig.ver}(pk, u, sig) = 1\right) \\ \vee\left((\sum_{j=1}^{n} w_{3,j} < e) \wedge (v_3 = 1)\right) \end{array} : \text{Exp}_1^{\mathcal{A}}(\text{input})\right] \leq \mu(\lambda)$$

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Authorised Push Payment (APP) Fraud

Our Solution

2. **Efficient Protocol:** we designed an efficient protocol that realises the PwDR's definition.

    - formally proved the protocol is secure (i.e., meets the formal definition).

3. **Analysed the Protocol's Cost:** we performed a cost analysis of the construction via both asymptotic and runtime evaluation (via a prototype implementation).

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Protecting Victims of APP Frauds

Main Tools We Used

- The PwDR Protocol's building blocks:
  - Commitment scheme
  - Digital signature
  - Smart contract
  - Pseudorandom function
  - Bloom filter
  - Threshold voting protocols

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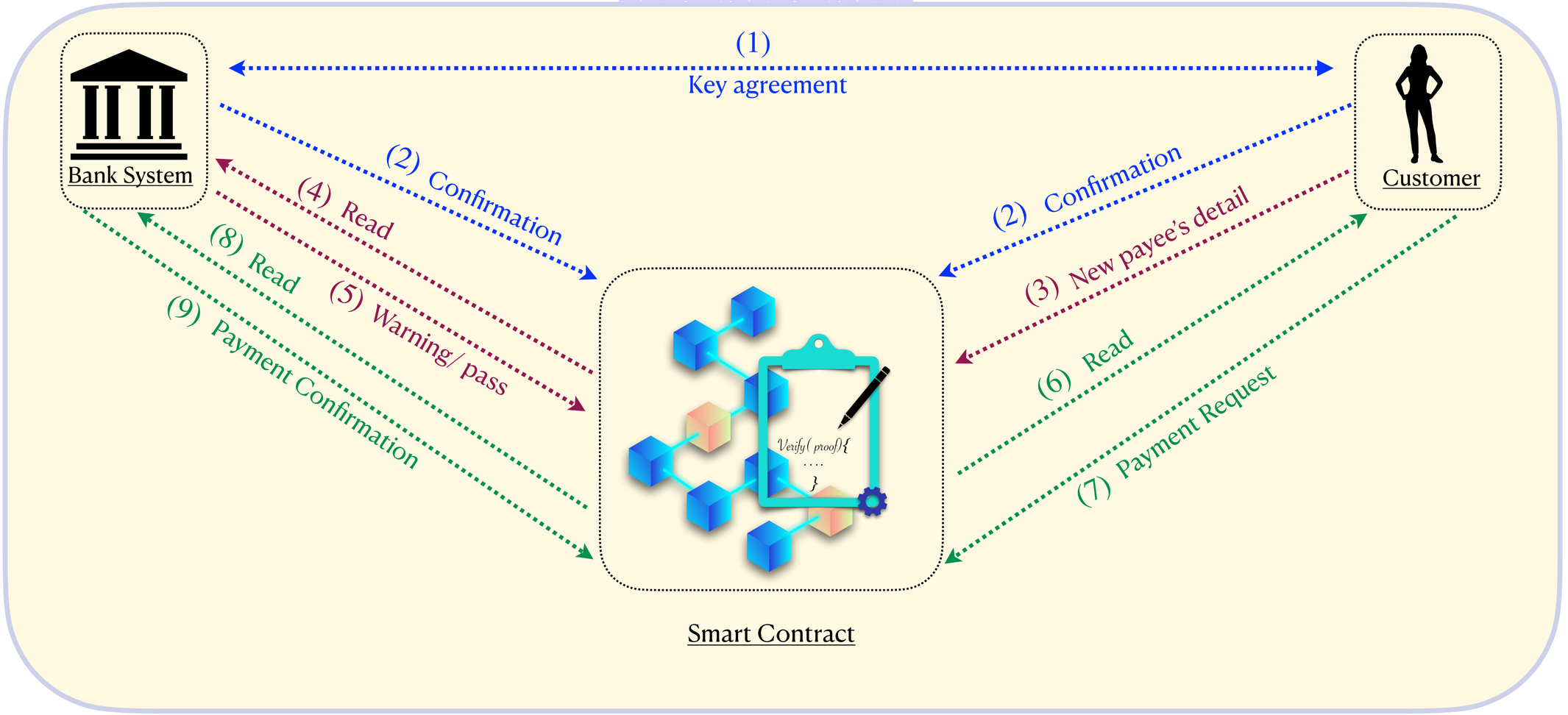
Protecting Victims of APP Frauds

The PwDR Protocol's Workflow

Payment Phase



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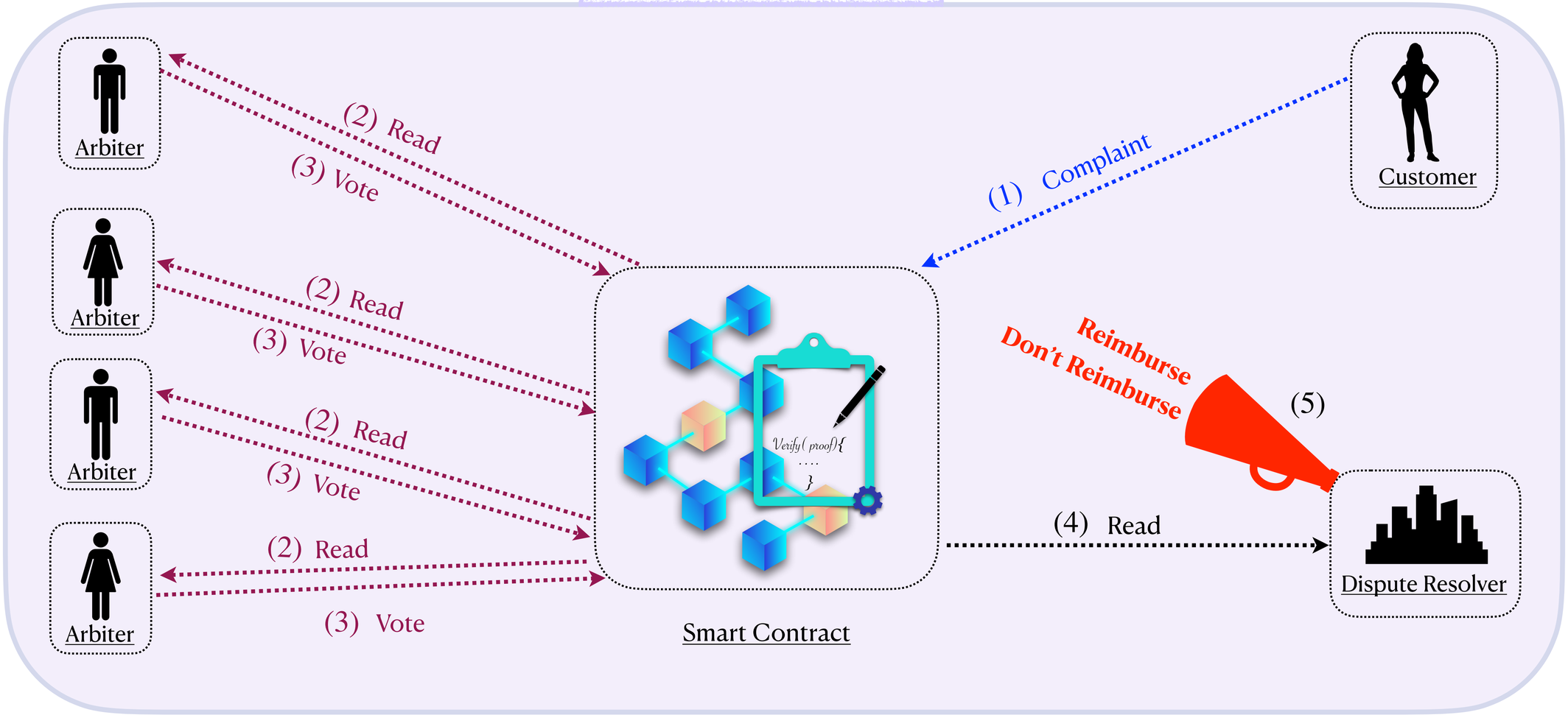
The PwDR Protocol's Workflow

Dispute Resolution



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The PwDR Protocol's Complexity

Party	Setting		Computation Cost	Communication Cost
	$e = 1$	$e > 1$		
Customer	✓	✓	$O(1)$	$O(1)$
Bank	✓	✓	$O(1)$	$O(1)$
Arbiter $\mathcal{D}_1, ..., \mathcal{D}_{n-1}$	✓	✓	$O(1)$	$O(1)$
Arbiter $\mathcal{D}_n$	✓		$O(n)$	$O(1)$
		✓	$O(\sum_{i=e}^{n} \frac{n!}{i!(n-i)!})$	$O(\sum_{i=e}^{n} \frac{n!}{i!(n-i)!})$
Dispute resolver	✓	✓	$O(n)$	$O(1)$

n: number of arbiters

e: threshold

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Protecting Victims of APP Frauds

The PwDR Protocol's Runtime in Millisecond

Party	$n = 6$		$n = 8$		$n = 10$		$n = 12$	
	$e = 1$	$e = 4$	$e = 1$	$e = 5$	$e = 1$	$e = 6$	$e = 1$	$e = 7$
Arbiter $\mathcal{D}_n$	0.019	0.220	0.033	0.661	0.035	2.87	0.052	10.15 *
Dispute resolver $\mathcal{DR}$	0.001	0.015	0.001	0.016	0.001	0.069	0.003	0.09

n: number of arbiters

e: threshold

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Protecting Victims of APP Frauds

Conclusion

- To protect victims of APP frauds, we proposed "Payment with Dispute Resolution" (PwDR) scheme.
- We hope that our result lays the foundation for future solutions that will protect victims of APP frauds.

The end