Distributed Identity Based Short Linkable Ring Signature

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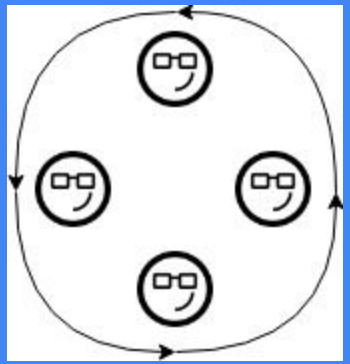
Goal

- Anonymity
- Accountability
- Usability

Ring Signature

Anonymous
Spontaneous



Linkable Ring Signature

- Event tag
- Accountable

- Linear size

Cryptographic Accumulator

- Make a short representation
- Not a compresion

Accumulator

- Accumulate set(X): V
- Generate witness: W
- Check membership: (x, W, V)

Additional properties

- Dynamic
- Authority

Bilinear Pairing (Nguyen)

- Master Secret Key: s

$$V = [\prod_{x \in X}(x + s)].P$$

- Publicly computable

$$(P, sP, s^2P, ..., s^nP)$$

Bilinear Pairing (Nguyen)

- With Authority:
  - Dynamic
  - Authority
- No Authority:
  - Trusted setup
  - Not efficient

Accumulator

vs

Ring Signature

Short Linkable Ring Signature

- Membership in ring
- Knowing private key
- Correct link tag

Identity Based Cryptography

- Public key is based on name
- No Certificate Authority
- Authority generate private key
- Key escrow

Bilinear pairing SLRS

- Membership: Nguyen’s Accumulator
- Knowledge of private key:
  - Sakai-Kasahara IBC
  - $1/(x+s).Point$
- Link

Secret Sharing: Direct

- Shamir polynomial
- Distributed key generation
- Compute: $Q \rightarrow sQ$

Secret sharing: inverse

- Compute: $Q \to 1/(x+s)Q$
- Secure Multiparty Computation
- Online participation for each request
- Not efficient

Distributed IBC

- Use SS inverse
- Distributed trust

Distributed Nguyen’s Acc

- Trusted setup
- Distributed trust
  - SS Direct: Week dynamic
  - SS Inverse: Fully dynamic

Distributed Accumulator

	None	SS Direct	SS Inverse
Witness generation	$O(n^2)$	$O(n)$	Accumulate: $O(n)$ No check witness: $O(1)$
Add member	$O(n^2)$	$O(1)$	$O(1)$
Remove member	$O(n^2)$	$O(n^2)$	$O(1)$

Idea

- Hierarchical Accumulator
  - Improve efficiency in non-trusted model
- Hierarchical SLRS
  - Different privacy levels
  - Set management

Voting

- Different levels: City, Canton, Country
- Autonomous sets
- Unique identity link across levels

PoP Party

- Merging parties
- Removing parties
- Attribute based parties
- Multiple attributes for a party
- Distinct parties? Same IBC authority?

Challenges

- Efficiency
- Efficiency
- Efficiency

Summary

- Accumulator
- Linkable Ring Signature
- Identity Based Cryptography
- Distributed Authority
- Distributed Identity Based Short Linkable Ring Signature (DIBSLRS)

RSA

- Accumulator
- Short Linkable Ring Signature (SLRS)

- Authority
- Certificate public key