# Blind Signatures Scheme for PCM Fraud Prevention

## W3C PrivacyCG F2F - May 2021


User

The Click Source

The Click Destination

Client visits website

Click source returns ad links with attribution attributes

<a attributionsourceid=3 attributiondestination="https://shoes.example" attributionsourcenonce="ABCDEFabcdef0123456789">Buy great shoes now! </a>

Clicks on link

GET https://clicksource.example/.well-known/private-click-measurement/get-token-public-keys/

Public Key of the Click Source

clientNonce = random(32)
(blinded_msg, inv) =
Blind(pkCS, clientNonce)

POST https://clicksource.example/.well-known/private-click-measurement/sign-unlinkable-token/
{ "key_id": …, "source_engagement_type": "click", "source_nonce": ABCDEFabcdef0123456789,
"source_unlinkable_token": blinded_msg , "version": 2}

Validates the source nonce is valid
And computes
blind_signature =
BlindSign(skCS, blind_msg)

"unlinkable_token": blind_signature

TokenSignature =
Finalize(pkCS, clientNonce, blind_signature, inv)
Store TokenSignature

Triggering event happens and
$r \rightarrow [24,48$ hours] passes

GET https://clicksource.example/.well-known/private-click-measurement/get-token-public-keys/

Public Key of the Click Source

Client verifies pkCS is still
a key of the click source

Attribution report is sent to clickSource and clickDestination, containing the clickSource, clientNonce …

GET https://clicksource.example/.well-known/private-click-measurement/get-token-public-keys/

Public Key of the Click Source

Verifies uniqueness of clientNonce and
validity of the signature of the
attribution report

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Issue #41 on GitHub.com/privacycg/private-click-measurement

# Cryptographic Scheme for Fraud Prevention

# Requirements for the cryptographic scheme

- **Unlinkability** between the issuance of the token with the source nonce, and the redemption flow when the attribution report is posted
- **Public verifiability** to allow both the click source and destination to verify the authenticity of the report
- **Resistance against “one-more-forgery” attacks**, to prevent an attacker from minting valid signatures for attribution reports

# Additional Considerations

- **Efficiency:**
  - *Computational*: The amount of computation on device and on the server is reasonable.
  - *Bandwidth*: The amount of data transmitted is reasonable.
- **Ease of Implementation**
- **Post-Quantum Security**

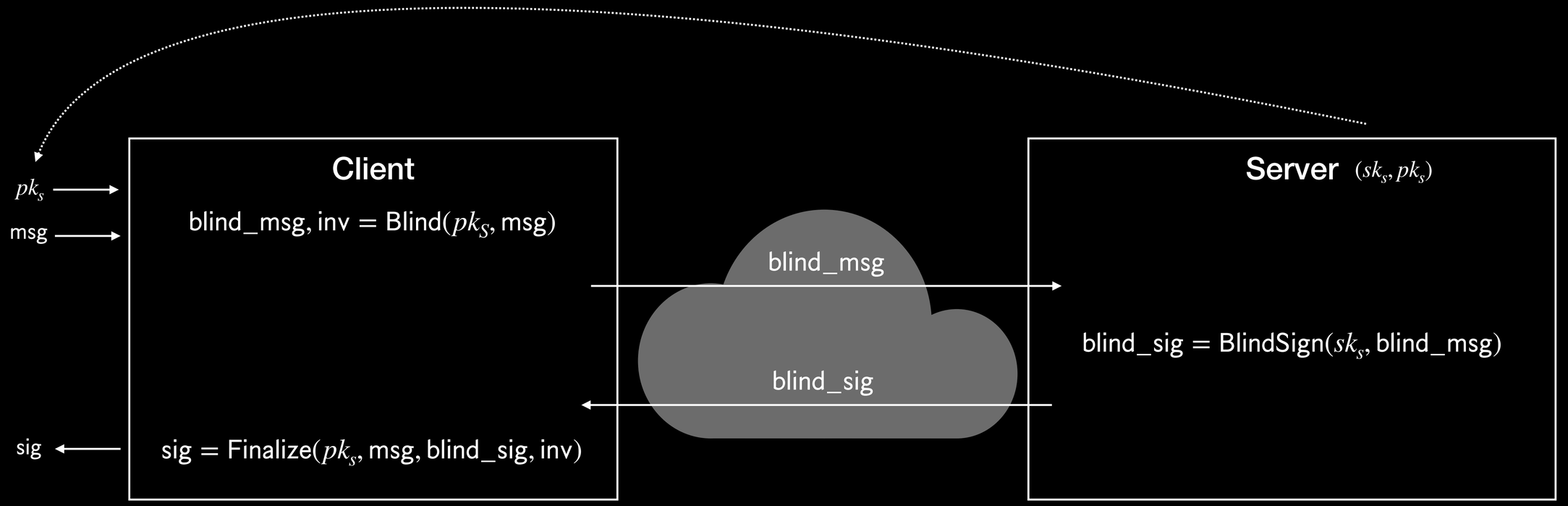
💡 **Cryptographic scheme is going to be versioned to allow future clients to use updated cryptographic primitives.**

# RSABSSA

## IETF Draft

- Based on Chaum's Blind Signatures (been around since 80s and well-studied)
- Publicly-verifiable RSA-PSS signatures
  - Widespread support in crypto libraries to verify those signatures
  - Resistance against "one-more-forgeries"
- Unlinkability against classical and quantum attackers.
  - Forgery believed to be possible by future quantum attacker.
- Implementation is straightforward for crypto libraries that have already RSA support

# Blind RSA
## Protocol



# Alternatives Considered

| Scheme | Pros | Cons |
|---|---|---|
| ECVOPRFs | Smaller key sizes, more efficient | Not publicly verifiable |
| Blind Schnorr Signatures | Smaller key sizes, more efficient<br>Threshold-friendly (c.f. FROST) | Three messages (state or computation overhead)<br><br>Polynomial-time ROS attack (2020/945), but FPS20 (Clause-blind Schnorr) seems plausible, but would require multiple round-trips for issuance and hasn't received much peer-review yet. |
| Blind BLS | Smaller key sizes | Expensive signing and verification<br><br>Pairing support is not (yet!) widely supported in common libraries (BoringSSL, ring, etc) |
| Abe | Polynomial concurrent security<br>Seems unaffected by ROS attack (2020/945) | Three messages (state or computation overhead)<br>Large signature sizes (several group elements) |