Partially Blind RSA Signatures

draft-amjad-cfrg-partially-blind-rsa

Ghous Amjad*, Scott Hendrickson, Christopher Wood, Kevin Yeo

IETF 120 - CFRG

Outline

- Motivation
- Background: Blind RSA Signatures
- Partially Blind RSA Signatures
- Benchmarks
- Current Status

Motivation: Blind Signatures

- Privacy Pass
- Web Browsing, e.g.,
  - Google VPN
  - iCloud Private Relay
- Avoiding Repeated CAPTCHA Solving
- Private Click Measurement
- Tor DOS Defenses
- …

Motivation: Partially Blind Signatures

- ‘draft-ietf-privacypass-public-metadata-issuance’
  - Adopted in the PrivacyPass working group
  - Defines two variants for token schemes with public metadata
    - Privately verifiable (‘draft-irtf-cfrg-voprf’)
    - Publicly verifiable (this draft!)

- Blind signatures enabling public metadata such as
  - expiration times,
  - service multiplexing etc.

- Avoiding one key per metadata approach
  - May require fixed public metadata choices ahead of time
  - Key management scalability concerns

Motivation: Blind RSA Signatures

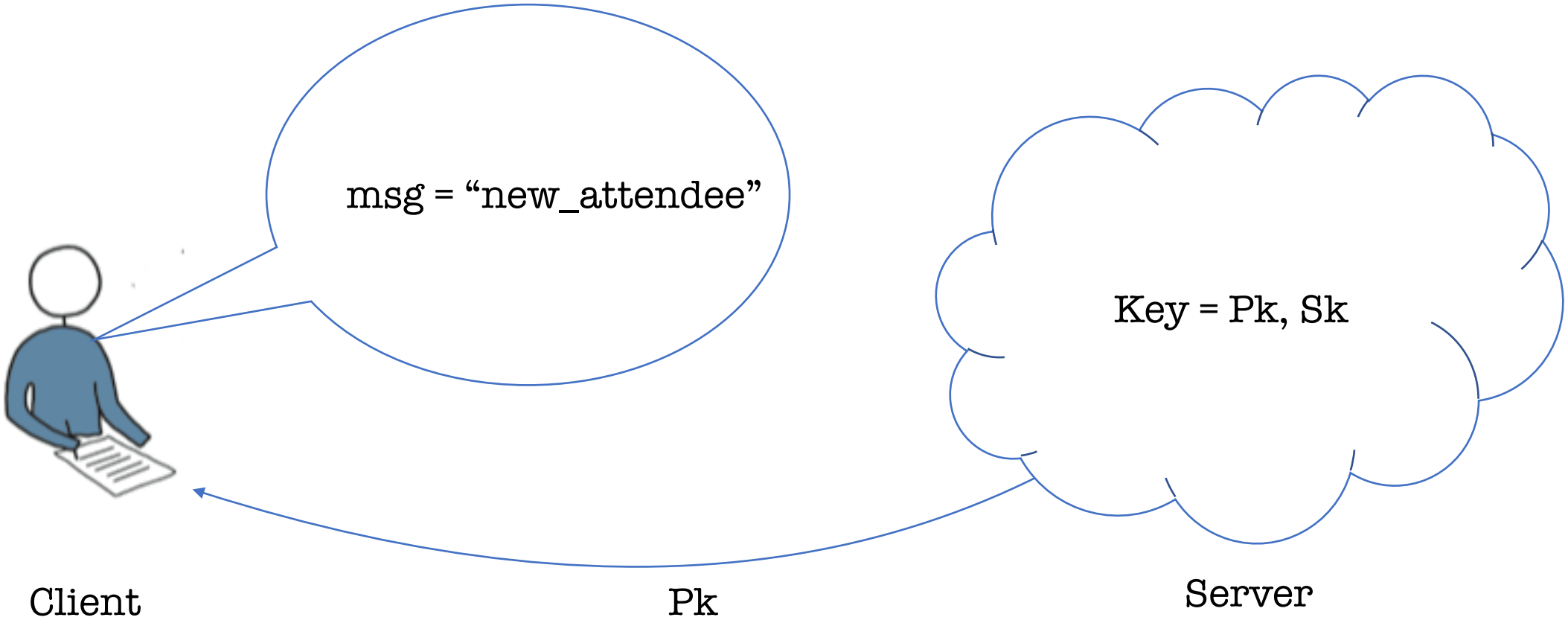
- RFC 9474 for Blind RSA Signatures
  - Simple (one-round scheme, stateless server issuance)
  - Widely supported public verification

- Natural to standardize variant supporting public metadata

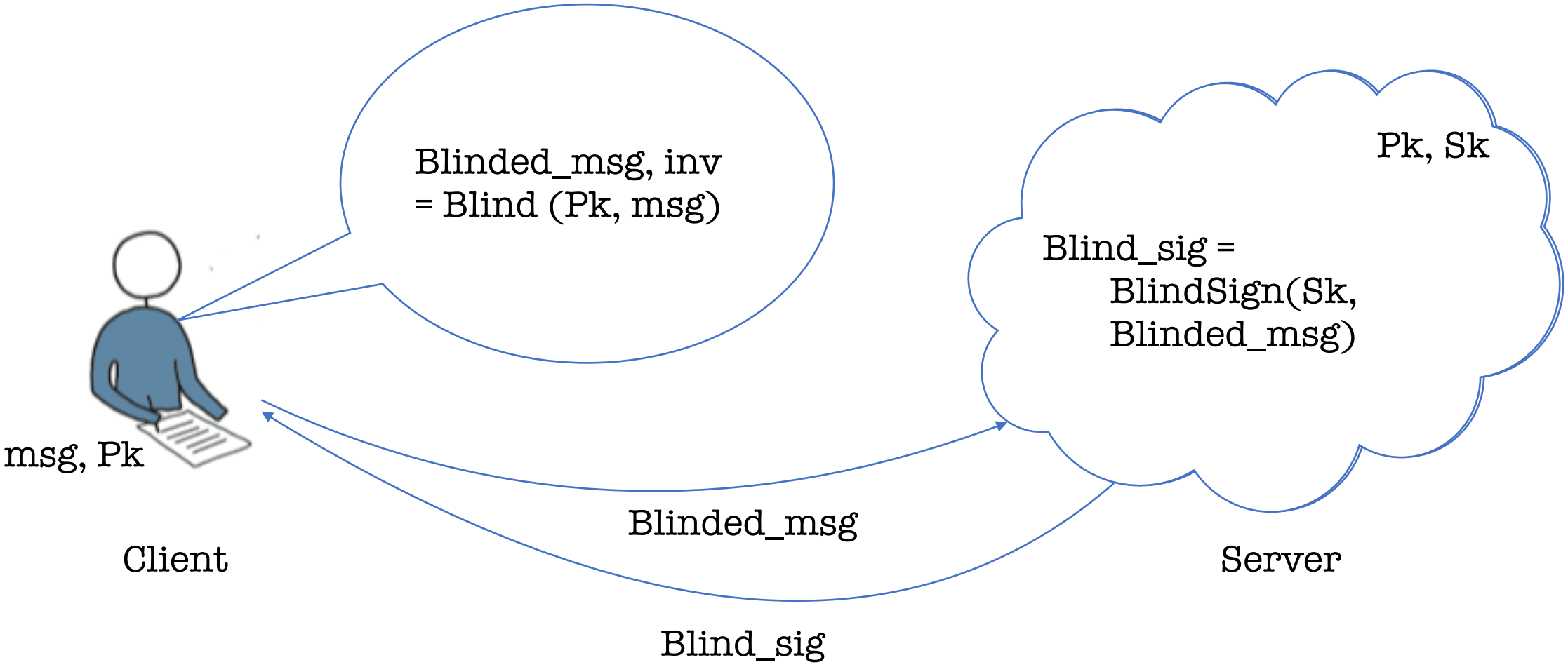
Outline

- Motivation
- Background: Blind RSA Signatures
- Partially Blind RSA Signatures
- Benchmarks
- Current Status

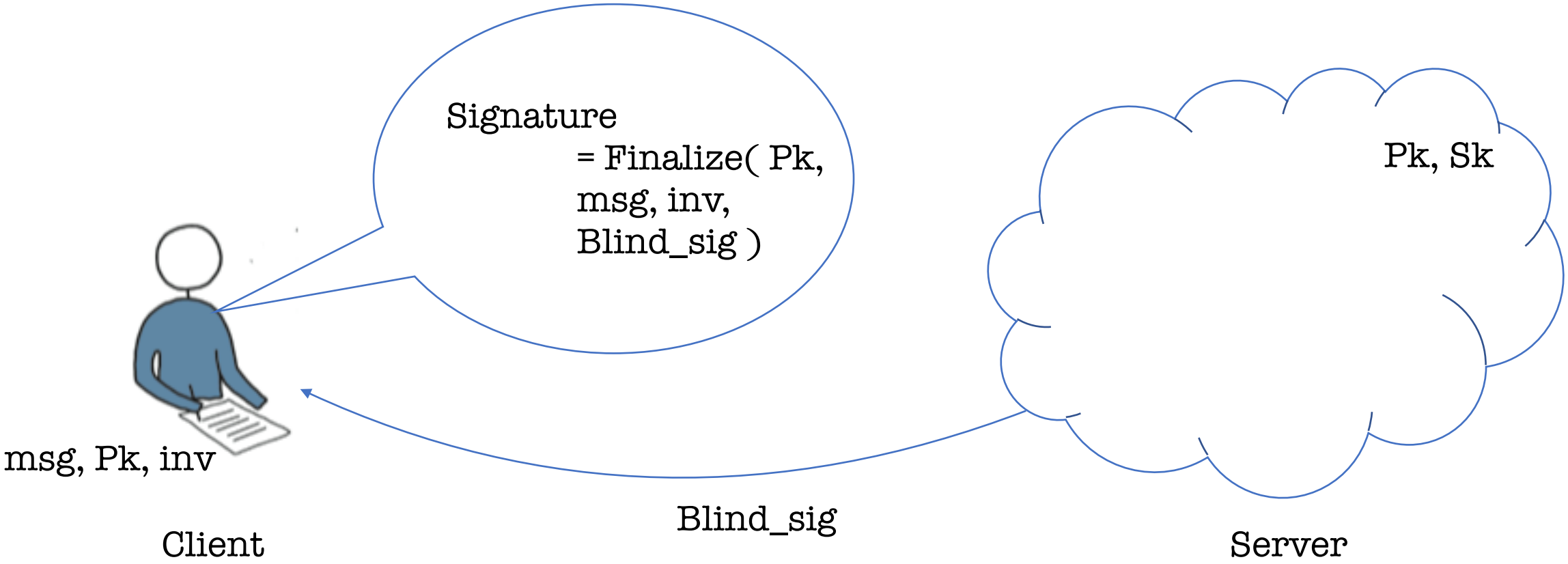
Background: Blind RSA Signatures



Background: Blind RSA Signatures



Background: Blind RSA Signatures



Background: Blind RSA Signatures

- Input message is encoded before being blinded
  - PSS Encoding
- Signature is verified as a sub-routine in Finalize
- Signature is publicly verifiable!

Outline

- Motivation
- Background: Blind RSA Signatures
- Partially Blind RSA Signatures
- Benchmarks
- Current Status

Partially Blind RSA Signatures [1,2,3]

- Use same public metadata (md) needed in all stages
  - Blinding
  - Signing
  - Finalizing
  - Verifying

1. Abe, M., Fujisaki, E. (1996). How to date blind signatures. ASIACRYPT, 1996.
2. Abe, M., Camenisch, J. (1997). Partially blind signature schemes. Proceedings of Symposium on Cryptography and Information Security, 1997.
3. Amjad, G., Yeo, K., Yung, M. RSA Blind Signatures with Public Metadata (in submission).

Partially Blind RSA Signatures

- Augmented Input Message
  - Unique encoding of message and “md” passed to PSS encoding

- Derive the Public Key based on public metadata
  - H(md)
    - using HKDF as H for implementation ease
  - H(md) needs to be co-prime to ϕ(N) where N is the RSA modulus
    - Strong RSA modulus (should be a product of two safe primes)
    - H(md) output is size restricted and an odd number

Security Considerations

- One-more-unforgeability
- Unlinkability under same public metadata
- Domain separation
  - Different RSA moduli will ensure different derived public keys for same public metadata
  - Hash functions in input message augmentation and public key derivation are domain separated
- Denial of service

Outline

- Motivation
- Background: Blind RSA Signatures
- Partially Blind RSA Signatures
- Benchmarks
- Current Status

Benchmarks

	Blind RSA Signatures	Partially Blind RSA Signatures
Blind	0.31 ms	1.4 ms
BlindSign	1.6 ms	4.3 ms
Finalize	0.028 ms	1.1 ms

* https://github.com/google/anonymous-tokens
* https://github.com/chris-wood/circl/blob/caw/pbrsa/blindsign/blindrsa/pbrsa.go

Outline

- Motivation
- Background: Blind RSA Signatures
- Partially Blind RSA Signatures
- Benchmarks
- Current Status

Current Status

- At Google:
  - Chrome IP Protection Authentication
  - Pixel VPN Authentication
- Third-party audit of the cryptography
- Academic paper with accompanying security proofs / analysis is currently in submission
  - Updated IACR e-print will be available by end of year
- Interest in adopting this document?

Thank you!