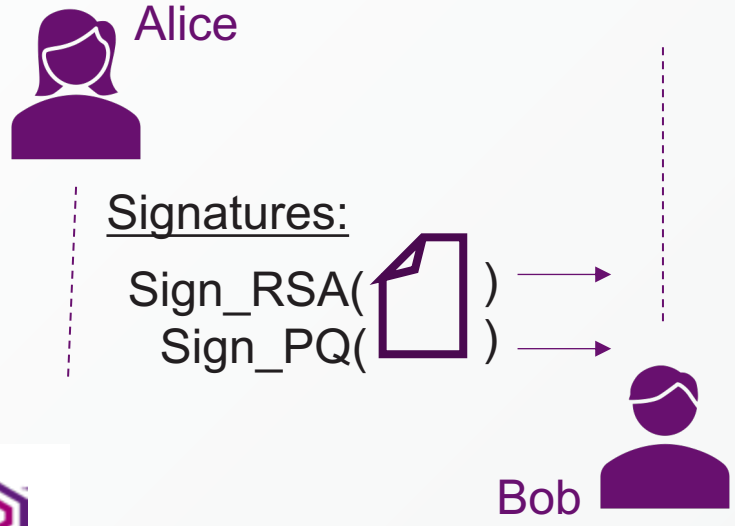
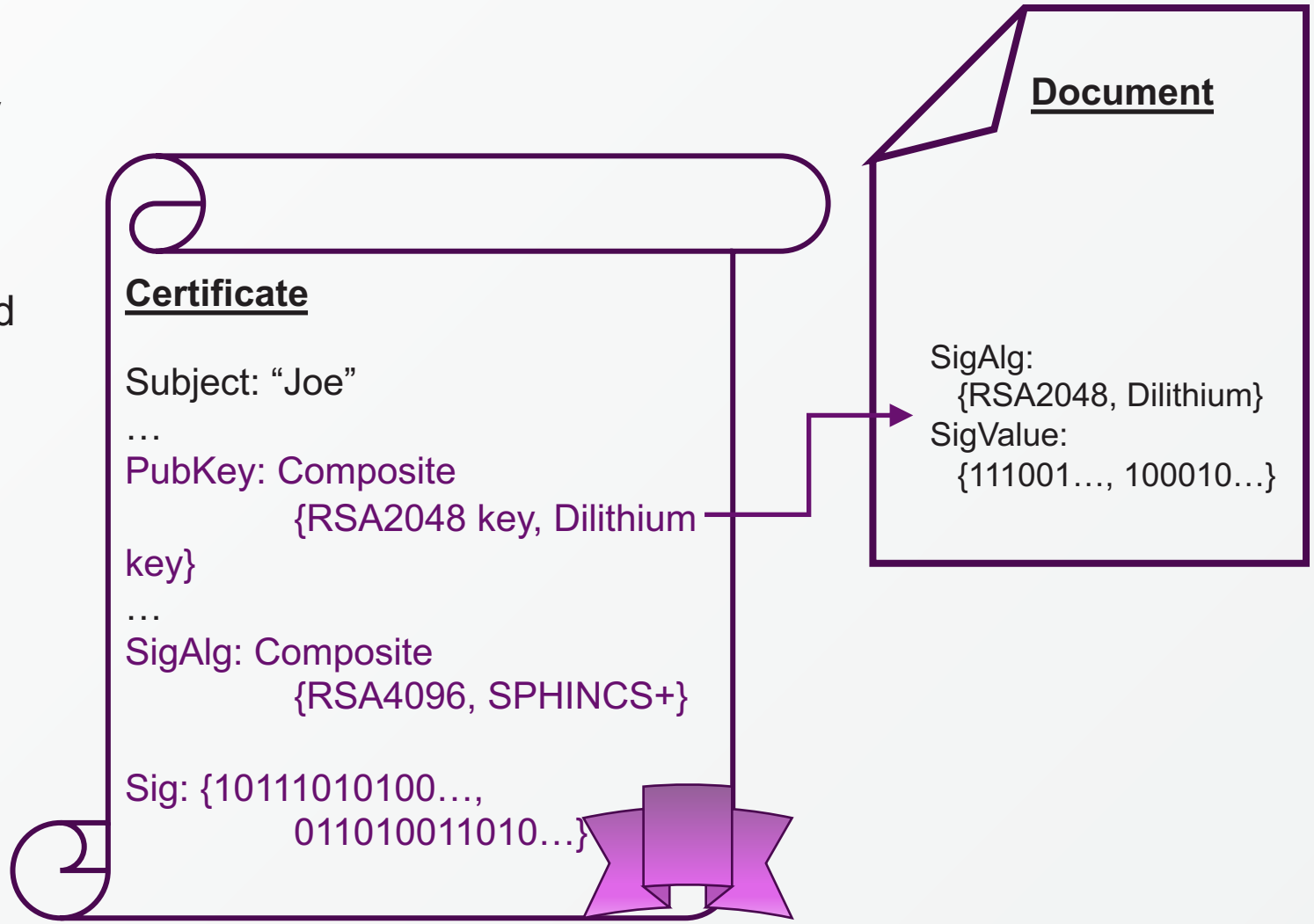
Composite Crypto

Composite Signatures and Keys for X.509 and CMS

Composite Signatures
What?

- Address quantum timeline uncertainty by extending public keys and signatures to have 2 or more “component” algorithms.
- Automatically applies to X.509, CMS, and any protocol that uses “ASN.1-based” signatures.





Composite Signatures
Why do it this way?

General

- **Simplicity:** list of SPKI / Signature, so inherits all flexibility of alg / param selection (for ex. vs pairwise alg OIDs).
- **Simplicity / Sec:** Alg:Composite" means that the "multiple-signature" logic is handled by crypto library, not protocol or application layer; harder for everyday programmers to get it wrong.

vs Multiple certs

- **Simplicity**: Fits into existing pubkey / sig fields in (any?) existing protocol.
- Binds multiple PubKeys / SigValues into one object.
  - **Sec**: easier to analyze, ex.: alg / key substitution attacks.
  - **Sec**: All component keys revoked together.
  - **Ops**: Still a single cert / private key to manage.
  - **Sec / Ops:** Single PKI chain/root.

Cert size

- **Objection**: *"PQ algs will blow certs up to ~50 kb!!!"*
  - This is unavoidable.
  - Solutions to this problem (ex.: certs contain hashes of key / sig data) would probably be made to the SPKI / SigValue objects, and therefore are orthogonal to this draft.

Composite Signatures
Open Design Questions

Verifier behavior for Unsupported and deprecated algs?

What if a client doesn't recognize a component AlgID?

What if RSA is deprecated, but is present as a component key?

- In single-key crypto, you reject.
- **Desired behaviour in composite:**
  proceed so long as "there are enough good algs left".
- Implementation is tricky.

Key Revocation:

- **Desired behaviour in composite:**
  If any component key is revoked, the entire composite key / cert is revoked.
- **Security Consideration:**
  Does each component key need to be checked individually for previous compromise?

Key Usage:

- This draft only covers signatures; we leave encryption keys as a future work.
- This draft applies the same KeyUsage to all component keys. "Dual-usage" or other kinds of non-homogenous KeyUsages are attractive, but makes security analysis very complex.

Composite Signatures
Implementation Gotchas

“Intrinsic” Message Digests

- Some sig algs (ex. RSA) expect to be given a digest to sign, while some have an intrinsic hash (ex. EdDSA) and expect to be given a full message.
- Some crypto libs will need re-architecture to do message digesting at sig verification layer, and not higher in the call stack.

Alg Parameters

- Currently, the AlgID inside the `PUBLIC-KEY` structure says *“I’m Composite”*
  rather than
  “I’m Composite with RSA-4096, EdDSA, and SPHINCS”
  (ie absent `PARAMS`) which means the AlgID by itself carries almost no information. Will that cause problems for any protocols?
- The `sa-CompositeSignature SIGNATURE-ALGORITHM` structure uses the `PARAMS` field to list component algs. RSASSA-PSS is the only existing alg that uses SigAlg `PARAMS`. Some implementations hard-code RSA-PSS as an exception and may not have generic support for SigAlg `PARAMS`.

