Selective End-To-End Data-Sharing in the Cloud

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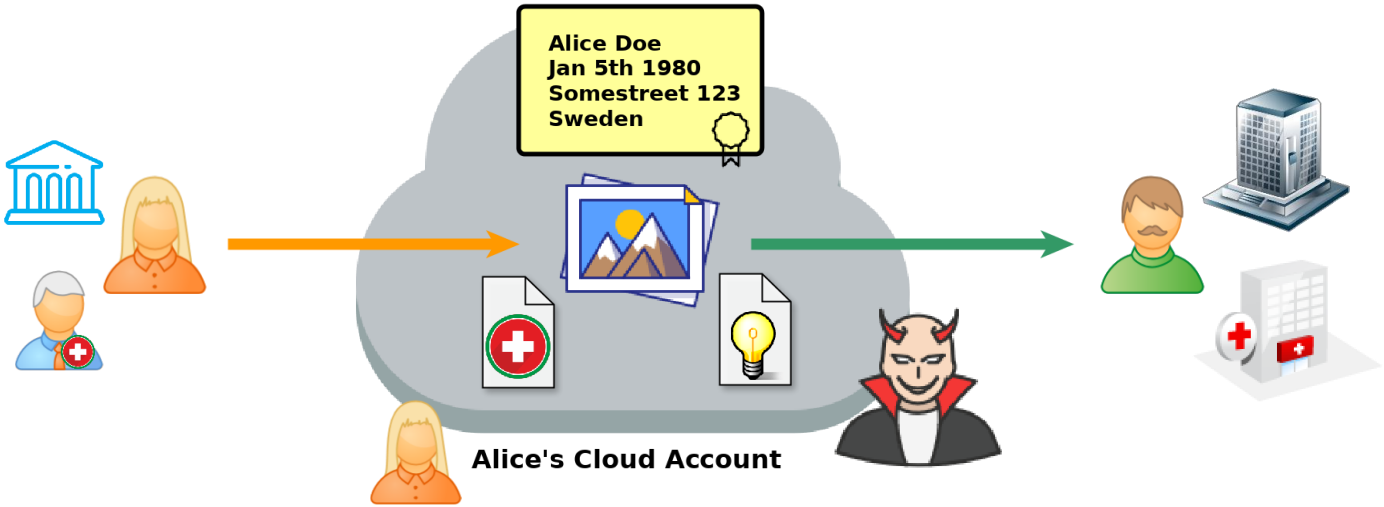
Data Sharing in the Cloud: Confidentiality

Cloud: Very convenient to share data (in plain)

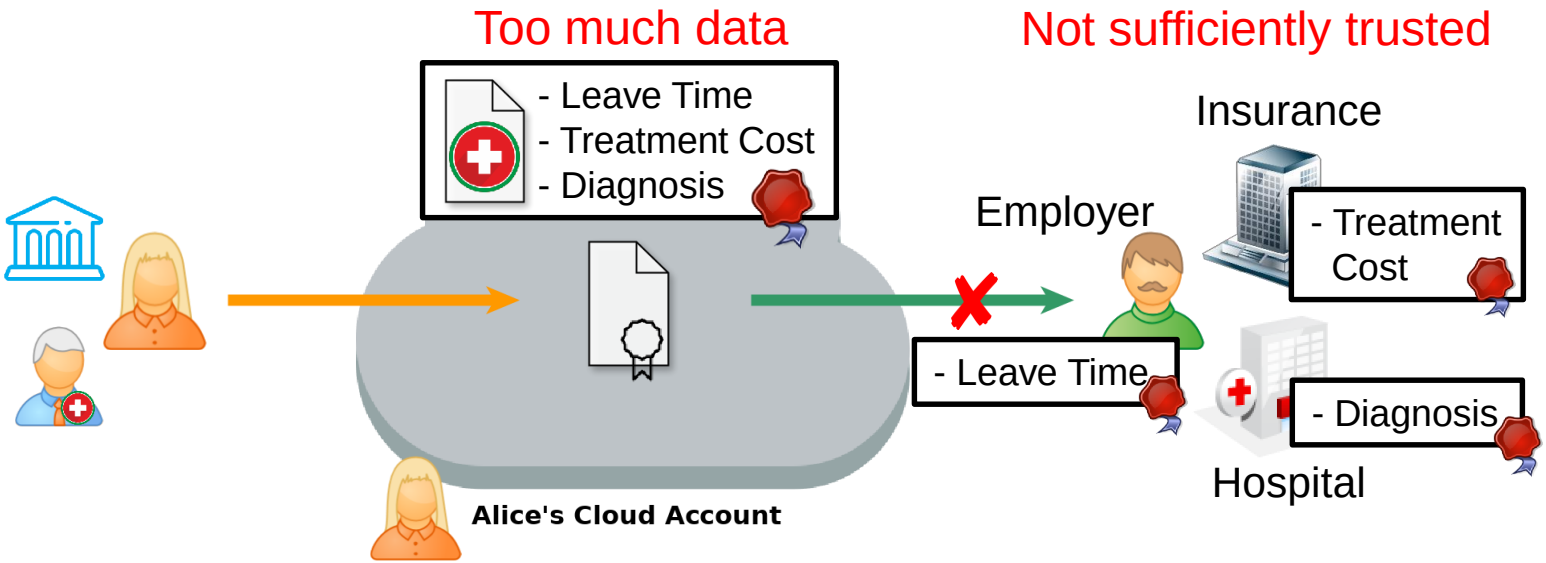


Cloud service

- Learns private data
- Trusted to not violate privacy?

➢ Need for end-to-end confidentiality

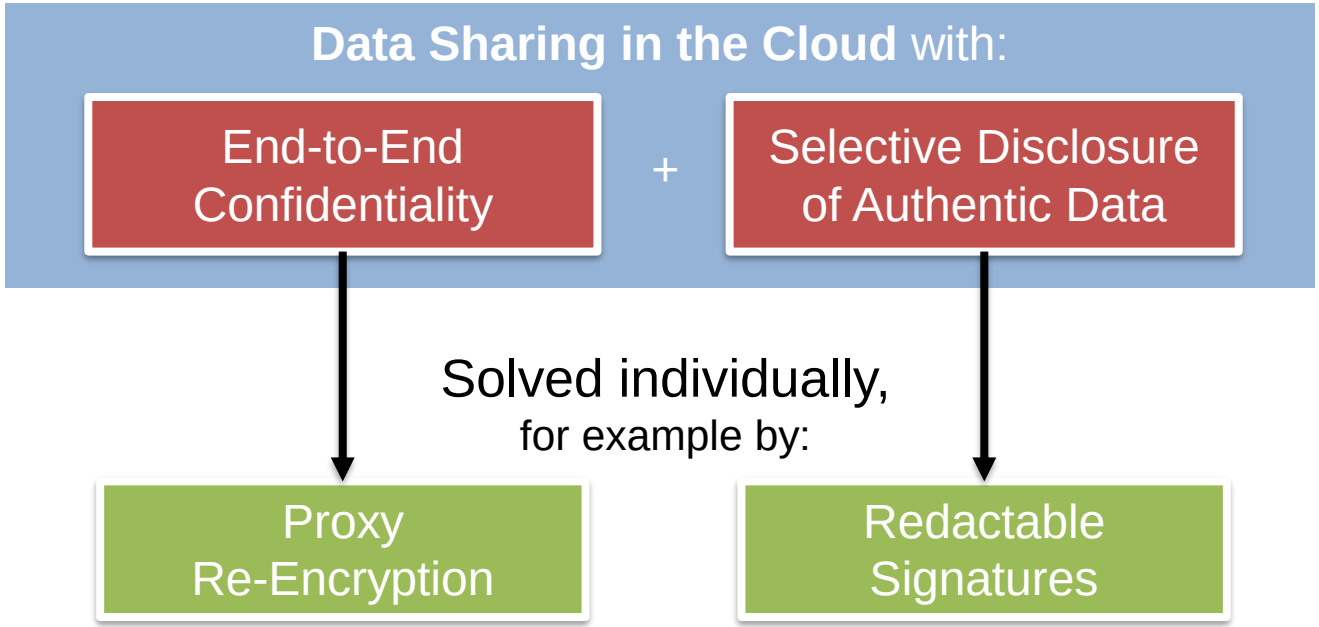
Data Sharing in the Cloud: Authenticity



- E.g. Digital signatures
- All or nothing

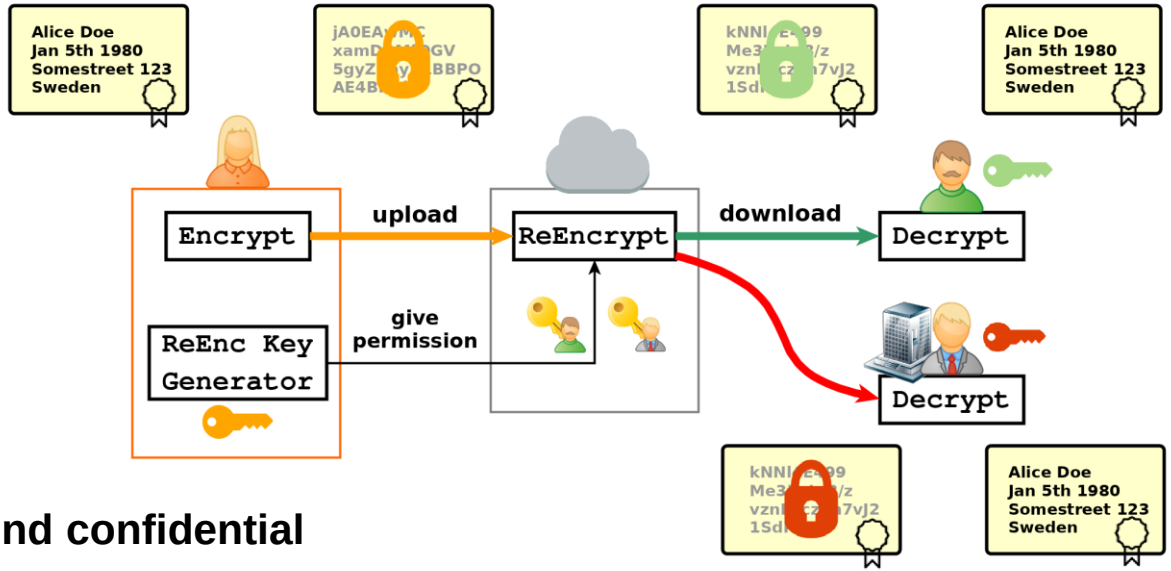
➢ Need for selective disclosure:
adapt data for each receiver

Ambition



➢ But **not trivial to combine**

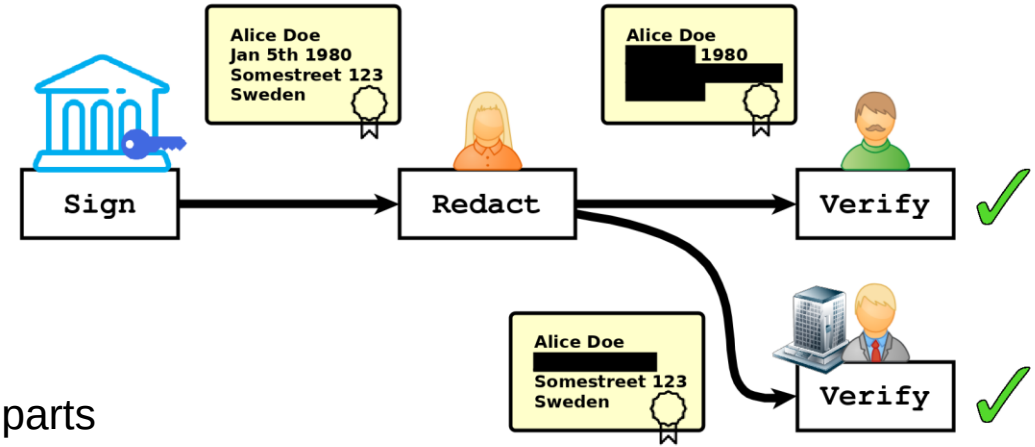
Background: Proxy Re-Encryption (PRE) [AFGH06]



- **End-to-end confidential**
- User: **no need to fully trust proxy**
- **User-centric:** Control through re-encryption key
- No duplicate data

[AFGH06] Giuseppe Ateniese, Kevin Fu, Matthew Green, Susan Hohenberger:
Improved proxy re-encryption schemes with applications to secure distributed storage.
ACM Trans. Inf. Syst. Secur. 2006

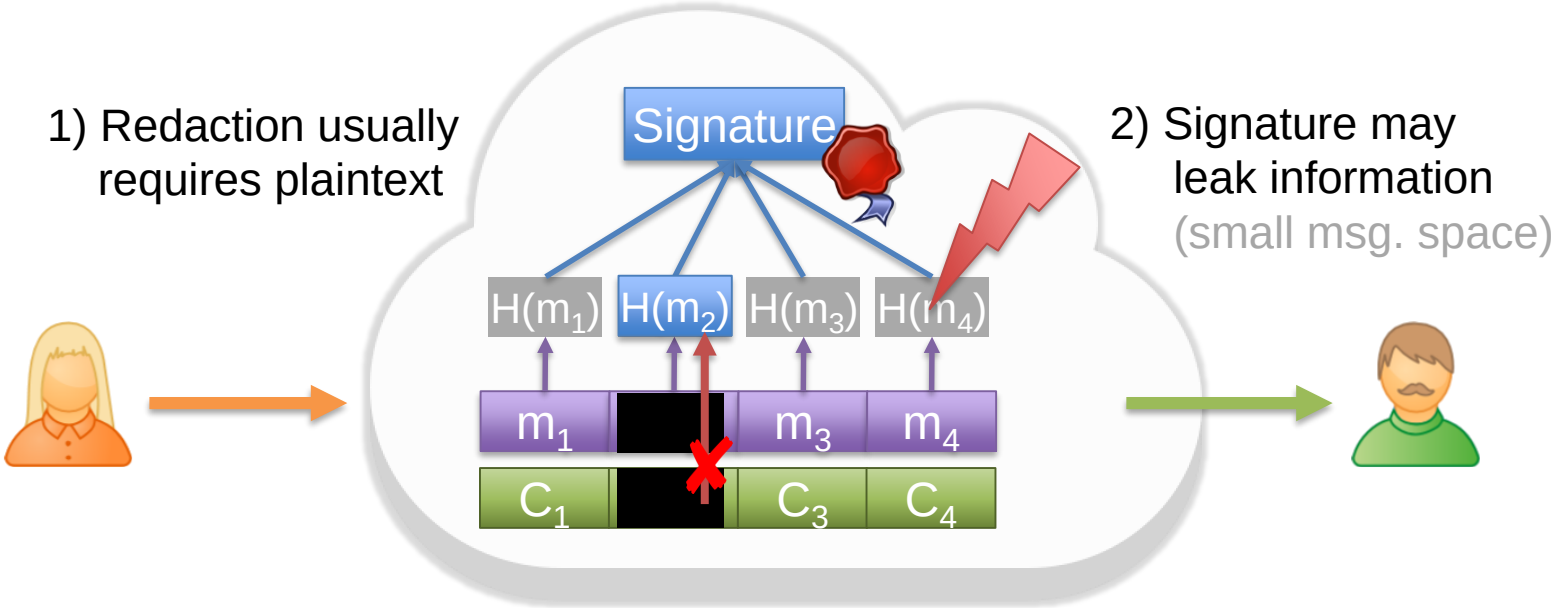
Background: Redactable Signatures (RS) [JMSW02]



- Black-out parts
- Signature stays valid for rest
- ➢ Selective disclosure

[JMSW02] Robert Johnson, David Molnar, Dawn Xiaodong Song, David A. Wagner: Homomorphic Signature Schemes. CT-RSA 2002

Combining: Naive Challenges



- **ReEncrypt and Redact conflict**
- **Privacy hard to get right**

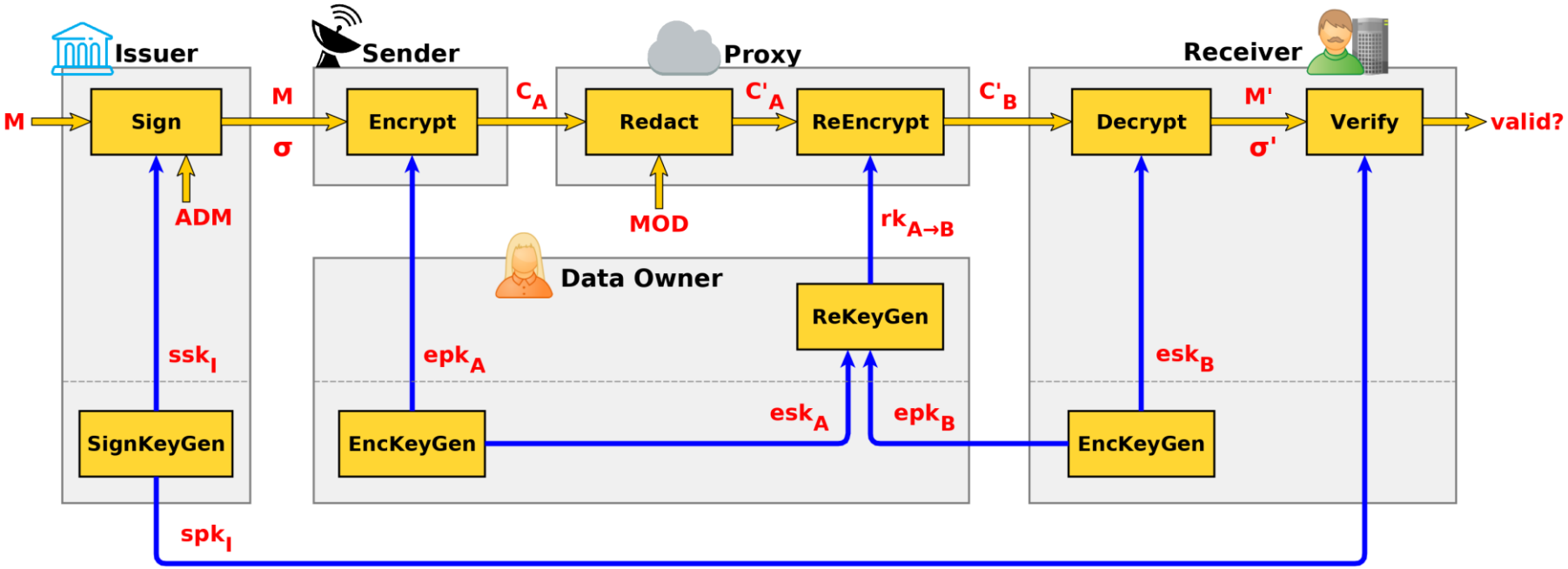
Our Contribution

Selective End-To-End Data Sharing (in the Cloud)

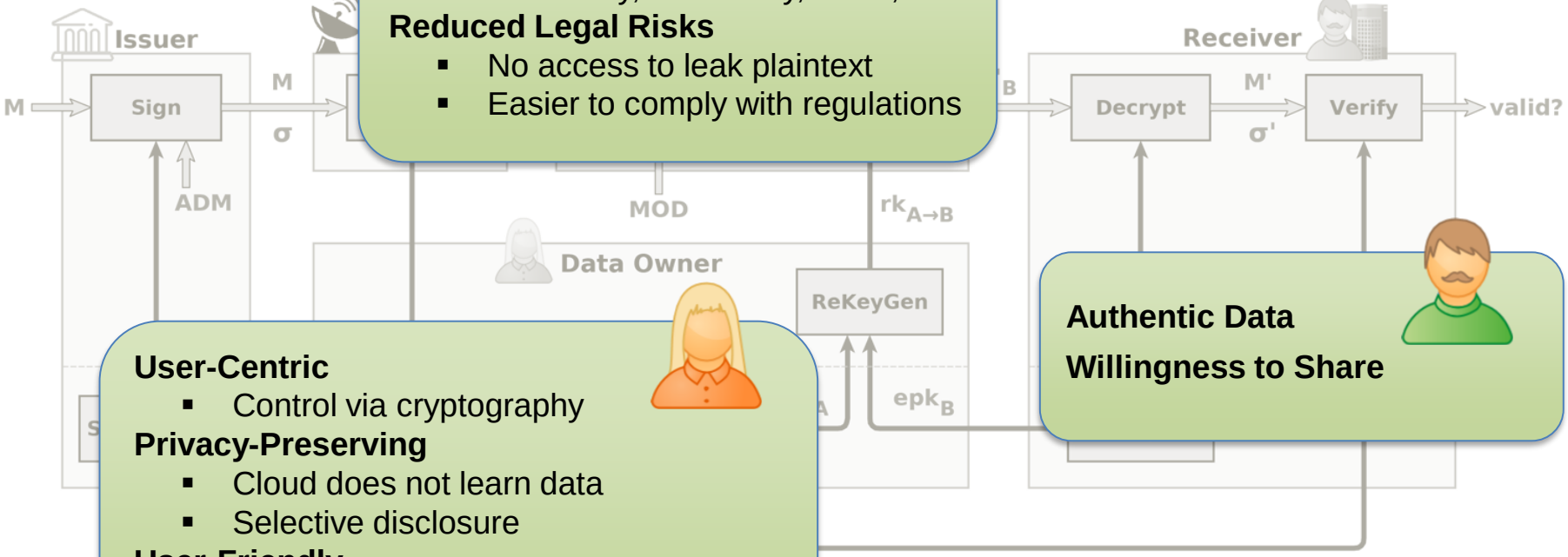
End-to-End Confidentiality + Selective Disclosure of Authentic Data

Model + Security Notions → Modular Instantiation → Three Implementations → Performance Evaluation

Model


Issuer
Sender
Proxy
Receiver
M
Sign
M
σ
Encrypt
C_A
Redact
C'_A
ReEncrypt
C'_B
Decrypt
M'
σ'
Verify
valid?
ADM
MOD
rk_A→B
Data Owner
ReKeyGen
ssk_I
epk_A
esk_B
esk_A
epk_B
SignKeyGen
EncKeyGen
EncKeyGen
spk_I

Benefits



Cloud-Benefits
- Scalability, availability, costs, ...

Reduced Legal Risks
- No access to leak plaintext
- Easier to comply with regulations

User-Centric
- Control via cryptography

Privacy-Preserving
- Cloud does not learn data
- Selective disclosure

User-Friendly
- Cloud: available, less maintenance, ...
- Single place to manage data/access

Authentic Data

Willingness to Share

Security Notions

- **Challenge**: Different/more data flows through system
  - E.g.: distinguish based on signature added to ciphertext
  - ➢ Adapt and combine notions from PRE and RSS

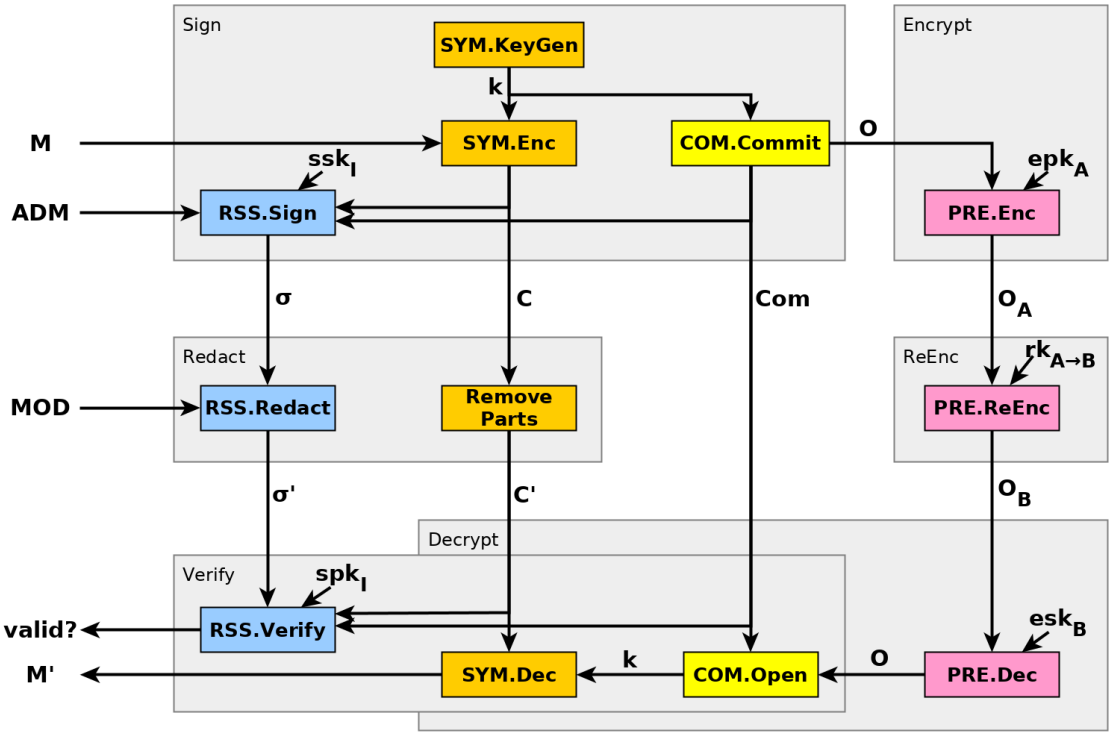
- **Unforgeability**
  Infeasible to create valid signature for given message without signing key

- **Receiver-Privacy**
  Receivers should not learn information on parts that were redacted

- **Proxy-Privacy**
  Proxy should not learn anything about plain data

- **Transparency**
  Infeasible to decide if parts of message were redacted

Modular Instantiation



- Sym. encrypt then sign
- Redact on sym. ciphertexts
- Commit to sym. key
- Share sym. key via PRE

- **Enables tailoring**: Choose underlying crypto according to app. needs

➢ **Proven secure**

Security Assumptions

- **Unforgeability**
  Infeasible to create valid signature for given message without signing key

  If: **COM** binding
  RSS unforgeable

- **Receiver-Privacy**
  Receivers should not learn information on parts that were redacted

  If: **RSS** private

- **Proxy-Privacy**
  Proxy should not learn anything about plain data

  If: **RSS** unforgeable
  PRE IND-RCCA secure
  COM hiding
  SYM IND-CPA secure

- **Transparency**
  Infeasible to decide if parts of message were redacted

  If: **RSS** transparent

➢ Only relies on std. notions of underlying schemes

Three Implementations

Common	PRE	Chow et al. [CWYD10]	3072bit
	SYM	AES	128bit
	COM	Hash Commitment (SHA3)	256bit
	Hash	SHA3	256bit
Impl. 1: Sets, CL	RSS	Derler et al. [DPSS15, Scheme 1]	
	Accu.	CL [CL02] (RSA)	3072bit
	DSS	RSA	3072bit
Impl. 2: Sets, DHS	RSS	Derler et al. [DPSS15, Scheme 1]	
	Accu.	DHS [DHS15] (ECC)	384bit
	DSS	ECDSA	256bit
Impl. 3: Lists, CL	RSS	Derler et al. [DPSS15, Scheme 2]	
	Accu.	CL [CL02] (RSA)	3072bit
	DSS	RSA	3072bit

128bit security

Different data structures
- Sets
- Lists

Different accumulators
- CL (RSA)
- DHS (ECC)

[CWYD10] Sherman S. M. Chow, Jian Weng, Yanjiang Yang, and Robert H. Deng. AFRICACRYPT 2010

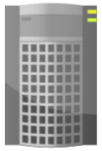
[DPSS15] David Derler, Henrich C. Pöhls, Kai Samelin, and Daniel Slamanig. ICISC 2015

[CL02] Jan Camenisch, Anna Lysyanskaya. CRYPTO 2002

[DHS15] David Derler, Christian Hanser, and Daniel Slamanig. CT-RSA 2015

Performance Evaluation

- **Platforms**



PC: Intel i7-4790 3.6 GHz (2014)

Mobile phone: Pixel 2 (2017)

- **Methodology**
  - Different number of parts & size per part
  - Redact half of parts before re-encrypting
  - For each of three implementations

- **Examples**:

Impl 1.: for sets with CL accumulator

		Sign	Enc	Redact	ReEnc	Dec	Verify
5 pages, each 200kB	PC	23	1	6	1	3	16
	Phone	177	12	73	6	28	106
50 x-rays, each 10MB	PC	1871	1	393	1	749	1100

(in milliseconds)

➢ Practical efficiency

Summary: Key Messages

- **Selective End-to-End Data-Sharing**
  - End-to-end confidentiality and
  - Selective disclosure of authentic data
  - ➢ New model and security notions
- **Modular Instantiation**
  - Combines proxy re-encryption and redactable signatures
  - ➢ Proven secure
- **Performance Evaluation** of three implementations
  - ➢ Practical efficiency

Thank you! Any Questions?