BLS signatures, hashing to curves, and more: Dispatches from the IETF

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Stanford

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People

- BLS signatures authors:

  Sergey Gorbunov, Hoeteck Wee, Zhenfei Zhang

- Hash-to-curve authors:

  Armando Faz-Hernández, Sam Scott, Nick Sullivan, Chris Wood

- Folks whose feedback has been crucial:

  Björn Haase, Dan Harkins, Leo Reyzin,

  Michael Scott, Shoko Yonezawa

Why standardize? +philosophy$^{\epsilon}$

The obvious one: interoperability

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Invalid curve attack [BMM00]

Mallory		**Bob**
P of order ℓ (on the *wrong curve*!)		secret $\beta \in \mathbb{Z}_q$
	P →	
		$Q = P^\beta$
	← Q	
Extract β mod ℓ		

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A forcing function for pragmatism

➔ Users will ignore bad or confusing standards...
...so make choices (but only the good ones)

1. Standardizing advanced crypto with the IETF

2. BLS signatures, hash-to-curve, and more

Standardizing advanced crypto with the IETF: the CFRG

Internet Engineering Task Force

"We believe in rough consensus and running code."

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➔ can be incorporated by "Standards Track" RFCs, e.g., TLS 1.3 incorporates the curve25519 RFC

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CFRG has an active mailing list, too!

➔ `https://irtf.org/cfrg`

CFRG standardization process—theory

Per [RFC5743]:

1. CFRG prepares a new “internet draft”
2. IRTF reviews it
3. IESG reviews it
4. RFC Editor prepares and publishes it

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   fine-toothed combing

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6. hand off document to IRTF, etc.

CFRG standardization process—how long does it take?

Examples (from `https://datatracker.ietf.org`):

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  12 drafts in total
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  - RFC Editor queue took 3 months
- BLS signatures (WIP): 6 months so far
  - 2 drafts so far
- Hash-to-curve (WIP): 17 months so far
  - 5 drafts so far

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- ➔ Don't patent crypto.

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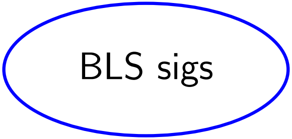
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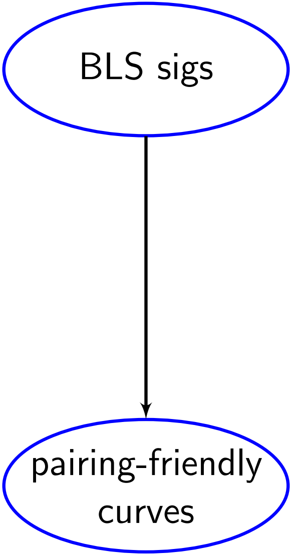
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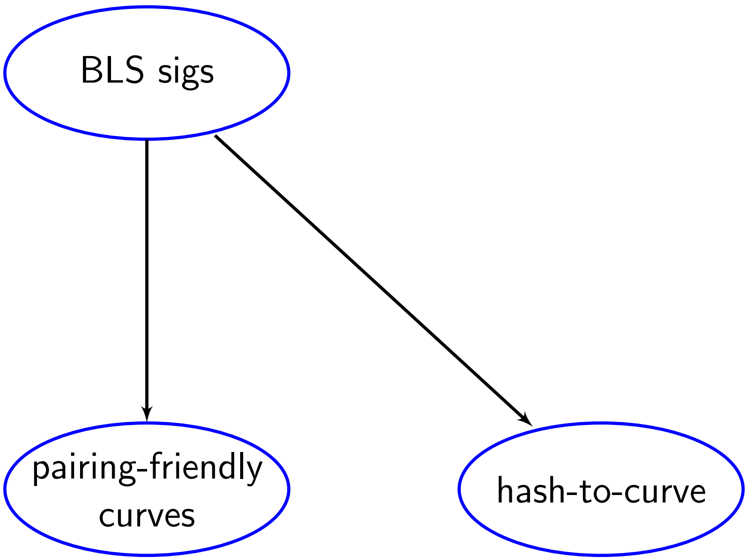
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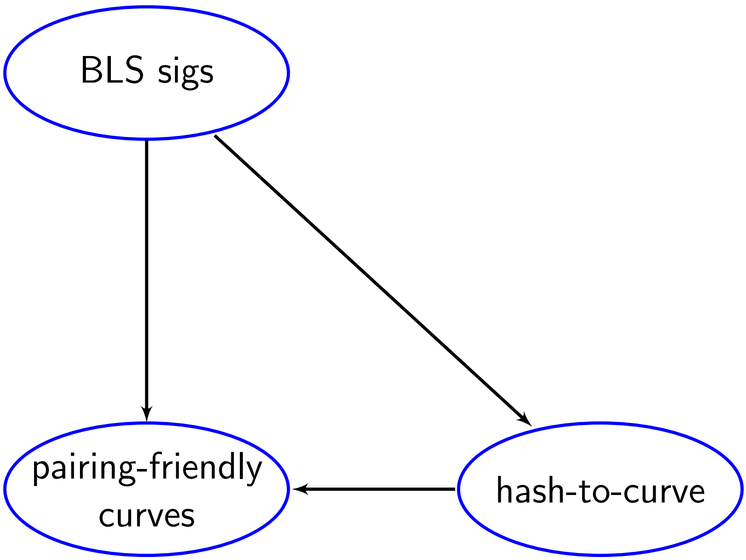
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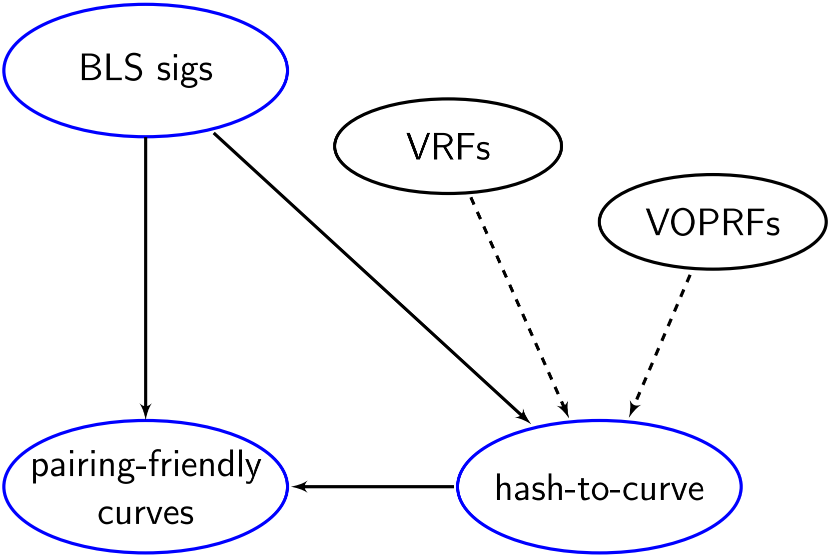
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Pairing-friendly elliptic curves

A pairing-friendly elliptic curve defines:

- $\mathbb{G}_1 \subseteq E_1(\mathbb{F}_1)$ and $\mathbb{G}_2 \subseteq E_2(\mathbb{F}_2)$ of prime order q generated by P_1 and P_2, respectively
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Hashing to elliptic curves (in constant time)

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$H(\mathsf{msg}) \to \mathbb{G}$ [BCIMRT10,FFSTV13]

$$Q_1 = \mathsf{MapToCurve}(\mathsf{HashToField}_1(\mathsf{msg}))$$
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Rogue key attack

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Since $\prod pk_i = P_2^x$, Mallory can forge a multi-signature for any msg:

$$e(H(\text{msg}), \prod pk_i) = e(H(\text{msg})^x, P_2)$$

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`https://github.com/cfrg/draft-irtf-cfrg-bls-signature`
`https://github.com/cfrg/draft-irtf-cfrg-hash-to-curve`
`https://bls-hash.crypto.fyi`