“Hades” Design Strategy for MPC/SNARKs/STARKs/Picnic/…

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Research of New Designs

Research of new designs is motivated by recent progress in practical applications of

- secure multi-party computation (MPC)
- zero-knowledge proofs (ZK)
- (post-quantum) signature scheme
- SNARKs and STARKs

where primitives from symmetric cryptography are needed and where linear computations are essentially "free":

Performance of symmetric-key algorithms influences the protocols efficiency.
“Hades” Strategy

How to reduce number of non-linear operations?

(a) SPN

(b) P-SPN

(c) “Hades” strategy
HadesMiMC (in $\mathbb{F}_p$ and/or in $\mathbb{F}_{2^n}$)
Experimental Results

- **PQ-Signature \((\mathbb{F}_{2^n} \text{ case})\):**
  
  better than LowMC: smaller signature size (777 bits vs 1140 bits) and 10x faster;

- **MPC \((\mathbb{F}_p \text{ case})\):**
  
  better than MiMC and Legendre PRF (the current best schemes for this application);

- **SNARKs/Bulletproof \((\mathbb{F}_p \text{ case})\) and STARKs \((\mathbb{F}_{2^n} \text{ case})\):**
  
  on-going work: 5-10x less constraints per bit than e.g. the recently introduced Pederson hash.