“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

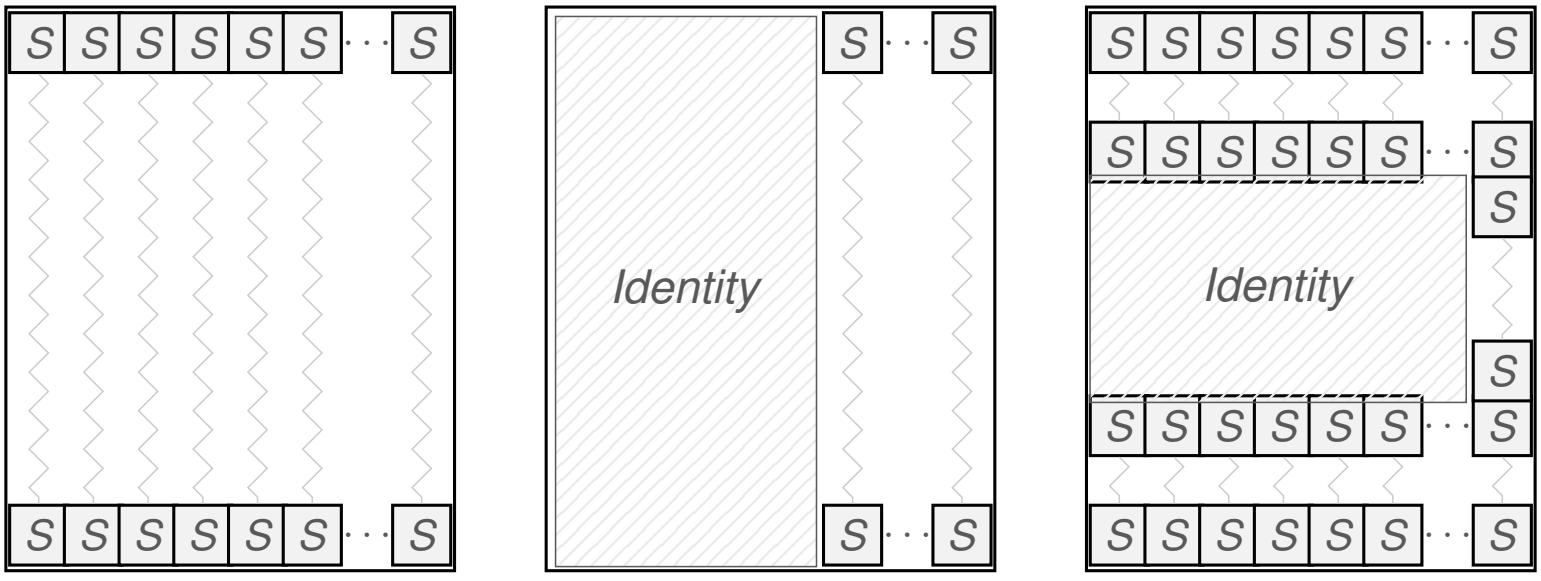
- secure multi-party computation (MPC)
- zero-knowledge proofs (ZK)
- (post-quantum) signature scheme
- SNARKs and STARKs

where *primitives from symmetric cryptography are needed* and where linear computations are essentially “free”:

Performance of symmetric-key algorithms influences the protocols efficiency.

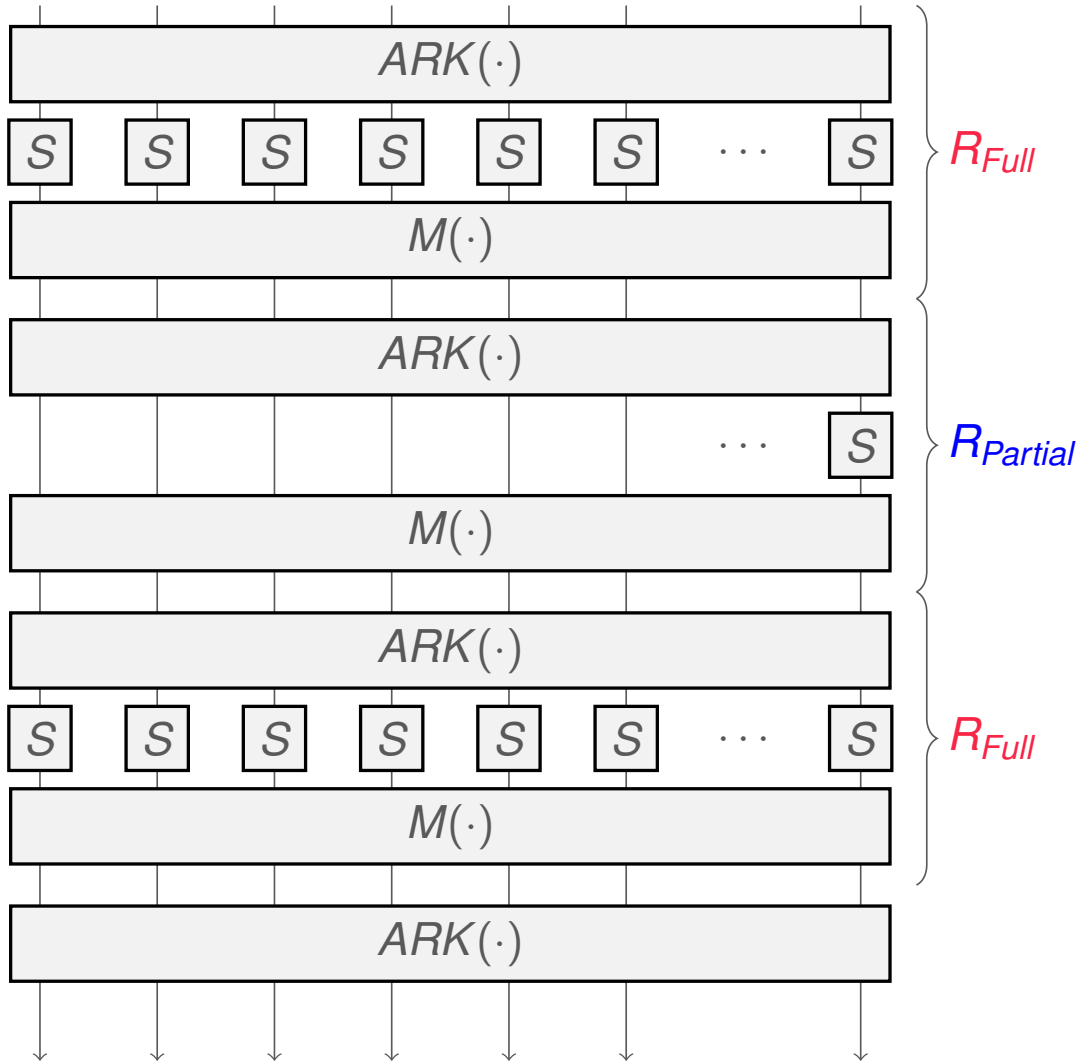
“Hades” Strategy

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 ($\mathbb{F}_{2^n}$ case):

  better than LowMC: smaller signature size (777 bits *vs* 1140 bits) and 10x faster;

- MPC ($\mathbb{F}_p$ case):

  better than MiMC and Legendre PRF (the current best schemes for this application);

- SNARKs/Bulletproof ($\mathbb{F}_p$ case) and STARKs ($\mathbb{F}_{2^n}$ case):

  on-going work: 5-10x less constraints per bit than e.g. the recently introduced Pederson hash.