Ensemble Approach to Failure-Resistant Password-Based Key Derivation Functions

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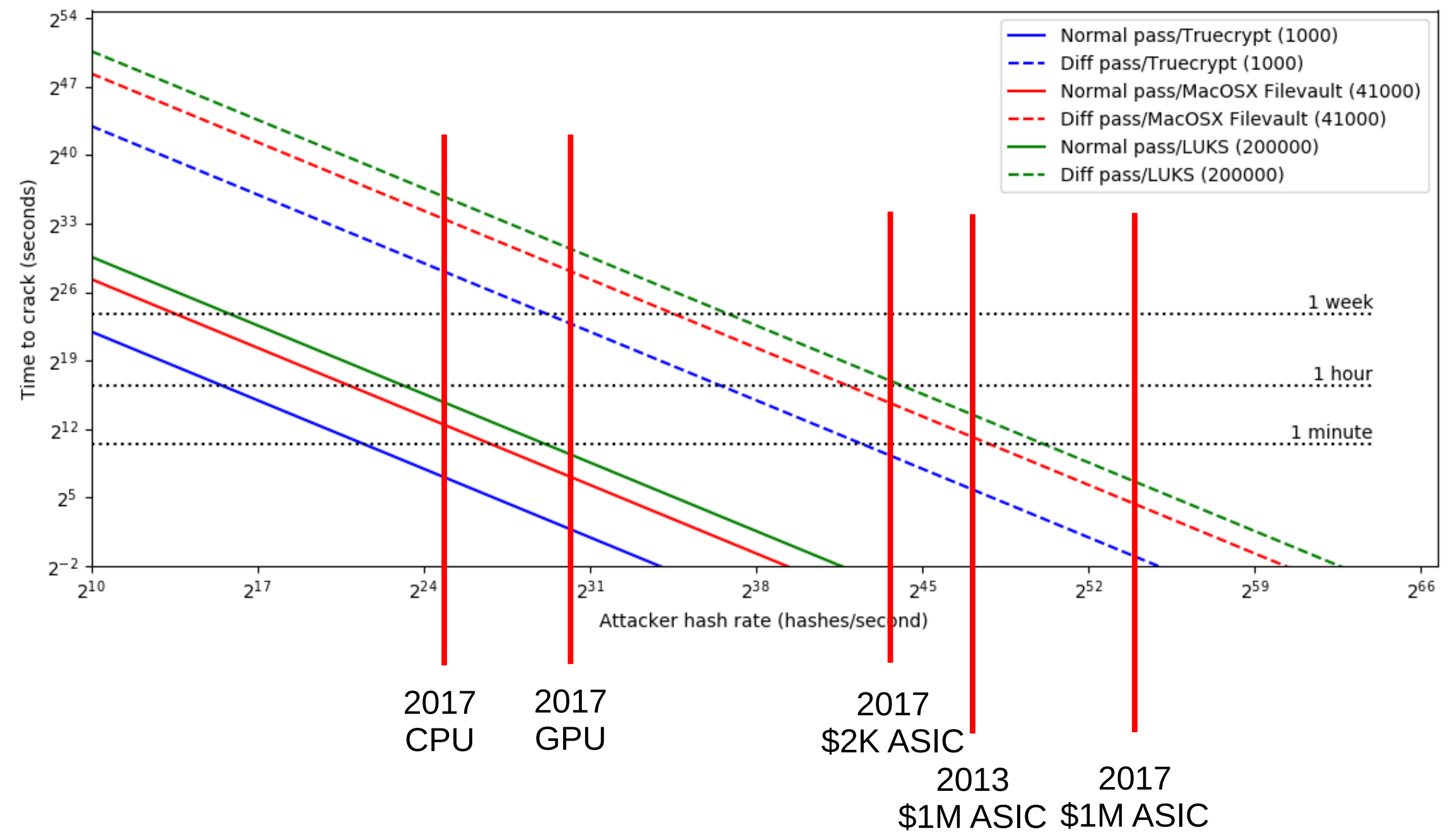
Motivation



- PBKDF2[13] (most widespread PBKDF) relies on simple, repeated hash invocations to increase password key derivation time for attackers
- Bitcoin provided a financial incentive to create high throughput, efficient hashing ASICs
- Passwords can now be guessed 10^6 to 10^{10} times faster using ASICs than CPUs of similar price
- State-of-the-art PBKDFs (e.g. scrypt[8], argon2[4]) improve by utilizing memory, but are still vulnerable to ASIC attacks [1]

Goal

Minimize efficiency gains of specialized hardware vs. honest user's device for key derivation

Properties

- **Resource consumption model** - plugins consume user-specified resources (e.g. memory, CPU, disk)
- **Failure resistance** - Hash construct guarantees security as good as strongest hash; failures in resource-consuming plugins limited to a single round
- **Optimization for specific platform** - Plugin and sponge construction designed for anti-pipelining and anti-parallelism

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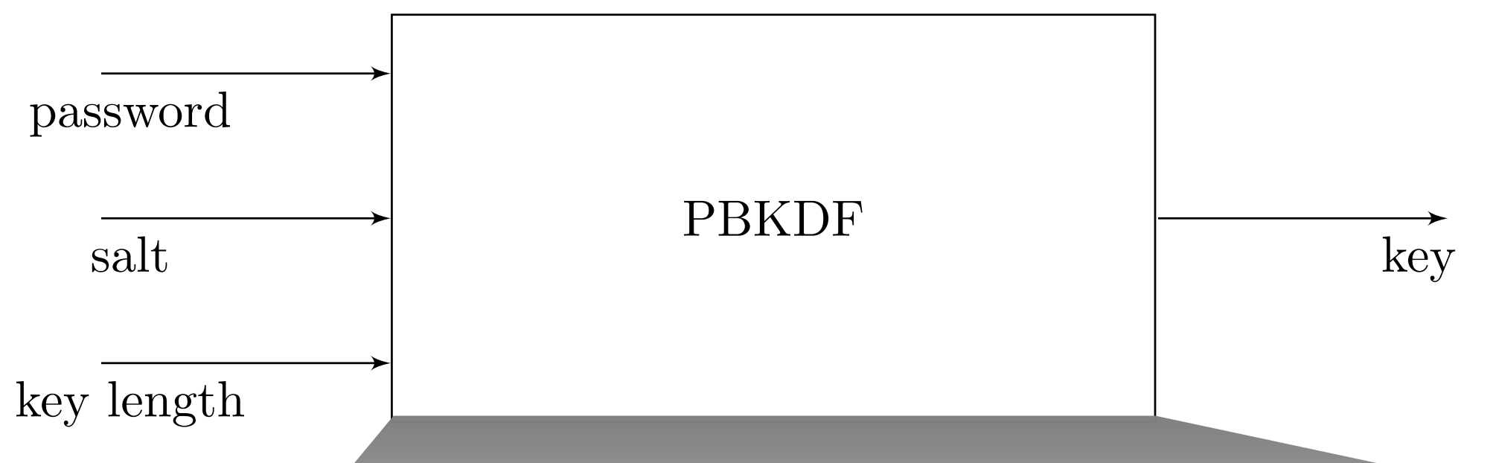
Construction

PBKDF Definition



Example Plugins

Resource	Plugin
Memory	scrypt[8], argon2d[4]
CPU	Hash functions
Chip/rate limit	TPM
Cache	argon2d[4]
Network	Pythia[6]
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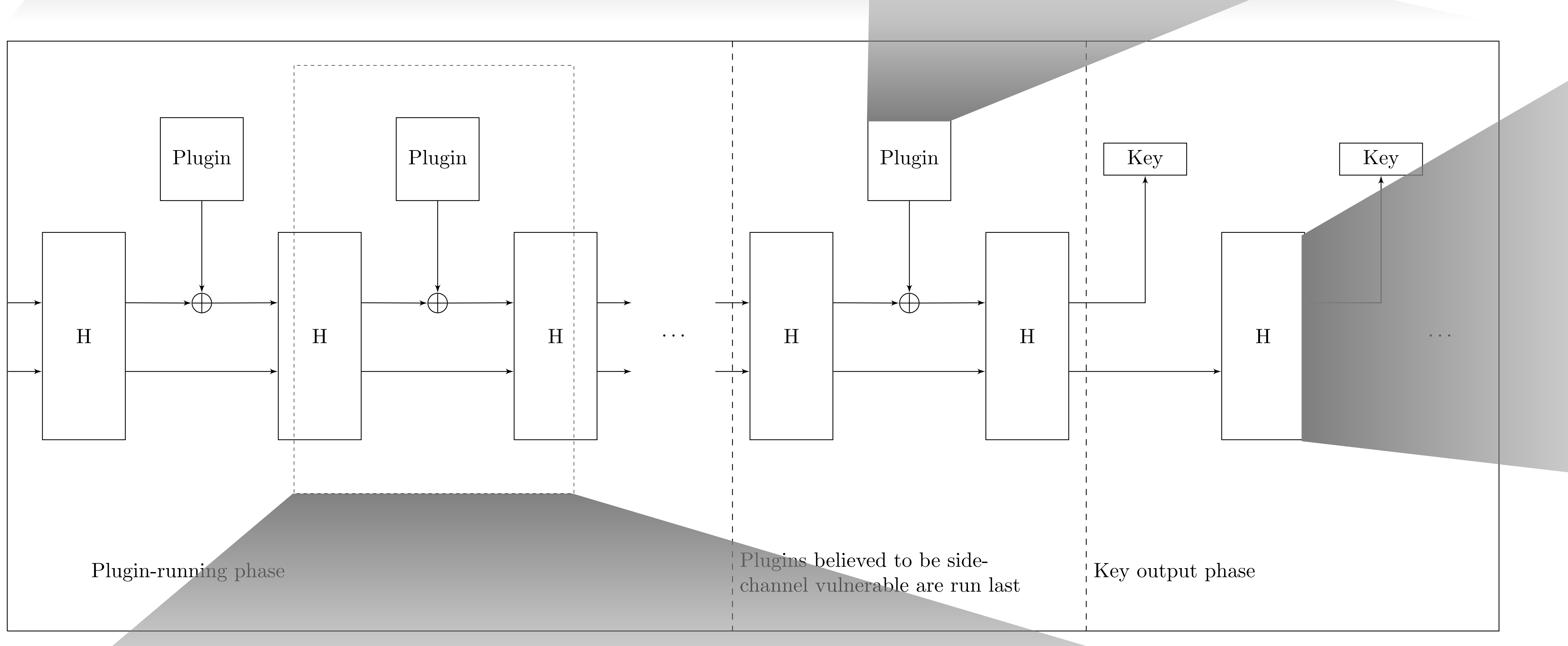

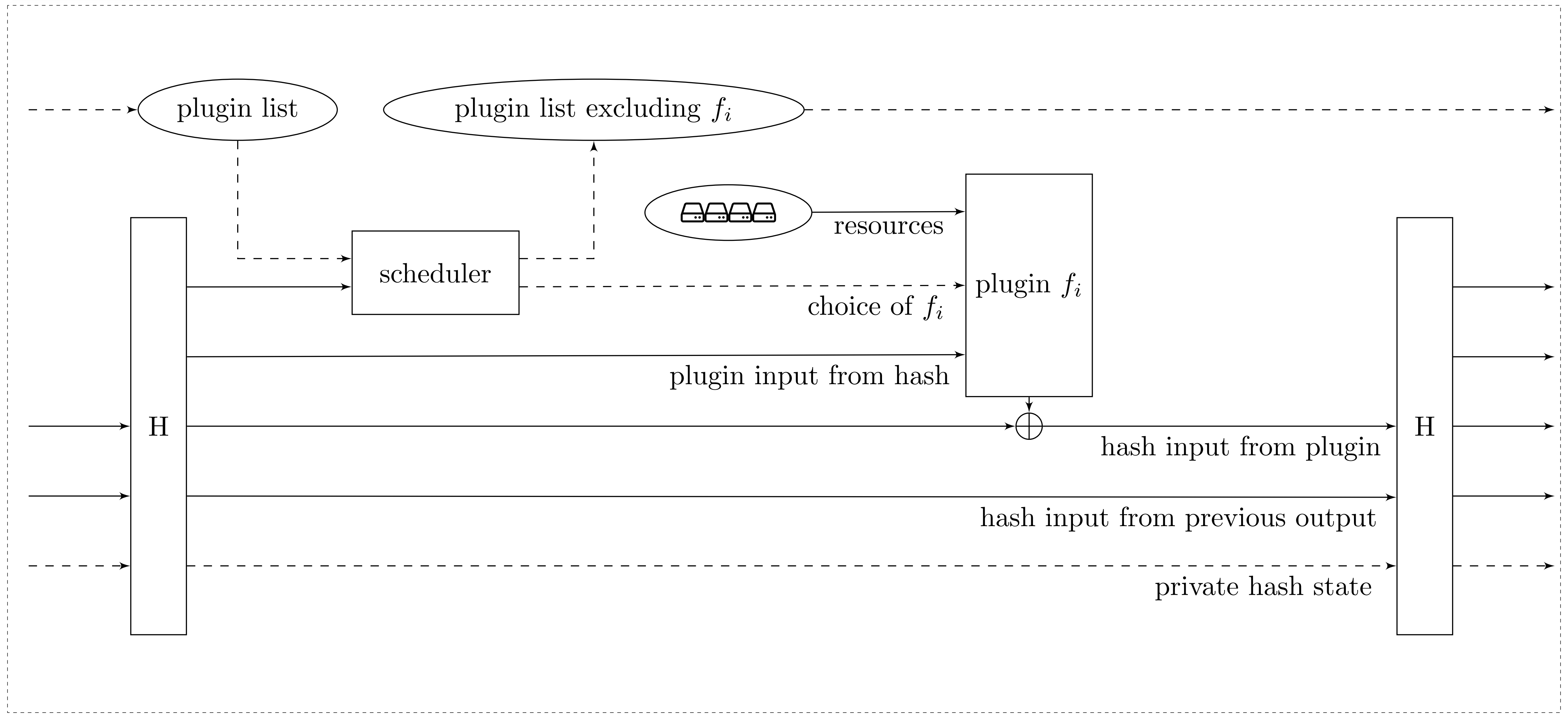

Example Hash Functions

Hash	Adopted by
SHA2-512 [11]	US/NIST + EU/NESSIE
Whirlpool [9]	Global/ISO + EU/NESSIE
SHA3-512 [12]	US/NIST
Steebog-512 [5]	Russia/FAPSI
BLAKE2-512 [2]	Open source projects
ChaCha20/Poly1305 [7]	Open source projects
AES/Poly1305 [3]	Open source projects
MD6 [10]	Open source projects
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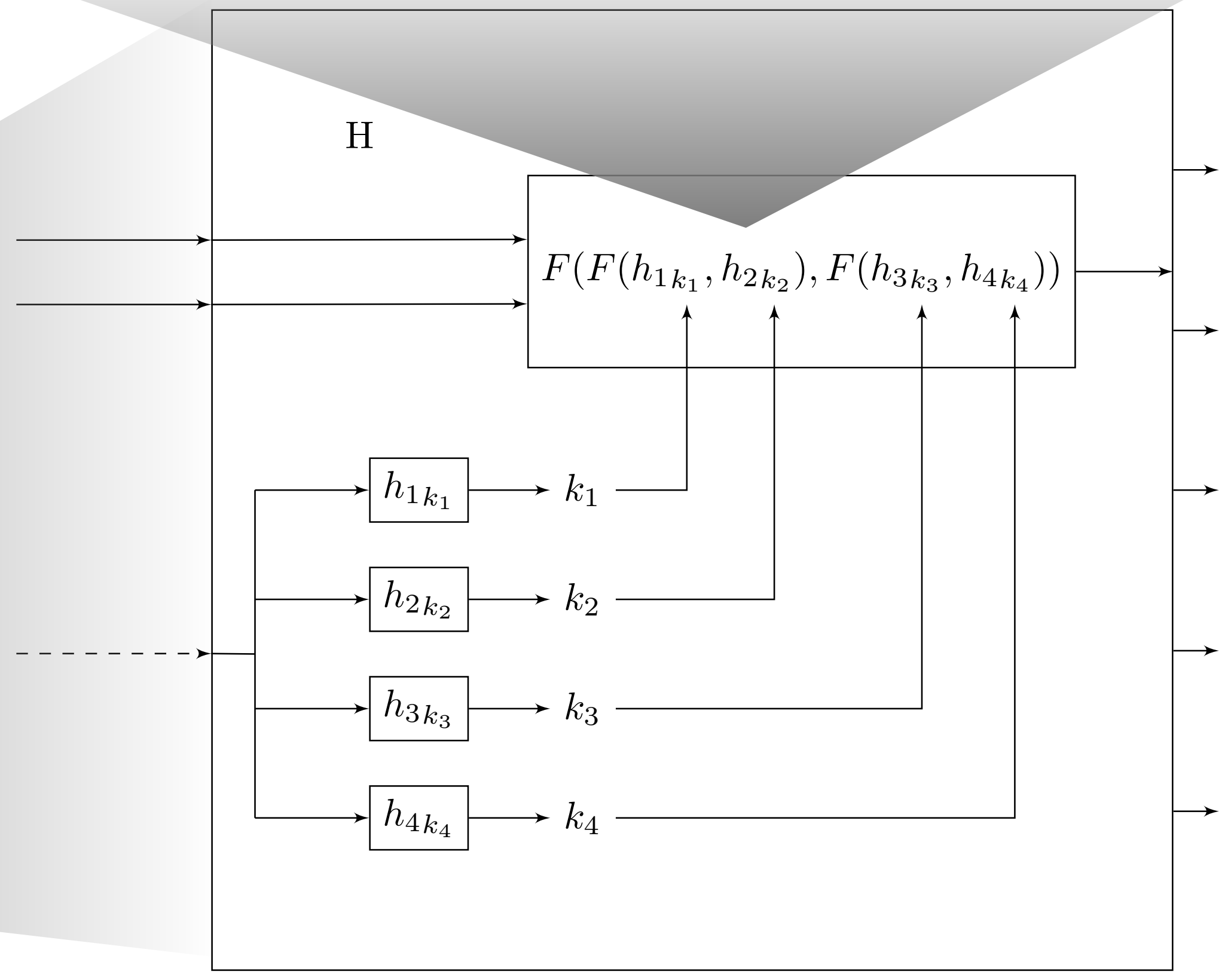

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