More engineering considerations for the SHA-3 hash function

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“Table lookup: A huge security problem”
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- Side channel attacks only apply when a secret is involved (e.g. KDF, HMAC). Many applications do not hash secret information.
- There are other side channels, e.g., power. Modular additions are hard to protect against DPA.
- An implementation can be protected, at some cost, if required.
“Table lookup: A huge security problem”
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- Expect second AES competition in 2012!
“[AES-based designs are] insecure on CPUs without AES instruction”
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- Bitsliced implementations resist cache-timing attacks.
- They can actually be faster than table-based implementations.
“Recommendation: avoid AES round function”
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- Using AES also has advantages:
  - Security analysis
  - Confidence
  - Implementation
- ARX-based vs. AES-based?
  - No indication that one is better than the other.
“Recommendation: optimize for 64-bit (rather than 32-bit) performance”
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- “The low end does not go away” (Bruce Schneier)
- Extreme optimisations for one platform (Intel Core2) often hurts other platforms.
- 32-bit optimised primitives are still fast on 64-bit, but not the other way around.
“Recommendation: also evaluate implementation without XMM registers”
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➢ Also pay attention to performance on 32-bit and 8-bit machines.
“Cannot use multiple cores”
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- Applications that cannot use multiple cores typically process only small messages.
- Some applications *can* use multiple cores, and those sometimes hash very long messages.
“SHA-256 (20 c/B) is a performance problem”
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- Why is it a problem?
  - Signatures? No.
  - HMAC? No, use fast dedicated MAC.
  - . . . ?

- “The security provided by an algorithm is the most important factor in the evaluation.” (NIST)
And now for something completely different...
Sponges are bad

- Can’t fit into small state after block.
- No key schedule to compute in parallel.
- No compression function; nothing reusable.
- Pseudo-collisions/preimages are easy to find.
- Large state $\rightarrow$ slow full diffusion.
- Sponges are recent; not well studied.
Sponges are good

- Immediate use of block saves space.
- Very fast diffusion; extra speed.
- No counters.
- Not many sponges broken so far.
- Sponges are recent; they improve over other designs.
Disclaimer

- Most of us are involved with one or more SHA-3 candidates.
  - From 15 different teams in total.
- Every team has different priorities.
- Every design was made to fit those.
  - Not the other way around.

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