SHA-3 update

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### SHA-3 Competition

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>11/2/2007</td>
<td>SHA-3 Competition Began.</td>
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<td>10/2/2012</td>
<td>Keccak announced as the SHA-3 winner.</td>
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Secure Hash Algorithms Outlook

- SHA-2 looks strong.
- We expect Keccak (SHA-3) to co-exist with SHA-2.
- Keccak *complements* SHA-2 in many ways. Keccak is good in different environments.

*Keccak is a sponge - a different design concept from SHA-2.*
Sponge Construction

Sponge capacity corresponds to a security level: $s = c/2$. 
SHA-3 Selection

► We chose Keccak as the winner because of many different reasons and below are some of them:
  ► It has a high security margin.
  ► It received good amount of high-quality analyses.
  ► It has excellent hardware performance.
  ► It has good overall performance.
  ► It is very different from SHA-2.
  ► It provides a lot of flexibility.
Keccak Features

- Keccak supports the same hash-output sizes as SHA-2 (i.e., SHA-224, -256, -384, -512).
- Keccak works fine with existing applications, such as DRBGs, KDFs, HMAC and digital signatures.
- Keccak offers flexibility in performance/security tradeoffs.
- Keccak supports tree hashing.
- Keccak supports variable-length output.
Support for variable-length hashes

Considering options:

- One capacity: \( c = 512 \), with output size encoding,
- Two capacities: \( c = 256 \) and \( c = 512 \), with output size encoding,
- Four capacities: \( c = 224 \), \( c = 256 \), \( c = 384 \), and \( c = 512 \) without output size encoding (preferred by the Keccak team).

Input format for SHA-3 hash function(s) will contain a padding scheme to support tree hashing in the future.

NIST will standardize 224, 256, 384 and 512 alternative hashes to the 4 hash sizes of SHA-2.
Other Features for standardization considerations

► NIST will look into the possibility of standardizing another authenticated encryption scheme using Keccak permutation (the Duplex mode) in the future.

► NIST will also look into the possibility of using smaller permutations of Keccak for lightweight applications in the future!
Comments

NIST’s Crypto Toolkit:  

Thanks to the security area directors for this presentation opportunity!

Any comments/questions?
Discussion mailing list: Hash-forum@nist.gov
Comments for NIST: internal-hash@nist.gov