Update on NIST Post-Quantum Cryptography Standardization

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Where we are?

Dec 2016 – NIST Announcement of Call for Proposals on post-quantum cryptography

- Public key encryption
- Key agreement
- Digital signature

Preliminary deadline:
- Sept. 30, 2017

Submissions received by this date will be reviewed for completeness and we will notify the submitters of any deficiencies by the end of October.

Final Deadline:
- November 30, 2017
Overview of NIST call for proposals

Requirements for Submission Packages
- Cover sheet, supporting documentation, media, IP statement

Minimum Acceptability Requirements
- Scope – Public-key crypto algorithms for digital signature, encryption, key establishment
- Basic requirements for each function

Evaluation Criteria
- Security definitions, targeted security strength (classical and quantum), cost and performance, etc.
Post-Quantum Cryptography and NIST Standards

NIST Crypto standards

Public key based
- Signature (FIPS 186)
- Key establishment (800-56A/B/C)

Symmetric key based
- AES (FIPS 197)
- TDEA (800-67)
- Modes of operations (800 38A-38G)
- SHA-1/2 (FIPS 180) and SHA-3 (FIPS 202)
- Randomized hash (800-106)
- HMAC (FIPS 198)

Guidelines
- Hash usage/security (800-107)
- Transition (800-131A)
- Key generation (800-133)
- Key management (800-57)

Tools
- RNG (800-90A/B/C)
- KDF (800-108, 800-135)
- SHA3 derived functions (parallel hashing, KMAC, etc. (800-185))
Major Updates in Requirements and Criteria

The draft Call for proposals with requirements and criteria was released for public comments in August 2016.
Comment period closed September 16, 2016 (Right before ETSI/IQC workshop 2016)
Major updates in resolving comments and concerns at the final release of call for proposals

1. Description of quantum security strength levels
   - NIST continues to specify five security strength categories in terms of the computational resources, classical and quantum, required to break a selected parameter set for a cryptographic primitive
   - Submitters are not required to provide different parameters for all five security categories

2. Notions for public-key encryption, key exchange/key agreement
   - Introduce notion of key encapsulation mechanism (KEM)
   - For KEM with ephemeral keys, use IND-CPA security notion instead of IND-CCA2

*“Summary of Draft Call for Proposals Comments and Changes” can be found at http://www.nist.gov/pqcrypto*
Discussions and Questions

Since the draft call for proposals was announced, NIST team has actively interacted with potential submitters and researchers. The questions include:

- APIs to support different ancillary functions
- Using third party libraries
- Submission format
- etc.

The topics discussed at pqc-forum@nist.gov include:

- Quantum vs. classical security strength
- Security notions (IND-CCA2, IND-CPA, etc.)
- Random number generator
- Key exchange vs. key encapsulation
- etc.

Answers to the common questions and summaries on the major discussion topics were added to FAQs at [www.nist.gov/pqcrypto](http://www.nist.gov/pqcrypto).
Observations and Strategies

Post-Quantum Cryptography standardization is going to be much more complicated, compared with AES and SHA3 competitions. Some PQC schemes require different subroutines from existing public key cryptography schemes and need to handle new issues, e.g.

- decryption failure, and
- signature compression, etc.

The potential submitters have expressed great concerns on performance, which has triggered many questions on using libraries and different programming languages.

PQC standardization is a new direction for NIST team and also for the community.

NIST team will continue to work with the community, including submitters, researchers, and practitioners, to learn from handling new issues as they appear.
What to expect next?

NIST will post “complete and proper” submissions for security and performance analysis at [www.nist.gov/pqcrypto](http://www.nist.gov/pqcrypto), that is,

- The submitted candidates are publicly available for scrutinizing and evaluating
- The First NIST PQC Standardization Conference (co-located with PQCrypto, April 2018)
  - For submitters to present the algorithms and design rationale
  - For researchers and practitioners to ask questions on the submitted algorithms
- Evaluation and analysis continue after The First NIST PQC Standardization Conference (~16 months)
- The Second NIST PQC Standardization Conference is planning to be held in the second half of 2019 (tentative Aug. 2018 to be confirmed)
Summary

We learnt a lot through questions and discussions when the potential submitters prepare submissions.

We are prepared to handle new issues in the procedure.

Please follow the discussions at pqc-forum@nist.gov.

Questions to NIST team should be sent to pqc-comments@nist.gov.

See future updates at www.nist.gov/pqcrypto.