NTRU Prime: round 2

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https://ntruprime.cr.yp.to

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Same one-way functions; same core advantage

Design space of lattice systems

Eliminate unstructured lattices—
focus on applications that want something much smaller
(e.g., OpenSSH 8.0 includes our round-1 sntrup4591761)

Eliminate unnecessarily complicated security review:
eliminate decryption failures, eliminate cyclotomics, etc.

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Optimize size vs. security against known attacks

Streamlined NTRU Prime Core and NTRU LPRime Core
Extra parameter sets; improved CCA conversion

Added smaller dim and larger dim to parameter sets:
  - sntrup653 and ntrulpr653. (New smaller dim.)
  - sntrup761 and ntrulpr761. (Same dim as round 1.)
  - sntrup857 and ntrulpr857. (New larger dim.)
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Tweaks to CCA conversion:
- Implicit rejection as second layer of CCA defense beyond plaintext confirmation.
- More hashing, to enforce unique encodings of ciphertexts and public keys.
- New unified encoding mechanism.
  Shorter key/ciphertext strings than round-1 encoding.
Expanded documentation

§2: Reorganized and expanded algorithm specification, with modules matching the conceptual layers of the design.

§3: Modularized and generalized parameter specification.
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§4: Extended design rationale: CCA changes in round 2; analysis of arguments for other one-way functions.

§9: Extended analysis of advantages and limitations.
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§9: Extended analysis of advantages and limitations.

§6: Expanded and updated analysis of known attacks. Many different security estimates computed by our new script: some to compare to “Estimate” page, some for improvements.

§7, §8: Expanded and updated analysis of expected strength.

§5: Expanded and updated performance analysis.
New software: more modular, faster

New test script ntruprime.sage. Same structure as spec. Covers all parameter sets. Also has round1 option.

New ref C implementation. Same structure as test script.

New factored implementation. Portable C wrapper around modules with separate tests and optimizations.

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59456 enc, 97684 dec, $\geq 600\,000\,000$ keygen. (titan0 cycles.)
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What round-1 submission said about sntrup4591761 speed: 59456 enc, 97684 dec, $>6000000$ keygen. (titan0 cycles.)

Our current round-2 sntrup761 speed: **55252 enc, 70464 dec, 946772 keygen.** (titan0 cycles.)

Slowdown from extra hashing, but speedups in constant-time inversion (CHES 2019 Bernstein–Yang), sorting, mults, etc.

ntrulpr761: **77280 enc, 95316 dec, 47396 keygen.**