

# Comparing proofs of security for lattice-based encryption

Daniel J. Bernstein

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Primary objective of this paper:  
Make a **complete plan**  
for **thorough security reviews**  
of 36 target KEMs.

Much harder: Do the reviews!  
Complete plan is framework  
to evaluate which pieces are done,  
and to coordinate further efforts.  
KEMs vary in what's needed.

The target KEMs (all proposed  
for wide deployment, IND-CCA2):

frodo	640, 976, 1344.
kyber	512, 768, 1024.
lac	128, 192, 256.
newhope	512, 1024.
ntru	hps2048509, hps2048677, hps4096821, hrss701.
ntrulpr	653, 761, 857.
round5n1	1, 3, 5.
round5nd	1.0d, 3.0d, 5.0d, 1.5d, 3.5d, 5.5d.
saber	light, main, fire.
sntrup	653, 761, 857.
threebears	baby, mama, papa.

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Revised plan:

1. Verify the “security proofs” .
2. Verify the cryptanalysis  
of the risks left by the proofs.

Again clean up; check by hand;  
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Are attack-cost analyses correct?  
How thorough is exploration of space of optimizations?  
How thorough is the study of claimed barriers to speedups that work for similar problems?  
Do the cryptanalytic targets match the proof risks? etc.

Long history of failures: e.g. NSA overstated DES attack;  $L(1/2)$  optimality conjecture for factorization was wrong; TLS Triple-DES-CBC was broken without Triple-DES attack; etc.



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But sometimes the proofs reduce cost of cryptanalysis.

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But sometimes the proofs reduce cost of cryptanalysis.

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Hopefully less chance of disaster.

Are attack-cost analyses correct?  
How thorough is exploration of space of optimizations?  
How thorough is the study of claimed barriers to speedups that work for similar problems?  
Do the cryptanalytic targets match the proof risks? etc.  
Long history of failures: e.g., NSA overstated DES attack cost;  $L(1/2)$  optimality conjecture for factorization was wrong; TLS Triple-DES-CBC was broken without Triple-DES attack; etc.

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Product NTRU: convert core PKE into PKE that builds multiplier  $G$  pseudorandomly from public seed.

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As far as I can tell, none of the target KEMs claim higher  $U$ -user security.