Better proofs for rekeying

D. J. Bernstein

Security of AES-256 key k is far below 2^{256} in most protocols: $(\mathrm{AES}_k(0), \ldots, \mathrm{AES}_k(n-1))$ is distinguishable from uniform with probability $n(n-1)/2^{129}$, plus tiny key-guessing probability. Yes, distinguishers matter.

Attacker actually has T targets: independent keys $k_1, \ldots, k_T$. Success chance $\approx Tn(n-1)/2^{129}$.

"Rekeying" seems less dangerous.

Expand k into $F(k) = (\mathrm{AES}_k(0), \ldots, \mathrm{AES}_k(999999))$.

Split $F(k)$ into 500000 "subkeys".

Output $F(k')$ for each subkey k': i.e., $F(\mathrm{AES}_k(0), \mathrm{AES}_k(1))$; $F(\mathrm{AES}_k(2), \mathrm{AES}_k(3))$; ... $F(\mathrm{AES}_k(999998), \mathrm{AES}_k(999999))$.

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Given key k and input (N_1, N_2), NMAC computes $S(S(k, N_1), N_2)$, where S is a ~~stream cipher~~ "compression function".

(Tweaks: output is encrypted; no prefix-free requirement.)

Step 1: Replace cascade outputs for *first* subkey with independent uniform random outputs.

Distinguisher for this step $\Rightarrow$ attack against S.

Step 2: Replace cascade outputs from next (distinct) subkey. . . .
Step q: Replace cascade outputs from qth (distinct) subkey.
Could skip steps if $q > \#\{N\}$.

Further complications in proof to monolithically handle ℓ levels.
2011 Bernstein: simpler to compose better 2-level theorem.

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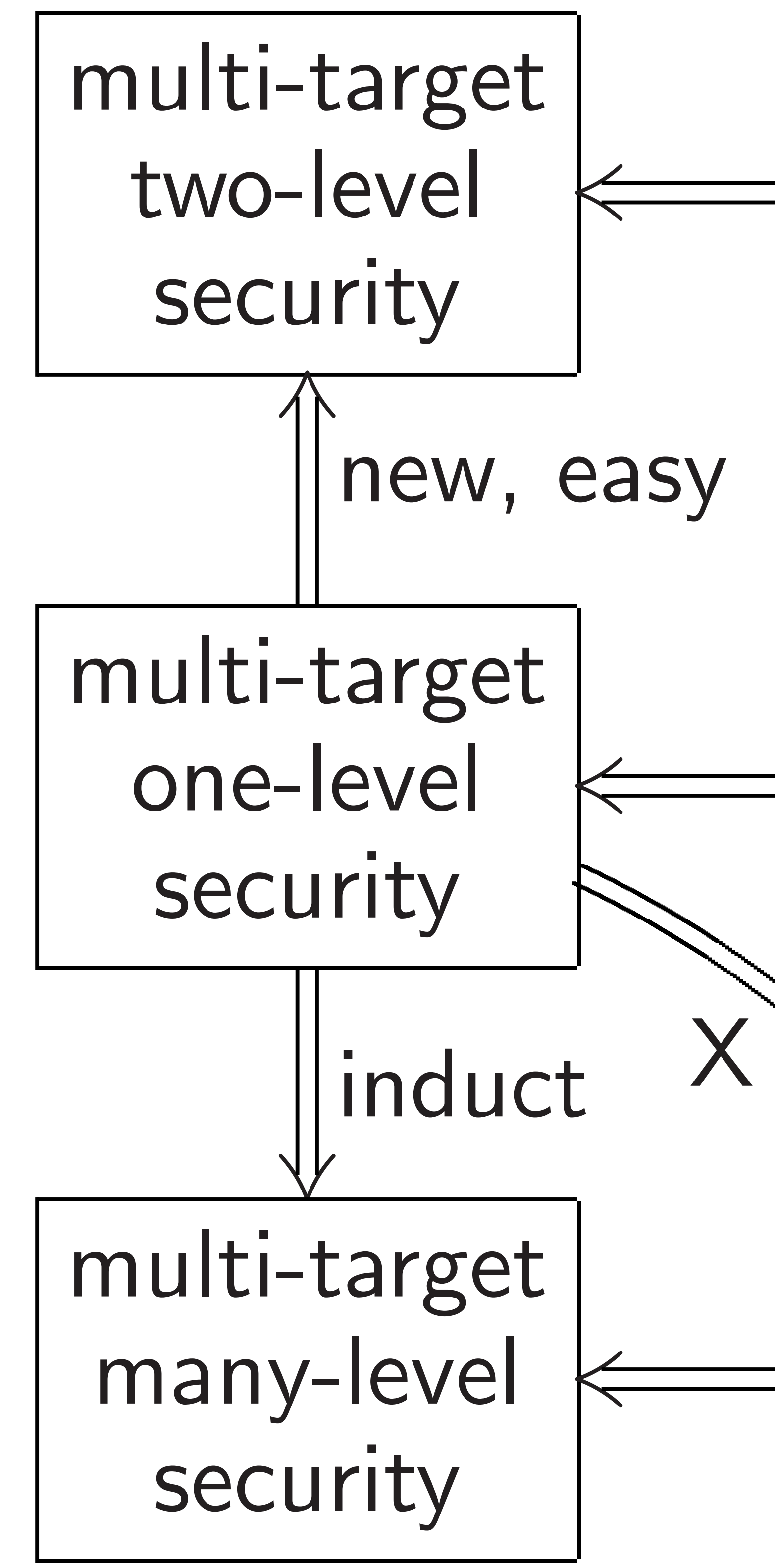

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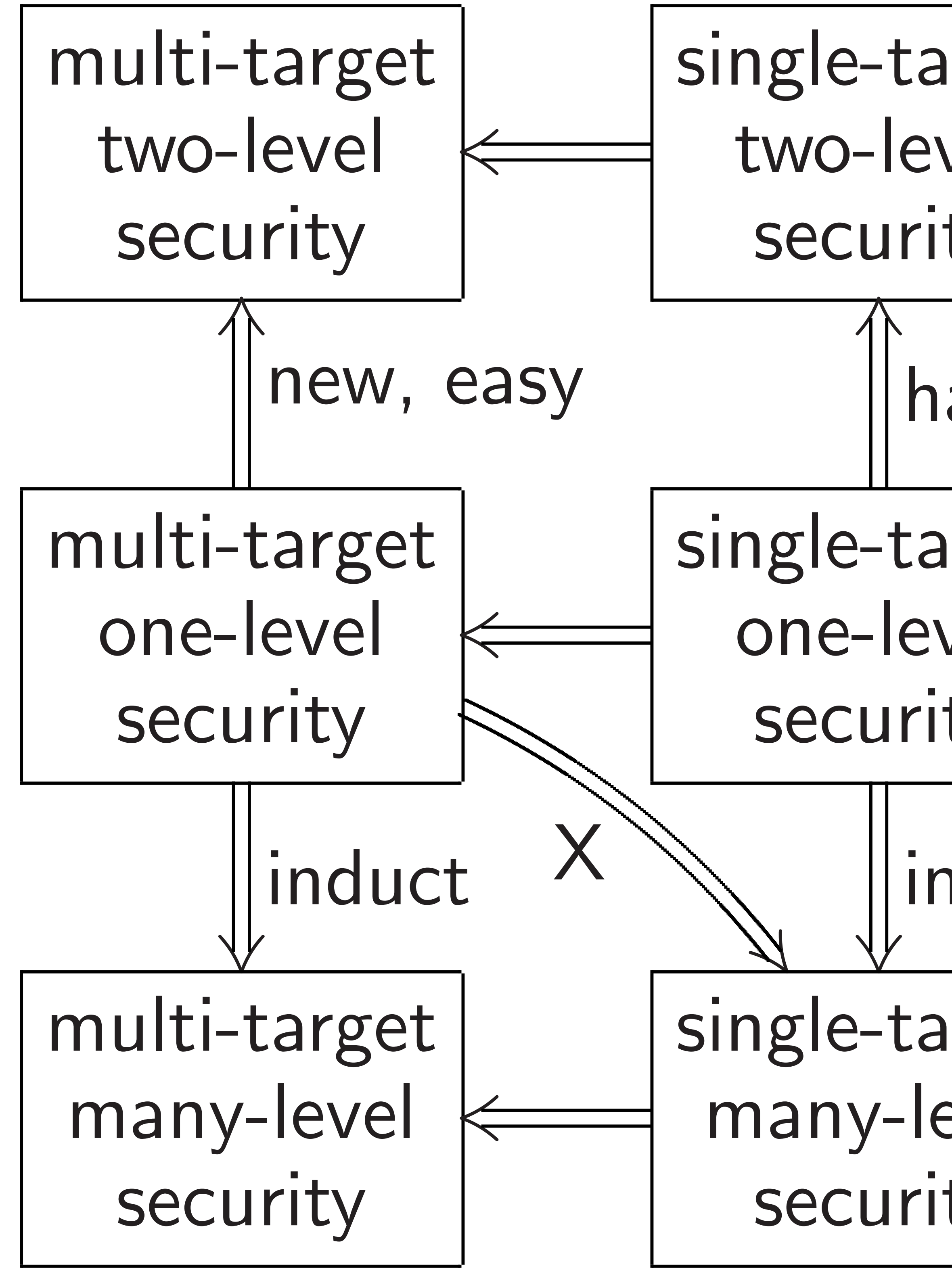

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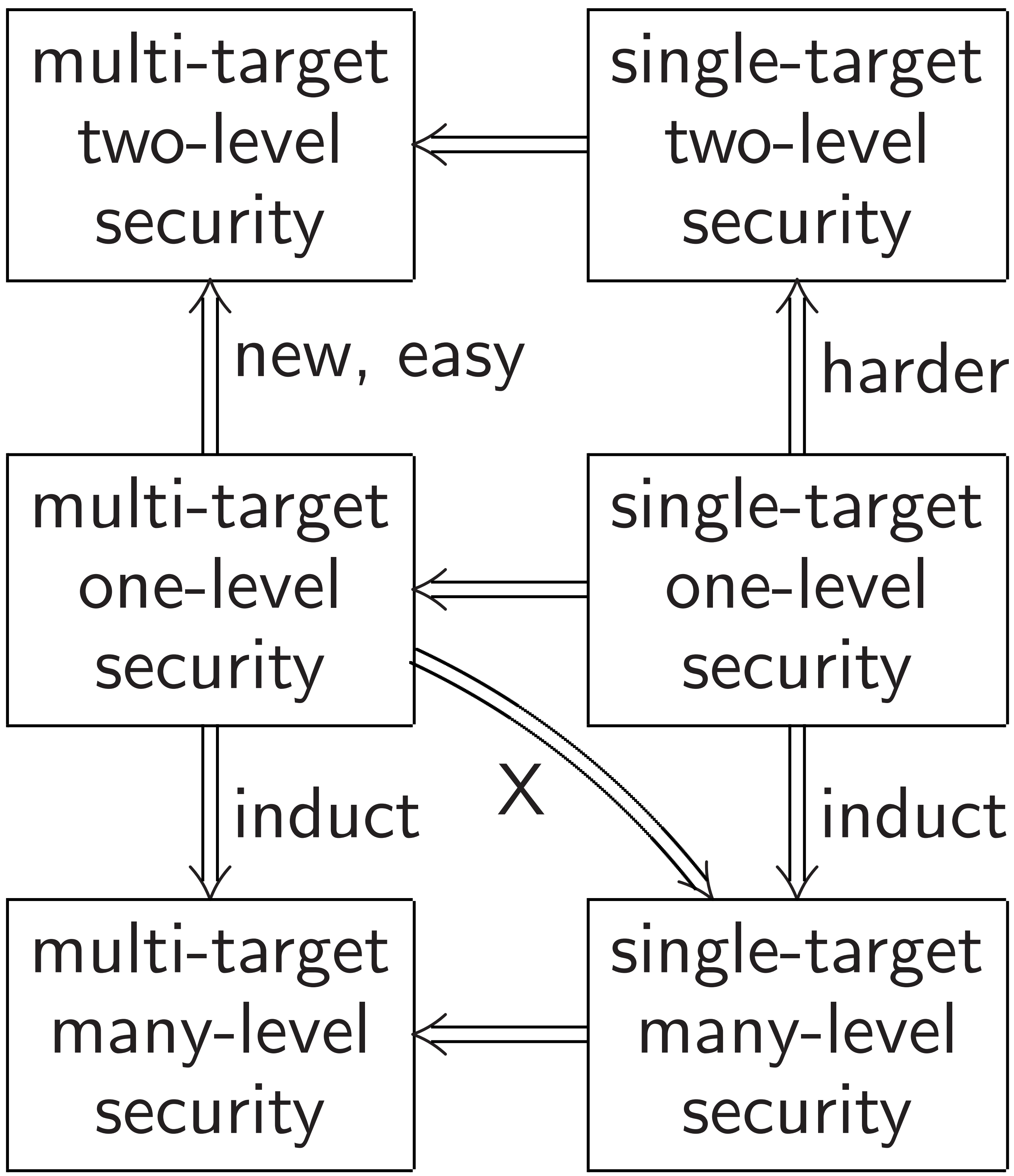

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