

A tool for automating the computationally complete symbolic attacker (Extended Abstract)

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The design of automated security proofs is a topic extensively studied for over 20 years. One problem that was raised about 12 years ago is the validity (or the scope) of such proofs. Symbolic models are quite far from the implementation. In contrast, modern cryptography typically considers more powerful attackers. This includes of course some computations that are not explicitly specified. This issue has been first addressed by M. Abadi and P. Rogaway [1], followed by many authors. The idea is to prove that the symbolic formal model is *sound* with respect to the more concrete computational model: if there is no attack in the symbolic model, then there is no attack in the computational model. There are several such soundness proofs, for various primitives and in various contexts (see e.g. [10], [2], [9] to cite only a few). However, all these results require heavy proofs and assume strong hypotheses, some of which are not quite realistic. Typical examples of unrealistic assumptions include: a key cycle is never created, or the attacker does [use the key generation algorithm to build his own keys](#).

These difficulties lead to try to prove the security protocols directly in the computational model. For instance CRYPTOVERIF [6] or EASYCRYPT [5] are designed in this spirit. The proofs have however to account for probability distributions computations, attacker's time computation, and are relatively difficult, often requiring user interactions. We study here an alternative approach presented in [4] which consists in specifying formally what the attacker *cannot do*. Each axiom in such a specification can be a consequence of an assumption on the primitives, which yields the soundness of the model by construction.

Intuitively, checking for cryptographic security in this model amounts to checking the satisfiability of a finite set of first order formulas. In [8] we provided an (efficient) decision procedure for a fragment of first order logic large enough to model reasonable security properties and computational assumptions.

Following these ideas, we present a tool that automates this procedure, together with a set of axioms allowing to prove (and find attacks on) most protocols involving encryption and signatures. [As often, our implementation slightly differs from the theoretical algorithm. First, we did not implement the full strategy, losing the polynomial complexity. Second, we have extended our procedure to cope with more axioms such as functionality and reflexivity, needed in our examples.](#) One of the main advantages of our tool is that it allows to find implicit implementation hypotheses. For example, a new attack has been discovered on Needham-Schroeder-Lowe (NSL) in [3] if a nonce can be confused with a pair. Such

an attack could not be detected in other symbolic models. We have applied our tool on several protocols from the literature. In particular, we have easily rediscovered the attack on NSL. We have also discovered a new attack on the Andrew secure RPC protocol, if the encryption scheme is not secure when the key is obtained by projecting a nonce. IND-CCA security does not provide any guarantee for this. As a result we conclude that implementations of Andrew's secure RPC should make sure that the second projection of a nonce fails with overwhelming probability. [This attack is similar to the one mentioned in \[7\] but is slightly more general in the sense that it works for more implementations. For example, our attack still holds when nonces are keys.](#) We hope to find more similar implicit hypotheses in the next few months using our tool.

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