Template Attacks on ECDSA on a 32-bit ARM

Theory

ECDSA Signature Generation

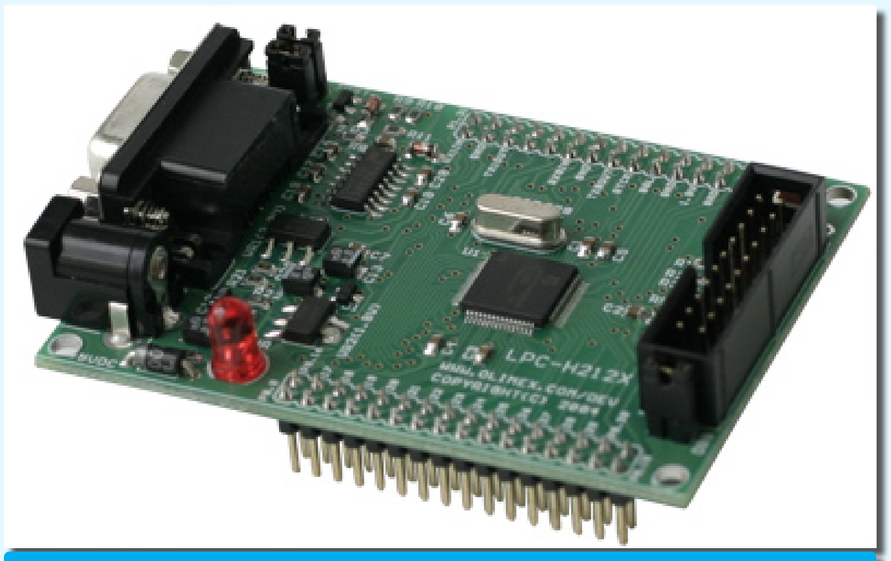
1. e = HASH(m)
2. random integer k from [1,n − 1].
3. r = x(mod n), where (x,y) = kG.
4. Calculate $s = k^{-1}(e + rd_A)(\mathrm{mod}\ n)$.
5. The signature is the pair (r,s).

Template Based SPA Attack

- Superior over standard SPA, succeeds even for SPA resistant algorithms
- Describes power consumption with a probability distribution
- Allows classification of all kinds of instructions, operations or features
- Single shot attack

Attack on ECDSA

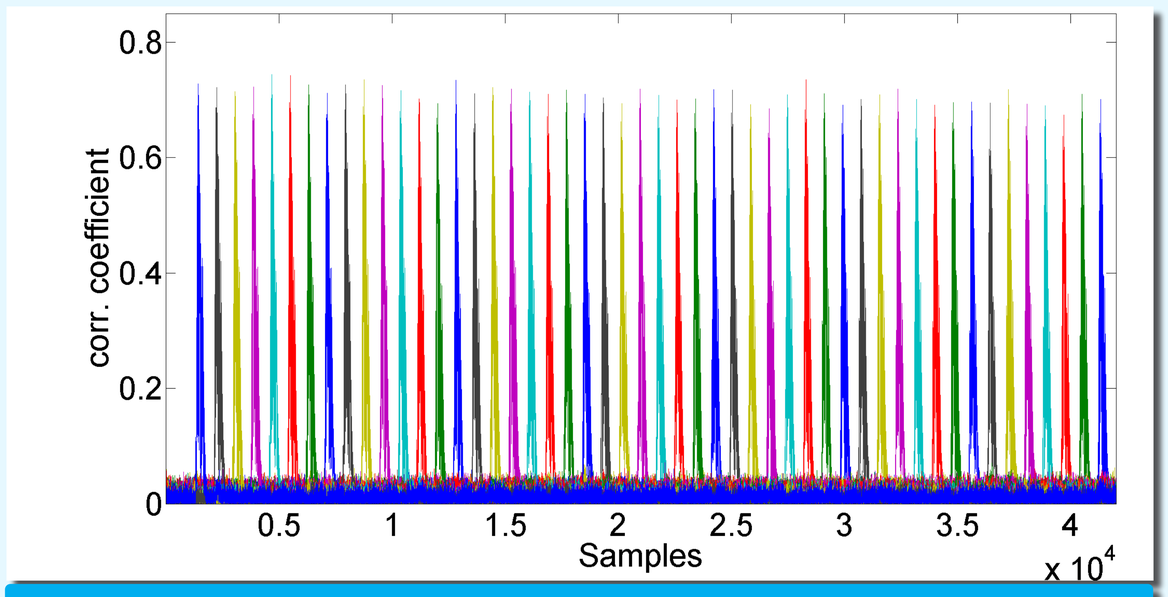
- ECDSA is well suited for template attacks
- Basepoint G is known and intermediate curve points can be precomputed and classified for a guessed key k
- Successful attacks on the ephemeral key k reveal the secret key d_A



All implementations have been attacked on this ARM7 based LPC2124 32-bit microcontroller

ECC Implementation

- Optimized for 32-bit ARM7 platform, which is used in many modern embedded systems
- NIST curve P192
- Binary and windowed double and always add method (both attacked successfully)
- Standard and constant runtime GF(p) arithmetic (both attacked successfully)



For the P192 curve a single group operation provides over 100 intermediate values, lager curves even more

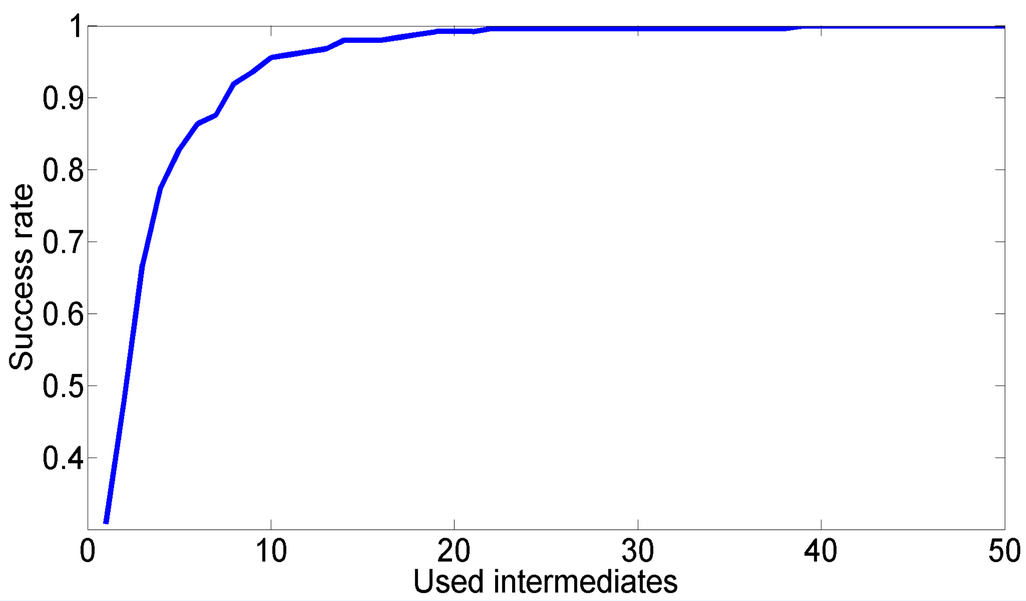
Practical Attack

Used Leakage

- Standard GF(p) implementations leak dramatically due to key-dependent reductions
- Constant runtime GF(p) arithmetic has DPA leakage

Templates for Several Curve Points

- Allows optimal template point selectoin Best DPA point per intermediate
- Use only intermediates with large Hamming distance
- Leads to a success rate beyond 99.99%



If the template performance for one intermediate is larger than 50% it is possible to constructivly combine them. Considering about 40 intermediate values is enough to achieve a success rate beyond 99.99%.

University of BRISTOL
Dr. Elisabeth Oswald
Elisabeth.Oswald@bristol.ac.uk
Marcel Medwed
Marcel.Medwed@student.tugraz.at
TU Graz
Graz University of Technology