DSA (Digital Signature Algorithm)

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What Is DSA (Digital Signature Algorithm)?

- ► The Digital Signature Algorithm (DSA) is a Federal Information Processing Standard for digital signatures.
- ▶ **Key generation**, Key generation has two phases. The first phase is a choice of algorithm parameters which may be shared between different users of the system, while the second phase computes public and private keys for a single user.

DSA

Per-user keys:

- Given a set of parameters, the second phase computes private and public keys for a single user:
- 2. Choose a secret key x by some random method, where 0 < x < q.
- 3. Calculate the public key $y = gx \mod p$.
- 4. There exist efficient algorithms for computing the modular exponentiations h(p 1)/q mod p and gx mod p, such as exponentiation by squaring.

DSA

- Let H be the hashing function and m the message
- Generate a random per-message value where 1 < k < q</p>
- Calculate r = (g k mod p) mod q
- In the unlikely case that r = 0, start again with a different random k
- ► Calculate $s = k 1 (H(m) + xr) \mod q$
- In the unlikely case that s = 0, start again with a different random k

DSA

Sensitivity

- 1. With DSA, the entropy, secrecy, and uniqueness of the random signature value k are critical. It is so critical that violating any one of those three requirements can reveal the entire private key to an attacker.[11] Using the same value twice (even while keeping k secret), using a predictable value, or leaking even a few bits of k in each of several signatures, is enough to reveal the private key x.[12]
- 2. This issue affects both DSA and ECDSA in December 2010, a group calling itself fail0verflow announced recovery of the ECDSA private key used by Sony to sign software for the PlayStation 3 game console. The attack was made possible because Sony failed to generate a new random k for each signature.[13]
- 3. This issue can be prevented by deriving k deterministically from the private key and the message hash, as described by RFC 6979. This ensures that k is different for each H(m) and unpredictable for attackers who do not know the private key x.
- In addition, malicious implementations of DSA and ECDSA can be created where k is chosen in order to subliminally leak information via signatures. For example an offline private key could be leaked from a perfect offline device that only released innocent-looking signatures.[14]

Reject the signature if or is not satisfied.

DSA

Verifying

- ullet Reject the signature if 0 < r < q or 0 < s < q is not satisfied.
- Calculate $w = s^{-1} \mod q$
- Calculate $u_1 = H(m) \cdot w \mod q$
- Calculate $u_2 = r \cdot w \mod q$
- Calculate $v = (g^{u_1}y^{u_2} \mod p) \mod q$
- The signature is invalid unless v=r

DSA is similar to the ElGamal signature scheme.