Collision resistance

Introduction

Recap: message integrity

So far, four MAC constructions:

PRFs:

- **ECBC-MAC, CMAC** : commonly used with AES (e.g. 802.11i)
- **NMAC** : basis of HMAC (this segment)
- **PMAC**: a parallel MAC

randomized MAC:

- **Carter-Wegman MAC**: built from a fast one-time MAC

This module: MACs from collision resistance.

Collision Resistance

Let $H: M \rightarrow T$ be a hash function ($|M| >> |T|$)

A **collision** for H is a pair $m_0, m_1 \in M$ such that:

$$H(m_0) = H(m_1) \quad \text{and} \quad m_0 \neq m_1$$

A function H is **collision resistant** if for all (explicit) "eff" algs. A:

$$\mathbf{Adv_{CR}[A,H] = Pr[\ A \text{ outputs collision for } H]}$$

is "neg".

Example: SHA-256 (outputs 256 bits)

MACs from Collision Resistance

Let I = (S,V) be a MAC for short messages over (K,M,T) (e.g. AES)

Let H: $M^{big} \rightarrow M$

Def: $I^{big} = (S^{big}, V^{big})$ over (K, M^{big}, T) as:

$$S^{big}(k,m) = S(k,H(m)) \quad ; \quad V^{big}(k,m,t) = V(k,H(m),t)$$

Thm: If I is a secure MAC and H is collision resistant

then I^{big} is a secure MAC.

Example: $S(k,m) = AES_{2\text{-block-cbc}}(k, \text{SHA-256}(m))$ is a secure MAC.

MACs from Collision Resistance

$S^{big}(k, m) = S(k, H(m))$; $V^{big}(k, m, t) = V(k, H(m), t)$

Collision resistance is necessary for security:

Suppose adversary can find $m_0 \neq m_1$ s.t. $H(m_0) = H(m_1)$.

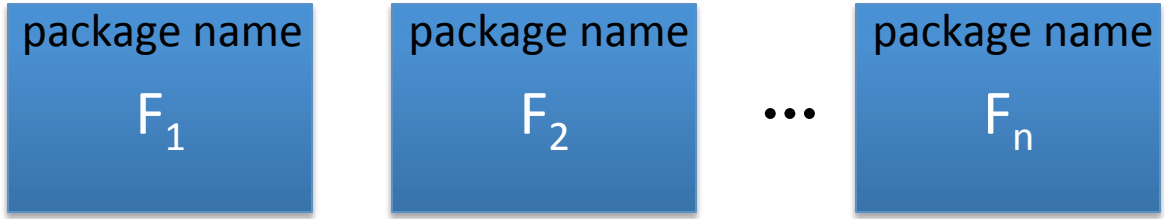
Then: S^{big} is insecure under a 1-chosen msg attack

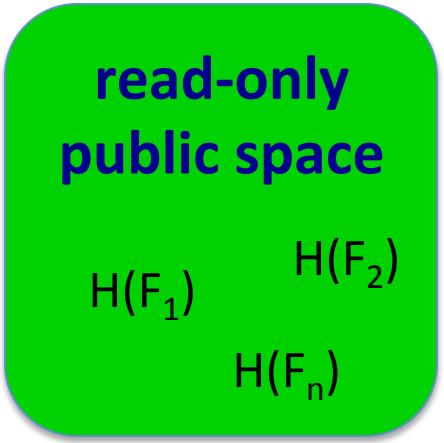
step 1: adversary asks for $t \leftarrow S(k, m_0)$

step 2: output (m_1, t) as forgery

Protecting file integrity using C.R. hash

Software packages:





When user downloads package, can verify that contents are valid

H collision resistant ⇒
attacker cannot modify package without detection

no key needed (public verifiability), but requires read-only space

End of Segment