CSE 5351 Homework 5

Due: Tuesday, March 6 by class time

1. In basic CBC-MAC, t_0 is fixed. Show that the following modification (where t_0 is not fixed) does not yield a secure fixed-length MAC for messages of length nq.

   (Modified) Tag generation: For key $k \in \{0,1\}^n$ and message $m \in \{0,1\}^{n \cdot q}$,

   – parse m as $m = (m_1, \ldots, m_q)$ // q blocks //

   – apply CBC to m, i.e., let

   $$t_0 \leftarrow_u \{0,1\}^n \text{ and } t_i := F_k(m_i \oplus t_{i-1}) \text{ for } 1 \le i \le q$$

   – output $\langle t_0, t_q \rangle$ as the tag

2. Show that appending the message length $|m|$ (number of blocks) to the *end* of m before applying basic-CBC-MAC does not result in a secure MAC for arbitrary-length messages.

   Hint : The adversary obtains three samples as follows:

   - Present a 1-block message m_1 to the oracle and obtain tag t_1, where $t_1 = \text{basic-CBC-MAC}_k(m_1, |m_1|)$. ($k$ is a secret key not known to the adversary.)
   - Present another 1-block message m_2 to the oracle and obtain tag t_2, where $t_2 = \text{basic-CBC-MAC}_k(m_2, |m_2|)$.)
   - Present a 3-block message $m_3 = (m_1, |m_1|, m_2)$ to the oracle and obtain tag t_3, where $t_3 = \text{basic-CBC-MAC}_k(m_1, |m_1|, m_2, |m_3|)$.
   - From the above three samples, construct a valid pair (m, t).

3. Let F be a pseudorandom function. Construct a fixed-length MAC scheme for messages of length $2n$ as follows. The shared key is a random $k \in \{0,1\}^n$. To authenticate a message $m_1 m_2$ with $|m_1| = |m_2| = n$, let the tag be $\langle F_k(m_1), F_k(F_k(m_2)) \rangle$. Is this scheme secure against chosen-message attacks? Justify your answer.