CIS 4360: Computer Security Fundamentals

Message Authentication Code

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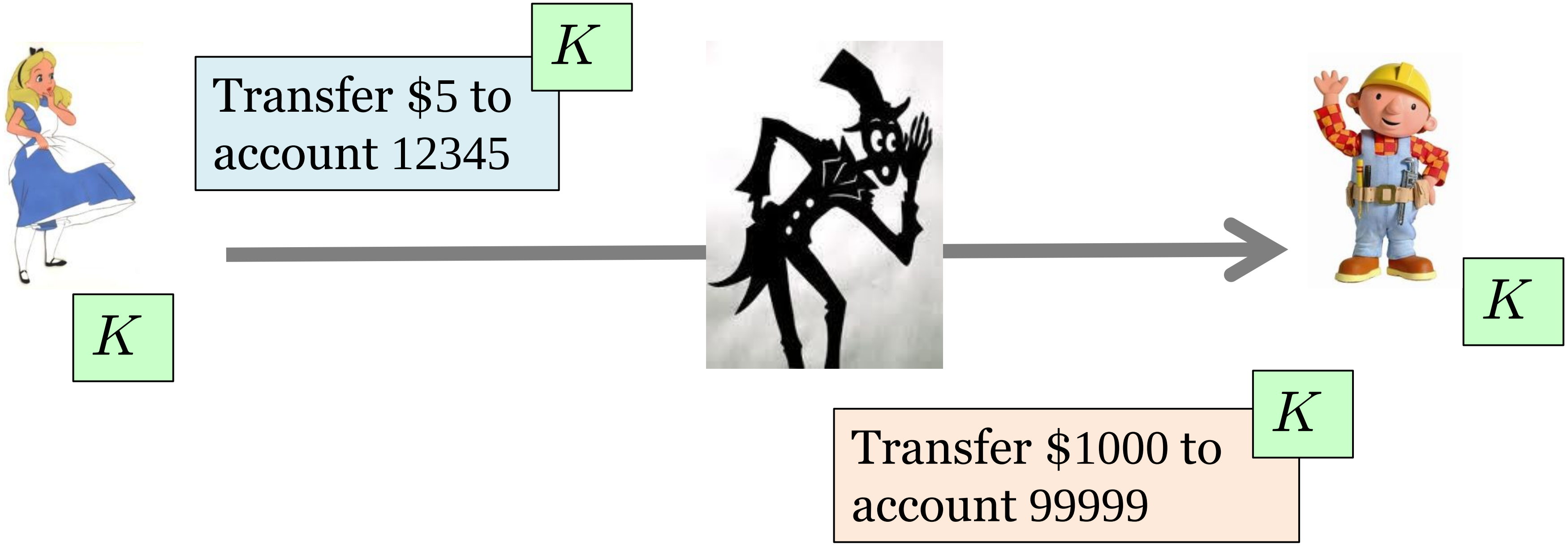
The slides are loosely based on those of
Prof. Mihir Bellare, UC San Diego.

Agenda

1. MAC and Authenticity

2. MAC Constructions

The Need for Authenticity



K

Transfer $5 to account 12345

K

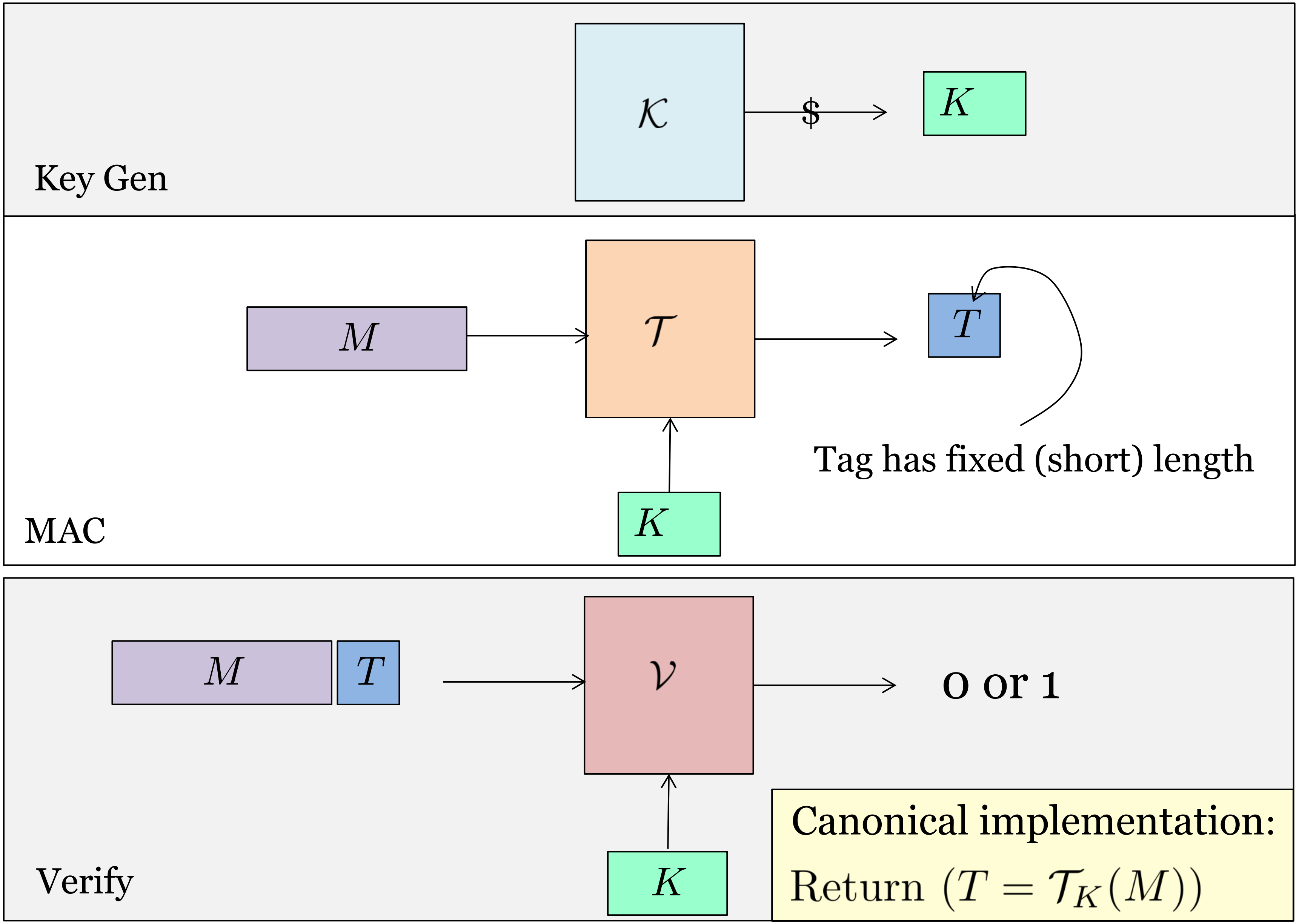
K

K

Transfer $1000 to account 99999

Classical encryptions (CTR, CBC) don’t provide authenticity

MAC Syntax



Key Gen

$\mathcal{K} \xrightarrow{\$} K$

MAC

$M \rightarrow \mathcal{T} \rightarrow T$, with K going into $\mathcal{T}$

Tag has fixed (short) length

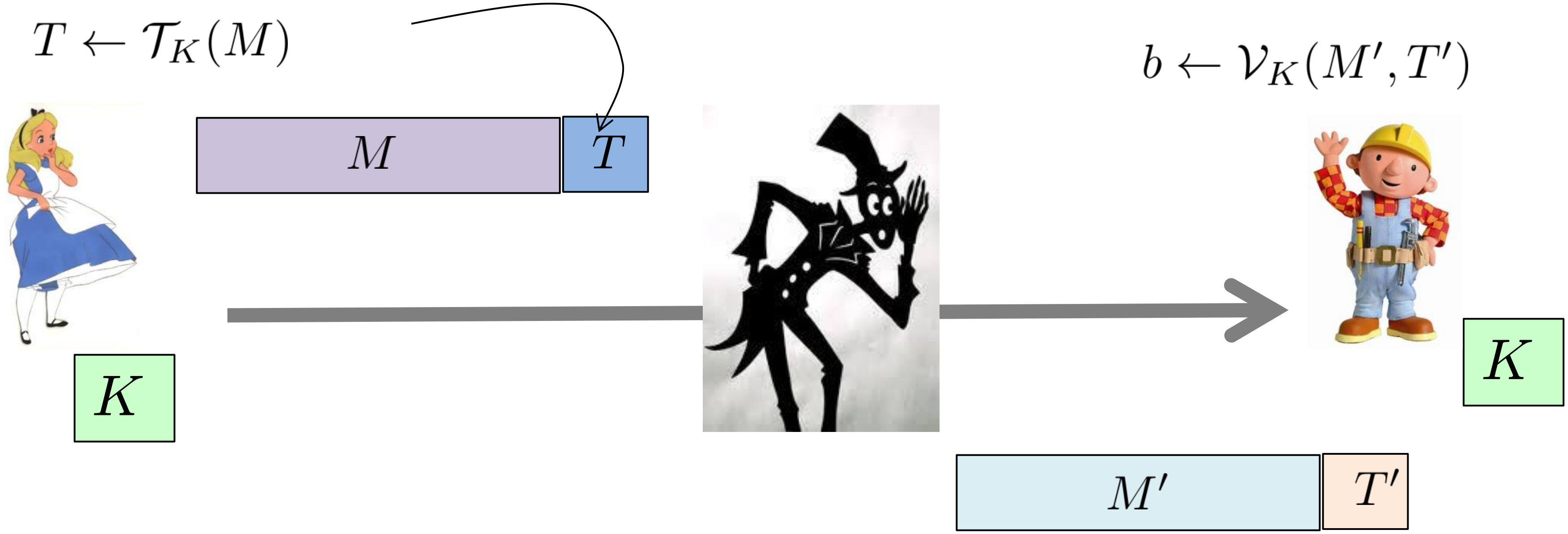
Verify

$M \; T \rightarrow \mathcal{V} \rightarrow$ 0 or 1, with K going into $\mathcal{V}$

Canonical implementation:

Return $(T = \mathcal{T}_K(M))$

MAC Usage



$T \leftarrow \mathcal{T}_K(M)$

M T

K

$b \leftarrow \mathcal{V}_K(M', T')$

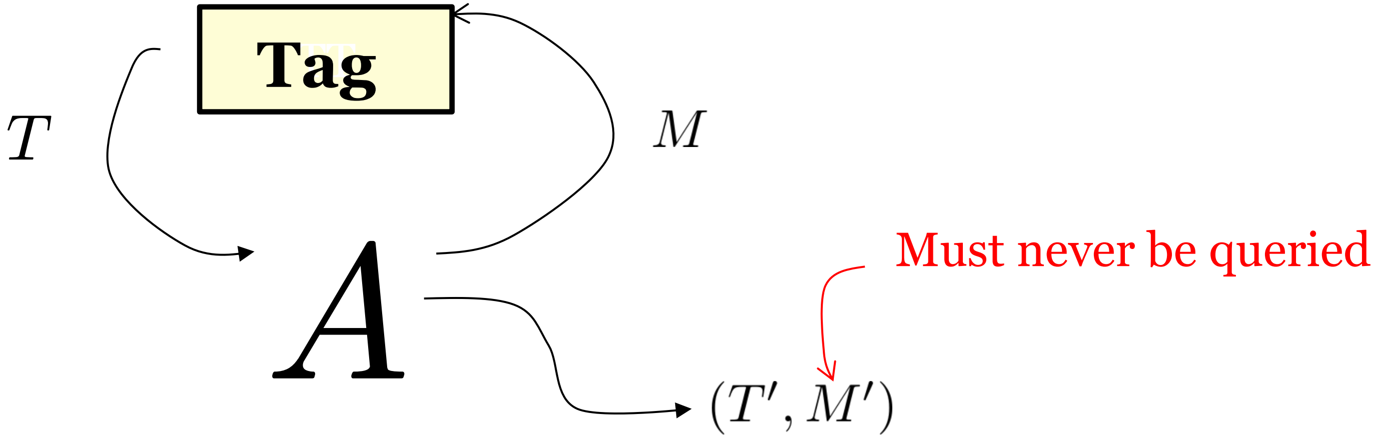
K

M' T'

Formalizing Security

MAC$_{\mathcal{T}}$

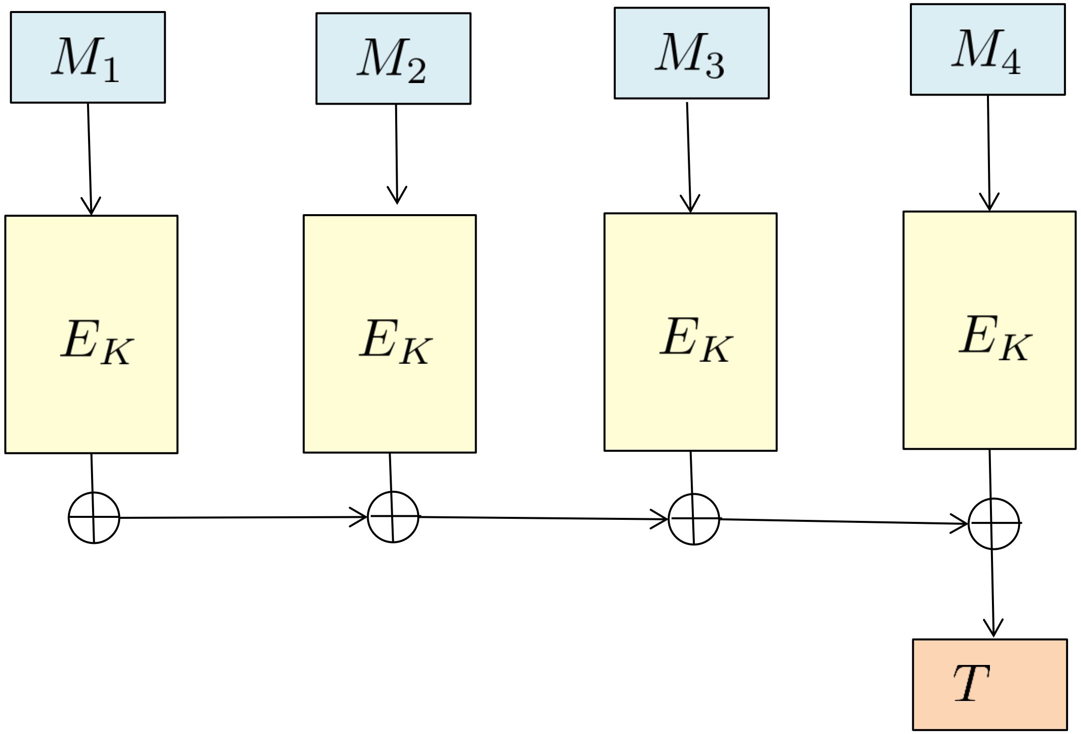
```
procedure Initialize()
    $K \xleftarrow{\$} \mathcal{K}$

procedure Tag($M$)
    Return $\mathcal{T}_K(M)$

procedure Finalize($T', M'$)
    Return $(T' = \mathcal{T}_K(M'))$
```



Must never be queried

$$\mathbf{Adv}^{\mathrm{mac}}_{\mathcal{T}}(A) = \Pr[\mathrm{MAC}^{A}_{\mathcal{T}} \Rightarrow 1]$$

Exercise: Breaking MAC Security With No Query

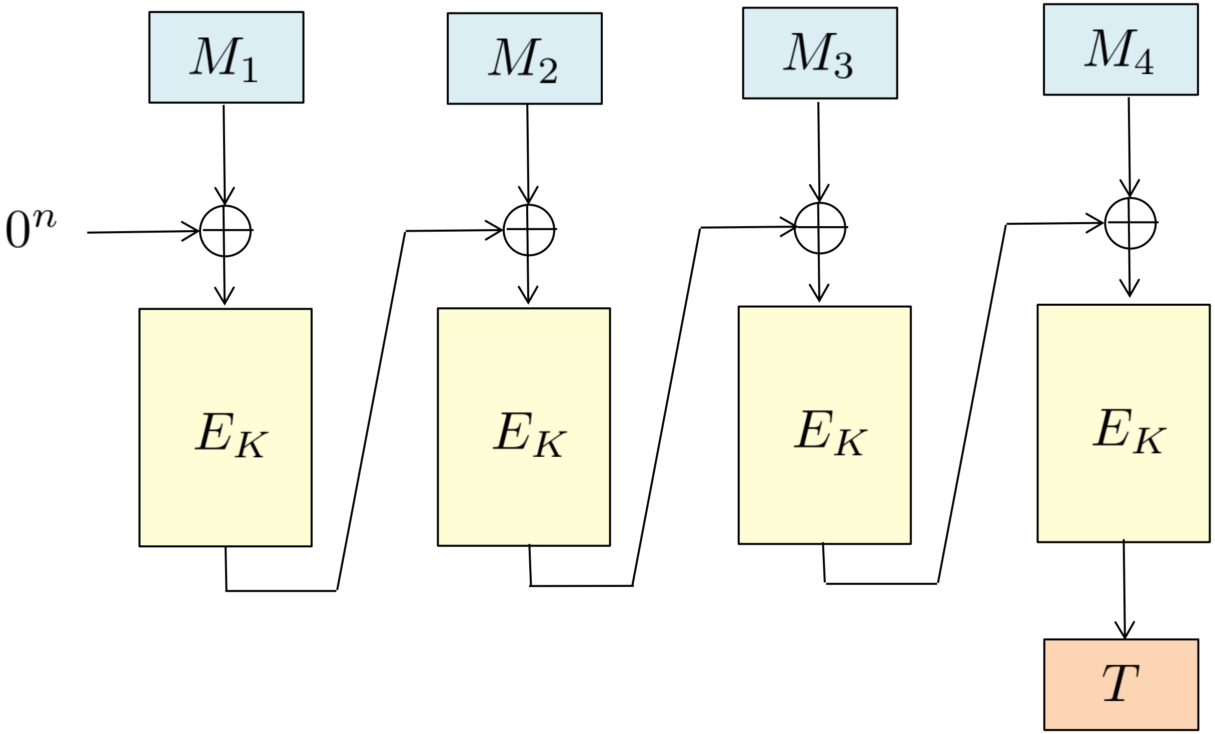


Agenda

1. MAC and Authenticity

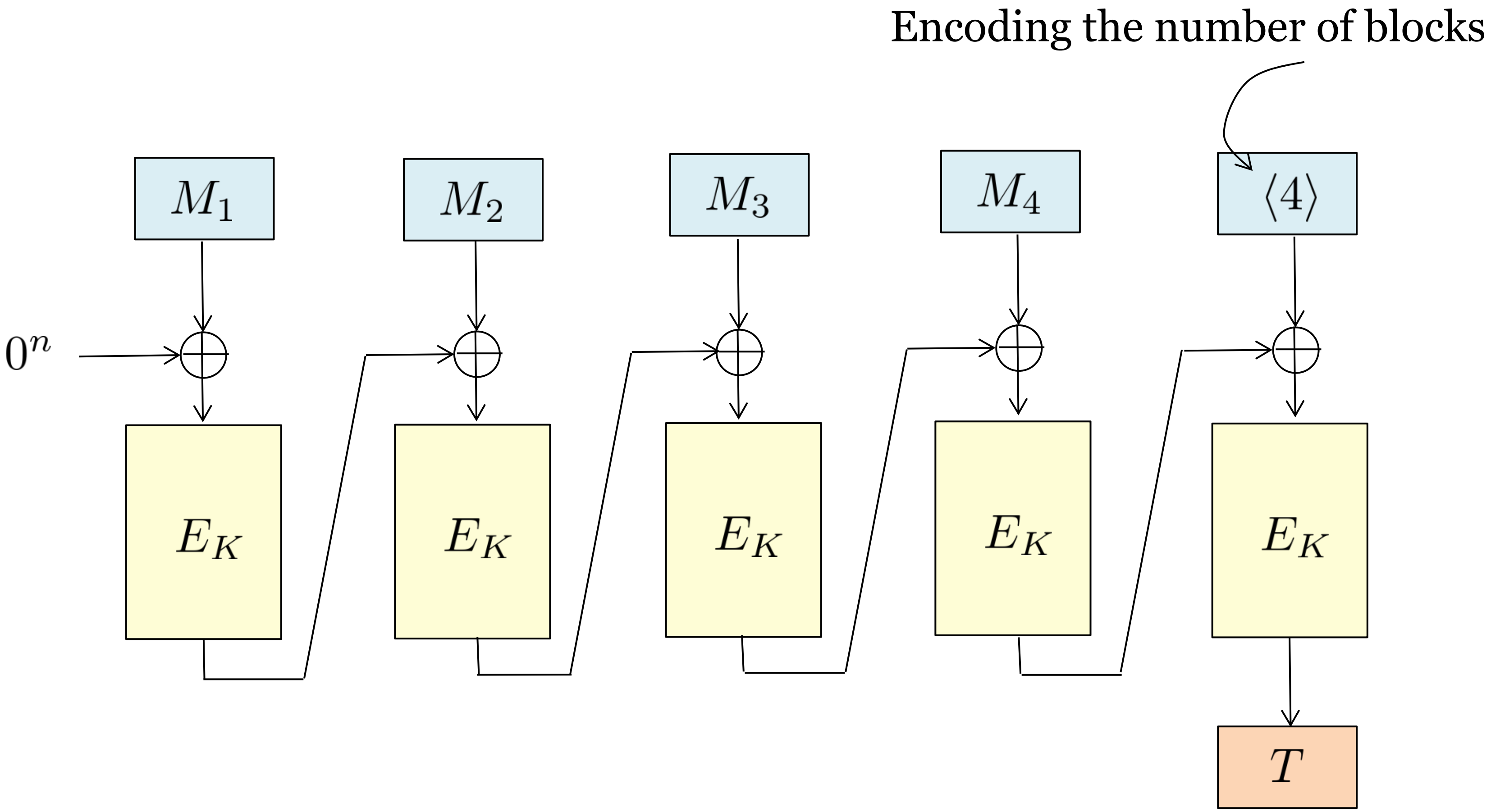
2. **MAC Constructions**

An Insecure Construction: Plain CBC-MAC



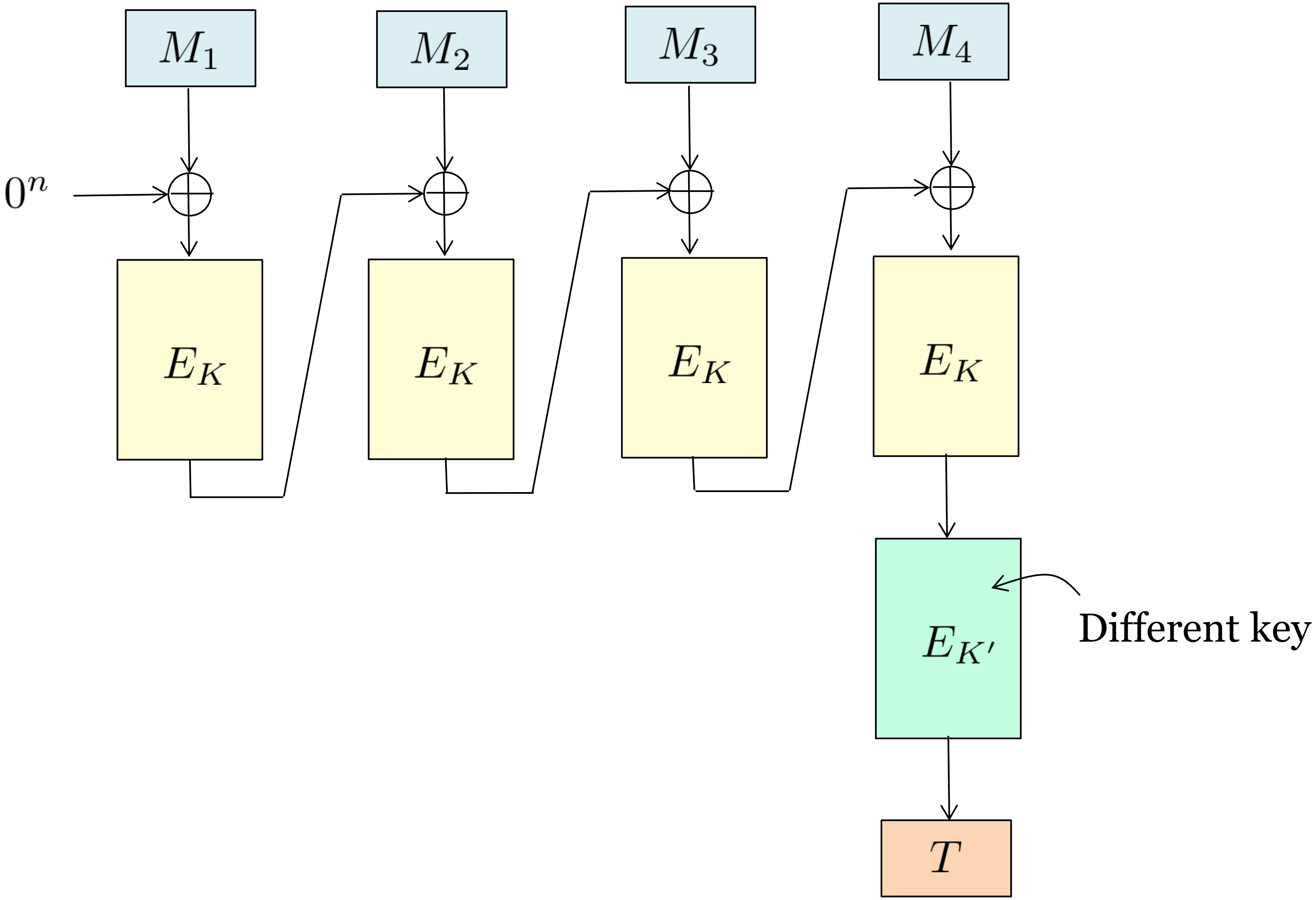
Question: Break CBC-MAC with a single Tag query

An Incorrect Fix of CBC-MAC



Exercise: Break this version using 3 Tag queries

A Good Construction: Encrypted CBC-MAC



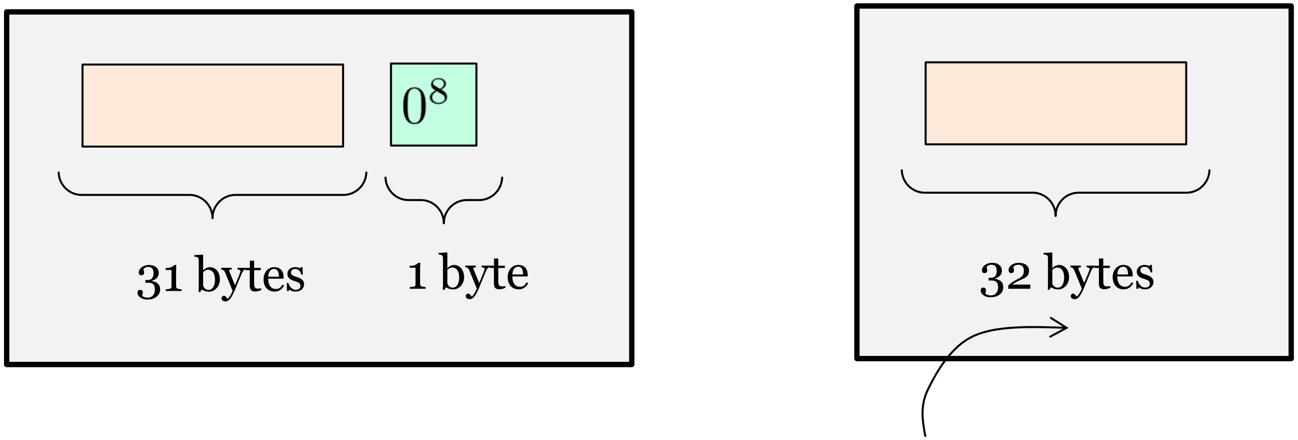
Different key

Dealing with Fragmentary Data

Solution: Padding with 10^*

Question: Can we instead use padding with 0^*?

Example: Suppose that the block length is 16 bytes.



No padding → save bandwidth

Answer: No, can break this with a single Tag query