Timing Attacks

Side Channel Attacks

-Timing
-Power
-Source
-Light

Usability and Security

-Depending on Users
-Role Playing

Modular Exponentiation

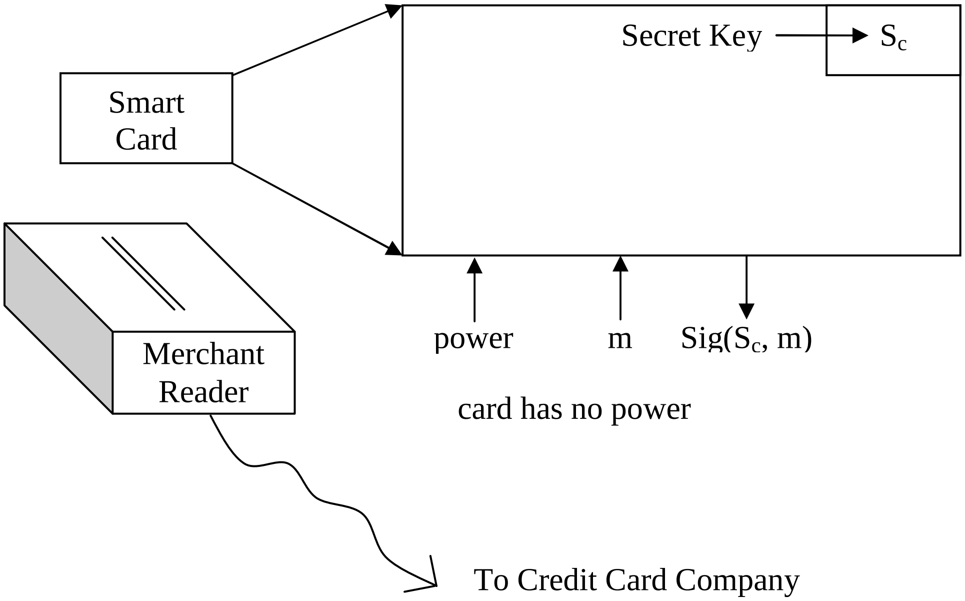
Modexp(m,e,n) // m^e mod n
let e_ℓ, …, e0 // the bits of e

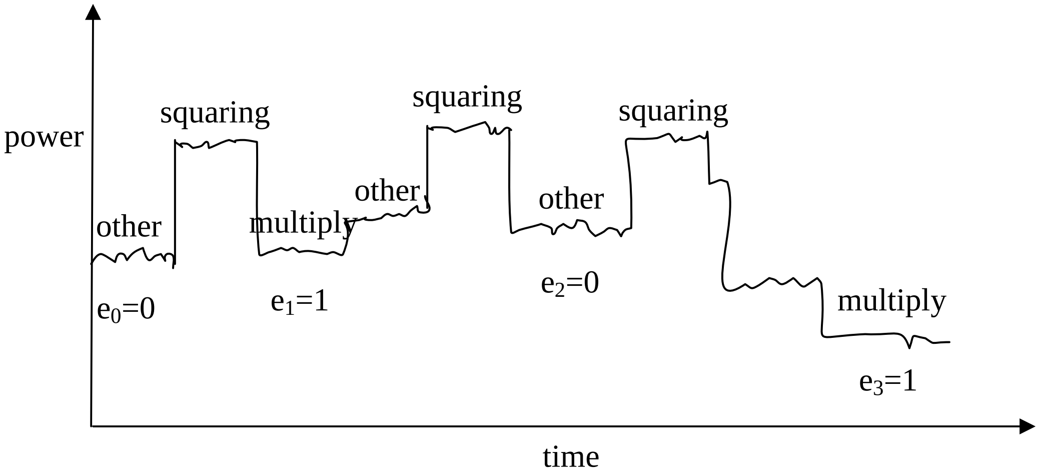
Square and Multiply

```
let acc = 1
for i=0 … $\ell$
  if $e_i$==1
    acc=acc*m mod n
  m=$m^2$ mod n
return acc
```

m^e mod n = m ^ ($2^0e_0 + 2^1e_1 + 2^2e_2 + \dots 2^\ell e_\ell$) mod n
= m ^ e_0 * (m^2)^e_1 * (m^4)^e_2 *** (m^2 $^\ell$)^ e_ℓ mod n

Power Analysis (Smart Cards)





Timing Attack against Square and Multiply

Some reductions take longer than others
-fast reductions
-slow reductions
-If attacker knows acc*m, he can predict whether reduction is fast or slow.

Attacker

input	time
m_0	t_0
m_1	t_1
m_2	t_2

.	.
.	.
.	.
m_k	t_k

Suppose $e_{=1}$
-can compute acc and match end of round 0
-Predict whether round 1 will be fast or slow for each message m_i.
let f_1 = average time of “fast” messages
s_1 = average time of “slow” messages

Two Cases

1. $|s_1-f_1|$ is small and $|s_0-f_0|$ is small => $e_1 = 0$
2. Suppose $|s_b-f_b|$ is large and $|s_{\tilde{b}}-f_{\tilde{b}}|$ is small => e1 = 1 and e0 = b

Repeat for rounds 2 ... ℓ

Safeguard against Timing Attacks

-modify the code

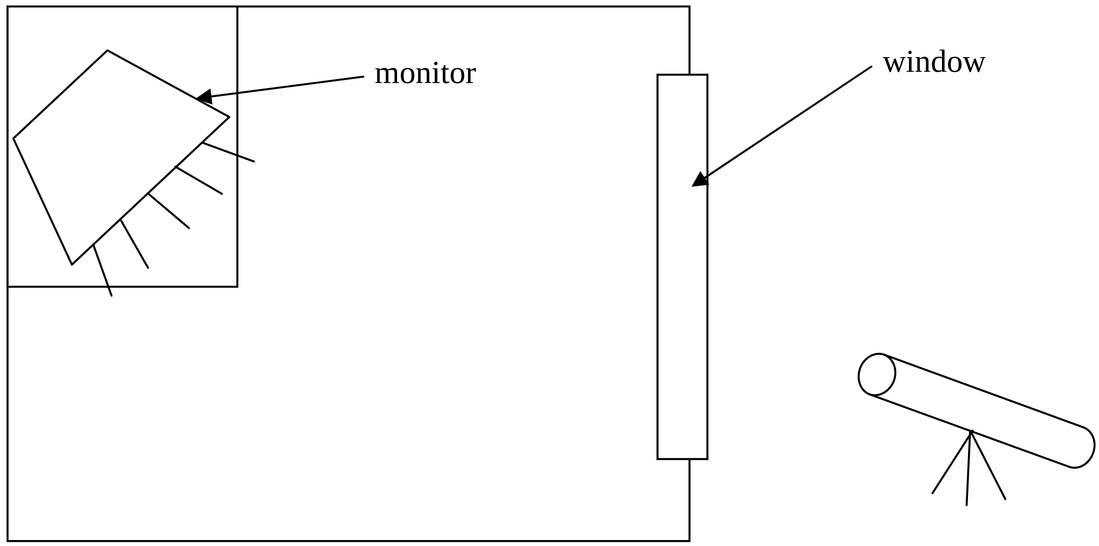
```
let acc = 1
for i=0 … $\ell$
  if $e_i$==1
    acc=acc*m mod n
  else
    tmp*m mod n
  m=$m^2$ mod n
return acc
```

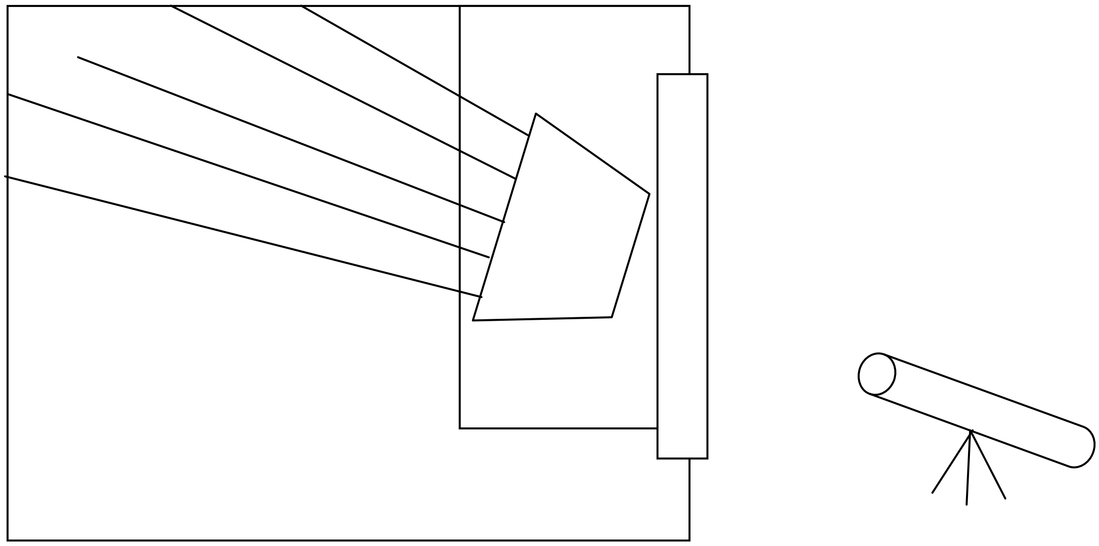
RSA Blinding

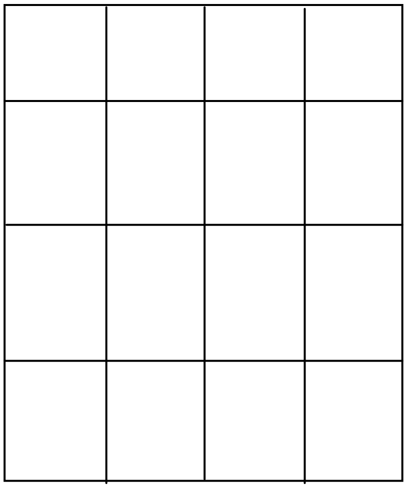
To compute m^e mod n

1. pick random r
2. compute $x=(r*m)^e$ mod n
3. compute $y=r^e$ mod n
4. return x/y mod n

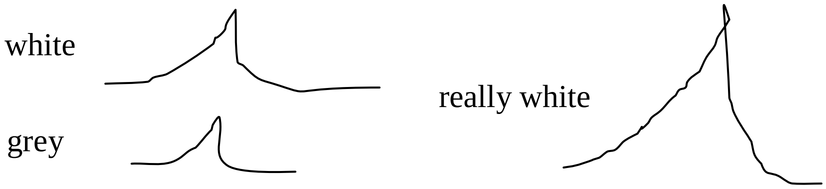
Light Attacks

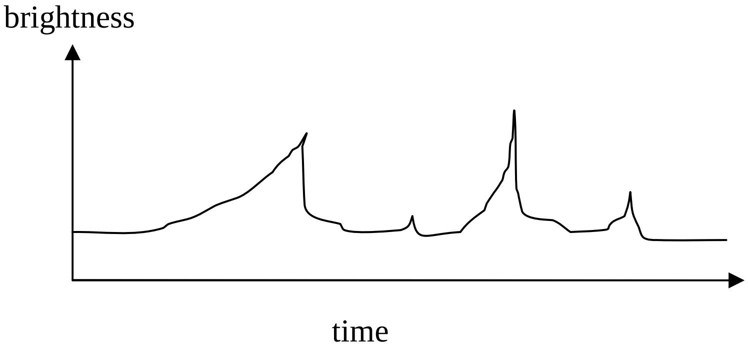

monitor
window





Screen, cathode ray tubes monitor





Can determine what is displayed on the screen by recording the brightness change since the monitor updates one pixel at a time. To prevent such an attack would be to update all pixels at once.