

虎符 CTF 2020 Crypto GM writeup

原创

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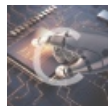
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GM writeup

审代码发现生成的 N 和 ϕ 很特殊, 有了 N 和 ϕ 显然可以算出来 p, q 。

看主要加密部分是把明文转化成二进制流, 对 b_i 逐个加密:

```
r = random.randint(1, N)
if gcd(r, N) == 1:
    br = bin(r)[2:]
    c = (pow(x, int(br + b_i, 2), N) * r ** 2) % N
    cipher.append(c)
    break
```

如果令 $e = \text{int}(br + b_i, 2)$,

$c = x * r \bmod N$ 。如果 b_i 为 0, 那么 e 就是偶数, 可以表示为 $e = 2 * k$, 那么 c 就是

c 是否为 $\bmod N$ 下的平方剩余可以通过勒让德符号来判断, N 不是个素数所以要分解 N , 然后通过勒让德符号来判断

$$c \bmod p$$

是否为模 p 下的平方剩余, 逐个判断就得到了明文的二进制流。

先用二分法算出 p :

```
phi = 94334516617494132259194145952433213117629020379088509547997033960838637186411365030532159955765580031712491
9296997286484079529878473055321041798371459376455758292743478491517763973199831089116868599924093740787177136997
1713515313634198744616074610866924094854671900334810353127446778607137157751925680243990711180904598841255660443
2140918486743762451639537747171132462039282445090337341849130058658376201348311428807118322566347975907734138316
5973361572257483025749680141776033707348483817055449795303348713163497337114335750702773189940277716951677026421
8656483487045393156894832885628843858316679793205572348688820
```

```
N = 943345166174941322591941459524332131176290203790885095479970339608386371864113650305321599557655800317124919
2969972864840795298784730553210417983714593764557582927434784915177639731998310891168685999240937407871771369971
7135153136341987446160746108669240948546719003348103531274467786071371577519256802439909055281410728641685445192
7989722449484920618426220213030582018756914805724773124365108425819400945993670290965544896969358980098726637824
9891157940262898554047247605049549997783511107373248462587318323152524969684724690316918761387154882496367769626
921299091688377118938693074486325995308403232228282839975697
```

```
K=N-phi+1#p+q
```

```
L,R=1,K
```

```
while L<R:
```

```
    mid=(L+R)//2
```

```
    if K<=mid:
```

```
        break
```

```
    y=(K-mid)*mid
```

```
    if y>N:
```

```
        R=mid
```

```
    elif y<N:
```

```
        L=mid
```

```
    else:
```

```
        print(mid)
```

```
        break
```

```
#941305244949403565068759409019015068729846990336109288142693109780033763077305806672342096403094435645602674146
3064486171233155944065885320180455678178449337628444642639307488294295744686992555842214667777408544991533387620
1669456003375126689843738090285370245240893337253184644114745083294361228182569510971
```

exp:

```

from Crypto.Util.number import *
N = 943345166174941322591941459524332131176290203790885095479970339608386371864113650305321599557655800317124919
2969972864840795298784730553210417983714593764557582927434784915177639731998310891168685999240937407871771369971
7135153136341987446160746108669240948546719003348103531274467786071371577519256802439909055281410728641685445192
7989722449484920618426220213030582018756914805724773124365108425819400945993670290965544896969358980098726637824
9891157940262898554047247605049549997783511107373248462587318323152524969684724690316918761387154882496367769626
921299091688377118938693074486325995308403232228282839975697
p = 9413052449494035650687594090190150687298469903361092881426931097800337630773058066723420964030944356456026741
4630644861712331559440658853201804556781784493376284446426393074882942957446869925558422146677774085449915333876
201669456003375126689843738090285370245240893337253184644114745083294361228182569510971

def Legrend(a, p):
    if a == 1:
        return 1
    if p % a == 0:
        return 0
    if a % 2 == 0:
        return Legrend(a // 2, p) * pow(-1, (pow(p, 2) - 1) // 8)
    return Legrend(p % a, a) * pow(-1, (a - 1)*(p - 1) // 4)

def read_file():
    f = open("output")
    fileread = f.read()
    cipher_list = []
    Number = "0123456789"
    temp = ""
    for i in fileread:
        if i not in Number and len(temp) != 0:
            cipher_list.append(int(temp))
            temp = ""
        elif i in Number:
            temp += i
    return cipher_list

cipher_list = read_file()
ans=""
for cip in cipher_list:
    if Legrend(cip,p)==1:
        ans+='0'
    elif Legrend(cip,p)==-1:
        ans+='1'
m=int(ans,2)
print(long_to_bytes(m))

```

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