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Toast

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[2](, 510632)
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: 移动终端在飞速发展的同时也带来了安全问题, 其中, 口令是用户信息的第一道安全防线, 因此针对用户口令的窃取攻击是主要的安全威胁之一. 利用 Android 系统中 Toast 机制设计的缺陷, 实现了一种基于 Toast 重复绘制机制的新型口令攻击. 通过分析 Android Toast 机制的实现原理和功能特点, 发现恶意应用可利用 Java 反射技术定制可获取用户点击事件的 Toast 钓鱼键盘. 虽然 Toast 会自动定时消亡, 但是由于 Toast 淡入淡出动画效果的设计缺陷, 恶意应用可优化 Toast 绘制策略, 通过重复绘制 Toast 钓鱼键盘使其长时间驻留并覆盖于系统键盘之上, 从而实现对用户屏幕输入的隐蔽劫持. 最后, 攻击者可以通过分析用户点击在 Toast 钓鱼键盘上的坐标信息, 结合实际键盘布局推测出用户输入的口令. 在移动终端上实现该攻击并进行了用户实验, 验证了该攻击的有效性、准确性和隐蔽性, 结果表明: 当口令长度为 8 时, 攻击成功率为 89%. 发现的口令漏洞已在 Android 最新版本中得到修复.

: 口令攻击; Java 反射; Toast 重复绘制
: TP311

: , , , , , . Toast . , 2022, 33(6): 2047–2060. http://www.jos.org.cn/1000-9825/6568.htm

: Ling Z, Yang Y, Liu RZ, Zhang Y, Jia K, Yang M. Repeating Toast Drawing Based Password Inference Attack Technique. Ruan Jian Xue Bao/Journal of Software, 2022, 33(6): 2047 2060 (in Chinese). http://www.jos.org.cn/1000-9825/6568.htm

Repeating Toast Drawing Based Password Inference Attack Technique

LING Zhen[1], YANG Yan[1], LIU Rui-Zhao[1], ZHANG Yue[2], JIA Kang[1], YANG Ming[1]

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[2](College of Cyber Security, Jinan University, Guangzhou 510632, China)

Abstract

Key words: password attack; Java reflection; repeating Toast drawing

, , . GSMA [1], 2021 4 , 78 , 51 . Android , , . Android . Android , , , . IDC [2], 2023 , 1 512 .

, . : , . : , , [3 7]; , [8,9] [10] , , ; [11 14] . , , , , . , . , , . Android Toast , Toast , , . Toast , Toast , . , Toast , Toast , . Android , , . , Java Android Toast , Toast , Toast , . Android 10 . Android 11 , Java Toast . Wang [15] Toast Overlay Android 11 , .

:

(1) Toast . Android Toast , Toast , Toast , , ;

(2) . Android : Java , Toast . , Toast , , ;

(3) . Android ; , . :

, 12 , 84.5%. , .

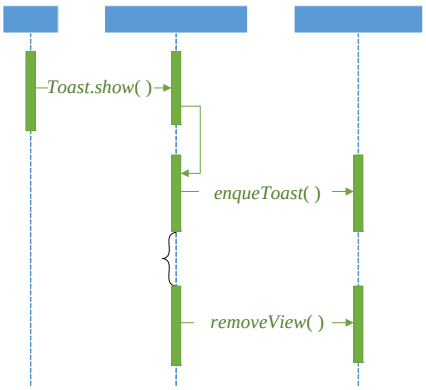
1 Toast . 2 Toast . 3 . 4 Toast . 5 . 6 .

1

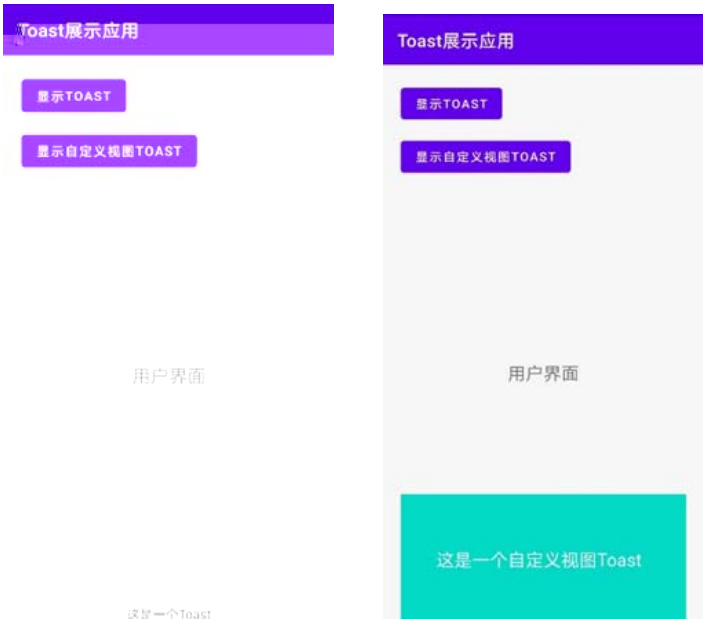
Android Toast . Toast Toast
, .

1.1 Toast

Toast Android ,
, ,
, . Toast
1 . Toast Toast.
Toast, Toast , *show*( )
. Toast *show*( ) ,
NotificationManager , *enqueueToast*( ) ,
(NotificationManager). ,
, (WindowManager),
Toast , Toast 2 s 3.5 s
.



Toast , . 1 Toast
Toast *Toast.makeText* (*context*,*text*,*duration*) Toast . *text*
Toast , *duration* Toast , :
LENGTH_LONG *LENGTH_SHORT*, 3.5 s 2 s. 2(a) ,
Toast, : “ Toast”. , Toast *setView*( )
(view), 2(b) .



(a) Toast (b) Toast

2 Toast
Toast , *removeView*( ) ,

Toast . , 500 ms , Toast
0. , , Toast . *removeView*( )
, , Toast , Toast,
Toast Toast .

1.2

Android Android ,
Android . Android ,
TalkBack, TalkBack ,
. , Android API .
, [12,16,17].
, , .
ID .
, ID,
, , . ,
, .

2

Android . Android ,
Toast , , Toast .

2.1

.

(1) , .
,
, , . Diao [18]
337 , (56.7%)
100 . Felt [19] , 17% .
Fratantonio [16] ;

(2) , .
;

(3) , ,
.

2.2

Toast , Toast .

(1) Toast , , ;

(2) Toast , . Toast ,
Toast Toast , Toast
;

(3) Toast .
Toast , Toast
. , .
Toast , Toast .

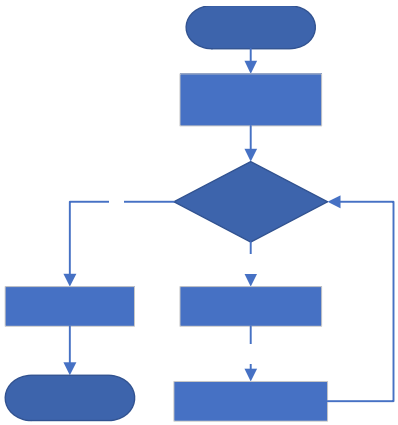
, , . ,
, Toast ,
, . , Toast , Android
, Java Toast .
. , ,
. , Toast
, . ,
.

3 Toast

Toast , ,
, , Toast ,
, .

3.1

3 , Toast 4 ,
. , ,
, . ,
, .



3 Toast

4 .

3.2

Toast .
, . ,
, .
, , .
, ,
. , EditText, ,
isPassword( ) true. , . ,
, .

3.3

, . , Toast
, , . Toast
3 : 1 Toast , 2
Toast , 3
.

3.3.1

Toast , .
. , Toast
, . , Toast , ,
, Toast . Android : Toast
Toast *mTn* *mNextView* , *mParams* ,
FLAG_NOT_TOUCHABLE[20], , 1 .

1. Toast .

```
1:  final WindowManager.LayoutParams params=mParams;
2:  params.type=WindowManager.LayoutParams.TYPE_TOAST;
3:  params.setTitle("Toast");
4:  params.flags=WindowManager.LayoutParams.FLAG_KEEP_SCREEN_ON
5:          |WindowManager.LayoutParams.FLAG_NOT_FOCUSABLE
6:          |WindowManager.LayoutParams.FLAG_NOT_TOUCHABLE;
```

Toast , Toast *show*( )
mNextView , *mParams* , *FLAG_NOT_TOUCHABLE* , , Toast
. *mTn* *mParams* public , ,
. , Java *mTn* , *mTn*
mParams , Toast , 2 .

2. Toast .

```
1:  Toast toast=new Toast(MainActivity.this);
2:  toast.setView(keyboard);  //
3:  Field f=toast.getClass( ).getDeclaredField("mTN");
4:  f.setAccessible(true);  //  Java  Toast  mTN
5:  Object mTn=f.get(toast);  //  toast  mTN
6:  Field f2=mTn.getClass( ).getDeclaredField("mParams");  //  mTn  TN  mParams

7:  f2.setAccessible(true);  //  Java  TN  mParams
8:  Object mParams=f2.get(mTn);  //  mTn  mParams
9:  mParams.flags=WindowManager.LayoutParams.FLAG_NOT_FOCUSABLE;  //
10: toast.show( );
```

3.3.2 Toast
, . Toast
3.5 s, .
, , .
.

1.1 , Toast ,
Toast . Toast, 1 Toast , Toast
Toast , Toast ,
Toast , Toast .
Toast 4 .

1. , *Toast.show*( )
Toast;

2. Toast token,
enqueueToast( ) Toast , token Toast;

3. token, Toast
. token, Toast token ,
Toast[21];

4. Toast (2 s 3.5 s) , *removeView*( )
Toast ;

5. Toast , . ,
Toast token, Toast .

D 1 5, Toast .
4 , Toast T_a, , Toast,
, . T_s, Toast
T_d, $T_s/(T_d+T_a)$ 1. Toast
Toast , $T_d/(T_d+T_a)$. : T_d , , .
4.3.2 , , Toast 3.5 s.

Toast , *D* Toast , Toast . Android Toast token , Toast , *D* , token, , Toast , . , *D* , Toast , Toast Toast , . , *D* Toast , *D* , *D* 3.4 s .

3.3.3

. ,

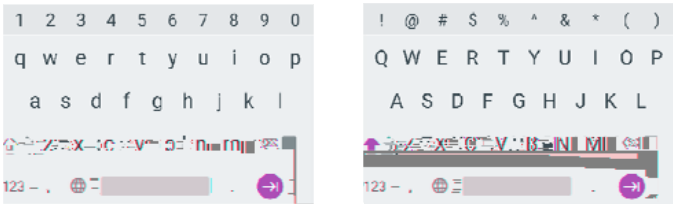
. , Toast ,

. , , , 5 ,

. , 5 .

, . Toast ,

setImageBitmap( ) Toast , .



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, . [22]

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. Pixel Gboard, ,

, Gboard .

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3.4

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. Google Android Keyboard , ,

QWERTY 0 9 . [23] : *X* ,

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. , ,
, . ,
performAction( ) , .

3.5

, . ,
, .
, Toast ,
Toast. , , ,
, 4.3.2 .
https://reurl.cc/WEzEM7. , Google Pixel 2 ,
, , , .
, Toast .
, Toast .

4

Toast . ,
; , ; ,
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4.1

, .
, , Toast
, , .
, Google nexus6p, Android 8,
5 , Skype Instagram,
, . , .
, ,
, .
. 20 , 3
17 , 22 33 , 25 , , 20
2.

2

Samsung	s8	8
Samsung	SMG9	9
Google	nexus6p	8
Google	pixel 2xl, pixel 4	9
Vivo	v1813A, x21iA, v1816A, v1813BA	9
Oppo	PMEM00	9
Xiaomi	mi5	8
Xiaomi	mix 2s, mi6, mi8	9
Xiaomi	mix3	10
Huawei	EML-AL00, mate20	9
Huawei	nova3	9.1
Huawei	mate20 x, HMA	10

4.2

. 7 ,
. 7 , ,
10 , . 7 ,
. 3.

3

Skype	com.skype.raider	8.45.0.43
	com.facebook.katana	196.0.0.16.95
	com.evernote	8.4.1
	com.twitter.android	7.68.1
Instgram	com.instagram.android	69.0.0.10.95
	com.infonow.bofa	8.1.16
	com.eg.android.AlipayGphone	10.1.65

: , 7
. ,
. , , Toast ,
, .
, . , ,
, . ,
. , ,
, ,
, Toast .
: , Toast
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4.3

, ,
. , Toast (2 s 3.5 s)
. , Toast
Toast .

4.3.1

, Toast 2 s (*LENGTH_SHORT*) 3.5 s (*LENGTH_LONG*) . 100
. , Toast C_t, C_p, $C_t/(C_t+C_p)$.
4 : , Toast , . :
, , Toast 3.5 s , Toast 2 s , .

4 Toast

	2 s (%)	3.5 s (%)
mix3	0	0
mix 2s	98	98
mi5	99	99
mi8	93	97

4 Toast ( )

	2 s (%)	3.5 s (%)
mi6	93	97
s8	0	0
SMG9	0	0
nova3	0	0
EML-AL00	96	99
nexus6p	98	99
mate20	98	100
HMA	0	0
mate20 x	0	0
pixel 2x1	85	93
pixel 4	96	99
v1813A	0	0
x21iA	0	0
v1816A	99	99
v1813BA	100	100
PMEM00	0	0

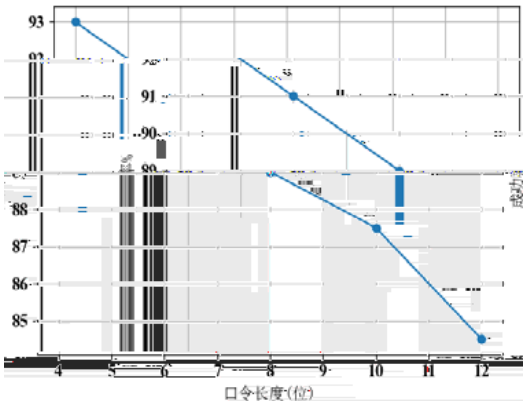
4.3.2

, Toast 3.5 s,

4 6 8 10 12 10 , . 6 .

: , . , Toast ,

. 12 , 84.5%. .



6 -

4.4

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(1) . Maggi [3] ,
,
, . Yue [4]
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, , . Xu [5]
, . Zhou [6]
, . Aviv [7] :
, .
, ,
. , , ,
;

(2) . Jung [8] : , .
, , ,
, . Aonzo [9]
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, . Ren [24] Android ,
. Wang [17] ActivityHijacker, Activity
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,
. , Android , ;

(3) . Niemietz [12] Toast Android UI ,
. Kraunelis [13] , Android . Kalysch
[14] , Android . :
, . Fratantonio [16]
Overlay , Overlay ,
, . .
, . , Android
, .

6

Android Toast ,
. Toast, . , Java
Toast , Toast , . ,
. , ,
, .
Toast , Toast ,
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9 26 , ,
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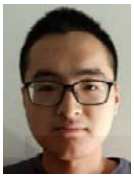
(1982), , , , , CCF , , , , .

(1989), , , IoT .

(1998), , , CCF , .



(1995), , , .

(1998), , , .

(1979), , , , , CCF , , .

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2022 3		, , ,
2022 4		, ,
2022 5		, , , ,
2022 6		, , ,
2022 6		, ,
2022 7		, ,
2022 8		,
2022 9		, , ,
2022 10		, , ,

R : http://www.jos.org.cn / .

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