ABUSING WEB APIS THROUGH SCRIPTED ANDROID APPLICATIONS

DANIEL PECK

- Barracuda Labs Principle Researcher
- Studying Malicious Messaging (Email/Social Networks/etc)
- Data/Trend Analysis in Security

@ramblinpeck

@barracudalabs

Past Lives

- SCADA, Snort Jockey, Reverser (not so past?), Assessment Work

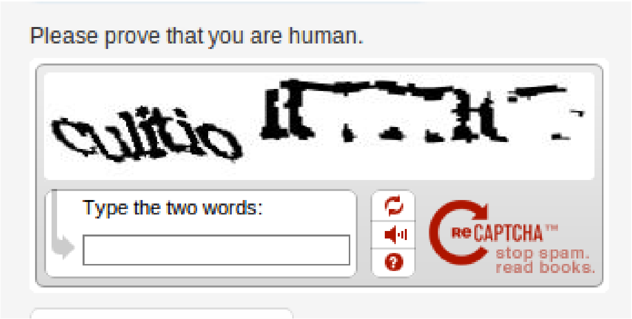
SESSION ROADMAP

- Brief overview of android/dalvik vm
- Reversing an apk
- Disassembly and static analysis
- Dynamic Analysis
- Control/scripting for our own usage

Do the dumb thing first and build on the work of smarter people.

twacebook

- Hot social app that I want to~~spam~~be a part of
- Great web interface, great api once we have a few hundred thousand accounts, but protected



Please prove that you are human.

Type the two words:

SOLUTION

- People are too worried about “friction” to put many safeguard/throttling into mobile apps
- Create our own client that mimics mobile app for api purposes.
- Lets target android

ASSUMPTIONS AND HOPES

- Twacebook has a well documented API thats protected using Oauth
- We'll probably need to extract some keys
- They probably use their own api for android app

BUILD ON EXISTING TOOLS

INTERCEPTING APP COMMUNICATIONS

- Need to MitM to be able to view tx/rx
- Proxydroid
    - **https://github.com/madeye/proxydroid (https://github.com/madeye/proxydroid)**
    - Run all/some of android traffic through our proxy
- SSL
    - The developers at Twacebook aren't idiots

- Create and add a cert to your testing device
    - Easy, and writeups all over so won't detail, basics for 2.x devices:

```
$ adb pull /system/etc/security/cacerts.bks
$ keytool …
$ adb push cacerts.bks /system/etc/security
```

- Gotchas
    - Make sure you have the right version of bouncycastle otherwise things break in not-fun ways
    - Different/easier procedures on Android 4.0+ devices

BURP PROXY

- Invisible proxying, generates cert on demand, but you have to provide hostname
- Look at dns requests/guess hostnames to tell burp to use for generated certs
- Done automatically in 1.4.12 release **http://releases.portswigger.net/2012/08/v1412.html (http://releases.portswigger.net/2012/08/v1412.html)**

INTERCEPTED TRAFFIC

```
POST /create_account HTTP/1.1
Content-Type: application/x-www-form-urlencoded
Content-Length: 296
Accept-Encoding: gzip,deflate
User-Agent: TwacebookAndroidApp(build 6294, v1.8.64)
Host: mobileapi.twacebook.com
Connection: Keep-Alive
Cache-Control: no-cache

auth_consumer_key=40iqOgCcXqfwwqoa02D7nQ
oauth_nonce=0437A32D733151CABA3A06A12243CD0A
oauth_signature_method=HMAC-SHA1
oauth_timestamp=1340141019
oauth_version=1.0
x_auth_mode=client_auth
x_auth_password=f00bar%24
```

```
x_auth_username=jimbo
oauth_signature=v%2FVnCJrssg9D07Zdy%2F8dPSapv8s%3D
```

OAUTH

- Consumers requests a consumer key and consumer secret from provider
- End users allow provider to grant a token and token secret to consumer to make requests on their behalf
- Signs requests (HMAC-SHA1 usually) with consumer secret & token secret

MORE OAUTH

- Users don't have to give their password to third party apps

  Thats good

- Providers get to restrict apps accessing their api to only (honest) approved ones, essentially DRM

  Thats bad

- Designed and works well for server ← → server

  Thats good

- Used extensively for mobile/desktop apps

  Thats just everyone fooling themselves

DISASSEMBLY AND DECOMPILATION

Apktool **http://code.google.com/p/android-apktool/**

(http://code.google.com/p/android-apktool/)

- Decodes apks
- Nice wrapper for smali/baksmali
- In theory should allow for some nice debugging..

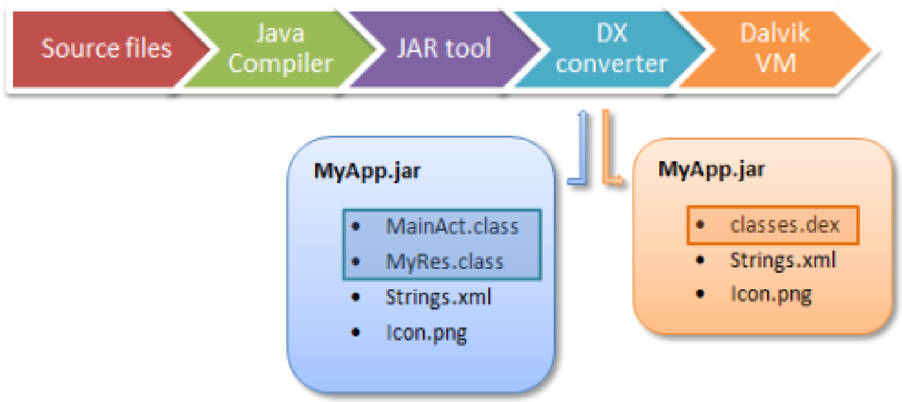
JD-GUI **http://java.decompiler.free.fr/?q=jdgui**

(http://java.decompiler.free.fr/?q=jdgui)

- dex2jar first
- not compilable source, sometimes misleading, good for general idea

ABOUT ANDROID

Runs within a Dalvik application virtual machine



DALVIK

- Register based machine
- Optimized for low memory environments
- Runs dex files
    - Deduped
    - Dalvik instruction set instead of standard JVM
- Smali bytecode

SMALI

```
class public final Lcd;
super Ljava/lang/Object;
# static fields
.field public static final a:Lcd;

.method constructor
init
()V
.locals 2
const/4 v1, 0x0
const/4 v0, 0x0
invoke-direct {p0, v1, v0, v1}, Lcd;-
init
(Laa;ILjava/lang/String;)V
return-void
.end method
```

DECIPHERING SMALI

- Register based machine
  - Parameters are stored in p0...pX
  - Local registers v0...vY where
  - Last X local registers are identical to paramer registers
- Registers store 32-bit values
  - 64-bit values (J, long, and D, double primitives) are stored in 2 registers

PRIMITIVES

Vvoid - can only be used for return types

Zboolean

Bbyte

Sshort

Cchar

Iint

Jlong (64 bits)

Ffloat

Ddouble (64 bits)

Lobjects. You'll see in the form of “Lpackage/name/ObjectName”

FUNCTION DECLARATIONS

```
method private static a
(
Lorg/apache/http/client/methods/HttpRequestBase;
Laa;
J
Ljava/lang/String;
Ljava/lang/String;
)Ljava/lang/String;
```

FUNCTION DECLARATIONS

```
method private static a #name and type
(
Lorg/apache/http/client/methods/HttpRequestBase; #p0
Laa; #p1
J #p2 + #p3
Ljava/lang/String; #p4
Ljava/lang/String; #p5
)Ljava/lang/String; #return type
```

OPCODES

move-result vx

return-object vx

invoke-direct parameters , methodtocall

invoke-static parameters , methodtocall

…

Many more, great reference:

http://pallergabor.uw.hu/androidblog/dalvik_opcodes.html

(http://pallergabor.uw.hu/androidblog/dalvik_opcodes.html)

BACK TO TARGETED CODE

```
const-string p1, "OAuth realm=\"%s\",
oauth_version=\"%s\", oauth_nonce=\"%s\",
oauth_timestamp=\"%s\", oauth_signature=\"%s\",
oauth_consumer_key=\"%s\", oauth_signature_method=\"%s\""
new-array p3, p3, [Ljava/lang/Object;
…
const/4 p2, 0x4
aput-object p0, p3, p2
const/4 p0, 0x5
aput-object p4, p3, p0
…
invoke-static {p1, p3}, Ljava/lang/String;-
>format(Ljava/lang/String;
[Ljava/lang/Object;)Ljava/lang/String;
move-result-object p0
```

BACK TO TARGETED CODE

```
const-string p1, "OAuth realm=\"%s\",
oauth_version=\"%s\", oauth_nonce=\"%s\",
oauth_timestamp=\"%s\", oauth_signature=\"%s\",
oauth_consumer_key=\"%s\", oauth_signature_method=\"%s\""
new-array p3, p3, [Ljava/lang/Object; #create array
…
const/4 p2, 0x4
aput-object p0, p3, p2 #filling array
const/4 p0, 0x5
aput-object p4, p3, p0
…
invoke-static {p1, p3}, Ljava/lang/String;-
>format(Ljava/lang/String;
[Ljava/lang/Object;)Ljava/lang/String; #filling in string
move-result-object p0
```

```
invoke-static {p0, p5, v0}, Lcd;-> a(
Ljava/lang/String;
Ljava/lang/String;
Ljava/lang/String;)Ljava/lang/String;
move-result-object p0
```

```
invoke-virtual {v0, v1}, Ljava/lang/String;-
>getBytes(Ljava/lang/String;)[B
    move-result-object v0
    new-instance v1, Ljavax/crypto/spec/SecretKeySpec;
    const-string v2, "HmacSHA1"
    invoke-direct {v1, v0, v2},
Ljavax/crypto/spec/SecretKeySpec;-><init>
([BLjava/lang/String;)V
    invoke-static {v0}, Ljavax/crypto/Mac;-
>getInstance(Ljava/lang/String;)Ljavax/crypto/Mac;
...
    invoke-virtual {v0, v1}, Ljavax/crypto/Mac;-
>init(Ljava/security/Key;)V
    const-string v1, "UTF8"
    invoke-virtual {p0, v1}, Ljava/lang/String;-
>getBytes(Ljava/lang/String;)[B
    move-result-object v1
    invoke-virtual {v0, v1}, Ljavax/crypto/Mac;-
```

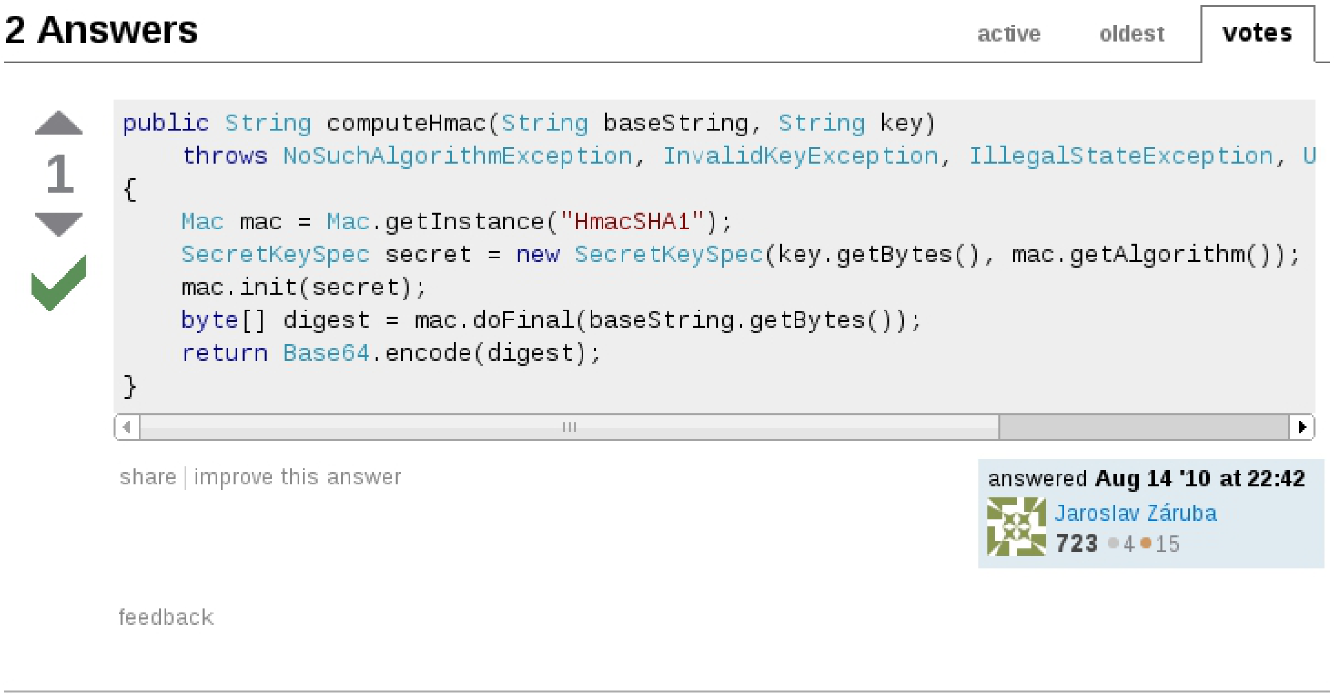
```
>doFinal([B)[B
    move-result-object v0
```

AND FROM JD-GUI

```
 private static String a(String paramString1, String 
paramString2, String paramString3)
  {
    if (paramString3 == null);
    while (true)
    {
      try
      {
        str1 = "";
        SecretKeySpec localSecretKeySpec = new 
SecretKeySpec((ch.a(paramString2) + "&" + 
ch.a(str1)).getBytes("UTF8"), "HmacSHA1");
        Mac localMac = Mac.getInstance("HmacSHA1");
        localMac.init(localSecretKeySpec);
        String str3 = ch.a(new 
String(cc.a(localMac.doFinal(paramString1.getBytes("UTF8"))),
 "UTF8"));
        str2 = str3;
        return str2;
      }
      catch (InvalidKeyException
localInvalidKeyException)
      {
        str2 = "";
        continue;
      }
      catch (NoSuchAlgorithmException
localNoSuchAlgorithmException)
      {
        str2 = "";
        continue;
      }
      catch (UnsupportedEncodingException
localUnsupportedEncodingException)
      {
        String str2 = "";
        continue;
      }
      String str1 = paramString3;
```

```
    }
}
```

LOOK SIMILAR?



2 Answers

```
public String computeHmac(String baseString, String key)
    throws NoSuchAlgorithmException, InvalidKeyException, IllegalStateException, U
{
    Mac mac = Mac.getInstance("HmacSHA1");
    SecretKeySpec secret = new SecretKeySpec(key.getBytes(), mac.getAlgorithm());
    mac.init(secret);
    byte[] digest = mac.doFinal(baseString.getBytes());
    return Base64.encode(digest);
}
```

answered **Aug 14 '10 at 22:42**
Jaroslav Záruba
723 ●4 ●15

AGAIN, DUMB THING FIRST

Printf debugging

```
const-string v2, "SECRETKEY , v0"
invoke-static {v2, v0}, Landroid/util/Log;-
>d(Ljava/lang/String;Ljava/lang/String;)I
invoke-virtual {v0, v1}, Ljava/lang/String;-
>getBytes(Ljava/lang/String;)[B
move-result-object v0
new-instance v1, Ljavax/crypto/spec/SecretKeySpec;
const-string v2, "HmacSHA1"
invoke-direct {v1, v0, v2},
Ljavax/crypto/spec/SecretKeySpec;-
init
  ([BLjava/lang/String;)V
```

Rebuild the apk and run it

```
$ apktool b twacebook.apk twacebook_new.apk
```

EXAMING THE LOGS

```
$ adb shell
$ adb logcat
…
"SECRETKEY , v0 -
I7PW5lgEkgMrqPOdxIj1o6llAbFdXHhVjFnvUsg1g"
```

SUCESS?

ERROR, INVALID SIGNATURE

Sadness → Confusion → Realization

Twacebook devs have been especially sneaky, passing the returned signatured to another method

Custom hash/encoding? No clue but its ugly

```
.method public final a([BIILjava/io/OutputStream;)I
    .locals 9

    const/4 v8, 0x0

    rem-int/lit8 v0, p3, 0x3

    sub-int v1, p3, v0

    move v2, v8

    :goto_0
    add-int/lit8 v3, v1, 0x0

    if-ge v2, v3, :cond_0

    aget-byte v3, p1, v2
    and-int/lit16 v3, v3, 0xff

    add-int/lit8 v4, v2, 0x1

    aget-byte v4, p1, v4
and-int/lit16 v4, v4, 0xff

    add-int/lit8 v5, v2, 0x2

    aget-byte v5, p1, v5

    and-int/lit16 v5, v5, 0xff

    iget-object v6, p0, Ll;->a:[B

    ushr-int/lit8 v7, v3, 0x2

    and-int/lit8 v7, v7, 0x3f

    aget-byte v6, v6, v7

    invoke-virtual {p4, v6}, Ljava/io/OutputStream;-
>write(I)V
```

```
    iget-object v6, p0, Ll;->a:[B

    shl-int/lit8 v3, v3, 0x4

    ushr-int/lit8 v7, v4, 0x4

    or-int/2addr v3, v7

    and-int/lit8 v3, v3, 0x3f

    aget-byte v3, v6, v3

    invoke-virtual {p4, v3}, Ljava/io/OutputStream;->write(I)V

    iget-object v3, p0, Ll;->a:[B

    shl-int/lit8 v4, v4, 0x2

    ushr-int/lit8 v6, v5, 0x6

    or-int/2addr v4, v6
    and-int/lit8 v4, v4, 0x3f

    aget-byte v3, v3, v4

    invoke-virtual {p4, v3}, Ljava/io/OutputStream;->write(I)V

    iget-object v3, p0, Ll;->a:[B

    and-int/lit8 v4, v5, 0x3f

    aget-byte v3, v3, v4

    invoke-virtual {p4, v3}, Ljava/io/OutputStream;->write(I)V

    add-int/lit8 v2, v2, 0x3

    goto :goto_0

    :cond_0
    packed-switch v0, :pswitch_data_0
```

```
:goto_1
:pswitch_0
div-int/lit8 v1, v1, 0x3

mul-int/lit8 v1, v1, 0x4

if-nez v0, :cond_1

move v0, v8

:goto_2
add-int/2addr v0, v1

return v0

:pswitch_1
add-int/lit8 v2, v1, 0x0

aget-byte v2, p1, v2

and-int/lit16 v2, v2, 0xff
```

```
    ushr-int/lit8 v3, v2, 0x2

    and-int/lit8 v3, v3, 0x3f

    shl-int/lit8 v2, v2, 0x4

    and-int/lit8 v2, v2, 0x3f

    iget-object v4, p0, Ll;->a:[B

    aget-byte v3, v4, v3

    invoke-virtual {p4, v3}, Ljava/io/OutputStream;->write(I)V

    iget-object v3, p0, Ll;->a:[B

    aget-byte v2, v3, v2

    invoke-virtual {p4, v2}, Ljava/io/OutputStream;->write(I)V

    iget-byte v2, p0, Ll;->b:B
    invoke-virtual {p4, v2}, Ljava/io/OutputStream;-
>write(I)V

    iget-byte v2, p0, Ll;->b:B

    invoke-virtual {p4, v2}, Ljava/io/OutputStream;-
>write(I)V

    goto :goto_1

    :pswitch_2
    add-int/lit8 v2, v1, 0x0

    aget-byte v2, p1, v2

    and-int/lit16 v2, v2, 0xff

    add-int/lit8 v3, v1, 0x0

    add-int/lit8 v3, v3, 0x1

    aget-byte v3, p1, v3
```

```
and-int/lit16 v3, v3, 0xff

ushr-int/lit8 v4, v2, 0x2

and-int/lit8 v4, v4, 0x3f

shl-int/lit8 v2, v2, 0x4

ushr-int/lit8 v5, v3, 0x4

or-int/2addr v2, v5

and-int/lit8 v2, v2, 0x3f

shl-int/lit8 v3, v3, 0x2

and-int/lit8 v3, v3, 0x3f

iget-object v5, p0, Ll;->a:[B

aget-byte v4, v5, v4
```

```
    invoke-virtual {p4, v4}, Ljava/io/OutputStream;->write(I)V

    iget-object v4, p0, Ll;->a:[B

    aget-byte v2, v4, v2

    invoke-virtual {p4, v2}, Ljava/io/OutputStream;->write(I)V

    iget-object v2, p0, Ll;->a:[B

    aget-byte v2, v2, v3

    invoke-virtual {p4, v2}, Ljava/io/OutputStream;->write(I)V

    iget-byte v2, p0, Ll;->b:B

    invoke-virtual {p4, v2}, Ljava/io/OutputStream;->write(I)V

    goto :goto_1
    :cond_1
    const/4 v0, 0x4

    goto :goto_2

    :pswitch_data_0
    .packed-switch 0x0
        :pswitch_0
        :pswitch_1
        :pswitch_2
    .end packed-switch
.end method
```

JD-GUI Output

```
  public final int a(byte[] paramArrayOfByte, int 
paramInt1, int paramInt2, OutputStream paramOutputStream)
  {
    int i = paramInt2 % 3;
    int j = paramInt2 - i;
    for (int k = 0; k < j + 0; k += 3)
    {
      int i9 = 0xFF & paramArrayOfByte[k];
      int i10 = 0xFF & paramArrayOfByte[(k + 1)];
      int i11 = 0xFF & paramArrayOfByte[(k + 2)];
      paramOutputStream.write(this.a[(0x3F & i9 >>> 2)]);
      paramOutputStream.write(this.a[(0x3F & (i9 << 4 | 
i10 >>> 4))]);
      paramOutputStream.write(this.a[(0x3F & (i10 << 2 | 
i11 >>> 6))]);
      paramOutputStream.write(this.a[(i11 & 0x3F)]);
```

```
}
int i4;
switch (i)
{
case 0:
default:
  i4 = 4 * (j / 3);
  if (i != 0)
    break;
case 1:
case 2:
}
for (int i5 = 0; ; i5 = 4)
{
  return i5 + i4;
  int i6 = 0xFF & paramArrayOfByte[(j + 0)];
  int i7 = 0x3F & i6 >>> 2;
  int i8 = 0x3F & i6 << 4;
  paramOutputStream.write(this.a[i7]);
  paramOutputStream.write(this.a[i8]);
  paramOutputStream.write(this.b);
  paramOutputStream.write(this.b);
  break;
```

```
        int m = 0xFF & paramArrayOfByte[(j + 0)];
        int n = 0xFF & paramArrayOfByte[(1 + (j + 0))];
        int i1 = 0x3F & m >>> 2;
        int i2 = 0x3F & (m << 4 | n >>> 4);
        int i3 = 0x3F & n << 2;
        paramOutputStream.write(this.a[i1]);
        paramOutputStream.write(this.a[i2]);
        paramOutputStream.write(this.a[i3]);
        paramOutputStream.write(this.b);
        break;
      }
    }
```

SAD PANDA
IS SAD

BUT WAIT, JRUBY?

Ruby interpreter implemented in Java

Allows calling java functions/libraries from ruby

And thankfully, dex are just another kind of jar

```
$ unzip twacebook.apk
$ d2j-dex2jar.sh classes.dex -o twacebook.jar
```

```
require 'java'
require './jars/twacebook.jar'
require './jars/android.jar'

java_import 'cc' do |clasname|
  "Obfuscater"
end

obs_arr = Obfuscater.a(byte_arr)
signature = String.from_java_bytes(obs_arr)
```

ITTERATING UP

```
require 'java'
require './jars/twacebook.jar'
require './jars/android.jar'

java_import 'ab' do |clasname|
    "User"
end

java_import 'cc' do |clasname|
    "ApiFactory"
end

social_bot = ApiFactory.register_new_user(<name>,
<email>)

social_bot.post_update("Posting from a JRUBY")
```

BUT HOW TO GET REALISTIC SOCIAL BOTS?

Stereotyping

BUILD ON OPEN DATA SOURCES

- US Census data
    - Last Name -> Ethnicity Mapping
- Facebook Data Dump circa 2010
    - Profile links -> pictures
    - Names to mix and match
- Mash up with scripts

REALISTIC INTERESTS

Pick a random sample of suggested users to follow from the services

Get "interest" areas from there.

Services give you the corpus of for your own filtering

EARNING REPORT OF SELLING FAKE FOLLOWERS BUSINESS

Forget malware distributing and spam

20k Followers sell for $30-$80

A few thousand puppet accounts closer to an advertorial social world...

EXPANDING

Opens up reuse of APK code for scripting

Testing frameworks for android apps in ruby?

Great for dynamic analysis during reversing, easily test assumptions with rapid smali->build->run.

And of course bypassing anything you don't want to deal with...

Almost certainly some bugs/inconsistencies. Find them. Have fun

Thank you Blackhat USA

Your ideas, thoughts and questions

peck@barracuda.com (mailto:dpeck@barracuda.com)

peck@danielpeck.com (mailto:peck@danielpeck.com)

@ramblinpeck

@barracudalabs