Using bulk_extractor for digital forensics triage and cross-drive analysis

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- Wednesday, August 8th, 2012. 12:30–2:30
  - *This tutorial will provide an in-depth introduction to the use of bulk_extractor, a high-speed feature extractor tool that can be used with any kind of digital forensics data. The tutorial will discuss how to use bulk_extractor for rapid triage of new media, how to use bulk_extractor's post-processing features for file identification and cross-drive correlation, and how to tune bulk_extractor to improve performance. Finally the internal design of the program will be presented, with instructions on how to develop new bulk_extractor modules.*

NPS is the Navy's Research University.

Location: Monterey, CA

Students: 1500

- US Military (All 5 services)
- US Civilian (Scholarship for Service & SMART)
- Foreign Military (30 countries)

Monterey, CA

Schools:

- Business & Public Policy
- Engineering & Applied Sciences
- Operational & Information Sciences
- International Graduate Studies

NCR Initiative:

- 8 offices on 5th floor, 900N Glebe Road, Arlington
- Current staffing: 4 professors, 2 lab managers, 2 programmers, 4 contractors
- **OPEN SLOTS FOR .GOV PHDs!**

900N Glebe, Arlington, VA

NPS research: “Automated Media Exploitation”

Area #1: Bulk Data Analysis

- Feature extraction (bulk_extractor)
- Statistical techniques (random sampler)
- Similarity metrics (sdhash & sdtext)

Area #2: End-to-end automation of forensic processing

- Digital Forensics XML Toolkit (fiwalk, md5deep, etc.)
- Disk Image ⇛ Power Point (smirk)

Area #3: Data mining for digital forensics

- Automated analysis (cross-drive analysis)

Area #4: Creating Standardized Forensic Corpora

- Freely redistributable disk and memory images, packet dumps, files (digitalcorpora.org).

Outline of today's tutorial

Introducing bulk_extractor

- Overview and history
- Output formats

Using bulk_extractor's output

Finding files

Cross drive analysis

Internal structure and writing plug-ins

Introducing bulk_extractor

Stream-Based Disk Forensics:
Scan the disk from beginning to end; do your best.

0 → 1TB

3 hours, 20 min to *read* the data

1. Read all of the blocks in order.
2. Look for information that might be useful.
3. Identify & extract what's possible in a single pass.

Primary Advantage: Speed

No disk seeking! (Good for HDs, SSDs, & E01 files)

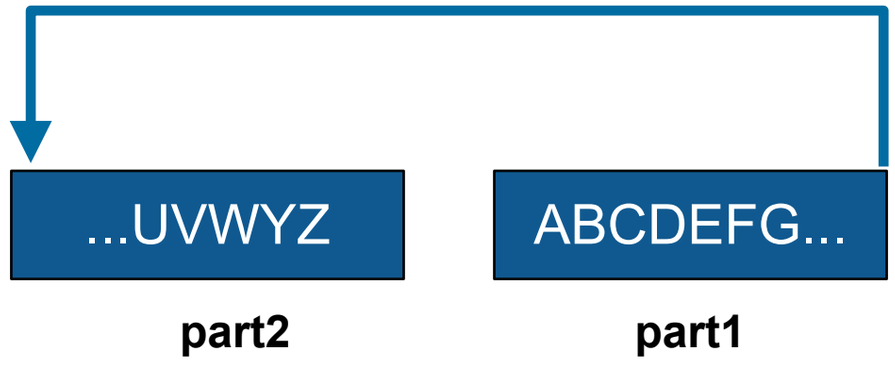
Easy to parallelize ("embarrassingly parallel")

Reads all the data — allocated files, deleted files, file fragments

Caveats:

- Compressed data must be decompressed
  - —*Fragmented, compressed files may not be recovered*
- Can only read at maximum I/O transfer rates if data can be *processed*
  - —*Even 24+ cores may not be enough*
- Does not provide file names
  - —*File names can be determined with a separate metadata extraction step.*

Fragmented files may not be recovered



ZIP, GZIP & LZMA use *adaptive* compression algorithms.

- Part 1 required to decompress part 2.
- Also an issue for JPEG.

Fortunately, most files are *not* fragmented.

- Individual components of a ZIP can be recovered (e.g. `word/document.xml`)

Most files that *are* fragmented have carvable internal structure:

- Log files, Outlook PST files, etc.

Our experience: bulk_extractor is *faster* and *finds data other tools miss*.

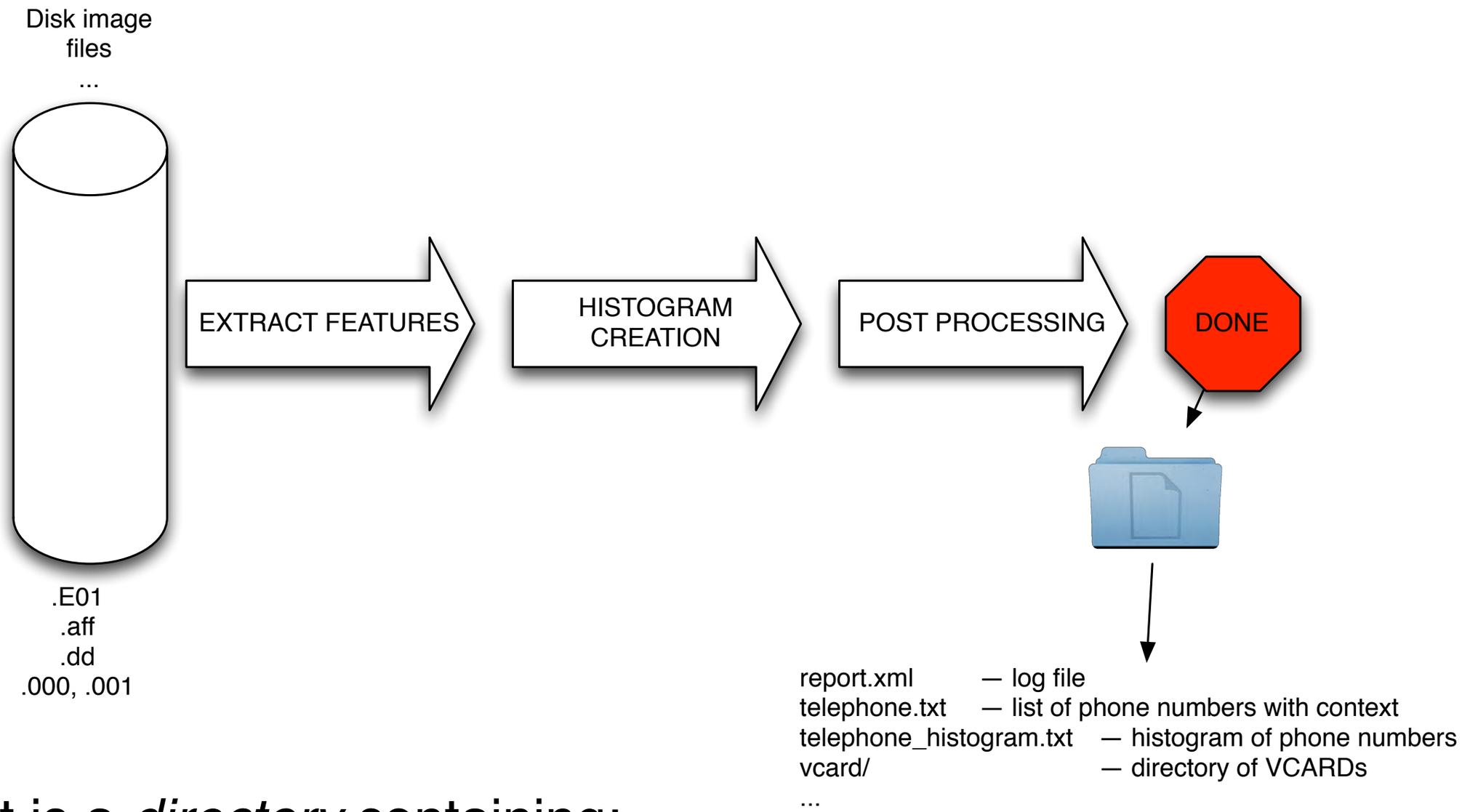
Runs 2-10 times faster than EnCase or FTK *on the same hardware.*

- bulk_extractor is multi-threaded; EnCase 6.x and FTK 3.x have little threading.

Finds email address, URLs, CCNs that other tools miss

- "Optimistically" decompresses and re-analyzes all data.
  - —*zip fragments*
  - —*gzip browser cache runs*
- Decompression operates on incomplete and corrupted data (until decompression fails)
- Decompresses fragments of Windows Hibernation Files
- Builds word lists for password cracking

bulk_extractor has three phases of operation: Feature Extraction; Histogram Creation; Post Processing



Output is a *directory* containing:

- feature files; histograms; carved objects
- Mostly in UTF-8; some XML
- Can be bundled into a ZIP file and process with bulk_extractor_reader.py

Feature files are UTF-8 files that contain extracted data.

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents/charlie-2009-12-11.E01
# Feature-Recorder: telephone
# Feature-File-Version: 1.1
...
6489225486    (316) 788-7300   Corrine Porter (316) 788-7300,,,,,,Phase I En
6489230027    620-723-2638    ,,,,Dan Hayse - 620-723-2638,,,,,,Phase I En
6489230346    620-376-4499    Bertha Mangold -620-376-4499,,,,,,Phase I En
...
3772517888-GZIP-28322  (831) 373-5555  onterey-<nobr>(831) 373-5555</nobr>
3772517888-GZIP-29518  (831) 899-8300  Seaside - <nobr>(831) 899-8300</nobr>
5054604751    716-871-2929    a%,888-571-2048,716-871-2929\x0D\x0ACPV,,,%Cape
```

Offset **Feature** **Context**

Designed for easy processing by python, perl or C++ program

- “Loosely ordered.”
- -GZIP- indicates that data was decompressed
- Non-UTF-8 characters are escaped

Histogram system automatically summarizes features.

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents/charlie-2009-12-11.E01
# Feature-Recorder: email
# Histogram-File-Version: 1.1
...
n=875   mozilla@kewis.ch          (utf16=3)
n=651   charlie@m57.biz (utf16=120)
n=605   ajbanck@planet.nl
...
n=288   mattwillis@gmail.com
n=281   garths@oeone.com
n=226   michael.buettner@sun.com          (utf16=2)
n=225   bugzilla@babylonsounds.com
n=218   berend.cornelius@sun.com
n=210   ips@mail.ips.es
n=201   mschroeder@mozilla.x-home.org
n=186   pat@m57.biz      (utf16=1)
```

-

Histogram of search terms can convey intent.

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents/charlie-2009-12-11.E01
# Feature-Recorder: url
# Histogram-File-Version: 1.1
n=59    1
n=53    exotic+car+dealer
n=41    ford+car+dealer
n=34    2009+Shelby
n=25    steganography
n=23    General+Electric
n=23    time+travel
n=19    steganography+tool+free
n=19    vacation+packages
n=16    firefox
n=16    quicktime
n=14    7zip
n=14    fox+news
n=13    hex+editor
```

-

New in bulk_extractor 1.3

New supported data types:

- Windows PE Scanner
- Linux ELF Scanner
- VCARD Scanner
- BASE16 scanner
- Windows directory carver

New Histogram options:

- Numeric only option for phone numbers
- Supports new Facebook ID

Better Unicode Support:

- Histograms now UTF-8 / UTF-16 aware
- Feature files are UTF-8 clean

Limited support for file carving:

- packets carved into pcap files
- VCARD carver

A bulk_extractor success story:
City of San Luis Obispo Police Department, Spring 2010

District Attorney filed charges against two individuals:

- Credit Card Fraud
- Possession of materials to commit credit card fraud.

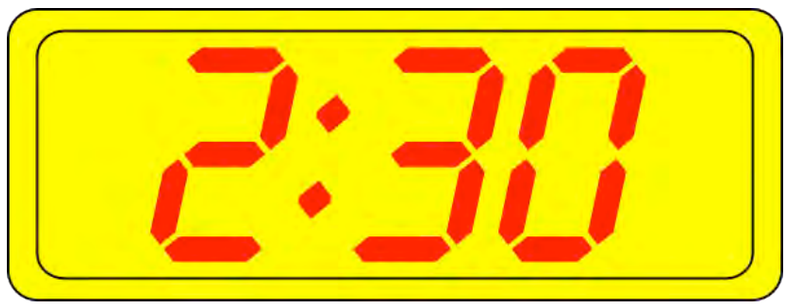
Defendants:

- Arrested with a computer.
- Expected to argue that defends were unsophisticated and lacked knowledge.

Examiner given 250GB drive *the day before preliminary hearing.*

- Typically, it would take several days to conduct a proper forensic investigation.

bulk_extractor found actionable evidence in 2.5 hours!



Bulk_extractor found:

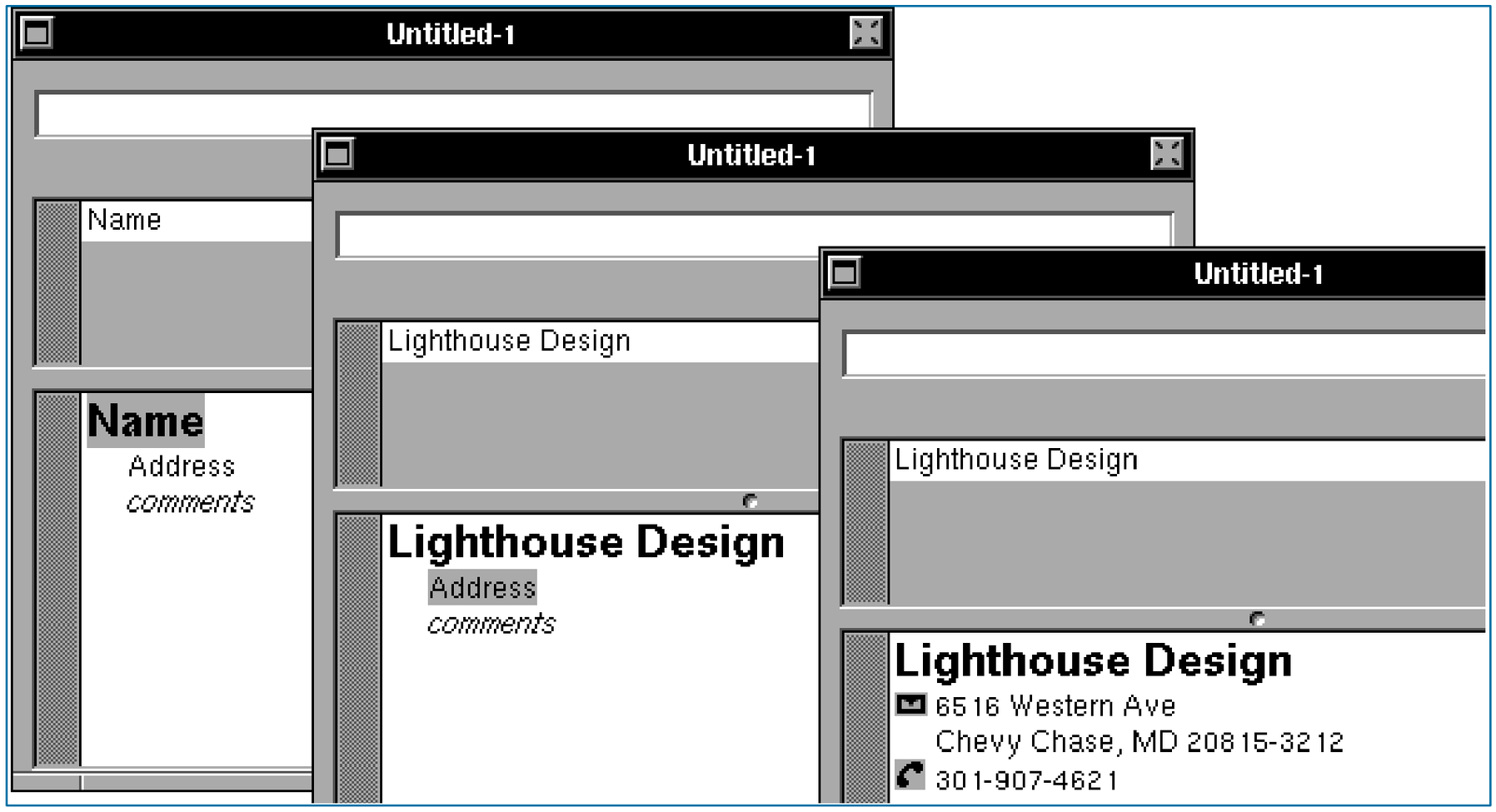
- Over 10,000 credit card numbers on the HD (1000 unique)
- Most common email address belonged to the primary defendant (possession)
- The most commonly occurring Internet search engine queries concerned credit card fraud and bank identification numbers (intent)
- Most commonly visited websites were in a foreign country whose primary language is spoken fluently by the primary defendant.

Armed with this data, the defendants were held without bail.

History of bulk_extractor

bulk_extractor: 20+ years of work

In 1991 I developed SBook, a free-format address book.

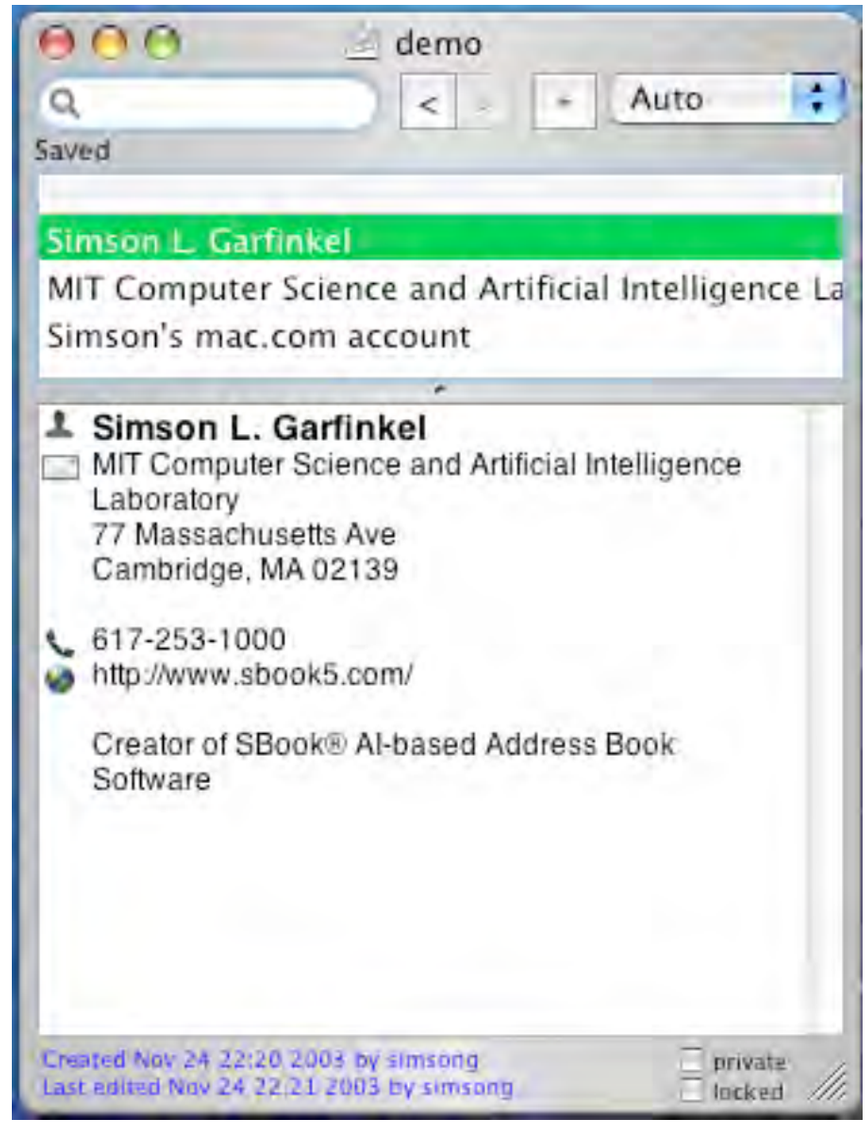


SBook automatically found addresses, phone numbers, email addresses *while you typed.*

Today we call this technology Named Entity Recognition

SBook's technology was based on:

- Regular expressions executed in parallel
  - *US, European, & Asian Phone Numbers*
  - *Email Addresses*
  - *URLs*
- A gazette with more than 10,000 names:
  - *Common "Company" names*
  - *Common "Person" names*
  - *Every country, state, and major US city*
- Hand-tuned weights and additional rules.



Implementation:

- 2500 lines of GNU flex, C++
- 50 msec to evaluate 20 lines of ASCII text.
  - *Running on a 25Mhz 68030 with 32MB of RAM!*

In 2003, I bought 200 used hard drives

The goal was to find drives that had not been properly sanitized.

First strategy:

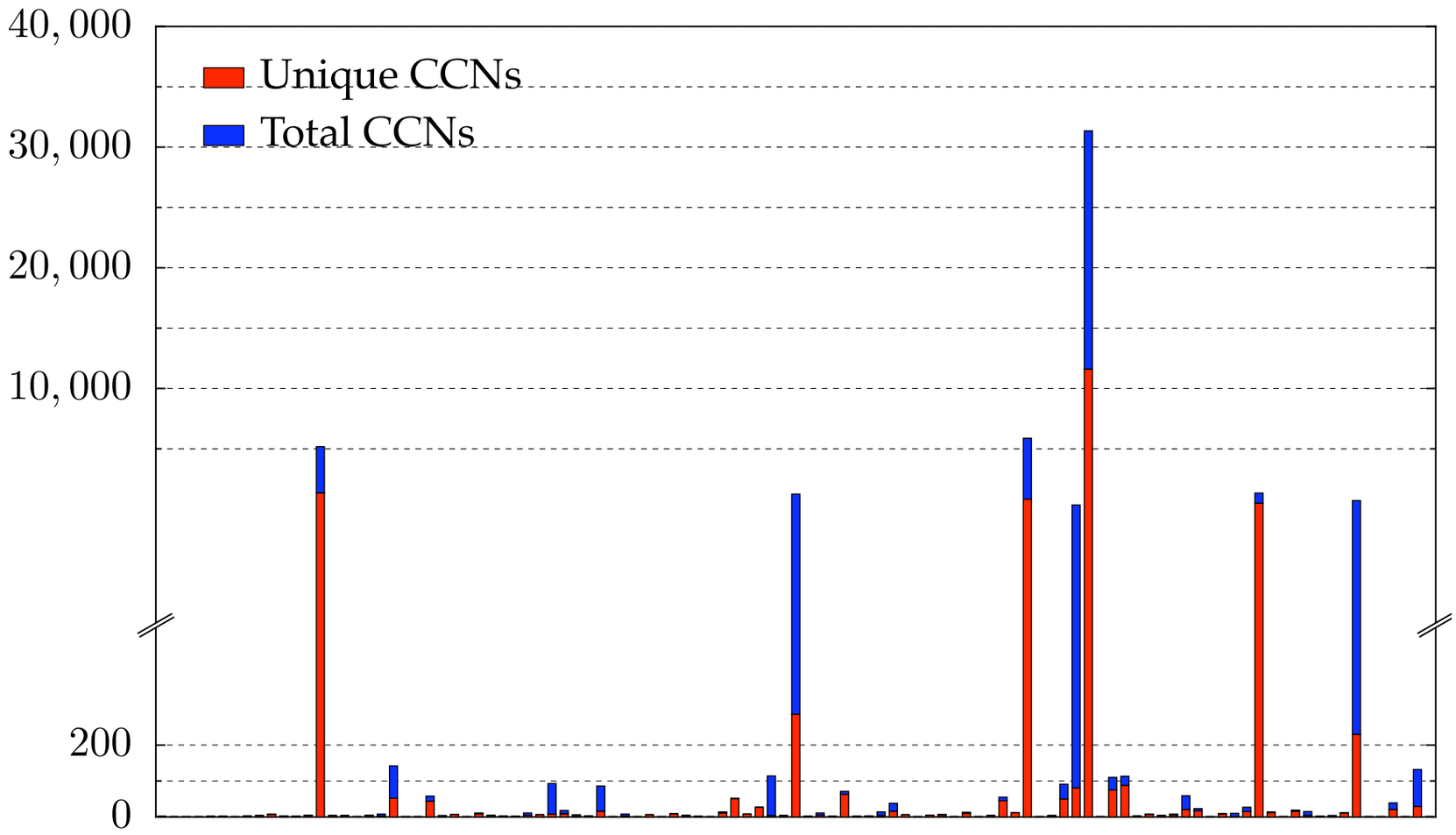
- **dd** all of the disks to image files
- **strings** to extract printable strings.
- **grep** to scan for email, CCN, etc.
  - *VERY SLOW!!!!*
  - *HARD TO MODIFY!*

Second strategy:

- Use SBook technology!
- Read disk 1MB at a time
- Pass the *raw disk sectors* to flex-based scanner.
- Big surprise: scanner didn't crash!

flex-based scanners required substantial post-processing to be useful

- Additional validation beyond regular expressions (CCN Luhn algorithm, etc).
- Examination of feature “neighborhood” to eliminate common false positives.
- Counting and histogram analysis to find drives with most “credit card numbers”



The technique worked well to find drives with sensitive information.

Between 2005 and 2008, we interviewed law enforcement regarding their use of forensic tools.

Law enforcement officers wanted a *highly automated* tool for finding:

- Email addresses & Credit card numbers (including track 2 information)
- Phone numbers, GPS coordinates & EXIF information from JPEGs
- Search terms (extracted from URLs)
- All words that were present on the disk (for password cracking)

The tool had to:

- Run on Windows, Linux, and Mac-based systems
- Run with *no* user interaction
- Operate on raw disk images, split-raw volumes, E01 files, and AFF files
- Run at maximum I/O speed of physical drive
- Never crash

Moving technology from the lab to the field has been challenging:

- Must work with evidence files of *any size* and on *limited hardware.*
- Users can't provide their data when the program crashes.
- Users are *analysts* and *examiners*, not engineers.

Inside bulk_extractor

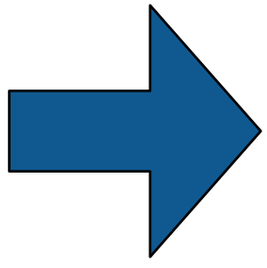
bulk_extractor: architectural overview

Written in C++, GNU flex and Java (GUI)

- Command-line tool.
- Linux, MacOS, Windows (compiled with mingw)
- BEViewer command-line tool and views results

Key Features:

- “Scanners” look for information of interest in typical investigations.
- Recursively re-analyzes compressed data.
- Results stored in “feature files”
- Multi-threaded



http://www.nps.edu/

202-555-1212
user@domain.com

202-555-1212

http://www.nps.edu/

user@domain.com

bulk_extractor: system diagram

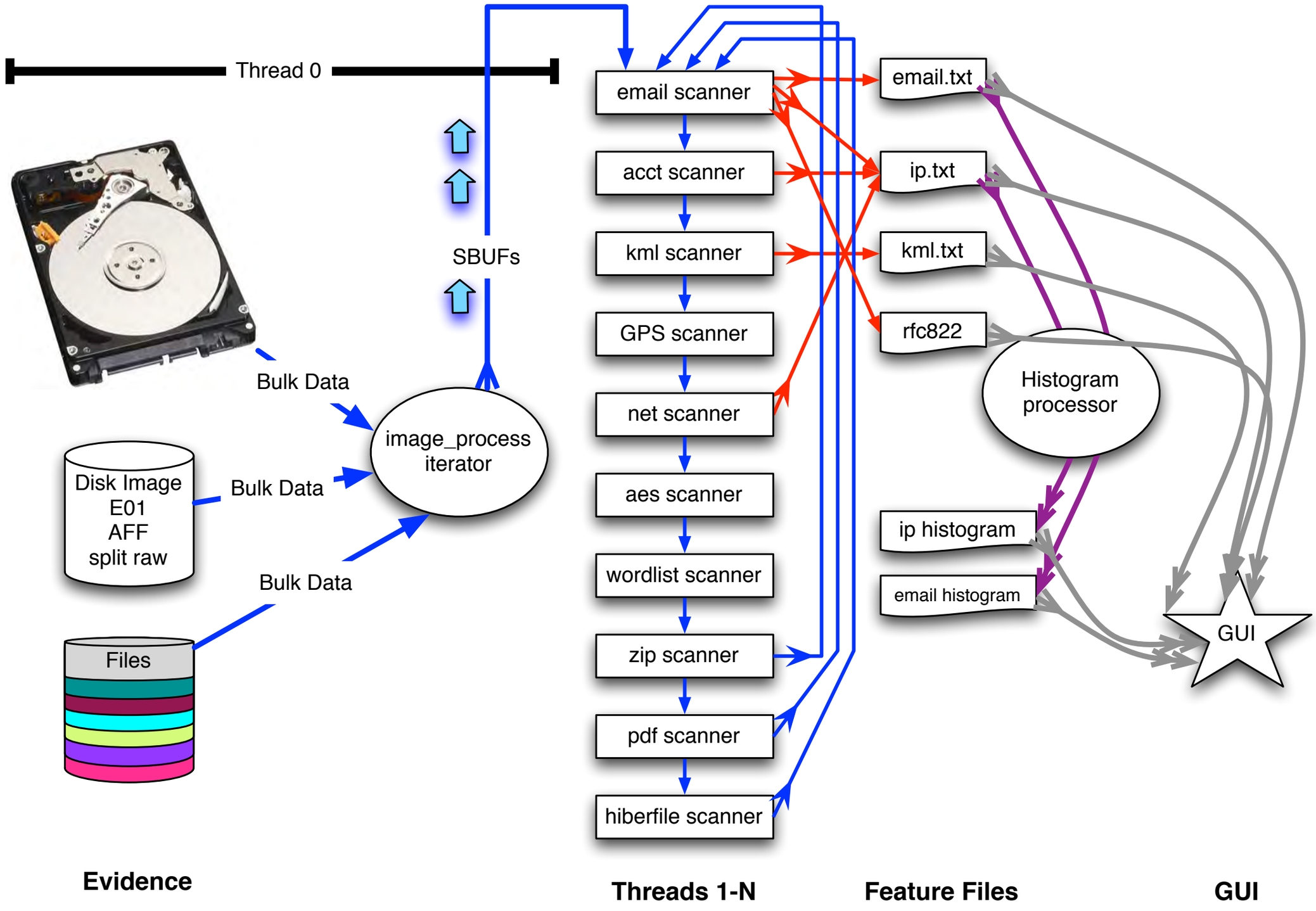
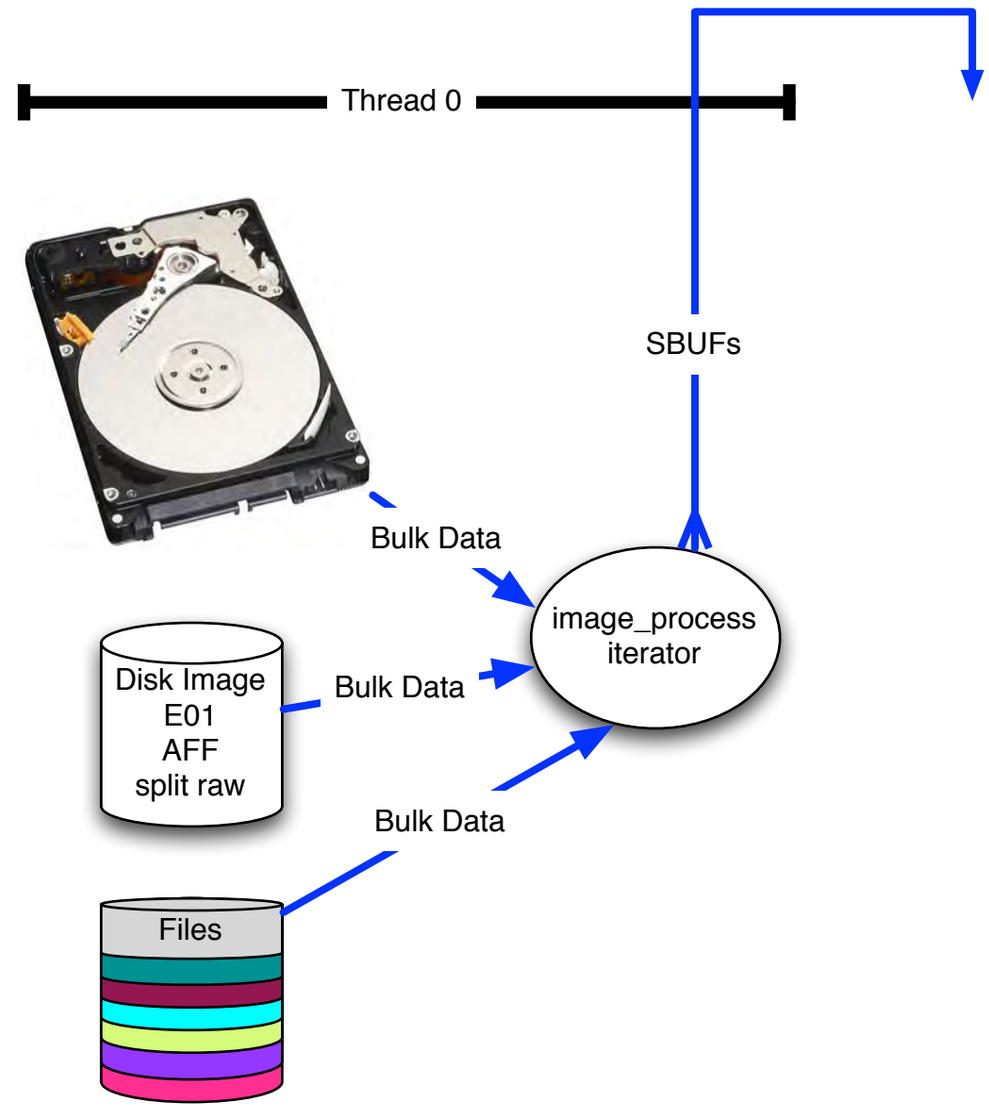


image processing
C++ iterator handles disks, images and files

Works with multiple disk formats.

- E01
- AFF
- raw
- split raw
- individual disk files



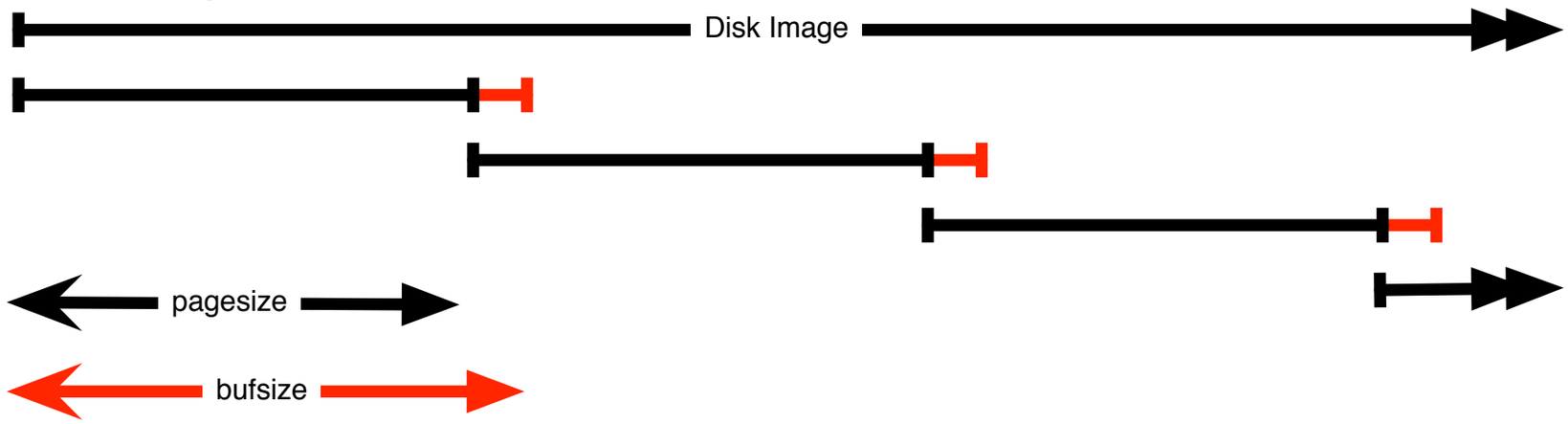
Evidence

We chop the 1TB disk into 65,536 x 16MiB “pages” for processing.

The “pages” overlap to avoid dropping features that cross buffer boundaries.

The overlap area is called the *margin*.

- Each sbuf can be processed in parallel — they don’t depend on each other.
- Features start in the page but end in the margin are *reported*.
- Features that start in the margin are *ignored* (we get them later)
  - *Assumes that the feature size is smaller than the margin size.*
  - *Typical margin: 1MB*



Entire system is automatic:

- Image_process iterator makes **sbuf_t** buffers.
- Each buffer is processed by every scanner
- Features are automatically combined.

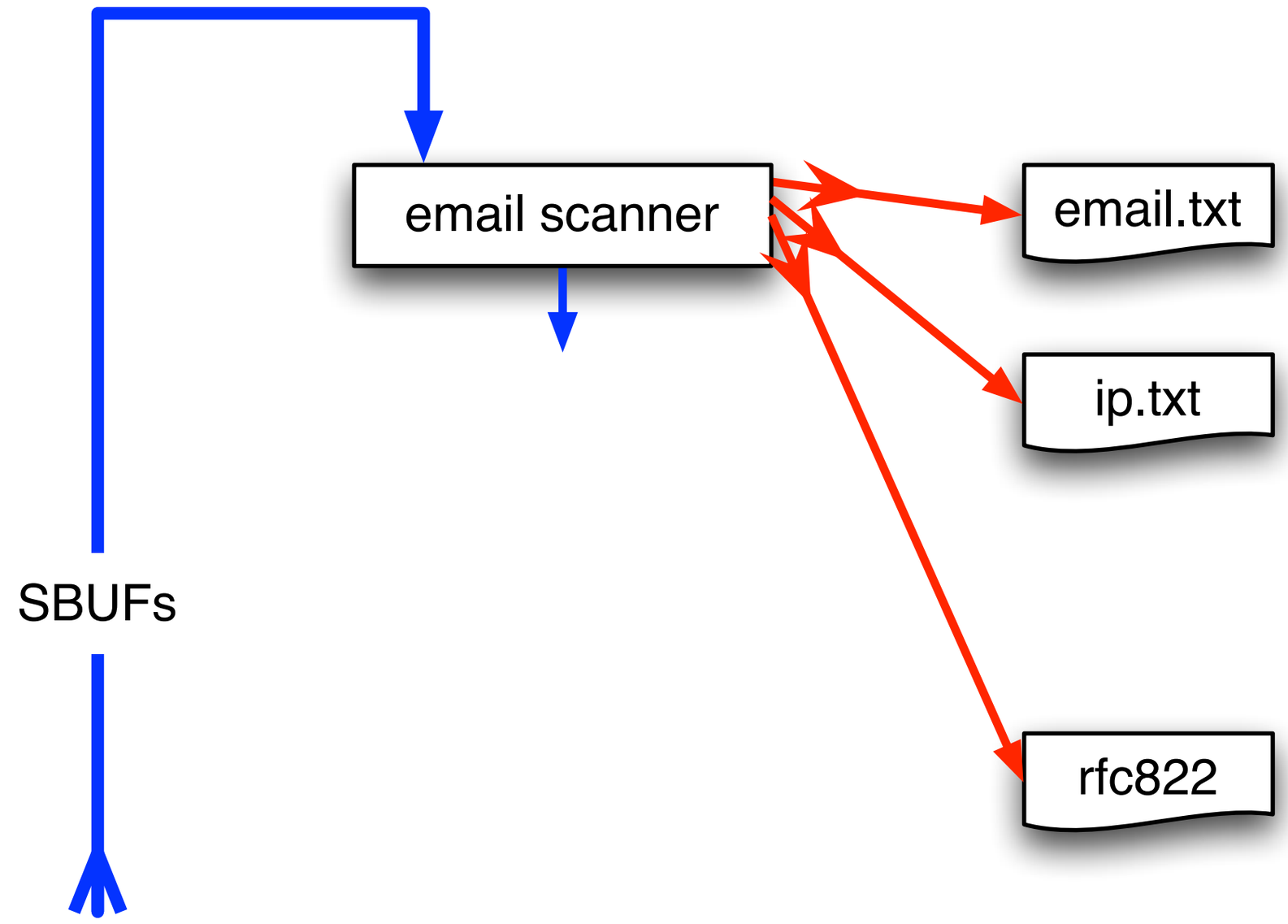
Scanners process each page and extract features

scan_email is the email scanner.

- inputs: **sbuf** objects

outputs:

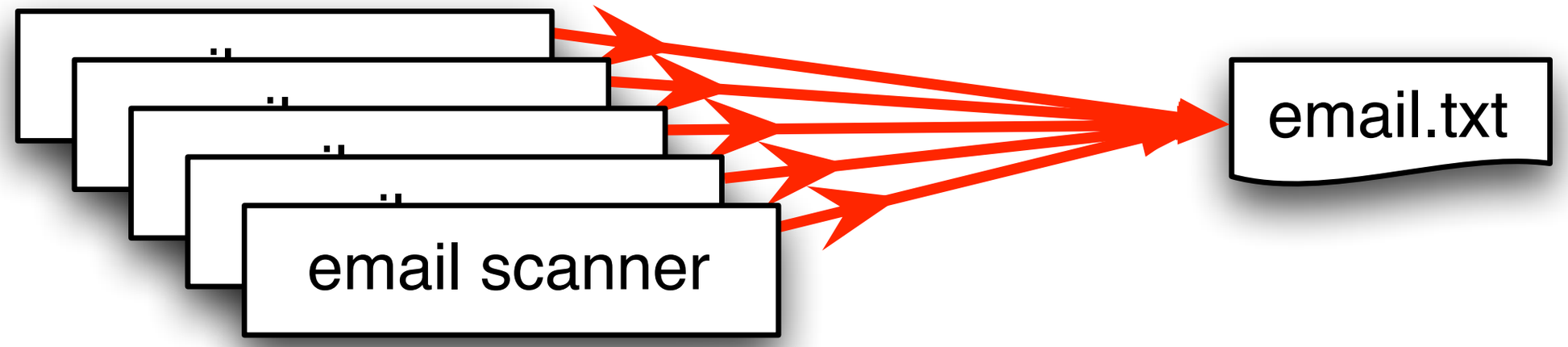
- **email.txt**
  - —*Email addresses*
- **rfc822.txt**
  - —*Message-ID*
  - —*Date:*
  - —*Subject:*
  - —*Cookie:*
  - —*Host:*
- **domain.txt**
  - —*IP addresses*
  - —*host names*



The *feature recording system* saves features to disk.

Feature Recorder objects store the features.

- Scanners are given a (feature_recorder *) pointer
- Feature recorders are *thread safe*.



Features are stored in a *feature file:*

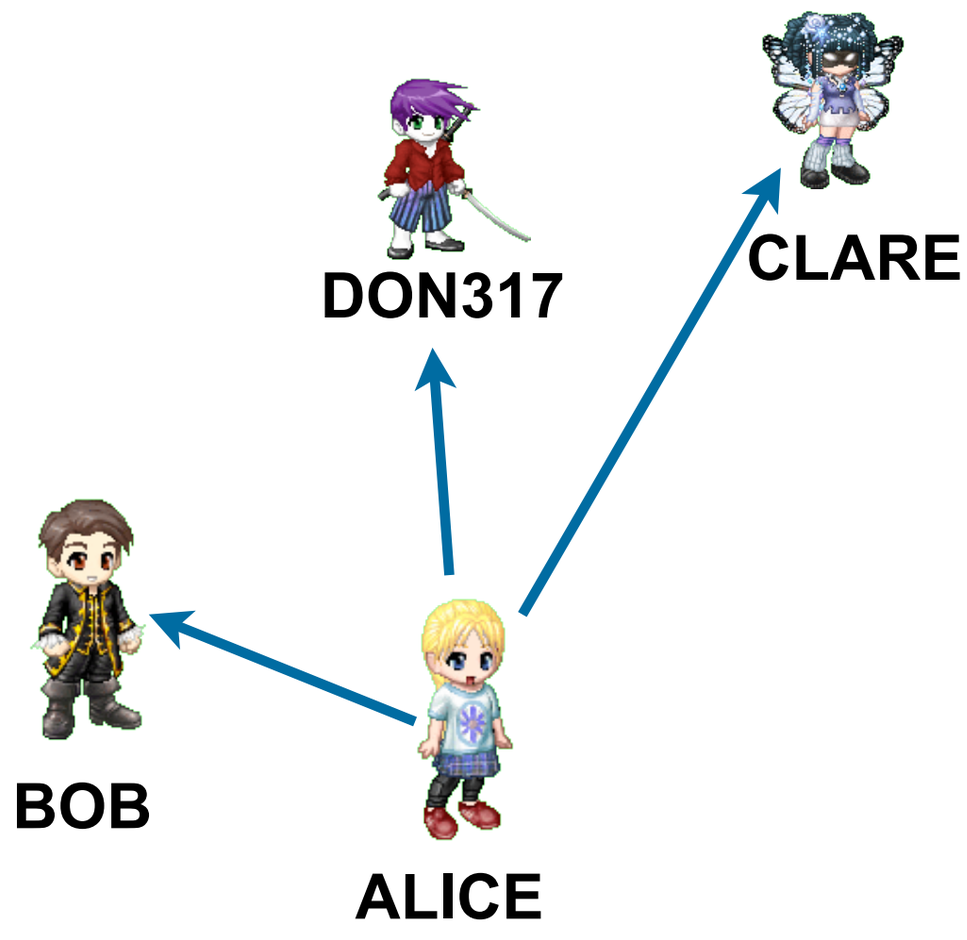
```
48198832  domexuser2@gmail.com    tocol>____<name>domexuser2@gmail.com/Home</name>____
48200361  domexuser2@live.com     tocol>____<name>domexuser2@live.com</name>____<pass
48413829  siege@preoccupied.net   siege) O'Brien <siege@preoccupied.net>_hp://meanwhi
48481542  danilo@gnome.org        Danilo __egan <danilo@gnome.org>_Language-Team:
48481589  gnom@prevod.org         : Serbian (sr) <gnom@prevod.org>_MIME-Version:
49421069  domexuser1@gmail.com    server2.name", "domexuser1@gmail.com");__user_pref("
49421279  domexuser1@gmail.com    er2.userName", "domexuser1@gmail.com");__user_pref("
49421608  domexuser1@gmail.com    tp1.username", "domexuser1@gmail.com");__user_pref("
```

offset **feature** **feature in evidence context**

Feature histograms are created at the end of processing. They are a powerful tool for understanding evidence.

Email address histogram allows us to rapidly determine:

- Drive's primary user
- User's organization
- Primary correspondents
- Other email addresses



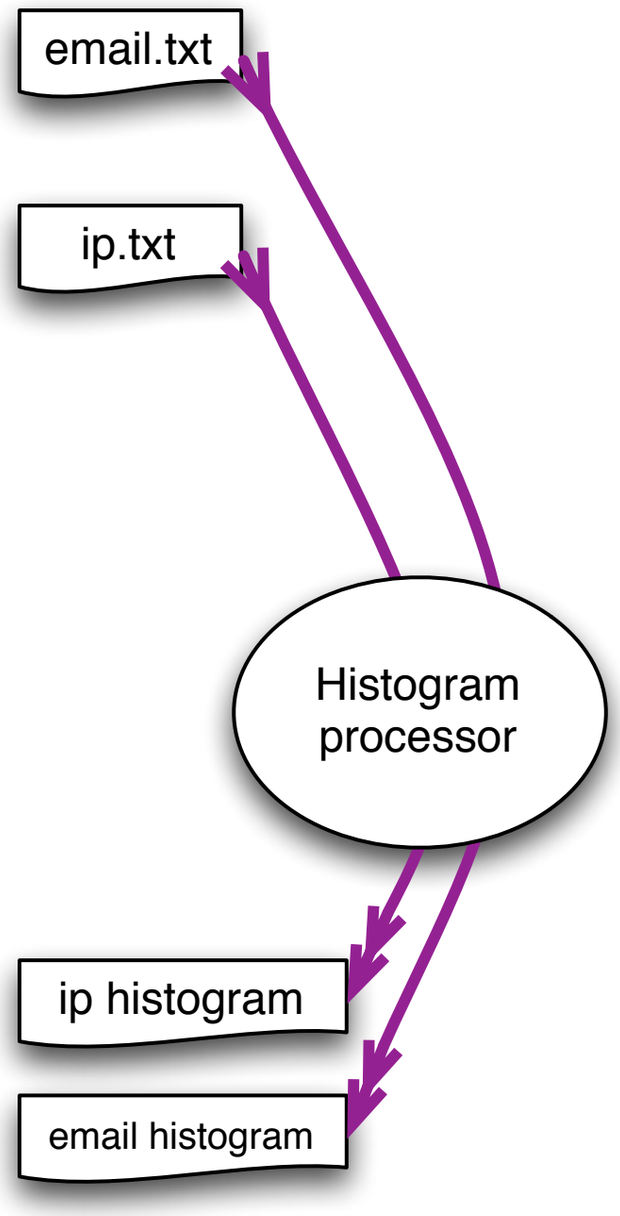
Drive #51 (Anonymized)

ALICE@DOMAIN1.com	8133
BOB@DOMAIN1.com	3504
ALICE@mail.adhost.com	2956
JobInfo@alumni-gsb.stanford.edu	2108
CLARE@aol.com	1579
DON317@earthlink.net	1206
ERIC@DOMAIN1.com	1118
GABBY10@aol.com	1030
HAROLD@HAROLD.com	989
ISHMAEL@JACK.wolfe.net	960
KIM@prodigy.net	947
ISHMAEL-list@rcia.com	845
JACK@nwlink.com	802
LEN@wolfenet.com	790
natcom-list@rcia.com	763

Histograms can be based on features or regular expression extracts from features.

Simple histogram based on feature:

```
n=579    domexuser1@gmail.com
n=432    domexuser2@gmail.com
n=340    domexuser3@gmail.com
n=268    ips@mail.ips.es
n=252    premium-server@thawte.com
n=244    CPS-requests@verisign.com
n=242    someone@example.com
```



Based on regular expression extraction:

- For example, extract search terms with **.*search.*q=(.*)**

```
n=18     pidgin
n=10     hotmail+thunderbird
n=3      Grey+Gardens+cousins
n=3      dvd
n=2      %TERMS%
n=2      cache:
n=2      p
n=2      pi
n=2      pid
n=1      Abolish+income+tax
n=1      Brad+and+Angelina+nanny+help
n=1      Build+Windmill
n=1      Carol+Alt
```

bulk_extractor has *multiple* feature extractors. Each scanner runs in order. (Order doesn't matter.)

Scanners can be turned on or off

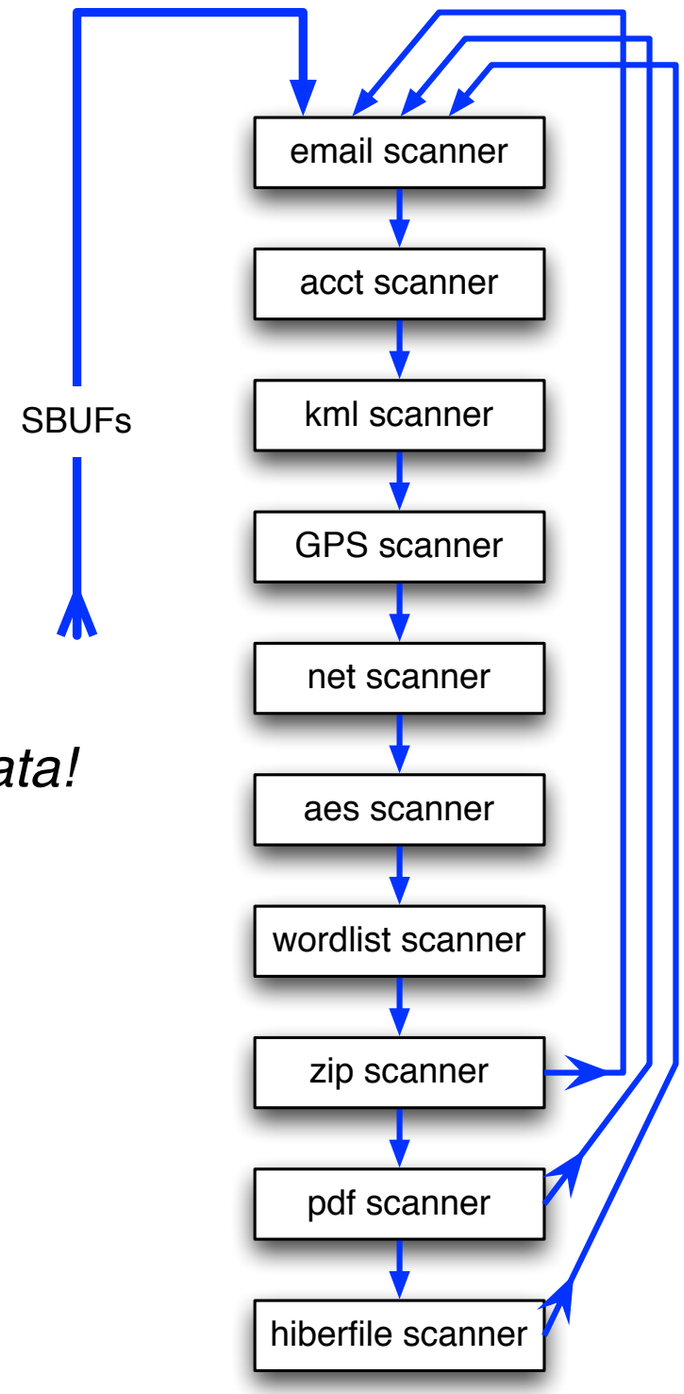
- Useful for debugging.
- AES key scanner is *very slow* (off by default)

Some scanners are *recursive.*

- *e.g.* scan_zip will find zlib-compressed regions
- An **sbuf** is made for the decompressed data
- The data is re-analyzed by the other scanners
  - *This finds email addresses in compressed data!*

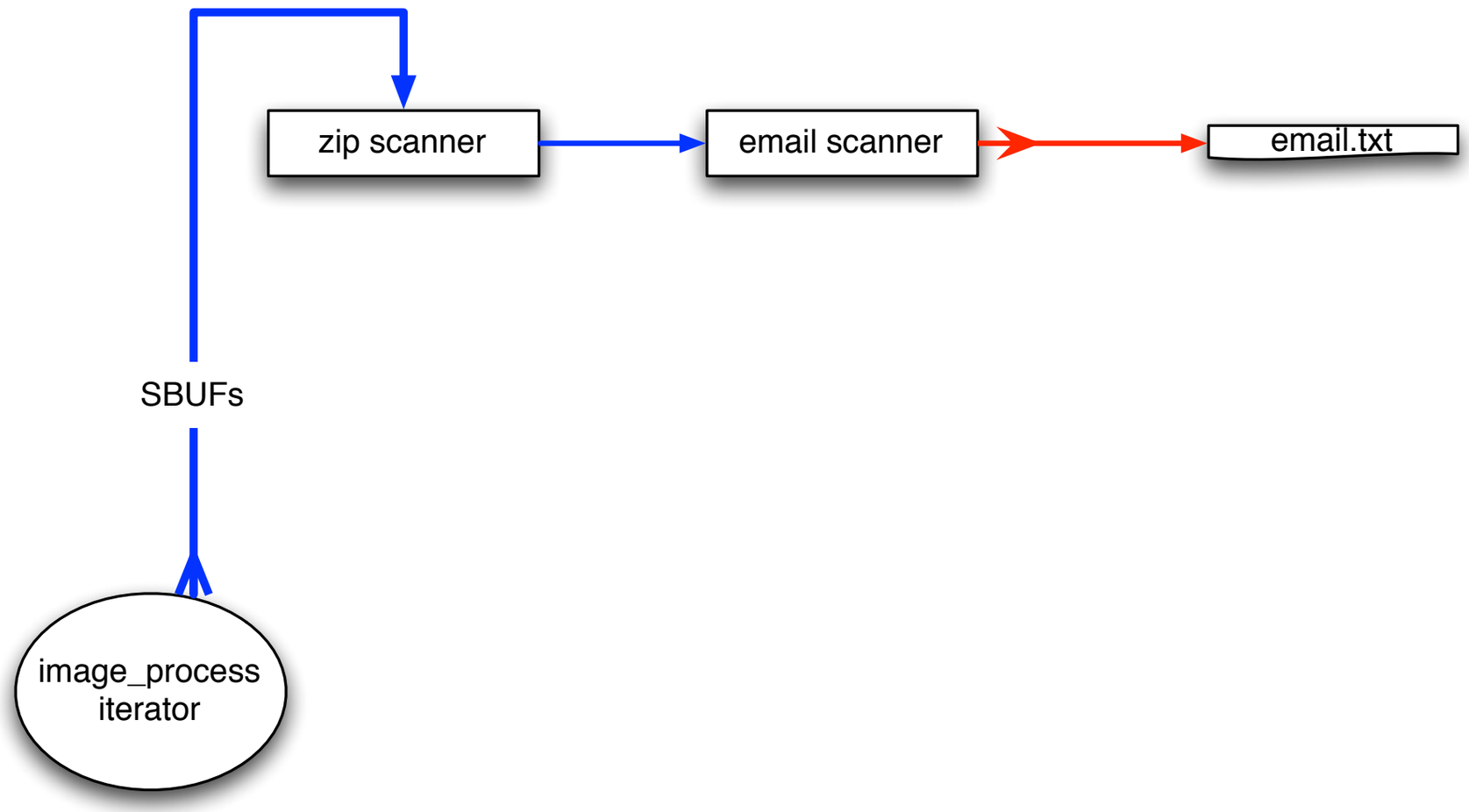
Recursion used for:

- Decompressing ZLIB, Windows HIBERFILE,
- Extracting text from PDFs
- Handling compressed browser cache data



Recursion requires a *new way* to describe offsets. bulk_extractor introduces the "forensic path."

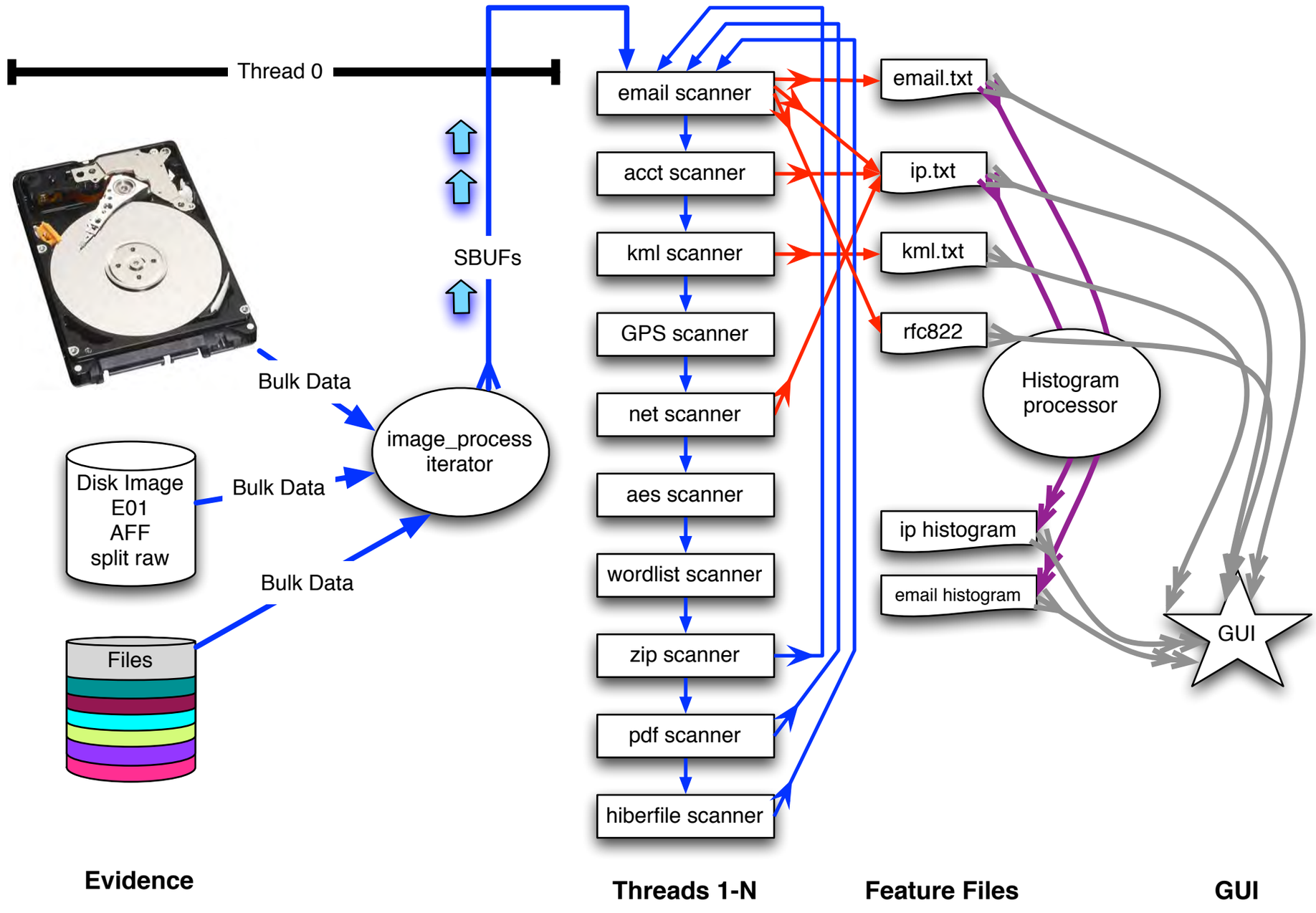
Consider an HTTP stream that contains a GZIP-compressed email:



We can represent this as:

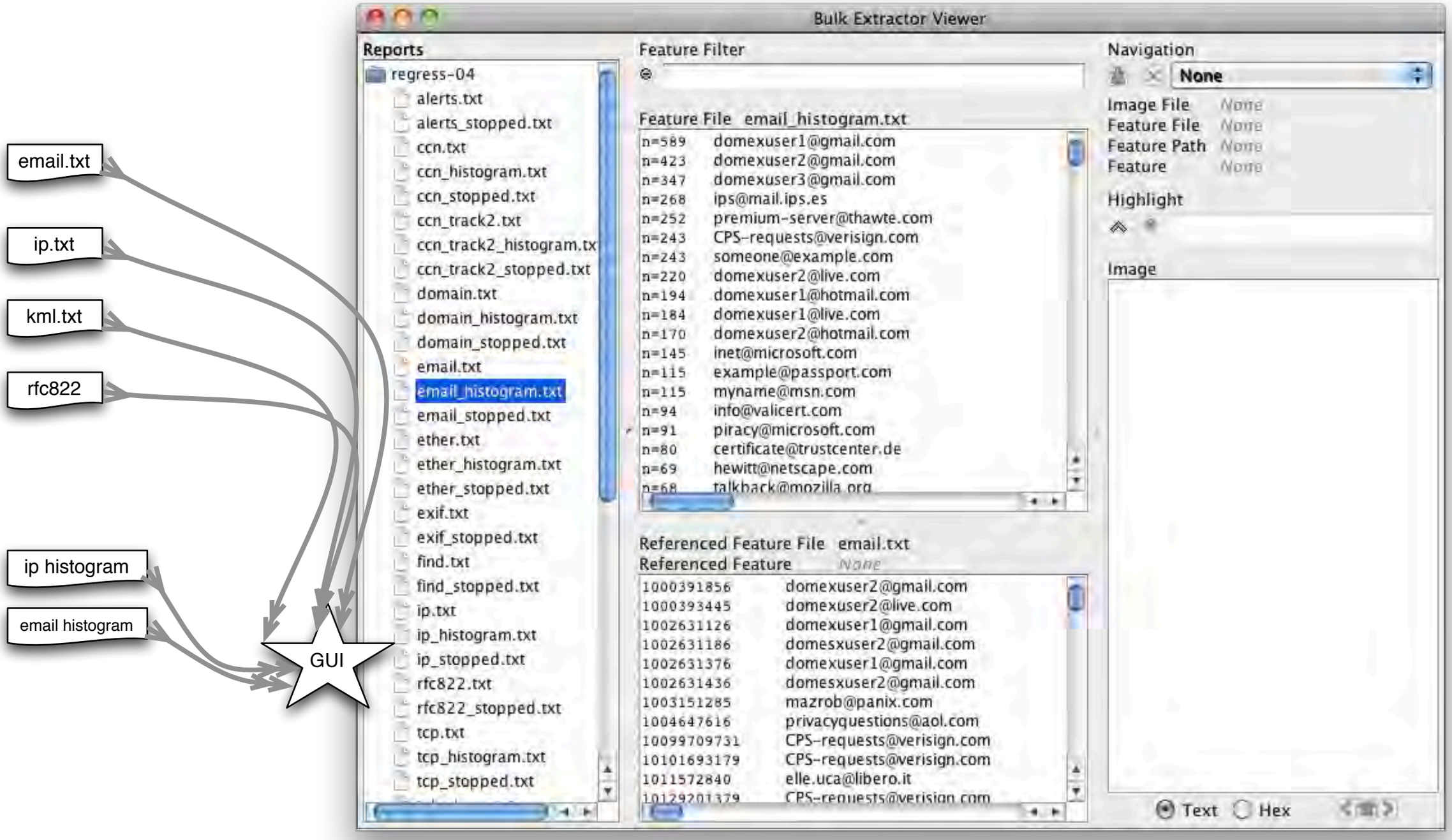
```
11052168704-GZIP-3437   live.com    eMn='domexuser1@live.com';var srf_sDispM
11052168704-GZIP-3475   live.com    pMn='domexuser1@live.com';var srf_sPreCk
11052168704-GZIP-3512   live.com    eCk='domexuser1@live.com';var srf_sFT='<
```

Integrated design, but compact.
20,573 lines of code; 41.94 seconds to compile on i5 iMac



BEViewer: GUI runs on Windows, Mac & Linux Launches bulk_extractor; views results

Uses bulk_extractor to decode forensic path



```
$ bulk_extractor -o output mydisk.raw
```

Running bulk_extractor

bulk_extractor is a command line tool.

```
$ src/bulk_extractor -h
bulk_extractor version 1.3b6 $Rev: 10046 $
Usage: src/bulk_extractor [options] imagefile
  runs bulk extractor and outputs to stdout a summary of what was found where

Required parameters:
   imagefile      - the file to extract
 or  -R filedir   - recurse through a directory of files
                    SUPPORT FOR E01 FILES COMPILED IN
                    SUPPORT FOR AFF FILES COMPILED IN
                    EXIV2 COMPILED IN
   -o outdir     - specifies output directory. Must not exist.
                    bulk_extractor creates this directory.
Options:
   -b banner.txt- Add banner.txt contents to the top of every output file.
   -r alert_list.txt  - a file containing the alert list of features to alert
                        (can be a feature file or a list of globs)
                        (can be repeated.)
   -w stop_list.txt   - a file containing the stop list of features (white list
                        (can be a feature file or a list of globs)s
                        (can be repeated.)
   -F <rfile>    - Read a list of regular expressions from <rfile> to find
   -f <regex>    - find occurances of <regex>; may be repeated.
                   results go into find.txt
   -q nn         - Quiet Rate; only print every nn status reports. Default 0; -1 for no status

Tuning parameters:
   -C NN         - specifies the size of the context window (default 16)
   -G NN         - specify the page size (default 4194304)
   -g NN         - specify margin (default 4194304)
   -W n1:n2       - Specifies minimum and maximum word size
                   (default is -w6:14)
   -B NN         - Specify the blocksize for bulk data analysis (default 512)
   -j NN         - Number of threads to run (default 8)
   -M nn         - sets max recursion depth (default 5)

Path Processing Mode:
   -p <path>/f   - print the value of <path> with a given format.
                   formats: r = raw; h = hex.
                   Specify -p - for interactive mode.
                   Specify -p -http for HTTP mode.

Parallelizing:
   -Y <o1>       - Start processing at o1 (o1 may be 1, 1K, 1M or 1G)
   -Y <o1>-<o2> - Process o1-o2
   -A <off>      - Add <off> to all reported feature offsets

Debugging:
   -h            - print this message
   -H            - print detailed info on the scanners
   -V            - print version number
   -z nn         - start on page nn
   -dN           - debug mode (see source code
   -Z            - zap (erase) output directory

Control of Scanners:
   -P <dir>      - Specifies a plugin directory
   -E scanner    - turn off all scanners except scanner
   -m <max>      - maximum number of minutes to wait for memory starvation
                   default is 60
   -s name=value - sets a bulk extractor option name to be value
   -e bulk - enable scanner bulk
   -e exiv2 - enable scanner exiv2
   -e wordlist - enable scanner wordlist
   -x accts - disable scanner accts
   -x aes - disable scanner aes
   -x base16 - disable scanner base16
   -x base64 - disable scanner base64
   -x elf - disable scanner elf
   -x email - disable scanner email
   -x exif - disable scanner exif
   -x gps - disable scanner gps
   -x gzip - disable scanner gzip
   -x hiber - disable scanner hiber
   -x json - disable scanner json
   -x kml - disable scanner kml
   -x net - disable scanner net
   -x pdf - disable scanner pdf
   -x vcard - disable scanner vcard
   -x windirs - disable scanner windirs
   -x winpe - disable scanner winpe
   -x winprefetch - disable scanner winprefetch
   -x zip - disable scanner zip
$
```

bulk_extractor input and output functions

Help is always available:

```
$ src/bulk_extractor -h
bulk_extractor version 1.3b6 $Rev: 10046 $
Usage: src/bulk_extractor [options] imagefile
  runs bulk extractor and outputs to stdout a summary of what was found where

Required parameters:
   imagefile     - the file to extract
 or  -R filedir  - recurse through a directory of files
                   SUPPORT FOR E01 FILES COMPILED IN
                   SUPPORT FOR AFF FILES COMPILED IN
                   EXIV2 COMPILED IN
-o outdir     - specifies output directory. Must not exist.
                bulk_extractor creates this directory.
```

-h updates automatically depending on how bulk_extractor is compiled.

- Disk image formats supported (E01, AFF)
- Compiled-in scanners that are compiled
- Plug-ins that are loaded at startup.

bulk_extractor input and output functions

Options change the behavior of the scanner:

```
Options:
   -b banner.txt - Add banner.txt contents to the top of every output file.
   -r alert_list.txt  - a file containing the alert list of features to alert
                        (can be a feature file or a list of globs)
                        (can be repeated.)
   -w stop_list.txt   - a file containing the stop list of features (white list
                        (can be a feature file or a list of globs)s
                        (can be repeated.)
   -F <rfile>   - Read a list of regular expressions from <rfile> to find
   -f <regex>   - find occurrences of <regex>; may be repeated.
                  results go into find.txt
 -q nn        - Quiet Rate; only print every nn status reports. Default 0;
                  -1 for no status
```

-b — Controls output appearance

-r, -w — Controls which features go to which feature files

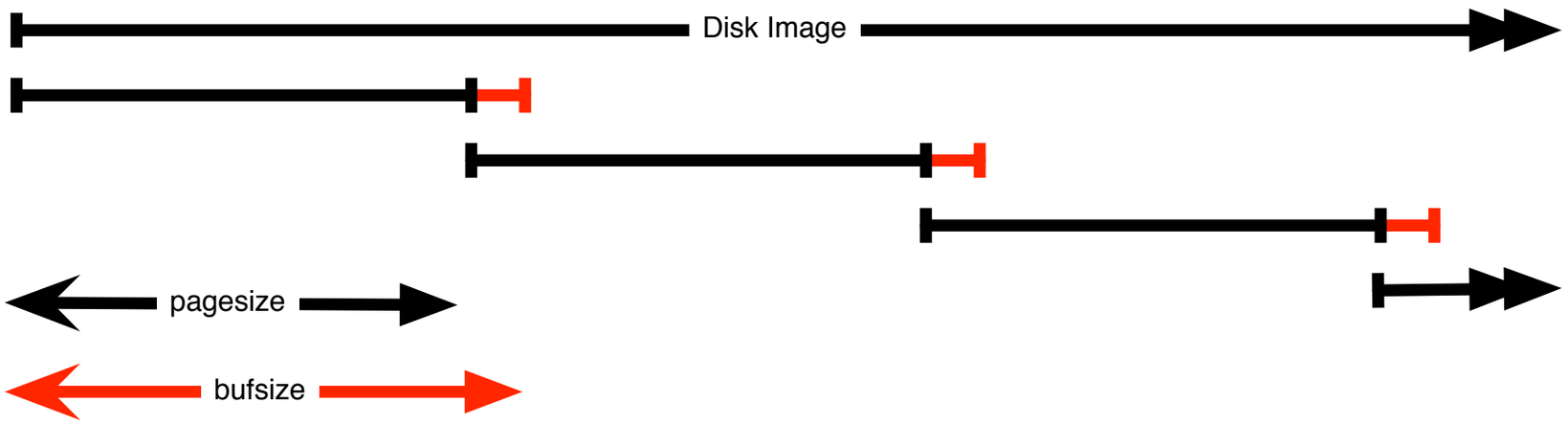
-F, -f — Allows command-line find

-q — Controls console output

bulk_extractor tuning

These parameters control the window and context:

```
Tuning parameters:
   -C NN          - specifies the size of the context window (default 16)
   -G NN          - specify the page size (default 4194304)
   -g NN          - specify margin (default 4194304)
   -W n1:n2       - Specifies minimum and maximum word size
                    (default is -w6:14)
   -B NN          - Specify the blocksize for bulk data analysis (default 512)
   -M nn         - sets max recursion depth (default 5)
```



bulk_extractor threading control

Normally bulk_extractor will run one analysis thread per core:

```
   -j NN          - Number of analysis threads to run (default 8)
```

```
Input file: /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen3.E01
Output directory: regress-1.3b7-norm-01
Disk Size: 2106589184
Threads: 8
Phase 1.
 9:33:28 Offset 0MB (0.00%) Done in n/a at 09:33:27
9:33:29 Offset 16MB (0.80%) Done in  0:00:58 at 09:34:27
9:33:29 Offset 33MB (1.59%) Done in  0:00:48 at 09:34:17
9:33:41 Offset 50MB (2.39%) Done in  0:08:27 at 09:42:08
9:33:41 Offset 67MB (3.19%) Done in  0:06:42 at 09:40:23
```

bulk_extractor path processing is used by the GUI for printing compressed regions...

```
Path Processing Mode:
   -p <path>/f  - print the value of <path> with a given format.
                  formats: r = raw; h = hex.
                  Specify -p - for interactive mode.
                  Specify -p -http for HTTP mode.
```

Consider:

```
340731773-GZIP-9287     tzeruch@ceddec.com    Tom Zerucha\x09\x09    tzeruch@ceddec.com
\x0ATomas Fasth\x09\x09
```

```
$ bulk_extractor -p 340731773 /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen3.E01
1f 8b 08 08 3f 23 90 48 02 03 54 48 41 4e 4b 53 00  6d 5a 4d 73 db 38 d2 3e 47 bf 02 b7 bd c4 d8   ....?#.H..THANKS.mZMs.8.>G......
cc 64 76 6b a6 f6 02 7f 7f 3b 1e d9 89 2b 7b d9 02  49 88 84 09 02 0c 00 4a 96 fe ec 5e e6 b2 f5   .dvk.....;...+{..I......J...^...
de e7 fc 3e 0d 90 b6 24 8f 2b 15 11 8d 26 d0 68 f4  c7 d3 00 cf ed 70 7f ce 56 32 30 e7 75 ad ad   ...>...$.+...&.h......p..V20.u..
34 66 cd 56 5e c7 a8 2c 2b d6 ec 49 79 ab 3c bb 76  65 c3 19 fb 12 1b 34 7a e5 7a a3 58 e9 6c f4   4f.V^..,+..Iy.<.ve.....4z.z.X.l.
ba 18 a2 aa 66 e0 f4 aa 77 3e 6a 5b b3 de bb c2 a8  2e 7c 64 61 a8 6b 15 12 71 29 bd 76 43 60 ba   ....f...w>j[......|da.k..q).vC`.
43 f7 52 75 ca 46 9a 13 2c 45 87 d9 c0 32 93 65 1c  a4 c1 b8 95 c2 5c 17 ca 2b a6 03 93 cc e8 10   C.Ru.F..,E...2.e......\..+......
99 5b b0 d8 b8 a0 c6 d9 39 fa 4d cf 30 60 ab 54 cf  74 c4 6b 1d e8 51 cd a4 ad d8 c2 2b 45 af 28   .[......9.M.0`.T.t.k..Q.....+E.(
ef 9d 0f 7c 36 3b ac 64 c7 6e 75 2c 1b 65 cc 87 0f  8c 31 09 8a 28 e5 42 fd fc 13 77 be 9e 1d 9a   ...|6;.d.nu,.e....1..(.B...w....
42 f9 c8 8e 1b 6d d9 de 5f 09 9a 14 58 fb a8 98 95  f3 15 c7 7c 78 47 95 ec 42 16 ba 4e 43 36 f4   B....m.._...X.......|xG..B..NC6.
24 8a a1 72 ea 67 5e 0c 5c 55 03 58 8c b4 ec d8 48  df e6 69 a9 5d 8a 50 ba 3c 82 25 71 af 87 ce   $..r.g^.\U.X....H..i.].P.<.%q...
```

```
$ bulk_extractor -p 340731773-GZIP-9200  /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen3.E01
20 53 61 74 6f 73 68 69 2e 54 6f 67 61 77 61 40 6a  70 2e 79 6f 6b 6f 67 61 77 61 2e 63 6f 6d 0a    Satoshi.Togawa@jp.yokogawa.com.
54 6f 6d 20 53 70 69 6e 64 6c 65 72 09 09 20 20 20  64 6f 67 63 6f 77 40 68 6f 6d 65 2e 6d 65 72   Tom Spindler..   dogcow@home.mer
69 74 2e 65 64 75 0a 54 6f 6d 20 5a 65 72 75 63 68  61 09 09 20 20 20 74 7a 65 72 75 63 68 40 63   it.edu.Tom Zerucha..   tzeruch@c
65 64 64 65 63 2e 63 6f 6d 0a 54 6f 6d 61 73 20 46  61 73 74 68 09 09 20 20 20 74 6f 6d 61 73 2e   eddec.com.Tomas Fasth..   tomas.
66 61 73 74 68 40 74 77 69 6e 73 70 6f 74 2e 6e 65  74 0a 54 6f 6d 6d 69 20 4b 6f 6d 75 6c 61 69   fasth@twinspot.net.Tommi Komulai
6e 65 6e 20 20 20 20 20 20 20 20 20 20 20 54 6f 6d  6d 69 2e 4b 6f 6d 75 6c 61 69 6e 65 6e 40 69   nen           Tommi.Komulainen@i
6b 69 2e 66 69 0a 54 68 6f 6d 61 73 20 4b 6c 61 75  73 6e 65 72 20 09 20 20 20 77 69 7a 40 64 61   ki.fi.Thomas Klausner .   wiz@da
6e 62 61 6c 61 2e 69 66 6f 65 72 2e 74 75 77 69 65  6e 2e 61 63 2e 61 74 0a 54 6f 6d 61 73 7a 20   nbala.ifoer.tuwien.ac.at.Tomasz
4b 6f 7a 6c 6f 77 73 6b 69 20 20 20 20 20 20 20 20  20 20 20 74 6f 6d 65 6b 40 72 65 6e 74 65 63   Kozlowski          tomek@rentec
2e 63 6f 6d 0a 54 68 6f 6d 61 73 20 4d 69 6b 6b 65  6c 73 65 6e 09 20 20 20 74 62 6d 40 69 6d 61   .com.Thomas Mikkelsen.   tbm@ima
```

bulk_extractor -p allows you to examine as much as you wish...

```
$ bulk_extractor -p 340731773-GZIP-9200  /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen3.E01
20 53 61 74 6f 73 68 69 2e 54 6f 67 61 77 61 40 6a  70 2e 79 6f 6b 6f 67 61 77 61 2e 63 6f 6d 0a   Satoshi.Togawa@jp.yokogawa.com.
54 6f 6d 20 53 70 69 6e 64 6c 65 72 09 09 20 20 20  64 6f 67 63 6f 77 40 68 6f 6d 65 2e 6d 65 72  Tom Spindler..  dogcow@home.mer
69 74 2e 65 64 75 0a 54 6f 6d 20 5a 65 72 75 63 68  61 09 09 20 20 20 74 7a 65 72 75 63 68 40 63  it.edu.Tom Zerucha..  tzeruch@c
65 64 64 65 63 2e 63 6f 6d 0a 54 6f 6d 61 73 20 46  61 73 74 68 09 09 20 20 20 74 6f 6d 61 73 2e  eddec.com.Tomas Fasth..  tomas.
66 61 73 74 68 40 74 77 69 6e 73 70 6f 74 2e 6e 65  74 0a 54 6f 6d 6d 69 20 4b 6f 6d 75 6c 61 69  fasth@twinspot.net.Tommi Komulai
6e 65 6e 20 20 20 20 20 20 20 20 20 20 20 54 6f 6d  6d 69 2e 4b 6f 6d 75 6c 61 69 6e 65 6e 40 69  nen           Tommi.Komulainen@i
6b 69 2e 66 69 0a 54 68 6f 6d 61 73 20 4b 6c 61 75  73 6e 65 72 20 09 20 20 20 77 69 7a 40 64 61  ki.fi.Thomas Klausner .  wiz@da
6e 62 61 6c 61 2e 69 66 6f 65 72 2e 74 75 77 69 65  6e 2e 61 63 2e 61 74 0a 54 6f 6d 61 73 7a 20  nbala.ifoer.tuwien.ac.at.Tomasz
4b 6f 7a 6c 6f 77 73 6b 69 20 20 20 20 20 20 20 20  20 20 20 74 6f 6d 65 6b 40 72 65 6e 74 65 63  Kozlowski           tomek@rentec
2e 63 6f 6d 0a 54 68 6f 6d 61 73 20 4d 69 6b 6b 65  6c 73 65 6e 09 20 20 20 74 62 6d 40 69 6d 61  .com.Thomas Mikkelsen.  tbm@ima
67 65 2e 64 6b 0a 55 6c 66 20 4d f6 6c 6c 65 72 09  09 20 20 20 33 75 6d 6f 65 6c 6c 65 40 69 6e  ge.dk.Ulf M.ller..  3umoelle@in
66 6f 72 6d 61 74 69 6b 2e 75 6e 69 2d 68 61 6d 62  75 72 67 2e 64 65 0a 55 72 6b 6f 20 4c 75 73  formatik.uni-hamburg.de.Urko Lus
61 09 09 20 20 20 75 6c 75 73 61 40 65 75 73 6b 61  6c 6e 65 74 2e 6e 65 74 0a 56 69 6e 63 65 6e  a..  ulusa@euskalnet.net.Vincen
74 20 50 2e 20 42 72 6f 6d 61 6e 20 20 20 20 20 20  20 20 20 20 20 62 72 6f 6d 61 6e 40 73 70 61 77  t P. Broman          broman@spaw
61 72 2e 6e 61 76 79 2e 6d 69 6c 0a 56 6f 6c 6b 65  72 20 51 75 65 74 73 63 68 6b 65 20 20 20 20  ar.navy.mil.Volker Quetschke
20 20 20 20 20 20 20 71 75 65 74 73 63 68 6b 65 40  73 63 79 74 65 6b 2e 64 65 0a 57 20 4c 65 77        quetschke@scytek.de.W Lew
69 73 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20  20 20 20 20 20 77 69 6d 6c 40 68 68 68 68 2e  is                  wiml@hhhh.
6f 72 67 0a 57 61 6c 74 65 72 20 48 6f 66 6d 61 6e  6e 09 09 20 20 20 57 61 6c 74 65 72 2e 48 6f  org.Walter Hofmann..  Walter.Ho
66 6d 61 6e 6e 40 70 68 79 73 69 6b 2e 73 74 75 64  2e 75 6e 69 2d 65 72 6c 61 6e 67 65 6e 2e 64  fmann@physik.stud.uni-erlangen.d
65 0a 57 61 6c 74 65 72 20 4b 6f 63 68 09 09 20 20  20 6b 6f 63 68 40 68 73 70 2e 64 65 0a 57 61  e.Walter Koch..  koch@hsp.de.Wa
79 6e 65 20 43 68 61 70 65 73 6b 69 65 20 09 20 20  20 77 61 79 6e 65 63 40 73 70 69 6e 6e 61 6b  yne Chapeskie .  waynec@spinnak
65 72 2e 63 6f 6d 0a 57 65 72 6e 65 72 20 4b 6f 63  68 09 09 20 20 20 77 6b 40 67 6e 75 70 67 2e  er.com.Werner Koch..  wk@gnupg.
6f 72 67 0a 57 69 6d 20 56 61 6e 64 65 70 75 74 74  65 09 09 20 20 20 62 75 6e 62 75 6e 40 72 65  org.Wim Vandeputte..  bunbun@re
70 74 69 6c 65 2e 72 75 67 2e 61 63 2e 62 65 0a 57  69 6e 6f 6e 61 20 42 72 6f 77 6e 20 20 20 20  ptile.rug.ac.be.Winona Brown
20 20 20 20 20 20 20 20 20 20 20 77 69 6e 40 68 75  68 2e 6f 72 67 0a 59 6f 73 69 61 6b 69 20 49           win@huh.org.Yosiaki I
49 44 41 09 09 20 20 20 69 69 64 61 40 72 69 6e 67  2e 67 72 2e 6a 70 0a 59 6f 73 68 69 68 69 72  IDA..  iida@ring.gr.jp.Yoshihir
6f 20 4b 61 6a 69 6b 69 09 20 20 20 6b 61 6a 69 6b  69 40 79 6c 75 67 2e 6f 72 67 0a 09 09 09 20  o Kajiki.  kajiki@ylug.org....
20 20 6e 62 65 63 6b 65 72 40 68 6e 73 2e 63 6f 6d  0a 0a 54 68 61 6e 6b 73 20 74 6f 20 74 68 65    nbecker@hns.com..Thanks to the
20 47 65 72 6d 61 6e 20 55 6e 69 78 20 55 73 65 72  20 47 72 6f 75 70 20 66 6f 72 20 73 70 6f 6e   German Unix User Group for spon
73 6f 72 69 6e 67 20 74 68 69 73 20 70 72 6f 6a 65  63 74 2c 0a 4d 61 72 74 69 6e 20 48 61 6d 69  soring this project,.Martin Hami
6c 74 6f 6e 20 66 6f 72 20 68 6f 73 74 69 6e 67 20  74 68 65 20 66 69 72 73 74 20 6d 61 69 6c 69  lton for hosting the first maili
6e 67 20 6c 69 73 74 20 61 6e 64 20 4f 70 65 6e 49  54 20 66 6f 72 0a 63 68 65 61 70 20 68 6f 73  ng list and OpenIT for.cheap hos
74 69 6e 67 20 63 6f 6e 64 69 74 69 6f 6e 73 2e 0a  0a 54 68 65 20 64 65 76 65 6c 6f 70 6d 65 6e  ting conditions...The developmen
74 20 6f 66 20 74 68 69 73 20 73 6f 66 74 77 61 72  65 20 68 61 73 20 70 61 72 74 6c 79 20 62 65  t of this software has partly be
65 6e 20 66 75 6e 64 65 64 20 62 79 20 74 68 65 20  47 65 72 6d 61 6e 0a 4d 69 6e 69 73 74 72 79  en funded by the German.Ministry
20 66 6f 72 20 45 63 6f 6e 6f 6d 69 63 73 20 61 6e  64 20 54 65 63 68 6e 6f 6c 6f 67 79 20 75 6e   for Economics and Technology un
64 65 72 20 67 72 61 6e 74 20 56 49 42 33 2d 36 38  35 35 33 2e 31 36 38 2d 30 30 31 2f 31 39 39  der grant VIB3-68553.168-001/199
39 2e 0a 0a 4d 61 6e 79 20 74 68 61 6e 6b 73 20 74  6f 20 6d 79 20 77 69 66 65 20 47 65 72 6c 69  9...Many thanks to my wife Gerli
6e 64 65 20 66 6f 72 20 68 61 76 69 6e 67 20 73 6f  20 6d 75 63 68 20 70 61 74 69 65 6e 63 65 20  nde for having so much patience
77 69 74 68 0a 6d 65 20 77 68 69 6c 65 20 68 61 63  6b 69 6e 67 20 6c 61 74 65 20 69 6e 20 74 68  with.me while hacking late in th
65 20 65 76 65 6e 69 6e 67 2e 0a 0a 20 43 6f 70 79  72 69 67 68 74 20 31 39 39 38 2c 20 31 39 39  e evening... Copyright 1998, 199
39 2c 20 32 30 30 30 2c 20 32 30 30 31 2c 20 32 30  30 32 2c 20 32 30 30 33 2c 0a 20 20 20 20 20  9, 2000, 2001, 2002, 2003,.
20
```

bulk_extractor “Parallelizing” options are experimental options for use with Hadoop...

```
Parallelizing:
   -Y <o1>       - Start processing at o1 (o1 may be 1, 1K, 1M or 1G)
   -Y <o1>-<o2>  - Process o1-o2
   -A <off>      - Add <off> to all reported feature offsets
```

You can run multiple copies of bulk_extractor on different machines...

- But currently there is no way to easily recombine the results.

bulk_extractor debugging features

You probably won't use these functions.... but I do.

```
Debugging:
   -h             - print this message
   -H             - print detailed info on the scanners
   -V             - print version number
   -z nn          - start on page nn
   -dN            - debug mode (see source code
   -Z             - zap (erase) output directory
```

New with version 1.3, each scanner has metadata which -H reports:

```
$ bulk_extractor -H

Scanner Name: accts
flags:  NONE
Scanner Interface version: 1
Author: Simson L. Garfinkel
Description: scans for CCNs, track 2, and phone #s
URL:
Scanner Version: 1.0
Feature Names: alerts ccn ccn_track2 telephone
```

bulk_extractor scanners can be compiled in or loaded on demand.

```
Control of Scanners:
   -P <dir>     - Specifies a plugin directory
   -E scanner   - turn off all scanners except scanner
   -m <max>     - maximum number of minutes to wait for memory starvation
                  default is 60
```

The -s option allows scanners to have settable tuning parameters:

```
-s name=value - sets a bulk extractor option name to be value
-e bulk - enable scanner bulk
```

Finally, individual scanners can be enabled or disabled.

-e enables scanners that are *disabled by default:*

```
-e bulk - enable scanner bulk
-e exiv2 - enable scanner exiv2
-e wordlist - enable scanner wordlist
```

-x disables scanners that are enabled by default:

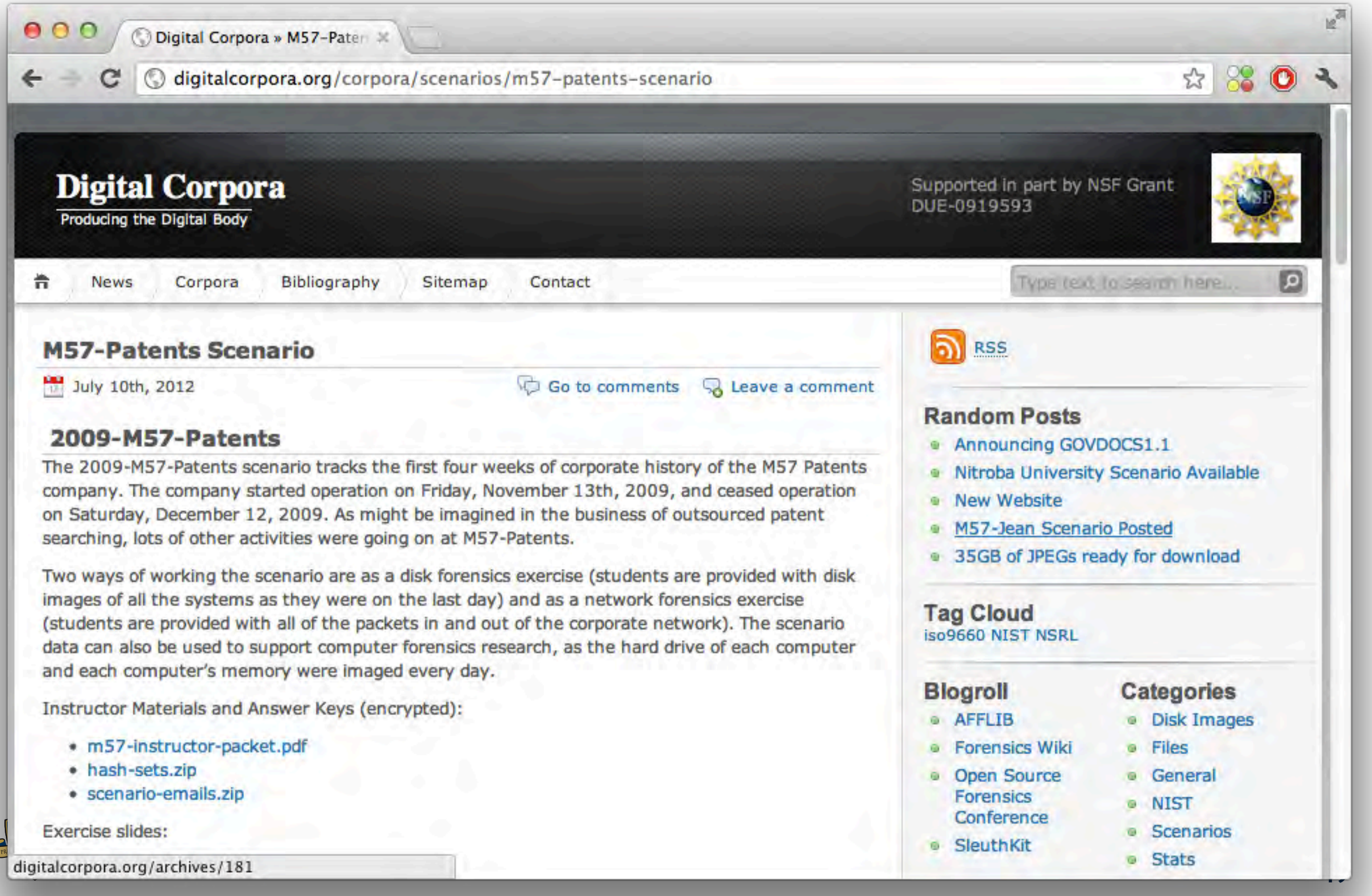
```
-x accts - disable scanner accts
-x aes - disable scanner aes
-x base16 - disable scanner base16
-x base64 - disable scanner base64
-x elf - disable scanner elf
-x email - disable scanner email
-x exif - disable scanner exif
-x gps - disable scanner gps
-x gzip - disable scanner gzip
-x hiber - disable scanner hiber
-x json - disable scanner json
-x kml - disable scanner kml
-x net - disable scanner net
-x pdf - disable scanner pdf
-x vcard - disable scanner vcard
-x windirs - disable scanner windirs
-x winpe - disable scanner winpe
-x winprefetch - disable scanner winprefetch
-x zip - disable scanner zip
$
```

Don't assume that you should enable every scanner!

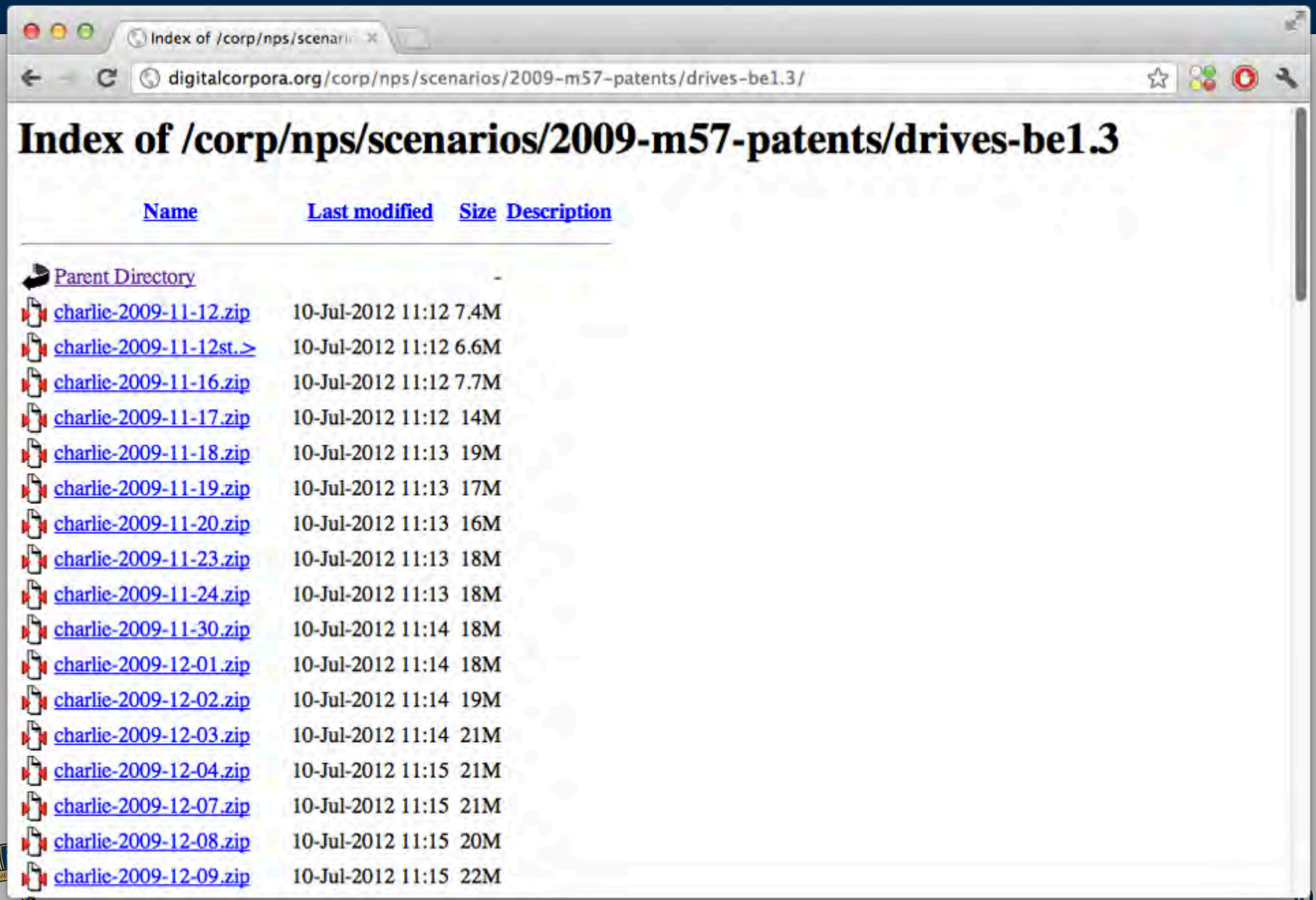
```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 alerts.txt
-rw-r--r--@ 1 simsong  staff      2743 Jul  7 23:59 ccn.txt
-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
-rw-r--r--@ 1 simsong  staff    185266 Jul  8 00:03 domain_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 find.txt
-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 hex.txt
-rw-r--r--@ 1 simsong  staff     95835 Jul  8 00:03 ip.txt
-rw-r--r--@ 1 simsong  staff     11603 Jul  8 00:03 ip_histogram.txt
-rw-r--r--@ 1 simsong  staff   2025702 Jul  8 00:03 json.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
-rw-r--r--@ 1 simsong  staff     59469 Jul  8 00:03 telephone.txt
-rw-r--r--@ 1 simsong  staff      6612 Jul  8 00:03 telephone_histogram.txt
-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
-rw-r--r--@ 1 simsong  staff  34128889 Jul  8 00:03 zip.txt
```

bulk_extractor output files

These data are from the M57 Patents Scenario



http://digitalcorpora.org/corp/nps/scenarios/2009-m57-patents/drives-be1.3/



bulk_extractor was run on *all* the images in the corpora. (Was run on the *redacted* drive images.)

```
$ ls -l charlie-2009-12-11.E01
-rw-r--r--+ 1 simsong  staff  3874203396 Aug  8  2011 charlie-2009-12-11.E01
$ ewfinfo 2009-m57-patents/drives-redacted/charlie-2009-12-11.E01
ewfinfo 20120304

Acquiry information
            Acquisition date:  Tue Jan 11 23:49:15 2011
            System date:                Tue Jan 11 23:49:15 2011
            Operating system used:      Linux
            Software version used:      20100226
            Password:          N/A

...
Media information
            Media type:                 fixed disk
            Is physical:                yes
            Bytes per sector:  512
            Number of sectors: 19999728
            Media size:                 9.5 GiB (10239860736 bytes)

Digest hash information
            MD5:                        0377b3d41bbbc295a1c9f00aa07ee174

$
```

charlie-2009-12-11.zip contains the output of running bulk_extractor on the charlie-2009-12-11 disk image.

```
$ bulk_extractor -o charlie-2009-12-11 drives-redacted/charlie-2009-12-11.E01
...
$ ls -l
total 195000
-rw-r--r--+ 1 simsong  simsong       499 Jul 20 16:55 aes_keys.txt
-rw-r--r--+ 1 simsong  simsong         0 Jul 20 16:54 alerts.txt
-rw-r--r--+ 1 simsong  simsong      2668 Jul 20 17:01 ccn.txt
-rw-r--r--+ 1 simsong  simsong       477 Jul 20 17:03 ccn_histogram.txt
-rw-r--r--+ 1 simsong  simsong         0 Jul 20 16:54 ccn_track2.txt
-rw-r--r--+ 1 simsong  simsong         0 Jul 20 17:03 ccn_track2_histogram.txt
-rw-r--r--+ 1 simsong  simsong  23368758 Jul 20 17:03 domain.txt
-rw-r--r--+ 1 simsong  simsong    185281 Jul 20 17:03 domain_histogram.txt
-rw-r--r--+ 1 simsong  simsong         0 Jul 20 16:54 elf.txt
-rw-r--r--+ 1 simsong  simsong   1719865 Jul 20 17:03 email.txt
-rw-r--r--+ 1 simsong  simsong     34866 Jul 20 17:03 email_histogram.txt
...
$ egrep 'threads|clocktime' report.xml
    <threads>16</threads>
    <clocktime>537.294874</clocktime>
$
```

Notice:

- 195MB of output from a 40GB disk image.
- Some output files are very large, some are small.
- 16 threads required 9 minutes to run
- empty file means nothing found.

Making sense of all this data is hard!

```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 alerts.txt
-rw-r--r--@ 1 simsong  staff      2743 Jul  7 23:59 ccn.txt
-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
-rw-r--r--@ 1 simsong  staff    185266 Jul  8 00:03 domain_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 find.txt
-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 hex.txt
-rw-r--r--@ 1 simsong  staff     95835 Jul  8 00:03 ip.txt
-rw-r--r--@ 1 simsong  staff     11603 Jul  8 00:03 ip_histogram.txt
-rw-r--r--@ 1 simsong  staff   2025702 Jul  8 00:03 json.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
-rw-r--r--@ 1 simsong  staff     59469 Jul  8 00:03 telephone.txt
-rw-r--r--@ 1 simsong  staff      6612 Jul  8 00:03 telephone_histogram.txt
-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
-rw-r--r--@ 1 simsong  staff  34128889 Jul  8 00:03 zip.txt
```

It’s ordered alphabetically; some of the output is “experimental.”

There are four main categories of feature files:

Identity Information:

- Domain Names; Email addresses; URLs
- Search terms; Facebook IDs; JSON data
- KML files
- VCARDs
- find output

Technical Info:

- ZIP files; EXIF data

Network Information:

- PCAP files; Ethernet Addresses; TCP/IP Connections; etc.

Information about executables:

- ELF & PE headers; Windows Prefetch files

```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
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-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
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-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
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-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
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There are four main categories of feature files:

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-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
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-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
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-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
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-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
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-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
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Technical Info:

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ccn.txt — potential credit card numbers.

bulk_extractor's credit card number finder:

- Considers pattern of digits; Luhn algorithm; distribution of digits; local context
- Frequently alerts on "false positives," so be careful!

```
# Feature-Recorder: ccn
88284672-GZIP-177427    5273347458642687        73A4B55CE2234D5\x0A5273347458642687\x0AC0841BAFA1B4C28
4909069775      6543210123456788        \x0Addadd7540 add '6543210123456788' 0.499999999
4909069811      6543210123456788        499999999   -> '6543210123456788' Inexact Rounde
4909069861      6543210123456788        \x0Addadd7541 add '6543210123456788' 0.5
4909069897      6543210123456788        5           -> '6543210123456788' Inexact Rounde
4909069947      6543210123456788        \x0Addadd7542 add '6543210123456788' 0.500000001
4814857216-GZIP-793     4015751530102097        ebO.d=0;ebO.rnd=4015751530102097;ebO.title="";eb
5304221350      5678901234560000                +4   -> 5678901234560000\x0D\x0Addshi052 shift
5612375618      6543210123456788        \x0D\x0Aaddx6240 add '6543210123456788' 0.499999999
5612375654      6543210123456788        499999999   -> '6543210123456788' Inexact Rounde
5612375703      6543210123456788        \x0D\x0Aaddx6241 add '6543210123456788' 0.5
5612375739      6543210123456788        5           -> '6543210123456788' Inexact Rounde
5612375788      6543210123456788        \x0D\x0Aaddx6242 add '6543210123456788' 0.500000001
```

In this example:

- 5273347458642687 looks like a valid CCN from the context (\x0A is a new line)
- 4015751530102097 looks like a random number in a piece of JavaeScript
  - *Notice it was compressed! offset 4814857216 starts a GZIP stream; +793 bytes is CCN*
- "Inexact Rounde" is actually from the Python source code
  - *http://svn.python.org/projects/python/branches/pep-0384/Lib/test/decimaltestdata/ddAdd.decTest*

ccn_histogram.txt: a histogram of the potential credit card numbers

Normally this is a great way to find the real numbers...

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: ccn
# Histogram-File-Version: 1.1
n=20    6543210123456788
n=2     4015751530102097
n=2     4920919202474441
n=1     4857994530998756
n=1     4909616081396134
n=1     5235714985079914
n=1     5273347458642687
n=1     5578481572827551
n=1     5678901234560000
n=1     5700122152274696
```

This time it's a great way to find that python test data!

ccn_track2.txt contains “track 2” credit card number information

```
  Length  Date         Time      File
--------  -----------  --------  ----------------------------------------
     476   8-Jul-2012  01:50:32  charlie-2009-12-11/aes_keys.txt
       0   8-Jul-2012  01:48:36  charlie-2009-12-11/alerts.txt
    2743   8-Jul-2012  01:59:24  charlie-2009-12-11/ccn.txt
     454   8-Jul-2012  02:03:14  charlie-2009-12-11/ccn_histogram.txt
       0   8-Jul-2012  01:48:36  charlie-2009-12-11/ccn_track2.txt
       0   8-Jul-2012  02:03:14  charlie-2009-12-11/ccn_track2_histogram.txt
...
```

In this case we don’t have any track 2 data...

domain.txt is a list of all the “domains” and host names that were found. Sources include URLs, email, dotted quads.

```
50395405        \x00h\x00o\x00t\x00m\x00a\x00i\x00l\x00.\x00c\x00o\x00m\x00
\x00b\x00r\x00e\x00_\x001\x002\x003\x00@\x00h\x00o\x00t\x00m\x00a\x00i\x00l
\x00.\x00c\x00o\x00m\x00\x0A\x00\x09\x00m\x00i\x00n\x00o\x00m\x00b\x00


235154  www.microsoft.com       teUrl = "http://www.microsoft.com/isapi/redir.dll

257091  www.DocURL.com  _404.htm#http://www.DocURL.com/bar.htm \x0D\x0A\x0D\x0A

169692672-GZIP-4139     us.ard.yahoo.com        8" href="http://us.ard.yahoo.com/
SIG=15s920d26/M

148770304-GZIP-63217    www.bakersfield.com     n value="http://
www.bakersfield.com">CA, Bakersfiel

148770304-GZIP-63295    www.thebakersfieldchannel.com   n value="http://
www.thebakersfieldchannel.com">CA, Bakersfiel

27766700        205.155.65.61   ustang.nps.edu [205.155.65.61])\x0D\x0A\x09(using
27766902        m57.biz \x0D\x0A\x09for <charlie@m57.biz>; Mon, 16 Nov 2
```

Note:

- UTF-16 is “escaped” as Python-style — \x00h\x00o\x00t means “hot”
- Domains are common in compressed data

domain_histogram.txt is a hitogram of the domains...

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: domain
# Histogram-File-Version: 1.1
n=10749 www.w3.org
n=6670  chroniclingamerica.loc.gov
n=6384  openoffice.org
n=5998  www.uspto.gov
n=5733  www.mozilla.org
n=5212  www.osti.gov
n=4952  www.microsoft.com
n=4474  patft.uspto.gov
n=4468  www.gpo.gov
n=3653  www.verisign.com
n=3167  www.google.com
n=3150  www.wipo.int
n=2733  news.bbc.co.uk
n=2595  crl.microsoft.com
```

Many of these domains are part of the operating system. Some aren't.

email.txt is similar to domain.txt, but has the email addresses!

```
50395384        n\x00o\x00m\x00b\x00r\x00e\x00_\x001\x002\x003\x00@\x00h\x00o
\x00t\x00m\x00a\x00i\x00l\x00.\x00c\x00o\x00m\x00  e\x00m\x00p\x00l\x00o
\x00:\x00\x0A\x00\x09\x00n\x00o\x00m\x00b\x00r\x00e\x00_\x001\x002\x003\x00@\x00h
\x00o\x00t\x00m\x00a\x00i\x00l\x00.\x00c\x00o\x00m\x00\x0A\x00\x09\x00m\x00i\x00n
\x00o\x00m\x00b\x00

50395432        m\x00i\x00n\x00o\x00m\x00b\x00r\x00e\x00@\x00m\x00s\x00n
\x00.\x00c\x00o\x00m\x00        i\x00l\x00.\x00c\x00o\x00m\x00\x0A\x00\x09\x00m
\x00i\x00n\x00o\x00m\x00b\x00r\x00e\x00@\x00m\x00s\x00n\x00.\x00c\x00o\x00m
\x00\x0A\x00\x09\x00e\x00j\x00e\x00m\x00p\x00l\x00
```

—*minombre@msn.com* — *myname@msn.com?*

—*50395384 is very early in the disk...*

Further down we see:

```
828564544       charlie@m57.biz (37190)\x0D\x0A\x09 for <charlie@m57.biz>; Fri,
20 Nov 2

828564992       4B01C378.3060603@m57.biz        0\x0D\x0AReferences:
<4B01C378.3060603@m57.biz>\x0D\x0ATo: charlie@m

828565023       charlie@m57.biz 3@m57.biz>\x0D\x0ATo: charlie@m57.biz\x0D
\x0ASubject: Still
```

email_histogram.txt shows a histogram of all potential email addresses

Clearly the histogram makes a difference:

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: email
# Histogram-File-Version: 1.1
n=875   mozilla@kewis.ch          (utf16=3)
n=651   charlie@m57.biz (utf16=120)
n=605   ajbanck@planet.nl
n=411   mikep@oeone.com
n=395   belhaire@ief.u-psud.fr
n=379   premium-server@thawte.com       (utf16=11)
n=356   lilmatt@mozilla.com
n=312   cedric.corazza@wanadoo.fr
```

Notice:

- Charlie's email is #2 (it would probably be #1 if the disk had been used for more than 3 weeks)
- Charlie's email appeared 651 times; 120 of those were in UTF-16.
- Many of these email addresses are from the software (ajbanck@planet.nl is in Mozilla Calendar)

find.txt is the result of the ‘find’ command

```
-rw-r--r--@  1 simsong  staff         0 Jul  7 23:48 find.txt
```

But we can run with the find command (-f) to do a string search.

- Here we look for any mentions of ‘nps.edu’ (any case) in charlie-2009-12-11

```
$ bulk_extractor -f '[nN][pP][sS].[eE][dD][uU]' -o charlie-2009-12-11-find /corp/
nps/scenarios/2009-m57-patents/drives-redacted/charlie-2009-12-11.E01
...
elapsed time: 1787.12 seconds
$
```

previous time was 537.29!

- The string search is executed as a first-class scanner (so it goes in compressed data)

```
27766691    nps.edu   ps.edu (mustang.nps.edu [205.155.65.61]
27767031    nps.edu    http://mustang.nps.edu:80/cgi-bin/mark
...
3449724105  nps.edu   wall at mustang.nps.edu. I'm sorry to i
3445904906  nps.edu   EDOA1F1@mustang.nps.edu)(25C=fe0)(261\x0D\x0A
...
9976666871  nps.edu   $\xA0"\x1B cifs/domex.nps.edu@DOMEX.NPS.EDU\x00\x00
9976666885  NPS.EDU   x.nps.edu@DOMEX.NPS.EDU\x00\x00\x00\x00\x0D\x00\x01\x00Fil
\xE5\x01\x00\x15\x02
```

Note that these “domains” are *not* included in the domain histogram!

Analyze the impact of find with the tests/regress.py script

```
$ python bulk_extractor-1.3/tests/regress.py --ana charlie-2009-12-11-find
Analyze charlie-2009-12-11-find
bulk_extractor version: 1.3b6-dev001
Filename:                /corp/nps/scenarios/2009-m57-patents/drives-redacted/
charlie-2009-12-11.E01
Scanner paths by time and calls
                      name  calls      sec            sec/call      % total
                      FIND      2442    18658.7566        7.6408   58.19%
                     HIBER      2442     3089.4381        1.2651    9.63%
                HIBER-FIND        19     2528.6812      133.0885    7.89%
                     EMAIL      2442     1898.3456        0.7774    5.92%
                     ACCTS      2442     1124.7081        0.4606    3.51%
                    BASE16      2442      830.0153        0.3399    2.59%
                       NET      2442      714.8930        0.2927    2.23%
                       ZIP      2442      588.4703        0.2410    1.84%
                       AES      2442      588.0705        0.2408    1.83%
                  ZIP-FIND     75052      401.8809        0.0054    1.25%
                      GZIP      2442      151.1465        0.0619    0.47%
                     WINPE      2442      117.5074        0.0481    0.37%
                      EXIF      2442      114.9825        0.0471    0.36%
              HIBER-EMAIL        19      104.6778        5.5094    0.33%
                 GZIP-FIND      1973       97.8214        0.0496    0.31%
              HIBER-ACCTS        19       91.1740        4.7986    0.28%
                HIBER-AES        19       87.1285        4.5857    0.27%
                     JSON      2442       81.9399        0.0336    0.26%
                      PDF      2442       77.1401        0.0316    0.24%
```

json.txt — JavaScript Objet Notation (Facebook, etc.)

Provides offset, JSON, and MD5 of JSON

- Use the MD5 for deduplication

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: json
# Feature-File-Version: 1.1
```

```
5091418457      [6, 4, 6, 4]    7ea5995a7acbd301b98e15b50b723e2b
5091418525      [6, 4, 6, 4]    7ea5995a7acbd301b98e15b50b723e2b

10002203123     {"url":"http://patft.uspto.gov/netacgi/nph-Parser?
Sect1=PTO2&Sect2=HITOFF&p=1&u=%2Fnetahtml%2FPTO%2Fsearch-
bool.html&r=26265.169749810822&f=G&l=50&co1=AND&d=PTXT&s1=mortality&OS=mortality&
RS=mortality","title":"United States Patent: 4035489","ID":63,"scroll":"0,0"}
81e95912dbb0e7e0966a9becf1c9f74a
```

Good luck with this!

- bulk_extractor is great at finding JSON in compressed streams, HIBER files, etc.
- There is a huge amount of stuff here

rfc822.txt — Email headers, HTTP headers, and more

```
114072068       SUBJECT:no investment   l investment\x5Cb\x00\x00SUBJECT:no
investment\x00\x00\x00SUBJECT:no gi
114072092       SUBJECT:no gimmick\x5Cb no investment\x00\x00\x00SUBJECT:no
gimmick\x5Cb\x00\x00\x00\x00SUBJECT:\x5Cbno
114072116       SUBJECT:\x5Cbno refund  no gimmick\x5Cb\x00\x00\x00\x00SUBJECT:
\x5Cbno refund\x00SUBJECT:\x5Cbno ag
114072136       SUBJECT:\x5Cbno age (restriction|limit) ECT:\x5Cbno refund
\x00SUBJECT:\x5Cbno age (restriction|limit)\x00\x00\x00\x00SUBJECT:\x5Cbno
114072176       SUBJECT:\x5Cbno medical exam    ction|limit)
\x00\x00\x00\x00SUBJECT:\x5Cbno medical exam\x00\x00\x00SUBJECT:no st
114072204       SUBJECT:no strings attached\x5Cb         medical exam
\x00\x00\x00SUBJECT:no strings attached\x5Cb\x00\x00\x00SUBJECT:no pu

1167648701      Host: www.ferrari.com   ss.js HTTP/1.1\x0D\x0AHost:
www.ferrari.com\x0D\x0AUser-Agent: Mo
1167649049      Cookie:
__utma=157168684.1746400801.1258507160.1260220504.1260306908.3; __utmz=157168684
ages/Home.aspx\x0D\x0ACookie:
__utma=157168684.1746400801.1258507160.1260220504.1260306908.3;
__utmz=157168684.1258507160.1.1.
```

We would like to have better reporting of mail headers.

- *Combining email address and name*
-

telephone.txt — Phone numbers!

Beware — many are tech support!

```
88850883        (800) 563-9048  rmation centre: (800) 563-9048\x0D\x0A<BR><b><i>Tech
88850995        (905) 568-4494  indows 95: (905) 568-4494\x0D\x0A<BR> Microsoft
88851056        (905) 568-2294  ice components: (905) 568-2294\x0D\x0A<BR> Other sta
88851111        (905) 568-3503  hnical support: (905) 568-3503\x0D\x0A<BR> Priority
88851162        (800) 668-7975  rt information: (800) 668-7975\x0D\x0A<BR> Text Tele
88851208        (905) 568-9641  phone (TTY/TDD) (905) 568-9641</P>\x0D\x0A\x0D\x0A<id ID="
88851367        (809) 273-3600  nc.\x0D\x0A<BR>Phone: (809) 273-3600\x0D\x0A<BR>Fax: (809)
```

Some are bogus:

```
5054603274      800-888-8800    ,,%Argentina%,0-800-888-8800,54-11-4317-2626
5054604226      +27 11 257 0000 %not_available%,+27 11 257 0000\x0D\x0ABVT,,,%Bouvet_
5054604316      800-701-1774    RA,,,%Brazil%,0-800-701-1774,(11) 3328-3396\x0D
5054604402      +27 11 257 0000 %not_available%,+27 11 257 0000\x0D\x0ABRN,,,%Brunei_
5054604738      888-571-2048    \x0ACAN,,,%Canada%,888-571-2048,716-871-2929\x0D\x0AC
5054604751      716-871-2929    a%,888-571-2048,716-871-2929\x0D\x0ACPV,,,%Cape_Ve
5054605064      800 830-1832    \x0D\x0ACHN,,,%China%,800 830-1832,+ 86 755 8340 9
```

And some are clearly legit:

```
6561037824-GZIP-28322   (831) 373-5555  onterey - <nobr>(831) 373-5555</nobr><br><a cl
6561037824-GZIP-29518   (831) 899-8300  Seaside - <nobr>(831) 899-8300</nobr><br><a cl
6561037824-GZIP-31176   (831) 899-8300  Seaside - <nobr>(831) 899-8300</nobr><br><a cl
```

telephone_histogram.txt: Usually a better place to look for phone numbers

```
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: telephone
# Histogram-File-Version: 1.1
n=42    4159618830
n=35    8477180400
n=24    2225552222
n=24    +27112570000
n=18    8005043248
n=15    2225551111
n=12    8772768437
n=11    2522277013
n=11    8662347350
n=9     1115554444
n=9     1771881984
n=8     4253532287
```

In version 1.3, non-digits are extracted from phone number.

url.txt: URLs

Note that UTF-16 data is escaped:

```
53946664        http://patimg2.uspto.gov/.piw?Docid=07626151&homeurl=http%3A%2F
%2Fpatft.uspto.gov%2Fnetacgi%2Fnph-Parser%3FSect1%3DPTO2%2526Sect2%3DHIT center>
\x0A<a href=http://patimg2.uspto.gov/.piw?Docid=07626151&homeurl=http%3A%2F
%2Fpatft.uspto.gov%2Fnetacgi%2Fnph-Parser%3FSect1%3DPTO2%2526Sect2%3DHITOFF%2526p
%3D1%25

34913630        H\x00T\x00T\x00P\x00:\x00/\x00/\x00     n\x00a\x00s\x00 \x00W
\x00e\x00b\x00 \x00H\x00T\x00T\x00P\x00:\x00/\x00/\x00 \x00e\x00 \x00H\x00T\x00T
\x00P\x00S\x00

34913650        H\x00T\x00T\x00P\x00S\x00:\x00/\x00/\x00.\x00   T\x00P
\x00:\x00/\x00/\x00 \x00e\x00 \x00H\x00T\x00T\x00P\x00S\x00:\x00/\x00/\x00.\x00
\x00N\x00o\x00 \x00e\x00n\x00t\x00a\x00

53952231        http://appft1.uspto.gov/netacgi/nph-Parser?
TERM1=20020186464&Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO
%2Fsrchnum.html&r=0& =left>\x0A<a href="http://appft1.uspto.gov/netacgi/nph-
Parser?TERM1=20020186464&Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO
%2Fsrchnum.html&r=0&f=S&l=50" target
```

url_histogram.txt: potential URLs from the disk UTF-16 is converted to UTF8

```
n=2     http://ebiz1.uspto.gov/vision-service/ShoppingCart_P/AddToShoppingCart?
docNumber=7626465&backUrl1=http%3A//patft1.uspto.gov/netacgi/nph
n=2     http://ebiz1.uspto.gov/vision-service/ShoppingCart_P/AddToShoppingCart?
docNumber=7627056&backUrl1=http%3A//patft1.uspto.gov/netacgi/nph
```

Note:

```
n=1022  http://www.uspto.gov/patft/help/help.htm        (utf16=3)
n=992   http://www.uspto.gov/patft/index.html   (utf16=4)
```

Not all URLs are accurate:

```
n=3922  http://www.mozilla.org/keymaster/gatekeeper/there.is.only.xul   (utf16=2609)

n=859   http://www.mozilla.org/keymaster/gatekeeper/there.is.only.xu    (utf16=858)
```

url_facebook, url_histogram, url_microsoft-live, url_searches and url_services pull info out of URLs...

```
-rw-r--r--@  1 simsong  staff        0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@  1 simsong  staff  5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@  1 simsong  staff        0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@  1 simsong  staff     8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@  1 simsong  staff   151673 Jul  8 00:03 url_services.txt
```

The most useful is url_searches.txt:

```
n=59    1
n=53    exotic+car+dealer
n=41    ford+car+dealer
n=34    2009+Shelby
n=25    steganography
n=23    General+Electric
n=23    time+travel
n=19    steganography+tool+free
n=19    vacation+packages
n=16    firefox
n=16    quicktime
n=14    7zip
n=14    fox+news
n=13    hex+editor
```

Searches frequently convey intent.

vcard.txt & vcard/ — vcard carving

There are no vcard entries in charlie-2009-12-11.

There are four main categories of feature files:

Identity Information:

- Domain Names; Email addresses; URLs
- Search terms; Facebook IDs; JSON data
- KML files
- VCARDs
- find output

```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 alerts.txt
-rw-r--r--@ 1 simsong  staff      2743 Jul  7 23:59 ccn.txt
-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
-rw-r--r--@ 1 simsong  staff    185266 Jul  8 00:03 domain_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 find.txt
-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 hex.txt
-rw-r--r--@ 1 simsong  staff     95835 Jul  8 00:03 ip.txt
-rw-r--r--@ 1 simsong  staff     11603 Jul  8 00:03 ip_histogram.txt
-rw-r--r--@ 1 simsong  staff   2025702 Jul  8 00:03 json.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
-rw-r--r--@ 1 simsong  staff     59469 Jul  8 00:03 telephone.txt
-rw-r--r--@ 1 simsong  staff      6612 Jul  8 00:03 telephone_histogram.txt
-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
-rw-r--r--@ 1 simsong  staff  34128889 Jul  8 00:03 zip.txt
```

Technical Info:

- ZIP files; EXIF data

Network Information:

- PCAP files; Ethernet Addresses; TCP/IP Connections; etc.

Information about executables:

- ELF & PE headers; Windows Prefetch files

aes_keys.txt — scheduled AES encryption keys, usually found in RAM, Swap, or hibernation files

bulk_extractor feature files now begin with a BOM and header info:

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: aes_keys
# Feature-File-Version: 1.1
```

- Any “scanner” can record in any feature file.

Next comes the data:

```
1023960572      00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15
16 17 18 19 1a 1b 1c 1d 1e 1f          AES256

1026549244      00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15
16 17 18 19 1a 1b 1c 1d 1e 1f          AES256
```

- These keys appear to be AES test vectors from a Windows DLL.
- We see them on many disk images.

exif.txt is a list of every EXIF that is found on the drive

This feature file has a different internal formatting:

[offset] [MD5 of first 4K of JPEG] [XML encoding of EXIF]

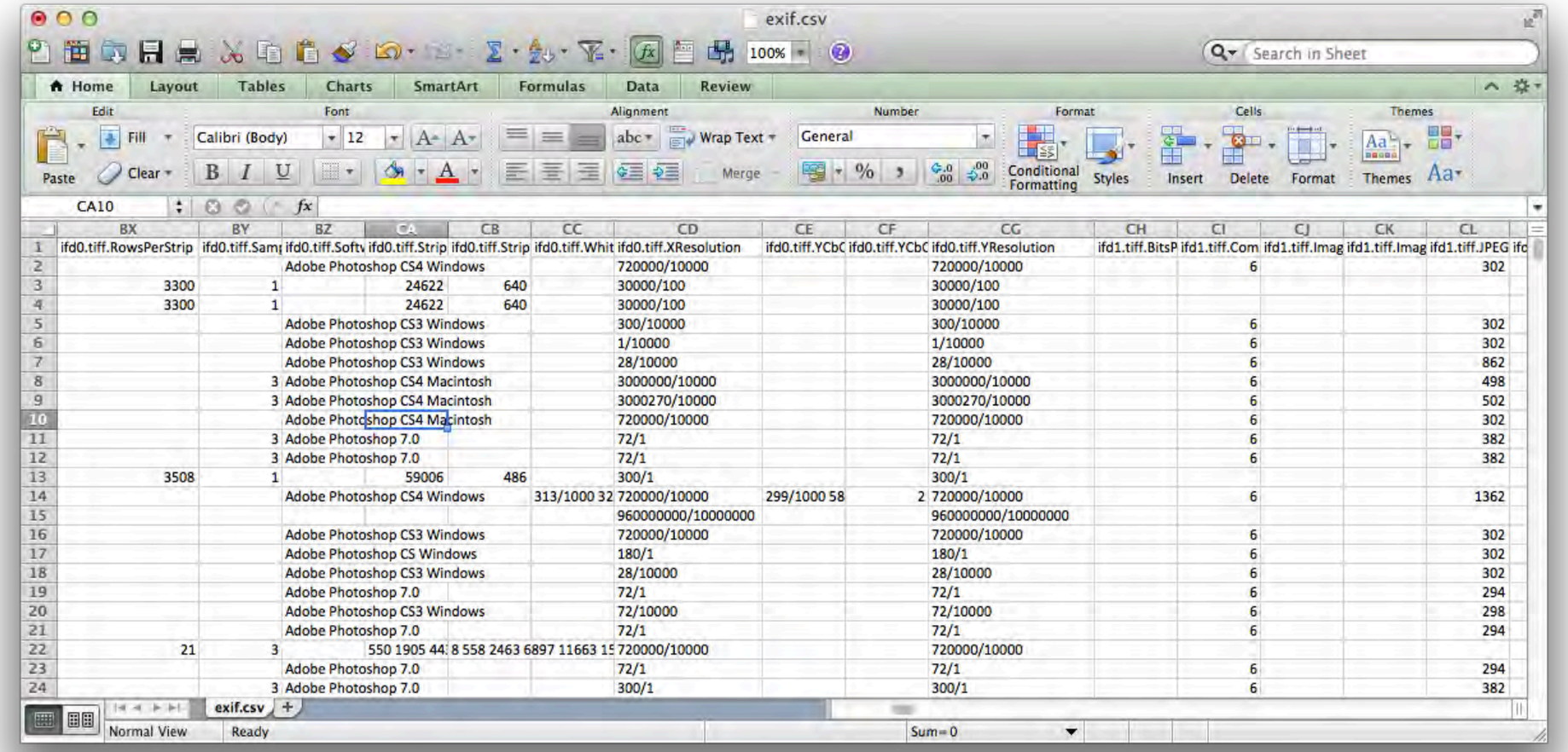
These files are *really* hard to understand...

```
75177472        15c1c6c52b34d64e368ffbf04bd14596        <exif><ifd0.tiff.Orientation>1</ifd0.tiff.Or\
ientation><ifd0.tiff.XResolution>720000/10000</ifd0.tiff.XResolution><ifd0.tiff.YResolution>720000/1\
0000</ifd0.tiff.YResolution><ifd0.tiff.ResolutionUnit>2</ifd0.tiff.ResolutionUnit><ifd0.tiff.Softwar\
e>Adobe Photoshop CS4 Windows</ifd0.tiff.Software><ifd0.tiff.DateTime>2009:09:03 14:30:07</ifd0.tiff\
.DateTime><ifd0.exif.ColorSpace>65535</ifd0.exif.ColorSpace><ifd0.exif.PixelXDimension>140</ifd0.exi\
f.PixelXDimension><ifd0.exif.PixelYDimension>96</ifd0.exif.PixelYDimension><ifd1.tiff.Compression>6<\
/ifd1.tiff.Compression><ifd1.tiff.XResolution>72/1</ifd1.tiff.XResolution><ifd1.tiff.YResolution>72/\
1</ifd1.tiff.YResolution><ifd1.tiff.ResolutionUnit>2</ifd1.tiff.ResolutionUnit><ifd1.tiff.JPEGInterc\
hangeFormat>302</ifd1.tiff.JPEGInterchangeFormat><ifd1.tiff.JPEGInterchangeFormatLength>4542</ifd1.t\
iff.JPEGInterchangeFormatLength></exif>
78016000        00000000000000000000000000000000        <exif><ifd0.tiff.entry_0x00fe>0</ifd0.tiff.e\
ntry_0x00fe><ifd0.tiff.entry_0x00ff>1</ifd0.tiff.entry_0x00ff><ifd0.tiff.ImageWidth>2560</ifd0.tiff.\
ImageWidth><ifd0.tiff.ImageLength>3300</ifd0.tiff.ImageLength><ifd0.tiff.BitsPerSample>1</ifd0.tiff.\
BitsPerSample><ifd0.tiff.Compression>4</ifd0.tiff.Compression><ifd0.tiff.PhotometricInterpreation>0<\
/ifd0.tiff.PhotometricInterpreation><ifd0.tiff.entry_0x010a>1</ifd0.tiff.entry_0x010a><ifd0.tiff.ent\
ry_0x010d>US020090196419A120090806</ifd0.tiff.entry_0x010d><ifd0.tiff.ImageDescription>00010001</ifd\
0.tiff.ImageDescription><ifd0.tiff.StripOffsets>640</ifd0.tiff.StripOffsets><ifd0.tiff.Orientation>1\
</ifd0.tiff.Orientation><ifd0.tiff.SamplesPerPixel>1</ifd0.tiff.SamplesPerPixel><ifd0.tiff.RowsPerSt\
rip>3300</ifd0.tiff.RowsPerStrip><ifd0.tiff.StripByteCounts>24622</ifd0.tiff.StripByteCounts><ifd0.t\
iff.entry_0x0118>0</ifd0.tiff.entry_0x0118><ifd0.tiff.entry_0x0119>1</ifd0.tiff.entry_0x0119><ifd0.t\
iff.XResolution>30000/100</ifd0.tiff.XResolution><ifd0.tiff.YResolution>30000/100</ifd0.tiff.YResolu\
tion><ifd0.tiff.entry_0x0125>0</ifd0.tiff.entry_0x0125><ifd0.tiff.ResolutionUnit>2</ifd0.tiff.Resolu\
tionUnit><ifd0.tiff.DateTime>2009:07:20 13:00:56</ifd0.tiff.DateTime><ifd0.tiff.entry_0x03e7>       \
                                                                                                \
```

Fortunately, we have a program that turns it into a spreadsheet...

python/post_process_exif.py

```
$ python bulk_extractor-1.3/python/post_process_exif.py exif.txt exif.csv
Input file: exif.txt
Output file: exif.csv
Scanning for EXIF tags...
There are 856 exif tags
$
$ open exif.csv
```



	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL
1	ifd0.tiff.RowsPerStrip	ifd0.tiff.Sam	ifd0.tiff.Softv	ifd0.tiff.Strip	ifd0.tiff.Strip	ifd0.tiff.Whit	ifd0.tiff.XResolution	ifd0.tiff.YCbC	ifd0.tiff.YCbC	ifd0.tiff.YResolution	ifd1.tiff.BitsP	ifd1.tiff.Com	ifd1.tiff.Imag	ifd1.tiff.Imag	ifd1.tiff.JPEG
2			Adobe Photoshop CS4 Windows				720000/10000			720000/10000		6			302
3	3300	1		24622	640		30000/100			30000/100					
4	3300	1		24622	640		30000/100			30000/100					
5			Adobe Photoshop CS3 Windows				300/10000			300/10000		6			302
6			Adobe Photoshop CS3 Windows				1/10000			1/10000		6			302
7			Adobe Photoshop CS3 Windows				28/10000			28/10000		6			862
8		3	Adobe Photoshop CS4 Macintosh				3000000/10000			3000000/10000		6			498
9		3	Adobe Photoshop CS4 Macintosh				3000270/10000			3000270/10000		6			502
10			Adobe Photoshop CS4 Macintosh				720000/10000			720000/10000		6			302
11		3	Adobe Photoshop 7.0				72/1			72/1		6			382
12		3	Adobe Photoshop 7.0				72/1			72/1		6			382
13	3508	1		59006	486		300/1			300/1					
14			Adobe Photoshop CS4 Windows			313/1000 32	720000/10000	299/1000 58	2	720000/10000		6			1362
15							960000000/10000000			960000000/10000000					
16			Adobe Photoshop CS3 Windows				720000/10000			720000/10000		6			302
17			Adobe Photoshop CS Windows				180/1			180/1		6			302
18			Adobe Photoshop CS3 Windows				28/10000			28/10000		6			302
19			Adobe Photoshop 7.0				72/1			72/1		6			294
20			Adobe Photoshop CS3 Windows				72/10000			72/10000		6			298
21			Adobe Photoshop 7.0				72/1			72/1		6			294
22	21	3		550 1905 44	8 558 2463	6897 11663 15	720000/10000			720000/10000					
23			Adobe Photoshop 7.0				72/1			72/1		6			294
24		3	Adobe Photoshop 7.0				300/1			300/1		6			382

- Still not great, but at least you can search it and re-arrange the columns.

gps.txt shows times and GPS info extracted from JPEGs and Garmin XML files.

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: gps
# Feature-File-Version: 1.1
258600448       fc0bae6e33d1bd9f286461b816d957d9        2009-10-21T17:16:59,,,,,
3775933952      ff9fd0fbe87c91be5a74c4f1eadf75c4        2009-05-30T18:32:56,,,,,
3776724480      67d71def1274fd56d718063da0023247        2009-12-07T16:18:29,,,,,
4549410304      8d491ae0e448c466bd2ecc36554f0e03        2008-10-16T17:54:44,,,,,
5185666560      9b258122d51cf340d680e88504ccc23f        2009-09-23T10:11:50,,,,,
6619950592      de9017779919ea62e3a31fbb5f8c31ed        2009-11-09T16:13:00,,,,,
6620278272      1b0ce3f082d96cd9009b68e936c19da8        2009-03-01T12:55:23,,,,,
9066278400      9b258122d51cf340d680e88504ccc23f        2009-09-23T10:11:50,,,,,
9066794496      ff9fd0fbe87c91be5a74c4f1eadf75c4        2009-05-30T18:32:56,,,,,
9069837939      00000000000000000000000000000000        2009-12-07T16:18:29,,,,,
9069891072      67d71def1274fd56d718063da0023247        2009-12-07T16:18:29,,,,,
9076293235      00000000000000000000000000000000        ,invalid entry type code:
3328,,0.000000,,invalid entry type code: 0
```

This is interesting because it's data from other devices (cameras, etc.)

We honestly don't know if it is useful to put in times without lat/lon info.

- What do you think?

hex.txt is extracted hexdecimal strings of special lengths.

This disk image doesn’t have any...

Uses:

- emailed strings of MD5 codes, AES keys, etc.
- Anything else?

kml.txt — KML files (typically from Google Maps & Earth)

There is no KML in the M57-Patents corpora

windirs.txt — FAT32 and NTFS directories (New in BE1.3!)

You will find most of the disk entries:

```
3230706176      EXCH_ntfsdrv.dll        <fileobject src='mft'>
  <atime>2009-11-09T01:24:59Z</atime><attr_flags>2080</attr_flags>
  <crtime>2009-11-09T01:24:59Z</crtime><ctime>2009-11-09T01:24:59Z</ctime>
  <filename>EXCH_ntfsdrv.dll</filename><filesize>38912</filesize>
  <filesize_alloc>40960</filesize_alloc><lsn>123102367</lsn>
  <mtime>2001-08-18T06:36:28Z</mtime><nlink>2</nlink><par_ref>71</par_ref>
  <par_seq>1</par_seq><seq>2</seq></fileobject>

3230707200      ntio404.sys     <fileobject src='mft'>
  <atime>2009-11-09T01:24:59Z</atime><attr_flags>2080</attr_flags>
  <crtime>2008-04-14T12:00:00Z</crtime><ctime>2009-11-08T17:08:04Z</ctime>
  <filename>ntio404.sys</filename><filesize>34560</filesize>
  <filesize_alloc>65536</filesize_alloc><lsn>29295332</lsn>
  <mtime>2008-04-14T12:00:00Z</mtime><nlink>1</nlink><par_ref>71</par_ref>
  <par_seq>1</par_seq><seq>1</seq></fileobject>
```

Error rate for FAT32 is high; ignore these if drive is not FAT:

```
159466528       -eSigPol.icy    <fileobject src='fat'>
  <atime>2037-09-13T00:00:00</atime><attrib>45</attrib><ctime>2030-03-09T00:00:00</ctime>
  <ctimeten>56</ctimeten><filename>-eSigPol.icy</filename><filesize>1937007917</filesize>
  <mtime>2034-09-13T12:43:13</mtime><startcluster>1701667951</startcluster></fileobject>

173063680-GZIP-470016   dukdxd1o.lH7    <fileobject src='fat'>
  <atime>2010-09-29T00:00:00</atime><attrib>32</attrib><ctime>1999-09-25T06:34:01</ctime>
  <ctimeten>50</ctimeten><filename>dukdxd1o.lH7</filename><filesize>1632198449</filesize>
  <mtime>2007-01-18T15:01:17</mtime><startcluster>2016504113</startcluster></fileobject>
```

Q: should we ignore startcluster > disksize?

winpe.txt — Windows executables (New in BE1.3!) (Don't worry — explained on next page!)


```
117886464       0316eaac06e782616036639824c04ceb        <PE>
  <FileHeader Machine="IMAGE_FILE_MACHINE_I386" NumberOfSections="5" TimeDateStamp="1255540604"
PointerToSymbolTable="0" NumberOfSymbols="0" SizeOfOptionalHeader="224">
<Characteristics><IMAGE_FILE_EXECUTABLE_IMAGE /><IMAGE_FILE_32BIT_MACHINE /><IMAGE_FILE_DLL /></
Characteristics></FileHeader><OptionalHeaderStandard Magic="PE32" MajorLinkerVersion="8"
MinorLinkerVersion="0" SizeOfCode="260096" SizeOfInitializedData="89088"
SizeOfUninitializedData="0" AddressOfEntryPoint="0x3963c" BaseOfCode="0x1000" /
><OptionalHeaderWindows ImageBase="0x6a520000" SectionAlignment="1000" FileAlignment="200"
MajorOperatingSystemVersion="4" MinorOperatingSystemVersion="0" MajorImageVersion="0"
MinorImageVersion="0" MajorSubsystemVersion="4" MinorSubsystemVersion="0" Win32VersionValue="0"
SizeOfImage="59000" SizeOfHeaders="400" CheckSum="0x5aedb" SubSystem=""
SizeOfStackReserve="100000" SizeOfStackCommit="1000" SizeOfHeapReserve="100000"
SizeOfHeapCommit="1000" LoaderFlags="0" NumberOfRvaAndSizes="10"><DllCharacteristics></
DllCharacteristics></OptionalHeaderWindows><Sections><SectionHeader Name=".text"
VirtualSize="3f73a" VirtualAddress="1000" SizeOfRawData="3f800" PointerToRawData="400"
PointerToRelocations="0" PointerToLinenumbers="0" ><Characteristics><IMAGE_SCN_CNT_CODE /
><IMAGE_SCN_MEM_EXECUTE /><IMAGE_SCN_MEM_READ /></Characteristics></SectionHeader><SectionHeader
Name=".rdata" VirtualSize="df22" VirtualAddress="41000" SizeOfRawData="e000"
PointerToRawData="3fc00" PointerToRelocations="0" PointerToLinenumbers="0"
><Characteristics><IMAGE_SCN_CNT_INITIALIZED_DATA /><IMAGE_SCN_MEM_READ /></Characteristics></
SectionHeader><SectionHeader Name=".data" VirtualSize="1128" VirtualAddress="4f000"
SizeOfRawData="a00" PointerToRawData="4dc00" PointerToRelocations="0" PointerToLinenumbers="0"
><Characteristics><IMAGE_SCN_CNT_INITIALIZED_DATA /><IMAGE_SCN_MEM_READ /><IMAGE_SCN_MEM_WRITE /
></Characteristics></SectionHeader><SectionHeader Name=".rsrc" VirtualSize="848"
VirtualAddress="51000" SizeOfRawData="a00" PointerToRawData="4e600" PointerToRelocations="0"
PointerToLinenumbers="0" ><Characteristics><IMAGE_SCN_CNT_INITIALIZED_DATA /><IMAGE_SCN_MEM_READ /
></Characteristics></SectionHeader><SectionHeader Name=".reloc" VirtualSize="672c"
VirtualAddress="52000" SizeOfRawData="6800" PointerToRawData="4f000" PointerToRelocations="0"
PointerToLinenumbers="0" ><Characteristics><IMAGE_SCN_CNT_INITIALIZED_DATA /
><IMAGE_SCN_MEM_DISCARDABLE /><IMAGE_SCN_MEM_READ /></Characteristics></SectionHeader></
Sections><dlls><dll>ADVAPI32.dll\x00\x006\x05memcpy\x00\x008\x05memmov</dll><dll>WS2_32.dll
\x00\x00,\x02InterlockedIncreme</dll></dlls></PE>
```


winpe.txt — Windows executables
First line is the offset, MD5(first 4K), XML of data

```
117886464       0316eaac06e782616036639824c04ceb        <PE>
  <FileHeader Machine=...
```

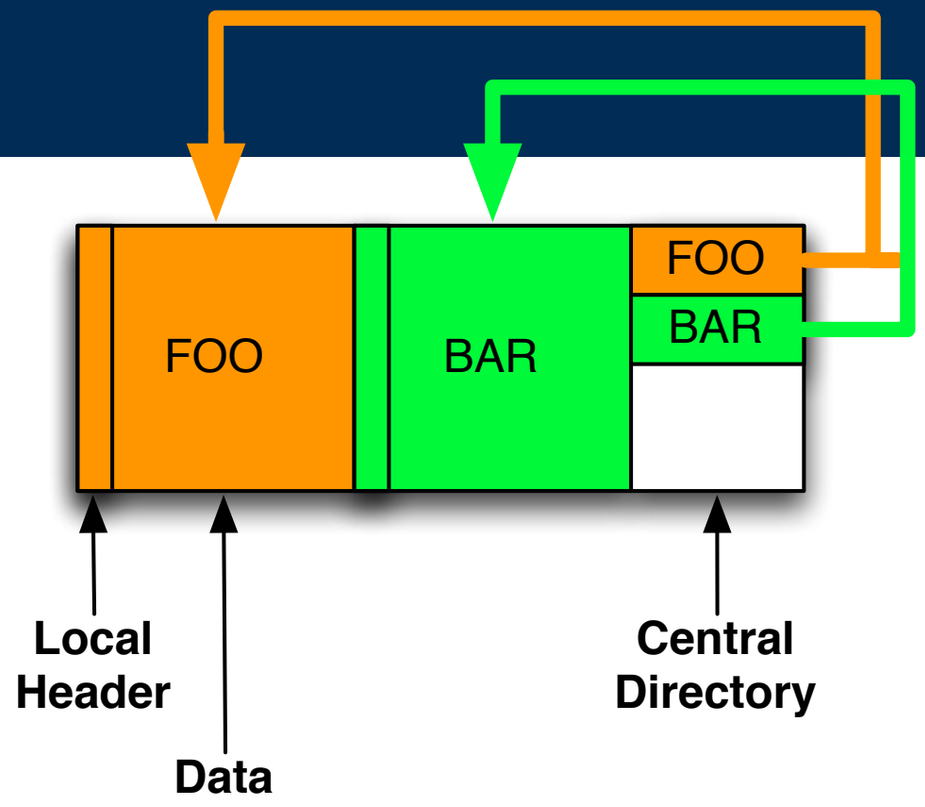
Uses:

- Offset tells you were the find the file (most executables are not fragmented)
- MD5 can be used to deduplicate and look up in hash database
- <PE> XML block breaks out all of the PE headers.

zip.txt — zipfile headers

ZIP has become the *defacto* archive format.

- zip, jar, docx, pptx, etc.
- ZIP64 provides for files larger than 4GiB
- Allows faster access to components that .tar.gz



bulk_extractor finds local file headers.

```
A.  Local file header:

local file header signature     4 bytes  (0x04034b50)
version needed to extract       2 bytes
general purpose bit flag        2 bytes
compression method              2 bytes
last mod file time              2 bytes
last mod file date              2 bytes
crc-32                          4 bytes
compressed size                 4 bytes
uncompressed size               4 bytes
file name length                2 bytes
extra field length              2 bytes

file name (variable size)
extra field (variable size)
```

zip.txt decodes every header of every zip archive

```
# Filename: /corp/nps/scenarios/2009-m57-patents/drives-redacted/
charlie-2009-12-11.E01
# Feature-Recorder: zip
# Feature-File-Version: 1.1
62865144        000024.tif      <zipinfo><name>000024.tif</name><name_len>10</
name_len><version>20</version><compression_method>8</
compression_method><uncompr_size>0</uncompr_size><compr_size>0</
compr_size><lastmodtime>8</lastmodtime><lastmoddate>34592</lastmoddate><crc32>0</
crc32><extra_field_len>0</extra_field_len><disposition
bytes='10846'>decompressed</disposition></zipinfo>

62874091        000025.tif      <zipinfo><name>000025.tif</name><name_len>10</
name_len><version>20</version><compression_method>8</
compression_method><uncompr_size>0</uncompr_size><compr_size>0</
compr_size><lastmodtime>8</lastmodtime><lastmoddate>34592</lastmoddate><crc32>0</
crc32><extra_field_len>0</extra_field_len><disposition
bytes='67680'>decompressed</disposition></zipinfo>
```

Possible uses:

- Identify MSOffice and OpenOffice documents
- Identify Java programs
- Reconstruct hiearchy

There are four main categories of feature files:

Identity Information:

- Domain Names; Email addresses; URLs
- Search terms; Facebook IDs; JSON data
- KML files
- VCARDs
- find output

Technical Info:

- ZIP files; EXIF data

Network Information:

- PCAP files; Ethernet Addresses; TCP/IP Connections; etc.

Information about executables:

- ELF & PE headers; Windows Prefetch files

```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 alerts.txt
-rw-r--r--@ 1 simsong  staff      2743 Jul  7 23:59 ccn.txt
-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
-rw-r--r--@ 1 simsong  staff    185266 Jul  8 00:03 domain_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 find.txt
-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 hex.txt
-rw-r--r--@ 1 simsong  staff     95835 Jul  8 00:03 ip.txt
-rw-r--r--@ 1 simsong  staff     11603 Jul  8 00:03 ip_histogram.txt
-rw-r--r--@ 1 simsong  staff   2025702 Jul  8 00:03 json.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
-rw-r--r--@ 1 simsong  staff     59469 Jul  8 00:03 telephone.txt
-rw-r--r--@ 1 simsong  staff      6612 Jul  8 00:03 telephone_histogram.txt
-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
-rw-r--r--@ 1 simsong  staff  34128889 Jul  8 00:03 zip.txt
```

ether.txt and ether_histogram.txt: a list of ethernet addresses (from packets and ASCII)

```
342699417       00:80:77:31:01:07       n008077310107 1 00:80:77:31:01:07 192.168.1.2  an
342700437       00:80:77:31:01:07       the following:  00:80:77:31:01:07 brn008077310107
342703371       00:80:77:31:01:07        -s 192.168.1.2 00:80:77:31:01:07   ping 192.168.
559251251       00:80:77:31:01:07       N008077310107 1 00:80:77:31:01:07 192.168.1.2</sp
567912435       00:80:77:31:01:07       class="command">00:80:77:31:01:07   BRN0080773101
684600847       00:80:77:31:01:07        -s 192.168.1.2 00:80:77:31:01:07</span></div><a
6341279242      00:0B:DB:4F:6B:10        (ether_dhost)
6341279242      00:19:E3:E7:5D:23        (ether_shost)
6341283338      00:0B:DB:4F:6B:10        (ether_dhost)
6341283338      00:19:E3:E7:5D:23        (ether_shost)
6341287434      00:0B:DB:4F:6B:10        (ether_dhost)
```

```
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# bulk_extractor-Version: 1.3b1-dev2
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: ether
# Histogram-File-Version: 1.1
n=255   00:19:E3:E7:5D:23
n=254   00:0B:DB:4F:6B:10
n=6     00:80:77:31:01:07
n=3     00:80:C7:8F:6C:96
```

Note:

- Packets clearly traveled from 00:19:E5:E7:5D:23 to 00:0B:DB:4F:6B:10
- Other usage appears to have Ethernet addresses in HTML!

ip.txt: ip addresses from packet carving (scan_net) (not from dotted quads)

```
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: ip
# Feature-File-Version: 1.1
117942521       20.137.78.24    struct ip R (src) cksum-bad
117942521       94.89.93.194    struct ip L (dst) cksum-bad
118342942       20.137.78.24    struct ip R (src) cksum-bad
118342942       94.89.93.194    struct ip L (dst) cksum-bad

9977306594      192.168.1.1     sockaddr_in
9977393926      63.245.209.93   sockaddr_in

5839793854-HIBER-17952268       90.4.162.232    struct ip L (dst) cksum-bad
5839793854-HIBER-17960460       78.0.3.185      struct ip R (src) cksum-bad
5839793854-HIBER-17960460       90.4.162.232    struct ip L (dst) cksum-bad
6339825268      192.168.1.104   struct ip L (src) cksum-ok
6339825268      192.168.1.1     struct ip R (dst) cksum-ok
6339825320      192.168.1.104   struct ip L (src) cksum-ok

5839793854-HIBER-129985200      8.3.2.3 sockaddr_in
```

- Local (“L”) or Remote (“R”)
- chksum-bad/chksum-ok — IP checksum good or bad
- sockaddr_in — IP address from sockaddr_in structure.

ip_histogram.txt removes random noise (1.3 histogram is only of chksum-ok values)

Histogram of all values:

```
# Filename: /corp/nps/drives/nps-2009-m57-patents-redacted/charlie-2009-12-11.E01
# Feature-Recorder: ip
# Histogram-File-Version: 1.1
n=93    108.5.218.9
n=93    7.90.102.193
n=64    20.137.78.24
n=64    94.89.93.194
n=31    176.69.248.3
n=30    5.225.0.252
n=26    120.23.102.15
n=26    182.210.102.137
n=24    152.6.0.164
n=24    152.6.0.220
n=19    192.168.1.1
n=14    192.168.1.104
n=13    141.77.252.81
n=13    80.4.139.6
```

chksum-ok:

packets.pcap — pcap file made from carved packets.

Use any packet analysis tool you like...

```
$ tcpdump -r packets.pcap
-5:-59:-59.0000 IP 192.168.1.1.microsoft-ds > 192.168.1.104.udpradio: Flags [.],
ack 416616880, win 65535, length 0
-5:-59:-59.0000 IP 192.168.1.1.microsoft-ds > 192.168.1.104.udpradio: Flags [.],
ack 4294967234, win 65535, length 0
-5:-59:-59.0000 IP 192.168.1.1.microsoft-ds > 192.168.1.104.udpradio: Flags [.],
ack 4294967084, win 65535, length 0

-5:-59:-59.0000 IP 192.168.1.1.microsoft-ds > 192.168.1.104.udpradio: Flags [P.],
seq 4294966956:4294967060, ack 4294967008, win 65535, length 104SMB PACKET:
SMBtrans2 (REPLY)
...
```

Notice time is -5:-59:-59.000

- This has a time zone of -0600 (I'm typing this in Utah in the summer)
- The time in the packet file is "1"

```
/* Possibly a valid ethernet frame but not preceeded by a pcap_record_header.
 * Write it out with time of 1.
 */
```

- Only packets carved from a PCAP file will have a the correct time.

tcp.txt — Details about TCP (and UDP) network flows

More detail than ip.txt

```
117942521       20.137.78.24:2048 -> 94.89.93.194:32824 (TCP)    Size: 232
118342942       20.137.78.24:2048 -> 94.89.93.194:32824 (TCP)    Size: 232
119672053       255.144.140.1:3972 -> 0.0.133.192:52224 (TCP)    Size: 3973
122908648       1.0.0.0:0 -> 117.17.2.0:0 (UDP)  Size: 512
101356868       56.141.76.36:65490 -> 28.81.139.206:35832 (TCP)  Size: 3972
101727492       56.141.76.36:65490 -> 28.81.139.206:35832 (TCP)  Size: 3972
102361428       56.141.76.36:65490 -> 28.81.139.206:35832 (TCP)  Size: 3972
102380242       20.137.78.24:2048 -> 94.89.93.194:21899 (TCP)    Size: 232
68852207        7.90.102.193:13311 -> 108.5.218.9:18387 (TCP)    Size: 3973
```

Be careful of false positives:

```
336089314-HIBER-100696361       0.0.0.0:101 -> 0.0.0.0:19829 (TCP)       Size: 77
336089314-HIBER-113107975       48.144.141.49:0 -> 176.61.0.0:0 (TCP)    Size: 70
336089314-HIBER-161355043       7.86.252.232:55425 -> 47.0.250.69:21841 (TCP)    Size: 1419
336089314-HIBER-166154373       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166162086       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166169799       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166194316       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166202507       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166210698       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166218889       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-166227080       255.118.14.233:57600 -> 255.164.149.80:52428 (UDP)       Size: 768
336089314-HIBER-168358773       57.93.93.93:3968 -> 8.141.88.247:17843 (TCP)     Size: 5631
336089314-HIBER-168361526       57.93.93.93:3968 -> 8.141.88.247:17843 (TCP)     Size: 5631
```

tcp_histogram.txt — would be nice to have total flow info

These packets:

```
101727492       56.141.76.36:65490 -> 28.81.139.206:35832 (TCP)  Size: 3972
102361428       56.141.76.36:65490 -> 28.81.139.206:35832 (TCP)  Size: 3972
```

Become this histogram:

```
n=93    7.90.102.193:13311 -> 108.5.218.9:18387 (TCP)
n=53    0.0.123.55:12288 -> 56.49.57.65:12336 (TCP)
n=48    5.100.228.83:64 -> 15.134.211.0:15 (TCP)
n=38    252.21.212.255:34048 -> 83.0.0.0:17792 (TCP)
n=38    252.21.212.255:34048 -> 83.0.16.16:17792 (TCP)
n=30    104.48.235.16:60160 -> 232.235.16.232:35701 (TCP)
n=30    5.225.0.252:61133 -> 176.69.248.3:63488 (TCP)
n=28    0.106.37.95:23179 -> 102.59.199.117:52968 (TCP)
n=27    20.137.78.24:2048 -> 94.89.93.194:21899 (TCP)
n=26    120.23.102.15:4160 -> 182.210.102.137:16449 (UDP)
n=24    106.0.80.83:51457 -> 141.74.255.139:65382 (UDP)
```

Caveats:

- Still a lot of false positives.
- The current histogram system can’t do math...

There are four main categories of feature files:

Identity Information:

- Domain Names; Email addresses; URLs
- Search terms; Facebook IDs; JSON data
- KML files
- VCARDs
- find output

Technical Info:

- ZIP files; EXIF data

Network Information:

- PCAP files; Ethernet Addresses; TCP/IP Connections; etc.

Information about executables:

- ELF & PE headers; Windows Prefetch files

```
-rw-r--r--@ 1 simsong  staff       476 Jul  7 23:50 aes_keys.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 alerts.txt
-rw-r--r--@ 1 simsong  staff      2743 Jul  7 23:59 ccn.txt
-rw-r--r--@ 1 simsong  staff       454 Jul  8 00:03 ccn_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 ccn_track2.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 ccn_track2_histogram.txt
-rw-r--r--@ 1 simsong  staff  23369167 Jul  8 00:03 domain.txt
-rw-r--r--@ 1 simsong  staff    185266 Jul  8 00:03 domain_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 elf.txt
-rw-r--r--@ 1 simsong  staff   1719842 Jul  8 00:03 email.txt
-rw-r--r--@ 1 simsong  staff     35073 Jul  8 00:03 email_histogram.txt
-rw-r--r--@ 1 simsong  staff     23961 Jul  8 00:00 ether.txt
-rw-r--r--@ 1 simsong  staff       337 Jul  8 00:03 ether_histogram.txt
-rw-r--r--@ 1 simsong  staff  11188830 Jul  8 00:03 exif.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 find.txt
-rw-r--r--@ 1 simsong  staff      1112 Jul  8 00:01 gps.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 hex.txt
-rw-r--r--@ 1 simsong  staff     95835 Jul  8 00:03 ip.txt
-rw-r--r--@ 1 simsong  staff     11603 Jul  8 00:03 ip_histogram.txt
-rw-r--r--@ 1 simsong  staff   2025702 Jul  8 00:03 json.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 kml.txt
-rw-r--r--@ 1 simsong  staff    194991 Jul  8 00:03 packets.pcap
-rw-r--r--@ 1 simsong  staff     21343 Jul  8 00:03 report.xml
-rw-r--r--@ 1 simsong  staff   3782598 Jul  8 00:03 rfc822.txt
-rw-r--r--@ 1 simsong  staff    213746 Jul  8 00:03 tcp.txt
-rw-r--r--@ 1 simsong  staff     61255 Jul  8 00:03 tcp_histogram.txt
-rw-r--r--@ 1 simsong  staff     59469 Jul  8 00:03 telephone.txt
-rw-r--r--@ 1 simsong  staff      6612 Jul  8 00:03 telephone_histogram.txt
-rw-r--r--@ 1 simsong  staff  67205326 Jul  8 00:03 url.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_facebook-id.txt
-rw-r--r--@ 1 simsong  staff   5706665 Jul  8 00:03 url_histogram.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  8 00:03 url_microsoft-live.txt
-rw-r--r--@ 1 simsong  staff      8504 Jul  8 00:03 url_searches.txt
-rw-r--r--@ 1 simsong  staff    151673 Jul  8 00:03 url_services.txt
-rw-r--r--@ 1 simsong  staff         0 Jul  7 23:48 vcard.txt
-rw-r--r--@ 1 simsong  staff  18549729 Jul  8 00:03 windirs.txt
-rw-r--r--@ 1 simsong  staff  29051041 Jul  8 00:03 winpe.txt
-rw-r--r--@ 1 simsong  staff   1984759 Jul  8 00:03 winprefetch.txt
-rw-r--r--@ 1 simsong  staff  34128889 Jul  8 00:03 zip.txt
```

elf.txt records ELF executables

charlie-2009-12-11 doesn't have any:

```
-rw-r--r--+   1 simsong  simsong         0 Jul 20 16:54 elf.txt
```

But nps-2009-ubnist1.gen3 does:

```
-rw-r--r--+  1 simsong  staff   5691737 Aug  3 12:39 elf.txt
```

Here is a sample:

```
# Feature-File-Version: 1.1
727114768-GZIP-2048     1b5984e4365278bee12c9be8849439f4        <ELF
class="ELFCLASS32" data="ELFDATA2LSB" osabi="ELFOSABI_NONE" abiversion="0 ><ehdr
type="ET_EXEC" machine="EM_386" version="1" entry="134514864" phoff="52"
shoff="19000" flags="0" ehsize="52" phentsize="32" phnum="8" shentsize="40"
shnum="27" shstrndx="26" /><sections><section name="" type="SHT_NULL" addr="0x0"
offset="0" size="0" link="0" info="0" addralign="0" shentsize="0"><flags></
flags></section><section name=".interp" type="SHT_PROGBITS" addr="0x8048134"
offset="134" size="13" link="0" info="0" addralign="1"
shentsize="0"><flags><SHF_ALLOC /></flags></section><section name=".note.ABI-tag"
type="SHT_NOTE" addr="0x8048148" offset="148" size="20" link="0" info="0"
addralign="4" shentsize="0"><flags><SHF_ALLOC /></flags></section><section
name=".hash" type="SHT_HASH" addr="0x8048168" offset="168" size="c0" link="5"
info="0" addralign="4" shentsize="4"><flags><SHF_ALLOC /></flags></
section><section name=".gnu.hash" type="SHT_GNU_HASH" addr="0x8048228" offset\
```

Decoding the <ELF> record...

The path indicates that the ELF is inside a GZIP stream:

```
# Feature-File-Version: 1.1
727114768-GZIP-2048     ...
```

The MD5 is the hash of the first 4KiB:

```
1b5984e4365278bee12c9be8849439f4
```

Next comes the XML for the header:

```
<ELF class="ELFCLASS32" data="ELFDATA2LSB" osabi="ELFOSABI_NONE" abiversion="0 >
<ehdr type="ET_EXEC" machine="EM_386" version="1" entry="134514864" phoff="52"
shoff="19000" flags="0" ehsize="52" phentsize="32" phnum="8" shentsize="40"
shnum="27" shstrndx="26" />

<sections>
  <section name="" type="SHT_NULL" addr="0x0" offset="0" size="0" link="0"
info="0" addralign="0" shentsize="0">
  <flags></flags>
  </section>
...
</sections>
<shared_objects><so>libc.so.6</so></shared_objects>
</ELF>
```

<PE> <FileHeader> provides information on header

```
<?xml version="1.0"?>
<PE>
  <FileHeader
      Machine="IMAGE_FILE_MACHINE_I386"
      NumberOfSections="5"
      TimeDateStamp="1255540604"
      PointerToSymbolTable="0"
      NumberOfSymbols="0"
      SizeOfOptionalHeader="224"
    >
  <Characteristics>
      <IMAGE_FILE_EXECUTABLE_IMAGE/>
      <IMAGE_FILE_32BIT_MACHINE/>
      <IMAGE_FILE_DLL/>
  </Characteristics>
</FileHeader
```

<PE><OptionalHeaderStandard>

```
<OptionalHeaderStandard
      Magic="PE32"
      MajorLinkerVersion="8"
      MinorLinkerVersion="0"
      SizeOfCode="260096"
      SizeOfInitializedData="89088"
      SizeOfUninitializedData="0"
      AddressOfEntryPoint="0x3963c"
      BaseOfCode="0x1000"/>
```

<PE> <OptionalHeaderWindows>

```
<OptionalHeaderWindows
      ImageBase="0x6a520000"
      SectionAlignment="1000"
      FileAlignment="200"
      MajorOperatingSystemVersion="4"
      MinorOperatingSystemVersion="0"
      MajorImageVersion="0"
      MinorImageVersion="0"
      MajorSubsystemVersion="4"
      MinorSubsystemVersion="0"
      Win32VersionValue="0"
      SizeOfImage="59000"
      SizeOfHeaders="400"
      CheckSum="0x5aedb"
      SubSystem=""
      SizeOfStackReserve="100000"
      SizeOfStackCommit="1000"
      SizeOfHeapReserve="100000"
      SizeOfHeapCommit="1000"
      LoaderFlags="0"
      NumberOfRvaAndSizes="10">
   <DllCharacteristics/>
</OptionalHeaderWindows>
```

<PE><Sections><SectionHeader>
Provides details of each PE section

```
<Sections>
  <SectionHeader
        Name=".text"
        VirtualSize="3f73a"
        VirtualAddress="1000"
        SizeOfRawData="3f800"
        PointerToRawData="400"
        PointerToRelocations="0"
        PointerToLinenumbers="0">
    <Characteristics>
      <IMAGE_SCN_CNT_CODE/>
      <IMAGE_SCN_MEM_EXECUTE/>
      <IMAGE_SCN_MEM_READ/>
    </Characteristics>
</SectionHeader>
```

```
<SectionHeader
        Name=".rdata"
        VirtualSize="df22"
        VirtualAddress="41000"
        SizeOfRawData="e000"
        PointerToRawData="3fc00"
        PointerToRelocations="0"
        PointerToLinenumbers="0">
<Characteristics>
 <IMAGE_SCN_CNT_INITIALIZED_DATA/>
 <IMAGE_SCN_MEM_READ/>
</Characteristics>
</SectionHeader>
```

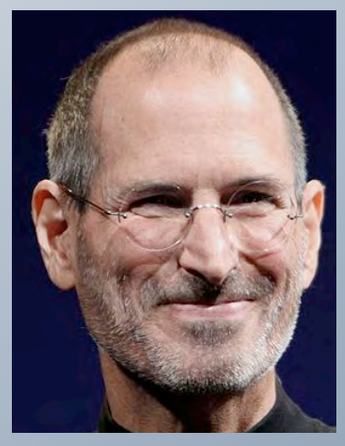
winprefetch.txt - bulk_extractor will carve prefetch files! Useful because PREFETCH files are frequently deleted

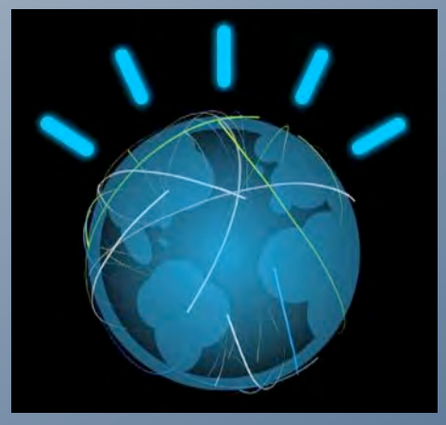
Prefetch files give you:

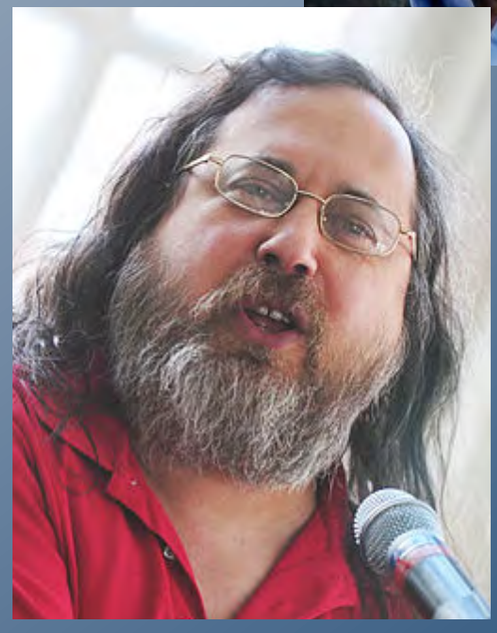
- *Name of executable*
- *Name of DLLs*
- *atime*
- *Number of runs*
- *Serial number*
- *Directory of DLLs*
- *ctime*

```
62123520        WMIPRVSE.EXE    <prefetch><os>Windows XP</os>

<filename>WMIPRVSE.EXE</filename>
<header_size>152</header_size>
<atime>2009-12-11T15:31:12Z</atime>
<runs>251</runs>
<filenames>
<file>\x5CDEVICE\x5CHARDDISKVOLUME1\x5CWINDOWS\x5CSYSTEM32\x5CNTDLL.DLL</file>
<file>\x5CDEVICE\x5CHARDDISKVOLUME1\x5CWINDOWS\x5CSYSTEM32\x5CKERNEL32.DLL</file>
<file>\x5CDEVICE\x5CHARDDISKVOLUME1\x5CWINDOWS\x5CSYSTEM32\x5CUNICODE.NLS</file>
<file>\x5CDEVICE\x5CHARDDISKVOLUME1\x5CWINDOWS\x5CSYSTEM32\x5CLOCALE.NLS</file>
...
</filenames>
<volume><path>\x5CDEVICE\x5CHARDDISKVOLUME1</path>
<creation>2009-11-08T16:58:56Z</creation>
<serial_number>d8cc759a</serial_number>
<dirnames><dir>\x5CDEVICE\x5CHARDDISKVOLUME1\x5C</dir>
<dir>\x5CDEVICE\x5CHARDDISKVOLUME1\x5CWINDOWS\x5C</dir>
```





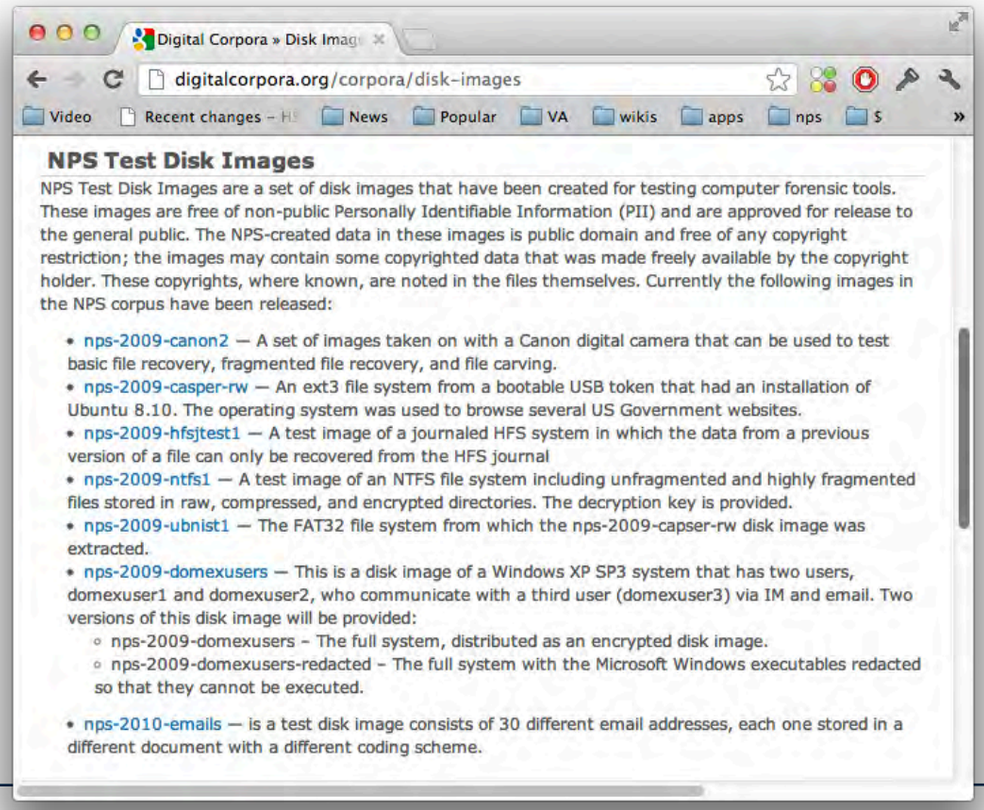


Suppressing bulk_extractor False Positives

For this section we will work with ubnist1

nps-2009-ubnist1 — Bootable Linux USB used to browse USG sites

```
-rw-rw-r--  1 simsong  staff        685 Jan 29  2009 narrative.txt
-rw-rw-r--  1 simsong  staff  725408916 Jan  6  2009 ubnist1.gen0.aff
-rw-rw-r--  1 simsong  staff 2106589184 Jan  6  2009 ubnist1.gen0.raw
-rw-rw-r--  1 simsong  staff  746023186 Jan  6  2009 ubnist1.gen1.aff
-rw-rw-r--  1 simsong  staff 2106589184 Jan  6  2009 ubnist1.gen1.raw
-rw-rw-r--  1 simsong  staff  838513850 Jan  9  2009 ubnist1.gen2.aff
-rw-rw-r--  1 simsong  staff 2106589184 Jan  9  2009 ubnist1.gen2.raw
-rw-rw-r--  1 simsong  staff 1572852102 May  2  2010 ubnist1.gen3.E01
-rw-rw-r--  1 simsong  staff  534512293 May  2  2010 ubnist1.gen3.E02
-rw-rw-r--  1 simsong  staff  890164681 Jan  7  2009 ubnist1.gen3.aff
-rw-rw-r--  1 simsong  staff 2106589184 Jan  7  2009 ubnist1.gen3.raw
```



Hard drives are *filled* with email addresses.

Bulk_extractor finds email addresses is many places:

- Windows binaries; SSL certificates
- Documents
- Cached web pages; Memory; Hibernation Files

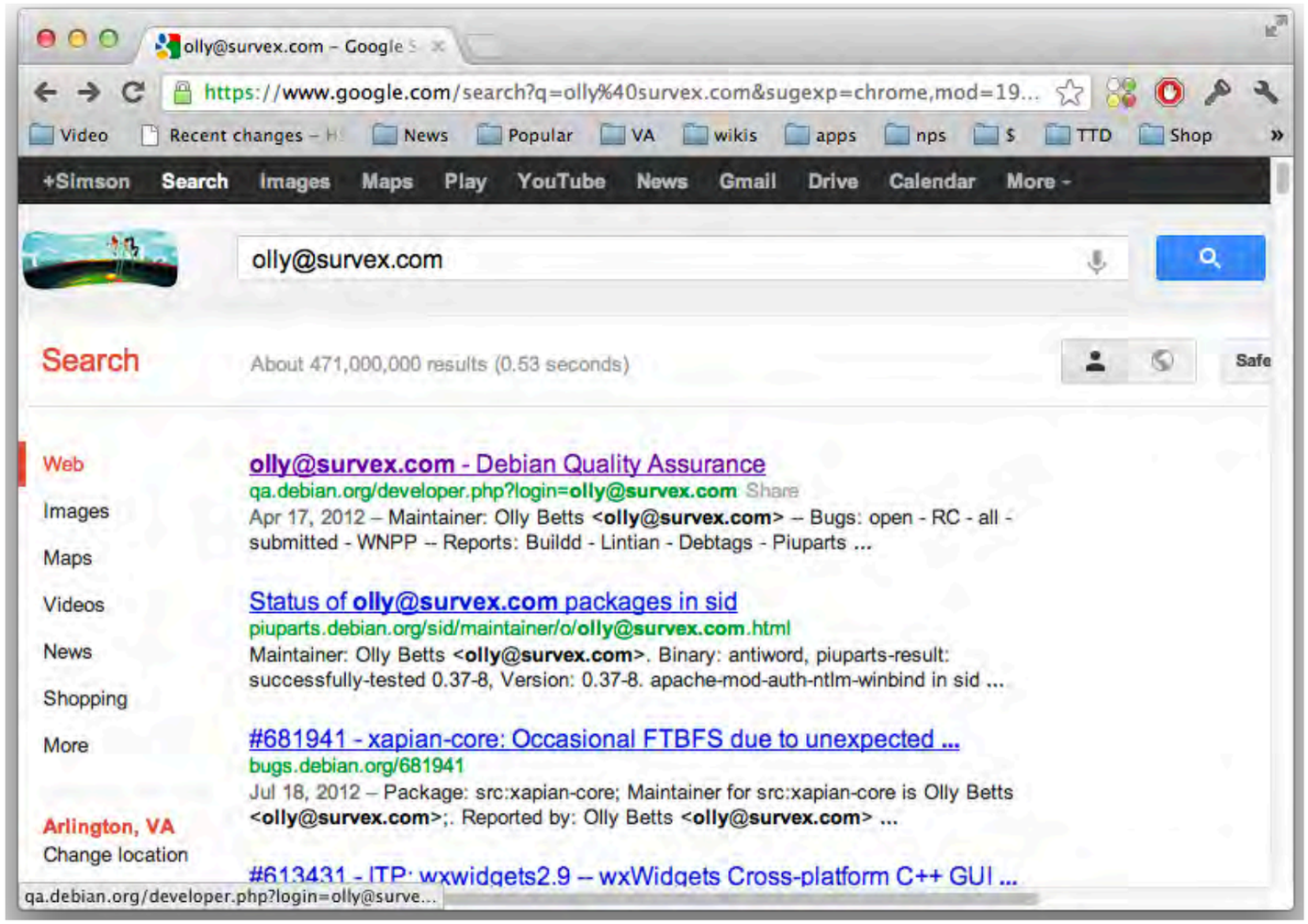
UBNIST1 have a LOT of email addresses; each snapshot sees more...

gen0	gen1	gen2	gen3
n=3447 olly@survex.com n=2237 hadess@hadess.net n=2040 daniel@veillard.com n=990 airlied@linux.ie n=910 cjwatson@debian.org n=909 dsandras@seconix.com n=893 rene@debian.org n=884 anholt@freebsd.org n=767 jirka@5z.com n=760 guillem@debian.org n=744 wakkerma@debian.org n=708 dshaw@jabberwocky.com n=660 doogie@debian.org n=659 brian.cameron@sun.com n=656 dsandras@gnome.org n=654 kyoshida@novell.com n=632 priikone@silcnet.org n=626 daniel@fooishbar.org	n=3455 olly@survex.com n=3254 ubuntu-devel-discuss@lists.ubuntu.com n=2241 hadess@hadess.net n=2040 daniel@veillard.com n=990 airlied@linux.ie n=930 cjwatson@debian.org n=910 rene@debian.org n=909 dsandras@seconix.com n=884 anholt@freebsd.org n=767 jirka@5z.com n=760 guillem@debian.org n=744 wakkerma@debian.org n=708 dshaw@jabberwocky.com n=660 doogie@debian.org n=659 brian.cameron@sun.com n=656 dsandras@gnome.org n=654 kyoshida@novell.com	n=27364 ubuntu-users@lists.ubuntu.com n=17213 ubuntu-motu@lists.ubuntu.com n=14291 ubuntu-devel-discuss@lists.ubuntu.com n=4086 language-packs@ubuntu.com n=3481 olly@survex.com n=2280 ubuntu-desktop@lists.ubuntu.com n=2239 hadess@hadess.net n=2040 daniel@veillard.com n=1696 debian-x@lists.debian.org n=1202 strk@keybit.net n=1122 bwy@benjaminwolsey.de n=1044 pkg-perl-maintainers@lists.alioth.debian.org n=1036 cjwatson@debian.org n=1017 rene@debian.org n=990 airlied@linux.ie n=909 dsandras@seconix.com	n=27672 ubuntu-users@lists.ubuntu.com n=17133 ubuntu-motu@lists.ubuntu.com n=12936 ubuntu-devel-discuss@lists.ubuntu.com n=4032 language-packs@ubuntu.com n=3477 olly@survex.com n=2239 hadess@hadess.net n=2040 daniel@veillard.com n=1966 ubuntu-desktop@lists.ubuntu.com n=1484 debian-x@lists.debian.org n=1202 strk@keybit.net n=1122 bwy@benjaminwolsey.de n=1023 cjwatson@debian.org n=1010 rene@debian.org n=1006 pkg-perl-maintainers@lists.alioth.debian.org n=990 airlied@linux.ie n=909 dsandras@seconix.com n=884 anholt@freebsd.org
6596 total	**6929 total**	**8734 total**	**8734 total**

It's important to distinguish email addresses that are relevant to a case from those that are not.

The top address is olly@survex.com

- We should probably ignore Mr. Betts:



gen0	
n=3447	olly@survex.com
n=2237	hadess@hadess.net
n=2040	daniel@veillard.com
n=990	airlied@linux.ie
n=910	cjwatson@debian.org
n=909	dsandras@seconix.com
n=893	rene@debian.org
n=884	anholt@freebsd.org
n=767	jirka@5z.com
n=760	guillem@debian.org
n=744	wakkerma@debian.org
n=708	dshaw@jabberwocky.com
n=660	doogie@debian.org
n=659	brian.cameron@sun.com
n=656	dsandras@gnome.org
n=654	kyoshida@novell.com
n=632	priikone@silcnet.org
n=626	daniel@fooishbar.org
6596 total	

Other sources that we might wish to ignore

- Windows binaries; SSL certificates; Sample documents; News Stories

stop lists specify features to be "stopped"

Stopped features *are not ignored*.

- Stopped features are moved from *email.txt* to *email_stopped.txt*.
- This is important for validation and error-diagnosis.

Stop lists are implemented with the word_and_context_list C++ class.

- "words" — Anything that might be in the "feature" column
  - —*Email address*
  - —*MD5 hash of the first 4KiB of a file (JPEG)*
  - —*AES key*
- "context" — Anything that might be in the "context" column
  - —*Includes the feature*
  - —*Will suppress a specific instance of a feature*
- regular expressions
  - —*Dramatically slows down the process*

bulk_extractor also supports *alert lists*

- "words" or "context" that should be flagged

stop lists and alert lists are specified with the “-w” and “-r” options.

```
Usage: bulk_extractor [options] imagefile

...
   -r alert_list.txt  - a file containing the alert list of features to alert
                        (can be a feature file or a list of globs)
                        (can be repeated.)
   -w stop_list.txt   - a file containing the stop list of features (white list
                        (can be a feature file or a list of globs)s
                        (can be repeated.)
```

The list can be a list of words or a feature file

- For example
  - *stop_list.txt:*

    ```
    olly@survex.com
    hadess@hadess.net
    daniel@veillard.com
    ```

  - *alert_list.txt:*

    ```
    daniel@fooishbar.org
    ```

- command to use is:

  ```
  bulk_extractor -r alert_list.txt -w stop_list.txt -o ubnist1.gen0-v1 ubnist1.gen0.raw
  ```

Stop lists processing is reflected in the feature files.

No stop list:

```
7324005 Aug  4 10:25 ubnist1.gen0/email.txt
 169609 Aug  4 10:25 ubnist1.gen0/email_histogram.txt

$ wc -l ubnist1.gen0/email*
   72965 ubnist1.gen0/email.txt
    6596 ubnist1.gen0/email_histogram.txt
```

With stop list:

```
6566160 Aug  4 11:20 email.txt
 169534 Aug  4 11:20 email_histogram.txt
 827940 Aug  4 11:20 email_stopped.txt

$ wc -l ubnist1.gen0-v1/email*
   65241 ubnist1.gen0-v1/email.txt
    6593 ubnist1.gen0-v1/email_histogram.txt
    7729 ubnist1.gen0-v1/email_stopped.txt
```

—stop_list.txt:

```
olly@survex.com
hadess@hadess.net
daniel@veillard.com
```

—alert_list.txt:

```
daniel@fooishbar.org
```

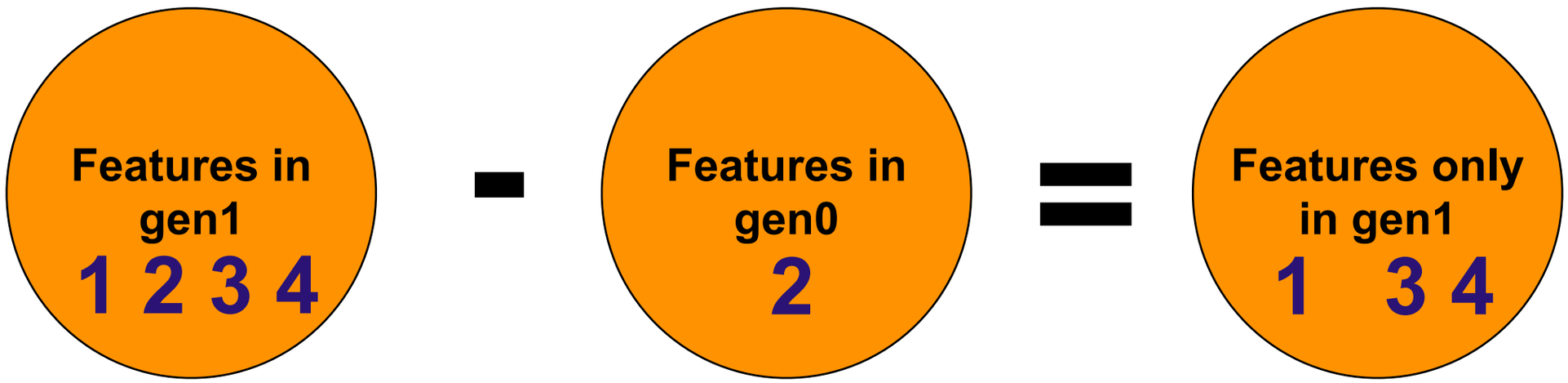
```
$ head ubnist1.gen0-v1/email_stopped.txt
# UTF-8 Byte Order Marker; see http://unicode.org/faq/utf_bom.html
# Filename: /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen0.raw
# Feature-Recorder: email_stopped
# Feature-File-Version: 1.1
317986809-GZIP-47       daniel@veillard.com  aniel Veillard <daniel@veillard.com>\x5Cx0A
\x5Cx0A\x5Cx09* configure.
317986809-GZIP-209      daniel@veillard.com  aniel Veillard <daniel@veillard.com>\x5Cx0A
\x5Cx0A\x5Cx09* libxslt/xs
317986809-GZIP-635      daniel@veillard.com aniel Veillard <daniel@veillard.com>\x5Cx0A
```

Here is more of the email stopped list:

```
317986809-GZIP-47     daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* configure.
317986809-GZIP-209    daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/xs
317986809-GZIP-635    daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/do
317986809-GZIP-1211   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* doc/xsltpr
317986809-GZIP-1377   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/pa
317986809-GZIP-1581   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* configure.
317986809-GZIP-1692   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libexslt/d
317986809-GZIP-1824   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* python/gen
317986809-GZIP-1943   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/xs
317986809-GZIP-2085   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libexslt/d
317986809-GZIP-2315   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* doc/xsltpr
317986809-GZIP-2724   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/wi
317986809-GZIP-2940   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* doc/xsltpr
317986809-GZIP-3331   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* libxslt/xs
317986809-GZIP-3494   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* python/tes
317986809-GZIP-3647   daniel@veillard.com    aniel Veillard <daniel@veillard.com>\x5Cx0A\x5Cx0A\x5Cx09* doc/xslt.h
...
330031689-GZIP-275885   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* queryparse
330031689-GZIP-276902   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* tests/api_
330031689-GZIP-277660   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* configure.
330031689-GZIP-277778   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* tests/harn
330031689-GZIP-277951   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* net/remote
330031689-GZIP-278061   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* tests/harn
330031689-GZIP-278198   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* tests/harn
330031689-GZIP-278379   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* tests/harn
330031689-GZIP-278529   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* configure.
330031689-GZIP-278655   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* net/progcl
330031689-GZIP-278783   olly@survex.com 07  Olly Betts <olly@survex.com>\x5Cx0A\x5Cx0A\x5Cx09* net/remote
```

A feature file can be used as a context stop list. So we can use the gen0 email as a stop for gen1

This makes the gen0 feature file a *filter*.



This isn't hard to do in practice:

```
$ src/bulk_extractor  -w ubnist1.gen0/email.txt  \
  -o ubnist1.gen1-filtered_by_gen0 ubnist1.gen1.raw
Reading context stop list ubnist1.gen0/email.txt
Stop list read.
  Total features read: 72961
  List Size: 32084
  Context Strings: 32083
  Regular Expressions: 0
```

The result of filtering gen1 with gen0: We only see the new email addresses

```
8424165 Aug  4 10:24 ubnist1.gen1/email.txt
 179549 Aug  4 10:24 ubnist1.gen1/email_histogram.txt
```

Features in gen1

−

```
7324005 Aug  4 10:25 ubnist1.gen0/email.txt
 169609 Aug  4 10:25 ubnist1.gen0/email_histogram.txt
```

Features in gen0

=

```
1083873 Aug  4 11:49 ubnist1.gen1-filtered_by_gen0/email.txt
  13867 Aug  4 11:50 ubnist1.gen1-filtered_by_gen0/email_histogram.txt
7805523 Aug  4 11:49 ubnist1.gen1-filtered_by_gen0/email_stopped.txt
```

Features only in gen1

The histogram is a histogram of the filtered email.txt:

```
n=3178   ubuntu-devel-discuss@lists.ubuntu.com
n=638    ubuntu-desktop@lists.ubuntu.com
n=444    debian-x@lists.debian.org
n=219    debian-boot@lists.debian.org
n=204    ubuntu-motu@lists.ubuntu.com
n=144    seb128@debian.org
n=132    pkg-gnome-maintainers@lists.alioth.debian.org
```

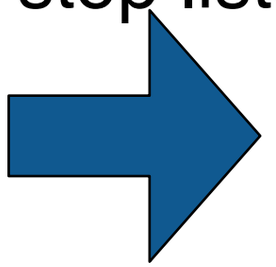
Stop lists and alert lists have minor impact on performance.

Longer stop lists are slower to process. t ∝ (features x stops)

lines in stop list	ubnist1.gen0 Execution time
0	**54.51 s**
3	**55.47 s**
235886	**55.41 s**

Regular expressions slow down stop lists dramatically:

```
olly@survex.com
hadess@hadess.net
daniel@veillard.com
```



```
.*@survex.com
.*@hadess.net
.*@veillard.com
```

re lines in stop list	ubnist1.gen0 Execution time
0	**54.51 s**
3	**66.41 s**

Stop and alert lists must be applied when bulk_extractor is run.

- A future version may allow filtering after-the-fact.

Context-sensitive stop lists are important when looking for unknown individuals.

Recall all of those email addresses on ubnist1

Although these emails are widely seen, they should not be whitelisted:

- Email addresses can be shared
- Email addresses can be sold
- A Linux developer might be engaged in a criminal enterprise

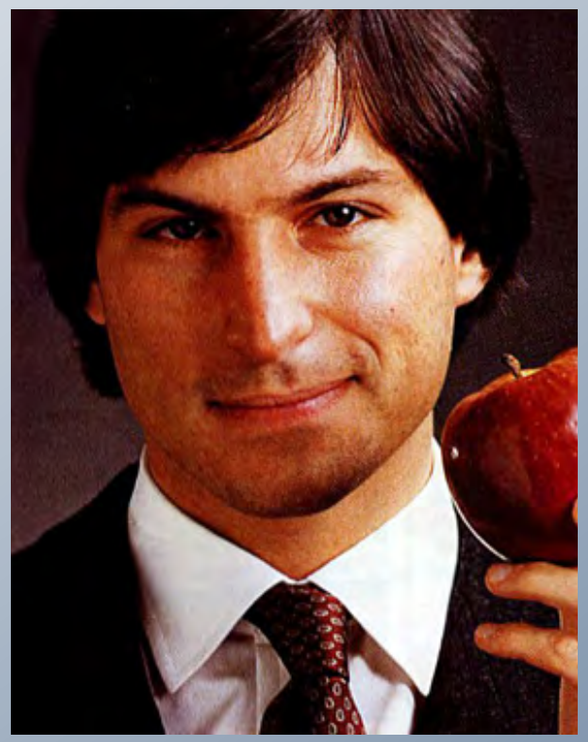
gen0
n=3447 olly@survex.com
n=2237 hadess@hadess.net
n=2040 daniel@veillard.com
n=990 airlied@linux.ie
n=910 cjwatson@debian.org
n=909 dsandras@seconix.com
n=893 rene@debian.org
n=884 anholt@freebsd.org
n=767 jirka@5z.com
n=760 guillem@debian.org
n=744 wakkerma@debian.org
n=708 dshaw@jabberwocky.com
n=660 doogie@debian.org
n=659 brian.cameron@sun.com
n=656 dsandras@gnome.org
n=654 kyoshida@novell.com
n=632 priikone@silcnet.org
n=626 daniel@fooishbar.org
6596 total

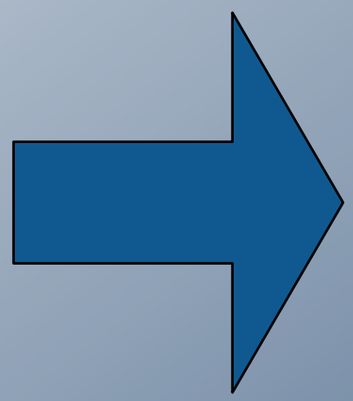
By using context-sensitive stop lists, we:

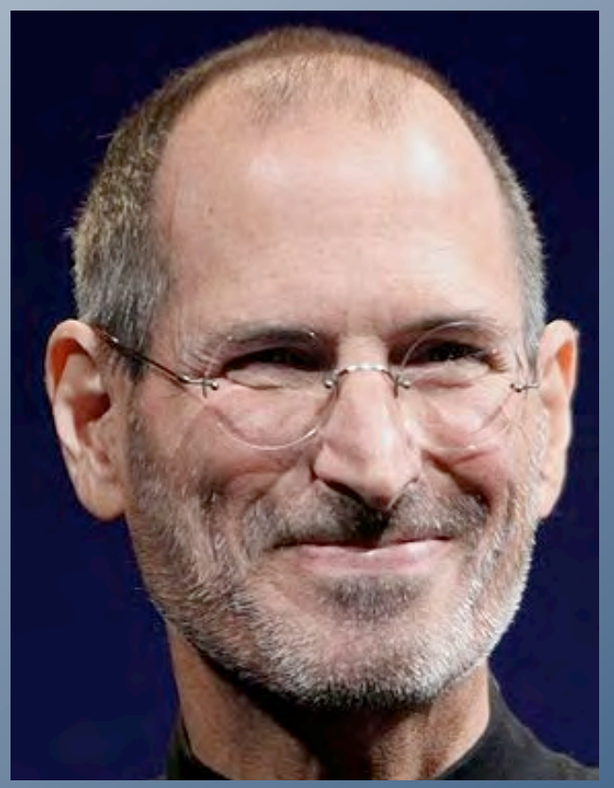
- Ignore the email address where it is widely seen
- Will still notice the email address in a new context

Context-sensitive lists need to be maintained!

- Build from default installs of operating systems & applications.
- NIST is running bulk_extractor over the entire NSRL and will make the results available.
- Organizations are free to trade the feature files amongst themselves.







post-processing

bulk_diff
identify_filenames.py
cross drive analysis

bulk_diff.py: compare two different bulk_extractor reports

The “report” directory contains:

- DFXML file of bulk_extractor run information
- Multiple feature files

bulk_diff.py: create a “difference report” of two bulk_extractor runs.

- Designed for timeline analysis
- Developed with analysts
- Reports biggest changes at top.
  - *Reporting “what’s new” turned out to be more useful*
  - *“what’s missing” includes data inadvertently overwritten*

```
$ python3.2 python/bulk_diff.py --help
Usage: usage: bulk_diff.py [options] <pre> <post>
<pre> and <post> may be a bulk_extractor output directory or a zip file.

Options:
  -h, --help          show this help message and exit
  --smaller           Also show values that didn't change or got smaller
  --tabdel=TABDEL     Specify a tab-delimited output file for easy import into Excel
  --html=HTML         HTML output. Argument is file name base
```

Example run: compare ubnist1.gen2 and ubnist1.gen3

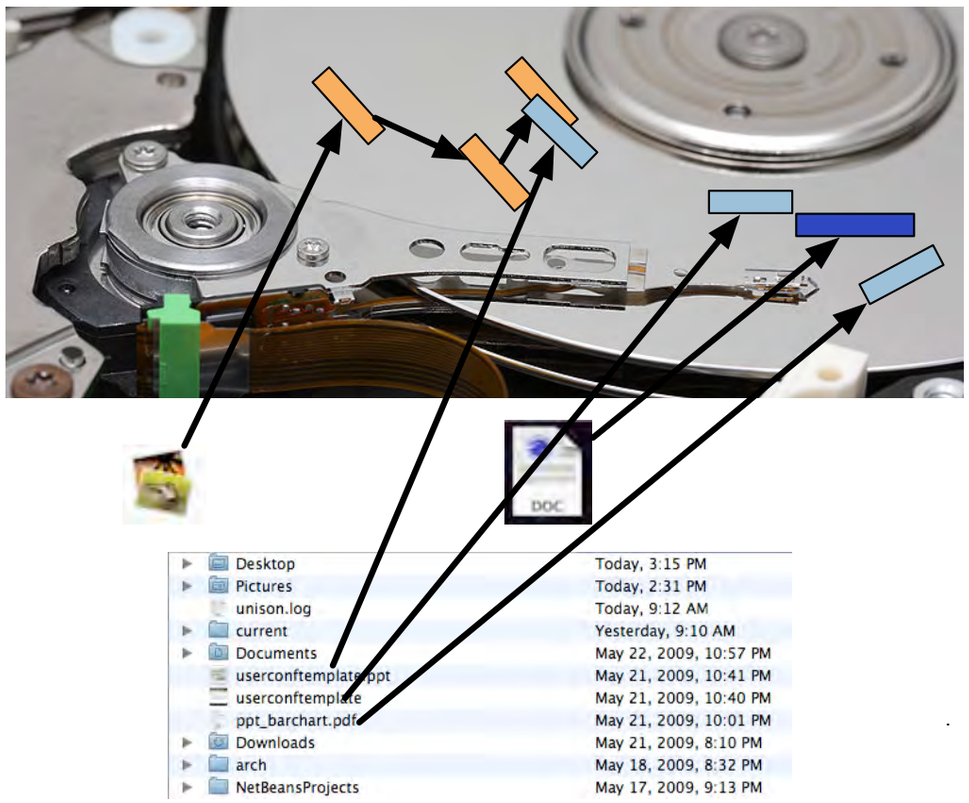
```
$python3.2 python/bulk_diff.py ubnist1.gen2 ubnist1.gen3
bulk_diff.py Version: 1.0
PRE Image:            /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen2.raw
POST Image:           /corp/nps/drives/nps-2009-ubnist1/ubnist1.gen3.raw
processing ccn_histogram.txt:
No differences

processing ccn_track2_histogram.txt:
No differences

processing domain_histogram.txt:
domain_histogram.txt:
# in PRE # in POST     Δ Value
-------------------------------------------------------------------
       0     5,546 5,546 schemas.openxmlformats.org
       0       569   569 www.nlrb.gov
     705     1,273   568 ns.adobe.com
       0       446   446 media.newjobs.com
       0       404   404 schemas.microsoft.com
...
processing email_histogram.txt:
email_histogram.txt:
# in PRE # in POST   Δ Value
-------------------------------------------------------------------
  27,364    27,672 308 ubuntu-users@lists.ubuntu.com
     314       334  20 kernel-team@lists.ubuntu.com
      88       103  15 akira@debian.org
```

identify_filenames.py: Determines the file name for each feature.

bulk_extractor reports the *offset in the disk image* for each feature.



To get the file names, you need to map the disk block to a file.

- Make a map of the blocks in DFXML with **fiwalk** (https://github.com/kfairbanks/sleuthkit)
  - —*Soon to be integrated into SleuthKit*
- Then use **python/identify_filenames.py** to create an *annotated feature file.*

identify_filenames correlation the feature file and the DFXML file!

python/identify_filenames.py

```
$ python3.2 python/identify_filenames.py --help
usage: identify_filenames.py [-h] [--all] [--featurefiles FEATUREFILES]
                             [--imagefile IMAGEFILE] [--xmlfile XMLFILE]
                             [--list] [-t] [-v] [--verbose] [--debug]
                             bulk_extractor_output outdir

Identify filenames from "bulk_extractor" output

positional arguments:
  bulk_extractor_output
                        Directory or ZIP file of bulk_extractor output
  outdir                Output directory; must not exist

optional arguments:
  -h, --help            show this help message and exit
  --all                 Process all feature files
  --featurefiles FEATUREFILES
                        Specific feature file to process; separate with commas
  --imagefile IMAGEFILE
                        Overwrite location of image file from bulk_extractor
                        output
  --xmlfile XMLFILE     Don't run fiwalk; use the provided XML file instead
  --list                List feature files in bulk_extractor_output and exit
  -t                    Terse output
  -v                    Print Version and exit
  --verbose             Verbose mode
  --debug               Debug mode
```

identify_filenames.py tries to use the information in the report.xml file to make operation automatic.

report.xml is a DFXML file that contains:

- Disk image that was processed
- Location of feature files

identify_filenames can work with:

- bulk_extractor output file
- a ZIP of a bulk_extractor output file
- disk image *or* DFXML of disk image

identify_filenames will run fiwalk if...

- no XML file is provided
- fiwalk is in the path
- But it's faster to provide the XML file!

```
$ python3.2 identify_filenames.py --list
charlie-2009-12-11.zip
Feature files in /Users/simsong/charlie-2009-12-11.zip:
ccn.txt
exif.txt
url.txt
url_searches.txt
url_services.txt
ether.txt
domain.txt
windirs.txt
email.txt
ip.txt
aes_keys.txt
zip.txt
rfc822.txt
json.txt
tcp.txt
winpe.txt
gps.txt
winprefetch.txt
telephone.txt
$
```

Currently the DFXML file has to be reprocessed for each feature file...

identify_filenames can take a long time

Time is proportional to (# of features) * (# of file fragments)

```
$ python3.2 python/identify_filenames.py ~/charlie-2009-12-10.zip
charlie-2009-12-10-id2 --xmlfile charlie-2009-12-10.xml --all
Adding features from aes_keys.txt
Using XML file /corp/nps/scenarios/2009-m57-patents/drives_dfxml/
charlie-2009-12-10.xml
Processed 1000 fileobjects in DFXML file
...
Processed 39000 fileobjects in DFXML file
Processed 40000 fileobjects in DFXML file
Generating output...
real     10298.68
user     10286.50
sys          8.25
$
```

Roughly 3 hours for the charlie-2009-12-10 disk image.

Reviewing the output...

```
$ ls -l
total 166088
-rw-r--r--+ 1 simsong  simsong       511 Aug  4 18:04 annotated_aes_keys.txt
-rw-r--r--+ 1 simsong  simsong      3511 Aug  4 15:39 annotated_ccn.txt
-rw-r--r--+ 1 simsong  simsong  24986176 Aug  4 17:53 annotated_domain.txt
-rw-r--r--+ 1 simsong  simsong   1882453 Aug  4 18:03 annotated_email.txt
-rw-r--r--+ 1 simsong  simsong     24451 Aug  4 16:48 annotated_ether.txt
-rw-r--r--+ 1 simsong  simsong  11208045 Aug  4 15:39 annotated_exif.txt
-rw-r--r--+ 1 simsong  simsong    125580 Aug  4 18:03 annotated_ip.txt
-rw-r--r--+ 1 simsong  simsong   3465286 Aug  4 21:40 annotated_json.txt
-rw-r--r--+ 1 simsong  simsong   3823218 Aug  4 18:26 annotated_rfc822.txt
-rw-r--r--+ 1 simsong  simsong    268678 Aug  4 21:41 annotated_tcp.txt
-rw-r--r--+ 1 simsong  simsong     79345 Aug  4 21:42 annotated_telephone.txt
-rw-r--r--+ 1 simsong  simsong  69150534 Aug  4 16:48 annotated_url.txt
-rw-r--r--+ 1 simsong  simsong  18776356 Aug  4 18:00 annotated_windirs.txt
-rw-r--r--+ 1 simsong  simsong   1944968 Aug  4 22:15 annotated_winprefetch.txt
-rw-r--r--+ 1 simsong  simsong  34263928 Aug  4 18:20 annotated_zip.txt
$
```

identify_output feature files have a 4th and 5th column... ... but only if a file is actually identified...

```
# Position      Feature Context Filename        File MD5
...
7277995794      4857994530998756        ible-price/
&rnd=4857994530998756\x00request-method\x00  Documents and Settings/Charlie/Local
Settings/Application Data/Mozilla/Firefox/Profiles/2usvf7i1.default/Cache/
_CACHE_001_      eca068c08645e300edd7530362d80a97
```

- position: 7277995794
- Feature: 4857994530998756
- Context: ible-price/&rnd=4857994530998756\x00request-method\x00
- Filename: Documents and Settings/Charlie/Local Settings/Application Data/Mozilla/Firefox/Profiles/2usvf7i1.default/Cache/_CACHE_001_
- File MD5: eca068c08645e300edd7530362d80a97

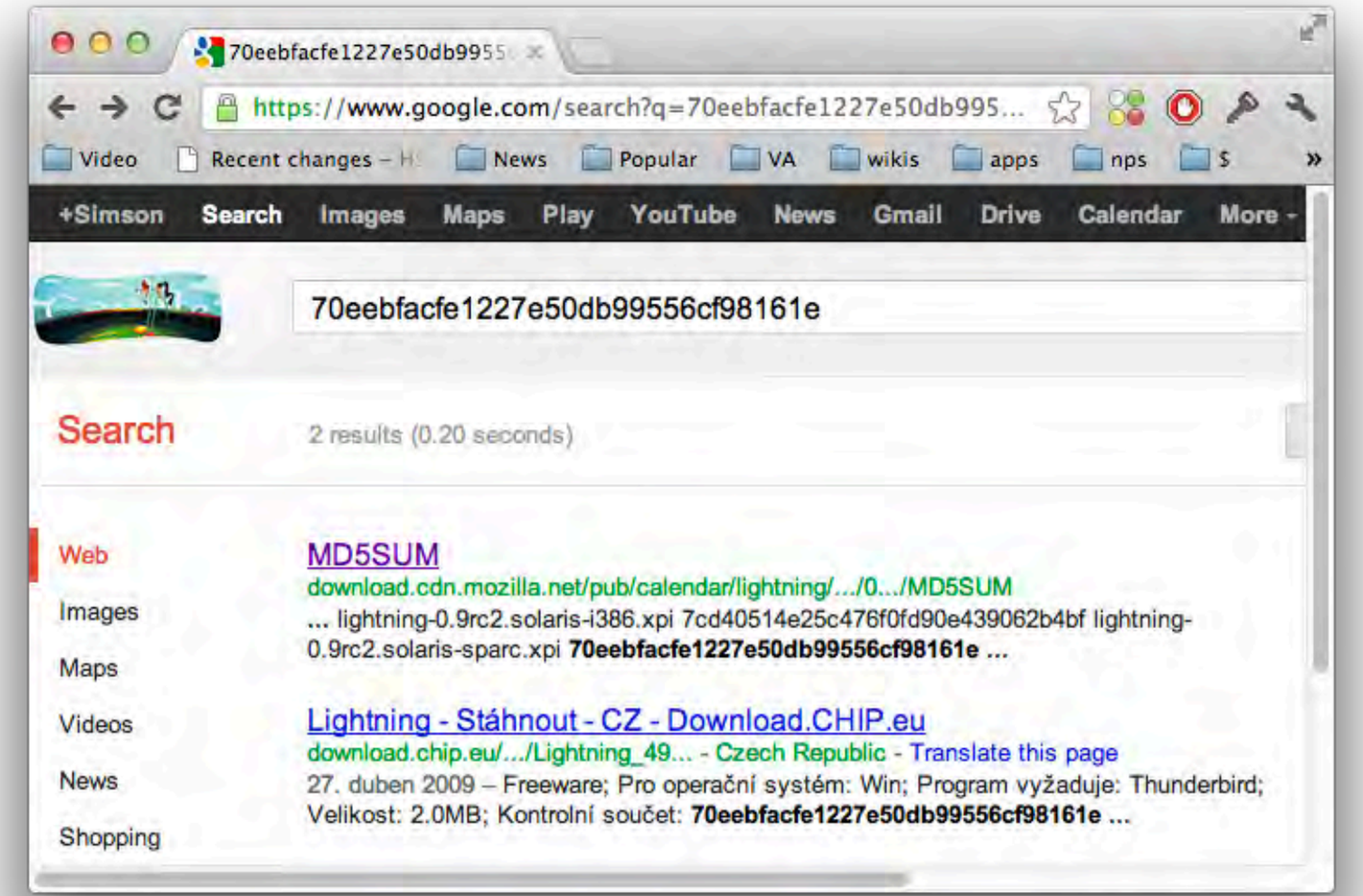
```
3598712863-ZIP-100622   michael.buettner@sun.com        chael Büttner
<michael.buettner@sun.com>\x0A   -   Philipp      Documents and Settings/Charlie/
My Documents/Downloads/lightning-0.9-tb-win.xpi  70eebfacfe1227e50db99556cf98161e
```

- position: 3598712863-ZIP-100622
- Feature: michael.buettner@sun.com
- Context: chael Büttner <michael.buettner@sun.com>\x0A - Philip
- Filename: Documents and Settings/Charlie/My Documents/Downloads/lightning-0.9-tb-win.xpi
- File MD5: 70eebfacfe1227e50db99556cf98161e

Never pass up an opportunity to Google an MD5

```
3598712863-ZIP-100622   michael.buettner@sun.com        chael Büttner
<michael.buettner@sun.com>\x0A   -   Philipp      Documents and Settings/Charlie/
My Documents/Downloads/lightning-0.9-tb-win.xpi  70eebfacfe1227e50db99556cf98161e
```

- File MD5: 70eebfacfe1227e50db99556cf98161e




```
8086ee725f2d3eca17c375a3812c3618  lightning-0.9rc2.linux-i686.xpi
13f72810f33a9817e832e4d929dd1e68  lightning-0.9rc2.mac.xpi
9ec2af4662146905d98d5481f233f86b  lightning-0.9rc2.solaris-i386.xpi
7cd40514e25c476f0fd90e439062b4bf  lightning-0.9rc2.solaris-sparc.xpi
70eebfacfe1227e50db99556cf98161e  lightning-0.9rc2.win32.xpi
```

identify_filenames.py — Lessons learned

feature file stability:

- Originally feature files had three fields: offset, feature, context
- with identify_filenames, they have four: offset, feature, context, filename
- Other options:
  - *The offset could have been replaced with the filename - but what about features w/o?*
  - *Perhaps each line should be an XML block? Harder to process?*
  - *Perhaps each line should be a JSON object? Harder to protect?*

ASCII vs. UTF-8

- Moving to Python3.2 and UTF-8 forced us to address UNICODE issues throughout BE
- It's worth the effort: Accents, Arabic, Hebrew in features can be seen natively.

Memory and Algorithm:

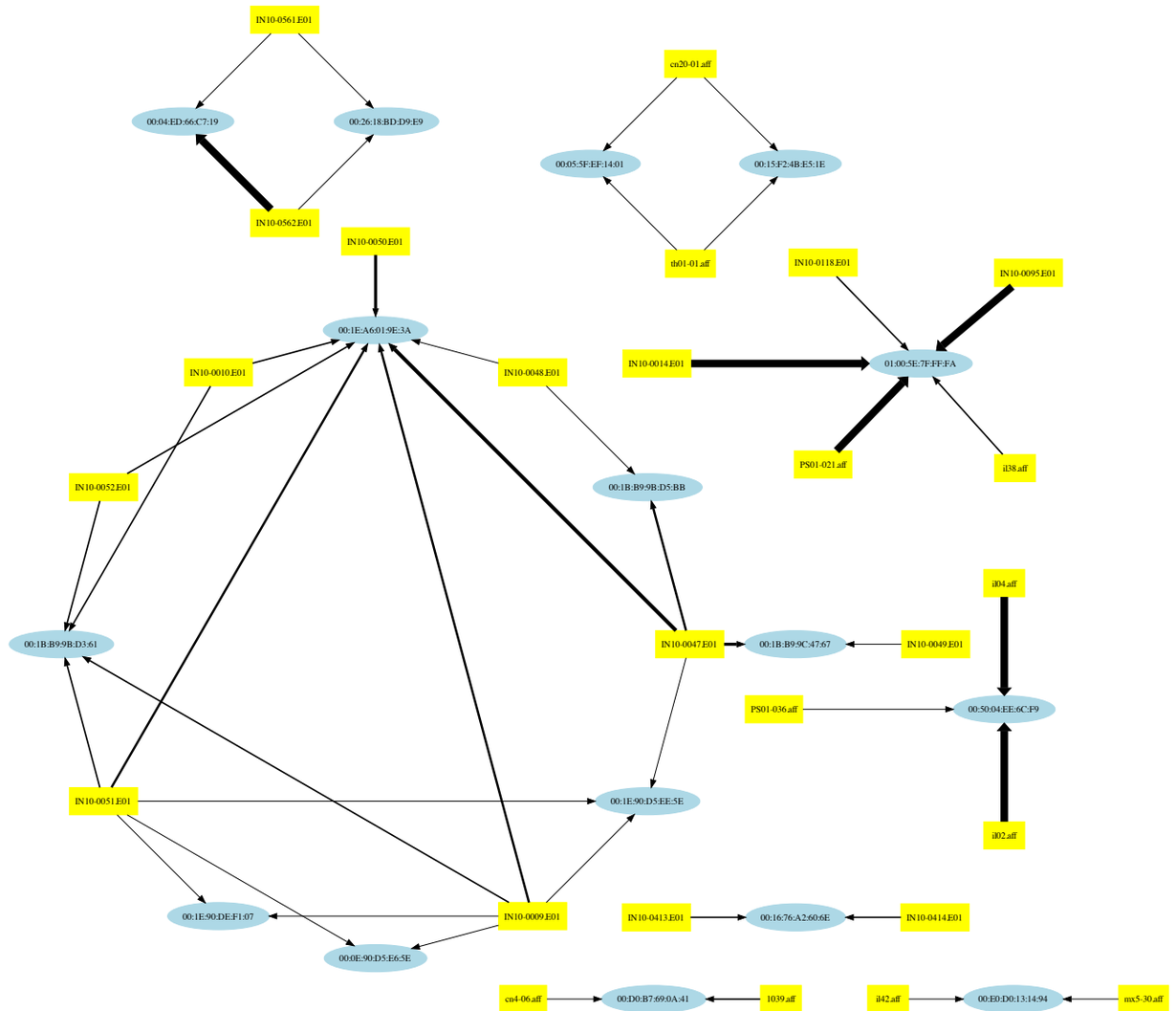
- Memory ∝#features ; time ∝#files; charlie-2009-12-10 took 300MiB and
- Originally used linear search through list of extents — Took days to process some images
- Replaced with call to python bisect module — Now took minutes
- Would take less memory by rewriting in C++; faster by making multi-threaded.

IP Carving and Network Reassembly plug-in

bulk_extractor extended to recognize and validate network data.

- Automated extraction of Ethernet MAC addresses from *IP packets in hibernation files.*

We then re-create the physical networks the computers were on:



Extending bulk_extractor with Plug-ins.

Plugins written in C++

Plugins are distributed as *shared libraries*.

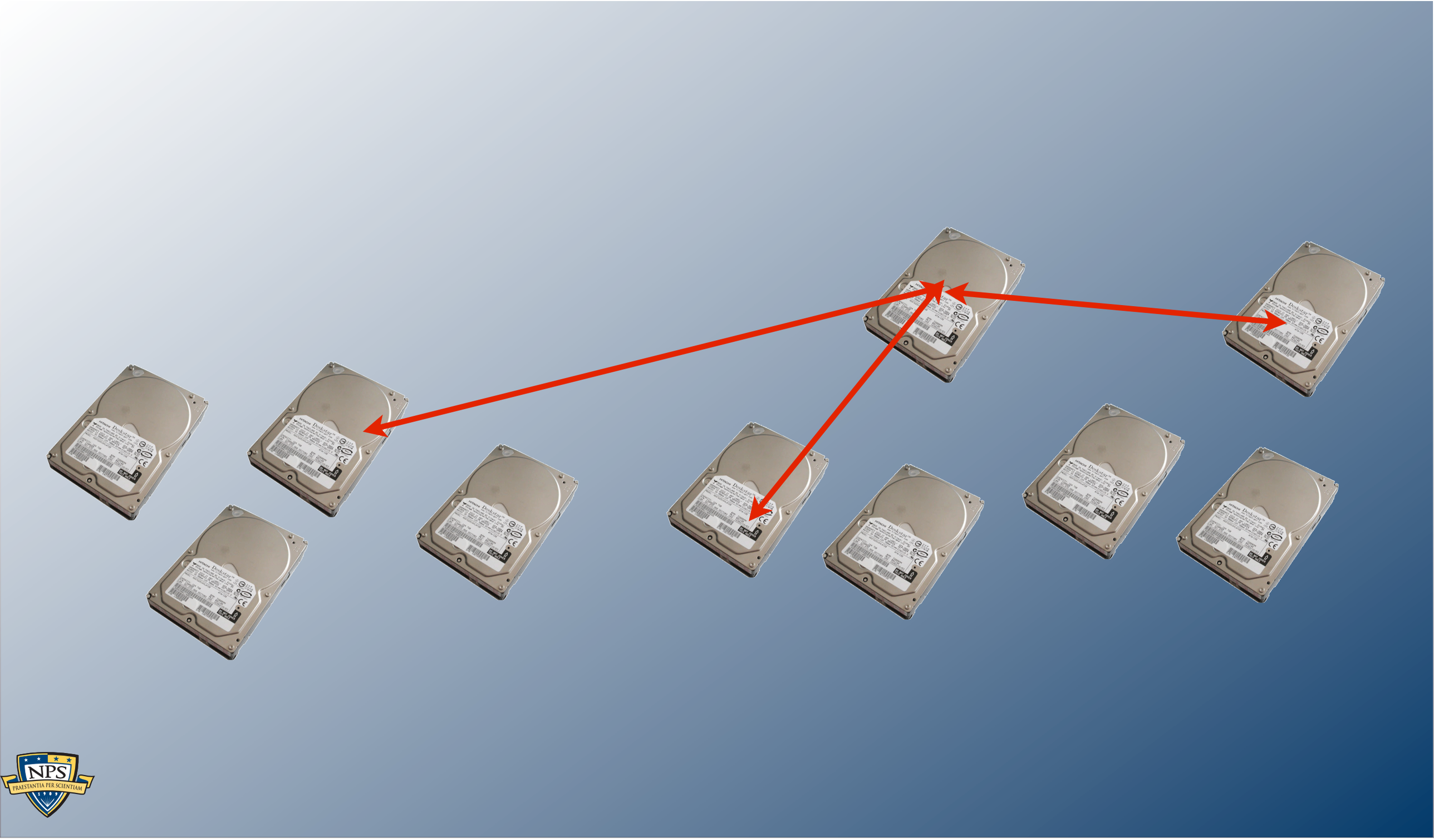
- Windows: **scan_bulk.DLL**
- Mac & Linux: **scan_bulk.so**

Plugins must support a single function call:

```
void scan_bulk(const class scanner_params &sp,
               const recursion_control_block &rcb)
```

- scanner_params — Describes what the scanner should do.
  - —*sp.sbuf* — *SBUF to scan*
  - —*sp.fs* — *Feature recording set to use*
  - —*sp.phase==0* — *initialize*
  - —*sp.phase==1* — *scan the SBUF in sp.sbuf*
  - —*sp.phase==2* — *shut down*
- recursion_control_block — Provides information for recursive calls.

The same plug in system will be used by a future version of **tcpflow**



Where do we go from here?

bulk_extractor: current status and future goals

Scanners:

- accts
- aes
- base64
- ccns
- email headers
- exif
- find
- gps
- gzip
- net
- hiberfile
- httpheader
- json
- kml
- net
- pdf
- vcard
- winprefetch
- wordlist
- zip
- windir

Future Releases:

- bulk (detects encrypted data)
- RAR, RAR2
- LZMA
- BZIP
- NTFS

There are many important areas for research

Algorithm development.

- Adopting to **different kinds of data**.
- **Different resolutions**
- **Higher Amounts (40TB—40PB)**

Software that can…

- Automatically identify outliers and inconsistencies.
- Automatically present complex results in simple, straightforward reports.
- Combine stored data, network data, and Internet-based information.

Many of the techniques here are also applicable to:

- Social Network Analysis.
- Personal Information Management.
- Data mining unstructured information.

Our challenges: innovation, scale & community

Most innovative forensic tools **fail when they are deployed**.

- Production data *much larger* than test data.
  - —*One drive might have 10,000 email addresses, another might have 2,000,000.*
- Production data *more heterogeneous* than test data.
- Analysts have less experience & time than tool developers.

How to address?

- Attention to usability & recovery.
- High Performance Computing for testing.
- Programming languages that are *safe* and *high-performance.*

Moving research results from lab to field is itself a research problem.

In summary, there is an urgent need for fundamental research in automated computer forensics.

Most work to date has been data recovery and reverse engineering.

- User-level file systems
- Recovery of deleted files.

To solve tomorrow's hard problems, we need:

- Algorithms that exploit large data sets (>10TB)
- Machine learning to find *outliers* and *inconsistencies.*
- Algorithms tolerant of data that is *dirty* and *damaged.*

Work in automated forensics is *inherently interdisciplinary.*

- Systems, Security, and Network Engineering
- Machine Learning
- Natural Language Processing
- Algorithms (compression, decompression, big data)
- High Performance Computing
- Human Computer Interactions