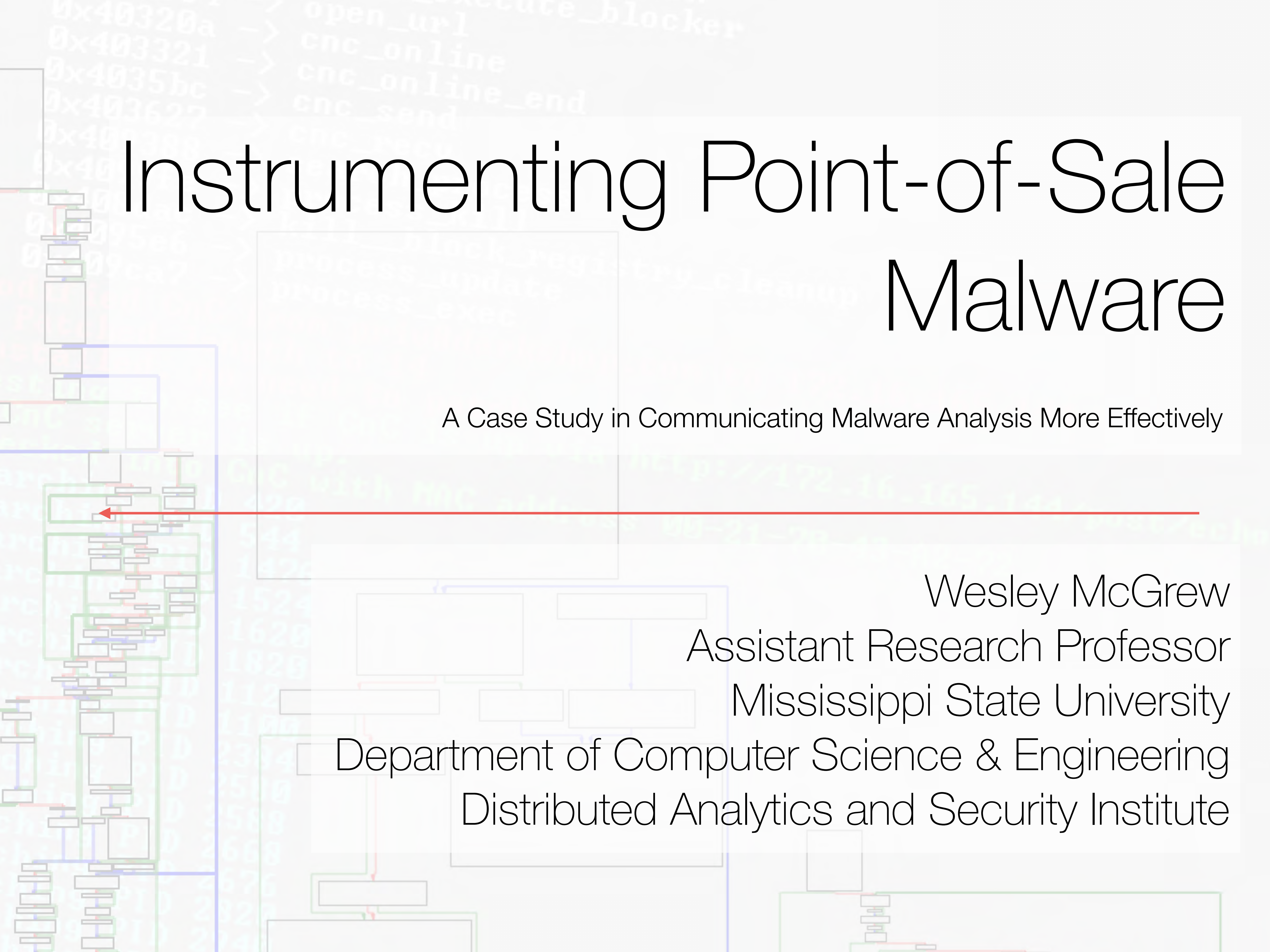


Instrumenting Point-of-Sale Malware

A Case Study in Communicating Malware Analysis More Effectively

Wesley McGrew
Assistant Research Professor
Mississippi State University
Department of Computer Science & Engineering
Distributed Analytics and Security Institute

Introduction

- The pragmatic and unapologetic offensive security guy
- Breaking things
- Reversing things
- Mississippi State University - NSA CAE Cyber Ops
- Enjoying my fourth year speaking at DEF CON

Covert Post-Exploitation Forensics with Metasploit

Wesley McGrew
McGrewSecurity.com

Mississippi State University
National Forensics Training Center

SCADA HMI & Microsoft Bob

Modern Vulnerabilities, With a 90's Flavor

R. Wesley McGrew
Research Associate
Mississippi State University
Critical Infrastructure Protection Center

Pwn the Pwn Plug:

Analyzing and Counter-Attacking Attacker-Implanted Devices

The Plan

- In general:
  - Adopt better practices in describing and demonstrating malware capabilities
  - Proposal to supplement written analyses with illustration that uses the malware itself
- What we'll spend a good chunk of today's session doing:
  - Showing off some cool instrumented POS malware
  - Talk about how you can do the same

Scientific Method (the really important bits)

- Reproducibility
- Reasons:
  - Verifying results
  - Starting new analysis where old analysis left off
  - Education of new reverse engineering specialists
- IOC consumers vs. fellow analysts as an audience

What’s often missing?

- Sample info
  - Hashes
  - **Availability**
- Procedure
  - Subverting malware-specific countermeasures
- Context
  - Redacted info on compromised hosts and C2 hosts
- Internal points of reference
  - Addresses of functionality/data being discussed

Devil's Advocate: Why it's not there…

- Fellow analysts and students are not the target audience of many published analyses
    - We're left to "pick" through for technically useful info
- Added effort - It's a lot of work to get your internal notes and tools fit for outside consumption
- Analysis-consumer safety - *preventing* the reader for inadvertently infecting
- Client confidentiality - Compelling. May be client-specific data in targeted malware
- Competitive advantage - public relations, advertising services, showcase of technical ability
    - Perhaps not in our best interest to allow someone to further it, do it better, or worse: prove it wrong.

What's Being Done Elsewhere?

- Reproducibility and verifiability are a big deal in any academic/scientific endeavor
- Peer review is *supposed* to act as the filter here
  - (Though maybe we aren't as rigorous as we ought to be with it in computer science/engineering)
- Software, environment, data, documented to the point that someone can recreate the experiment
- *Executable/interactive research paper*
  - Embedded algorithms and data,
  - (Doesn't that sound a bit scary re: Malware? :))

Recommendations

- Beyond sandbox output…
- Sample availability (!!!!!!!!!)
  - virusshare.com is the best positive example of the right direction here
- Host environment documentation
- Target data - give it something to exfiltrate
- Network environment - give it what it *wants* to talk to
- **Instrumentation** - programmatic, running commentary
  - Scriptable debugging (winappdbg!)
  - Isolate functionality, document points of interest, put it all into a big picture

Case Study: JackPOS

(to make sure I get these in before we geek-out on the demo)

Acknowledgements

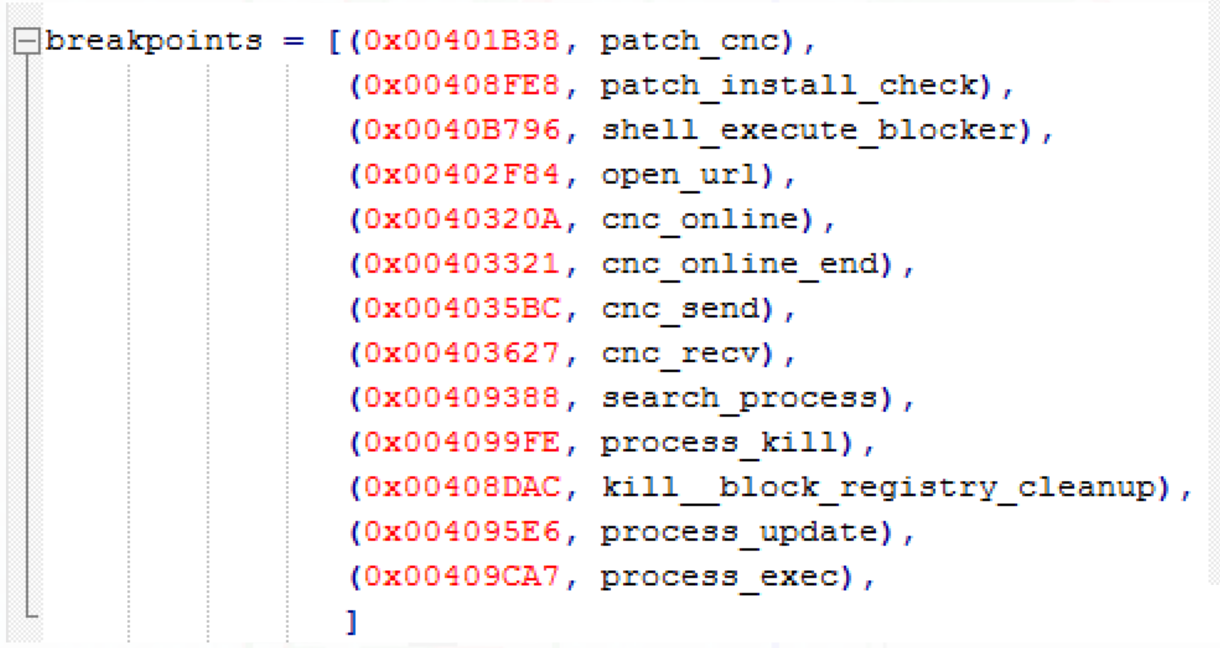
- Samples - @xylit0l - http://cybercrime-tracker.net
- Prior-to-now-but-post-this-work analyses
  - http://blog.spiderlabs.com/2014/02/jackpos-the-house-always-wins.html
  - http://blog.malwaremustdie.org/2014/02/cyber-intelligence-jackpos-behind-screen.html
- Please check the white paper citations for tools, executable paper prior work, etc.

Why JackPOS?

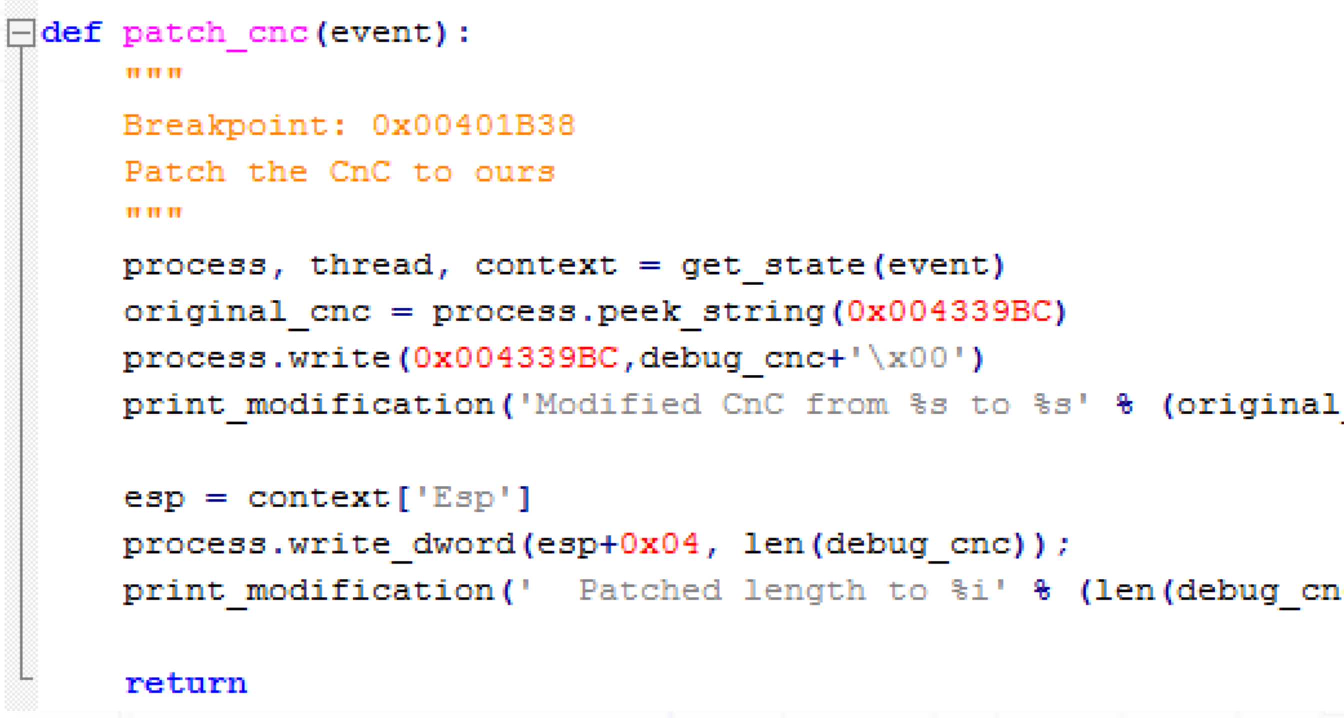
- Current concern surrounding POS malware
- C2 availability - Ability to demonstrate a complete environment
    - From card-swipe to command-and-control
- C++ strings, STL - runtime objects make static analysis with IDA Pro a bit more awkward
- Good use case for harnesses
    - Independent memory-search functionality

Harness Design

- WinAppDbg - Python scriptable debugging
  - *Really* fun library - Well-documented, lots of examples, easy to use
- Callbacks for breakpoints



```
breakpoints = [(0x00401B38, patch_cnc),
               (0x00408FE8, patch_install_check),
               (0x0040B796, shell_execute_blocker),
               (0x00402F84, open_url),
               (0x0040320A, cnc_online),
               (0x00403321, cnc_online_end),
               (0x004035BC, cnc_send),
               (0x00403627, cnc_recv),
               (0x00409388, search_process),
               (0x004099FE, process_kill),
               (0x00408DAC, kill__block_registry_cleanup),
               (0x004095E6, process_update),
               (0x00409CA7, process_exec),
               ]
```

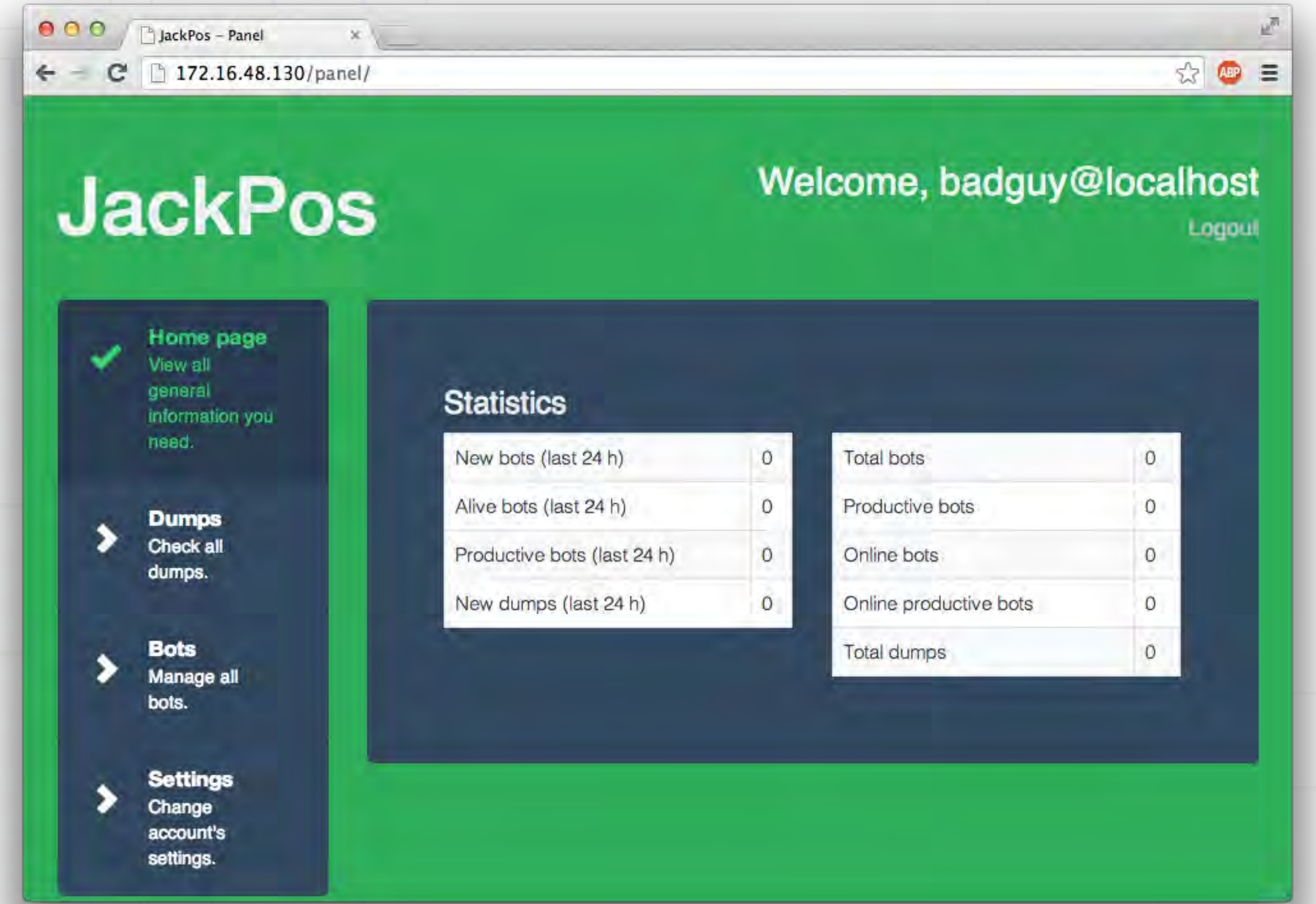


```
def patch_cnc(event):
    """
    Breakpoint: 0x00401B38
    Patch the CnC to ours
    """
    process, thread, context = get_state(event)
    original_cnc = process.peek_string(0x004339BC)
    process.write(0x004339BC,debug_cnc+'\x00')
    print_modification('Modified CnC from %s to %s' % (original_

    esp = context['Esp']
    process.write_dword(esp+0x04, len(debug_cnc));
    print_modification('  Patched length to %i' % (len(debug_cn

    return
```

JackPOS

- Example sample - SHA1 `9fa9364add245ce873552aced7b4a757dceceb9e`
    - Available on virusshare (and mcgrewsecurity.com)
    - This is the only part *not* on the DEF CON DVD.
- Command and Control
    - PHP, Yii Framework

Command and Control



JackPos – Panel

172.16.48.130/panel/

JackPos

Welcome, badguy@localhost

Logout

Home page View all general information you need.

Dumps Check all dumps.

Bots Manage all bots.

Settings Change account's settings.

Statistics

New bots (last 24 h)	0
Alive bots (last 24 h)	0
Productive bots (last 24 h)	0
New dumps (last 24 h)	0

Total bots	0
Productive bots	0
Online bots	0
Online productive bots	0
Total dumps	0

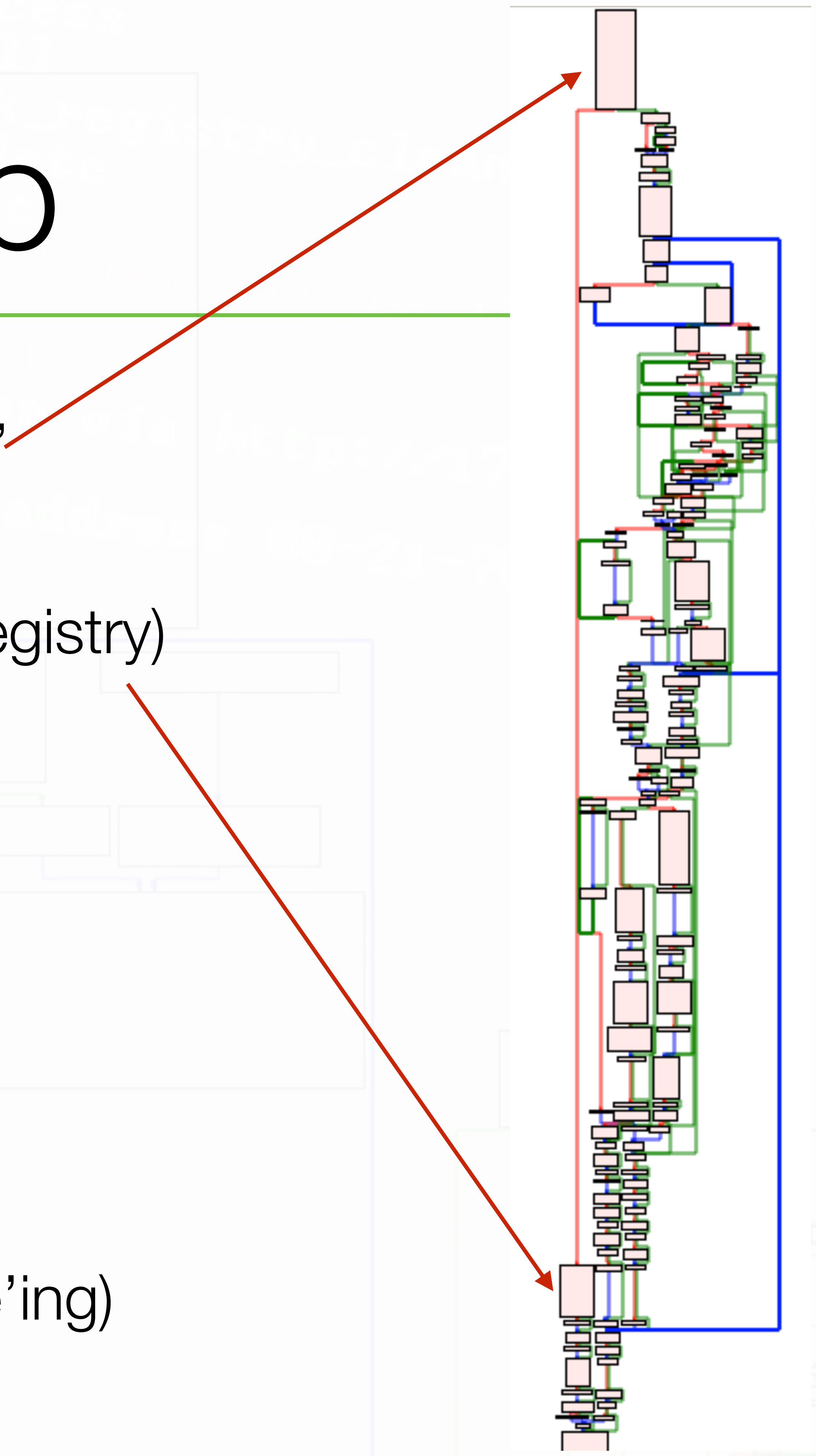
- Data model - bots, cards, commands, dumps, ranges, tracks, users

Back to the sample

- UPX (thankfully not an unpacking talk/tutorial)
  - Unpacked version crashes due the stack cookie seed address not relocating
  - Easy fix: disable ASLR (also makes our analysis easier), unset:
    - IMAGE_NT_HEADERS > IMAGE_OPTIONAL_HEADER > IMAGE_DLLCHARACTERISTICS_DYNAMIC_BASE

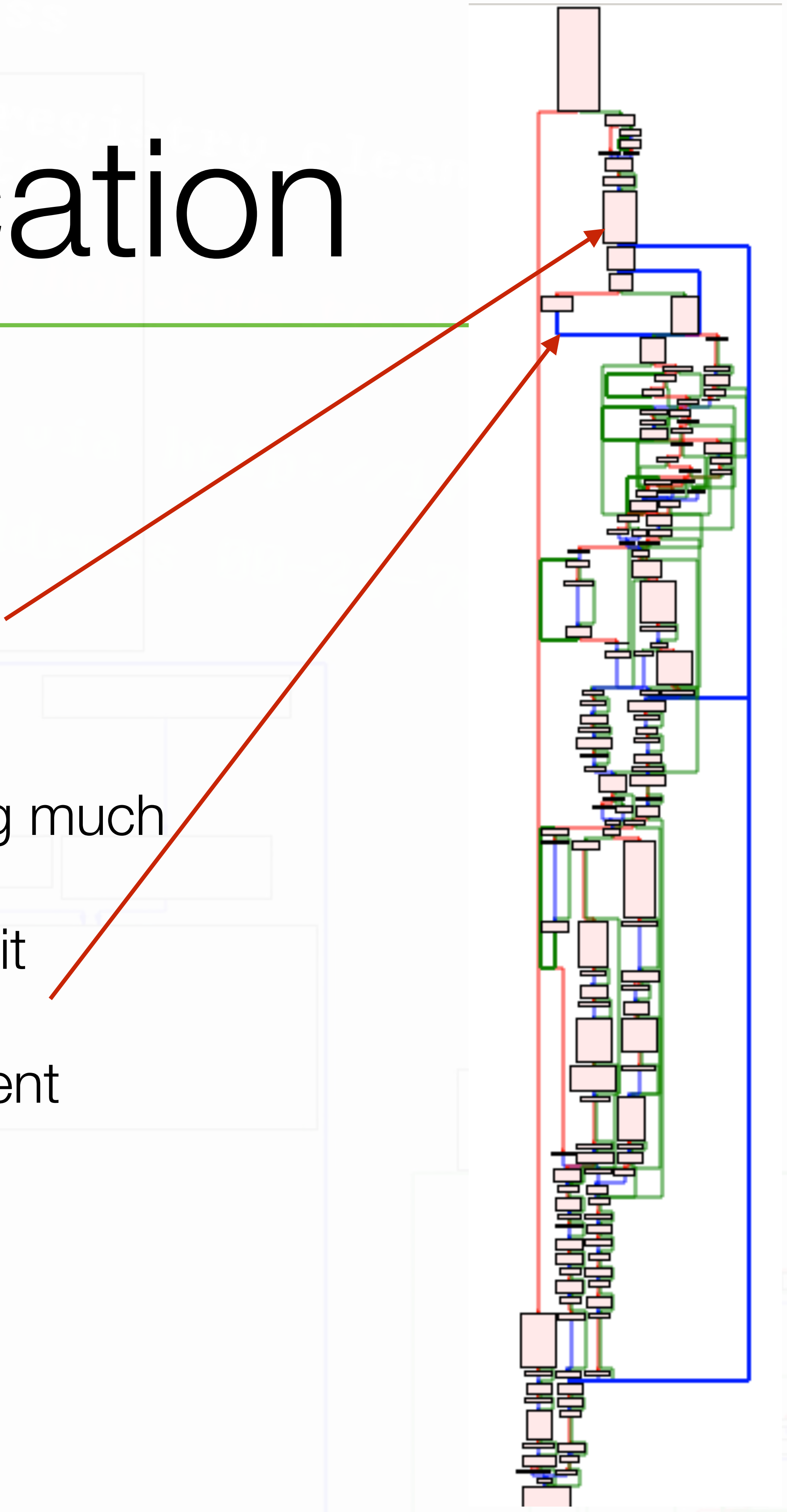
Setup

- String setup - c2, executable filenames, process names for memory search
- Installation (copying self)/persistence (registry)
- Harness patches -
  - Command and control
  - Installation check
  - Prevents watchdog process (and anything else from ShellExecute'ing)



Communication

- Command and Control Check-in
    - Checks C2 for http://[c2]/post_echo
        - (PostController.php responds “up”)
        - Prevents simple sandbox from getting much
    - If there’s track data, base64 it and send it
        - Harness configured to display data sent
    - Check command queue
- Hosts uniquely identify by MAC



Commands

- Credit card track theft happens without having to be commanded to do so

- Remainder of command set is simple:

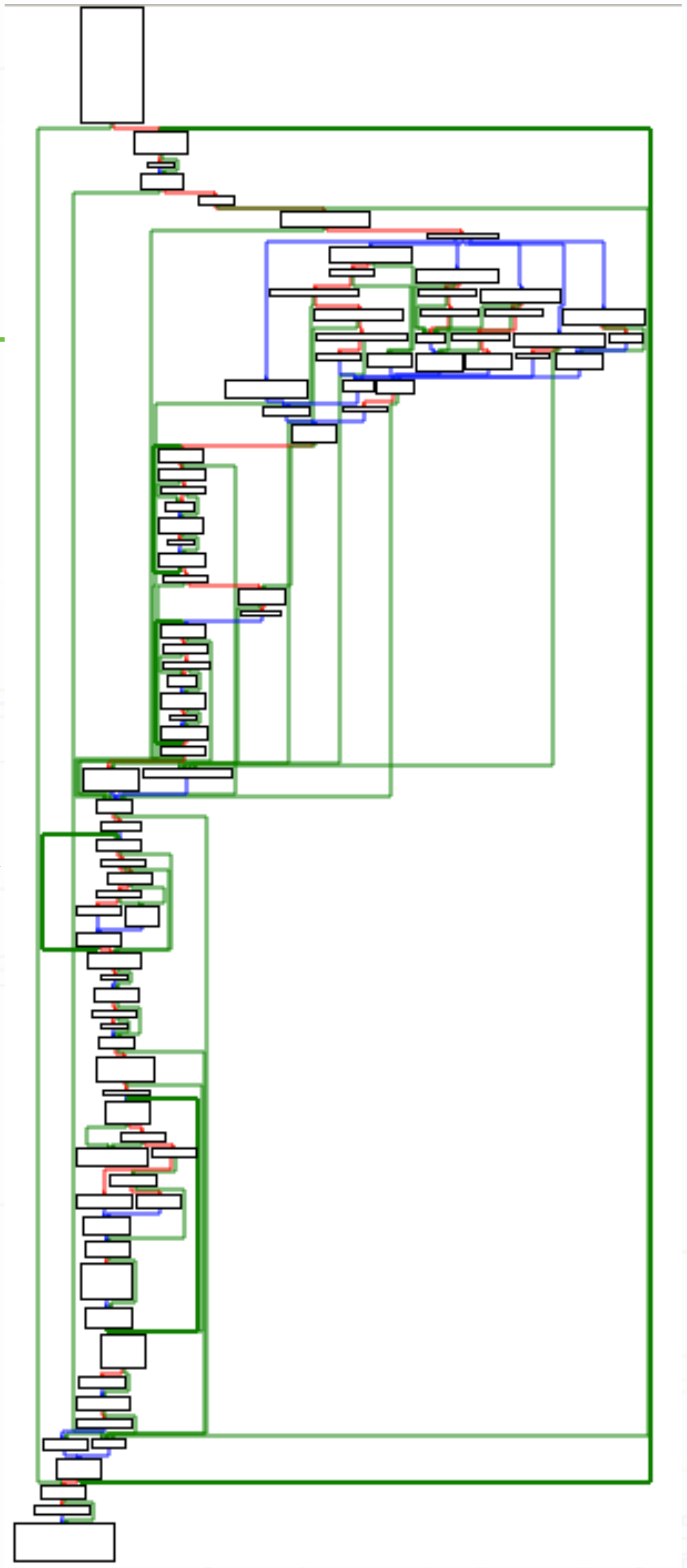
  - kill

  - update - (replace current install with latest from /post/download)

  - exec <url>

Scraping Memory

- Get a list of functions
    - No 64-bit process
    - No processes matching internal table (system, etc)
- Iterate and search for card data using two regular-expression-esque functions
    - ISO/IEC 7813 (we can generate and instrument this)
- Harness identifies search process
- Another harness can be used to instrument the code to scan arbitrary PIDs



Demo

- Sample MD5 - aa9686c3161242ba61b779aa325e9d24
- Harnesses
    - jackpos_harness.py - Instruments all operation
    - search_proc_harness.py - Skips to and illustrates track-data capture
- Track data generator - Generate and hold card swipes in memory
- PHP source for (actual) C2
    - (recreated DB schema (uh it works))

Wrapping up

- Addressing reproducibility/verifiability, potential benefits
  - Effective illustration for lay audiences, students
  - Base to work from (not “from scratch”) for other analysts
- Illustration using the resources malware “wants”, vs. generic sandbox
- Potential for publishing instrumented analysis in virtual/cloud environments for others to work with more immediately

Contact Info

wesley@mcgrewsecurity.com
@McGrewSecurity