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Logs in Incident Response

loglogic™

Mitigating Risk. Automating Compliance.

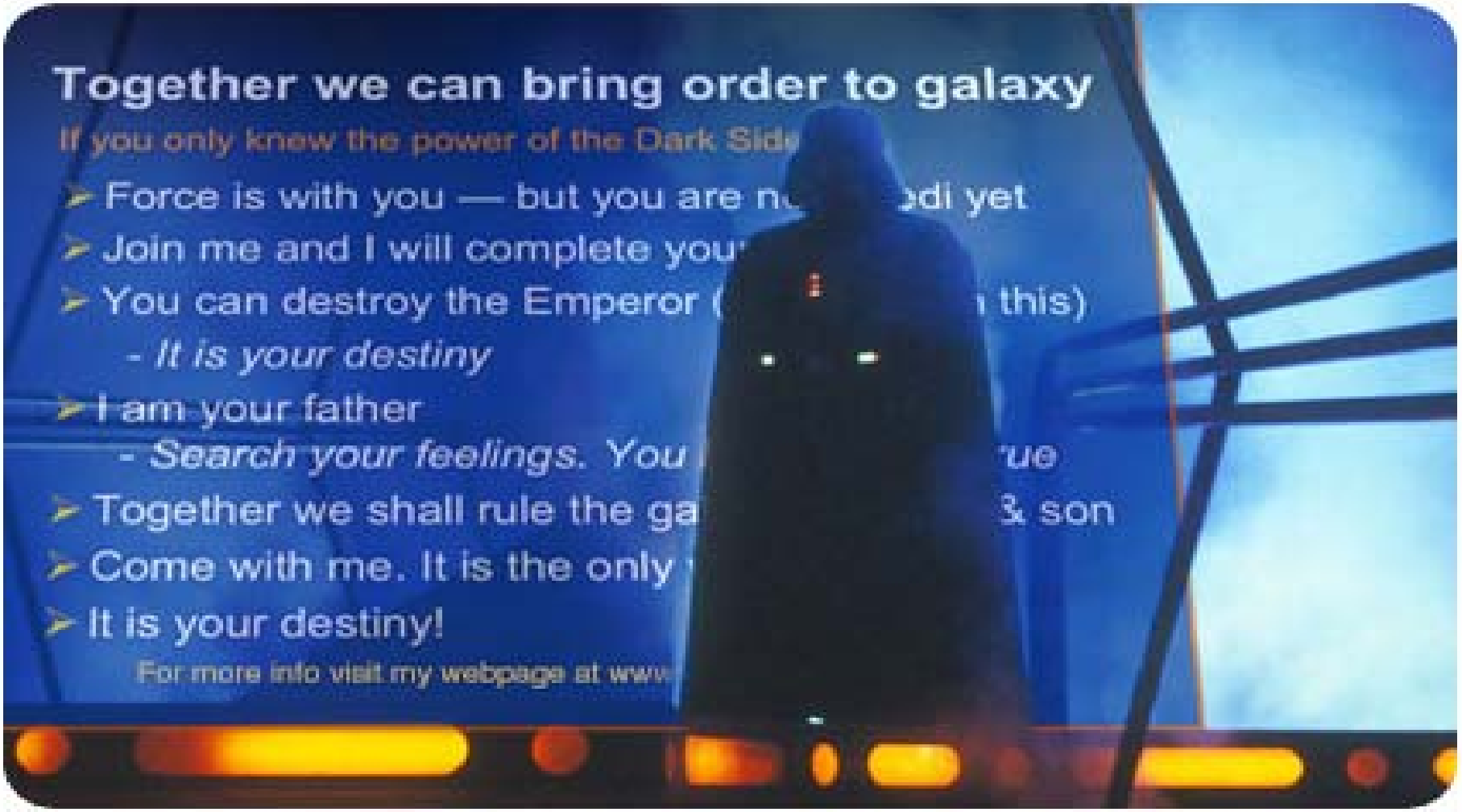
Outline - I

- Incident Response Process
- Logs Overview
- Logs Usage at Various Stages of the Response Process
- How Log from Diverse Sources Help

Outline - II

- Log Review, Monitoring and Investigative processes
- Standards and Regulation Affecting Logs and Incident Response
- Incident Response vs Forensics
- Log Analysis and Incident Response Mistakes
- Case Studies (throughout…)

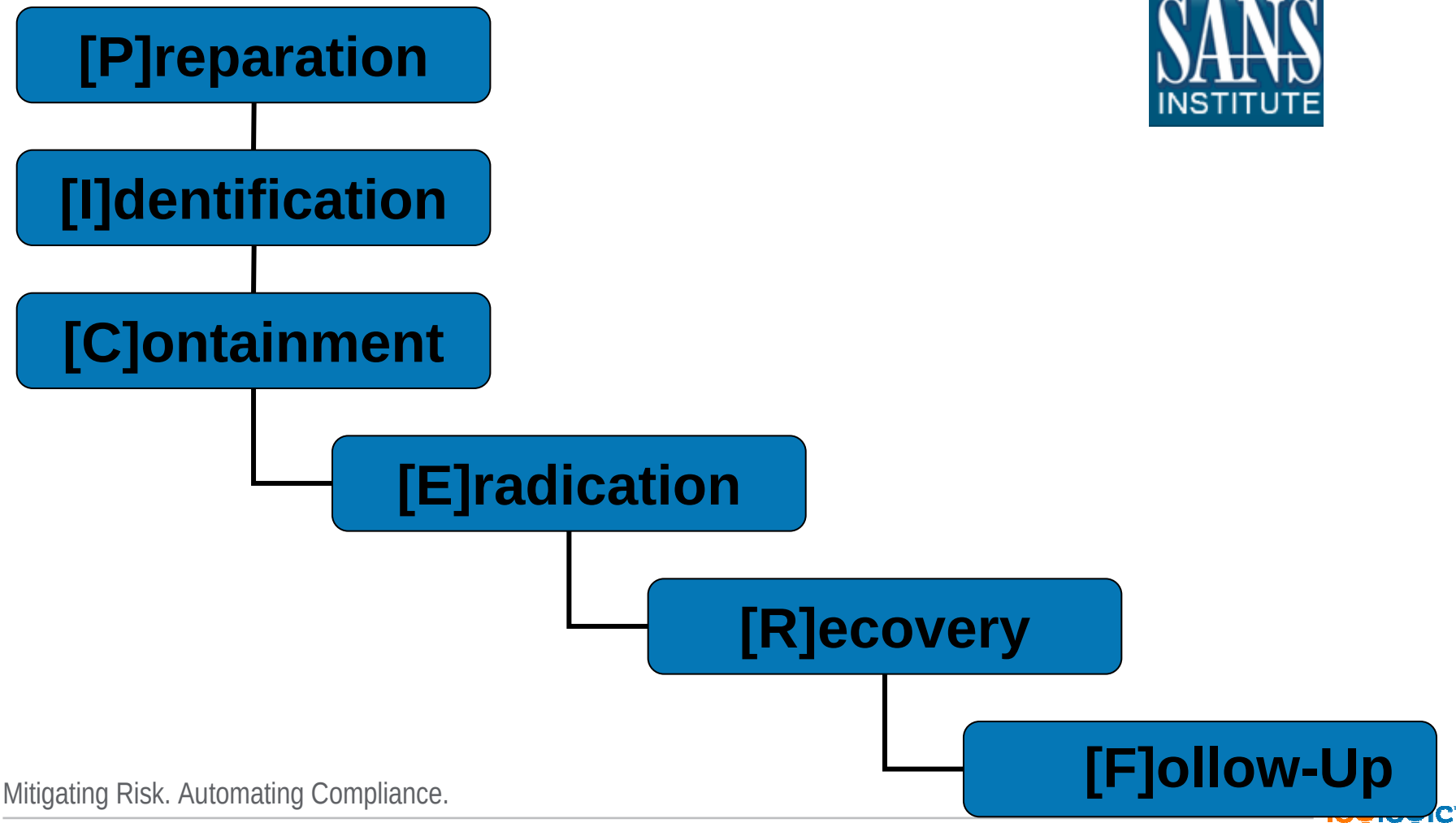
To Avoid DBPPT Disease ☺



Incident Response Processes

Incident Response Methodologies: SANS

- SANS Six-Step Process

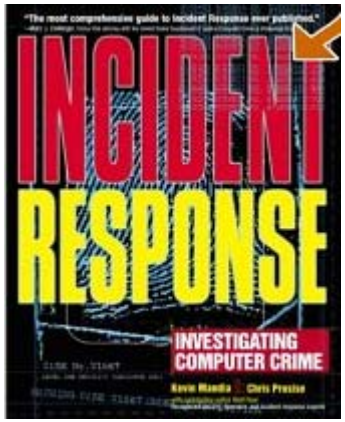


Incident Response Methodologies: NIST

- NIST Incident Response 800-61
  1. Preparation
  2. Detection and Analysis
  3. Containment , Eradication and Recovery
  4. Post-incident Activity

Process from “Incident Response and Forensics”

- Process from “Incident Response and Forensics”
  1. Preparation
  2. Detection
  3. Initial response
  4. Formulate response strategy
  5. Investigation
  6. Resolution and Recovery
  7. Reporting

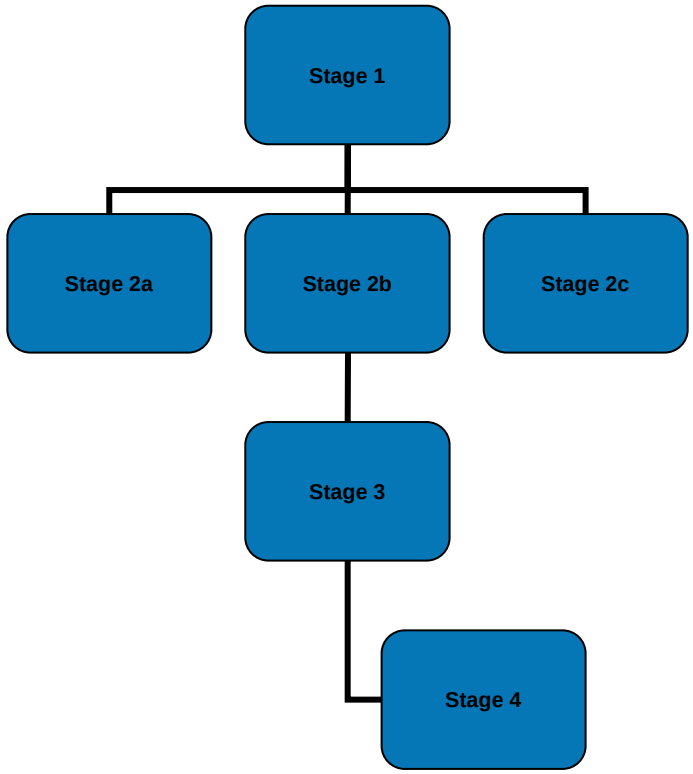


Other IH/IR Frameworks and Methodologies

- Company-specific Policies and Procedures
- *Sometimes*: good, bad and ugly (aka “Just put it the way it was…”)
  - Escalation trees
  - Virtual CIRT structures and call lists
  - Intra-company processes
  - Etc, etc, etc

Why Have a Process?

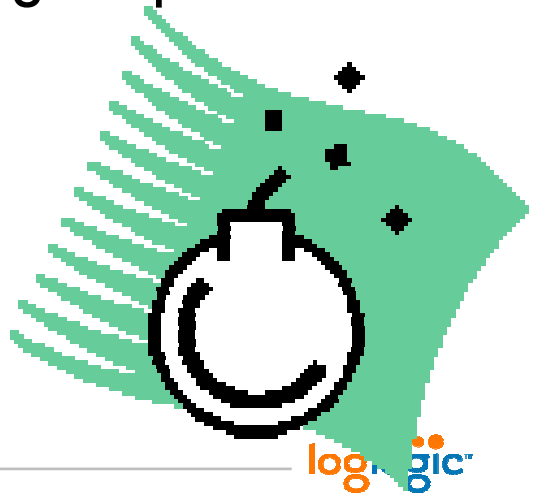
- It helps…
  - Predictability
  - Efficiency
  - *Auditability*
  - Constant Improvement
- It shrinks…
  - Indecision
  - Uncertainty
  - Panic! ☹



Example: Worm “Mitigation” in a Large Company…

… circa 2002 AD ☺

- Worm hits
- Panic + initial response in parallel (urgh! ☺)
- Mitigation + investigation at the *same* time
- Two walking steps forward and 10 running steps back…



From Incident Response to Logs

Terms and Definitions

- Logging
- Auditing
- Monitoring
- Event reporting
- Log analysis
- Alerting

- **Message** – some system indication that an event has transpired
- **Log** or **audit record** – recorded message related to the event
- **Log file** – collection of the above records
- **Alert** – a message usually sent to notify an operator
- **Device** – a source of security-relevant logs

So, What is A Log?

- Typically, a log “file” is a file that lists all actions that have occurred on a device, within an application, or on a server
- *Example*: is SNMP trap a log? Is a netflow record?

Log Data Overview

What data?

- Audit logs
- Transaction logs
- Intrusion logs
- Connection logs
- System performance records
- User activity logs
- Various alerts

From Where?

- Firewalls/intrusion prevention
- Routers/switches
- Intrusion detection
- Hosts
- Business applications
- Anti-virus
- VPNs

Devices that Log: An *Attempt* at a Comprehensive List

- Network gear: routers, switches,
- Security gear: firewall, IDS, VPN, IPS,
- Access control: RAS, AD, directory services
- Systems: OS (Unix, Windows, VMS, i5/OS400, etc)
- Applications: databases, email, web, client applications
- Misc: physical access,
- Other: just about everything with the CPU…

What Commonly "Gets Logged"?

- System or software **startup, shutdown, restart, and abnormal termination** (crash)
- Various **thresholds being exceeded** or reaching dangerous levels such as disk space full, memory exhausted, or processor load too high
- **Hardware health** messages that the system can troubleshoot or at least detect and log
- **User access** to the system such as remote (telnet, ssh, etc.) and local login, network access (FTP) initiated to and from the system, failed and successful
- User access **privilege changes** such as the su command—both failed and successful
- User credentials and **access right changes**, such as account updates, creation, and deletion—both failed and successful
- System **configuration changes** and software updates—both failed and successful
- **Access to system logs** for modification, deletion, and maybe even reading

“Standard” Messages

10/09/200317:42:57,146.127.94.13,48352,146.127.97.14,909,,,accept,tcp,,,,909,146.127.93.29,,0,,4,3,,' 9Oct2003 17:42:57,accept,labcpngfp3,inbound,eth2c0,0,VPN-1 & FireWall-1,product=VPN-1 & FireWall-1[db_tag={0DE0E532-EEA0-11D7-BDFC-927F5D1DECEC};mgmt= labcpngfp3;date=1064415722;policy_name= Standard],labdragon,48352,146.127.97.14,909, tcp,146.127.93.145,',eth2c0,inbound

PIX

Oct 9 16:29:49 [146.127.94.4] Oct 09 2003 16:44:50: %PIX-6-302013: Built outbound TCP connection 2245701 for outside:146.127.98.67/1487 (146.127.98.67/1487) to inside:146.127.94.13/42562 (146.127.93.145/42562)

2003-10-20|15:25:52|dragonapp-nids|TCP-SCAN|146.127.94.10|146.127.94.13|0|0|X|------S-|0|total=484,min=1,max=1024,up=246,down=237,flags=------S-,Oct20-15:25:34,Oct20-15:25:52|

Oct 20 15:35:08 labsnort snort: [1:1421:2] SNMP AgentX/tcp request [Classification: Attempted Information Leak] [Priority: 2]: {TCP} 146.127.94.10:43355 -> 146.127.94.13:705

SENSORDATAID="138715" SENSORNAME="146.127.94.23:network_sensor_1" ALERTID="QPQVIOAJKBNC6OONK6FTNLLESZ" LOCALTIMEZONEOFFSET="14400" ALERTNAME="pcAnywhere_Probe“ ALERTDATETIME="2003-10-20 19:35:21.0" SRCADDRESSNAME="146.127.94.10" SOURCEPORT="42444" INTRUDERPORT="42444" DESTADDRESSNAME="146.127.94.13" VICTIMPORT="5631" ALERTCOUNT="1" ALERTPRIORITY="3" PRODUCTID="3" PROTOCOLID="6" REASON="RSTsent"

Logs at Stages of IR (SANS Model)

- **Preparation**: verify controls, collect normal usage data, baseline, etc
- **Identification**: detect an incident, confirm incident, etc
- **Containment**: scope the damage, learn what else is lost, etc
- **Eradication**: preserving logs for the future, etc
- **Recovery**: confirming the restoration, etc
- **Follow-Up**: logs for “peaceful” purposes (training, etc)

Using Logs at Preparation Stage

- Verify Controls
- Ongoing Monitoring
- Change Management Support
- “If you know the cards, you’d live on an island” ☺

1: P

- In general, verifying that you have control over your environment

Example 1 Logging Infrastructure for Optimum Response

- Monitoring infrastructure based on NSM philosophy: *netflow + packet content + logs (NIDS, etc)*
- Pre- and post-incident monitoring
- Useful even if *deployed after* the incident, but most useful if *deployed prior* to it

Using Logs at Identification Stage

- Detect Intrusion, Infections and Attacks
- Observe Attack Attempts, Recon and Suspicious Activity
- Perform Trend Analysis and Baselining for Anomaly Detection
- Mine the Logs for Hidden Patterns, Indicating Incidents in the Making…
- "What is Out There?"

2: I

Example 2 FTP Hack Case

- Server stops
- Found ‘rm-ed’ by the attacker
- What logs do we have?
- Forensics on an image to undelete logs
- Client FTP logs reveals…
- Firewall confirms!

Using Logs at Containment Stage

- Assess Impact of the Infection, Compromise, Intrusion, etc
- Correlate Logs to Know What You Can [Still] Trust
- Verify that Containment Measures Are Working
- “What Else is Hit?”

3 : C

Example 3 But Did It Spread?

- “A classic”: regular desktop starts scanning internally
- Cut from the network soon after: an incident is declared
- An impressive array of malware is discovered; AV is dead
- Problem solved? Did it infect anybody else?!
- Logs from firewalls and flow to the rescue…

Using Logs at Eradication Stage

- Preserving the Log Evidence from Previous Stages
- Confirming that Backups are Safe (Using Logs, How Else?)
- “Is it Gone?

4: E

Example 4 Logs for [Possible] Litigation

- Deliberations on the log retention (and destruction!) policy: IDS, VPN, firewalls, servers – oh, my!
- Decided: IDS – longest; server – next; firewalls, VPN – shortest
- Case: financial information leaked to the media
- Investigation points to a specific user
- Did he do it?!!
- Well, the answer *died* with 6-mo old VPN logs…

Using Logs at Recovery Stage

- Increased Post-Incident Monitoring
- Watch for Recurrence
- Watch for Related Incidents Elsewhere
- “Better Safe than Sorry”

5: R

Example 5 When They Come Back…

- Password guessing hack: non-root account password guessed
- IRC bot, scanning, phishing site setup, etc
- Password changed; attacker files cleaned
- More guessing attempts across the network– are those the same folks?
- *Will they succeed again?*

Using Logs at Follow-Up Stage

- Train Analysts, Responders and Administrators
- Create Management Reports (*Don't You Love Those!* ☺)
- Verify and Audit Newly Implemented Controls

6: F

Example 6 Logs for Responder Training

- Honeynet #34 Challenge Example

Addendum: Incident Record Keeping

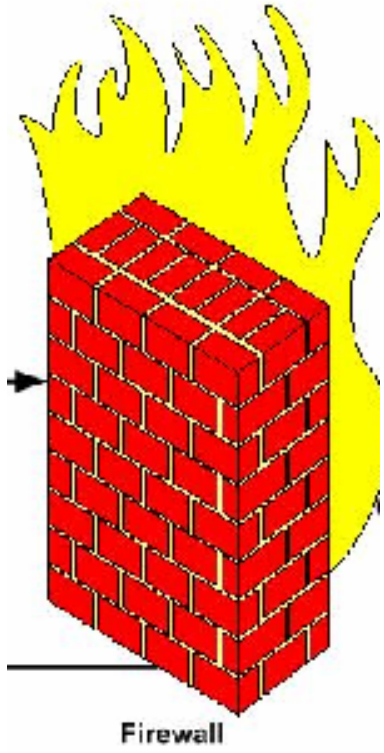
- Retention policy for routine and incident logs
- #1: Human action logs – the longest!
  - Logs *created* during incident response
- Before planning any log retention policy changes – define incident and routine log retention
- Then: by area, by technology, by business case, etc
  - 2- or 3- Tiered retention strategy is common

So, What Logs are Useful for Incident Response?

- Security Logs vs “Non-Security” Logs
  - Witness confusion in the NIST guide on log management ….
- Let’s quickly go through various logs and see how they help (and helped in specific cases!)
  - Looking at some specifics in the process

Firewall Logs in Incident Response

- Proof of Connectivity
- Proof of NO Connectivity
- Scans
- Malware: Worms, Spyware
- Compromised Systems
- Misconfigured Systems
- Unauthorized Access and Access Attempts
- Spam (yes, even spam!)



Example 7 Firewall Logs in Place of Netflow

- Why Look at Firewall Logs During Incident Investigation?
- 1990-2001 – to see what *external* (inbound) threats got **blocked**
- 2002-2006 – to see what *internal* system got **connected** (out)
- Thus, firewall logs is poor-mans netflow…

NIDS Logs in Incident Response

- Attack, Intrusion and Compromise Detection
- Malware Detection: Worms, Viruses, Spyware, etc
- Network Abuses and Policy Violations
- Unauthorized Access and Access Attempts
- Recon Activity
- [NIPS] Blocked Attacks

Example 8 Zero-Day Discovery with NIDS

- Can I discover undiscoverable?
- [Mostly] Signature NIDS is still king! But what about those pesky 0days?
- NIDS log pattern discovery to the rescue!
- Samba hack case: 3-4 of the same semi-suspicious signatures firing in the same time sequence => 0day in action

Server Logs in Incident Response

- Confirmed Access by an Intruder
- Service Crashes and Restarts
- Reboots
- Password, Trust and Other Account Changes
- System Configuration Changes
- *A World of Other Things* ☺

Example 9 “Irrelevant, You Say”

- Using disk failures for IDS ☺
- “Detection by catastrophe”
- Is *CNN* you *IDS*?

Database Logs in Incident Response

- Database and Schema Modifications
- Data and Object Modifications
- User and Privileged User Access
- Failed User Access
- Failures, Crashes and Restarts

Example 10 And What is NOT Stolen?

- *Supposedly*, all of ChoicePoint 40 mil CCs were not stolen…
- Database logs as a way of *non-intrusion detection* (or, rather, confirmation)

Proxy Logs in Incident Response

- Internet Access Patterns
- IP theft and/or disclosure
- Policy violations
- Malware: Spyware, Trojans, etc

Client Logs in Incident Response

- FTP client: remote connections and file transfers
- IRC client logs
- Other client software: usually no logs, but usually leave other traces
  - E.g. web browser cache (OK, these are not logs)

Antivirus Logs in Incident Response

- Virus Detection and Clean-up (or lack thereof!)
- Failed and Successful Antivirus Signature Updates
- Other Protection Failures and Issues
- Antivirus Software Crashes and Terminations

Back to the Process

"Back to the Process II" ☺

BREAK!!!

Logging Process for IR Review

- Main idea…
- Log *everything*
- Audit *little*
- Monitor *a bit*

- *During the incident* you'd be grateful you did!

Log Management Process for IR

- **Collect** the log data
- **Convert** to a common format
- **Reduce** in size, if possible
- **Transport** securely to a central location
- **Process** in real-time
- **Alert** on when needed
- **Store** securely
- **Report** on trends

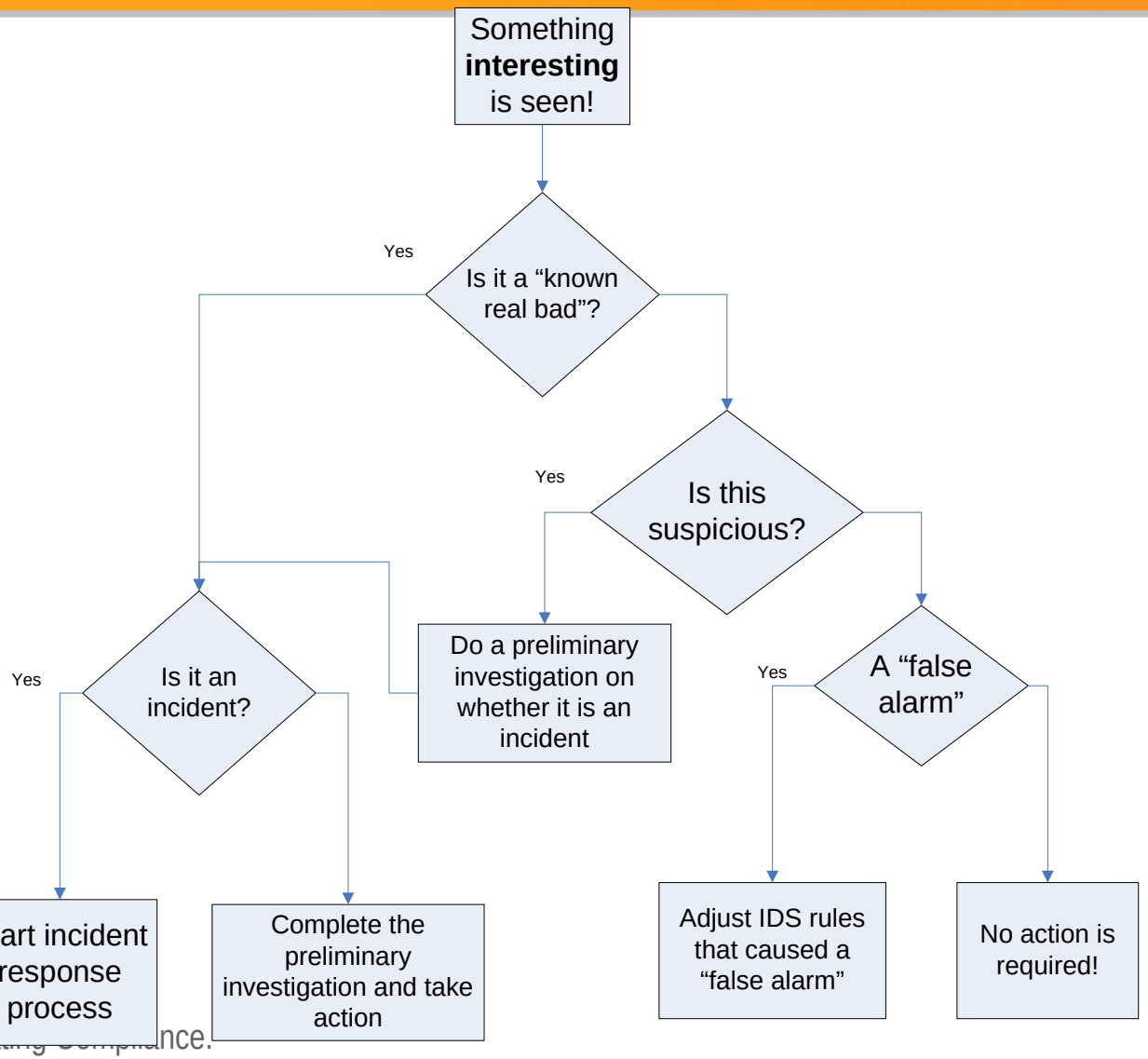
Log Management Challenges

- Not enough data
- Too much data
- Diverse records
- Time out of sync
- False records
- Duplicate data
- Hard to get data
- Chain of custody issues

Monitoring or Ignoring Logs Before the Incident?

- How to plan a **response strategy** to activate when monitoring logs?
- Where to start?
- How to tune it?

Monitoring Strategy



Value of Logging and Monitoring

Logging

- Audit
- Forensics
- Incident response
- *Compliance*

Monitoring

- Incident detection
- Loss prevention
- *Compliance*

Analysis and Mining

- Deeper insight
- Internal attacks
- Fault prediction

“Real-Time” Tasks

- Malware outbreaks
- Convincing and reliable intrusion evidence
- Serious internal network abuse
- Loss of service on critical assets

Daily Tasks

- Unauthorized configuration changes
- Disruption in other services
- Intrusion evidence
- Suspicious login failures
- Minor malware activity
- Activity summary

Weekly Tasks

- Review inside and perimeter log trends and activities
- Account creation/removal
- Other host and network device changes
- Less critical attack and probe summary

Monthly Tasks

- Review long-term network and perimeter trends
- Minor policy violation summary
- Incident team performance measurements
- Security technology performance measurements

Logs for Incident Response Challenges

- “Can you get’em?” – political boundaries and control issues
- “Can you understand them?” – log format and skill issues
- “Are they kosher?” – logs that can be challenged

Anton's Five Log Mistakes

How many have **you** committed? ☺

1. Not looking at logs
2. Not retaining long enough
3. Not normalizing logs
4. Deciding what's relevant before collection
5. Only looking at known bad

Anton's Five Incident Response Mistakes

How many have **you** committed? ☺

1. Not having a plan
2. Failing to increase monitoring and surveillance
3. Being unprepared for a court battle
4. "Putting it back the way it was"
5. Not learning from mistakes

Logs and Laws, Rules, Standards, Frameworks

Laws and Rules that Touch Logs and IR

- HIPAA
- FISMA
- GLBA and SOX (indirectly)
- ISO17799/27001
- COBIT
- *Countless* others…

Logs in Support of Compliance

- **Application and asset risk** measurement
- **Data collection and storage** to satisfy auditing of controls requirements
- Support for **security metrics**
- Industry **best-practices** for incident management and reporting
- Proof of security **due diligence**

Regulations Recommend Log Management

CobiT 4

- Provide adequate audit trail for root-cause analysis
- Use logging and monitoring to detect unusual or abnormal activities
- Regularly review access, privileges, changes
- Monitor performance
- Verify backup completion

ISO 17799

- Maintain audit logs for system access and use, changes, faults, corrections, capacity demands
- Review the results of monitoring activities regularly
- Ensure the accuracy of the logs

NIST 800-53

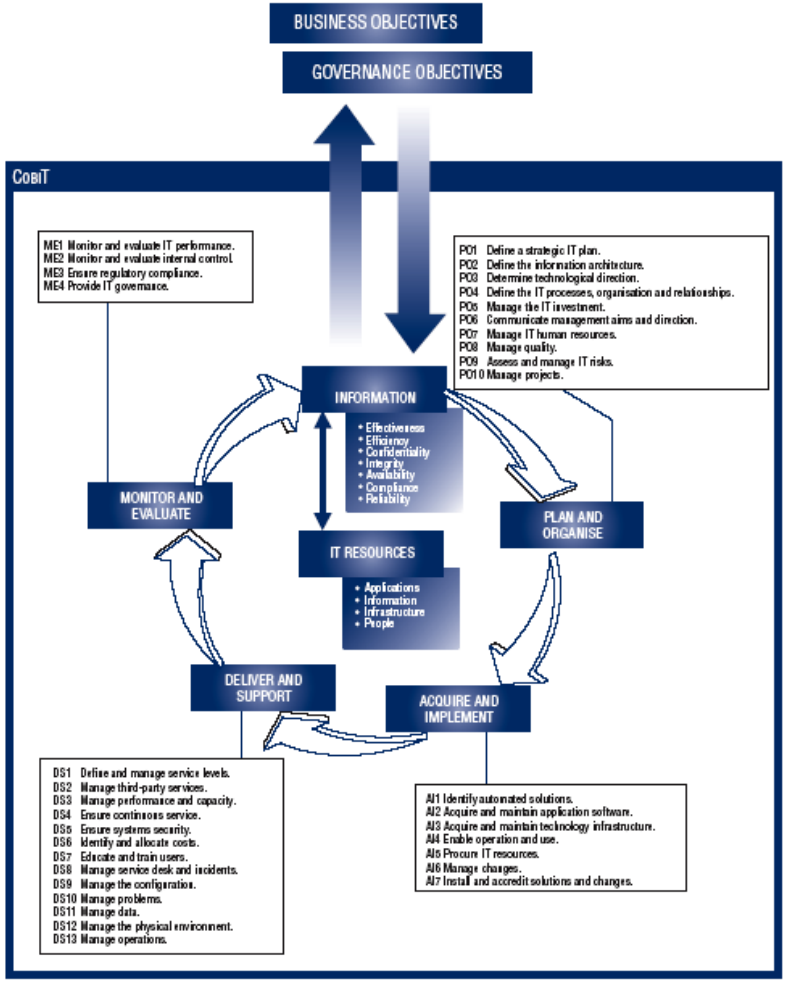
- Capture audit records
- Regularly review audit records for unusual activity and violations
- Automatically process audit records
- Protect audit information from unauthorized deletion
- Retain audit logs

PCI

Requirement 10

- Logging and user activities tracking are critical
- Automate and secure audit trails for event reconstruction
- Review logs daily
- Retain audit trail history for at least one year

Spotlight on: COBIT 4.0

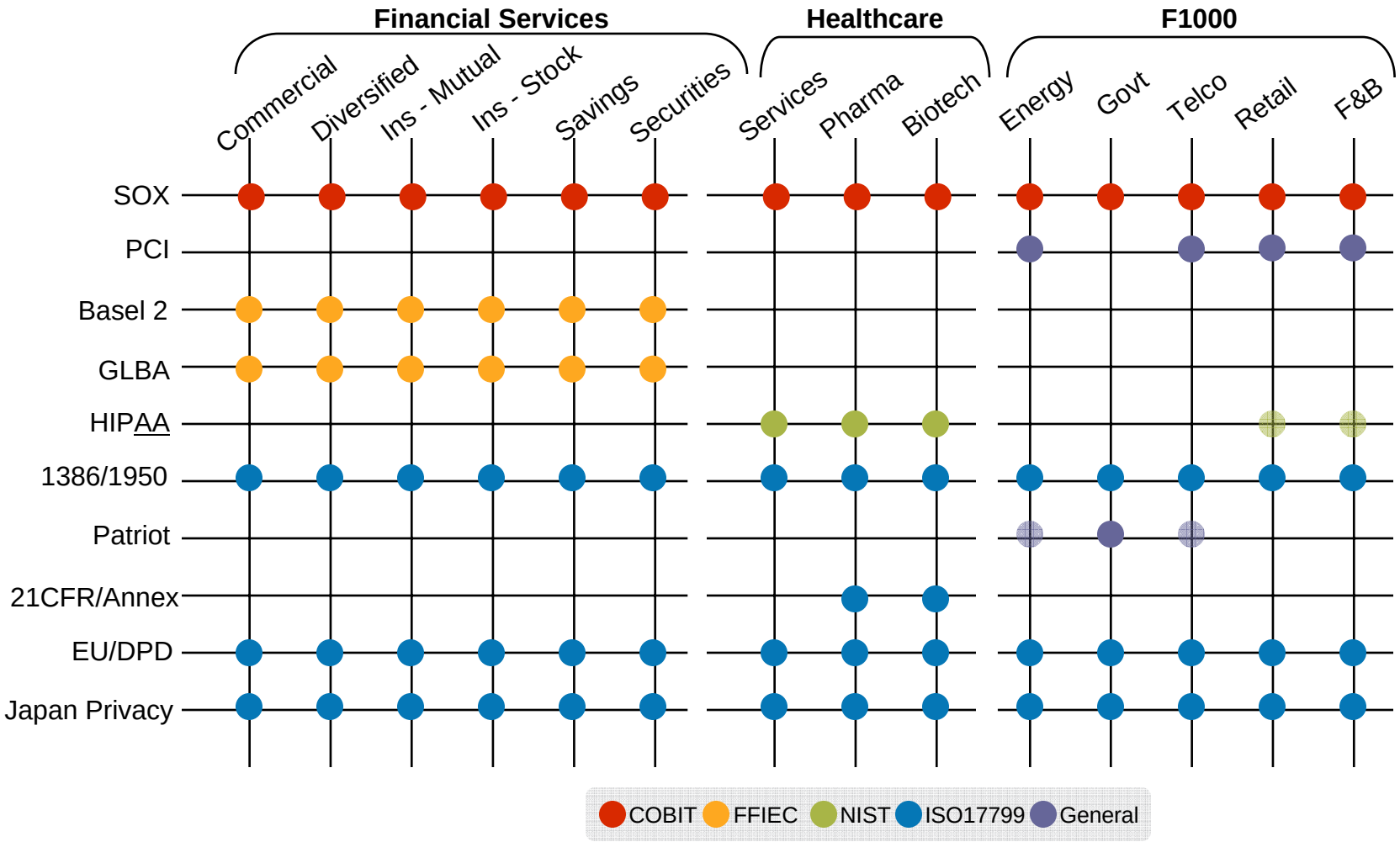


- (Re-)released in Dec 2005
- Four (4) Goals for IT
  - Align IT with business
  - Maximize IT benefits
  - Use IT assets responsibly
  - Manage IT risks
- 34 IT Processes
- Most used framework for SOX compliance

Log Data Evidences COBIT 4.0 Controls

Identity and Access	DS5.3 Identity management
	DS5.3 User account management
	PO7.8 Job change and termination
User Activity	PO4.11 Segregation of duties
	AI2.3 Application control and audit ability
Change	AI6.1 Change standards and procedures
	DS9.3 Configuration integrity review
Security	DS5.2 IT security plan
	DS5.5 Security testing, surveillance, monitoring
	DS5.10 Network security
	DS11.6 Security requirements for data mgmt
IT Infrastructure	DS1.5 Monitoring of service level agreements
	DS2.4 Supplier performance monitoring
	DS3.5 Monitoring of performance and capacity
	DS13.3 IT infrastructure monitoring
	DS10.2 Problem tracking and resolution
Business Continuity	DS4.1 IT continuity framework
	DS4.5 Testing of the IT continuity plan
	DS11.5 Backup and restoration

Compliance Drives New Controls



From Incident Response to Forensics

Logs and Forensics

- What Makes Your Incident Investigation a “Forensic” Investigation?
- Incident Response vs Forensics
- *… and is the ‘vs’ really appropriate?*

Forensics Brief

"Computer forensics is application of the scientific method to **digital** media in order to **establish factual information** for **judicial** review. This process often involves investigating computer systems to determine whether they are or have been used for illegal or unauthorized activities (Wikipedia)"

So, What is "Log Forensics"

- **Log analysis** is trying to make sense of system and network logs
- "**Computer forensics** is application of the scientific method to digital media in order to establish factual information for judicial review."

So….

- Log Forensics = trying to make sense of system and network logs + in order to establish factual information for judicial review

How Logs Help… Sometimes

If logs are *there*, we can *try* to

- … figure out **who**, **where**, **what**, **when**, **how**, **etc**

but

- **Who** as a person or a system?
- Is **where** spoofed?
- **When**? In what time zone?
- **How**? More like ‘how’d you think’…
- **What** happened or what got recorded?

Logs Forensics Challenges

What? You think this is evidence? Bua-ha-ha-ha ☺

"Computer Records and the Federal Rules of Evidence"

- "**First**, parties may **challenge the authenticity** of both computer-generated and computer-stored records by questioning whether the records were altered, manipulated, or damaged after they were created.
- **Second**, parties may question the authenticity of computer-generated records by **challenging the reliability** of the computer program that generated the records.
- **Third**, parties may challenge the authenticity of computer-stored records by **questioning the identity** of their author."

Example 11 Scan of the Month Challenge #34 *Revisited*

- Honeypot hacked
- All logs available
- In fact, too many ☺
- Analysis process

Example 12 Sysadmin Gone Bad

- Service Restarts Out of Maintenance Windows
- Correlated with Some Personnel Departures
- Information Leaks Start
- Log Analysis Reveals Unauthorized Software Installation

Example 13 Spyware Galore!

- System Seen Scanning – Firewall Logs
- Analysis of Logs Shows Antivirus Failures
- VPN Logs Help Track the Truth
- Full Forensic Investigation Confirms the Results of Log Analysis

Example 14 Compromise Detection

Security technology/resource	Method	Example	Reliability
NIDS	Compromise signature	Shell commands on SSL port TCP 443	Medium
NIDS	Post exploit activity	'whoami' in command flow	Medium
NIDS	Volume of outbound exploits (same or different)	Lots of SSL hits out	Medium
NIDS	Volume of outbound exploits after a similar inbound exploit	Lots of SSL hits out after the system is hit by SSL exploit	High
NIDS, firewall	Outbound massive port scanning, DoS, etc	Many connections to port 1434 UDP from a single system	Medium
HIDS	Abuse-related system log records	New account created	Medium
HIPS	Application behaving significantly different from known good	Connections, registry access, file replacements	Medium

Conclusion

- Turn ON Logging!!!
- Make Sure Logs Are There When You Need Them (and need them you will ☺)
- Include Log Analysis into the IH Process
- Avoid Above (and Other) Mistakes
- Prepare and Learn the Analysis Tools
- When Going Into the Incident-Induced Panic Think *'Its All Logged Somewhere – We Just Need to Dig it Out'* ☺

More information?

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Contributor to “Hacker’s Challenge 3” (Osborne 2006)

Book on logs is coming soon!

See www.info-secure.org for my papers, books, reviews and other security resources related to logs

Q & A

Thank You