Facilitating Fluffy Forensics 3.0

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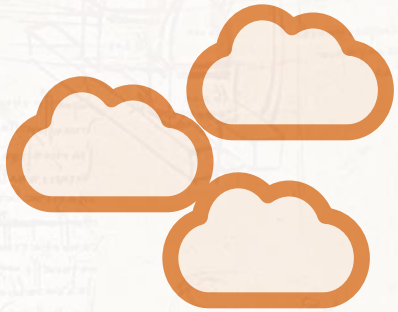
About Andrew Hay

- Andrew Hay
- Co-Founder and CTO @ LEO Cyber Security
- Former:
  - CISO @ DataGravity
  - Director of Research @ OpenDNS
  - Chief Evangelist & Director of Research @ CloudPassage
  - Senior Security Analyst @ 451 Research
  - Sr. Security Analyst in higher education and a bank in Bermuda
  - Product, Program, and Engineering Manager @ Q1 Labs
- Wrote some books, blog, spend more time on planes than I care to mention…

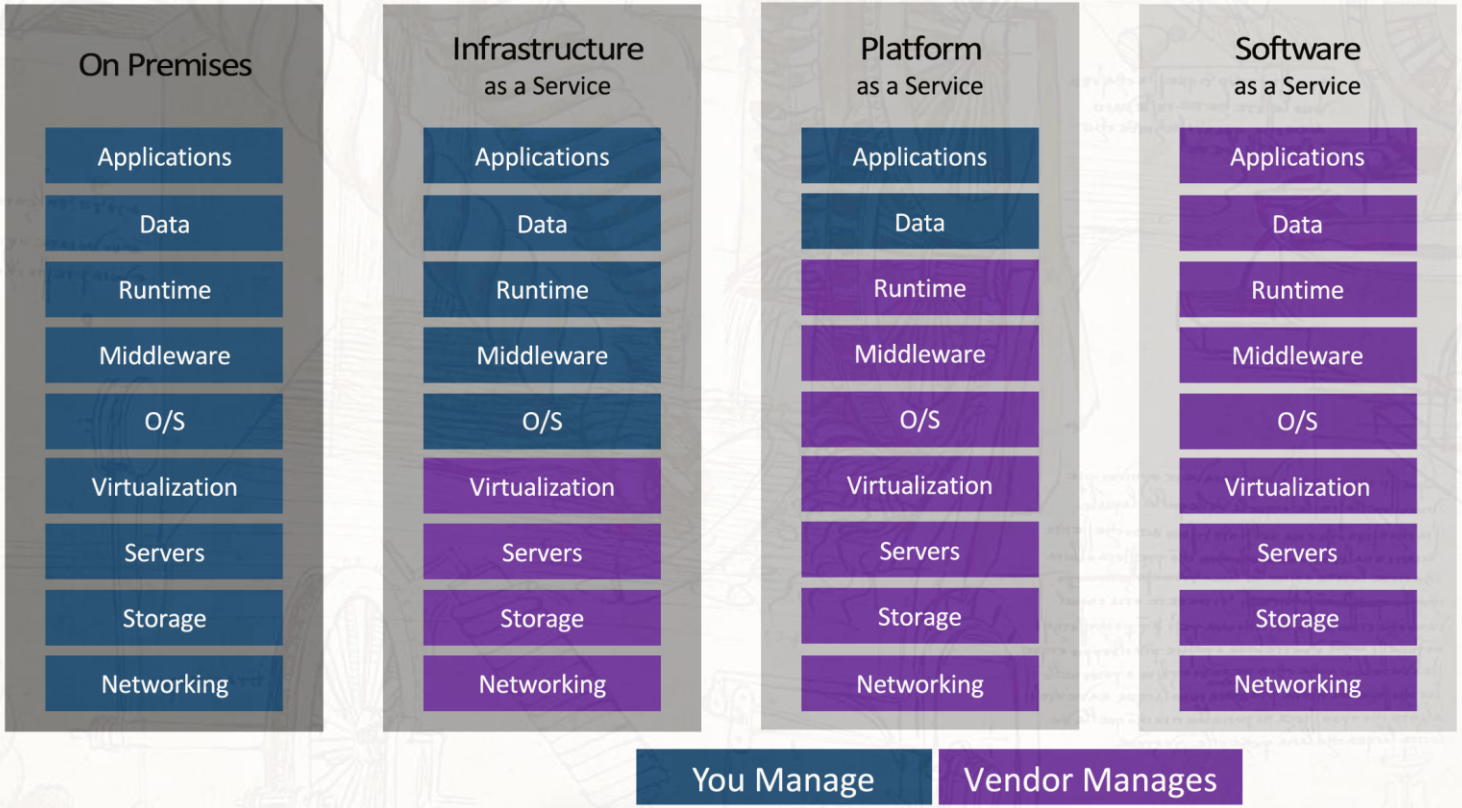
Overview

- Cloud architectural challenges for responders
- How existing forensics/IR tools can help
  - and what they can do better
- Advantages of conducting forensics/IR in cloud environments



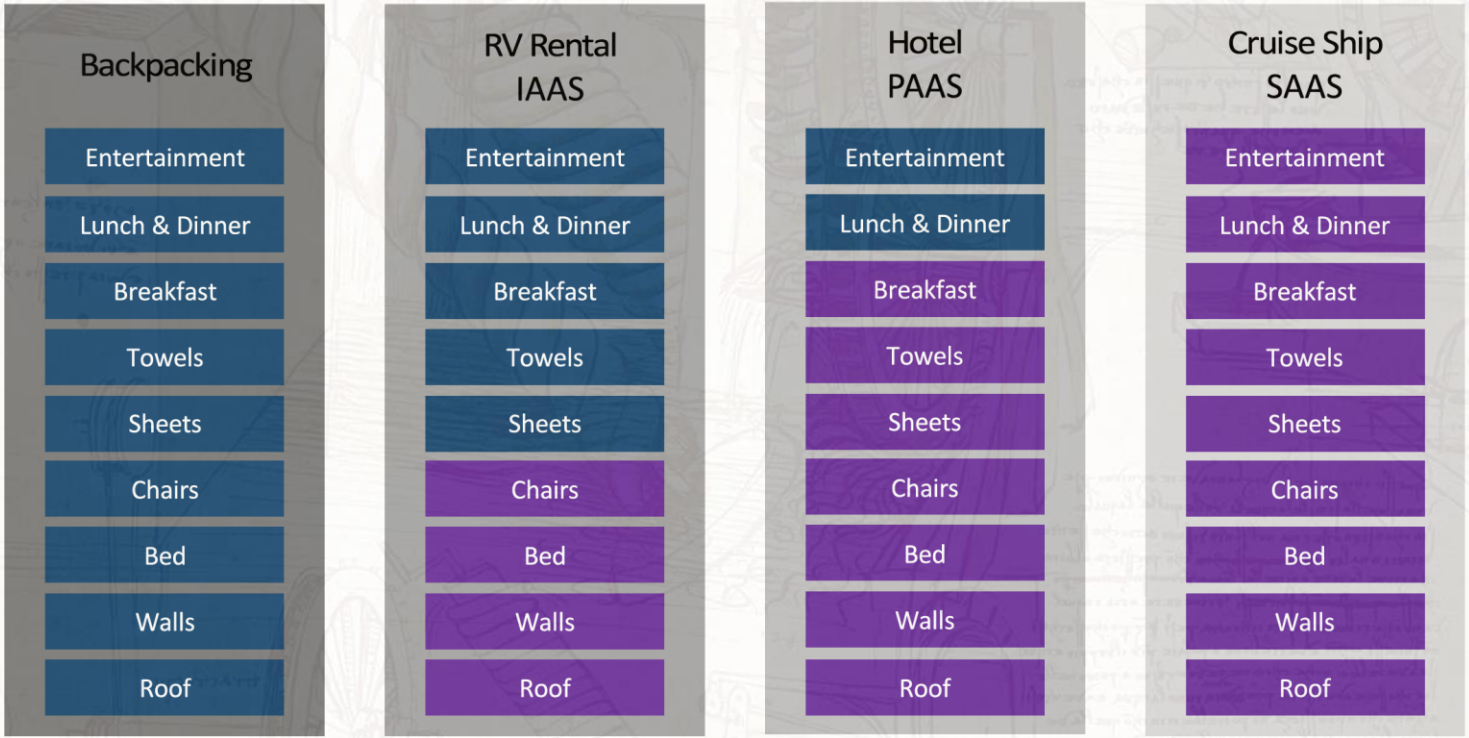
Cloud Architectural Challenges For Responders

Cloud Security Responsibility (Alternative)



With thanks to Troy Larson, Azure | MSRC, Microsoft Corp.

Vacation Responsibility



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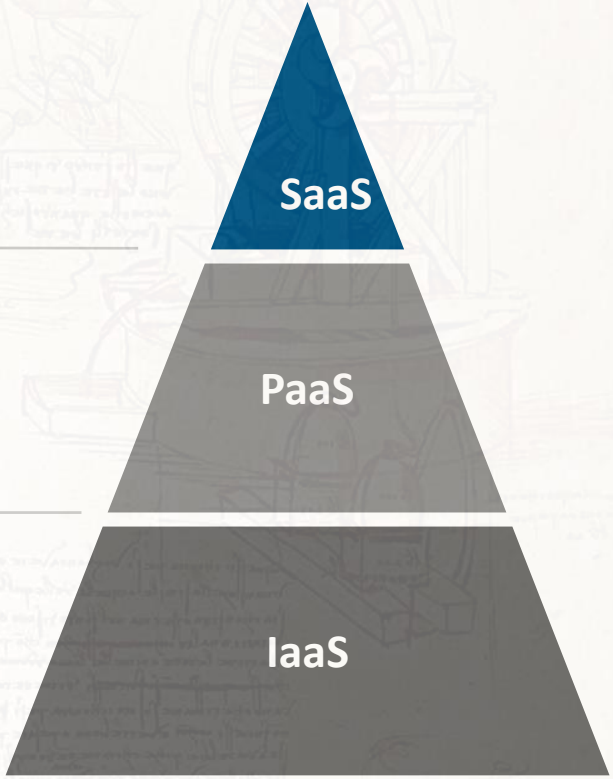
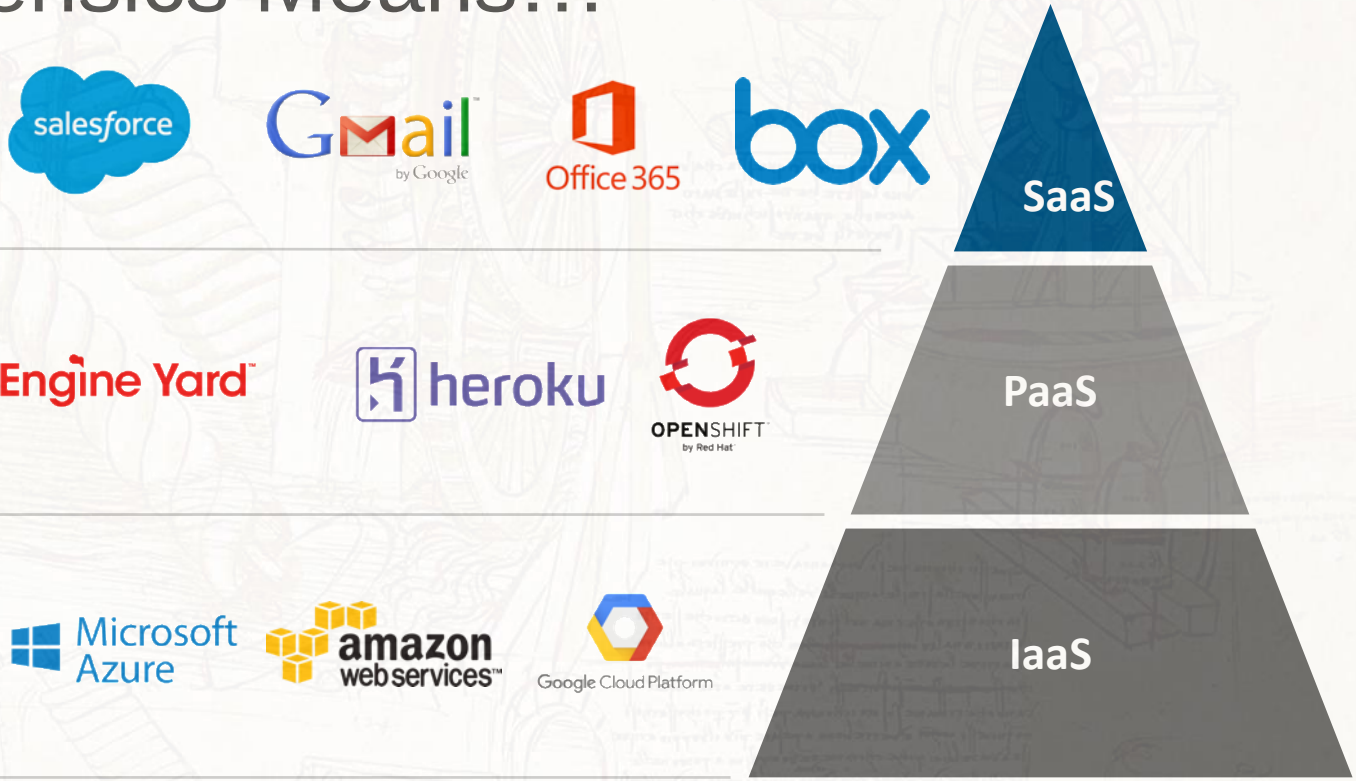
Cloud Forensics Means…



Cloud Forensics Means…



Cloud Forensics Means…

salesforce

Gmail by Google

Office 365

box

Engine Yard

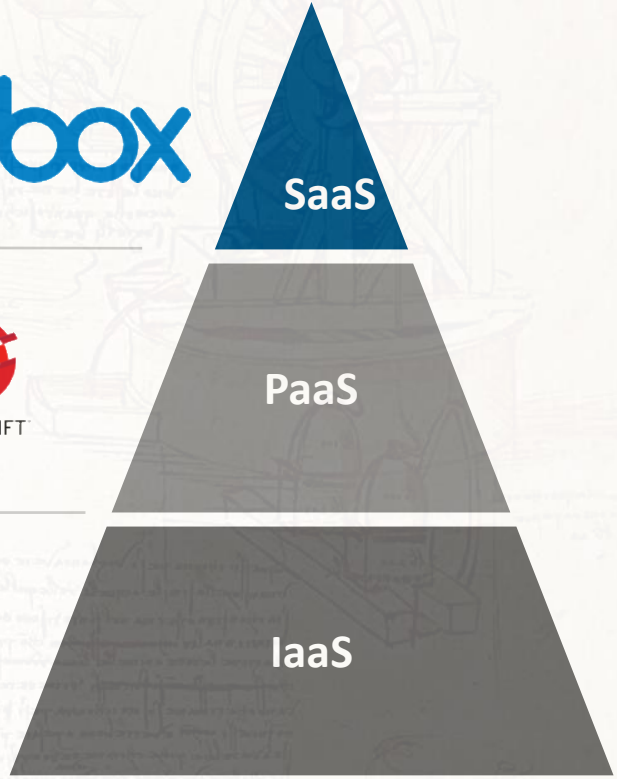
heroku

OPENSHIFT by Red Hat

Microsoft Azure

amazon web services™

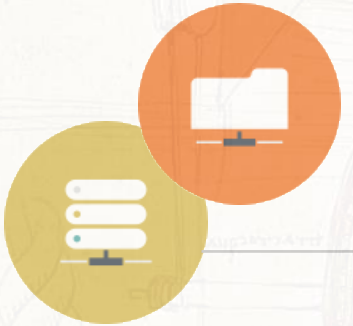
Google Cloud Platform



Cloud Forensics Means…

Since they won't let me talk for 8hrs

…we'll focus on IaaS today ☺



Microsoft Azure

amazon web services™

Google Cloud Platform

5 Major Challenges

1. **Data residence**
2. **Physical acquisition**
3. **Instance isolation**
4. **Hypervisor introspection & data integrity**
5. **Lack of CSP collaboration/support**

Data Residence

- Need to know where the data is
- This adds validity to your investigation
- This, in turn, makes your results more credible

Data Residence: AWS (2008)

Where is my data stored?

Amazon S3 offers storage in the United States and in Europe (within the EU). ***You can specify where you want to store your data when you create your Amazon S3 buckets.***

- Source: https://web.archive.org/web/20081016104719/http://aws.amazon.com/s3/faqs/#Where_is_my_data_stored

Data Residence: AWS (2013)

Where is my data stored?

Amazon S3 offers storage in the US Standard, US West (Oregon), US West (Northern California), EU (Ireland), Asia Pacific (Singapore), Asia Pacific (Tokyo), Asia Pacific (Sydney), South America (Sao Paulo), and AWS GovCloud (US) Regions. You specify a Region when you create your Amazon S3 bucket. ***Within that Region, your objects are redundantly stored on multiple devices across multiple facilities.***

- Source: https://web.archive.org/web/20130502034405/http://aws.amazon.com/s3/faqs/#Where_is_my_data_stored

Data Residence: AWS (Now…)

Where is my data stored?

You specify a region when you create your Amazon S3 bucket. ***Within that region, your objects are redundantly stored on multiple devices across multiple facilities. Please refer to Regional Products and Services for details of Amazon S3 service availability by region***.

Source: http://aws.amazon.com/s3/faqs/#Where_is_my_data_stored

Data Residence: Windows Azure (2012)

Location of Customer Data

> Microsoft may transfer Customer Data within a major geographic region (e.g., within Europe) for data redundancy or other purposes. For example, Windows Azure Storage geo-replication feature ***will replicate*** Windows Azure Blob and Table data, at no additional cost, ***between two sub-regions within the same major region for enhanced data durability*** in case of a major data center disaster. However, customers can choose to disable this feature.

- Source: https://web.archive.org/web/20120510055557/https://www.windowsazure.com/en-us/support/trust-center/privacy/

Data Residence: Windows Azure (2013)

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- Source: https://web.archive.org/web/20130512060355/http://www.windowsazure.com/en-us/support/trust-center/privacy/

Where'd the "*customers can choose to disable this feature*" part go?

Data Residence: Windows Azure

You know where your customer data is located

Microsoft maintains an ever-expanding network of cloud-scale datacenters in locations around the globe, and verifies that each meets strict security requirements. As a Microsoft Cloud customer, you will know the location where your data is stored. ***Each Microsoft cloud service has its own location policies for customer data.***

- Source: https://www.microsoft.com/en-us/TrustCenter/Privacy/default.aspx & https://www.microsoft.com/en-us/TrustCenter/Privacy/You-are-in-control-of-your-data

Data Residence: GCE (2013)

Do I have the option of using a regional data center in selected countries?

> Yes, Google Compute Engine offers datacenter options in Europe and within the United States. These datacenter options are designed to provide low latency connectivity options from those regions, however ***at this time selection of datacenter will make no guarantee that project data at rest is kept only in that region.***

- Source: https://web.archive.org/web/20130429150332/https://developers.google.com/compute/docs/faq

Data Residence: GCE (2014)

Do I have the option of using a regional data center in selected countries?

Yes, Compute Engine offers data centers in the United States, Europe, and Asia. These data center options are designed to provide low latency connectivity options from those regions.

- Source: https://web.archive.org/web/20140913123317/https://developers.google.com/compute/docs/faq

Where'd the "*project data at rest is kept only in that region*" part go?

Data Residence: GCE (2016)

Do I have the option of using a regional data center in selected countries?

Yes, Compute Engine offers data centers in the United States, Europe, and Asia. These data center options are designed to provide low latency connectivity options from those regions. ***For specific region information, including the geographic location of regions, see Regions and Zones.***

- Source: https://developers.google.com/compute/docs/faq

No mention of where your data *might* be located since 2013…

What About Multi-Cloud Data Residence?

Physical Acquisition

- Unless you own the cloud architecture…
- Or have the bent the CSP to your will…
- You may be stuck with snapshots and/or logical imaging

Image Acquisition: AWS

- There are 3+ ways that I know of
  1. Snapshot the EBS volume, mount, and copy locally
  2. Have AWS ship you the data from S3 on physical device
  3. Use AMI Tools to compress, encrypt, and sign a snapshot

Image Acquisition: AWS EBS

- Launch a clean Amazon Linux AMI
- Stop the instance of the root volume you wish to capture
- Detach the `/dev/sda1` volume
- Create a snapshot of the now detached `/dev/sda1` volume
- Attach the `/dev/sda1` volume to the new AMI as `/dev/sdf` (don't mount)

Image Acquisition: AWS EBS

- Create a new EBS volume the same size as the root volume you wish to capture
- Attach this new volume as `/dev/sdg`
- Then use these commands:
  - sudo mkfs -t ext3 /dev/sdg
  - sudo mkdir /vol1
  - sudo mount /dev/sdg /vol1
  - sudo chown ec2-user /vol1
- Use dd to make an image of /dev/sdf
  - `sudo dd if=/dev/sdf | gzip -c > /vol1/sda1.img.gz`

Image Acquisition: AWS EBS

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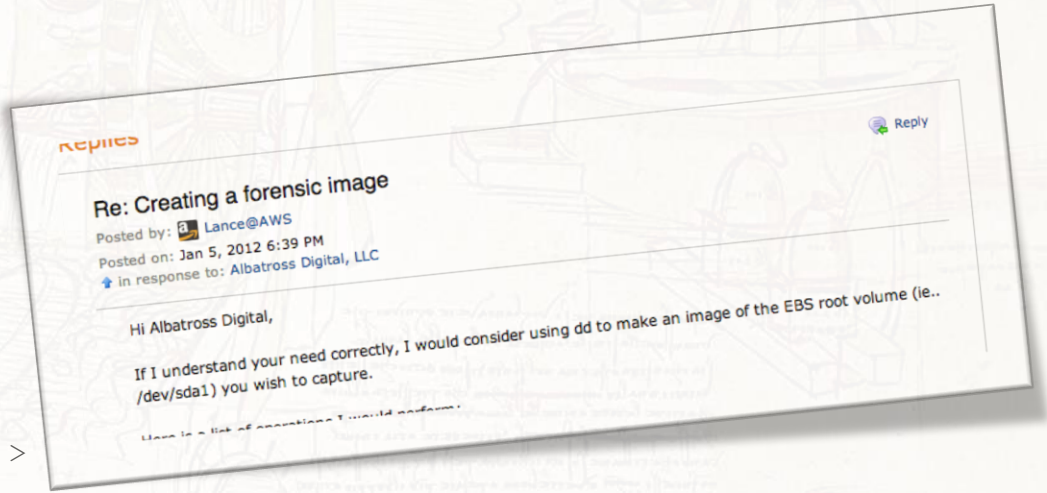


Image Acquisition: AWS S3

- Amazon provides a service to export data from S3 onto a physical device and ship it to the requestor
- Customer must provide the storage device and is billed $80 per storage device handled plus $2.49 per data-loading hour
- In EBS or S3 methods it is impossible to verify the integrity of the forensic disk image*

Source: J. Dykstra, A.T. Sherman / Digital Investigation 9 (2012) S90–S98

Image Acquisition: AWS S3 + AMI Tools

- ec2-bundle-vol
  - Creates a bundled AMI by ***compressing, encrypting and signing*** a snapshot of the local machine's root file system
- ec2-migrate-bundle
  - Copies a bundled AMI from one Region to another
- ec2-download-bundle
  - Downloads the specified bundles from S3 storage

Dykstra/Sherman Experiment

- Experiment by J. Dykstra, A.T. Sherman
  1. Manual installation of EnCase Servlet and FTK Agent
  2. Used VM introspection for complete drive image
  3. AWS Export process (ship a drive)

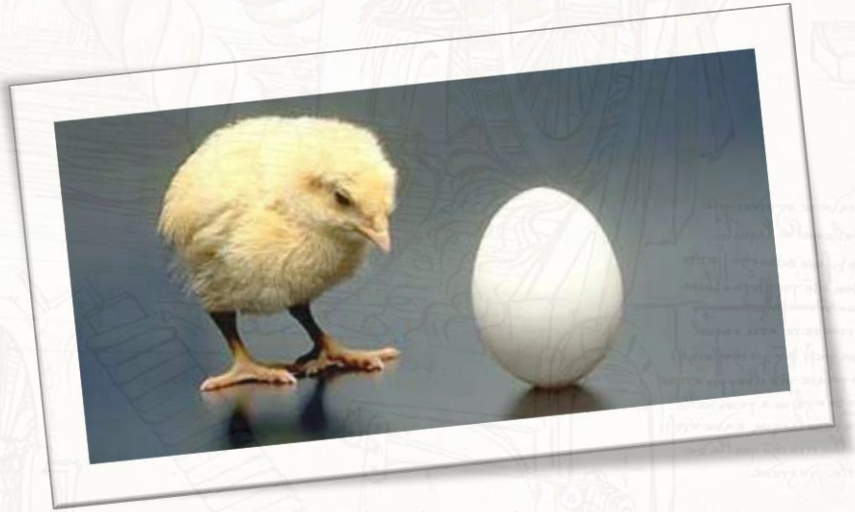
Experiment	Tool	Evidence collected	Time (hrs)	Trust required
1	EnCase	Success	12	OS, HV, Host, Hardware, Network
1	FTK	Success	12	OS, HV, Host, Hardware, Network
1	FTK Imager (disk)	Success	12	OS, HV, Host, Hardware, Network
1	Fastdump	Success	2	OS, HV, Host, Hardware, Network
1	Memoryze	Success	2	OS, HV, Host, Hardware, Network
1	FTK Imager (memory)	Success	2	OS, HV, Host, Hardware, Network
1	Volume Block Copy	Success	14	OS (imaging machine), HV, Host, Hardware, Network
2	Agent Injection	Success	1	HV, Host, Hardware, Network
3	AWS Export	Success	120	AWS Technician, Technician's Host, Hardware and Software, AWS Hardware, AWS Software

Introspection & Data Integrity

- Introspection is not new
  - First introduced by T. Garfinkel and M. Rosenblum in *A Virtual Machine Introspection Based Architecture for Intrusion Detection*
- Way to look into current state of the guest virtual machine
  - e.g. covert, low-level access to read find processes and threads, recover files mapped in memory, and extract information about the Windows registry

Introspection & Data Integrity

- Enabled by provider
- Transparent to tenant and server instance
- Great for forensic acquisition
  - but hard to prove integrity



Instance Isolation

- **Several conditions must be met in order for a cloud instance to be successfully isolated:**
  - **Location:** The physical location of the instance is known
  - **Incoming & Outgoing Blocking:** The instance is blocked from sending/receiving communications to/from the outside world

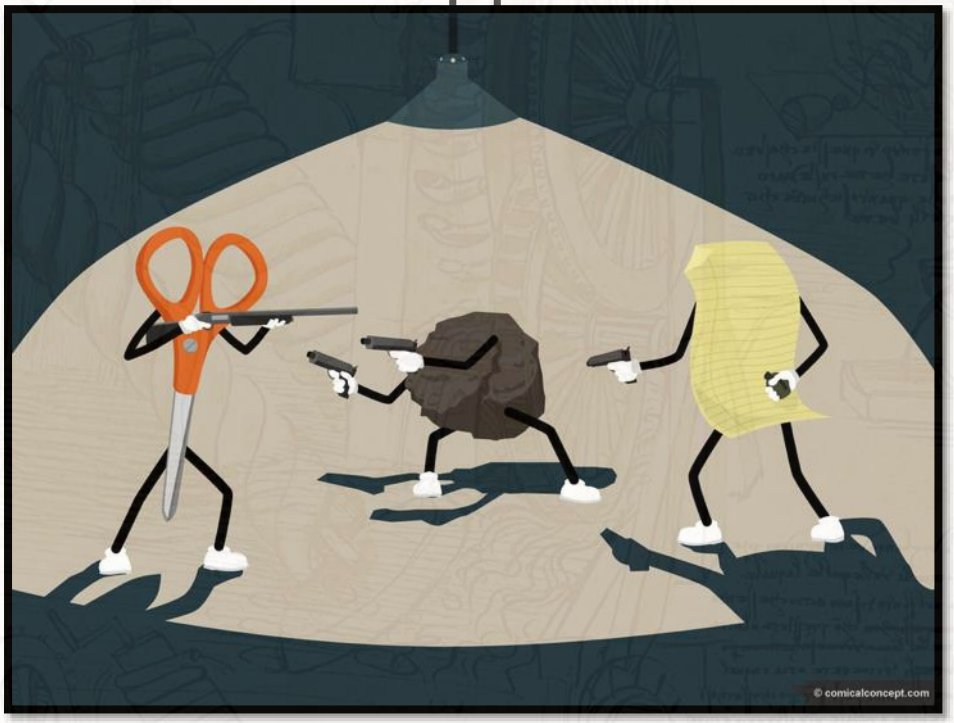
Source: Waldo Delport and Martin Olivier - *Isolating Instances In Cloud Forensics*

Instance Isolation

- **Several conditions must be met in order for a cloud instance to be successfully isolated:**
  - **Collection:** Evidence from the instance can be gathered
  - **Non-Contamination:** Evidence from the instance is not contaminated by the isolation process
  - **Separation:** Information unrelated to the incident is not part of the isolation process

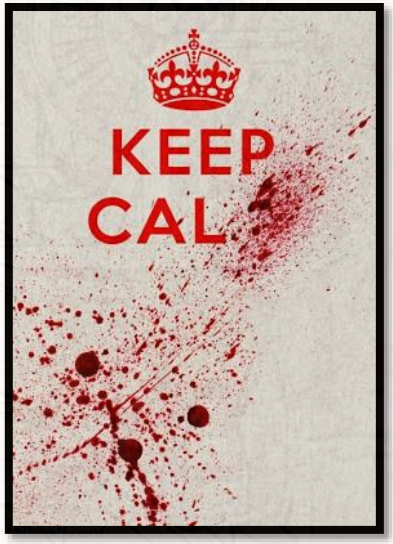
Source: Waldo Delport and Martin Olivier - *Isolating Instances In Cloud Forensics*

CSP Collaboration/Support



CSP Collaboration/Support

- Most providers have people that can help
- Contracts should indicate level of effort…
  - That you're expected to exert
  - That they're willing to exert
- Ask for:
  - Samples/examples of past investigations
  - Methodologies employed
  - Credentials of staff
  - Interviews with CSP team members



How Existing Forensics/IR Tools Can Help

…And What They Can Do Better

New Architecture, Similar Tools

- Your old tools and techniques may still work
  - Some, but not all

Cellebrite

FireEye

X-Ways

MAGNET FORENSICS

Rekall

e-fense
CARPE DATUM

F-Response

REDLINE

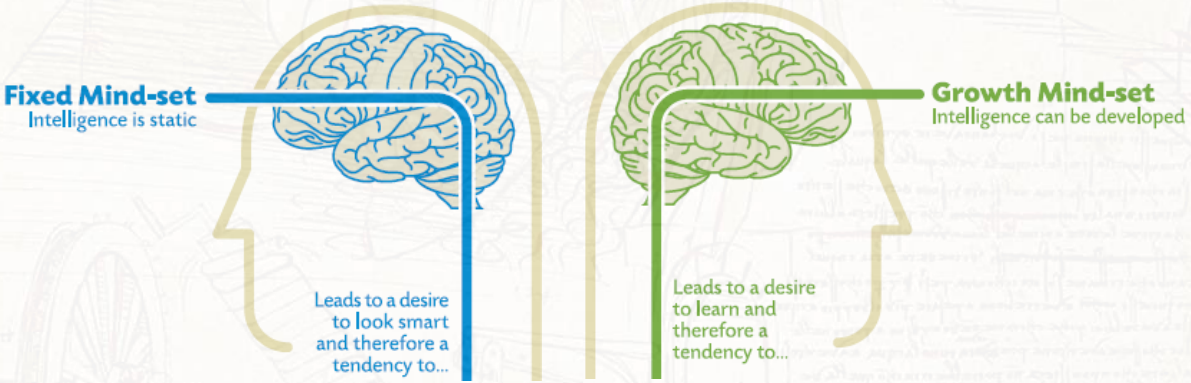
ACCESSDATA

GUIDANCE SOFTWARE

ARSENAL RECON

Not Just Technical Challenges

- Biggest challenge is mindset
- Need to grow comfortable with
  - Storing images/data/ off-site (*a.k.a. The Cloud*)
  - Processing off-site (*a.k.a. The Cloud*)
  - Launching off-site analysis consoles in…you guessed it, *The Cloud*!



Existing Tools Can Be Used…

- e.g. NBDServer
  - Serves the (XP, Win 7, Win 2008) server as a read-only network block device
  - Also possible to use this tool (w/Volatility or Rekall) to image the Windows system RAM across the network to your client

Existing Tools Can Be Used…

[server] `nbdserver.exe -c 192.168.2.197 -f \\.\PHYSICALDRIVE0 -n0`

[client] `modprobe nbd`

[client] `nbd-client 192.168.2.157 60000 /dev/nbd0`

This starts the client, tells it to look for the server on 192.168.2.157, use port 60000 and create the new network block device as /dev/nbd0.

[client] `fls -f ntfs -m C: -r /dev/nbd0 > test.fls`

NBD-Server Advances

- https://github.com/yoe/nbd
  - Latest commit 46ce5cb 19 days ago
- https://github.com/reidrac/swift-nbd-server
  - This is a NBD server for OpenStack Object Storage (Swift)
    - Latest commit dafc44a on Mar 30, 2016
- https://github.com/psychomario/PyPXE
  - Pure Python2 PXE (DHCP-(Proxy)/TFTP/HTTP/NBD) Server
    - Latest commit 6cc6b51 on Dec 26, 2016

F-Response Cloud Connector

- F-Response 4.0.4
  - The new Cloud Connector
  - Let's you 'mount'
    - Amazon S3 Buckets
    - HP, Rackspace Cloud Containers
    - Windows Azure Blob Storage Containers

- F-Response (as of 3/21/16)
  - Let's you 'mount'
    - Amazon S3 & Microsoft Windows Azure Blob Storage
    - Box.com & Dropbox
    - Gmail (OAuth) & Google Apps for Business Drives
    - HP Helion & Rackspace Cloud Files
    - Office 365 email, OneDrive, and Sharepoint

Finally!!!

F-Response Universal now available on Amazon EC2

Apr/22/2015

We are very pleased to announce that F-Response Universal, our newest and most comprehensive version of F-Response is now available as a Amazon EC2 Machine Image (AMI).

We've been working with multiple customers to refine the Amazon EC2 process and present a clean and simple way for new customers looking to stand up F-Response Universal in the Amazon cloud.

REF: https://www.f-response.com/blog/f-response-univ-on-ec2

AccessData Joins The Party

Wednesday, November 01, 2017 (11:51:29)

AccessData's AD Lab Becomes First Forensics Platform Available On AWS And Azure

AccessData Group today announced that its AD Lab centralized investigations platform is now the first product in its category to be available to users in a cloud-based environment.

REF: https://www.forensicfocus.com/News/article/sid=3011/

Chad Tilbury's Blog Post

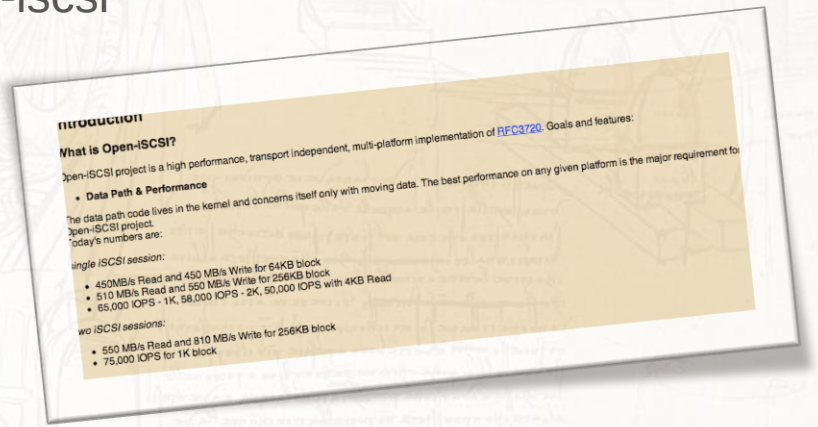
Like many great inventions, the idea behind F-Response is so simple and elegant it is hard not to punish yourself for not thinking of it. Using the iSCSI protocol to provide read-only mounting of remote devices opens up a wealth of options for those of us working in geographically dispersed environments. I have used it for everything from remote imaging to fast forensic triage to live memory analysis. F-Response is vendor-neutral and tool independent, essentially opening up a network pipe to remote devices and allowing the freedom of using nearly any tool in your kit. The product is so good, I really wouldn't blame them for just sitting back and counting their money. Luckily, counting money gets boring fast, so instead the folks at F-Response have kept innovating and adding value. Their latest additions are new "Connector" tools: Database, Cloud, and Email.

Chad Tilbury
@chadtilbury

REF: http://forensicmethods.com/fresponse-cloud-forensics

I Once Had An Idea…

- It went something like this…
  - “It would be great if someone built me (and everyone else doing forensics) a client-server architecture based on the Open-iSCSI protocol”
  - https://github.com/mikechristie/open-iscsi
  - http://www.open-iscsi.org/



Introduction

What is Open-iSCSI?

Open-iSCSI project is a high performance, transport independent, multi-platform implementation of RFC3720. Goals and features:

- **Data Path & Performance**

The data path code lives in the kernel and concerns itself only with moving data. The best performance on any given platform is the major requirement fo
Open-iSCSI project.
Today's numbers are:

Single iSCSI session:

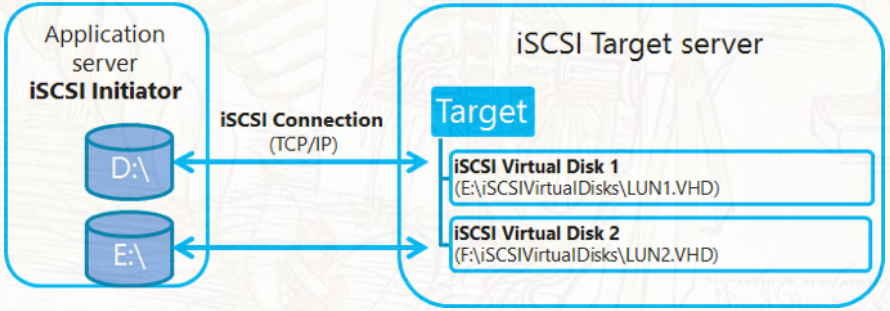
- 450MB/s Read and 450 MB/s Write for 64KB block
- 510 MB/s Read and 550 MB/s Write for 256KB block
- 65,000 IOPS - 1K, 58,000 IOPS - 2K, 50,000 IOPS with 4KB Read

Two iSCSI sessions:

- 550 MB/s Read and 810 MB/s Write for 256KB block
- 75,000 IOPS for 1K block

Windows 2008 R2 ++

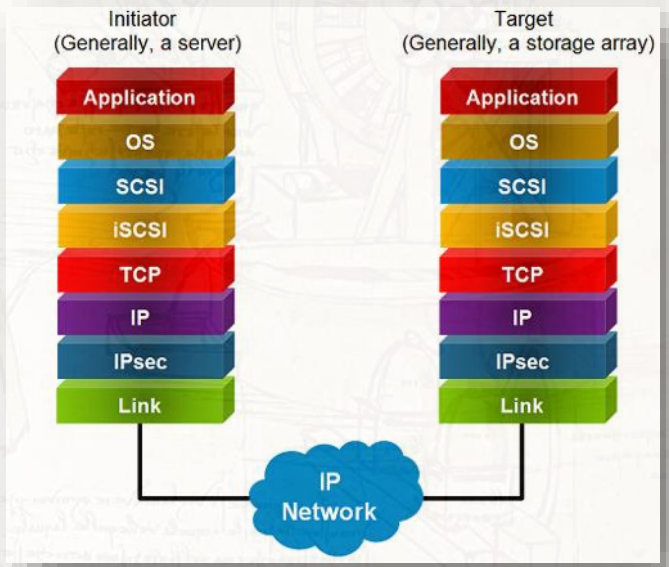
- The iSCSI Target in Microsoft Windows Server
  - Downloadable in Windows 2008 R2
  - Standard in Windows 2012



  - Fantastic walkthrough and PowerShell scripts to configure
    - http://www.lazywinadmin.com/2013/07/create-iscsi-target-using-powershell-on.html

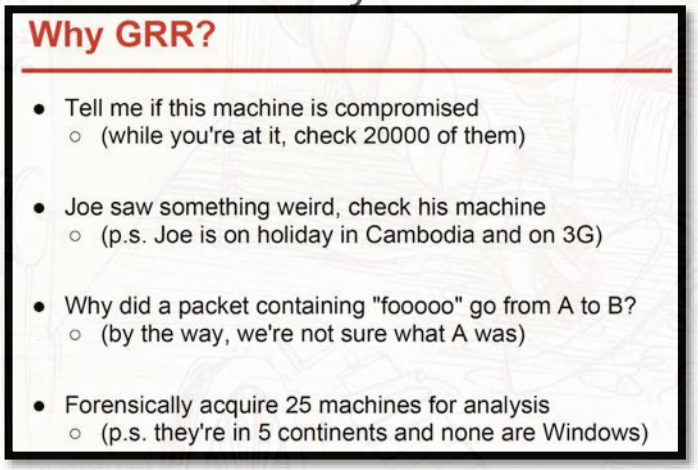
iSCSI Initiator Clients

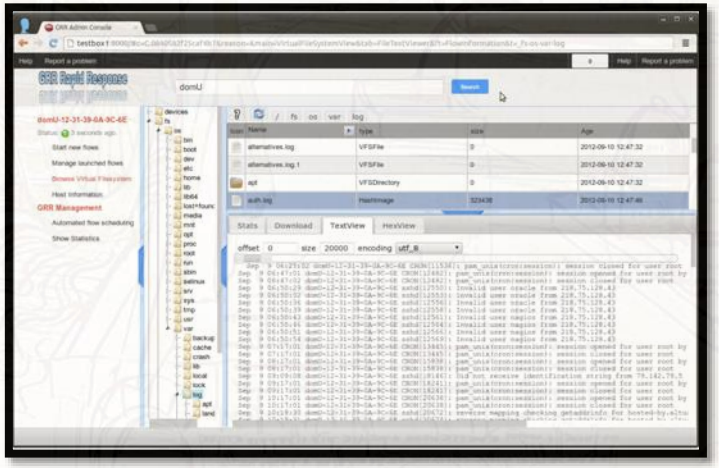
- OS X
  - iSCSI Initiator for OS X
    - https://github.com/iscsi-osx/iSCSIInitiator
- FreeBSD
  - FreeBSD iSCSI Initiator
    - https://github.com/oberstet/iscsi
- Linux (Ubuntu)
  - open-iscsi
    - https://help.ubuntu.com/lts/serverguide/iscsi-initiator.html



GRR

- GRR Rapid Response
  - Remote live forensics for incident response
  - Was in its infancy back in 2011/2012





GRR

- Much more mature now
  - Cross-platform support for Linux, OS X and Windows clients
  - Live remote memory analysis using open source memory drivers for Linux, OS X and Windows via the Rekall memory analysis framework
  - Powerful search and download capabilities for files and the Windows registry
  - Secure communication infrastructure designed for Internet deployment
- https://github.com/google/grr

Other Tools

- http://wirespeed.io/ (now known as https://evimetry.com/)
  - “Wirespeed gives you the ability to analyse evidence without the delays of traditional acquisition, regardless of whether your target device is local, or across the internet.”
- https://github.com/google/turbinia/
  - OSDFCon submission by Cory Altheide & Johan Berggren entitled “*Turbinia: Cloud-scale forensics*”
- https://www.brimorlabs.com/tools/
  - Live Response Collection – Allosaurus Build
    - Automated tool that collects volatile data from Windows, OSX, and *nix based operating systems

ThreatResponse: The New Hotness?

- ThreatResponse
  - “A Free Open Source Security Suite for Hardening and Responding in AWS.”
  - http://www.threatresponse.cloud

Continued Evolution Required

- Cloud presents challenges
- Cloud also presents opportunities

Advantages Of Conducting Forensics/IR

In Cloud Environments

Advantages (now and future)

- Automated instance isolation
- On-demand forensic workbenches
- Automated timeline generation
- Dynamic analysis ‘workers’
- Distributed file carving
- Multi-cloud analysis

More Information

- Introduction of iSCSI Target in Windows Server 2012
  - https://blogs.technet.microsoft.com/filecab/2012/05/21/introduction-of-iscsi-target-in-windows-server-2012/
- Cloud Forensics Bibliography
  - http://www.forensicswiki.org/wiki/Cloud_Forensics_Bibliography
- SANS Digital Forensics and Incident Response Blog
  - https://digital-forensics.sans.org/blog

More Information (Continued…)

- Forensics in AWS: an introduction
  - https://blyx.com/2016/03/11/forensics-in-aws-an-introduction/
- How I learned to stop worrying and love the cloud: Azure Forensics for the Security Responder
  - https://blogs.msdn.microsoft.com/azuresecurity/2015/08/14/how-i-learned-to-stop-worrying-and-love-the-cloud-azure-forensics-for-the-security-responder/

Summary

- Cloud forensics and incident response require an open mind
- Cloud can be used to help with complex investigations
- Tools continue to evolve to better handle dynamic environments

Thank You

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Questions?

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