

# Forensics 2.0: Challenges in the Cloud

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# The Speaker

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- Main interests: Cloud Security, Network Security, Security and Privacy Issues in Social Networks

# What's this all about?

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- Dr. Andy Jones (Head of Security Research at BT) outlined the following emerging **challenges in the field of digital investigations** at the *e-Forensics 2009* in Australia:

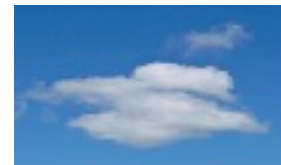
- Impact of solid-state memory



- Ultra-portable devices



- Distributed storage  
also known as **Cloud Computing**



# Scuse'me, why should I bother?

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- In "*Assessing the Security Risks of Cloud Computing*" Gartner specifically highlighted the investigative support and auditing within Cloud Computing environments ...
- "[...] to our knowledge, no research has been published on how cloud computing environments affect digital artifacts, and on acquisition logistics and legal issues related to cloud computing environments"  
*Digital Forensic Research: The Good, the Bad and the Unaddressed – Bebee, Nicole*
- Safe Harbor agreement vs. USA Patriot Act  
Who will win the prioritization race in front of a court?
- *Scuse'me, do **You** know where your data is in the Cloud?*

# Tell me, why is the Cloud so dark?

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- Cloud Service Provider (CSP) artificially eclipse the Cloud for several reasons:
  - Competitors could use workload information for improving their own range of services or use it to harm the reputation of the CSP.
  - Adversaries could use technical information about infrastructure and system usage for launching attacks against the provider.
- Additionally, this "darkness" lies in the current principle of flexibility in the field of Cloud Computing
- These circumstances yield one main issue: *Is it possible for the customer to perform a traditional digital investigation in case it is needed for one of his virtual instances in the cloud environment of the vendor and if so, where the investigation begins?*

# SAP Cycle

## Conventional Digital Forensics

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- "*Chain of Custody*" is needed
- The **Securing-Analyzing-Presentation** (SAP) Cycle
  - Digital Investigations require an appropriate **Securing** of evidence data. This normally happens with the help of bitwise duplication of the physical volume.
  - During the **Analyzing** stage, bits and pieces are pulled together for *deciphering* the story of what happened
  - In the **Presentation** phase, all other phases are documented and explained.

# Cloud Computing Deployment Models

*ISACA Definition*

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- Private
    - Operated solely for an organization
    - May not provide the scalability and agility of public cloud services
  - Community
    - Shared by several organizations
  - Public
    - Made available to the general public
    - Owned by an organization selling cloud services (CSP)
  - Hybrid
    - Composition of public and private clouds bound together by standardized or proprietary technology
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# Digital Forensics in Real Private Clouds

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- **Securing the data:** Possible because the *Cloud* is in your own data center ✓
- **Analyzing:** Possible because you have trustworthy access-logs, images of VMs, router logs etc ... ✓
- **Problem:**
  - Private Clouds do not offer the advantages of real Public Clouds and scale only for huge companies with the help of extraordinary investments → Security vs. Business



# Digital Forensics in Real Public Clouds

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- **Securing the data:** You cannot secure the data in the traditional way because you don't know where exactly it is. ✘
- **Analyzing:** You possibly don't have trustworthy access-logs, images of VMs, router logs etc ... ✘
- **Problem:**
  - Public Clouds do offer a lot of advantages, however they represent a risk to your sensitive data.
  - The absence of physical access leads to further problems especially in cases of digital investigations.

# Example: AWS VPC

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- **Guessing Game:** Is Amazon's VPC a real *Private Cloud*?
  - VPC principle: put your EC2 instances in one VLAN cluster with IPsec VPN connection to your company network at home
- **Question:** Do your EC2 instances still share one physical host with other potentially evil instances?  
*See: Hey, You, Get Off of My Cloud: Exploring Information Leakage in Third-Party Compute Clouds*
- Traditional forensic investigations are still **not** possible
- **Advantage:** The VPC is still a real Cloud with all its pros and cons

# Forensics in SaaS

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- Eventually high-level logs will provide information
- Highly depends on what the CSP logs
- No deeper view into the system and its underlying infrastructure is possible  
→ connection through API only
- No possibility to install any toolkits, analysis tools etc.



Source: startswithabang.com

- *"Srsly, You know nothing about your data in SaaS environments"*

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# Forensics in PaaS

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- You can control your own source!
- No control over the environment where the application runs
- **Problem:** Even if you log syscalls of your application, the underlying runtime environment can modify it.
- Again, what you get depends strongly on the CSP



Source: DPA

# Forensics in IaaS

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- Complete control over the VM – but not the host system!
- It's possible to install suitable tools and configure your system for forensic purposes
- What happens if you turn off the VM or cancel the contract?
- You still don't know the exact location of your data!

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Interesting: <http://blog.cloud404.com/2010/01/22/cloud-investigation-%E2%80%93-part-deux/>



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# Solving the Problem

## Forensics on Guest Systems

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- Possibility to create Snapshots, made by the system, not by the digital investigators
  - Do these Snapshots get admitted in court?
- Even if guest system is shut down, system memory is still there
  - Nice place for forensic investigations
  - But this depends on the VMM and postulates access to the host system
- **Conclusion:**
  - Basic approaches on digital investigations are possible, but you, and the court, have to trust the CSP.
  - Why should the CSP manipulate digital evidence?



# Solving the Problem

## Forensics on Host Systems

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- Firewall logs could be of interest ...
  - Neighbor-2-neighbor attacks
  - Network attacks in general
- System logs could be of interest ...
  - VMM: Privilege Escalation, Memory Corruption, ...
  - Covert channel attacks?
- But even if you have control over the host system, you have to trust the CSP
  - You still don't control the hardware!



# Solving the Problem

## A Theoretical Approach

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- **Fact:** Practical approaches on the forensic problem do obviously not work
- **Theoretical approach:** Uncloak the black box the CSP makes out of Cloud Computing environments by using a theoretical estimation approach
- Use modified Distributed Sensor Network (DSN) for gathering needed information and establish a Data Fusion Framework for enriching the collected data
- **Main goal:** Forensic identification and validation of computational structures in distributed environments – at least, the investigator knows *where* to begin the investigation

# Further Unsolved Forensic Aspects

Do current SLAs help in the Context of Digital Investigations?

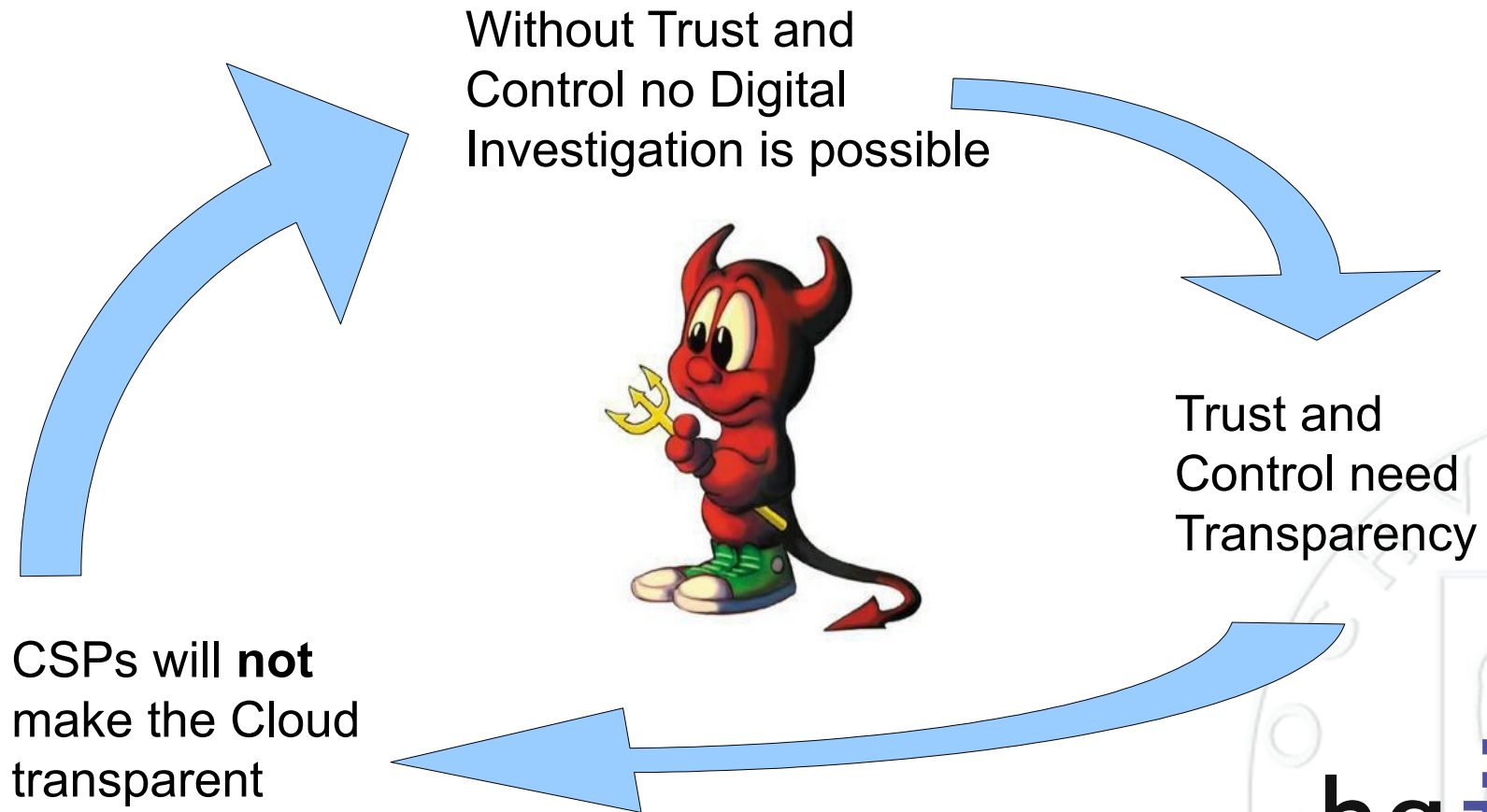
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- Is there any knowledge about what the CSP logs and how long he keeps this information? Does the CSP vouch for the integrity of the evidential data?
- If SLAs exist, they are mostly useless in the context of digital investigations
- Secure File Deletion: Used to not be an issue until the advent of Cloud Computing, however, who guarantees the customer that the sensitive data stored on a virtual machine has been deleted exhaustively?



# Future Problem of Cloud Forensics

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See: *Digital Trust in the Cloud - Liquid Security in Cloudy Places*

# Conclusion

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- The CSP obtains all the power!
  - If you cannot trust the CSP, leave the Cloud!
- Methods of digital forensics have to be revised and adapted to the new Cloud Computing environment
  - Will digital images (snapshots) be trusted by courts?
- CSPs should think about
  - giving the investigators the option of reconstructing the corresponding environment for recreating scenarios and test hypotheses.
  - offering customers physical hosts for solely usage.



# Thanks for Your Attention!

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