A Case Study in Teaching Forensic Computing

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Joint work with Thorsten Holz and Martin Mink

Motivation

- Digital investigations are becoming more and more common
- High demand for trained investigators
- No dedicated degree programme in Germany exists (apart from "standard" computer science)
- Apart from offering good practical training, we need to set academic standards (and then raise them)
- Research and education in forensic computing in Germany has a lot of potential

Online Master in Digital Forensics

- Joint project between Albstadt-Sigmaringen University, University of Tübingen, University of Mannheim, Pädagogische Hochschule Thurgau
- 2 years plus Master's Thesis
- Blended learning: 75% of course taught offline (good also for part-time students)
- Planned to start in 2009/2010
- For more information ask Steve Kovacs or me

Focus of This Talk

- Connect to other (German) researchers, professors and instructors
- Exchange experiences on teaching forensic computing, in particular
  - Experiences in writing investigation reports
  - Experiences in use of tools

Outline

- Overview of courses
- Definition of forensic computing
- First (2007) course: dead analysis
- Second (2008) course: mobile phone analysis
- Lessons learnt

Two Courses

- For students in computer science ("Informatik") or business informatics ("Wirtschaftsinformatik")
- **Forensic Computing** ("Forensische Informatik"), Summer Term 2007
  - Lecture with practical exercises
  - 30 students (4th year diploma)
  - Exclusively focused on forensic computing
  - Exercises: Dead (hard disk) analysis and live (honeypot) analysis
- **Hacking Lab** ("Hacker Praktikum"), Summer Term 2008
  - Lab course
  - 13 students (3rd year bachelor)
  - 30% of course on forensic computing
  - Exercises: hard disk analysis and mobile phone analysis

Other Courses in Germany

- Courses specialized on forensic computing:
  - RWTH Aachen (Dr. Dornseif), 2004
  - TU Chemnitz (Prof. Baumgartl), since 2007
  - FH Offenburg (Prof. Hammer), since 200?
  - FH Ingolstadt (Prof. Hahndel), since 2007
- Many other courses on security offer small parts on forensics

Definition of Forensic Computing

- ... discipline to reconstruct the events which lead to a security policy violation in an information system.

- Particularly interesting: Reconstruction based on **technically unavoidable evidence**
  - in contrast to evidence explicitly generated for reconstruction purposes
- Example: Traces of files in slack space of the file system in contrast to log file entries

Forensic Computing and Computer Security

- Goal: give students a **research-oriented** introduction into forensic computing
  - Not only a tool for the legal system
  - Also a tool for **understanding computer security** in general
- Understanding security failures is the basis for improved security in the future

2007 Course Overview

- Two lecture hours per week
- 12 weeks of course
- Three extra meetings to hand out and explain practical exercises
- Four invited talks by practitioners
  - Steven Wood (Alste), Andreas Körner (PwC), Andreas Schuster (Telekom), Knut Eckstein (ESA)
- Course material (including videos of lectures) available online

2007 Course Topics

1. Course overview: forensic science and digital evidence
2. Attack patterns and common computer crime; forensic mindset
3. Process models for forensic computing
4. Hard disk technology, imaging, integrity preservation
5. Disk volumes and disk partitions (DOS partition system)
6. File system analysis: Carrier's reference model
7. File system analysis: FAT
8. File system analysis: NTFS
9. File system analysis: ext2/3
10. Network, Internet, Application Forensics
11. Commercial tools and legal aspects
12. Theoretical basis: Carrier's hypothesis-based approach

Exercise 1: Live Analysis

- Paused VMware image of a Linux machine compromised in August 2003
- Source: Forensic challenge of the Honeynet project
- Required skill level: “intermediate to advanced”

Exercise 2: Dead Analysis

- Plan: Have students analyse "real" hard disks
- Role playing exercise: students are investigators and should prepare a report for a court case
- Bought about 50 hard disks on e-bay (1€ each)
- Question: Find out as much as possible about the prior owner!
- Students were free to choose tools

“Court Evidence”

Recommended Report Structure

- Following best practices:
  - Formalities: name of investigator, reference, etc.
  - List of evidence (e.g. serial number), documentation of chain of custody
  - Task description
  - Summary of evidence found
  - Details of acquisition process of evidence
  - Summary of used tools
  - Summary of implications of evidence found
  - Appendix: log files, screen shots, etc.

#	Manufacturer	Size (MB)	Reports and their size (in pages)
A	Western Digital	170	A1 (9), A2 (10), A3 (16), A4 (56), A5 (7)
B	Seagate	545	B1 (52)
C	Conner	412	C1 (13)
D	IBM	4330	D1 (19)
E	IBM	30700	E1 (14), E2 (13)
F	Conner	210	F1 (39), F2 (18)
G	Conner	420	G1 (65), G2 (48)
H	Seagate	545	H1 (14)
I	Western Digital	325	I1 (186)
J	Seagate	546	J1 (29)
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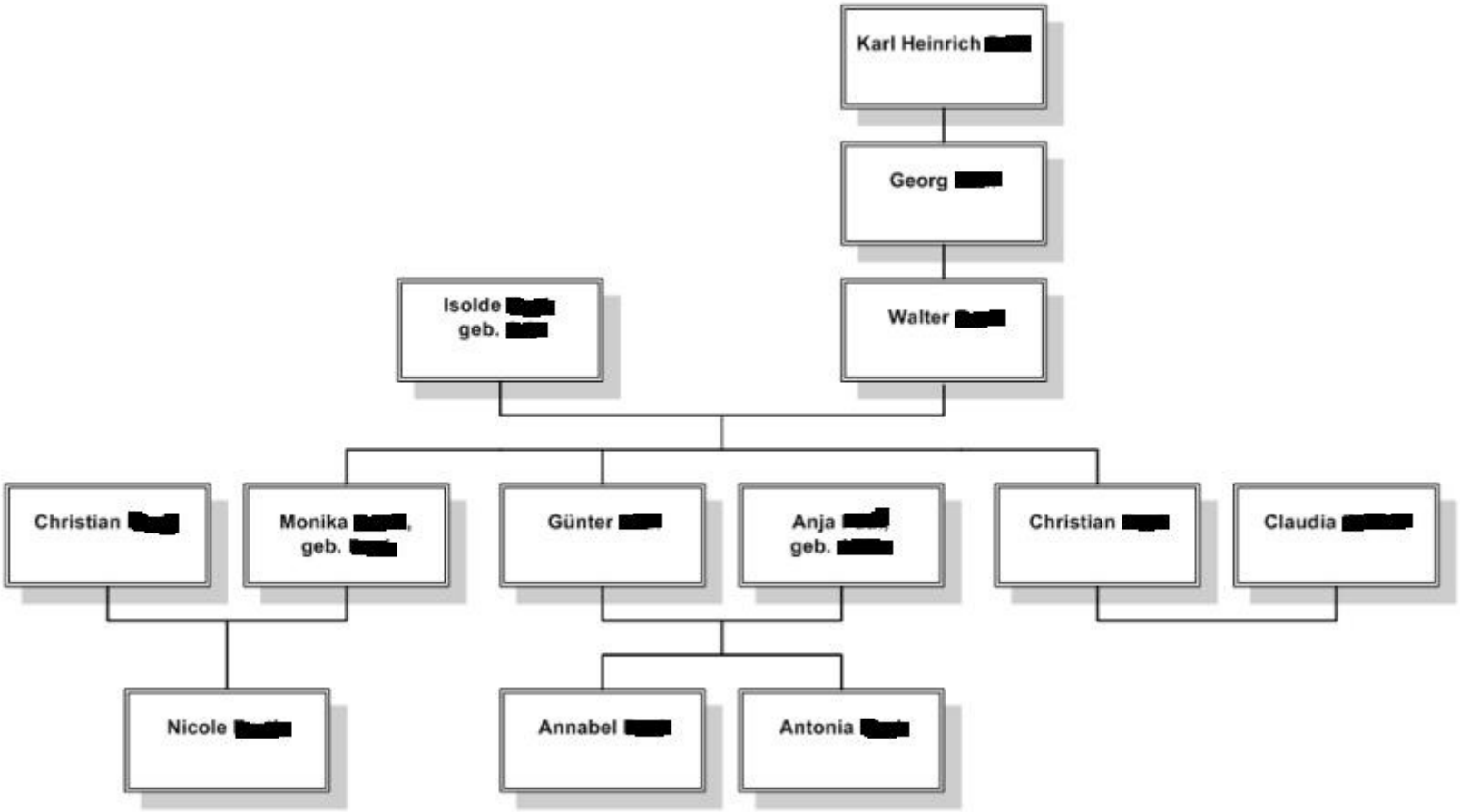
Highlight From Report M1



Interesting Points

- Students reverted mostly to open source tools like dd, Sleuthkit, foremost
  - Some used evaluation copy of FTK
- Students often used two independent tools to cross-check evidence found
  - Example: partition table extraction via mmls and foremost

2008 Course Overview

- Laboratory course ("Hacker Praktikum")
- Simulation of a CERT ("PCERT")
- Thirteen students formed four CERT teams
- All had to investigate the same incidents
- Incident types (examples):
  - Malicious website analysis
  - Malware binary analysis
  - Dead analysis of floppy and hard disks
  - Mobile phone analysis
- 30% of course devoted to forensic analysis

Mobile Phone Analysis

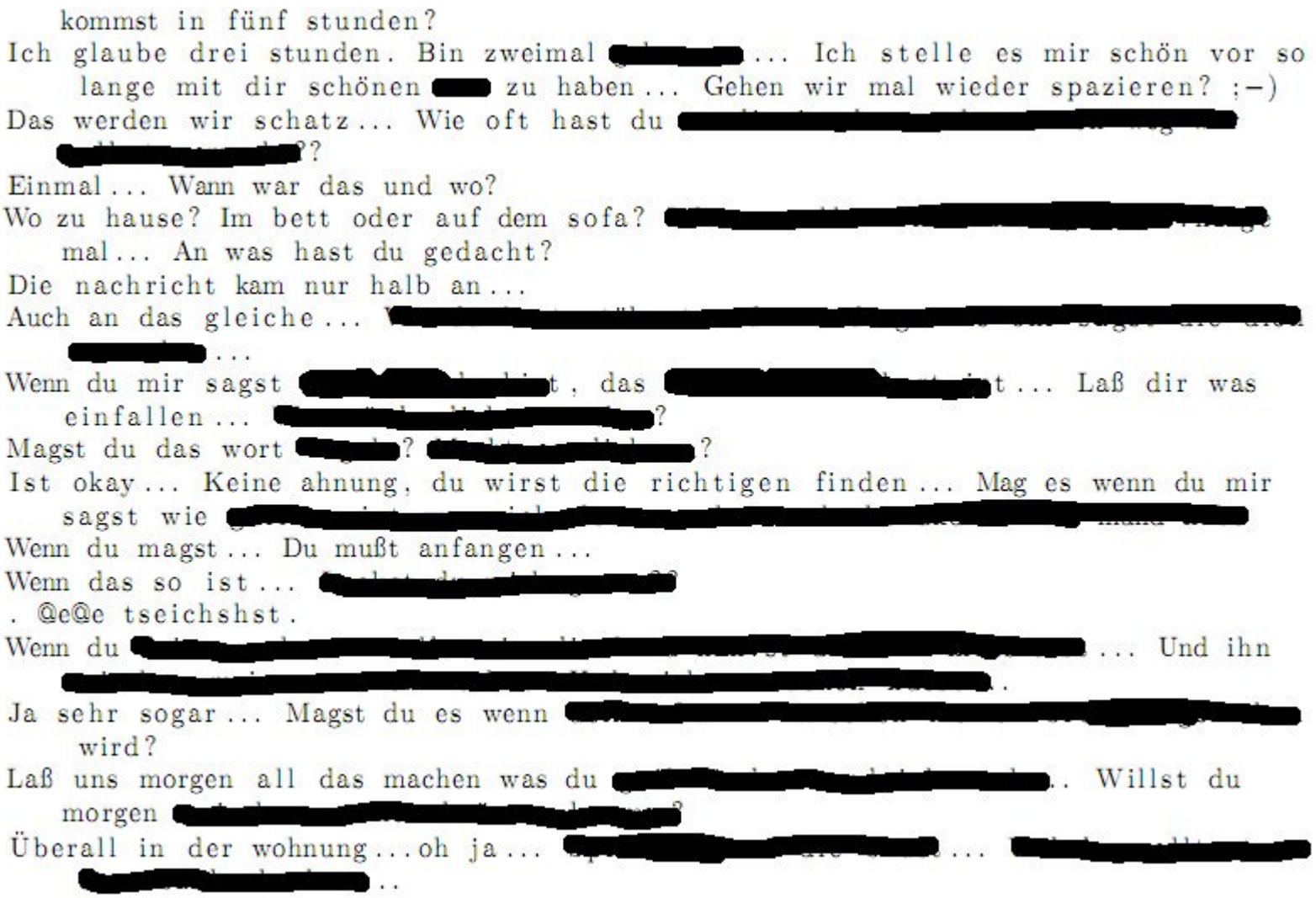
- Phones are prime sources of digital evidence
- Large portions of flash memory
- Need special hardware (twister box) to access memory
- Bought 10 mobile phones (mostly Nokia) for around 130 €
- 7 phones were analyzed

Interesting Points

- Phones contain standard file systems, but proprietary file formats
- All teams reverted to evaluation version of the commercial analysis tool Cell Phone Analyzer
  - Use a script to defeat random character obfuscation

Nokia 3510i

- Students were able to recover contact lists, dialed and received call numbers, received and sent SMS
- No pictures (no phone had a camera)
- Still a lot of interesting evidence ...


kommst in fünf stunden?
Ich glaube drei stunden. Bin zweimal [redacted] ... Ich stelle es mir schön vor so lange mit dir schönen [redacted] zu haben ... Gehen wir mal wieder spazieren? ;-)
Das werden wir schatz ... Wie oft hast du [redacted]?
Einmal ... Wann war das und wo?
Wo zu hause? Im bett oder auf dem sofa? [redacted] mal ... An was hast du gedacht?
Die nachricht kam nur halb an ...
Auch an das gleiche ... [redacted] ...
Wenn du mir sagst [redacted], das [redacted] ... Laß dir was einfallen ... [redacted]?
Magst du das wort [redacted]? [redacted]?
Ist okay ... Keine ahnung, du wirst die richtigen finden ... Mag es wenn du mir sagst wie [redacted]
Wenn du magst ... Du mußt anfangen ...
Wenn das so ist ... [redacted]
. @e@e tseichshst .
Wenn du [redacted] ... Und ihn [redacted].
Ja sehr sogar ... Magst du es wenn [redacted] wird?
Laß uns morgen all das machen was du [redacted]. Willst du morgen [redacted]?
Überall in der wohnung ... oh ja ... [redacted] ... [redacted] ..

Lessons Learnt: Tools

- Bias towards open-source tools in lecture
  - Most students started using Sleuthkit and foremost
  - 6 students then chose to use evaluation versions of FTK, because evidence could be extracted and analyzed "faster"
  - No real evidence to measure this aspect
- Open-source tools fail to help in specialized settings (like mobile phone analysis)
  - After first scans using strings and Hex editors, students quickly reverted to (evaluation versions of) commercial tools
- **Programming experience helped** students to circumvent restrictions of these tools

Lessons Learnt: Documentation

- Report structure lead to mostly good results
  - Chain of custody missing in most reports
  - Only half of the students documented their investigation environment
- Participants of second course had mostly followed first course
  - Documentation was much better
- Identified requirement of **quality control**
  - Documents need to be versioned
  - Authors responsible for parts should be clearly indicated
- Short "executive summary" for non-technical staff at beginning necessary
- Report should follow standard academic practices (like writing a term paper)

Conclusions and Open Questions

- Good evaluation (1.27 out of 6, standard deviation 0.44)
- We will teach course regularly in summer term (aimed at Master's degree students)

- How "legal" is the acquisition of dead data?
  - Who owns it? What can we do with it?
- Can we create disk images for future exercises that just "look real" but are artificial?

Contact

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