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Directors and Corporate Advisors’ Guide to Digital Investigations and Evidence

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Information Assurance Advisory Council

DIRECTORS AND CORPORATE ADVISORS' GUIDE TO DIGITAL INVESTIGATIONS AND EVIDENCE

PREPARED BY PETER SOMMER FOR IAAC

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Preface

As Chairman of the Information Assurance Advisory Council (IAAC), I am delighted to be associated with this Guide for Directors and Corporate Advisors written by Peter Sommer.

The nature of company assets is changing from purely tangible ones to include more intangible assets - knowledge, intellectual property, electronic processes, electronic supply chains, customer databases and electronic order books are just some examples. Indeed it can be said that in the information society, information is the single most important component of economic value. Companies are becoming dependent upon a complex web of globalised information infrastructures, without necessarily understanding or quantifying the risks. Organisations are therefore too often unaware of the level of their exposure and their vulnerability and do not have the know-how to reduce these risks or mitigate against potential abuse.

The knowledge and confidence to investigate and, if necessary, prosecute people engaged in computer abuse is a significant means of reducing risk. Effective detection and prosecution have a central role to play in deterrence. However, a complete approach to the problem also needs to address the many factors involved: employees need to know how their individual actions can affect computer security, computer policies need to be kept up-to-date and be well communicated, everyone in any organisation needs to appreciate the potential damage to brand value that can go well beyond the purely financial losses associated with computer crime.

IAAC's mission is to create a safe and secure information society for all. I see this present work as a significant contribution to that effort and I would like to thank Peter Sommer very much for his work.

Pauline Neville-Jones

Dame Pauline Neville-Jones
Chairman, IAAC

About the Author

Peter Sommer (peter@pmsommer.com) is Senior Research Fellow, Information Systems Integrity Group, London School of Economics where his speciality is the legal reliability of computers and he teaches the Information Security course.

His first degree was in law and in the course of a long professional career has carried out many post-incident investigations, acted as risk analyst for leading insurers and loss adjusters and acted as an expert witness in many leading criminal and civil trials involving complex digital evidence.

Case-work has included charges of high-value fraud, industrial espionage, defamation, theft of intellectual property, software counterfeiting and piracy, global computer misuse, large-scale distribution of paedophile material, multiple murder, narcotics trafficking and terrorism.

He is a former Parliamentary Specialist Advisor and sits on a number of Whitehall Advisory Panels. He is an external examiner at the Centre for Forensic Computing, RMCS Shrivenham.

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Executive Summary

If your organisation was asked to produce reliable evidence of what has happened within its computers, perhaps after a suspected crime or attack, or to resolve a legal dispute – how well would it respond?

Nearly all organisations underestimate how often they may be called on to produce reliable evidence of what has happened in and around their information and communication technology (ICT) systems. They also underestimate the demands that the legal system makes in terms of ensuring the admissibility and reliability of digital evidence. Both of these can have a profound impact on business welfare.

The detail of the problems that arise may be "techie", but the implications for the continued smooth running of the organisation require proper control from, and the full understanding of, the organisation's most senior decision-makers.

Evidence is required in a very wide range of circumstances, for example:

- in disputed transactions;
- in allegations of employee misbehaviour;
- to show compliance with legal and regulatory rules;
- to avoid charges of negligence or breach of contract;
- to assist law enforcement in criminal and anti-terrorist investigations;
- to meet disclosure requirements in civil claims;
- to support insurance claims after a loss.

"Computer forensics" is now an established set of disciplines and the very high standards in place for preserving material from personal computers creates high expectations of other forms of digital evidence, including those from large corporate systems and networks, across the Internet and the emerging families of personal digital assistants (PDAs), mobile phones and portable media units.

Unless the organisation has developed a detailed planned response to typical risk scenarios, much potential evidence will never be collected or will become worthless as a result of contamination. Moreover, during an investigation, the organisation will be constantly faced with a dilemma: lose business when essential systems are switched off so that evidence can be properly preserved; or be profoundly handicapped and incur losses because evidence cannot be produced.

What is needed is a forensic readiness plan.

The first part of this guide is directed at major decision-makers, corporate strategists and their senior advisers, including lawyers. It covers the following:

- **explaining the legal requirements of "evidence" and the problems of admissibility;**
- **showing the life-cycle of incidents and how evidence collection needs to be integrated into regular crisis management, incident response and litigation plans;**
- **showing the management planning, processes and disciplines necessary if an organisation is to emerge with the greatest possible range of options;**
- **providing a scheme for deciding the resources that will be required and when and how far requirements can be outsourced to specialist third parties.**

The second part of the guide is for those who will have to implement policy such as information security staff, computer security incident response staff and those tasked with dealing with the sharp end of an investigation. It offers essential background information, including:

- **techniques for evidence preservation;**
- **descriptions of the relevant laws of evidence and admissibility;**
- **disclosure, human rights and data protection issues;**
- **the limits of powers to carry out various forms of surveillance and investigation;**
- **the handling of obscene and paedophiliac material;**
- **points of contact in law enforcement agencies;**
- **pointers to further information;**
- **a glossary**

Lawyers called upon to provide detailed guidance will also find some of the technical material on types of evidence and methodologies for acquisition helpful.

Although this guide is designed for use within the United Kingdom and the descriptions of the law refer to English law, many of the principals are universal in all jurisdictions.

1 Introduction: the Need for Digital Evidence

Digital evidence is often highly volatile and easily compromised by poor handling. The chances of success in litigation or successful criminal prosecution by law enforcement agencies depend heavily on the availability of strong evidence. Failure in civil litigation means financial loss, including legal expenses; a failed criminal prosecution can also generate reputational damage to a victim. While many sensible organisations have arrangements in the event of fire, flood, failure of electricity and telecommunications services or acts of terrorism, very few have thought-through plans to identify, collect and preserve digital evidence in forms which will prove robust against testing in legal proceedings.

Yet demands for digital evidence are far more common than any of the subjects of conventional disaster contingency planning. Very few organisations have the management structures in place to enable them to carry out an efficient, cost-effective and low-impact digital investigation.

Following some of the major financial scandals of the late 1990s and the new millennium, new strands of legislation and regulation impose on businesses the requirement to produce and preserve a wide variety of business records. In the best known of these, the US Sarbanes-Oxley Act of 2002, there are explicit penalties for deliberate destruction of certain essential files. The Basel Committee on Banking Supervision Revised International Capital Framework of 2004(“Basel II”) requires companies in the financial services industry to conduct a broad risk assessment of those to whom it makes loans or in which investments are made[1]. The UK Combined Code of Corporate Governance applies to quoted companies and lists a wide range of compliance requirements, including operation issues and risk management[2]. An undercurrent to these and similar items of legislation and regulation is that material produced in electronic form is reliable. Forensic compliance services are already being set up to maintain reliable archives of essential business documents and emails, but their remit is limited. In the UK, the Freedom of Information Act 2000 states that all public sector bodies must supply requested information within 20 working days, and that such information has to be “reliable”.

This guide aims to help directors, senior managers and their legal advisers to understand the key strategic and management issues. It is designed to anticipate the need for provision of digital evidence and investigations by setting up management procedures, acquiring appropriate resources and identifying third-party sources of emergency assistance. For lawyers, it provides an overview of the types of digital evidence and the associated problems of probative value, admissibility and disclosure. But it is only a starting point – other, more specialist publications will need to be consulted while a detailed plan is formulated.

[1] Http://brief.weburb.dk/frame.php?loc=archive/00000141/

[2] Http://brief.weburb.dk/frame.php?loc=archive/00000147/

While the detail of collecting and analysing digital evidence is substantially a matter of deploying technical skills, success in doing so depends heavily on the level of careful pre-planning. As we will see, in the middle of an incident there are often important choices to be made between the proper preservation of evidence – which may involve shutting down central computer services for the duration – and the continuity of the business. These are decisions for the business's most senior managers, not computer technicians or hurriedly-hired external consultants. Again, if planning is poor, key personnel may find themselves being diverted into supporting investigatory and legal processes instead of running the business. The text and appendices to this guide will help to start the process of establishing a proper corporate strategy.

2 Digital Investigations and Digital Evidence

The triggers for digital investigations are not confined to the obvious cybercrime spectaculars which capture media attention. Far more common are relatively low-level events such as contractual and employment disputes which, if not handled properly, can still cause considerable direct and indirect losses to organisations. One or more of these events will happen to most organisations within any given year, and the triggers for these can include suspected, attempted or actual:

- **frauds perpetrated by employees or third parties;**
- **contractual disputes;**
- **allegations of breach of duty of care;**
- **email and Internet abuse;**
- **online defamation;**
- **employee disputes;**
- **sexual harassment;**
- **acquisition and storage of pornographic and paedophiliac material;**
- **theft of confidential data, data theft and industrial espionage;**
- **theft of source code and software piracy;**
- **unauthorised access by employees;**
- **unauthorised access by outsiders ("hacking") and unauthorised data modification (viruses, Trojan horses, etc.);**
- **theft of corporate computer resources for private exploitation;**
- **use of corporate computer resources to facilitate file-sharing which violates third-party intellectual property rights or are obscene or indecent;**
- **use of corporate computer resources as one stage in a complex criminal act and where a third party is the intended victim;**
- **failure of an organisation's computer systems, causing damage to third parties and giving rise to legal claims for breach of contract or in negligence;**
- **failure of an organisation's computer systems such that the organisation wishes to sue suppliers for breach of contract;**
- **extortion attempts, whether based on physical threats or logical attacks such as distributed denial of service;**
- **"phishing", where someone is induced to give away important confidential information to a fake website – businesses may either lose information in this way or find that their own website is being mimicked by phishers;**
- **denial of service and terrorist-motivated attacks; and**
- **insurance claims arising out of the above.**

Organisations can find themselves pulled into computer investigations against their will. In civil proceedings the other party is often entitled to demand disclosure or discovery of computer-derived materials. In criminal proceedings, even though the organisation may be a victim or otherwise a wholly innocent bystander, requests for disclosure from a computer system may be made by the defendant's legal team.

Attempts at investigation involving computers often fail because of mistakes made at a very early stage – essential digital evidence is ignored, destroyed or compromised and suspects are inappropriately handled. The very fact of having to start such an investigation can create a crisis within a victim organisation. The crisis then needs to be managed. These are some of the main questions that will need to be addressed and which we will be considering later:

- **To whom should initial suspicions be reported?**
- **Who runs the investigation within the organisation?**
- **Who needs to be involved?**
- **How should the investigation be carried out?**
- **What important procedures need to be followed?**
- **What are the characteristics of good evidence?**
- **What steps are necessary to identify "relevant" digital evidence – and once located, how can it be reliably preserved?**
- **What legal obligations exist during such an exercise?**
- **What may third parties be able to demand by way of "disclosure"?**
- **How can the investigation operate effectively without hindering day-to-day activities or promoting a crisis of confidence with greater potential for damage than the original wrong?**
- **How much external help is needed – and what kind?**
- **Do suspected crimes always need to be reported to the authorities?**
- **Once a suspicious incident has been reported, how should the relationship with law enforcement and the courts be managed?**
- **How does an organisation's senior management retain control of the agenda and direction of an investigation? And how does it relate this to its top-level obligations to keep the organisation's business functioning normally?**

The arrangement of this guide is as follows. First, it looks at the life-cycle of incidents and investigations: without an appreciation of organisational activity, planning is impossible. Second, it develops an understanding of the various overall management aims during an incident so that possible conflicts can be identified (and hopefully be resolved in advance).

Third, the likely risk scenarios that might face a specific organisation are identified. This process has something in common with traditional security and contingency planning analysis. The aim here is not to develop preventative or detective measures, but to elucidate the kinds of digital evidence that are likely to be required for each scenario.

Finally, the general characteristics of "good" evidence and the particular problems of handling digital evidence are considered, and the main types identified. These aspects inform us as to the standards that need to be strived for, and the traps that may snare an organisation if it fails to consider the types of evidence likely to be required.

With this groundwork, directors and senior managers should be in a position to devise a corporate plan of action that is specific to their organisation. This has to cover risk analysis, management aims, management structures (including appropriate reporting), core procedures and resourcing.

Throughout this guide, the more technical detail is omitted from the main narrative but appears in the second half as a series of appendices. This guide cannot give more than an overview of the issues as they apply to a wide range of generic organisations. Success will depend on the extent to which directors and senior managers take these ideas forward and adapt them to the specific needs and features of their own organisations.

3 Life-cycle of incidents and investigations

No two computer investigations are identical. However, the timeline (see Figure 3.1) gives an indication of the number, complexity and duration of typical corporate tasks that may occur, and for which a management framework is essential. The actual details may vary considerably. It is only possible to grasp the range and extent of management decisions that may be involved during and after a computer investigation by understanding the elements in the life-cycle.

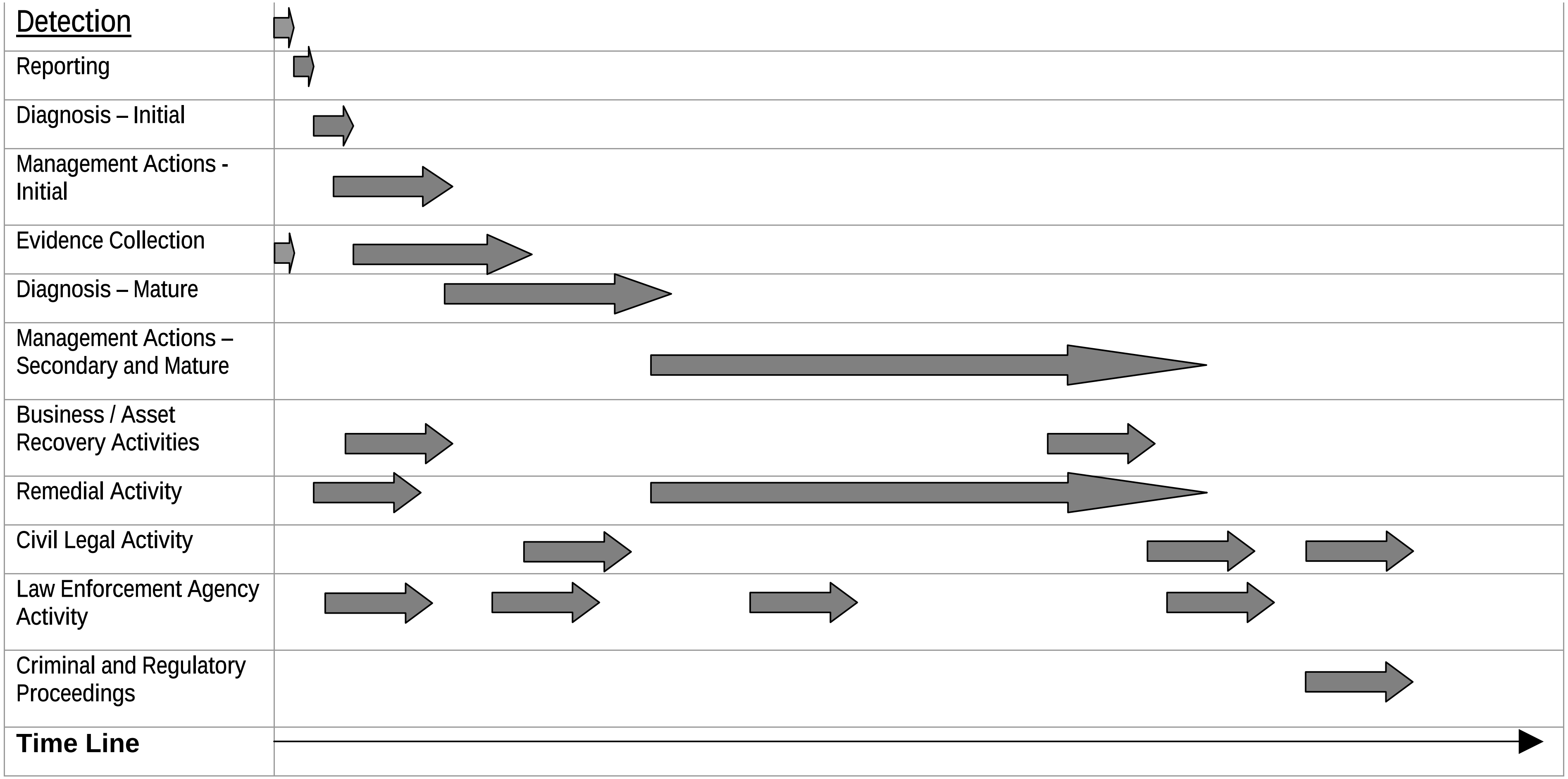
The following section concentrates on what happens in an "incident", but a number of the features in the timeline will also apply in other circumstances, for example, if there is an unexpected third-party demand that digital evidence of various types be produced. In practice, many of the tasks enumerated here will operate concurrently; for some there will be successive bursts of activity and inactivity (Table 3.1).

Table 3.1: Incident Lifecycle

Detection	Detection may be prompted by a dramatic event, such as the arrival of an extortion demand, obvious failure of major services. Or it could be no more than a suspicion triggered by anomalous behaviour.
Reporting	All organisations need a designated point to which reports can be made, whether corporate security, computer security, audit, the company secretary, human resources or a legal adviser. Although reporting is shown here as a single event, in practice the full extent of an incident may take some time to evolve, so there could be several reports. In addition, some reports will turn out to be false.
Diagnosis – initial	Whoever receives the report should have the skill, experience, resources and corporate clout to make an assessment of what may have happened and to provide initial guidance about how the organisation should tackle the problem.
Management actions based on initial diagnosis	At this point, the relevant executives will be informed and staff detailed to carry out specific tasks. This will usually involve setting up a special "taskforce".
Evidence collection	This is one of the most important early stages. It includes identifying likely sources of evidence, collection under controlled conditions and preservation.
Diagnosis – mature	Initial diagnoses are likely to be wrong. Evidence collection soon moves into evidence assessment, with a consequential effect on how the problems are perceived. Few crises are so purely computer-based that the only kind of evidence is obtained from computers. The ongoing process of diagnosis will take in evidence from and about individuals and businesses and paper-based documents.

Management actions based on mature diagnosis	As the nature of the problem becomes clearer, the organisation is able to define its objectives with greater clarity and certainty. Once the immediate risks to the integrity of information systems have been resolved, corporate aims will have a more long-term focus. In the timeline, “mature management action” does not cease until the very end, once lessons have been learned.
Business/asset recovery activity	If computer systems have been compromised, there has been some interruption to business, assets have been lost or some aspect of the crisis has become public, there will need to be a business recovery phase, similar to that after premises have been affected by fire or flood, or after a conventional theft. Experience from the established disaster recovery/business contingency planning industry suggests that full recovery always takes much longer than expected. Typical tasks include: restarting computer systems; recovering lost assets; and public relations.
Remedial activity	This includes learning lessons, preventing repetition, introducing new management and audit procedures, and new security engineering facilities.
Civil legal activity	This covers, for example, insurance claims, asset recovery, claims for damages, negligence, breach of confidence, etc.
Law enforcement agency activity	There may be several phases of law enforcement activity: initial enquiries; collection of statements and evidence; return visits for further interviews and search for evidence; preparation for trial; and attention to defence requests for disclosure.
Criminal and regulatory proceedings	A complex criminal trial may go through several phases, including committal and the substantive trial. Further information may be requested during the trial process.

Life-Cycle of Incidents



Detection

Reporting

Diagnosis – Initial

Management Actions - Initial

Evidence Collection

Diagnosis – Mature

Management Actions – Secondary and Mature

Business / Asset Recovery Activities

Remedial Activity

Civil Legal Activity

Law Enforcement Agency Activity

Criminal and Regulatory Proceedings

Time Line

4 Overall Management Aims

The type of events with which we are dealing here fall outside the mainstream activities of most organisations. The normal delicate balance of conflicting requirements within an organisation is placed at hazard whenever there is an unexpected crisis. What we are concerned with is not revenue or profit generation, but loss mitigation. A computer-related investigation is usually triggered by a crisis but can become one in its own right. Once an organisation decides to anticipate the problem there are issues about the adequacy of setting the right levels of resource. Against the risks of being unprepared are the risks of expenditure on facilities and personnel that may never be used.

Up to a point all crises, however set-off, have common features and can be handled through a common business continuity plan. So it may not matter whether a business interruption is caused by a fire, flood, terrorist action or telecommunications service failure – individual detailed business continuity plans for each of these scenarios would be very similar.

The first duty of an organisation is to survive so that it can continue to serve its customers and clients, meet its obligations to debtors, bankers, employees, the public at large and the state. In addition, commercial organisations are expected to generate profits for shareholders. Typical top-level aims during a crisis include:

- arranging for the organisation to continue with its main activities;
- rapid recovery to full operational status;
- recovery of any organisational assets that are at hazard;
- successful insurance claims;
- successful legal claims against third parties;
- meeting obligations to third parties;
- assisting law enforcement in potential criminal matters;
- realising the largest possible number of options for the organisation in terms of future action.

Not least of the difficulties is that, in computer investigations, management objectives may change as more is learned about what has taken place. In particular there will be significant conflict between the need for organisational continuity and the requirement to collect evidence reliably from the very machines that keep the organisation operating.

So, an organisation needs a management and executive framework within which crisis decisions can be made. Some key questions for consideration are as follows.

- To whom should initial reports be made?
- How is an emergent problem to be diagnosed?
- Who will assess the overall impact on the organisation?
- How will the organisation's main management be in a position to arbitrate the key decisions?
- Who will pursue in detail the investigation, the recovery, the liaison with third parties, the possible public relations impact, the legal aspects?

Many larger organisations already have contingency plans for fire or flood, bombing, kidnap or malicious tampering with a product, for example. But there are also a number of unique features, examined below, which will need to be addressed separately. Before describing the complexion of a planning team and its role within an overall management structure, the nature of the task that it faces needs to be appreciated.

Further, the organisation will need an executive resource. This may be an existing security or contingency planning unit or extensions thereof, perhaps even a completely new unit. Each organisation will need to make its own decisions according to its needs. Finally, there is the question of how extensive that resource should be: does it require its own in-house forensic computing expertise, or can it rely on third parties, or should there be a combination of the two? (These problems are analysed in detail in Appendix 9).

5 Risk Scenarios

The types of evidence that an organisation may need to collect and the methods that it uses to carry out the acquisition emerge from carrying out risk scenarios.

All prudent organisations develop their security policies on the basis of risk analysis. They collect data on the threats that their type of business might face and try to rate each hazard in terms of the frequency and cost of each potential incident. In regular security analysis, the outcome is usually a set of preventative and detective measures. In some instances, measures to mitigate damage and recover losses are added to these. The types of measures selected will include administrative changes, audit controls, the deployment of appropriate technologies, contracts for disaster recovery sites and insurance.[3] Usually it is not possible to produce risk analysis against precise financial metrics because of the lack of accurate actuarial data – and past a certain point, too much effort in risk analysis is counterproductive. However, informed approximations are extremely helpful. For example, the estimated annual costs of likely breaches of security can give a strong pointer to a prudent annual budget for security measures. Risk analysis is the essential precursor to sound, panic-free risk management.

But, as it is usually practised, regular risk analysis often fails to identify the types of evidence that could and should be captured. In addition, various lower level situations – for example, disputes about transactions or employment – fall below the horizon of conventional security analysis. So, it is desirable to review all the threat scenarios from the evidence perspective and how it will be collected and preserved to a sufficient degree. A scenario consists of starting with a likely triggering event and then playing out, as a paper exercise, all the likely consequences and possible reactions.

For example, consider a scenario for computer disaster recovery. An essential computer service goes down (due to one of various reasons: failure of hardware or software; a fire in the building; a distributed denial of service attack). Playing out the scenario tells an organisation how soon the business is unable to respond to queries, the point at which revenue streams become affected, how quickly existing emergency procedures will begin to offer prospects of return to normal working, and what losses will have been incurred in the meantime.

Existing risk scenarios as well as others need to be examined from the evidence perspective. This means being able to relate activities of potential interest to the computer resources on which the activities are being carried out, and developing an understanding of the files that are being created. For each plausible risk scenario an organisation should create documentation identifying the computer resources and associated files which are likely to be of interest. For example, most businesses are vulnerable to fraud, both from employees and third parties. To prove what has happened an organisation will need at

[3] See for, example, *Risk Management and Accreditation of Information Systems*, published by the National Infrastructure Co-ordination Centre (NISCC) http://www.niscc.gov.uk/niscc/docs/re-20050804-00653.pdf?lang=en

the very least the main transaction records, even if the *modus operandi* is not explicitly via a computer. If the activity is computer-mediated, access control logs, web logs and intrusion detection logs will be needed. In an employee dispute, emails, activity logs, telephone logs and access control logs may be necessary. But each business is unique and there is no substitute for doing the analysis for each plausible scenario.

It is beyond the scope of this guide to provide an exhaustive list of all the potential sources of evidence and their importance in every conceivable type of business operation. However, it is possible to identify certain baseline capabilities which the organisation needs to be able to develop. Many of these are existing records and logs, but the organisation needs to know precisely how to turn them into evidence which is unimpeachable in terms of reliability (see Table 5.1).

Table 5.1: Potential sources of evidence

Main transaction records	These include all purchases, sales and other contractual arrangements at the heart of the business.
Main business records	These include all of the above, but also all documents and data that are likely to be necessary to comply with legal and regulatory requirements.
Email traffic	Emails potentially provide important evidence of formal and informal contacts.
Selected individual personal computers (PCs)	If individuals are under any form of suspicion, the organisation will need to be able to seize their PCs and make a proper forensic "image", which produces a precise snapshot of everything on the hard disks (this includes deleted material which technicians may be able to recover).
Selected data media	Most computer users archive all or part of their activities on external storage media. These include CDRoms, Digital Video Discs (DVDs), floppy disks, tape, external hard disks and Universal Serial Bus (USB) thumbdrives. There needs to be a routine for identifying all of these and securing them, pending examination.
Access control logs	All but the simplest of computer systems require a password or authenticating device before allowing admission. Usually, these access control systems can be configured to maintain records of when usernames and passwords were issued, when passwords were changed, when access rights were changed and/or terminated. In addition, many systems also maintain logs of failed access. These logs, properly managed and preserved, are powerful evidence of tracking activity on a computer system.
Configuration, event, error and other internal files and logs	All computers contain files which help to define how the operating system and various individual programs are supposed to work. In the current generation of Windows systems, the most important set of configuration information is the registry. From this, forensic technicians can discover a great deal about recent and past activity, including recently accessed files and passwords. Often, there are important configuration files associated with individual programs. Many operating systems also generate error and other internal logs.

Internet activity logs	Individual PCs maintain records of recent web access in the form of the history file and the cache held in the temporary internet files folder. But many corporate networks also maintain centralised logs, if only to test quality of service and check against abuse. When properly managed and preserved, these logs are powerful evidence of activity on a computer system.
Anti-virus logs	Related to these are logs created by corporate installations of anti-virus software. These record the detecting and destruction of viruses and “trojans”. A common defence tactic is to suggest that suspicious behaviour has been caused by a rogue program; anti-virus logs often contribute to resolving such claims.
Intrusion detection logs	Larger computer systems often use intrusion detection systems as part of their security measures – they are intended to detect and prevent several forms of hacking. Producing such logs may help to identify perpetrators, or demonstrate that reasonable precautions have been taken to secure the system.
Back-up media	All computer systems need to have back-up procedures, if only to enable rapid recovery after a disaster. Some organisations back up their entire systems every 24 hours; others have in place a partial, incremental policy. Back-up archives are extremely important sources of evidence, as they can show if “live” files have been tampered with. They can also provide data which has been deleted from the “live” system.
Telephone logs	Private Branch Exchanges (PABXs) usually have extensive features for recording usage activity. There may be difficulty in using these in evidence; there are also significant problems associated with intercepting the content of conversations. However, these are potentially very important sources of intelligence and evidence.
Physical security access control logs	Many buildings control physical access by the use of swipe cards or other tokens. There may be additional facilities to deal with parking or to give access to particularly sensitive areas. There is usually a central control system which generates logs – this can be extremely useful in pinpointing individuals’ movements.

A useful distinction can be made between material which ought to be routinely collected and available, for example, in the form of regular audit logs and additional capabilities for in depth surveillance. Here, an organisation pre-identifies certain categories of evidence, has facilities and procedures for acquiring and collecting it, but only does so against a specific need. There are two main reasons for doing this: (1) there is little point in collecting vast quantities of data against a very limited need; and (2) it is very likely that the more intrusive forms of data collection will need to be justified in law against a proportionality test. So, depending on the circumstances, increased surveillance of, for example, web usage would need to be justified against reasonable suspicion of abuse. (The main legal issues are explored in more detail in Appendix 4.)

It is reasonably well-known that when computer data is deleted it is often readily recovered. This applies to varying degrees to data on the hard disks of personal computers, PDAs, file servers and large corporate machines. Substantial expertise in forensic digital data recovery now exists and can be applied both to substantive documents and to the various logs and configuration files mentioned previously. Data recovery is even possible if a disk has been reformatted and partially overwritten with a new “installation”. In forensic digital data work, some forms of recovery are trivially easy, whereas others may require high levels of skill and result only in data fragments, the precise significance of which may see some disagreement among experts.

For each item of desirable evidence, an organisation’s evaluation and procedures need to reflect answers to the following.

- **How will the evidence be acquired, physically and practically?**
- **How will the evidence be preserved, and how will continuity be demonstrated?**
- **Are there any legal obstacles, such as data protection, human rights legislation or compliance with interception legislation such as the Regulation of Investigatory Powers Act 2000?**
- **Will the material be admissible?**
- **Are there likely to be any problems over disclosure?**
- **Where an organisation has had to rely on forensic digital data recovery, will the results be unambiguous?**

The situations where these questions produce disappointing answers should prompt anticipatory action to be able to “cover” the position with more reliable sources of evidence. (Appendix 2 provides some detail on how various classes of digital evidence may be reliably acquired and preserved. Some of the legal issues are discussed in the next section.)

6 “Good” Evidence

Digital evidence must have all the attributes of other types of admissible evidence. Computer-derived evidence provides a number of challenges for the courts and for forensic procedures in general. To understand some of the issues it is useful to consider what “evidence” is in general terms.

Evidence is that which is offered before a court to persuade it to reach a particular view of events which may be in dispute. In general, evidence may be:

real – an object which can be brought to court and examined on the spot;

testimonial – the eyewitness observations of someone who was present and whose recollections can be tested before the court;

documentary – a business or other record in any form which, once its authenticity has been proved, can be examined for content;

technical – where a forensic technician has carried out some procedures on original “real” evidence and has produced some results. Technical evidence, in the eyes of the court, is not the same as expert evidence, which also includes giving opinions;

expert – the opinions of someone who is expert in a particular field and/or the conclusions of that expert after carrying out a specific investigation;

derived – a chart, video, etc. created from primary evidence to illustrate how certain conclusions might be drawn.

Evidence presented in court has to satisfy tests which fall into two main categories, admissibility and weight.

6.1 Admissibility

For evidence to be admissible, it must satisfy certain purely legal tests of acceptability. This tends to be a function of jurisdictions derived from the English common law as opposed to those based on European civil codes. The best known of the admissibility rules are:

the **“hearsay”** rule, which excludes reports of reports;

the **“fairness in evidence acquisition”** rule, which grants discretion to judges to exclude material obtained, for example, in violation of the codes of conduct in the Police and Criminal Evidence Act 1984 and Police Act 1997; and

the **“broad”** rule that exhibits including documents need to be produced into court by a human witness who can be cross-examined.

The actual rules are quite complex and have many exceptions. In the UK, intercepted data content can be used only for intelligence purposes – it cannot be admitted in evidence for a court to consider[4]. In the US the Federal Rules of Evidence help to define “admissibility” in that jurisdiction; US court decisions have produced special rules, not replicated elsewhere, to deal with the admissibility of novel scientific and technical

[4] Regulation of Investigatory Powers Act 2000, see also p. *nn* below.

evidence[5]. In most European countries, where criminal procedure is dominated by the notion of an examining magistrate, admissibility rules are either absent or informal, depending largely on a “relevancy” test.

6.2 Weight

Having satisfied the admissibility criteria, the evidence can be considered then for weight of fact – its persuasiveness or probative value. While in the final analysis “weight” is a non-scientific concept, there are a number of desirable features in non-testimonial evidence, that is, exhibits and documents of various kinds. These attributes include that an exhibit is:

authentic – specifically linked to the alleged circumstances and persons;

accurate – free from any reasonable doubt about the quality of procedures used to collect the material, analyse it (if appropriate and necessary) and introduce it into court. It has to be produced by someone who can explain what has been done. If a forensic method has been used it needs to be “transparent”, that is, freely testable by a third-party expert. In the case of exhibits which themselves contain statements – a letter or other document, for example – “accuracy” must also encompass accuracy of content. This normally requires the document’s originator to make a witness statement and be available for cross-examination;

complete – it tells within its own terms a complete story of particular set of circumstances or events.

6.3 Continuity of Evidence

Also known as “chain of custody” in the US, continuity of evidence refers to the ability to report everything that has happened to an item of evidence from the point at which it was acquired to when it is presented as an exhibit in court. Thus, for a knife found at a scene of crime, continuity would be established by means of police notes, photographs, “bagging and tagging” of the knife in a polythene bag with the number of the tag recorded, a witness statement from an exhibits officer, witness statements from each forensic scientist looking for blood, fingerprints, DNA, etc., which include references to handling the “bag and tag” as well as further witness statements from any forensic scientists instructed by the defence team. The process is designed to limit the opportunities for contamination or confusion, accidental or deliberate, or to pinpoint when contamination occurred. But there are also other elements which set computer-derived evidence apart, as follows.

6.3.1 Computer data can be highly volatile

[5] The *Daubert* tests – *Daubert* v. *Merrell Dow* 509 U.S. 579 (1993) provides the following tests: (1) whether the theory or technique can be (and has been) tested; (2) the error rate associated with the method; (3) publication in a peer-reviewed journal; and (4) whether the technique has gained widespread acceptance.

Many forms of conventional evidence are claimed to be a “snapshot” of a particular set of circumstances, but the problems are particularly acute with computers. This can create considerable difficulties over authentication as to the content and time of creation.

6.3.2 Alteration of computer data

Computer data can be easily altered without leaving any obvious trace that such alteration has taken place. Alterations in handwritten and typed documents are usually self-evident; log and account books are designed so that it is easy to detect whether an entry or page has been omitted. It can be argued that there are plenty of examples of forgery based on typed and handwritten originals, but computer-based documents can be forged with an ease and freedom from detection which is of a quite different order. It is of course entirely possible to design a computer system that thwarts certain forms of unacknowledged alteration. But, in contrast to, for example, paper-based accounts books, there are few obvious “standards” which set a measure of what to expect.

6.3.3 Changing computer material

As a result of the process of collecting it as evidence, computer material can be easily changed. Many forms of forensic examination run the risk of contamination. Biological samples from a subject can be intermingled with those of the examiner. But the problems with some computer-derived material are intense – the very act of starting up a computer or opening an application or file, even if there is no intention to alter anything, can create changes although they may not be immediately visible.

6.3.4 Reading computer evidence

Much immediate computer evidence is not obviously readable by humans. Actual exhibits are often derived, manipulated and “presented” away from their point of origin. This becomes apparent as soon as one moves from the limited vision of “computer evidence” as being simply a “record or document produced by a computer”. There is nothing wholly unique about this; the typical DNA trace exhibit is not DNA itself but a purported representation in a form which aids analysis. The particular problem in relation to computer evidence is that a large number of possible and potentially “accurate” representations of original computer data can exist. What is seized may be a computer disk which in turn contains large numbers of directories of files of various kinds, while what is put immediately before the court may be any of a number of purportedly accurate printouts or “screen dumps”. The large variety of possible representations of original material makes difficult the evolution of “standards” such as those existing for DNA charts, for example. And the possibilities for inaccurate representation are very much greater. Nearly always, computer-derived exhibits require that the court makes a chain of inference before reaching a conclusion.

6.3.5 Computers create evidence as well as record and produce it

Traditional, paper-based account books consisted of sheets of paper onto which handwritten or typed entries were recorded manually; subsequent calculations were also substantially manual, even if a simple calculator was employed for some of the stages. But in the computerised equivalent, it is only the original entries that are input manually – all the other "records" are produced by the computer. There are many examples where computers "assemble" documents, etc. and only do so at the point at which a request is made for the document to be created. This can be true of online requests as well as conventional printouts or on-screen reports.

6.3.6 The changing ICT landscape

The ICT landscape of hardware, operating systems, software, application programs, communications protocols and social and commercial infrastructures is in constant change. The vast majority of "forensic science" deals with underlying physical, biological and chemical situations which do not change, although over time new techniques for analysing them emerge. But in ICT, significant changes are to be expected even over a five-year period. The Internet as a consumer "product" is only 10 years old. Specialists in digital forensics have to cope with an unparalleled rate of change but still strive to work to the same standards of rigorous verification that are expected in the more traditional forensic disciplines.

6.4 Cyber-evidence in Practice

Computer evidence can consist of, among other things:

- **content** – of a file, typically, the words and figures in a document or report, images, designs within an application file, a database or selection, emails, webpages, files downloaded;
- **meta-data** – within certain files, that is, data about data which is not immediately viewable but indicates, for example, who created a file, how many times it has been edited and when it was last printed. Microsoft wordprocessing and spreadsheet documents may contain extensive meta-data;
- **directory data –** information about a file which is held in a system's storage media containing details of name, various associated date and time stamps, and size;
- **configuration data** – files and directory data which help a computer and/or application programs to behave in a particular way and which may provide evidence of how and when the computer was used. On a Windows PC, this includes material found in the registry;
- **logging data** – files created by application programs and operating systems which either record activity explicitly as in audit trails and online keystroke captures, or which can be used to attempt to reconstruct events, eg "history", "session" and "recent" files;
- **material from back-ups** – depending on the circumstances, any of the above;
- **forensically recovered data** – material obtained from storage media which would not normally be seen, eg undeleted files, files from slack space, swap files, caches, plus of fragments of any of the above;
- **eavesdropped data** – material obtained by placing a monitor across a telephone or network connection. This in turn divides into two:
  - **traffic data** – who called whom, when and for how long;
  - **content** – what was said;
- **expert interpretations** – based on any of the above in any combination.

These categories are not mutually exclusive.

6.5 Continuity of Digital Evidence

This encompasses the same underlying concepts as those for more physical types of evidence. Clearly, some types of "computer" evidence are physical objects – personal computers, disks, disk media, PDAs, mobile phones and so on – and these are bagged and tagged in the same way as the paraphernalia of street crime. Particular care may need to be taken with the storage conditions of computers, mobile phones and PDAs. Some gadgets need to be supplied with electrical power or their internal clocks (even data) may fail. Some media may be spoiled by proximity to magnetic currents or damp.

Evidence which is in electronic format can be demonstrated to be uncontaminated if at an early stage it has been subjected to digital fingerprinting (MD5 and similar tests) and the original digital fingerprint has compared successfully with the tendered exhibit.

But there is a further meaning to "continuity of digital evidence": most exhibits produced to a court are *derived* from material originally acquired, not the material itself. Often, at the very least it will be a printout of material originally found in digital form – there needs to be clear continuity on whether the printout is complete and reliable and who carried it out. To take the matter a little further: by itself an entire log file is indigestible; usually someone will have used software tools to look for patterns of activity that are thought to be significant. The same applies to any of the large databases that are usually at the heart of most commercial enterprise packages, which record orders received, goods despatched, send invoices and create a general ledger; it will only be selections from the database that are relevant. Again, a court is unlikely to be comfortable when presented with an entire PC; an analyst will have carried out searches for files and perhaps other patterns of usage. Continuity means that the defence team has to be in a position to trace back from the helpful *derived* evidence to the raw material from which it has been drawn. This is not only to ensure that the evidence has not been altered during processing, but also to establish that no mistakes have been made by the analyst or the tools deployed.

The issue can be illustrated by a brief look at an important technique used by law enforcement to trace the movements of individuals from the logs created by their Global Systeme pour Mobile (GSM) mobile phones. For a mobile phone to receive a call, the system has to know where the phone is at all times, so that it can send a signal to a transmitter mast close to the phone. Thus the system tracks the location of the phone (handset and base station exchange periodic brief signals) at all times even if no calls are being made. For mobile site analysis to work, reliable data is required from the mobile phone company to identify the phone (actually the Subscriber Identification Module or SIM card) by the base station and time; separate reliable data is required about the location of the base station; someone has to go and check the actual area covered by the base station (which may be affected by buildings, terrain, propagation) and successive readings; and data items must then be transferred to a geographic map to build up a picture of how the phone owner moved over the landscape. At each point there are opportunities for errors of transcription, processing and interpretation.

7 Devising the Corporate Plan of Action

By now it should be possible to identify the elements in a corporate plan of action in order to be able to respond to the requirements of producing digital evidence. Table 7.1 (below) provides an outline. As with any generic list, some items will be inappropriate for certain types of organisation and larger types of business may need to add further elements. Small and medium-sized enterprises may feel that the list is more sophisticated than they require; although they may lack such things as a "disaster recovery team" nevertheless this is a function that they need to anticipate. The table is divided into anticipatory measures, incident management measures and longer term measures. Some of the functions can be outsourced to third-party specialists – but careful decisions will need to made about which functions and their extent. It should also be borne in mind that at any one time there may be several "incidents" in play, operating on a variety of timescales.

Table 7.1: Outlining the corporate plan of action

Anticipatory Measures	
Risk analysis	The starting point is to identify the likely triggers for situations where evidence may be needed. These will include a number of the events almost certainly already identified during a conventional security risk analysis, but in addition should also include "lesser" events such as disputed transactions, employee disputes and breaches of contract (see Chapter 5 Risk Scenarios). A "frequency of occurrence" estimate for each would help to set priorities. A "cost of occurrence" calculation will need to include direct, consequential and reputational losses.
Desirable evidence analysis	For each event identified a list of potential desirable sources of evidence should be produced.
Available evidence review	The analysis should then be compared with what is actually available and deficiencies identified.
Assembly of key system documentation	In any unexpected event it is often helpful to have at hand key system documentation so that additional potential sources of evidence can be identified or additional monitoring introduced. The documentation may assist in explaining aspects of the system and services to third parties, such as investigators and the legal system.
Review of back-up, archiving procedures and facilities	Computer-dependent organisations usually only back up for the purposes of disaster recovery or regulatory compliance. But good back-up may also provide good evidence.
Evidence collection and preservation policy and specific guides	At this point it should be possible to produce a written policy for evidence collection and preservation, plus a series of specific guides to cover particular computer resources. The guides should have a similar status to disaster recovery plans, and be subject to periodic revision and testing.
Set up incident management team	It has to be clear who is supposed to do what and to whom they report. An incident management team will require resources (see below).

Review of employment contracts, etc.	The organisation may need certain additional powers to remove any ambiguity about its right to collect certain kinds of evidence as there is the potential for clashes with, for example, human rights and data protection legislation. Adjustments in contracts of employment and notifications regarding changes of policy may be necessary.
Identification of gaps	The above exercises will probably result in the identification of gaps in response. The urgent issues (defined from the risk analysis) will need swift attention; longer term matters can be put into a future programme.
Incident management measures	
Reporting point/first responder and procedures	This is the person or team to whom suspicions and fears or requirements to produce evidence are first reported. In an incident, this is the individual who will make the initial diagnosis. Every member of the organisation should be clear about to whom reports should be made. Those who receive such reports should have, among other things, excellent sober diagnostic skills. Quite often, initial fears may be exaggerated and all that is required is that information technology (IT) support is brought in for a remedy.
Incident management team	One of the key lessons from conventional disaster recovery management is that the main board of an organisation should not attempt the detail of response but, while maintaining supervision and ensuring adequacy of reporting, should delegate the task to a specialist team. Helpful advice about Computer Security Incident Response Teams (CSIRTs) can be found at http://www.cert.org/archive/pdf/03tr 001.pdf. Depending on the circumstances, this team may have strong links with existing security and contingency planning teams, although the emphasis may need to change. A typical team might include: • the head of IT; • the head of IT security; • links to the board/chief executive (if not already arranged); • a representative from corporate security; • a representative from human resources; • a representative from public relations; • a lawyer (internal or external); • a leader of specialist investigators/technicians (internal or external).
Role of top management	By implication, the role of the main management team may have, in addition to their regular duties, the following additional ones: • supervision of the emergency management team, including specific tasking, resourcing, performance; • assessment of diagnoses; • review of the implications for main business activities; • review of the implications for relationships with customers, bankers, the investment community, etc.; • review of any specific legal requirements and regulatory obligations thought to be at risk; • review of implications for employees and contractees, including the possibility of termination; • consideration of the need to report suspected crimes to the authorities, the nature of liaison; • supervision of insurance claims and asset recovery; • supervision of public relations issues.
Resourcing – internal	A tempting option is to consider having in-house forensic computing expertise. There will probably be no shortage of techies who would love to attend courses and buy appropriate kit. Specialist vendors who have

	to attend courses and buy appropriate kit. Specialist vendors who have concentrated mostly on law enforcement are now expanding their products into the corporate market. The problem for many individual organisations is that for most of the time they will have no need for forensic computing skills, but when they do, they may need very high levels of skill, and may also want it in quantity. Perhaps the best analogy is that of medical First Aid: all organisations of any size need a competent First Aider, some may be so large as to justify the employment of a few nurses and perhaps even a doctor. But very few need a permanently-employed surgeon. Thus, for most organisations, what is likely to be required is someone with a basic awareness of evidence collection issues and a knowledge of what specialist third-party suppliers can offer.
Resourcing – third-party contracts	If specialist skills are going to be required from third parties – and more often than not for most organisations this will be the case – it is better to know where they are going to come from and not rely simply on advertisements. Will the organisation need consultants for high-level strategic advice, good contacts with law enforcement and the regulatory authorities, investigatory skills or detailed technical support, and in what combinations? In terms of likely need, a review of the firms and individuals that are available, as well as their strengths and weaknesses, is essential. As with any purchase of third-party security services it is important to establish that the company has relevant experience (as opposed to simply having an impressive background in law enforcement or intelligence) and that it is trustworthy. It may be useful to contemplate a contract for services on a contingency basis: this enables the parties to evaluate each other and for the supplier company to have sufficient pre-knowledge of an organisation's IT infrastructure and internal culture to be able to respond promptly.
Asset recovery, loss mitigation issues	During any incident where there has been a loss, whether tangible or reputational, the organisation will want to have specific resources for recovering assets and minimising/mitigating other losses. This is a normal security function. The existence of good-quality evidence of the types and quantum of loss will assist.
Legal and law enforcement liaison	At a practical level it is important to designate a Single Point of Contact (SPOC) to deal with law enforcement requirements. This enables an organisation to track every contact with law enforcement and also simplifies the tasks of law enforcement investigators. The function is distinct from the role of a legal adviser – the SPOC will need to mediate and serve law enforcement and prosecutor requirements for access to specific evidence, background information and arrangements to interview individuals. The SPOC should be able to respond to requests for formal disclosure. Later, they may need to make arrangements for court appearances. In a civil case involving complex evidence, a technically-aware SPOC will be required to deal with lawyers and the needs of specialist expert witnesses (on both sides). The task of SPOC could be combined with that of first responder, as overlapping skill sets are required.
Longer term measures	

Programmes to address gaps in available evidence	Faced with the many issues surrounding provision of reliable digital evidence, most organisations will aim for an initial programme to meet the most urgent and obvious needs. Once this task has been achieved, any plan should be subject to periodic review and revision. Business functions and technical infrastructures tend to change significantly over time; in addition, new forms of IT-related crime become fashionable, causing a change in the requirements to produce evidence.
Improvements in overall system specification and management procedures to capture more potential worthwhile evidence	
Improved enhanced local evidence handling training	

8 Issues for the Future

Ten years ago the commercial, retail Internet was just beginning. There was almost no Internet-based e-commerce, no Internet-based e-banking, Google, Amazon and other commercial giants of cyberspace did not exist. Typical PCs had hard disks with capacities measured in megabytes, not gigabytes, and the Microsoft Windows family of operating systems had just been launched. Email was possible but existed in a series of silos dependent on the employer, or the "community" to which a person belonged, not as a universal standard. Even those relatively few UK homes that connected digitally to the outside world used dial-up – always-on broadband was a dream for the far future. Four years ago, digital cameras were an expensive gimmick; the hard disk-based miniaturised portable music and media player has been around for only two years.

It is obvious that these technological changes have brought about profound changes in everyday private and commercial life. And almost every one of them has created opportunities for new forms of crime, albeit often variants on existing ones. Ten years ago, almost no one was predicting a crisis for the music and film publishing industries prompted by easy, low-cost copying and distribution of their product. And only the very paranoid were predicting the extent to which individuals might leave large numbers of digital footprints of their activities.

For organisations and individuals that recognise the need to be able to capture digital evidence of important transactions and activities, the lesson is: today, whatever analysis you carry out and whatever measures you install, they will become rapidly obsolete. Not too far away on the horizon are ever-expanding amounts of personally-created data, ever higher speeds of data transfer, always-on portable computing, ubiquitous computing, remotely-located data stores protected by strong encryption and grid computing.

It would be a rash futurologist who made predictions at too great a level of detail. And that includes forecasts of how digital forensics might have to respond.

Appendix 1: Preservation of Evidence – Guidelines

The only area where there are well-developed procedures for seizing digital evidence relates to data on hard disk – disk forensics – where a number of organisations have published guides[6]. Many of them are similar to the *Good Practice Guide* of the UK's Association of Chief Police Officers (ACPO)[7], which has some useful principles.

> Principle 1: No action taken by law enforcement agencies or their agents should change data held on a computer or storage media which may subsequently be relied upon in court.
>
> Principle 2: In exceptional circumstances, where a person finds it necessary to access original data held on a computer or on storage media, that person must be competent to do so and be able to give evidence explaining the relevance and the implications of their actions.
>
> Principle 3: An audit trail or other record of all processes applied to computer-based electronic evidence should be created and preserved. An independent third party should be able to examine those processes and achieve the same result.
>
> Principle 4: The person in charge of the investigation (the case officer) has overall responsibility for ensuring that the law and these principles are adhered to.

The Guide goes on:

> Computer-based electronic evidence is no different from text contained within a document. For this reason, the evidence is subject to the same rules and laws that apply to documentary evidence.
>
> The doctrine of documentary evidence may be explained thus: the onus is on the prosecution to show to the court that the evidence produced is no more and no less now than when it was first taken into the possession of the police.
>
> Operating systems and other programs frequently alter and add to the contents of electronic storage. This may happen automatically without the user necessarily being aware that the data has been changed.
>
> In order to comply with the principles of computer-based electronic evidence, wherever practicable, an image should be made of the entire target device. Partial or selective file copying may be considered as an alternative in certain circumstances e.g. when the amount of data to be imaged makes this impracticable.
>
> In a minority of cases, it may not be possible to obtain an image using a recognised imaging device. In these circumstances, it may become necessary for

[6] See Appendix 8.

[7] Available at: http://www.nhtcu.org.uk

> the original machine to be accessed to recover the evidence. With this in mind, it is essential that a witness, who is competent to give evidence to a court of law makes any such access.
>
> It is essential to show objectively to a court both continuity and integrity of evidence. It is also necessary to demonstrate how evidence has been recovered showing each process through which the evidence was obtained. Evidence should be preserved to such an extent that a third party is able to repeat the same process and arrive at the same result as that presented to a court.

A proposed Standards for the Exchange of Digital Evidence from the International Organisation on Computer Evidence suggests a similar set of principles for the standardised recovery of computer-based evidence[8]:

- upon seizing digital evidence, the actions taken should not change that evidence;
- when it is necessary for a person to access original digital evidence, that person must be forensically competent;
- all activity relating to the seizure, access, storage, or transfer of digital evidence must be fully documented, preserved and available for review;
- an individual is responsible for all actions taken with respect to digital evidence while the digital evidence is in their possession;
- any agency that is responsible for seizing, accessing, storing, or transferring digital evidence is responsible for compliance with these principles.

Council of Europe Convention on Cybercrime

The Council of Europe Convention on Cybercrime of 23 November 2001 is the first internationally binding legal instrument with regard to the consequences of modern information technology for criminal law and procedure. Although the Council of Europe is a regional body, the Convention provides for a global framework for law enforcement in cyberspace; non-Member States of the Council of Europe such as Canada, Japan and the US contributed to the preparation of the Convention and accordingly signed and supported the agreement[9]. The Convention aims to provide harmonised definitions of various computer-related crimes, so that mutual cooperation and extradition can be expedited. Most jurisdictions require some equivalence between their own law and that of the country requesting assistance before they will grant an extradition request.

[8] For a G8 conference: http://www.ioce.org/G8_proposed_principles_for_forensic_evidence.html

[9] Chart of signatures and ratification of the Convention on Cybercrime: http://conventions.coe.int/Treaty/Commun/ChercheSig.asp?NT=185&CM=1&DF=09/07/04&CL=ENG. The Convention on Cybercrime entered into force on 1 July 2004.

The Convention also extends towards issues involving evidence, both in terms of warranting methods and actual procedures. With regard to electronic evidence, Council of Europe Recommendation No. R(95)13 concerning problems of criminal procedural law connected with information technology[10], adopted on 11 September 1995, states the following:

> Special procedures and technical methods for handling electronic evidence should be developed which ensure and reflect the integrity and authenticity of the evidence. Legal provisions on evidence relating to traditional (paper) documents should similarly apply to electronic documents. (Principle IV.13)

The Explanatory Memorandum to the Recommendation explains the difficulties of electronic evidence as opposed to paper documents:

> Among other things electronic documents can only be read by means of special hard- and software and they can be easily manipulated in such a way that the manipulation is not detectable by the eye. (Para. 152f)

The Explanatory Memorandum suggests different procedures for authentication of electronic evidence, as with the establishment of a complete chain of custody, from the person who first copied the data to the person who produced the printout for the trial, or the use of electronic signatures (para. 161).

The development of a harmonised approach in this matter at an international level is indispensable because IT offences are often cross-border in nature (para. 164). Otherwise, according to the Explanatory Memorandum, serious problems with regard to the admissibility of electronic evidence will continue to exist. (ISO 15489, the International Standard on Records Management, discussed below).

[10] Available at: http://www.coe.fr/cm/ta/rec/1995/95r13.htm

Table A.1 notes some of the more important standards and initiatives.

Table A.1: Standards and initiatives

ACPO	The *Good Practice Guide for Computer Based Evidence* is available for download from http://www.nhtcu.org. It is fair to say that its main focus is on disk forensics, PDAs and mobile phones as opposed to larger computers and networks but there are some useful general principles, an overview of legal issues, a glossary and a list of UK police contact points
US Department of Justice	The Computer Crime and Intellectual Property Section (CCIPS), Criminal Division, of the US Department of Justice provides a useful manual, available at: http://www.usdoj.gov/criminal/cybercrime/s&smanual2002.htm Obviously, the description of the law is for US readers. The overall CCIPS site contains many documents, press releases and links of considerable value to the researcher: http://www.usdoj.gov/criminal/cybercrime/ and contains references to the Council of Europe Cybercrime Treaty to which the UK is a signatory. There is also a *Guide for First Responders*: http://www.iwar.org.uk/ecoespionage/resources/cybercrime/ecrime-scene-investigation.pdf
Council of Europe Convention on Cybercrime	The Convention aims to harmonise definitions of cybercrime and procedures for warrants and evidence collection across international jurisdictions. It provides significant guidance on evidential standards. http://www.coe.fr/cm/ta/rec/1995/95r13.htm
Scientific Working Group on Digital Evidence (SWGDE) International Organisation on Digital Evidence (IOCE)	SWGDE was established in February 1998 through a collaborative effort of the Federal Crime Laboratory Directors. As the US-based component of standardisation efforts conducted by the IOCE, SWGDE was charged with the development of cross-disciplinary guidelines and standards for the recovery, preservation and examination of digital evidence, including audio, imaging and electronic devices: http://www.fbi.gov/hq/lab/fsc/backissu/april2000/swgde.htm
Internet Request for Comments (RFC)	Internet RFC 3227 provides the *Guidelines for Evidence Collection and Archiving* (http://www.faqs.org/rfcs/rfc3227.html). RFCs are one very important way in which Internet protocols and good practice are discussed and promulgated: http://www.ietf.org/rfc/rfc3227.txt
(Cyber Tools Online Search for Evidence) CTOSE	CTOSE is a research project funded by the European Commission. Its purpose is to gather available knowledge from different expert groups on all the processes involved in dealing with electronic evidence and to create a methodolgy on how to deal with electronic evidence that might occur as a result of disputed electronic transactions or other computer related and hi-tech crime: http://www.ctose.org/

ISO 17799	ISO 17799 is the International Standard for Information Security Management. It addresses many aspects of information security and internal controls, but also stresses the need for formal incident response procedures and tools. These procedures should cover: • analysis and identification of the cause of the incident; • planning and implementation or remedies to prevent recurrence, if necessary; • collection of audit trails and similar evidence; • communication with those affected by, or involved with, recovery from the incident; • reporting the action to the appropriate authority. The organisation that has suffered a security incident must collect evidence properly for three purposes: • internal problem analysis; • use as evidence in relation to a potential breach of contract, breach or regulatory requirement or in the event of civil or criminal proceedings, e.g. under computer misuse or data protection legislation; • negotiating for compensation from software and service suppliers. See: http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=33441&ICS1=35
ISO 15489/ British Standards Institute PD0008	International Standard on Records Management – standards for record-keeping in electronic form http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=31908&ICS1=1
Handbook of Legal Procedures of Computer and Network Misuse in EU Countries	2005 Project to update the EC Handbook of Legislative Procedures of Computer and Network Misuse. It will include a confirmation and review of the existing information, as well as collection of legislative information relating to the 10 new member states. http://www.csirt-handbook.org.uk

Appendix 2: Preservation of Evidence – Individual Procedures

Individual Workstations/Personal Computers

The aim is to make an exact copy of the hard disk(s) as soon as possible after the computer has been seized. The exact copy must include not only all the normally visible files but encompass all the sectors of the hard disk, even if initially they appear to be empty, so that any deleted data fragments can be recovered. Technicians and investigators must avoid contaminating the evidence so that what is produced is a detailed snapshot immediately prior to seizure. The process is called "forensic imaging".

To be carried out successfully this requires both appropriate technical products and following certain procedures. Each step in turn needs to be carefully recorded so that there is no opportunity for others to question the technician's skills.

There are a variety of software products. Retail "imaging" products are designed to assist recovery after a hard disk failure. For PC, products such as Ghost, Acronis True Image and Powerquest DriveImage (for Apple Mac, SubRosaSoft's CopyCatX II) may not be adequate in a forensic arena as they usually concentrate only on "live" files as opposed to data that has been deleted but are still resident on disk; some retail imaging products actually add data during imaging. *dd* is a reliable and flexible standard part of Unix operating systems and is completely free, although not easy to use. Most computer forensic practitioners use stand-alone products such as SafeBack or EnCase. The latter provides a complete disk forensics suite, including imaging. The professional products often contain in-built integrity checking, so that an "image file" (intermediate file which either can be directly examined or from which exact clones of the original can be made) can be verified against the original using "digital fingerprinting".[11] Not all imaging products can cope with all the disk operating systems that might be encountered and some versions of well-known products may fail to capture everything on a hard disk, which is why competent technicians need to be employed to carry out the work.

The first task is to ensure that, once the computer has been seized, the computer is not booted up normally as, under most modern operating systems, during the process fresh data will be written to disk, even if all that happens is that the computer is started up and then almost immediately afterwards shut down. To avoid this, usually a technician will remove the hard disk and install it in his own specialist workstation. The workstation will contain, among other things, specialist "imaging" software; a write-protect device so that the hard disk to be imaged can only be "read", not "written to"; and a further hard disk onto which the resulting "image file" can be stored prior to being backed-up to DVD and/or CD, tape or network store. In the case of a laptop or other computer where disk removal is difficult, the computer is started up with an alternative operating system from the floppy or CD drive. The special floppy or CD contains the imaging software and

[11] A complex mathematical calculation is performed on the contents of the original and then on the clone – if original and clone are identical, the product of the calculation will also be identical.

networking capability. The computer to be imaged is linked via a network or parallel cable to the technician's computer, which then takes charge of events and collects the image file over the network (or parallel) cable. "Network" and "parallel" imaging tends to be a lengthy process because of the slow speed of data along the cable compared with carrying it out disk-to-disk.

There are also specialist hand-held hardware devices which can carry out high-speed imaging of disks, once they have been removed from their computers. They are of particular value when time is of the essence, for example where computer downtime may incur extensive consequential loss.

In general terms, a PC that is seized in depowered mode should not be started up by anyone other than by a trained forensic technician. PCs that have to be seized while powered up will require careful consideration to decide the precise method; if the suspect is an ordinary user, a note of what is on screen and perhaps photographs of the screen, plus notes and photographs covering all cables, etc. connected to the PC is often sufficient. If the suspect is an IT specialist, where there is the possibility that "logic bombs" are already in place to destroy data wholly or partly, or where there there may be a link open to a significant remote computer, then it is essential to involve a trained forensic technician before any attempted seizure takes place, as there may be a variety of opportunities to capture essential evidence and avoid data destruction.

A further problem occurs where a larger "personal" computer contains several hard disks designed to work together in a "RAID" array. These are used mainly where very fast performance is required, as in an office server or in video-editing workstations. Usually, the disks cannot be imaged separately and specialist assistance is required to determine the best course of action.

In any event, the technician will make notes of what has been done, to be incorporated in a witness statement or exhibit later.

A further essential task for the technician is to check the "clock-time" on the computer that is being imaged. All computers have an onboard clock, sometimes referred to as the BIOS clock, from which the day and time stamps used by the computer are derived. It is important to establish how far the computer's clock-time diverges from the actual time, as this may have an impact on assessments of chronologies of events later.

Some software-based imaging products permit the technician to "preview" a hard disk of interest – that is, carry out an initial examination safely but without first having to make an image. This can save time by the early elimination of "irrelevant" material and is particularly useful when large numbers of disks have to be examined.

Most of the popular forensic analysis products available are for PCs running the Windows family of operating systems. Many of these products can also cope with Linux and some other Unix family operating systems. However, experienced forensic technicians often prefer to use Linux-based forensic tools to examine Linux-based hard disks. The Apple Mac family is relatively poorly supported by commercial forensic tools. EnCase "understands" the disk filing system but, at the time of writing, only one company, Black Bag,[12] provides specialist tools. Since Apple OS X is in fact underpinned by BSD Unix, it is possible to use Unix-based tools for imaging and analysis.

If a hard disk of any kind is found to be of interest, it should be properly sealed as a potential exhibit. If the owner of the original computer says that the hard disk contained essential working data, a clone of the hard disk can be made from the original onto a new hard disk which can then be installed in the computer; alternatively, key files can be exported to CD, DVD or external hard disk. Hard disks are now extremely low-cost and there is little excuse for not preserving original evidence. There may be circumstances in which some of the material found on a hard disk is such that it should not be returned to general circulation. Examples include indecent images, data subject to the Official Secrets Act and terrorism legislation and material which might prejudice a fair trial. In these circumstances it will be necessary to negotiate with the law enforcement agency for the release of essential but non-sensitive material.

Legal issues

Seized computers will normally be regarded as "real" evidence for admissibility purposes. However, the contents of individual documents (files) found on a computer may need to be admitted separately[13], particularly if more than one person has had routine access to that computer. Investigators also need to demonstrate that they are "authorised" to access the computers for the purposes of the Computer Misuse Act 1990.

In general terms, employers and their agents are normally "authorised" to access computers used by their employees, but this may be subject to a detailed examination of contracts of employment. Section 10 of the Computer Misuse Act 1990 protects law enforcement officers in the execution of their powers of inspection, search or seizure. Where computers are seized from professionals such as lawyers and accountants there may be issues of professional privilege (under Part 2 of the Criminal Justice and Police Act 2001 and associated codes of practice)[14]. Section 54 restates the rule that legally privileged material seized in a warrant must be returned. But it goes on to say that legally privileged material can be retained if it is "inextricably linked" to other material which is seizable.

Large and Medium Computer Systems

Traditionally, the courts have simply accepted the printout of reports and documents. In the UK police powers to obtain these in the course of a search are covered, among other places, under general powers of seizure in s. 19 of the Police and Criminal Evidence Act

[12] Http://www.blackbagtech.com/software.html

[13] For example, under the business records provisions in s. 24 of the Criminal Justice Act 1988.

[14] Actually an update of the Police and Criminal Evidence Act 1984, Code B.

1984. Section 19(4) permits “the constable” to require that information held in a computer is “to be produced in a form in which it can be taken away and in which it is visible and legible”.

But should an organisation not now be expecting the system to be “imaged” in the way that it is for single hard disks, so that defence experts are absolutely sure that they can run as many verification tests as they wish? Does an organisation have to make a forensic copy of the entire network of a large bank with a global presence and all its subsidiaries, just because an assistant manager in a UK branch is accused of fraud by colluding with customers over credit agreements and says that the computer is not accurately reflecting all the business transactions and queries made?

Often, it is not feasible to “image” or “clone” larger computer systems, so some form of selection will have to be made. In so doing, several things need to be borne in mind:

- the organisation needs to persuade a court that the output of the computer, taken as a whole, is reliable;
- the organisation has to show that it has captured the “complete” evidence in terms of the litigation being pursued, not just a selection favourable to its case;
- the evidence must be admissible.

In terms of the overall reliability of a computer system, the following elements in a witness statement may help to persuade a sceptical court:

- a description of the computer system's overall functions within the organisation;
- an account of how long the system in its present configuration has been in operation;
- what forms of testing took place prior to commissioning and what forms of routine audit are in place;
- what external factors exist to act as a check on reliability. For example, most accounts systems refer to transactions with other organisations and banks – failures in an organisation's own computer systems would soon produce complaints from counterparties. Third-party computer records may corroborate the records an organisation wishes to introduce in evidence;
- what security features exist and how they are managed – this is to anticipate a suggestion that incriminating material was placed there by someone other than the suspect;

In terms of the exhibit that is being produced, it is useful to be able to give the following:

- where it comes from:
  - is it in the form of a report that the computer regularly produces as part of its normal functions?
  - is it a regular audit or log file generated as part of the computer system's normal functions?
  - is it a regular back-up – if so, how far is it a "complete" back-up?
  - if the exhibit is the result of monitoring or specialised analysis to test initial suspicions, how was the monitoring set up?
- how the selection of evidence was made and why it can be regarded as "complete" in terms of the issues at hand;
- what procedures were used to collect the evidence such that it can be regarded as free from tampering;
- what procedures were used to preserve the evidence so that it can be regarded as free from subsequent tampering. This may take the form of imaging some computers or copying selected files to write-once data media such as CD or DVD, or making a digital fingerprint of the files;
- what manipulation or subsequent analysis was carried out to make the material "easier to understand" – this is a perfectly legitimate course of action, but in this event the original material should be exhibited so that the defence team can test the manipulation or analysis.

An organisation should be prepared for defence team demands for further disclosure so that they can test the overall reliability of its evidence and perhaps request further information from its computer system in order to test or prove assertions of their own.

Usually, admissibility of evidence will be on the basis that the material is a "business record" as defined in s. 24 of the Criminal Justice Act 1988; an "expert report" for the purposes of s. 30 of the same Act; or "real evidence". However, evidence may be excluded, for example if it has been obtained unfairly (judicial discretion under s. 78 of the Police and Criminal Evidence Act 1984), or in contravention of data protection or human rights legislation.

Corporate Networks

In addition, often it is not feasible to "image" or "clone" networks. Apart from the quantity of machines that would need to be imaged, if the evidence is to have real integrity, the entire network would have to go offline and be shut down for the duration. If this does not happen, then the images of each of the various constituent computers will be "snapshots" taken at different times – the data will not synchronise and corroborate. So, again, the form of selection will have to be made. In so doing, several things need to be borne in mind:

- the organisation needs to show that it has captured the "complete" evidence in terms of the litigation that it is pursuing;
- the evidence must be admissible.

An organisation will need to be able to justify the overall reliability of the network and the particular workstations and servers that it is submitting as evidence. The following elements in a witness statement may help to persuade a sceptical court:

- a description of the network's overall functions within the organisation;
- the network's topography – does it have one server, several servers or none? Are there any unusual features about the communications links?
- how the network is managed;
- what security features exist and how they are managed – this is to anticipate suggestion that incriminating material was placed there by someone other than the suspect;
- how long the network in its present configuration has been in operation;
- what forms of testing took place prior to commissioning and what forms of routine audit are in place;
- what external factors exist to act as a check on reliability. For example, most accounts systems refer to transactions with other organisations and with banks – failures in a business's own computer systems would soon produce complaints from counterparties; third-party computer records may corroborate the records you wish to introduce in evidence;
- what can be said about the reliability of the constituent elements of the network – operating systems, software, hardware;
- compliance with any external good practice or system audit standards.

In terms of the exhibit that is being produced, it is useful to be able to say:

- where it comes from:
  - is it in the form of a report that the system regularly produces as part of its normal functions?
  - is it a regular audit or log file generated as part of the normal functions?
  - is it a regular back-up – if so, how far is it a "complete" back-up?
  - if the exhibit is the result of monitoring or specialised analysis to test initial suspicions, how was the monitoring set up?
  - is a complete image being provided of key workstations and servers?
- how the selection of evidence was made and why it can be regarded as "complete" in terms of the issues at hand – why it was considered safe to exclude other potential sources of evidence? Particular regard should be given to the position of servers;
- what procedures were used to collect the evidence such that it can be regarded as free from tampering;
- what procedures were used to preserve the evidence so that it can be regarded as free from subsequent tampering. This may take the form of imaging some computers or copying selected files to write-once data media such as CD or DVD, or making a digital fingerprint of the files;
- what manipulation or subsequent analysis was carried out to make the material "easier to understand" – this is a perfectly legitimate course of action, but in this event the original material should be exhibited so that the defence team can test the manipulation or analysis.

As always, an organisation should be prepared for defence team demands for further disclosure so that they can test the overall reliability of its log evidence and perhaps request further information from its computer system in order to test or prove assertions of their own.

In the last two years products have begun to emerge which allow for workstations to be remotely monitored and imaged across a corporate network. The most mature product appears to be EnCase Enterprise Edition (and ProDiscover Professional). These new products require that each workstation to be monitored has a small "servlet" program installed on it. The monitoring takes place from a specially designated workstation and the servlet on each monitored workstation accepts commands from it. Communications between the monitoring and monitored workstation run across the corporate network, but encrypted. The hard disk on the monitored workstation becomes "write-protected", just as it would during a conventional examination, so that the process should be free from contamination by the examiner.

Although this approach seems very promising it has yet to be tested fully in the courts and there may be practical problems such as the time taken to image. For any organisation considering the deployment of remote monitoring or imaging, in addition to the costs of the software licence, significant funds will need to be set aside for the related training and development of appropriate procedures. There will still be problems of selection of material and anticipating how a defence expert might test it – or the defence team complaining that their expert is not able to conduct a realistic test and that as a result the evidence should be excluded.

Legal Issues

Admissibility of evidence will be on a similar basis to that for material obtained from large computer systems: that the material is a "business record" as defined in s. 24 of the Criminal Justice Act 1988; an "expert report" for the purposes of s. 30 of the same Act; or "real evidence". However, evidence may be excluded, for example if it has been obtained unfairly (judicial discretion under s. 78 of the Police and Criminal Evidence Act 1984), or in contravention of data protection or human rights legislation. Where remote monitoring has been used, there may be arguments which suggest that a interception for the purposes of the Regulation of Investigatory Powers Act 2000 has taken place. In any event, in a corporate environment employees will need to be have been forewarned that their computer use may be subject to monitoring of various kinds.

Email

Copies of emails may be found on the personal computers of the sender, the recipient and on one or more email servers. For each of these, copies may exist in archived back-ups. If either the sender or recipient uses a mobile device such as a mobile phone or PDA, copies may exist there as well. Obviously, a simple printout of an email is better than nothing, but because of the ease with which a wordprocessor can be deployed to alter or fake an email, a more sophisticated approach is required.

The key to securing reliable email evidence within an organisation is to know how the specific email service works – in particular, where copies of emails are likely to be stored. It is not unusual for suspects to attempt to delete emails from their local machine – hence the importance of being able to locate alternative copies. Clearly, each further copy of an individual email that is discovered provides greater levels of corroboration, and hence authenticity.

Usually, emails sent over the Internet or using internet-like protocols have "headers" associated with them, which are normally suppressed when viewed through a regular email client program[15], which contain information about where the email originated and what route it took to the recipient. This information, though it can be forged or spoofed, can be used to provide a level of authentication.

Email programs can be divided into two types: client programs, which are found on the PCs of those who send and receive email; and server programs, which act as a hub for email exchange between individuals within a business and also mediate the relationship with the outside world. Client programs include Microsoft Outlook and Outlook Express, Eudora and Thunderbird. Server programs include Microsoft Exchange, FTGate, MailTraq and IBM/Lotus Notes (although this last has a number of additional functions).

[15] In Microsoft Outlook Express, for example, the headers can be viewed via right-clicking and selecting "Properties".

The emails themselves are stored in files associated with the email application – a forensic technician needs to have a knowledge of which files are important and where they are located. Attachments to emails may be stored elsewhere, in another directory on the disk. In the simpler older products, often the email files can be read directly using a text editor, but in more modern products such as Outlook and Outlook Express, the emails are held inside a structured database and can be read only from within the email program or a specialist utility. Email server programs also store messages within specialist databases. The advantage of the structured database is that it then becomes easy to carry out sophisticated searches for individual emails, by sender, recipient, subject, content, date and so on. In addition, the fact that each email is within a structured database makes tampering with the content of individual emails more difficult.

One disadvantage is that the set of emails within a database may contain material that is wholly irrelevant to the litigation and which is subject to data protection or human rights legislation, is commercially sensitive or covered by legal privilege. In these circumstances it may be necessary to arrange for an independent third party to have formal supervision of the files, along the lines of what is done in civil search orders or under Part 2 of the Criminal Justice and Police Act 2001 and associated codes of practice.

Some email services are presented via a web interface. For individuals, there are services such as Hotmail, Yahoo and Gmail, and many large ISPs offer a web-based service so that their customers can access email when away from their usual base via someone else's computer or an Internet café. Similar web-based email services can be offered by large organisations for their staff based on corporate email servers – Microsoft Exchange can be set up in this way, for example. In those circumstances the participants' PCs will not maintain a permanent record of emails sent and received. However, for recent emails, a computer forensic technician may be able to retrieve copies from the "temporary internet files" folders (also known as the cache).

Legal Issues

There are some general restrictions on employer surveillance of employees and these apply to emails, phone calls and web browsing, among others (they also apply to the use of closed circuit television) (these are considered in Appendix 4).

Once these hurdles have been overcome, emails obtained from a PC may be admissible either as "business records" or as "real evidence" but there has to be a basis for them to be lawfully obtained in the first place. As far as PCs are concerned, the computer owner or another authorised person has to give permission, otherwise there may be an offence under the Computer Misuse Act 1990[16]. Further, this would produce the inevitable argument that information obtained in an unauthorised fashion should be excluded under s. 78 of the Police and Criminal Evidence Act 1984. It is likely that emails obtained from servers will be admissible as "business records". However, if the server

[16] There may be explicit or implied authorisation under an employee's contract of employment. In addition, it is possible to seize a computer under a warrant.

contains emails which have yet to be delivered to their destination, those emails might be regarded as passing through a communications medium and thus be subject to the Regulation of Investigatory Powers Act 2000. So, part of the skill of looking for email evidence is to avoid those potential sources of emails which might be rendered inadmissible.

Statements producing email exhibits will need to cover the following:

- where the email has come from a client program installed on an individual PC – the identification of the program and the steps taken to capture and preserve the supporting files;
- where the email has come from a server program – the identification of the program and the steps taken to extract and preserve the supporting files; whether this is simply a subset of the total email data available and what basis was made for the selection, whether a larger subset is available against appropriate defence team request;
- in the case of a server program – what security features exist and how they are managed (this is to anticipate a suggestion that incriminating material was placed there by someone other than the suspect);
- compliance with any external good practice or system audit standards.

Personal Digital Assistants

Despite their small physical size, PDAs are often substantial PCs in their own right. They hold personal data, diaries, documents and often emails. Increasingly, portable phones and PDAs are converging.

In terms of capturing evidence, there are a number of choices. Ideally, like hard disks PDAs should be “imaged”. As with evidence from hard disks and other data storage media, it is important to be able to demonstrate that the process of collection has not caused the data to be modified. Just as with conventional PCs, in some instances the mere act of “just having a look” may cause data alteration. PDAs often contain two sorts of memory: internal and external. The external is usually on a card – Compact Flash, Secure Digital, etc., and this presents relatively few problems as the cards can be removed and read. But the internal memory cannot be removed easily or read without somehow powering up the PDA. Furthermore, some PDAs lose data if their internal batteries are not kept charged up. If a PDA is to be regarded as prime evidence then advice should be sought to ensure that critical data is not lost after seizure and before a case comes to trial.

Specialist forensic tools have emerged. At the time of writing, Paraben seems to have the best regarded collection, although EnCase also offers some facilities. In addition, there are some “free” or Open Source utilities such as *pdd?* for Palm[17] and OSImage and Dumpprom for Pocket PCs. Precise technical procedures vary between PDA “families”. In the Palm family there is a hidden command which puts the Palm into “console” mode, whereas Pocket PCs have to be imaged via the “ActiveSync” program. Because of

[17] Http://www.grandideastudio.com/portfolio/index.php?id=1&prod=17

the many opportunities to make mistakes, technicians are advised to provide fuller than usual contemporaneous notes.

Depending on the circumstances, it may be necessary or appropriate to use a lesser technique for capturing essential information. The large PDA families, Pocket PC and Palm[18], have achieved their popularity in part from the ease with which information can be shared between the portable device and a PC, capturing the PC files (Palm terms this "Hotsyncing" and PocketPC terms it "ActiveSync"). However, not all information on the PDA is copied to the PC. The safest route is to secure the PDA and await proper imaging by trained personnel. Detailed technical advice has been produced by US National Institute of Standards and Technology[19].

Legal Issues

These are similar to those regarding PCs. In admissibility terms the entire PDA is "real evidence". However, there are significant hurdles in terms of getting full legal access to a PDA where the owner does not want to cooperate and the PDA is personal property, not that of the business. Unauthorised access may be a criminal offence and there may be data protection and human rights issues.

Other Storage Media: Cameras, Thumbdrives, Media Players and Other Portable Media

The physical size of media in relation to the amount of data held continues to plummet, as does the variety of devices upon which they can be found. Digital camera media, Compact Flash, Secure Digital, etc. can hold any kind of data, not just photographs. At the time of writing, USB "thumbdrives" with a capacity of 2Gb cost under £100. In 2000 most laptop computers had hard disks with less capacity. 2Gb is also equivalent to three fully-filled CDRoms. Many portable disk drives and music players, with typical capacities of 20Gb and priced well below £150, are capable of being secreted in a modest-sized pocket. Only the most careful examination of a computer will reveal whether any of these devices have ever been connected to it. Yet a company's entire financial records, list of customers, research and development programme can be secreted easily even on a 2Gb capacity. The same goes for 100,000 web-sized photographic images.

Most of these classes of media operate in a similar fashion to hard disks in that often, deleted data can be recovered. So, it is important that any devices suspected of holding data relevant to an incident or investigation are seized and properly imaged.

Legal Issues

[18] Some PDAs also use a version of the Linux operating system.

[19] *Guidelines on PDA Forensics*, available at: http://www.iwar.org.uk/comsec/resources/nist/pda-forensics-sp800-72.pdf

The main legal issue in a corporate, non-law enforcement inquiry is that the devices may be the personal property of a suspect and there may be no immediate and timely basis upon which they can be seized.

Telecommunications data and content

There are a modest number of practical problems in gathering telecommunications data and content from corporate sources, but these are dwarfed by the legal hurdles.

Analogue Telephony

This covers conventional telephone calls taking place on or through corporate switchboards (PABXs). Such switchboards routinely provide data about the numbers called and the time and duration of calls. They do so in order to monitor costs for external calls and to check on service quality in respect of internal calls. The logs produced can be of considerable value in many kinds of investigations. To capture the contents of such calls a recording device – tape or disk – is placed across the relevant lines. Some businesses routinely record phone calls as a check against disputed transactions, or to see whether their employees are misbehaving.

In a forensic situation, the immediate and important issue is to be able to demonstrate that the logs and/or recordings are reliable and have not been tampered with. For the logs:

- it is helpful to be able to say something about the specific PABX and what logging facilities exist;
- there should be some statement about how they were collected, by whom, what precautions were taken, and how selections of data were made;
- once taken, they should be subjected to some form of integrity check, such as MD5 digital fingerprinting, as a guard against post-capture tampering.

For voice monitoring:

- it is helpful to be able to say something about the specific facilities used;
- there should be a statement about what precautions against partial capture were taken and how selections of conversations were made in terms of counterparties, periods of time and so on;
- once taken, the logs should be subjected to some form of integrity check, as a guard against post-capture editing.

The real difficulty is establishing a legal basis on which to carry out the monitoring of internal telephone communications data and content (this is reviewed below and in Appendix 4).

Companies and private individuals can request from their telephone companies copies of their own past telephone bills and detailed call records. Since this is their own personal data there is no conflict with data protection legislation. In practical terms, and because telephone companies must comply with a telecommunications directive (Directive 97/66/EC of the European Parliament) not to hold personal data longer than is necessary for business purposes, call records for earlier periods may not be available. Most telecommunications companies will make a charge to supply historic information.

Data Traffic

There is little practical difficulty for an organisation to monitor data traffic on its own internal networks. In effect, one or more network cards are set up in areas of high traffic flow and instead of just listening for packets of data specifically directed at the associated workstation, all the passing data is collected (putting the card into "promiscuous" mode) and then filtered according to various criteria. Such facilities are used regularly to monitor the quality and load of data traffic on a network and to carry out a variety of technical diagnostics. In the situation of an investigation it is trivial to switch such facilities to monitoring activity by workstation, user identity, email name or the occurrence of specific words. Forensically, the technical issues to be covered in a witness statement include the following:

- can the organisation provide a brief technical description of the monitored network?
- can the organisation identify and describe the technical facilities, hardware and software used to carry out monitoring, including the location of the monitoring points on the network?
- can the organisation describe and provide the raw logs that were generated during the monitoring, and say how it preserved them?
- can the organisation describe any post-capture processing that was carried out to analyse the logs and produce more understandable derived exhibits?

In certain circumstances some organisations may be unwilling to be wholly candid in revealing all about their internal networks. In that event, careful calculations need to be made of the balance of advantage in refusing disclosure requests (with the possible result that crucial evidence is disallowed) and the chances that litigation or prosecution may fail.

Legal Issues

As with the surveillance of internal telephone calls, the real difficulty is establishing a legal basis on which to carry out the monitoring of data activity (this is reviewed below and in Appendix 4).

Subject to obtaining appropriate authorities and warrants, law enforcement and other government agencies have access to material from public telecommunications businesses which include land-based telecom companies, mobile phone companies and ISPs.

The main law is the Regulation of Investigatory Powers Act 2000 (RIPA 2000). Briefly, this makes it unlawful to intercept any communication in the course of transmission without the consent of one of the parties or without lawful authority. English law is unusual in that it makes a distinction between interception of communications or traffic data (who called who, when and for how long) and content (what was said). Traffic data also includes location data such as where a mobile phone company holds records on which specific base station a given mobile was registered at any one time. Some data held by ISPs or collectable by them is also classified as "communications data". Warrants for interception of content can be issued only by the Home Secretary and are subject to various criteria, which include "the interests of national security", "for the purpose of preventing or detecting serious crime" and "for the purpose of safeguarding the economic well-being of the United Kingdom". The Home Secretary has to be convinced that such interception of content is necessary in relation to other possible means of obtaining the same information and proportionate to the circumstances. Section 17 excludes content evidence from most legal proceedings and also forbids any disclosure that interception of content has taken place. Chapter II of RIPA 2000 (ss. 21–25) covers the circumstances in which authorisations and notices to collect and disclose communications data are issued and by whom. The grounds on which such authorisations and notices may be issued include the following:

- "in the interests of national security";
- "for the purpose of preventing or detecting crime or of preventing disorder";
- "in the interests of the economic well-being of the United Kingdom";
- "in the interests of public safety";
- "for the purpose of protecting public health";
- "for the purpose of assessing or collecting any tax, duty, levy or other imposition, contribution or charge payable to a government department";
- "for the purpose, in an emergency, of preventing death or injury or any damage to a person's physical or mental health, or of mitigating any injury or damage to a person's physical or mental health"; and
- for any other purpose specified by an order made by the Secretary of State.

There is a lengthy and complex list of "designated persons" who can issue authorisations, but such authorisations have to be necessary and proportionate to the circumstances. There are arrangements to make payments to meet the cost of the telecoms companies, etc.

Communications data is admissible in evidence. It may be used not only to show that a conversation took place at a particular time but also to show patterns of contact which may in turn suggest relationships between those involved.

The scope for a private company to get access to records from a public telecommunications service without the assistance of law enforcement or one of the other agencies empowered under Part II of RIPA 2000 seems extremely limited.

The debate continues as to whether the UK is wise to maintain the distinctions between content and communications data. Most of the public debate is about the relative risks of losing important cases because content cannot be produced and the possible issues of disclosure of precise methods. But once one leaves the world of conventional telephones, where there is a clear technical distinction between content and communications (tariff and connection data versus recording voices), within most forms of data communication such as email, web-browsing and Voice over Internet Protocol (VoIP) telephony, the clear technical distinction no longer exists and the courts may have to interpret the legislation. They may only be able to do so by examining material that may turn out to be "content" and therefore both inadmissible and which should be excluded from legal proceedings.

Data from Internet Service Providers

ISPs provide what is in fact a bundle of services to customers. Typically, these include:

- connection to the Internet;
- facilities for emails to be sent from the customer to others on the Internet;
- facilities for emails addressed to customers to be received by the ISP and then held until such time as the customer requests the emails, either by connecting or opening their email client;
- facilities for hosting websites so that they are permanently available to the world wide web. These websites may be simply "static" – that is, containing information that does not change very frequently, or may be full-scale e-commerce sites capable of taking orders from the public, linking to credit card authorisation schemes, confirming details of sales and originating computer records for the vendor to translate into despatch of orders;
- facilities such as newsgroup feeds, hosting for chatrooms, etc.

In legal terms an ISP is for some of these functions a "common carrier", in the same way as a conventional telecoms company specialising in voice telephony. But for other functions such as hosting websites, the ISP is more like a publisher.

The operation of a ISP generates various logs which are essential to its business, either in terms of maintaining quality of service or for tariffing. From the perspective of law enforcement the most important of these is the Remote Authentication Dial In User Service (RADIUS) log. In order to communicate on the Internet each user needs an IP (Internet Protocol) address, which has the form 123.123.123.123 (four triplets separated by dots). There are currently insufficient numbers of these to provide unique permanent IP addresses for everyone who communicates on the Internet, so in practice each ISP has a pool of addresses which it assigns on a temporary basis to its customers. Thus, if an organisation is interested in the identity of someone who is communicating with it and their IP address is obtained (a relatively simple technical procedure), it will need to discover (from Internet resources) which ISP owns that address. But it will only be by reference to the RADIUS log that the actual identity of the person can be revealed.

Legal Issues

If ISPs operate in the UK, they can readily provide customers with their own personal data that the ISP holds about them. But for most purposes, ISPs cannot supply data on third parties other than against a proper authorisation under RIPA 2000. Again, in relation to a website that an organisation may have had hosted by an ISP, the ISP can provide the organisation with such web logs as it has collected and the organisation is prepared to pay for. But logs from the websites of third parties are unlikely to be available in the absence of authorisation under RIPA 2000.

Emails held on the ISP's mail server computers will be regarded almost certainly as being on a public telecommunications service for the purposes of RIPA 2000. To obtain traffic data, law enforcement will require an appropriate authorisation under Chapter II of RIPA 2000 but that evidence will be admissible. To get the content a warrant signed by the Home Secretary will be necessary, and the material can only be used for intelligence purposes but will not be admissible as evidence.

Evidence from the Web

An organisation may have come across something on a remote website and thinks that it may be needed for evidence. It could be an offer of something for sale after a transaction has been completed or it could be defamatory. How does an organisation capture it?

One route is simply to use the "Print" option within the browser. Most browsers will not only print out what you can see on the screen but also provide a footer with details of the URL (website and specific page) together with a day and time stamp. As with other printouts, the result is better than nothing but also open to the charge of ease of subsequent alteration. The same could be said of "saves" to disk. Both Microsoft Internet Explorer and Mozilla Firefox gives options to save "Web Page Complete" and "Web Page HTML only", but here too, post-capture modification of content is easy.

There are programs that can capture an entire website or part thereof. One example is Webwhacker[20], which can preserve the directory structure of a website and save it to external storage such as a CDRom for later examination. The process is sometimes called "spidering". In addition, the program can monitor a website for changes, which may be useful during an investigation.

There are some important limitations that need to be considered. The first is that what can be seen on screen is not necessarily what is currently on a remote site due to the caches kept by ISPs and on Internet browsers. A further complication is that what is being seen on screen may have been assembled from a number of sources and in quite complex ways, as when the web designer has used "frames" or "cascading style sheets". Older web-capturing tools may fail to "get" every single element.

All this means that both web-capturing and writing accompanying witness statements have to be carried out with some care in order to anticipate criticism.

[20] Http://www.bluesquirrel.com/products/webwhacker/. Other examples include Pagesucker: http://www.pagesucker.com/ and Surfsaver: http://www.surfsaver.com/

The second limitation is that spidering only works when the webpages have fixed content: that is, they exist as files on the remote website. But on many websites the pages being seen are created "on-the-fly" against a specific request or in response to specific circumstances – this is known as dynamic page creation. Examples include the "results" pages created by search engines such as Google, the "welcome" page on Amazon.com where, in response to a cookie on your computer, you are greeted by name and with a list of uniquely personalised "recommendations" based on previous purchases, as well as the accumulated shopping baskets that almost all e-commerce pages have.

In these circumstances the only evidence an organisation may be able to collect is a "controlled" printout: one where careful contemporaneous notes are written up during the process, in the hope that this will be sufficient to persuade a court. Web travels may leave information in the cache which, when reviewed in a cache analysing program such as Netanalysis[21], may provide corroboration – however, not all e-commerce pages are captured in the cache[22]. Ways around this include the use of a video camera to record onscreen activity, or programs such as Camtasia, which sit in the background and save snapshots of the screen to a movie file – the program is used to develop computer training modules.

Evidence from Web Servers

This is the other side of the same problem. An organisation may own a website and wish to assert that it has been been publishing certain items of information, or it may wish to demonstrate that certain individuals have been visiting the site at particular times and carrying out certain types of activity.

Web server programs, among which the most popular are Apache and Microsoft Internet Information Services, can be set up easily to collect activities into a log. These logs are usually in Common Log Format (CLF), although it is possible to collect additional information. From a forensic perspective, these logs are no different from other types of computer log that one may wish to offer in evidence.

In terms of the overall reliability of web server logs, the following elements in a witness statement may help to persuade a sceptical court:

- a description of the computer system's overall functions and the role of the web server within it;
- an account of how long the system in its present configuration has been in operation;
- what forms of testing took place prior to commissioning and what forms of routine audit are in place;
- what external factors exist to act as a check on reliability;
- what security features exist and how they are managed (this is anticipates suggestion that incriminating material was placed there by someone other than the suspect);
- whether other similar systems are in existence that have a good history of reliability;
- compliance with any external good practice or system audit standards.

In terms of the precise exhibit that is being produced, it is useful to be able to say:

- how the selection of the data in the exhibit was made and why it can be regarded as "complete" in terms of the issues at hand;
- what procedures were used to collect the evidence such that it can be regarded as free from tampering;
- what procedures were used to preserve the evidence so that it can be regarded as free from subsequent tampering – this may take the form of imaging some computers or copying selected files to write-once data media such as CD or DVD, or making a digital fingerprint of the files;
- what manipulation or subsequent analysis was carried out to make the material "easier to understand" – this is a perfectly legitimate course of action, but in this event the original material should be exhibited so that the defence team can test the manipulation or analysis.

Usually, admissibility of evidence will be on the basis that the material is a "business record" as defined in s. 24 of the Criminal Justice Act 1988.

Evidence from Computer Intrusions

An interesting issue arises when an investigator wishes to make a covert entry into a suspect's computer across a network or the Internet. At a technical level, this is a relatively easy task: any of a number of Trojan horse and remote administrator programs will accomplish this. Facilities for capturing each keystroke on a computer or collecting screen snapshots at regular intervals (keylogger programs) are also widely available and usually operate covertly.

However, for the corporate investigator there are significant legal hazards. Any such entry without authorisation from the computer owner is an offence under the Computer Misuse Act 1990. Even if the computer is owned by the investigator's employer, the computer user has a reasonable expectation of privacy and the circumstances must be such that these expectations can be overcome – for example, because of a term in the employee's contract of employment (see Appendix 4 for the general problems of employer surveillance of employees).

For law enforcement it is possible to get a warrant for intrusive surveillance under s. 26(3) of RIPA 2000. Section 32(3) sets out the circumstances in which such surveillance has to be justified, and there are overarching tests of necessity and proportionality[23]. There are a number of problems for law enforcement: it may wish to avoid disclosing its precise methods and, although it is possible for law enforcement to

[23] A code of practice can be found at: http://www.homeoffice.gov.uk/crimpol/crimreduc/regulation/codeofpractice/surveillance/part1.html

approach a judge under the public interest immunity agenda, this may be at the expense of not being able to use the result of the intrusion.

In addition, there is a “reliability of evidence” problem: how can the investigator reassure the court that the evidence on the computer submitted has not been tampered with? Essentially, once the investigator is inside the computer, all assurance of the integrity of any evidence derived vanishes – it is no longer possible to categorically state that the evidence has not been tampered with. At worst, if in a criminal case defence lawyers suspect that their client has suffered a law enforcement intrusion, even if no evidence has been adduced by the prosecution, they may have powerful arguments for claiming that the evidence is so tainted that the trial should be abandoned.

Appendix 3: Admissibility of Evidence from Computers

The word "admissibility" refers to legal rules that are applied to an item of potential evidence before a court can consider the value of the facts that it purports to offer. This Appendix provides an overview of the issues.

If a device is simply recording information as in, for example, automated records of telephone calls, or who entered a building at a particular time, or an amount of fuel dispensed, evidence from such devices is admissible as "real evidence". To qualify: there must no possibility that the recording can be adjusted or manipulated – it must be a "dumb", automated process.

If an entire computer or some item of data storage media (disks, tapes, etc.) are seized and can be offered in court, they are admissible as "real evidence". Anything derived from this real evidence – printout, display, CDROM extracts, the product of analysis – becomes a separate exhibit which becomes admissible when the person who carried out the derivation is present in court and can formally produce the exhibit and be cross-examined.

Up until April 2000 there was a separate admissibility regime for computer evidence which required a certificate that the computer was operating properly and was not used improperly, before any statement in a document produced by the computer could be admitted in evidence (the former s. 69 of the Police and Criminal Evidence Act 1984). But today a presumption exists that the computer producing the evidential record was working properly at the material time and that the record is therefore admissible as real evidence. However, this presumption can be rebutted if evidence to the contrary is adduced. In this event it will be for the party seeking to produce the computer record in evidence to satisfy the court that the computer was working properly at the material time.

Nevertheless, documents found on a computer may be "documentary hearsay" – although the existence of the document on a computer is admissible, its contents may need to be separately admitted.

A printout or substantive computer file is a document if:

- the document was created or received by a person in the course of a trade, business, profession or other occupation, or as the holder of a paid or unpaid office; and
- the information contained in the document was supplied by a person (whether or not the maker of the statement) who had, or may reasonably be supposed to have had, personal knowledge of the matters dealt with.

It then becomes admissible as "business document" for the purposes of s. 24 of the Criminal Justice Act 1988. It is possible for a judge to exclude potential business documents and, if challenged, the judge must be satisfied as:

> (a) to the nature and source of the document containing the statement and to whether or not, having regard to its nature and source and to any other circumstances that appear to the court to be relevant, it is likely that the document is authentic;
> (b) to the extent to which the statement appears to supply evidence which would otherwise not be readily available;
> (c) to the relevance of the evidence that it appears to supply to any issue which is likely to have to be determined in the proceedings; and
> (d) to any risk, having regard in particular to whether it is likely to be possible to controvert the statement if the person making it does not attend to give oral evidence in the proceedings, that its admission or exclusion will result in unfairness to the accused or, if there is more than one, to any of them. (s. 25 of the Criminal Justice Act 1988)

Communications data is admissible and normally will be produced by a telecoms company or similar using the business records rule under s. 24 of the Criminal Justice Act 1988. Currently, content is not admissible under s. 17 of the Regulation of Investigatory Powers Act 2000 (RIPA 2000). However, content is admissible if it has been obtained from an overseas law enforcement agency within its own jurisdication and is subject to the availability of someone to produce it before the English court.

Expert evidence has been admissible in English law since 1782 and there are cases going back to 1554. But "expert" for this purpose means the right of the witness to offer opinions based on experience. This is distinct from the role of a forensic technician who may have carried out a technical investigation or procedure and simply reports factually on their findings. In the end it is for a judge to form a view of the extent of any individual's "expertise" and hence the territory over which opinions can be offered.

A judge has general discretion to exclude any evidence which appears to be so unfair (normally by reference to the way in which it was obtained) that it would have an adverse effect on the fairness of the proceedings; s. 78 of the Police and Criminal Evidence Act 1984). Normally, judges only make such exclusions on the application of defence lawyers.

Admissibility rules in countries on the European mainland tend to be much more relaxed than in the UK. This is often a function of the different criminal justice procedure. The UK procedure is adversarial – the judge acts as the chair over proceedings in which the evidence and arguments are presented by opposing lawyers. The continental procedure is inquisitorial, dominated by an examining magistrate. Admissibility rules in the US follow the English common law model but have evolved differently. One of the more interesting divergences is the way in which novel scientific and technical evidence is handled. In the UK, the jury is simply presented with opposing expert witnesses (who may have been informally pressured to identify points of agreement and disagreement). In the US, novel scientific and technical evidence is an admissibility issue, with the judge acting as a gatekeeper to protect the jury from scientific evidence which has not been established as “generally accepted”. Where necessary, a trial before the main trial is held (*a voir dire*) – the *Daubert* rules (see above).

Appendix 4: Employer Considerations in Carrying Out Surveillance on Employees

Computer investigations into employees by employers operate under the same constraints and rules as ordinary investigations. Among other things, the individual employee is protected by the following:

- Employment Rights Act 1996;
- Human Rights Act 1998;
- Data Protection Act 1998;
- Sexual Discrimination Act 1975;
- Race Relations Act 1976;
- Police and Criminal Evidence Act 1984.

For example, this last covers the circumstances in which an interview takes place and when a caution should be administered. Two other Acts are particularly important in the IT domain:

- the Computer Misuse Act 1990;
- the Regulation of Investigatory Powers Act 2000 (RIPA 2000).

In determining a legal policy for any form of surveillance, there are some general principles from which the detail flows:

- the employee begins with a reasonable expectation of privacy, which may be qualified either by specific consent or in circumstances which meet specific criteria;
- any action by an employer has to pass a test of “necessity” (there was no less intrusive route) and “proportionality” (what was done was limited to what appeared to be strictly relevant to the circumstances).

The rules for legitimate interceptions are mainly to be found in the Telecommunications (Lawful Business Practice) (Interception of Communications) Regulations 2000[24]. To fall within the Regulations, the interception has to be by, or with, the consent of a person carrying on a business, for purposes relevant to that person’s business and using that business’s own telecommunications system.

[24] The full text of the Regulations is available at : http://www.hmso.gov.uk/si/si2000/20002699.htm

Interceptions are authorised for monitoring or recording communications:

- to establish the existence of facts;
- to ascertain compliance with regulatory or self-regulatory practices or procedures;
- to ascertain or demonstrate standards which are (or ought to be) achieved (quality control and training);
- in the interests of national security (in which case, only certain specified public officials may make the interception);
- to prevent or detect crime;
- to investigate or detect unauthorised use of telecommunication systems;
- to secure, or as an inherent part of, effective system operation;
- to determine whether received communications are business or personal communications;
- made to anonymous telephone helplines.

The UK also has a code of guidance for employer–employee relationships. The Information Commissioner's 2005 Employment Practices Data Protection Code[25] states the obligations of employers. It lays down strong principles of data protection, prohibits the making of decisions solely on the basis of automated data, requires employers to notify employees of surveillance policies and places limits on the extent of monitoring which can take place. It requires the explicit consent of employees before sensitive data such as medical or information can be collected. The third part of the Employment Practices Data Protection Code contains a guideline on how firms can legally monitor staff emails. Employers have the right to monitor staff emails, provided that employees have been warned that monitoring is taking place and that the reasons for monitoring have been explained. The Employment Practices Data Protection Code covers a range of surveillance activities including opening emails or voicemail, checking internet usage and recording with closed circuit television (CCTV) cameras but it also warns businesses that the covert monitoring of employees is unlikely to be permissible unless it is done in response to a request from a law enforcement agency.

[25] Available at:
http://www.informationcommissioner.gov.uk/cms/DocumentUploads/ico_emppraccode.pdf

The Code states that following it will:

- increase trust in the workplace – there will be transparency about information held on individuals, thus helping to create an open atmosphere where workers have trust and confidence in employment practices;
- encourage good housekeeping – organisations should dispose of out-of-date information, freeing up both physical and computerised filing systems and making valuable information easier to find;
- protect organisations from legal action – it will help employers to protect themselves from challenges against their data protection practices;
- encourage workers to treat customers' personal data with respect – it will create a general level of awareness of personal data issues, helping to ensure that information about customers is treated properly;
- help organisations to meet other legal requirements – the Code is intended to be consistent with other legislation such as the Human Rights Act 1998 and RIPA 2000;
- assist global businesses to adopt policies and practices that are consistent with similar legislation in other countries – the Code is produced in the light of EC Directive 95/46/EC of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data and ought to be in line with data protection law in other European Union (EU) Member States;
- help to prevent the illicit use of information by workers – informing them of the principles of data protection and the consequences of not complying with the Act should discourage them from misusing information held by the organisation.

The Code goes on to give some general principles about monitoring:

- it will usually be intrusive for an organisation to monitor its workers;
- workers have legitimate expectations that they can keep their personal lives private and that they are also entitled to a degree of privacy in the work environment;
- if employers wish to monitor their workers, they should be clear about the purpose and satisfied that the particular monitoring arrangement is justified by real benefits that will be delivered;
- workers should be aware of the nature, extent and reasons for any monitoring, unless (exceptionally) covert monitoring is justified.

In any event, workers' awareness will influence their expectations.

It says that any organisation that wishes to monitor electronic communications should establish a policy on their use and communicate it to workers. Further detail in the Code suggests specific elements of such a policy. Each specific act of monitoring should be accompanied by a formal impact assessment, carried out by a group of people able to look at all the likely implications.

The Computer Misuse Act 1990 refers to "unauthorised acts" of accessing computers or modifying their contents. In a corporate situation, a business is normally authorised to examine its own computers but the provisions of data protection and human rights legislation still apply. A business is not authorised to access the computers owned privately by its employees – these can include laptop computers, mobile phones, PDAs and data storage devices such as thumbdrives and personal media players,

Although most of RIPA 2000 is directed towards interception of a public telecommunications service, it is also a criminal offence to "intentionally and without lawful authority" intercept any communication in the course of its transmission by private telecommunications systems. However, s. 1(6) of RIPA does allow for certain legitimate interceptions of communications by organisations on their private telecommunications networks.

Appendix 5: Problems of Disclosure and Confidentiality

For businesses, one of the potentially worrisome features of cooperating with law enforcement in a prosecution or embarking on a civil action is that the "other side" is entitled to disclosure. Indeed, in a criminal matter, someone who is not a direct victim but a third party may find that they are the subject of a disclosure requirement. There is little doubt that on occasion some defence lawyers, lacking any better tactic, have attempted "aggressive disclosure", hoping to thwart a prosecution or civil action by requiring the disclosure of embarrassing or sensitive information to the point where the party concerned decides that it is in their wider interest to withdraw cooperation.

This appendix provides an outline of the law and the issues, but it is stressed that in any individual situation, an organisation will need access to specific legal advice.

Criminal Procedure

The main current law is to be found in the Criminal Procedure and Investigations Act 1996 (CPIA 1996)[26]. There is also a Code of Practice issued under ss. 23 and 26 of the Act. It replaces an earlier and simpler "materiality" or "relevancy" test which was thought to be too vague and liable to abuse. There is also in force a set of guidelines prepared by the attorney-general[27].

CPIA 1996 makes the investigator responsible for ensuring that any information relevant to the investigation is retained, whether gathered in the course of the investigation or generated by the investigation. The investigator is required to draw the prosecutor's attention to anything that might undermine the prosecution case. When evidence is served it must be accompanied by a schedule of "unused material" which the defence team can then ask to see, should it so wish. This is called "primary disclosure".

If material is thought to be "sensitive", it must be listed in a separate schedule. Sensitive material is that which an investigator believes not to be in the public interest to disclose. Examples within digital evidence could include material relating to national security, material given in confidence and material relating to police methods. It is for prosecutors to decide, subject to the law and codes of practice, what to disclose as "unused material" to the defence by way of primary disclosure.

CPIA 1996 imposes on the defence the obligation to produce, in good time before trial, a defence case statement indicating the broad bases upon which a charge is to be challenged. Failure to do so may mean that late-announced defence arguments may be disallowed by the judge at trial. Once the investigator has received the defence case statement, they are under a duty to re-evaluate what has been in the primary disclosure

[26] Http://www.hmso.gov.uk/acts/acts1996/1996025.htm. The Criminal Justice Act 2003 introduces a number of amendments which emphasise the defence's duties as well as the prosecutor's duty of continuing review of matters which might undermine their case and assist the defence.

[27] Http://www.lslo.gov.uk/pdf/guidelines.pdf

and advise the prosecutor of any further unused evidence which might now undermine the prosecution case. In addition, the defence team can make specific requests for disclosure, subject to a materiality test. The prosecutor is under a duty to produce secondary disclosure in reply to a defence statement and is under a continuing duty to review questions of disclosure. If the defence is dissatisfied with the response to a request, or if the prosecutor believes that a request is unjustified by reason of irrelevance to the stated bases of the defence or excessive, resort is made to the court for a ruling.

The precise position of computer-derived materials remains unclear – how much needs to be disclosed? From the investigator's perspective, the quantity of digital evidence that may have been obtained or seized may be so vast that they have not had the opportunity to make an exhaustive assessment of what they have in their possession, and so make a judgment under CPIA 1996 of what ought to be disclosed. The Association of Chief Police Officers' Guidelines currently suggest that the defence should be made aware by way of schedule of this "unused material" and in addition should be warned specifically that neither investigators nor prosecutors have carried out a full review of what might be contained.

The basis upon which a prosecutor can withhold disclosure is usually via the mechanism of public interest immunity. This usually takes the form of an application by a prosecutor to a judge. Depending on the circumstances, it is possible for a hearing to be *ex parte* – that is, without notifying the defence. The judge has to weigh the balance between the dangers of disclosure against the need to ensure a fair trial. It is almost never possible for a prosecutor to adduce evidence which has been derived from material which is withheld from disclosure. Public interest immunity simply excludes material which might be relevant to the defence's case.

From the perspective of most commercial organisations, the main heading for allowing "unused" material to be "sensitive", and hence be excluded, is that the material was "given in confidence", but there is nothing automatic about this and a judge may still order to disclose if it is believed necessary.

One route to limit disclosure that sometimes can be pursued fruitfully is to allow a defence expert access to sensitive material but against a formal written undertaking that the sole purpose of such disclosure is for the immediate legal proceedings. If necessary, a party from whom disclosure is required can ask that the expert's undertakings are covered by a court order. The effect of this is that any unauthorised or *ultra vires* disclosure would be contempt of court.

The National High Tech Crime Unit has produced a confidentiality charter and associated draft memorandum of agreement to anticipate some of the more common confidentiality issues, both formal and informal[28].

Procedures for cases of complex fraud may vary from this general explanation.

[28] Available on their website: http://www.nhtcu.org

Civil Procedure

The general rules for the disclosure of "documents" in the English Civil Procedure are to be found in Civil Procedure Rule 31. What is required to be disclosed is set out in Civil Procedure Rule 31.6, which provides:

> (c)
>
> Standard disclosure requires a party to disclose only –
>
> (a) the documents on which he relies; and
>
> (b) the documents which –
>
> (i) adversely affect his own case;
>
> (ii) adversely affect another party's case; or
>
> (iii) support another party's case; and
>
> (c) the documents which he is required to disclose by a relevant practice direction.

There is a duty of search in respect of standard disclosure that is set out in Civil Procedure Rule 31.7, which provides:

> (1) When giving standard disclosure, a party is required to make a reasonable search for documents falling within rule 31.6(b) or (c).
>
> (2) The factors relevant in deciding the reasonableness of a search include the following–
>
> (a) the number of documents involved;
> (b) the nature and complexity of the proceedings;
> (c) the ease and expense of retrieval of any particular document; and
> (d) the significance of any document which is likely to be located during the search.
>
> (3) Where a party has not searched for a category or class of document on the grounds that to do so would be unreasonable, he must state this in his disclosure statement and identify the category or class of document.

The rules were largely conceived on the basis that the "documents" would be in paper form. A recent report from a working party chaired by Mr Justice Cresswell has reviewed the position and come up with a series of recommendations[29]. In any event, the report

[29] Http://www.courtservice.gov.uk/cms/media/electronic_disclosure1004.doc

indicates a number of practical routes that can be followed, irrespective of the need to change the rules or associated guides and practice directions. It includes a draft suggested revision to the existing Commercial Court Guide.

Appendix 6: Problems of Obscene and Indecent Material

Human beings are interested in sex and in some cases this takes the form of accumulating and sometimes distributing quantities of pictures with extreme sexual content. In a corporate environment this may be the subject of a specific inquiry or may be discovered during an entirely separate investigation.

This appendix explains the main problems that corporate investigators may encounter and the risks to and obligations of the organisation.

English law distinguishes between adult and child pornography. For this purpose a "child" is someone who is or appears to be under the age of 18 (s. 45 of the Sexual Offences Act 2003).

In terms of adult material there is no offence in simple possession – there has to be an act of publication. In the final analysis, the test of obscenity is applied by a court. Section 1(1) of the Obscene Publications Act 1959 states:

> (1) For the purposes of this Act an article shall be deemed to be obscene if its effect or (where the article comprises two or more distinct items) the effect of any one of its items is, if taken as a whole, such as to tend to deprave and corrupt persons who are likely, having regard to all relevant circumstances, to read, see or hear the matter contained or embodied in it.

In practice over the years, juries have become steadily more permissive and the prosecution criteria have tended to move in step. The test for publication is:

> (3) For the purposes of this Act a person publishes an article who–
> (a) distributes, circulates, sells, lets on hire, gives, or lends it, or who offers it for sale or for letting on hire; or
> (b) in the case of an article containing or embodying matter to be looked at or a record, shows, plays or projects it [, or, where the matter is data stored electronically, transmits that data].

The Crown Prosecution Service tends to want strong *prima facie* evidence of publication for gain, widespread offence being caused by virtue of public display, or ease of access.

Child material is dealt with under the Protection of Children Act 1978 and an important extension of it exists within s. 160 of the Criminal Justice Act 1988. The effect of s. 160 of the Criminal Justice Act 1988 is that it is a "strict liability" offence to possess "indecent" pictures (i.e. of children in a sexual situation). Strict liability means that there is enough to convict, provided that a person is found in possession of offending material and that they know that they are in possession. There are a small number of defences, which the defendant has to prove to the court on the balance of probabilities.

Another feature of the Protection of Children Act 1978 is the main relevant offence of "making" an indecent photograph. The Court of Appeal has interpreted "making" to include the simple "making of a copy" or even "causing a picture to appear on screen knowing that it was indecent".

Both of these legal features have the potential to create significant difficulties for the organisation or corporate investigator, who just wants to do the right thing.

Section 46 of the Sexual Offences Act 2003 provides a defence that a "making" was necessary to do so for the purposes of the prevention, detection or investigation of crime, or for the purposes of criminal proceedings. Section 46 works on a "reverse burden of proof" basis. A defence is available where a person "making" such a photograph or pseudo-photograph can prove that it was necessary to do so for the purposes of the prevention, detection or investigation of crime, or for the purposes of criminal proceedings. A memorandum of understanding between the Crown Prosecution Service and the Association of Chief Police Officers dated 6 October 2004 provides guidance[30]. It seeks to protect those who genuinely come across such material unexpectedly but may be called upon to preserve evidence while discouraging amateur sleuths, bogus "researchers" and vigilantes.

The factors affecting the decision whether to accept a claim that "making" was covered by the new defence are:

- the way in which the indecent photograph or pseudo-photograph was discovered or made – those knowingly making abusive images will need to demonstrate that they have some identified role or duty, as a result of which they needed to respond to a complaint, investigate the abuse of a computer or other electronic communications system, or access particular data, and that they "made" the images within the course of that duty;
- the speed with which the indecent photograph or pseudo-photograph was reported and who it was reported to;
- the handling and storage of the indecent photograph or pseudo-photograph –whether it was appropriate and secure;
- that the copying of photographs or pseudo-photographs must be the minimum to achieve the objective and be appropriate;
- that individuals should be expected to have acted reasonably.

The Internet Watch Foundation (http://www.iwf.org.uk) is the only non-police body to whom suspected indecent material can be reliably and readily reported. The website contains, among other things, a form for reporting and various items of advice for IT professionals as well as an explanation of its other activities. It was formed in 1996 following an agreement between the government, police and the Internet Service Provider (ISP) industry that a partnership approach was needed to tackle the distribution of child abuse images online. It operates the only authorised hotline in the UK for the

[30] See http://www.cps.gov.uk/publications/docs/mousexoffences.pdf

public to report their inadvertent exposure to illegal content on the Internet. It is funded by the EU and UK Internet industries, including ISPs, mobile network operators and manufacturers, content service providers, telecoms and software companies and credit card bodies.

Appendix 7: Law Enforcement Resources and Structures

In the UK, computer crime units (CCUs) emerged from within fraud squads, the first being the Metropolitan Police's CCU in 1985. Ten years later other police forces, HM Revenue and Customs, Serious Fraud Office and other agencies had established specialist units to carry out computer forensic examinations, although this was concentrated largely on the investigation of the hard drives of PCs. The Metropolitan Police now has several semi-separate units dealing with computer evidence, not only the Computer Crime Unit but also specialist entities to assist in Special Branch, anti-terrorism and child protection. The City of London Police's unit concentrates on fraud and has close contacts with financial institutions and regulators.

The National High Tech Crime Unit (NHTCU) began work in April 2001 with a budget of £25 million for its first three years, £15 million of which was for a central resource and £10 million for the development of regional expertise. The East London Docklands headquarters of NHTCU houses just over 50 staff in four sections: operations, intelligence, tactical and technical support and digital evidence. The local expertise – usually called network investigators – exists within the traditional police force. Although dominated by the police, NHTCU is multi-agency and also includes staff seconded from HM Revenue and Customs, the National Criminal Intelligence Service, National Crime Squad, the military and the security services. In this respect it provides a model for the Serious and Organised Crime Agency announced by the Prime Minister and Home Secretary in March 2004; it was given a legislative basis in April 2005. NHTCU will become part of the Serious and Organised Crime Agency.

Currently, NHTCU is part of the National Crime Squad. Its website (http://www.nhtcu.org) explains its mission and provides details of how it works with business, in particular the operation of its confidentiality charter, which seeks to address some of the problems of the relationship between NHCTU officers and a business wishing to share sensitive information during an investigation. For example, NHTCU will enter into a formal memorandum of understanding. The confidentiality charter also forms a key part of the way in which NHTCU gathers intelligence from the business community. Industry representatives wishing to contact the NHTCU Industry Liaison Unit can do so via a form which can be found on the website: http://www.nhtcu.org/nqcontent.cfm?a_id=12445&tt=nhtcu. This section also contains a telephone number for urgent queries.

The problem for businesses and organisations is to know where and how to report a crime. NHTCU makes a distinction between:

- new crimes and new tools – offences such as hacking, viruses and denial of service attacks;
- old crimes and new tools – traditional crimes supported by the use of the Internet and hi-technology, such as fraud, blackmail and extortion, paedophilia, pornography, identity theft and cyberstalking.

NHTCU covers both situations, provided that there is a strong hi-tech component. The vagueness in definitions of the second category sometimes creates doubt as to which agency, in any given investigation, has primacy: is the essence of the crime "fraud", "child abuse" or 'hi-tech'? Often much depends on which agency receives the first report. Similar arguments concern decisions whether to deal with a report at national or local level.

All local police forces now have some capacity to handle computer disk and network forensics, although the latter is limited to networks which follow internet-like (TCP/IP) protocols. In some forces the specialists are all police officers but others employ civilians; in addition there are a number of private companies, usually ex-law enforcement, which provide technical support.

The best practical guidance that can be given is as follows. The NHTCU is focused on the investigation of serious and organised crime and, as such, in most cases it will be necessary to report possible crimes via your local police force. An operational protocol was agreed between the NHTCU and all forces in 2002, which is designed to facilitate and enhance cooperation between the NHTCU and partners within the law enforcement community in England and Wales. It includes arrangements for the coordination of investigations, intelligence and the reporting of possible offences between local forces and the NHTCU. It also sets out how jurisdiction is to be determined in such cases and when investigations should be escalated for investigation by NHTCU. (The NHTCU website contains a section advising how to report various types of high-tech crime.)

Specialist units within the Serious Fraud Office, HM Revenue and Customs, Benefits Agency and Department of Trade and Industry continue to grow. At the beginning of 2005 the First Forensic Forum (F3), whose membership was created by invitation only, had over 1,000 members drawn from law enforcement and the private sector.

The National Technical Assistance Centre handles warranted intercepts under the Regulation of Investigatory Powers Act 2000 and also acts as the central law enforcement resource for handling encrypted data. It is staffed predominantly by law enforcement officers but is physically located at Security Service premises.

The Association of Chief Police Officers (ACPO) encompasses a Computer Crime Working Group. The Working Group works closely with the Home Office Digital Evidence Group, which has representatives from all law enforcement agencies and the Crown Prosecution Service.

A *Good Practice Guide for the Handling of Computer Evidence* is published by ACPO and contains a list and contact details for the relevant units in all police forces.

In the private sector, some large telecoms companies, including ISPs, have set up their own investigatory and specialist forensic units, not only to address fraud against themselves but to service the requirements of law enforcement under the Regulation of Investigatory Powers Act 2000; a system of Single Point of Contact (SPOC) has been set up to streamline the process and develop consistent standards. A number of organisations support the anti-piracy initiatives of the trade associations for owners of intellectual property, e.g. Federation Against Software Theft, Business Software Alliance, Entertainment and Leisure Software Publishers Association; often their staff are drawn from law enforcement and Trading Standards.

Appendix 8: Good Practice Guidance – National and International Standards for Records Management

Further "good practice" guidance can be found in the International Standard on Records Management – ISO 15489. ISO 15489 is for any organisation that needs to ensure that its records (both paper and electronic) are properly maintained, easily accessible and correctly documented from creation right through to ultimate disposal, be it archiving, imaging or destruction. The standard ensures that disposal is carried out in a transparent manner according to pre-determined criteria. ISO 15489, which emerged from work done by the British Standards Institute (BSI) in the 1990s (Code of Practice on 'Legal Admissibility and Evidential Weight of Information Stored Electronically'- BSI PD0008), is directly aimed at organisations that need to reassure customers and clients that they maintain accurate, detailed records according to a stated policy, for example, the health, financial services and state-funded sectors.

In its earliest form the Standard addressed a technology known variously as document management systems or electronic records management. Many organisations were scanning important paper documents – mortgages, insurance policies, cheques, etc. – and placing them on optical media (in the mid-1990s this was on so-called Write Once Read Many - WORM media) so that they could be stored and retrieved efficiently and economically. The immediate problem was to take proper steps to ensure that the results would be regarded as both reliable and admissible in court. BSI PD0008[31] provided high-level guidance and the detail came in a workbook, PD0009[32].

The updated and international version appeared in 2001 as ISO 15489[33]. The Standard provides a descriptive benchmark that organisations can use to assess their record-keeping systems and practices. The two parts of the Standard are designed to help organisations create, capture and manage full and accurate records to meet their business needs and legal requirements, as well as to satisfy other stakeholder expectations. Both parts apply to records in any format or media that are created or received by any public or private organisation during the course of its activities.

Part 1 provides a high-level framework for record-keeping and specifically addresses the benefits of records management, regulatory considerations affecting its operation and the importance of assigning of responsibilities for record-keeping. It also discusses high-level records, management requirements, the design of record-keeping systems and the actual processes involved in records management, such as record capture, retention, storage, access, etc. For example, conventional "computer security" and audit practices are important components because it is essential to be able to demonstrate beyond doubt that data has not been altered at any stage. Part 1 concludes with a discussion of records management audit operations and training requirements for all staff of an organisation.

[31] Code of Practice for Legal Reliability and Evidential Weight of Information Stored Electronically, available at: http://www.bsi-global.com/ICT/Legal/bip0008.xalter

[32] See http://www.bsi-global.com/ICT/Legal/bip0009.xalter

[33] Http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=31908&ICS1=1

Part 2 provides practical and more detailed guidance about how to implement the framework outlined in Part 1. For example, it provides specific detail about the development of records management policy and responsibility statements. Part 2 also provides practical guidance about the development of records processes and controls and specifically addresses the development of key record-keeping instruments such as thesauri, disposal authorities and security and access classification schemes. It then discusses the use of these tools to capture, register, classify, store, provide access to and otherwise manage records. Further, Part 2 provides specific guidance about the establishment of monitoring, auditing and training programmes to promote and effectively implement records management within an organisation.

Compliance with an international standard, even the production of a certificate of compliance, does not automatically make records produced from such a system admissible, but it does provide a great deal of comfort. BSI PD0008 is specifically referred to in the Code of Practice issued under s. 46 of the Freedom of Information Act 2000, which lays down rules for all public bodies that are likely to be called upon to produce their records. (Appendix 2 lists some of the main types of digital evidence and the problems likely to be encountered when seeking to acquire and preserve them.)

Appendix 9: Additional Resources

Statistics and Forecasts About the Future of Cybercrime

Many published surveys can be dismissed because the survey sample is too small or unrepresentative. However, the following detailed studies are worth examining:

- *Cyber Trust and Crime Prevention* – a study by the Home Office and the Department of Trade and Industry Foresight Team: http://www.foresight.gov.uk/previous_projects/cyber_trust_and_crime_prevention/index.html
- *The Future of Netcrime Now* – a Delphi study by the Home Office: http://www.crimereduction.gov.uk/internet01.htm
- *Audit Commission ICT Fraud and Abuse Survey* – http://www.audit-commission.gov.uk/
- Computer Security Institute / Federal Bureau of Investigation Computer Security Survey – http://www.gocsi.com/

Risk Management and Information Security

The international standard for Information Security Management is ISO 17799, which is based on BS 7799, available from http://www.bsonline.bsi-global.com/server/index.jsp. NISCC publishes a guidance document, *Risk Management and accreditation of information systems* which is also HMG Infosec Standard No 2. It is available for download from http://www.niscc.gov.uk/niscc/docs/re-20050804-00653.pdf?lang=en

Computer Security and Incident Response Teams

Evidence collection is likely to be an aspect of other corporate activities. It could be one of the functions of a Computer Security and Incident Response Team (CSIRT).

A CSIRT is a service organisation that is responsible for receiving, reviewing and responding to computer security incident reports and activity. Its services are usually performed for a defined constituency that could be a parent entity such as a corporation, government or educational organisation, region or country, research network or paid client.

Part of a CSIRT's function can be compared in concept to a fire department. When a fire occurs, the fire department is called into action. They go to the scene, review the damage, analyse the fire pattern and determine the course of action to take. They then contain the fire and extinguish it. This is similar to the reactive functions of a CSIRT.

A CSIRT will receive requests for assistance and reports of threats, attack, scans, misuse of resources or unauthorised access to data and information assets. They will analyse the report, determining what they think is happening and the course of action to take to mitigate the situation and resolve the problem.

Just as a fire department can be proactive by providing fire-prevention training, instructing families in the best manner to exit a burning building safely and promoting the installation of smoke alarms and the purchase of fire escape ladders, a CSIRT may also perform a proactive role. This may include providing security awareness training, security consulting, configuration maintenance and producing technical documents and advisories.

A good starting point is: http://www.cert.org/archive/pdf/03tr001.pdf. The websites http://www.cert.org and http://www.first.org provide a wide range of advice.

Computer Forensic Analysis Tools

The following are some of the better-known products. It is not possible to make effective use of them without proper training. Because of the rate of change in ICT, products can rapidly become obsolete unless there are frequent new versions. Most experienced digital forensic investigators will use a variety of tools.

Disk imaging and analysis

- EnCase (http://www.guidancesoftware.com)
- AccessData FTK (http://www.accessdata.com)
- ProDiscover (http://www.techpathways.com)
- Sleuthkit and Autopsy (http://www.sleuthkit.org)
- SMART (http://www.asrdata.com/index.html)
- Ilook (Law enforcement only) http://www.ilook-forensics.org)
- Blackbag (for Apple Mac) (http://www.blackbagtech.com/products.html)
- Paraben (also for PDAs) (http://www.paraben-forensics.com)
- Tucofs – website listing many tools (http://www.tucofs.com/tucofs.htm)
- Open Source tools (http://www.opensourceforensics.org)

A Google or other search on “computer forensics” and “forensic computing” will yield many websites, articles, courses, training schemes and conferences.

Glossary of Terms Used in Digital Evidence

ACPO Guide The Association of Chief Police Officers' *Good Practice Guide to Computer-based Evidence*

ActiveX A Microsoft programming device used on websites, for example to create fillable forms or animations

application A computer program

attachment A file of any kind linked to an email, newsgroup posting, etc. The attachment may usually be in any of a number of formats

audit trail A record of activities in chronological form

backdoor A facility, in either software or hardware, which enables security and authentication mechanisms to be circumvented

back-up A regular process to create additional copies of essential data and programs, or indeed entire systems. Back-up may be either complete or partial and, on each occasion, may be complete or incremental

BIOS Basic Input–Output System. More colloquially BIOS refers to the hardware chip on a computer that runs on start-up and "looks for" a disk with a full operating system. The BIOS contains the system clock and may contain details of additional hardware installed on the computer. Although they are not identical, sometimes also referred to as CMOS (see *CMOS*)

bot A robot program used to perform a particular function, for example, to keep a transmission channel artificially open or to send out rogue commands. A bot army or botnet is a collection of bots on different computers working in concert. Innocent third-party computers taken over in this way are referred to as zombies. May be used for "phishing" or denial of service (DOS) attacks

browser (or web browser) A program used to view the world wide web, such as Internet Explorer, Netscape, Mozilla, Firefox, Opera, Safari

brute force A common technique to break a password system by writing a program to throw large numbers of potential passwords exhaustively at a computer in the hope of eventually finding the correct one

cache A holding area for temporary files, often used to speed up regular computer processes. The best known example is the Internet cache which contains recently viewed webpages and pictures

CERT Computer Emergency Response Team

chatroom An Internet facility to enable participants to talk online by typing on the keyboard. It occurs in real-time (see *newsgroups*)

CMOS clock A battery-driven device which is the main source for the day and time data associated with each file (see *BIOS*)

communications data In English law, "communication" is information about who is connected to who, when and for how long, but not including the content of the communication. Traffic data is a subset (see Traffic Data).

configuration file	A file normally hidden on a computer that affects the specific way in which an individual program, hardware accessory or entire computer works. On Windows machines, it is often identified by the extension ".ini" (INI files)
cookie	A small text file installed and stored on a computer by a website so that it can track a user's activities and welcome them on a return visit
cryptography	Method used to hide the contents of a file, etc. (see *Encryption*, *Steganography*)
CSIRT	Computer Security Incident Response Team
day and time stamps	Day and time information from an on-board computer clock. All modern operating systems associate with each file a series of day and time stamps, although there are variations.
denial of service (DOS) attack	An attack on an Internet site which involves sending large numbers of messages to that site to overwhelm and prevent it from operating properly
dictionary attack	A common technique to break a password system by writing a program to throw large numbers of "likely" potential passwords at a computer
digital fingerprint	A technique for uniquely identifying identical files (see *hash*)
directory	A hierarchical system of organising files in places where they can be easily found on a computer hard disk (also known as folders)
disclosure	The legal process by which information is fairly made available to opposing counsel and which is subject to a number of rules and obligations (known as "discovery" in the US)
disk acquisition	A process to make an accurate exact copy or "image" of a hard disk, CDROM or other data memory device, creating an intermediate file which can be examined using specialist tools and from which clones of the original can be created
distributed denial of service (DDOS) attack	Using large numbers of computers to attack and overwhelm a target computer (see *denial of service (DOS) attack*)
DNS	Domain Name Server. An essential element of the Internet – a constantly updated collection of computers that translates the name of a computer into its IP address
DNS poisoning	Attacking a DNS so that requests to one website are redirected to another rogue site
dongle	Hardware device, usually connected to a USB or printer port, sometimes used to provide encryption protection to computers, without the dongle the disk can't be "read". Also used as a counter-piracy measure – the dongle is required to make a particular high-value program "run".
DOS (1)	Disk Operating System. Windows, Unix, Linux, MacOS, Solaris, OS/2 and VMS are all operating systems for various items of computer hardware.

DOS (2)	MS-DOS, the Microsoft disk operating system which was common before Windows 95
dynamic IP address	An IP address assigned on an as-needed basis. Over a period of time an individual may use several IP addresses from the same range within the user's Internet Service Provider (ISP) (see *IP address*)
email server	A computer that manages the distribution and reception of email on behalf of a community of users, holding mail until an individual is ready to download it
EnCase	Popular forensic computing suite which is capable of imaging a hard disk and then analysing it
encryption	The translation of files, data, pictures, etc. into a form in which it can only be read/viewed by those authorised to do so. Encryption requires an algorithm (generic method) a key which is only known to participants. In conventional encryption the same key is used by both sender and recipient. Encryption, together with an appropriate management system, can also be used to authenticate documents
expert evidence	In English law, opinion evidence from someone whom the court has decided to accept as an expert (see *technical evidence)*
false positive	Where a system has raised an alarm which on inspection turns out to be misplaced
FAT, FAT32	The Microsoft disk operating system used in MS-DOS and Windows 95, 98, etc. The FAT table contains information about the specific physical locations on disk of files (which may be fragmented) and is also the source of date and time stamp data (see *NTFS*)
file compression	A technique for reducing the size of a file to make it smaller to transmit or store. In "lossless" compression, no original data is lost but many compression schemes involve an "acceptable" level of loss. ZIP, RAR, tar and Stuffit are general-purpose file compression schemes, MP3 is particular to sound files (see *ZIP*)
file-sharing program	A system to enable many people to share files. These files may have an "illegal" element because they violate copyright or are indecent. In order to participate in a file-sharing system, a user may require specialist client software
file signature	A specific series of computer characters at the start of the internal structure (or format) of a file which helps computer applications identify the file.
firewall	Security device for internet-connected computers that is able to limit inbound and outbound traffic. The best firewalls are separate hardware units, although software firewalls exist and can provide a degree of protection
folder	See *directory*
format (1)	of a disk – the creation of an internal structure so that it can hold files. Reformatting consists of replacing an existing scheme with a

	new one, which renders the old files difficult to read and recover without the use of advanced techniques
format (2)	of a file – each computer application creates and reads files with a specific internal structure, known as format
FRP	Forensic Readiness Program
Gb	Gigabyte. A unit of capacity of data or memory (1 Gb = 1024 Mb)
hash	See *digital fingerprint*
hash analysis/ hash libraries	Libraries exist of digital fingerprints for well-known files, for example, those associated with popular operating systems and programs and offensive material. They can be used to scan hard disks rapidly to eliminate files of no interest or to look for files of particular significance
hot-firing	The process by which a clone of an original file is placed in suitable hardware so that what the original user saw can be viewed. The usual result is that data on the hard disk becomes altered and re-cloning may be necessary during an extended examination
HTML	Hypertext Mark-up Language. The language used for creating webpages containing not only content but formatting and other instructions. Many browsers contain a “View Source” option so that code can be viewed easily.
HTTP	Hypertext Transmission Protocol. The protocol of the World Wide Web. HTTPS is a secure version used for e-commerce transactions, etc.
IDS	Intrusion detection system – in effect, a burglar alarm for computer systems
image (1)	A file containing a photograph or a picture
image (2)	The process of making an entire copy of data media such as a hard disk. Some “imaging” programs” are designed to aid data recovery or to support the needs of a large organisation
Internet Relay Chat (IRC)	The international protocol for online chatting. Other web interfaces can be used (see *chatroom*)
IP address	A uniquely identifiable, machine readable, number for each computer or host, on the Internet, that can be used by the Internet Protocol to transmit and receive traffic. Servers, websites and other computers permanently connected to the Internet always have the same, static IP address. Many ISPs allocate users an IP address on an as needed basis – this is known as a ‘dynamic IP address’ as it can change within a range set by the ISP. Over a period of time an individual may have used several IP addresses from within one range.
IP spoofing	A technique for altering or compromising an IP address so that it appears be a third party
ISP	Internet Service Provider. A business or other organisation that links individual users to the Internet and that also provides other associated services such as email management and web space

Java	A programming language frequently used on websites, for example to create online forms or animations
jumper	A small connector on a hardware device such as a motherboard or disk drive. The connector links one or more protruding pins and makes the hardware behave differently, for example, to order which of two hard disks has priority – "master" or "slave"
Kb	Kilobytes. Unit of capacity of data or memory (1024 Kb = 1 Mb)
keystroke monitor/ keylogger	A covert program which captures every keystroke that a computer user makes so that they can be examined later. It can be used to identify passwords and may be part of a Trojan. But it may be deployed also for investigatory surveillance purposes
Linux	Popular operating system, part of the Unix family
logic bomb	Rogue program with a delayed effect which causes damage to data. It may be triggered by time or some external event
macro	An automated sequence of computer commands
Mb	Megabyte. Unit of capacity of data or memory (1024 Kb = 1 Mb)
meta-data	Literally, data about data. Some regular computer files contain hidden additional information which can be viewed
newsgroups	Internet-based discussion groups, one of the oldest Internet "institutions", where participants post messages for later viewing. It can be used to publish attached files (also known as Usenet)
NTFS	The Microsoft Disk Operating System used in Windows NT, 2000 and XP, A replacement for FAT and FAT32. The MFT (Master File Table) contains information about the specific physical locations on disk of files (which may be fragmented) and is also the source of date and time stamp data
Open Source	Computer programs which are written on a "community" basis and are usable without restriction (also known as "freeware"). They may need to be adapted to work well in specific circumstances
packet	The quantity of data sent over a network. Both for efficiency and to allow for error-checking, files are split up into packets for transmission and then re-assembled in the correct order on reception. "Packet switching" is a data transmission technique to maximise the efficient use of physical cables, satellite links, etc.
packet filtering	A technique for listening on a data transmission and selecting packets according to particular criteria
packet sniffer	The device that listens for data transmission (see *packet filtering*)
partition	A means of dividing a hard disk so that it presents itself to the operating system as one or more hard disks (e.g. C:, D:, etc.). The technique separates programs from data files and makes back-up easier; it makes one or more operating systems available on the computer; and it maintains an area containing recovery files. Partitions can also be hidden
payload	The "bomb" or result of a logic bomb or virus

PDH	Pleas and directions hearing. An increasingly important procedure in the English criminal justice system where, prior to a trial, discussions take place about its length, numbers of witnesses, arrangements for experts, dates, etc.
phishing	Creating temporary fake websites to incite visitors to release sensitive information for fraudulent purposes. Usually, users are lured to the fake websites via emails purporting to come from legitimate sources such as banks
phreaking	The abuse of telephone and similar systems
pop-up	Subsidiary windows which appear on the screen during Internet use. These may contain detail related to the main window or for advertising
port	Exit and entry points to a computer system. Internet communications protocols designate a number of ports to a computer system; certain ports always have the same function (port 80 is used for websites, for example). All ports on a computer which are not going to be used should be closed off (see *firewall*)
port scanner	A program which looks for "open" ports – in malicious scanning, leading to computer intrusion and possible abuse
protocol	A set of rules enabling computers and electronic devices to exchange data, etc. in an agreed, pre-defined way
proxy	A device or program that performs an operation while hiding the details from outside scrutiny
PKI	Public Key Cryptography - a more sophisticated version, where there are large numbers of participants to a system, different (paired) keys are used for encryption and decryption – public key cryptography. Encryption, together with an appropriate management system, can also be used to authenticate documents
RADIUS	Remote Authentication Dial In User Service – a log maintained by many ISPs to record who had the use of a specific dynamic IP address at a given time
registry	In modern Windows systems, a normally hidden part of the operating system that holds important configuration and other data
root	The operating system at its most fundamental level of control
root kit	A series of rogue programs used to take control of an operating system
serialing	An ascending unique serial number assigned in situations where a system is recording transactions, so that any attempt at transaction deletion can be seen
server	A program that sits on a network (including the Internet) waiting to respond to requests (see *email server* and *web server*)
spidering	A technique for capturing a website – the program identifies all the internal links on a page and follows them through. Spidering can only capture fixed pages, not ones which are dynamically created
steganography	A techniques for hiding data in an apparently innocent file

swap file	When a computer runs out of memory on its motherboard during use it will "swap" data to the hard disk. The swap file sometimes contains a record of recent activity on the computer
Tb	Terabyte. Unit of capacity of data or memory (1 Tb = 1024 Gb)
TCP/IP	Transmission Control Protocol / Internet Protocol. The set of networking protocols used on the Internet and on some private networks
technical evidence	Evidence which is the result of a specific technical procedure or investigation; "expert evidence", on the other hand, as far as the courts are concerned, can include the opinion of the witness
thumbdrive	A small portable hard disk drive, usually with a Universal Serial Bus adaptor
Tracert (traceroute)	A program used to identify all the links between a computer and the one to which it is connected
Traffic Data	explanation…
Trojan defence	A claim by a defendant that they are not responsible for activities apparently associated with their computer. The counter to the Trojan defence is to search the defendant's computer for signs of a rogue program (see *Trojan horse*)
Trojan horse	A hidden program which covertly opens a port on an Internet-connected computer, enabling the contents of that computer to be viewed and altered and the whole computer to be remotely controlled. To work, the Trojan needs a "server", which is installed on the target computer; and a "client", which the perpetrator uses to send out commands
Unallocated space	Files or fragments of files that do not have an associated entry in an index on the hard disk but are still physically present. Very often they have missing or incomplete date or time stamps. Also known as material from unallocated clusters.
Unix	Family of operating systems which includes GNU-Linux, Solaris, BSD Unix and many others
URL	Universal Resource Locator – the address of a site or file on the world wide web
user profiles	On more sophisticated computer operating systems, a profile of each user with their own desktops, programs, etc, accessed via a separate username and password. The most important user profile is that of the Administrator, who may have complete control of and access to the computer
virus	A self-replicating malicious program. There are many specific definitions that distinguish a virus from a worm (see *worm*)
war-driving	The technique of driving around in a motor vehicle looking for open, unprotected wireless networks
web server	A program holding webpages that will be sent on specific request
whois	An internet facility to find out who owns an IP address or website
worm	A self-replicating malicious program (see *virus*)

write-protect	A hardware or software device used to prevent inadvertent alteration of an original disk
ZIP	A file compression program. A zip file contains one or more compressed files
ZIP disk	Larger capacity removable disk medium
zombie	A third-party computer utilised in a distributed denial of service (DDOS) attack (see *Denial of service (DOS*))

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