

## Chapter 3

# SURVEY OF LAW ENFORCEMENT PERCEPTIONS REGARDING DIGITAL EVIDENCE

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**Abstract** This paper analyzes state and local law enforcement agents' perceptions about prosecutors' knowledge of digital evidence and their willingness to prosecute cases involving digital evidence, and agents' perceptions about judges' knowledge of digital evidence and their willingness to admit digital evidence in legal proceedings. Statistical analysis indicates that a significant negative correlation exists between the size of the population served by law enforcement agents and their perceptions about judges' knowledge of digital evidence and willingness to admit digital evidence. Also, positive relationships exist between the size of the population served and law enforcement perceptions of prosecutors' knowledge of digital evidence and willingness to prosecute digital evidence cases, and perceptions about judges' willingness to admit digital evidence. The implications of these findings are discussed along with suggestions for future research.

**Keywords:** State and local law enforcement, digital evidence, prosecutors, judges

## 1. Introduction

Digital forensics has recently garnered a considerable amount of attention. Numerous articles have been published on issues ranging from the lack of trained investigators and the use of *ad hoc* procedures to the difficulty of coping with massive amounts of electronic evidence [3–5, 11]. Other issues include the lack of standards in the discipline of digital forensics and the paucity of certifications for practitioners [12, 14]. Most experts agree that systematic educational and research and development initiatives are required if digital forensics is to obtain the scientific and

legal status of other forensic sciences such as DNA and latent fingerprint analysis [2, 9, 14].

Meanwhile, several studies have focused on the needs of the law enforcement community [1, 8, 14, 15]. The studies have identified that law enforcement needs advanced tools for extracting and analyzing digital evidence, especially evidence residing in large-scale distributed networks. Agencies also require more resources for equipment and personnel, and for education and training of existing personnel.

What is lacking, however, are studies that examine how law enforcement agencies are dealing with the ubiquity of digital evidence in criminal investigations, not just those involving electronic crimes. Certain federal agencies have indicated at least 80% of all cases involve digital evidence, and the volume of evidence per case is increasing (albeit not as rapidly as Moore's law). The quantity and complexity of digital evidence are expected to overwhelm law enforcement capabilities. Moreover, the legal community and the judiciary are unprepared to deal with the digital evidence brought into legal proceedings. According to a preliminary study by Losavio and colleagues [10], judges, in general, are uncomfortable with their knowledge of digital evidence. Furthermore, they are unsure about the weight that should be given to digital evidence and whether or not digital evidence should be admitted at trial.

Meanwhile, no studies have been published about how prosecutors and defense lawyers feel about their own abilities regarding digital evidence and their willingness to deal with cases involving digital evidence. Even more important are the perceptions of state and local law enforcement agents (796,518 officers in 17,784 agencies in the United States according to the most recent census [13]), who constitute the first line in the investigative process and who are, therefore, most affected by the quantity and complexity of digital evidence.

This paper attempts to fill a gap in the understanding of the perceptions of state and local law enforcement agents related to digital evidence. In particular, it analyzes state and local law enforcement agents' perceptions about prosecutors' knowledge of digital evidence and their willingness to prosecute cases involving digital evidence. Also, it examines agents' perceptions about judges' knowledge of digital evidence and their willingness to admit digital evidence in legal proceedings.

## **2. Law Enforcement Survey**

The law enforcement survey described in this paper is part of a larger study sponsored by the National Institute of Justice (NIJ) that examined digital evidence in the context of U.S. state and local law enforce-

ment agencies. This larger study followed up on the work of Appel and Pollitt [1] that investigated how state, local and tribal law enforcement agencies were coping with investigations involving digital evidence.

This paper focuses on two issues regarding state and local law enforcement agents. The first deals their perceptions about prosecutors' knowledge of digital evidence and their willingness to prosecute cases involving digital evidence. The second relates to agents' perceptions about judges' knowledge of digital evidence and their willingness to admit digital evidence at trial. These two issues were chosen because they build on the research conducted by Losavio and co-workers [10], which examined Kentucky circuit court judges' knowledge and attitudes regarding digital evidence.

Given the dearth of research related to digital evidence in general, and state and local law enforcement agencies in particular, the study reported in this paper was strictly exploratory in nature. No hypotheses were tested; rather, the survey was designed to add to the limited knowledge base in the area.

### 3. Survey Methodology

This section discusses the survey methodology, including the survey participants and the survey instrument.

#### 3.1 Survey Participants

The respondents were drawn from state and local law enforcement agencies in the United States. The agencies were selected from the National Public Safety Information Bureau's database. The sample included the 200 largest agencies, and a stratified sample of municipal and county agencies as well as state bureaus of investigation where appropriate ( $N = 279$ ). The respondents, who were contacted by mail, were asked to answer a series of questions about digital evidence. A total of 667 surveys were mailed; 279 surveys were returned, resulting in a response rate of 41.8%.

Each survey questionnaire was accompanied by a cover letter that presented the objective of the study and the principal investigator's contact information. The cover letter also provided a guarantee of anonymity and discussed the survey's adherence to guidelines related to research involving human subjects. A self-addressed stamped envelope was included for returning the completed questionnaire.

Table 1 shows the numbers of respondents from various law enforcement agencies. The majority of the respondents were from municipal agencies (49.5%).

Table 1. Respondents by agency type.

Type of Agency	Freq.	Pct.
Municipal	138	49.5
County Sheriff	70	25.1
County Police	19	6.8
State Police	43	15.4
Marshal	3	1.1
Bureau of Investigation	3	1.1
Merged County and Municipal	1	0.4
State Sheriff	1	0.4
City Sheriff	1	0.4
Total	279	100.0

Table 2. Respondents by state (Total: 279).

State	Freq.	Pct.	State	Freq.	Pct.
Alabama	4	1.4	Montana	0	0.0
Alaska	1	0.4	Nebraska	4	1.4
Arizona	7	2.5	Nevada	2	0.7
Arkansas	3	1.1	New Hampshire	3	1.1
California	19	6.8	New Jersey	7	2.5
Colorado	4	1.4	New Mexico	4	1.4
Connecticut	1	0.4	New York	11	3.9
Delaware	0	0.0	North Carolina	5	1.8
Florida	12	4.3	North Dakota	2	0.7
Georgia	17	6.1	Ohio	12	4.3
Hawaii	2	0.7	Oklahoma	3	1.1
Idaho	2	0.7	Oregon	5	1.8
Illinois	10	3.6	Pennsylvania	5	1.8
Indiana	8	2.9	Rhode Island	2	0.7
Iowa	5	1.8	South Carolina	4	1.4
Kansas	8	2.9	South Dakota	3	1.1
Kentucky	7	2.5	Tennessee	7	2.5
Louisiana	7	2.5	Texas	14	5.0
Maine	0	0.0	Utah	2	0.7
Maryland	6	2.2	Vermont	1	0.4
Massachusetts	5	1.8	Virginia	10	3.6
Michigan	9	3.2	Washington	5	1.8
Minnesota	5	1.8	West Virginia	6	2.2
Mississippi	2	0.7	Wisconsin	8	2.9
Missouri	9	3.2	Wyoming	1	0.4

Table 3. Zero order correlations.

	TA	PS	PK	PW	JK	JW
TA	1.00					
PS	0.49 <sup>1</sup>	1.00				
PK	0.22 <sup>1</sup>	-0.04	1.00			
PW	0.22 <sup>1</sup>	-0.05	0.90 <sup>1</sup>	1.00		
JK	0.13 <sup>2</sup>	-0.16 <sup>2</sup>	0.77 <sup>1</sup>	0.81 <sup>1</sup>	1.00	
JW	0.16 <sup>2</sup>	-0.17 <sup>2</sup>	0.72 <sup>1</sup>	0.80 <sup>1</sup>	0.91 <sup>1</sup>	1.00

<sup>1</sup>  $p < 0.01$ ; <sup>2</sup>  $p < 0.05$

TA: Type of agency; PS: Population served; PK: Prosecutors' knowledge of digital evidence; PW: Prosecutors' willingness to prosecute; JK: Judges' knowledge of digital evidence; JW: Judges' willingness to admit digital evidence.

Table 2 presents the distribution of respondents by state. The state with the largest number of respondents was California ( $n = 19$  agencies, 6.8%).

### 3.2 Survey Instrument

The survey instrument was developed based on other instruments that have been used to study law enforcement needs related to digital evidence and electronic crime [1, 7, 8, 15]. The questionnaire consisted of 34 items. The first five items collected demographic information about respondents. The remaining questions consisted of Likert scale dichotomous questions (yes/no) and two free-form questions. For heuristic purposes, the Likert scale answers were treated as interval data for the correlational analysis only.

## 4. Survey Results

The survey data was analyzed for outliers, missing data and violations of test assumptions using standard SPSS procedures. Given the exploratory nature of the study, a two-tailed test of significance ( $p = 0.05$ ) was used.

### 4.1 Correlation Analysis

The results of a zero order correlation analysis are presented in Table 3. The analysis indicates that a positive correlation exists between perceptions of judges' knowledge related to digital evidence and perceptions about their willingness to admit digital evidence at trial ( $r = 0.91$ ,  $p = 0.00 < 0.01$ ) (see Table 3). Also, positive correlations exist between perceptions of judges' knowledge and (i) perceptions of pros-

Table 4. Percentages of criminal investigations involving digital evidence.

Type of Agency	≤25%	26-59%	51-75%	76-100%
Municipal	108 (88.5%)	8 (6.6%)	1 (0.8%)	5 (4.1%)
County Sheriff	44 (66.7%)	9 (13.6%)	9 (13.6%)	4 (6.1%)
County Police	13 (68.4%)	3 (15.8%)	2 (10.5%)	1 (5.3%)
State Police	33 (86.8%)	3 (7.9%)	1 (2.6%)	1 (2.6%)
Marshal	2 (66.7%)	1 (33.3%)	0 (0.0%)	0 (0.0%)
Bureau of Investigation	1 (33.3%)	1 (33.3%)	1 (33.3%)	0 (0.0%)
Merged County and Municipal	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	202 (80.2%)	25 (9.9%)	14 (5.6%)	11 (4.4%)

ecutors' knowledge about digital evidence ( $r = 0.77$ ,  $p = 0.00$ ), and (ii) perceptions of prosecutors' willingness to prosecute cases involving digital evidence ( $r = 0.81$ ,  $p = 0.00$ ). Moreover, positive correlations exist between perceptions of judges' willingness to admit digital evidence and (i) perceptions of prosecutors' knowledge about digital evidence ( $r = 0.72$ ,  $p = 0.00$ ), and (ii) perceptions of prosecutors' willingness to prosecute cases involving digital evidence ( $r = 0.80$ ,  $p = .001$ ).

The results in Table 3 also show that negative correlations exist between the size of the population served by law enforcement agencies and (i) perceptions of judges' knowledge about digital evidence ( $r = -0.17$ ,  $p = 0.01$ ), and (ii) perceptions of judges' willingness to admit digital evidence ( $r = -0.16$ ,  $p = 0.01$ ). In other words, judges in smaller communities were perceived to be less willing to prosecute cases with digital evidence.

Positive correlations exist between the type of law enforcement agency and (i) perceptions of judges' knowledge of digital evidence ( $r = 0.13$ ,  $p = 0.04$ ), (ii) perceptions about judges' willingness to admit digital evidence ( $r = 0.16$ ,  $p = 0.01$ ), (iii) perceptions about prosecutors' knowledge of digital evidence ( $r = 0.22$ ,  $p = 0.00$ ), and (iv) perceptions about prosecutors' willingness to prosecute cases involving digital evidence ( $r = 0.22$ ,  $p = 0.00$ ).

## 4.2 Contingency Table Analysis

Table 4 summarizes the survey respondents' assessments of the percentages of criminal investigations that involved digital evidence. Note that 80% ( $n = 202$ ) of the respondents reported that no more than 25% of investigations involved digital evidence, and only 4.4% ( $n = 11$ ) of the respondents reported percentages greater than 76%. Moreover, there is

Table 5. Prosecutors' knowledge of digital evidence.

Population	L	S	ML	K	VK	NA	U	Total
≤50K	32 31.4%	21 20.6%	31 30.4%	10 9.8%	1 1.0%	3 2.9%	4 3.9%	102 100.0%
50K-100K	3 27.3%	2 18.2%	3 27.3%	1 9.1%	0 0.0%	1 9.1%	1 9.1%	11 100.0%
100K-250K	9 32.1%	5 17.9%	11 39.3%	2 7.1%	0 0.0%	0 0.0%	1 3.6%	28 100.0%
250K-1M	9 13.4%	15 22.4%	24 35.8%	10 14.9%	7 10.4%	2 3.0%	0 0.0%	67 100.0%
>1M	5 9.6%	9 17.3%	22 42.3%	8 15.4%	5 9.6%	0 0.0%	3 5.8%	52 100.0%
Total	58 22.3%	52 20.0%	91 35.0%	31 11.9%	13 5.0%	6 2.3%	9 3.5%	260 100.0%

L: Limited knowledge; ML: Moderately limited knowledge; K: Knowledgeable; VK: Very knowledgeable; NA: Not applicable; U: Unknown.

no significant association between type of law enforcement agency and the percentage of cases involving digital evidence.

As this study was exploratory in nature, the traditional threshold of  $r = 0.20$  for determining the relationships to investigate further was not followed. Each of the significant correlations stated was examined. The contingency table analysis indicates that with regard to the population served variable, only perceptions about (i) prosecutors' knowledge of digital evidence (likelihood ratio = 41.24,  $df = 20$ ,  $p = 0.02$ ), (ii) prosecutors' willingness to prosecute cases involving digital evidence (likelihood ratio = 31.5,  $df = 24$ ,  $p = 0.02$ ), and (iii) judges' willingness to admit digital evidence in cases (likelihood ratio = 34.32,  $df = 20$ ,  $p = 0.02$ ) were significant (see Tables 5, 6 and 7, respectively). Note that the population served variable was collapsed into five categories to reduce the number of cells with expected counts that are less than five.

## 5. Discussion of Results

The correlation analysis findings are not surprising, although care must be taken when interpreting the results because the dependent and independent variables are ordinal. The positive correlations between law enforcement agents' perceptions of prosecutors' and judges' knowledge of digital evidence and their willingness to prosecute cases/admit digital evidence are to be expected.

In general, law enforcement agencies in urban areas tend to serve larger populations. Therefore, the negative correlation between the pop-

Table 6. Prosecutors' willingness to prosecute cases involving digital evidence.

Population	NW	SW	MW	EW	NA	U	Total
≤50K	1 1.0%	39 39.0%	36 36.0%	16 16.0%	2 2.0%	6 6.0%	100 100.0%
50K-100K	0 0.0%	2 18.2%	5 45.5%	3 27.3%	1 9.1%	0 0.0%	11 100.0%
100K-250K	0 0.0%	7 25.0%	13 46.4%	7 25.0%	0 0.0%	1 3.6%	28 100.0%
250K-1M	1 1.5%	10 14.9%	25 37.3%	28 41.8%	2 3.0%	1 1.5%	67 100.0%
>1M	2 3.9%	12 23.5%	21 41.2%	13 25.5%	0 0.0%	3 5.9%	51 100.0%
Total	4 1.6%	70 27.2%	100 38.9%	67 26.1%	5 1.9%	11 4.3%	257 100.0%

NW: Not at all willing; Somewhat willing; Moderately willing; Extremely willing;  
 NA: Not applicable; U: Unknown.

Table 7. Judges' willingness to admit digital evidence.

Population	NW	SW	MW	EW	NA	U	Total
≤50K	2 2.2%	28 31.1%	35 38.9%	10 11.1%	4 4.4%	11 12.2%	90 100.0%
50K-100K	0 0.0%	2 22.2%	4 44.4%	1 11.1%	1 11.1%	1 11.1%	9 100.0%
100K-250K	0 0.0%	4 14.8%	15 55.6%	7 25.9%	0 0.0%	1 3.7%	27 100.0%
250K-1M	0 0.0%	9 13.2%	39 57.4%	17 25.0%	1 1.5%	2 2.9%	68 100.0%
>1M	0 0.0%	7 13.7%	30 58.8%	11 21.6%	0 0.0%	3 5.9%	51 100.0%
Total	2 0.8%	50 20.4%	123 50.2%	46 18.8%	6 2.4%	18 7.3%	245 100.0%

NW: Not at all willing; Somewhat willing; Moderately willing; Extremely willing;  
 NA: Not applicable; U: Unknown.

ulation served variable and perceptions of judges' knowledge and willingness to admit digital evidence may be an artifact of urban versus rural attitudes and the ubiquity of technology in urban settings, which would result in greater awareness and comfort in dealing with digital evidence. Note that all the correlations are lower than the usual threshold of  $r = 0.20$  and are relatively weak.



The same observations hold for the positive correlations between the type of law enforcement agency and perceptions about prosecutors' and judges' knowledge of digital evidence and their willingness to prosecute cases/admit digital evidence. The correlations are also relatively weak. Intuitively, prosecutors and judges in urban areas have more exposure and comfort with digital evidence. Also, larger agencies typically have significant personnel and technological resources, enabling them to process digital evidence quickly and efficiently.

The results of contingency table analysis are very interesting. For one, 80% of the respondents reported that no more than 25% of their cases involved digital evidence. This is inconsistent with estimates reported by federal agencies (e.g., approximately 80% of the FBI's cases involve some form of digital evidence).

Even more interesting is the fact that agents from municipal departments reported that most of their cases did not involve digital evidence. One plausible reason is that state and local law enforcement agents mainly focus on traditional physical and/or document-based evidence because they have limited knowledge and resources to deal with digital evidence. This is consistent with the findings of several studies (e.g., [1, 7, 8, 14, 15]) that state and local law enforcement agents have inadequate training and resources for investigating computer crimes and cases involving digital evidence. This finding is troubling as valuable evidence is possibly being overlooked by law enforcement, which may result in dropped or reduced charges as well as wrongful convictions.

Positive relationships exist between the population served variable and perceptions of prosecutors' and judges' knowledge and willingness to prosecute cases/admit digital evidence. Law enforcement agents from larger communities indicated that prosecutors and judges had moderate knowledge and exhibited moderate willingness to prosecute cases/admit digital evidence. However, the Somers'  $d$  values for the contingency tables, while positive, were less than 0.20, which indicate weak relationships. These relationships are not surprising as they may be indicative of the rural versus urban effect.

Despite the positive finding using zero order correlation, contingency table analysis did not reveal a significant relationship between the population served variable and perceptions of judges' knowledge about digital evidence. This may be due to the fact that both variables are ordinal, which can affect Pearson correlation analysis. Specifically, problems arise when Likert scale data is treated as interval scale data. In such cases, contingency table analysis using a likelihood ratio is more appropriate. Note also that in the contingency table analysis, several cells

had expected counts less than five; this required the use of the likelihood ratio to determine significance.

Since the survey was restricted to U.S. state and local law enforcement agents, caution must be exercised when attempting to generalize these findings to the international community. Future studies should examine the international law enforcement community's perceptions and capabilities related to digital evidence.

## 6. Conclusions

The exploratory study of the perceptions of state and local law enforcement agents provides guidance on conducting further investigations on attitudes and requirements related to the use of digital evidence in legal proceedings. The study also provides empirical support for anecdotal reports about law enforcement perceptions regarding digital evidence. The study finds that the current situation regarding digital evidence is similar to how it was with DNA evidence some years ago. Specifically, in the face of limited education, training and awareness, professionals are unwilling to compromise cases by attempting processes (law enforcement agents) and procedures (attorneys and judges) with which they are unfamiliar. The question is: How do we educate and train "teams" of professionals (law enforcement agents, attorneys and judges) who are willing to treat digital evidence with the same familiarity as physical evidence and to use it as evidence in legal proceedings?

Clearly, law enforcement agents from larger organizations with more resources for education, training and awareness, and better facilities for processing digital evidence would be more willing to treat digital evidence in a more routine manner. However, when one considers that the overwhelming majority (approximately 90%) of U.S. law enforcement agencies are relatively small, it is troubling to note that valuable evidence is likely being overlooked by law enforcement, which may result in dropped or reduced charges as well as wrongful convictions. It is, therefore, extremely important to implement broad initiatives that raise the level of expertise of state and local law enforcement agents (as well as attorneys and judges) to ensure that digital evidence is introduced routinely and successfully in legal proceedings.

## References

- [1] E. Appel and M. Pollitt, Report on the Digital Evidence Needs Survey of State, Local and Tribal Law Enforcement, National Institute of Justice, U.S. Department of Justice, Washington, DC ([www.jciac.org/docs/Digital%20Evidence%20Survey%20Report.pdf](http://www.jciac.org/docs/Digital%20Evidence%20Survey%20Report.pdf)), 2005.

- [2] H. Armstrong and P. Russo, Electronic forensics education needs of law enforcement, *Proceedings of the Eighth Colloquium on Information Systems Security Education*, 2004.
- [3] M. Caloyannides, *Computer Forensics and Privacy*, Artech House, Norwood, Massachusetts, 2001.
- [4] E. Casey (Ed.), *Handbook of Computer Crime Investigation: Forensic Tools and Technology*, Elsevier, London, United Kingdom, 2002.
- [5] R. Clifford, D. Moreau, M. Miquelon-Weismann, D. Lamb, I. Orton, J. Savage and S. Brenner, *Cybercrime: The Investigation, Prosecution and Defense of Computer-Related Crime*, Carolina Academic Press, Durham, North Carolina, 2006.
- [6] B. Etter, The challenges of policing cyberspace, *Proceedings of the NetSafe II Conference* ([www.netsafe.org.nz/Doc\\_Library/netsafepapers\\_barbaraetter\\_policing.pdf](http://www.netsafe.org.nz/Doc_Library/netsafepapers_barbaraetter_policing.pdf)), 2003.
- [7] Institute for Security Technology Studies (ISTS), Law Enforcement Tools and Technologies for Investigating Cyber Attacks: A National Needs Assessment, Dartmouth College, Hanover, New Hampshire ([www.ists.dartmouth.edu/TAG/lena.htm](http://www.ists.dartmouth.edu/TAG/lena.htm)), 2002.
- [8] Institute for Security Technology Studies (ISTS), Law Enforcement Tools and Technologies for Investigating Cyber Attacks: Gap Analysis Report, Dartmouth College, Hanover, New Hampshire ([www.ists.dartmouth.edu/TAG/gap\\_analysis.htm](http://www.ists.dartmouth.edu/TAG/gap_analysis.htm)), 2004.
- [9] E. Lambert, T. Nerbonne, P. Watson, J. Buss, A. Clarke, N. Hogan, S. Barton and J. Lambert, The forensic science needs of law enforcement applicants and recruits: A survey of Michigan law enforcement agencies, *Journal of Criminal Justice Education*, vol. 14(1), pp. 67–81, 2003.
- [10] M. Losavio, J. Adams and M. Rogers, Gap analysis: Judicial experience and perception of electronic evidence, *Journal of Digital Forensic Practice*, vol. 1(1), pp. 13–17, 2006.
- [11] A. Marcella and R. Greenfield (Eds.), *Cyber Forensics: A Field Manual for Collecting, Examining and Preserving Evidence of Computer Crimes*, Auerbach/CRC Press, Boca Raton, Florida, 2002.
- [12] R. Mercuri, Challenges in forensic computing, *Communications of the ACM*, vol. 48(12), pp. 17–21, 2005.
- [13] B. Reaves and M. Hickman, Census of state and local law enforcement agencies, 2000, *Bureau of Justice Statistics Bulletin*, NCJ 194066, U.S. Department of Justice, Washington, DC ([www.ojp.usdoj.gov/bjs/pub/pdf/cslllea00.pdf](http://www.ojp.usdoj.gov/bjs/pub/pdf/cslllea00.pdf)), 2002.

- [14] M. Rogers and K. Seigfried, The future of computer forensics: A needs analysis survey, *Computers and Security*, vol. 23(1), pp. 12–16, 2004.
- [15] H. Stambaugh, D. Beaupre, D. Icove, R. Baker, W. Cassady and W. Wiliams, State and local law enforcement needs to combat electronic crime, National Institute of Justice, U.S. Department of Justice, Washington, DC ([www.ncjrs.gov/pdffiles1/nij/183451.pdf](http://www.ncjrs.gov/pdffiles1/nij/183451.pdf)), 2000.