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Distracted Driving: Determining Cell Phone Usage from Forensic Cellular Records

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Abstract

This paper presents an analysis of an alleged texting-while-driving collision case involving cellular call records. The plaintiff's expert, unfamiliar with cellular networks, made serious errors in interpreting the cellular records, which resulted in a mischaracterization of the defendant's cell phone usage at the time of the collision. Thus, the plaintiff's expert could not support his opinion that the defendant was using her phone at the time of the collision. The expert made three critical mistakes interpreting the cellular records — mistakes that are commonly made by analysts who are unfamiliar with the design and operation of cellular phone networks. This paper explains the common mistakes and faulty assumptions behind them. The proper analysis methods of a qualified engineer with an understanding of cellular networks are also presented.

Keywords

Auto collision, base station records, call detail records, CDR, cell phones, cell phone usage, cellular records, distracted driving, mobile phones, mobile phone records, forensic engineering

Introduction

According to the National Highway Transportation Safety Administration (NHTSA), more than 3,500 people were killed on U.S. highways as a result of distracted driving in 2021[1]. Additionally, the National Institute for Occupational Safety and Health (NIOSH) states that in 2020, 13% of all motor vehicle traffic crashes in the United States involved distraction[2]. These crashes have been attributed to novice and experienced drivers alike[3]. Distracted driving is defined as any activity that diverts a driver's attention from driving, which includes cell phone usage[1]. Cell phone distractions are especially dangerous because sending/reading a text or checking social media updates can take a driver's eyes off the road for several seconds.

Forty-eight states have text messaging bans in place for all drivers[4]. These restrictions help to limit a driver's distractions when operating a motor vehicle. When an automobile collision occurs, a driver may claim that the motorist who crashed into him was texting at the time of the collision and was distracted. If proven true, additional penalties may exist for the texting driver. For example, the plaintiff may be able to sue the defendant for negligence.

There are two main sources of evidence engineers and analysts may use to determine if a driver was texting at the time of a collision: records from the cellular carrier and the cell phone itself. Cellular carrier records are commonly referred to as call detail records (CDRs).

This paper analyzes the assumptions and methods of two experts in a particular case. The plaintiff's expert found the defendant driver was using her phone at the time of the collision; the defense expert found she was not. This case demonstrates how an expert's assumptions and methods affect conclusions — and why it is so important to retain qualified engineers with a background in cellular networks to review forensic cellular records.

Case Background

A motor vehicle collision occurred involving a delivery truck and a car. The delivery truck driver (defendant) who caused the collision was employed by a national auto parts store (for the sake of this paper, we will call this company "ABC Auto Parts"). She was making a delivery in an ABC Auto Parts truck to one of the company's retail stores. The delivery driver was found to be at fault for the collision; therefore, she was responsible for the damage. Additionally, the motorist she crashed into (plaintiff) claimed that ABC's driver was texting at the time of the collision. Given this claim, the plaintiff also sought to sue ABC Auto Parts and their driver for negligence.

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The plaintiff's lawyers hired an expert to review the defendant's CDR. The plaintiff's expert determined from the CDR that ABC's driver was using her cell phone at the time of the collision. Likewise, the ABC Auto Parts' counsel hired an expert to review the same cellular records. The defendant's expert determined that ABC's driver was not using her cell phone at the time of the collision. Both experts examined the same CDR yet came to different conclusions.

Both experts cannot be right. As it turned out, the plaintiff's expert had no background or understanding of the design or operation of mobile cellular networks. His conclusions were based upon unfounded assumptions and incorrect methods. This undermined the plaintiff's negligence claim against ABC Auto Parts. That is why a background in cellular network design and operation is necessary to provide an accurate and reliable analysis of CDRs.

About Cellular Call Detail Records

Cellular CDRs are essentially cellular carrier phone records. Obtained from cellular carriers with a subpoena from a lawyer, they are basically logs of transactions (calls, texts, data, etc.) contained in spreadsheets. It is not possible for forensic engineers to obtain the records on their own authority, although individual cellular customers may request their own records.

The records typically contain information on voice, message, and data transactions for a given phone number. In the CDR, a "call" can be a telephone call (voice transaction) or an SMS message (texting transaction). Each voice and message transaction in the record typically includes a time stamp (in the UTC time standard), call direction (incoming or outgoing), the number that initiated the call, the number that received the call, location information, and other cellular network information. This can include the base stations (or towers), sectors, and switches used to route the call. Entries are added to a user's call record whenever a call or text is sent or received. Data transactions can be entered separately.

Some of this information is only available if the call was routed over a long-term evolution (LTE) cellular network. Calls routed over an internet protocol (IP), Wi-Fi network, or the public switched telephone network (PSTN) may include different information.

CDRs are not archived by the carriers indefinitely. Most carriers retain the full records for a period of up to two years. After that, limited records may be available. Billing information from the CDRs is typically retained for longer periods of time.

The CDRs are often provided in spreadsheets, and many people are proficient in analyzing spreadsheet data. However, without sufficient knowledge of cellular networks, it is unlikely that the CDR spreadsheet data could be interpreted correctly. Although these records may appear self-explanatory, analysts without a strong understanding of the design and operation of cellular networks can make critical mistakes in interpreting CDRs. These mistakes — and the poor methods that accompany them — do not yield proper understanding or facts. In fact, in this case, the plaintiff's expert issued a total of three reports: an original report, a revised report (to correct the first mistake), and a second revised report (to correct the second mistake). These mistakes and poor methods are described in detail below.

Three Common Mistakes

Although competent with analyzing spreadsheet data, the plaintiff's expert had no background in cellular network design or operation. The three mistakes the plaintiff's expert made are common among inexperienced cellular analysts. These mistakes are discussed below along with the impact they had on the case.

Three common mistakes people make when analyzing CDRs are:

1. Time zone conversion errors.

2. Attributing handoffs (or handovers from one base station to another) to indicate phone activity initiated by the user.

3. Attributing increased data usage to the phone user.

Time Zone Conversions

The CDR entries include a time stamp indicating when an activity occurred. Because of the complexity of timekeeping on nationwide cellular networks, the cellular carriers may store time stamps in one common time standard, such as Universal Time Coordinated or UTC, which is also called Universal Coordinate Time and Coordinated Universal Time. It is the basis for local times worldwide. UTC is similar to Greenwich Mean Time (GMT) and is referred to as "Zulu" time in military settings. UTC is a fixed time standard at zero degrees longitude (the Prime Meridian). UTC does not observe Daylight Savings Time (DST).

To properly evaluate the records, the time stamps must be translated from UTC to the local time zone where the crash took place (in this case, Central Daylight Time or CDT). When the plaintiff's expert did the conversion, he didn't account for DST in the local time zone. He reported:

> *The defendant's cellular records show an outgoing call that started at 6:43:25 PM and lasted until 6:43:53 PM for a duration of 28 seconds. These facts indicate that the defendant was on her cell phone at the time of or immediately before the crash.*

However, the CDR shows that this outgoing call occurred one hour after the crash at 7:43 PM CDT (00:43 UTC). Thus, the conversion from UTC to CDT is [-5] hours. Stated another way, the CDT time zone offset is UTC-5. The plaintiff's expert did not account for DST in the time conversion. Instead, he mistakenly used UTC-6 for the offset.

To correctly convert from UTC to local time zones, four items are required:

1. The UTC time stamp.
2. The local time zone (e.g., Eastern, Central, Mountain, Pacific).
3. The local date.
4. Whether the local time zone is affected by DST.

It is important to note that not all localities observe DST, and the dates when DST begins and ends each year change. To avoid mistakes, analysts can use appropriate computer functions or libraries that perform the conversions automatically.

As a result of this mistake, the plaintiff's expert issued his first revised report in which he corrected his error. In this report, he committed another error, which is described below.

Misunderstanding Handoffs

In the plaintiff's expert's next report, once again he concluded that the defendant was on the phone at the time of the collision. This time, he based his opinion on the fact that the CDR showed there were multiple handoffs between the mobile phone and the neighboring base stations just before the collision.

Handoffs occur when a cell phone switches from one base station, sector, or channel to another in order to stay connected to the cellular network[5,6]. Handoffs are also referred to as "handovers." Base stations are also referred to as "towers" in colloquial language. The plaintiff's expert stated these frequent handoffs occurred because the defendant was on her phone and that her phone usage caused the handoffs to occur. He wrote:

> *The defendant's cellular records show that her phone switched base stations several times just before the crash. These facts indicate that the defendant was using her cell phone at the time of or immediately before the crash.*

The plaintiff's expert did not account for the fact that a mobile cell phone autonomously switches among base stations to maintain the best connection to the network — even when it's not in use. Thus, mobile cell phone connections are handed-off among base stations, sectors, and even communication channels without any input from the user. Handoffs occur when a mobile phone moves out of range from one base station or sector and into range of another[5,6]. These handoffs can occur frequently when a mobile phone traverses the service borders of base stations or sectors. Handoffs occur even when the phone is not in use. For a handoff not to occur, the phone would have to be turned off or put in airplane mode.

Information in the CDR showed that the collision occurred in an area along the border between two base stations. Frequent handoffs, as those shown in the CDR, should be expected. The phone's user has no control over the handoffs. Additionally, handoffs among base stations, sectors, and channels occur even when a phone is not in use[5,7].

It was incorrect for the plaintiff's expert to attribute the frequent handoffs that occurred just before the collision to the defendant's phone use. Handoffs provide no evidence of phone use, as they occur autonomously — even when a phone is not in use. Once again, the plaintiff's expert could not support his opinion that the defendant was on the phone at the time of the collision. His methods did not result in knowledge or facts.

Misattributing Data Throughput

The CDR also contains information on data throughput — that is, how much data is transferred to and from the phone at given times. Sources of data throughput include user data, such as phone calls, messages, web browsing,

streaming services, emails, etc., and control data. Control data includes channel assignments, power level assignments, quality-of-service metrics, etc. Control data are also used to facilitate handoffs.

In the third revision to his report, the plaintiff's expert again concluded that the defendant was on her phone at the time of the collision. This time, he attributed his conclusion to the fact that the CDR showed there was an increase in data throughput (or data usage) just before the collision. He reported:

> *The defendant's cellular records show a fourfold increase in data throughput prior to the accident. Both the bytes up (transmit) and bytes down (receive) data increased. These facts indicate that the defendant was using her cell phone at the time of the accident.*

Although the CDR did show an increase in data throughput just before the collision, it cannot be attributed to the phone user. Just as with handoffs, data usage can increase autonomously without any input or activity from the user.

Data throughput consists of two types of data: user-initiated data and network-initiated data[8].

User-initiated data result when the phone user interfaces with the phone and sends or receives data. Examples of user-initiated data include sending emails, texts, or multimedia messages; surfing the web; and posting messages, photos, or videos on social media.

Network-initiated data include information sent over the network's control channels. Control channels are special radio channels used by the phone and the base stations to establish and maintain a reliable connection. When the control channels are active, network-initiated data are being transferred, and data usage will increase. Additionally, this data usage can increase even when the phone is not in use. The phone user has no control over the network-initiated data. The control channels send and receive information without any input from the user. In fact, this process is transparent to the user[8,9].

The defendant's cellular carrier did not differentiate between user-initiated data throughput and network-initiated data throughput in the CDR. Many carriers do not. Data is data, regardless of its source. As a result, it was not possible to distinguish the two data sources. Therefore, the data throughput listed in the CDR could not be attributed to the defendant. In fact, the cellular provider stated that it:

> *[D]oes not retain records that can definitively show whether a transaction was a customer-initiated or network-initiated data transaction.*

Additionally, mobile phone apps can transfer data without any input from the user, increasing data throughput. This can occur when certain apps are running on a phone in either the foreground or background. For example:

- Google Maps can transfer data to and from the user without any user input when it's being used for navigation. This activity will increase data throughput.
- Streaming apps, such as iHeart Radio, Spotify, or Apple Music, will increase data throughput without any input from the user.
- A phone's email app could download a message to the phone with a large attachment, increasing data throughput — without any input from the user.

These are just a few examples of how different apps can autonomously increase a user's data throughput.

To distinguish the user-initiated from the network-initiated data would require an examination of the phone itself along with the CDR. Even then, it may not be possible to attribute all data transactions.

Conclusions

Although the CDRs are supplied in spreadsheets, it is important that reviewers of these spreadsheets have a solid understanding of cellular networks.

When reviewed by a qualified forensic engineer with a solid understanding of cellular networks, the following conclusions can be made about the information in the defendant's CDR:

- No voice phone calls took place immediately preceding or at the time of the collision.
- No text messaging took place immediately preceding or at the time of the collision.
- The handoffs that took place preceding the

collision occurred autonomously and do not indicate any type of phone activity by the defendant.

- The increased data throughput that occurred preceding the collision cannot positively be attributed to the defendant and do not indicate any type of phone activity by the defendant.

- The CDR provides no evidence that the ABC Auto Parts delivery truck driver was distracted by her cell phone.

This case study demonstrates the importance of retaining a forensic engineer knowledgeable in cellular network design and operation to review forensic call detail records. This constitutes the most reliable method to ensure accurate and reliable analysis of the records.

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