Reconstruct Accident with Cell Phone Data

Summary of two cases, one criminal and one civil

Introduction

There were 1,664,598 accidents that caused injury and 39,221 accidents that caused death in the US in 2022 according to the National Highway Traffic Safety Administration. [1] According to the data 12% of the fatal crashes and 10% of the injury crashes involved cell phone use. Many of these accidents end up as legal cases both criminal and civil. Accident reconstruction is critical in determining who is at fault and who is not at fault.

Accident reconstruction typically utilizes experts that evaluate the site, and through specialized software, enter measured parameters to determine speed, braking distance, positions of vehicles, etc. This article does not go into details of this process. Rather, this article looks at the use of data collected and stored by cell phones and cell phone networks to assist in analyzing the cause of the accident.

Background

Cell phones collect a lot of information. Some of it is obvious such as text messages, recent phone calls, contacts, location, etc. However, there is a multitude of additional data that is buried deep within the hidden folders and artifacts of the phone's file system. Special software can be used to extract the entire contents of the cell phone's files. If one knows where to look there are key data that can be decoded and used in accident analysis.

Cell phone manufacturers are constantly updating the operating system on the phone. It seems that more data is being collected as the software versions get updated. Experts in this field need to keep updated to continue to identify and extract this data.

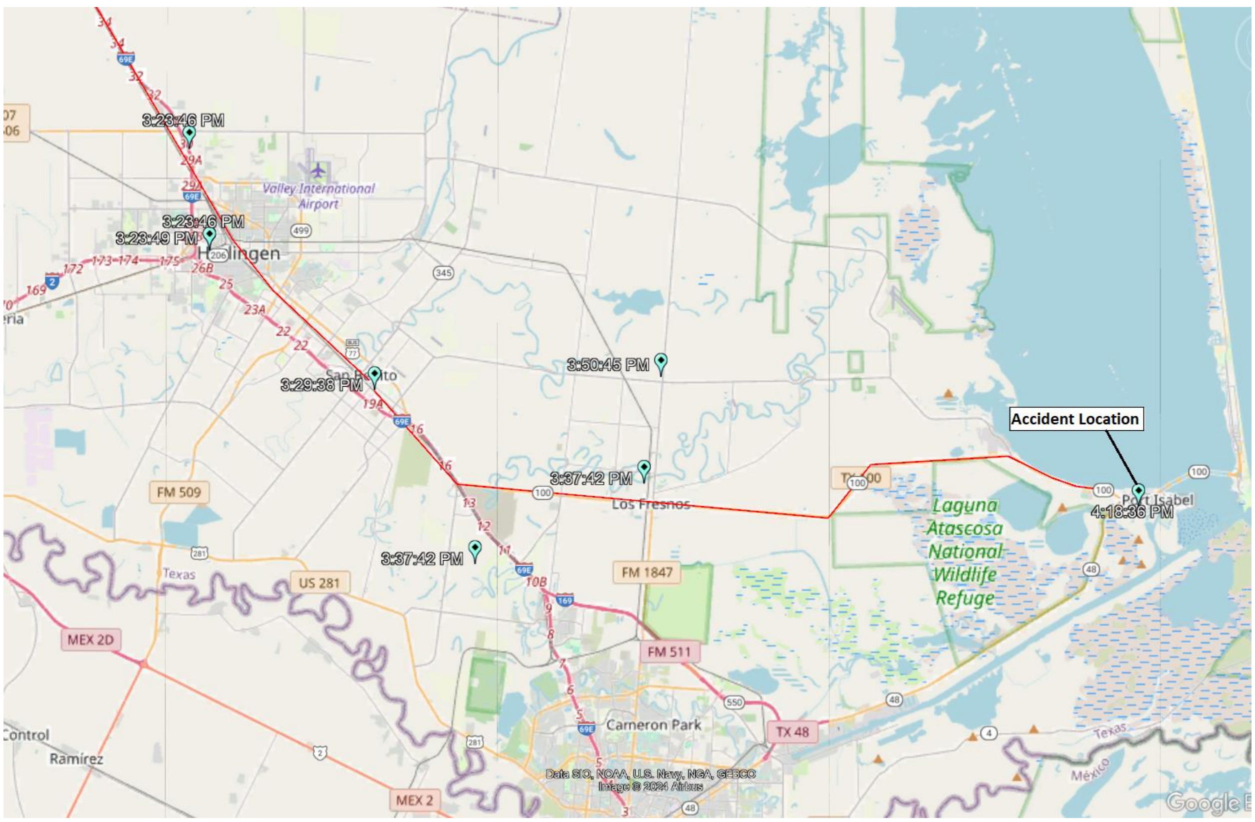
[1] Traffic Safety Facts – NHTSA https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813559

Case Analysis

The two cases presented here are similar such that they both involve vehicle accidents. However, the cell phone data provided in each case was different. In the first case only network data was provided by AT&T. In the second case only, the data extracted from the driver's phone was provided. Based on these data sets, two different approaches were used to add additional detail to the complete accident reconstruction picture as well as to try to determine the user activity with the cell phone just prior to the accident.

Ramiro Terrones Silva vs Gabriel Dwayne Davis [2]

In the Cameron County Texas case of Ramiro Terrones Silva vs Gabriel Dwayne Davis, the driver, Mr. Davis caused an accident in Port Isabel, Texas. He was accused of causing the accident due to being distracted by his cell phone. Cell phone network data was provided by AT&T consisting of reports containing cell tower locations, phone calls, text messages and data activity. The locations of the cell towers connected to the phone were mapped onto Google Earth as shown below. The blue icons represent the location of the cell towers connected to the phone at the time, not the position of the phone.



Davis drove south down I-69E then east on Hwy 100 handing off to different cell towers as he travelled. According to the police report the accident occurred at 3:59pm. The cell tower location near the accident location was logged at 4:18 pm as shown on the right side of the map. The location point prior

[2] 2016-CCL-01313 | Ramiro Terrones Silva VS Gabriel Dwayne Davis, Cameron County, TX

to 4:18 pm was at 3:50 pm so the cell phone data confirms the accident occurred between these two times.

As stated prior, there were no voice calls or text messages in the time window prior to the accident. There were, however, data activity records. Data activity consists of any application on the phone that sends data back and forth through the cellular network on to the internet. Typical applications that send and receive data might be a web browser, social media, mapping, music, etc.

There were two data records that were logged by AT&T within the time frame of the accident.

The two data records in the AT&T file looked like the following table.

Latitude	Longitude	Time (CDT)	ET	Bytes Up	Bytes Down
26.0429080	-97.5704170	3:37:42 PM	1:00:00	1467448	7376366
26.1320110	-97.4720120	3:50:45 PM	1:00:00	20916	18376

ET is the elapsed time of the session, in this case equal to one hour or 60 minutes. Bytes up is the amount of data that was sent from the mobile and Bytes Down is the amount of data received by the mobile over the 60-minute time-period. The data rate is simply the number of Bytes divided by the time.

If we add the Bytes Up and Down in the first record we get (1,467,448 + 7,376,366) 8,843,814 Bytes or 8.84 Megabytes or simply 8.84MB transmitted over a 60-minute time-period.

I compared that to data transfers for typical mobile applications. There are over 3 million apps in the Apple store and it is impossible to compare them all so I picked the ones most used. These included video, music, mapping, and social media apps.

The data rate on the phone compares to normal Spotify use and low Google Music rates as shown in the highlighted table below. Two columns of values are shown, one for data transferred in 12 minutes and one column for data transferred over an hour. The 60-minute AT&T record begins at 3:37 pm which is 12 minutes prior to the reported time of the accident at 3:59 pm. The first column is the typical amount of data transferred in 12 minutes and the second over an hour. If the app on the phone stopped at the time of the accident then the entire 8.84MB would have been transferred in the first 12 minutes of the 60-minute period.

Music					
Spotify	Normal	8.64	MB/12min	43.2	MB/hr
	High	14.4	MB/12min	72	MB/hr
	Extreme	28.8	MB/12min	144	MB/hr
Apple Music		23.04	MB/12min	115.2	MB/hr
Google Music	Low	8.64	MB/12min	43.2	MB/hr
	Normal	23.04	MB/12min	115.2	MB/hr
	High	28.8	MB/12min	144	MB/hr
YouTube Music	240p	13.5	MB/12min	67.5	MB/hr
	480p	33.3	MB/12min	166.5	MB/hr
	720p	60.3	MB/12min	301.5	MB/hr
	1080p	99	MB/12min	495	MB/hr

The table below shows the typical data rates for Apple and Google Mapping apps. The highlighted values were consistent with the data rates on Davis's phone.

Maps				
Google	1.00	MB/12min	5	MB/hr
Apple	1.08	MB/12min	5.4	MB/hr
Apple	1.86	MB/12min	9.3	MB/hr
Apple	5.42	MB/12min	27.12	MB/hr

Video uses much more data than what this driver used so that was ruled out. Social media was also ruled out as it typically uses much more data than this driver used. Since Music and mapping apps are mostly non-user interactive there was no way to prove the user was interacting with the phone by analyzing the data records. Ultimately this case was settled for a nominal amount.

State of Michigan vs Logan Brown[3]

This was a criminal case where the driver that caused the accident (Logan Brown) hit a stopped car at a construction site and veered off to the right where his car hit a construction worker resulting in the worker's death. This was a tragic event for all involved.

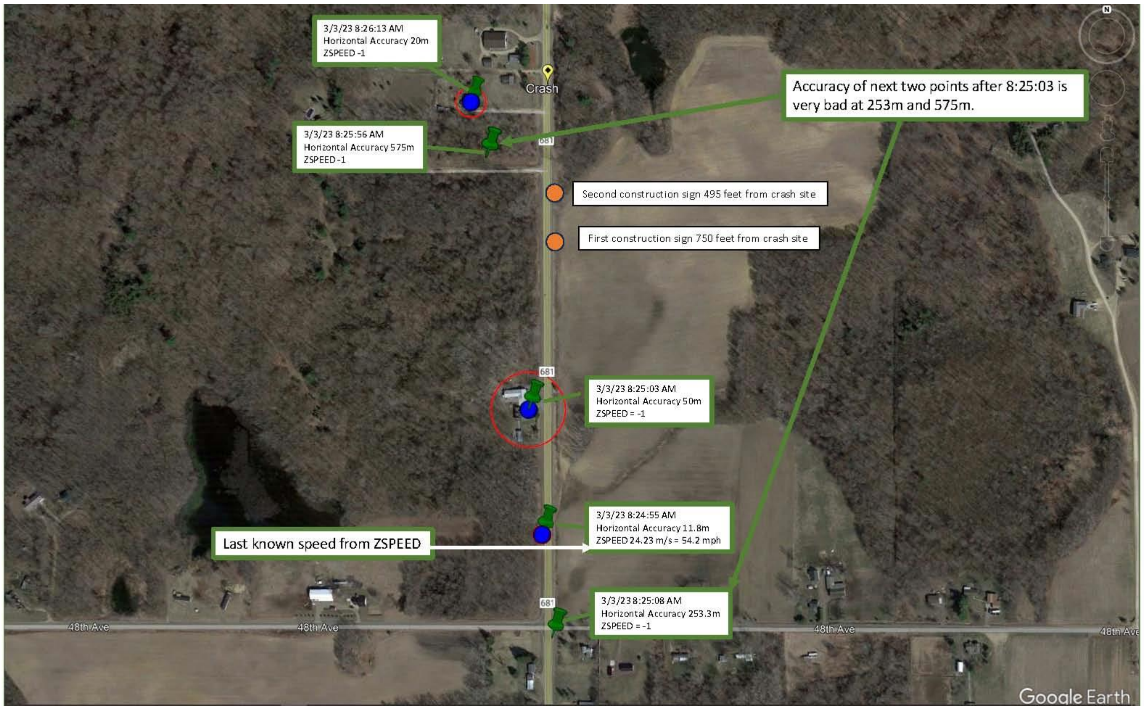
While there was a standard accident reconstruction analysis performed based on tire marks, drone footage, witness statements, etc., there was also a very detailed analysis of the driver's cell phone.

The entire contents of the driver's Apple iPhone were extracted creating a duplicate image of all the raw folders on the phone. Every file, folder and database that was on the phone was successfully extracted for analysis.

The extracted files provided an overwhelming amount of data to peruse and analyze. The three databases that were key to this investigation were Cache.sqlite, KnowedgeC.db and InFocus.db.

[3] State of Michigan vs Logan Brown, 36th Circuit Court, Paw Paw County Case: 2023-0000024558-FH

The Cache.sqlite database contains the times, speeds and locations for the phone. Based on this data we know the accident occurred between 8:25:03 AM and 8:26:13 AM. The point at 8:26:13 AM is when the vehicle was stopped at the accident site. The point at 8:25:03 am is the point just prior to that so we know the accident happened between these two points in time. That narrows it down to a 70 second window. The following map shows the points from 8:25:08 AM to 8:26:13 AM.



The vehicle was traveling northbound. The last known speed prior to the accident is at 8:24:55 AM at 54.2 mph. The next point at 8:25:03 AM has no speed data (e.g. -1) but has an accuracy of 50 meters. The next point at 8:25:08 AM is south of the first point which doesn't seem to make sense except the accuracy is 253.3 meters so theoretically his actual position may be north of the second point. The next point is north of the two construction warning signs at 8:25:56 AM again with a poor accuracy of 575 meters. The last point is when the vehicle stopped at 8:26:13 with a 20 meters accuracy which doesn't match with the actual crash site so the accuracy figures should be taken with a grain of salt and not to be expected to be completely 'accurate'.

The final part of this analysis has to do with what the driver was doing on the phone. Or more specifically, what apps were active and what was physically displayed on the phone screen during this time. For this information we accessed the KnowledgeC and InFocus databases.

I opened both databases using DB Browser then combined them into Excel using the date and time. I filtered out all the records except those between the times of 8:24:55 AM and 8:26:13 AM. The result is the following sheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ZSTARTDATE	ZENDDATE	ZSTARTDATE (EST)	ZENDDATE (EST))	DURATION	ZVALUEDOUBLI	ZDOUBLEVALUI	ZUUID	ZSTREAMNAME	ZVALUESTRING			
2	699542688	699542703	3/3/2023 8:24:48 AM	3/3/2023 8:25:03 AM	0:00:15	5.69E+18		29F34A52-4D5E-4CEC-83F6-43D6B0062ED8	/app/usage	com.toyopagroup.picaboo	InFocus	com.apple.SpringBoard.transitionReason.homescre	Snapchat on screen
3	699542696.6	699542696.6	3/3/2023 8:24:57 AM	3/3/2023 8:24:57 AM	0:00:00	3.53E+18		21FA8051-633F-4C79-998C-5A43DC77D7E5	/event/tombstone	597AAE81-28F6-4F8E-97C4-77BDB19EEAB9			
4	699542696.6	699542696.6	3/3/2023 8:24:57 AM	3/3/2023 8:24:57 AM	0:00:00	1.25E+19		C7FF1F94-3D9A-4E68-9995-DD7497967C75	/event/tombstone	8AF6C8D4-D819-407B-923C-CC60B32853FA			
5	699542704	699542704	3/3/2023 8:25:04 AM	3/3/2023 8:25:04 AM	0:00:00	1.41E+19		9F319C39-BA0C-4453-89A1-528238F7B1A8	/app/activity	com.apple.mobilemail			No activity
6	699542704	699542711	3/3/2023 8:25:04 AM	3/3/2023 8:25:11 AM	0:00:07	1.41E+19		555C9BA2-563D-4894-917B-773256B98534	/app/usage	com.apple.mobilemail	InFocus	com.apple.SpringBoard.transitionReason.homescre	Apple Mail on screen
7	699542710	699542710	3/3/2023 8:25:10 AM	3/3/2023 8:25:10 AM	0:00:00	1.41E+19		20EC4116-B2B3-43E1-AAC8-E4D1F53E2202	/app/activity	com.apple.mobilemail			No activity
8	699542711	699542713	3/3/2023 8:25:11 AM	3/3/2023 8:25:13 AM	0:00:02	6.53E+18		F8F0E6E0-C2E9-424D-A50B-3371D40E1D97	/app/usage	com.apple.MobileSMS	InFocus	com.apple.SpringBoard.transitionReason.homescre	Message on screen - possible notification
9	699542712	699542712	3/3/2023 8:25:12 AM	3/3/2023 8:25:12 AM	0:00:00	4.10E+18		2E2517E9-5D79-43D7-B94D-85C628873072	/notification/usag	Receive			
10	699542712	699542712	3/3/2023 8:25:12 AM	3/3/2023 8:25:12 AM	0:00:00	7.02E+15		E39B93D9-AEA8-4EB3-8291-CE3472EDA3AC	/notification/usag	Hidden			
11	699542718	699542770	3/3/2023 8:25:18 AM	3/3/2023 8:26:10 AM	0:00:52	8.01E+18		6CBF4534-6E39-4764-BF87-996EF74D3694	/app/usage	com.zhiliaoapp.musically	InFocus	com.apple.SpringBoard.transitionReason.homescre	TokTok on screen
12	699542719	699542719	3/3/2023 8:25:19 AM	3/3/2023 8:25:19 AM	0:00:00	8.01E+18		D94ACB0C-E43B-40FA-9303-187883D4B1F5	/app/activity	com.zhiliaoapp.musically			
13	699542768	699542768	3/3/2023 8:26:08 AM	3/3/2023 8:26:08 AM	0:00:00	8.01E+18		5269593C-C426-48D5-B847-FF6B561F0D56	/app/activity	com.zhiliaoapp.musically			
14	699542768	699542780	3/3/2023 8:26:08 AM	3/3/2023 8:26:20 AM	0:00:12	0		E245E5A6-9367-495D-951E-C61698BBB1B9	/display/isBacklit				Backlight is off

The highlighted rows are those with a duration greater than zero. The records with "InFocus" in column 'K' indicate the app was being displayed on the phone screen. Notes in column 'M' are my decoding in plain language of which app was on the screen. Column 'E' shows the duration of the app activity. Using this data along with the location data we can approximate the location of the car when each app was launched. We don't have speed data after 8:24:55 AM but we can make some assumptions such as constant speed or constant deceleration and estimate location ranges.

The first three items Snapchat, Apple Mail and Message notification were not necessarily deemed to be obstructing the driver but it is believed the jury had an issue with the TikTok video. The defense argued that this could have been launched and not viewed. In other words, the driver could have been listening to it but keeping his eyes on the road. The jury ultimately decided this was the crucial factor in the cause of the accident. There were three visible warning signs starting at 750 feet from the crash site that the driver should have seen and would have had enough time to slow down.

A classical accident construction analysis was also performed and used at trial. The cell phone data was key in providing additional detail in the reconstruction of this tragic accident and to the driver usage of his phone.

Conclusion

Analysis of accidents continues to change. The use of cell phone and cell network data has improved our ability to add more detail to accident reconstruction and to determine if cell phone activity contributed to the cause. Data provided by the network operators provides valuable information about voice calls, text messages, data usage and locations along with their highly accurate time stamps. Data extracted from the phone can provide content of text messages, speed of the vehicle and what app was on the screen and being used. These data sets are highly valuable in determining the details of the accident and its potential cause by cell phone use.

About the Author

Richard Miletic has been in wireless technology for over 30 years. He graduated with a B.S in Engineering from the University of Illinois and a master's degree from DePaul University. He has worked with major wireless companies including Verizon, AT&T, Qualcomm, Motorola and others. He has a deep understanding of wireless communications and location technologies. He has theoretical training and in-field experience testing hundreds of wireless networks. He has been providing expert witness services since 2018 and has worked on over 50 cases, both criminal and civil, testifying in many of these.

Email: rich@zkservices.net
Web: www.zkservices.net
Linkedin: https://www.linkedin.com/in/rich-miletic/
Phone: 650-279-2403