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Excluding Cellphone Operator Per Call Measurement Data

Defense lawyers are increasingly dealing with cellphones and location. Does information from a cellphone carrier show — as the prosecution says — that the defendant was in the area when the crime was committed? Cellphone operator per call measurement data (PCMD) files provide an estimate of the location (latitude and longitude) of a cellphone. However, a cellphone's location cannot be pinpointed with per call measurements. There is a margin of error. This article explains the technology used, the error rate, and the basis for a *Daubert* challenge.

PCMD is a generic acronym that is known by several names depending on the cell network operator. AT&T calls it NELOS, Verizon calls it RTT, and T-Mobile refers to it as Truecall. The PCMD files are different than Call Detail Record (CDR) files provided by the cellular operator. The CDR provides the location of the cell tower antenna/sector that is serving the call, text message, or data session of the phone in use. The CDR does not provide an estimate of a phone's location.

State of Indiana v. Larry Jo Taylor[1]

The state of Indiana charged Larry Jo Taylor with the November 2015 murder of a pastor's pregnant wife. He was accompanied by two other people who agreed to a plea deal. Taylor and the other two arrived at the victim's home early in the morning. They took the victim's ATM card and, while Taylor stayed in the home with the victim, the other two went to the ATM to take out cash.

In March 2021, the court held a Rule 702 hearing to determine whether Verizon RTT data would be excluded.[2] The judge decided to exclude the use of the RTT data.

After multiple delays, the case went to trial in September 2022. Taylor was convicted of murdering the victim while the other two were at the ATM.[3]

PCMD Technology

It is important to note that the technology used to estimate the location of the phone is not owned or developed by the cellular operators. The manufacturer of the cellular network infrastructure develops it. The PCMD technology is proprietary; thus, no industry standard exists, and it is not in the public domain. Cellular operators are typically bound by agreements with the manufacturers not to disclose information about their PCMD technology.

Even though the technology is proprietary, the fundamentals of the technology are known. Obtaining cellphone location estimates is achieved by using round-trip-time algorithms. PCMD does not use GPS technology.[4]

In PCMD's simplest form, the cell tower sends a message to the phone and requests an immediate response. The cell tower measures the time the mes-

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sage takes from when it was sent to when the response was received. Since radio signals travel at the speed of light, a very simple formula can be used to calculate the distance that the message traveled.

The formula D = (T x C)/2 provides the distance from the cell tower to the phone. See Figure 1.

By combining three or more cells, one can estimate the location of the phone as shown in Figure 2.

Analysis of Key Decision Factors

Using PCMD to determine cellphone location presents several major problems:

- Reliability of the data — unknown algorithms.
- Intent of purpose.
- Cellphone operator disclaimer.
- Multipath interference — search window size.

Reliability of Data — Unknown Algorithms

Data reliability in the legal realm is governed by Federal Rule of Evidence 702 and *Daubert v. Merrell Dow Pharmaceuticals*.

Rule 702:

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

1. the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
2. the testimony is based on sufficient facts or data;
3. the testimony is the product of reliable principles and methods; and
4. the expert has reliably applied the principles and methods to the facts of the case.

Rule 702 was further clarified in *Daubert*.[5]

Under the *Daubert* standard, the factors that may be considered in determining whether the methodology is valid are:

1. whether the theory or technique in question can be and has been tested;
2. whether it has been subjected to peer review and publication;
3. its known or potential error rate;
4. the existence and maintenance of standards controlling its operation; and
5. whether it has attracted widespread acceptance within a relevant scientific community.

The key factor in Larry Taylor's case was the proprietary nature of the algorithms used by Verizon that estimate the location of the phone. While the general technology used is known, Verizon does not provide the actual calculations of how it determines the estimate. Thus, no way exists to independently test the accuracy of the estimates. *We must take Verizon's word for it.*

Further, every estimate must have some error factor; a plus/minus value assigned that the estimate should fall within. Verizon provides the error factor with an "L," "M," or "H" in the RTT file. We assume this to mean low, medium and high, although the definition is not distinctly provided by Verizon. Without assigning a value to low, medium and high, the values could be anything and thus are meaningless. Without an error factor with a definite value, it is impossible to show the location of the estimate, including the error factor on a map.

These two factors directly conflict with *Daubert*. The estimates cannot be tested and verified because they are proprietary. They cannot be peer reviewed. The error rate is unknown, and no industry standard exists. It also has *not* attracted widespread acceptance, as the judgment in this case

Figure 1

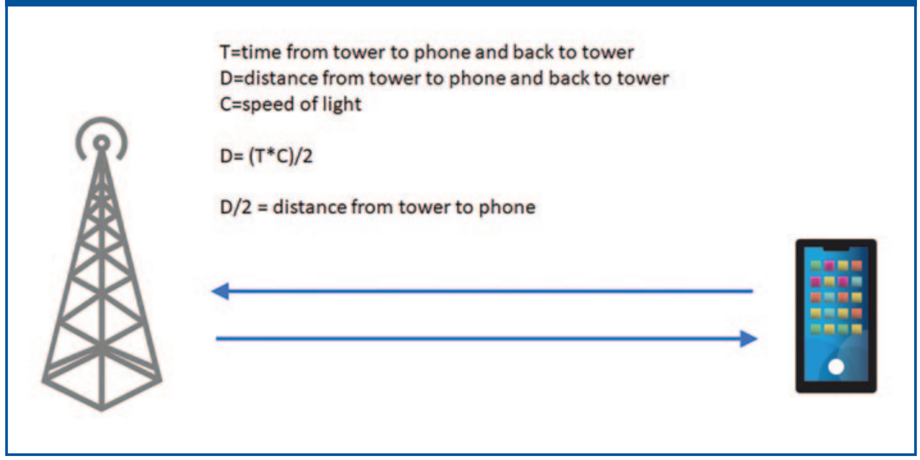

Image courtesy of Richard Miletic

Figure 1 — Distance from tower to phone

Figure 2

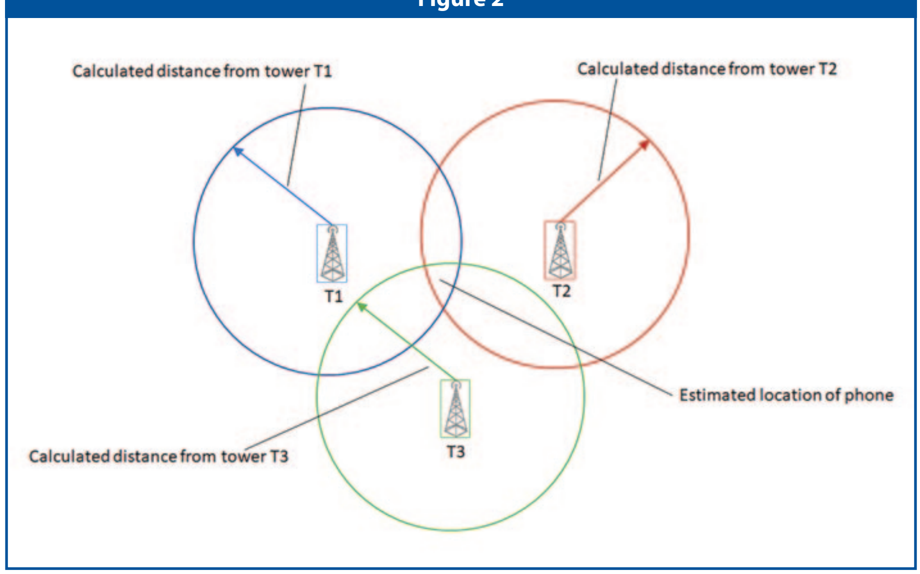

Image courtesy of Richard Miletic

Figure 2 — Location by triangulation

Figure 3

Image courtesy of Julian Giles

Figure 3 — Multipath interference

reveals. Any representation of this data on a map is inaccurate and misleading.

Intent of Purpose

The evidence presented must also be scientifically valid for the purpose it is used.[6] Cellular operators do not use PCMD data for the purpose of locating individual phones. They use the data for network performance improvement. They aggregate location estimates for many phones and look at trends of performance issues.

One example would be the existence of a high number of dropped calls in a particular area at a certain time of day based on the aggregated RTT data results. The cellular engineer would look at other sources of data in addition to the RTT data to troubleshoot the problem. The engineer may also drive the area with the intent of recreating the problem and capturing the root cause. Thus, the PCMD data is used to point engineers to problem areas and provide some prioritization to their process. They would not look at a single phone and its location for this purpose because it provides no statistical validity and could be an anomaly.

If the original purpose of the data is not to locate individual phones but rather to aggregate the data to prioritize troubleshooting processes, then it is being used incorrectly in locating individual phones in legal cases.

Cellphone Operator Disclaimer

Verizon included the following disclaimer against using RTT data as the equivalent of a GPS location:

> The latitude and longitude measurements on the Real Time Tool "RTT" report are derived solely from the Round Trip Delay measurement. They are best estimates and are not related to any GPS measurement. Measurements with a high confidence factor may be more accurate than measurements with a low confidence factor, but all measurements contained in this report are best estimates rather than precise locations. *Verizon Wireless RTT Report and Round-Trip Delay Disclaimer*.

Verizon's own words establish that it does not assume any liability for the location estimates of individual phones, and the measurements are not GPS measurements.

Search Window Size — Multipath Interference

The radio signal being transmitted from the tower and the phone is sent in waves. These waves travel at the speed of light, bounce off reflective objects, and are absorbed by nonreflective objects. Most of them typically do not take a direct path to the phone. Figure 3 represents some of the paths the radio waves follow. They can bounce off buildings, cars or signs and be absorbed by foliage, terrain, and the varying weather conditions.

Due to refractions, reflections and absorption, the radio waves arrive at the handset at slightly different times and different signal levels. The search window is the amount of time allotted when these signals are accepted and rejected. Any signal inside the search window is accepted, and any signal outside the search window is rejected.

Radio signals travel at the speed of light, so the signal that takes longer to arrive travels a longer distance. It may have come from far away or bounced off several buildings before arriving. If the search window is large, then it takes in signals that have traveled a longer distance. If it is short, then it takes in signals that have traveled a short distance.

Figure 4 depicts the search window. Varying signals are represented by the graph line. The signals are received at different times and levels, shown as the x and y axis, respectively. The search window aggregates them to provide a higher quality signal.

The cellular engineer can assign the search window value to each individual

Figure 4

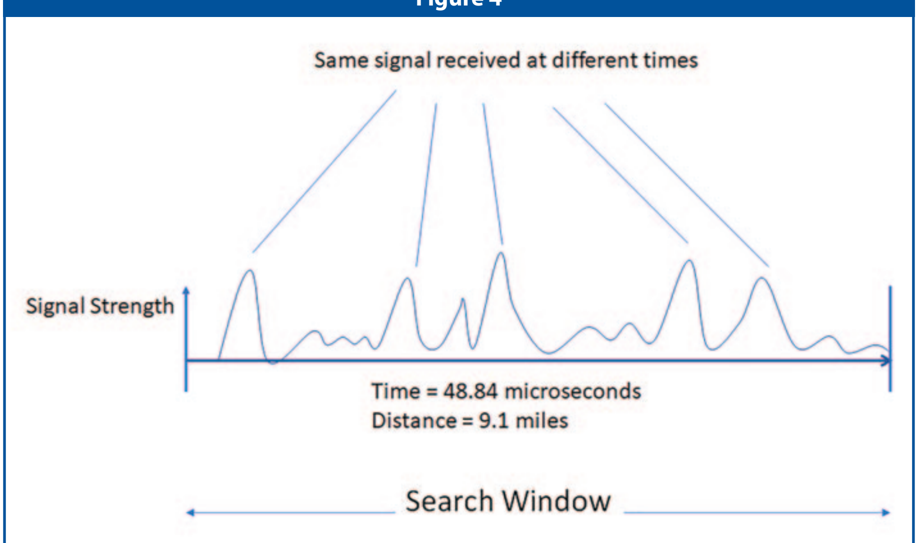

Image courtesy of Richard Miletic

Figure 4 — Search window

Figure 5

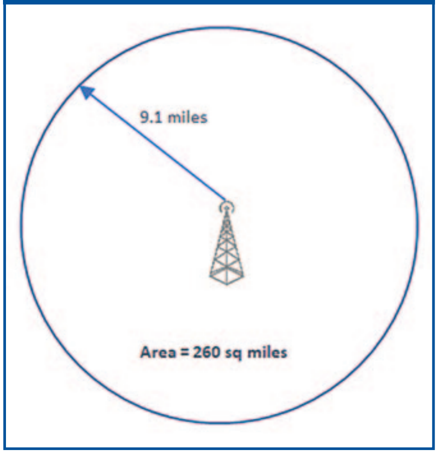

Image courtesy of Richard Miletic

Figure 5 — Cell coverage area

cell tower and corresponding phones. The size of the search window affects the performance of the network; thus, the network engineer controls these settings. The typical setting for the urban area in this example is 48.84 microseconds or 0.00004884 seconds. This is the range of the search window. Signals that arrive within this time are accepted and aggregated. Signals that do not arrive within this time range are rejected.

This may seem like a very small number, and it is, in terms of time. However, if it is multiplied times the speed of light, one obtains the distance that the signal traveled. In terms of distance, 48.84 microseconds equals 9.1 miles. What does this mean? The phone location has an error factor of 9.1 miles and could be anywhere within that radius from the tower. That is quite a large area. Using the equation for determining the area of a circle, one gets a total area of 260 square miles. The phone could theoretically be within an area of 260 square miles around the cell tower.

It must be acknowledged that the cellular operators perform some improvement on the location estimates since an error factor of 260 miles does not seem to pass the logic test. However, this is where the proprietary algorithms come into play. Their data shows more accurate estimates than 260 miles, but they do not provide the algorithms used to calculate these refined estimates.

If a cell network operator does not provide the calculations to determine a more exact location of the phone, then experts must fall back on what they do know. They know the typical search window size, and they know the distance traveled. Therefore, all that is known for sure that can be verified and tested is the phone could be anywhere within the 260-mile square mile area around the cell tower.

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Decision

The judge in Larry Taylor's case was bothered by the lack of transparency from the cellular operators in providing the algorithms used to determine their estimates of the location of Taylor's phone. While he also was concerned about the purpose of the data and the lack of error values, the judge mainly decided to exclude the use of the RTT data based on the data not fulfilling the *Daubert* standard due to unverifiable location estimates and the inability to test the accuracy.

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Notes

1. Cause Number 49G05-1511-MR-041732; Case Number 49D31-1511-MR-041732.

2. The author testified at the hearing for the defense.

3. Taylor was convicted on 14 charges, including murder, burglary, and possessing an illegal handgun.

4. GPS uses a constellation of satellites that sends signals to a receiver on the ground. The receiver uses the data from the satellites to determine its position.

5. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993).

6. See *Daubert*, 509 U.S. at 591 (noting "scientific validity for one purpose is not necessarily scientific validity for other, unrelated, purposes").

About the Author

Richard Miletic has been in the wireless field for over 30 years. He testifies as an expert in criminal and civil cases all over the United States. He has a Bachelor of Science in Engineering from the University of Illinois in Urbana, Illinois, and a Master's in Business from DePaul University in Chicago.

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