



CELL TOWER ANALYSIS

Cell tower tracking is often misrepresented as a science, rather than a practice which is only used and taught by police departments- not cell tower or cell companies.

Most PD "cell tower experts" are not engineers, they are police officers who have been through a week-long course or less to push a button on a program.

In some cases, tower pings can be valuable. For example, out in the boonies, where there are is but 1 tower. In a city, It's basically a non-repeatable science due to the number of towers, volume of traffic, data packet loss, data packet bandwidth etc.

You will hit the nearest available tower, which is determined by a few different factors. Proximity is equally balanced with other factors such as signal strength, topographical issues such as buildings being in the way of line of sight. Antenna gain, signal quality called GT. GT is more of a factor then proximity.

How many transmitters of a similar frequency are within a 4-mile radius of the tower hit (in a city: hundreds)

Most antennas aren't listed or licensed due to an AZ State law that supersedes the FCC, so they don't show up on a tower map. In Phoenix there are only 2,049 registered towers for almost 2 million people. There are many more cell phones than actual people as well according to the FCC.

The amount of DAS systems (distributed antenna system) etc, aren't even listed in the report. These antennas that are in malls, businesses, shopping centers, movie theaters, sporting complexes, etc, that feed to towers that can be miles away.

The FCC states a cell phone signal can reach 30 miles in the right conditions. An antenna that has a 10-mile radius covers 371 square miles.

Using tower readings, you must use available NELOS data, tower antenna strength, topographical considerations, horn azimuth, width and sector: alpha, beta or gamma, signal clarity, signal to noise ratio.

Even when listed often the "experts" don't understand that Nortel and Lucent towers are 120 degrees off from each other.

First set of questions I give to attorneys to ask the opposition's 'tower experts'

Do you consider cell tower an "actual Science", if so what is the Theorem that proves the same results will always be exactly duplicated in repeated tests?

Science requires experiments to be repeated with the same result time after time.

Since a cell phone can theoretically hit any tower within a 35-mile range according to the FCC and there is no scientific theory to predict which one, how is that a reliable source of data.

What 4-year university did he get his cell phone tower tracking degree.

(there is no Tower tracking degree or anything similar as the phone companies state specifically they are just "propagation maps" for in house use by the Tower Providers- which in most cases is not the cell provider -Top tower companies would be Crown and American in the US) these CDRS are to determine where more tower coverage may be needed due to geographical issues, heavy use in an area, distances covered, potential for multi-pathing of signal etc.

Do they teach semester courses in cell phone tracking at any accredited universities. (no) If they say they have "certificates" ask what accredited universities they came from and how many years and total hours it took to get them. Odds are it's a course offered a law enforcement teaching company or the agency itself. (only cops teach this as they have adapted the Tower pings for use against the cell companies recommendations) The reasons it can be inaccurate is that the PD is getting a "Propagation map" meant for cell tower providers to study coverage during peak demand.

Since there is no way to verify which towers were missed as a cell phone has a maximum range of 35 miles according to the FCC. What formula do you use that take into consideration all the variables of signal diffusion, obstacles, weather, angle tower strength, cellphone strength etc.

Did the investigator get a report from the cell tower owner/operator as to which towers were up or down during the time period in question? (most all cell towers are leased. From American Tower, Crown Communications or similar in the US rather than being owned by cell service providers) no -They did not get the actual maintained records from the tower providers as to tower conditions at the time of the incident.

What topographical data was taken into account when using your mapping software?

What software was used and was it up to date as the online tower grid can change daily.

Does it say anywhere on any cell company provider cover sheet that CDR's are designed to be used for cell tower tracking by law enforcement.

No, quite the opposite, they don't want the liability of a bad interpretation, so they state on the cover that the maps are strictly for propagation planning *NOT* for use by law enforcement.

What was the Antenna Gain or wattage?

That's the factor by which input power to the antenna will be multiplied to provide higher output power. It is this higher power output which will be transmitted over the air as EM waves. The higher the power, potentially the bigger coverage area.

What was the EM radiation pattern of antenna?

Electro-magnetic waves emitted from the antenna is referred as antenna radiation pattern. It is made of a major lobe and more than one side lobes. The region near the antenna is referred as near field region and region far away is referred as far field region. It can be represented either in polar or in rectangular coordinates.

What was the Beam Width of the horns?

The difference between half power points (3dB points) on antenna radiation pattern is referred as antenna beam width? The unit is degrees. This has to do with the amount of sector coverage a horn has.

Who manufactured these horns/antennas as they all are configured a bit different? Since Lucent and Nortel towers read 120 degrees different on their horn alignment. Which type of towers were these and what's the difference in alpha, beta and gamma Readings by these two tower types?

What was the Antenna Gain to Noise temperature ratio? - referred as figure of merit of the antenna. Also known as antenna G/T. Has to do if the signal was clear enough to be accepted by a tower.

What is the antennas frequency Bandwidth? Range of frequencies over which antenna operates satisfactorily. The difference between highest and lowest frequency points is referred as antenna bandwidth.

What was the Antenna's Efficiency at the time? The ratio of power radiated, or power dissipated in the antenna structure to the power input to the antenna. Higher antenna efficiency means good amount of power is radiated into the space and less is the power losses within antenna. $\epsilon R = P_{\text{radiated}} / P_{\text{input}}$

What was the Antenna Impedance?

The ratio of voltage to the current at the antenna input. If antenna impedance at input is 50 Ohm means sinusoidal voltage amplitude is 1volt and current amplitude is 1/50 Amps. Based on this and transmission line impedance, Balun may or may not require. Balun is also referred as impedance transformer.

Was the antenna a horizontal or vertically polarized antenna? Polarization refers to polarization of electromagnetic wave transmitted or received by the antenna. It is the direction of the electric field vector embedded within the EM wave.

What was the Antenna aperture? How much power can be captured by the antenna. Effective aperture or effective area of the antenna can be expressed as follows: $A_e = \lambda^2 * G / 4 * \pi$ (has to do with the tilt angle of the horn from the height of the horn)

The wavelength of the specific antenna and antenna directivity?

Size of antenna depends on wavelength. Wavelength is distance a radio frequency wave travels during one cycle period. Half wave dipole will have half wavelength long. $\lambda = c/f$, where c is speed of light i.e. 3×10^8 m/s

What was the Antenna's Directivity? - the ability of the antenna to focus EM waves direction for transmission and reception. It related to antenna gain and antenna efficiency as follows: $\text{Gain} = \eta * \text{Directivity}$, where η is antenna efficiency

These would need to be covered for an accurate tower reading

1. Horns hit- alpha, beta or gamma
2. Azimuth of horns
3. Strength of signal $L < m < h < \text{div} = "" >$
4. Switcher location
5. Topographic map due to "signal multi-pathing" (the signal bouncing off reflective surfaces) buildings, natural hard surfaces, any metal or glass reflective surfaces.

6. Tower maintenance records. i.e. which horns were down for maintenance on a particular day or time period. These are provided by the companies that own and maintain the towers.
7. Company list of who owns the tower in question and leases it the cell provider
8. Operational records of area horns at the time of the incident. (Where there horns that were closer that were out of operation)?
9. Data-packet flow of LTE or Internet use which bogs down horns.
10. Available bandwidth: How heavy was the cell traffic in the area during the time of in incident. Was it at a heavy cell traffic time, say 6pm, or a light traffic time 3m. This comes in to play with "Pass-Forwarding".
11. Calls forwarded from busy towers, pass-forwarding records from tower maintenance company.
12. Triangulation between any Wi-Fi pings and actual Tower Pings, NOT switcher hits.
13. Temporary towers (cells on wheels (COWs). These are put up during heavy traffic events, concerts or if there is tower work being performed. These records come from the tower owners.
14. List of towers operating under an FCC umbrella. Called "mom & pop" towers, there can be many added to a busy area. These horns and towers do not register on the FCC maps. They often transfer to a switching point which makes the data read as if the call came in from a main tower rather than a M&P tower.

Was an unreacted .xls workbook provided to the defense?

This comes in the form of a 12-20 column wide excel sheet from the tower operators, not the phone company. The phone company basically just logs minutes for billing from switchers

Article in the New Yorker re Cell Tower Tracking inaccuracies in relation to a case:

<https://www.newyorker.com/news/news-desk/what-your-cell-phone-cant-tell-the-police>

