Project Achilles: Low Altitude Cellphone Experiments

A. K. Dewdney

Introduction

Claims that passengers aboard the doomed aircraft hijacked on the morning of September 11 2001 had used their cellphones to contact acquaintances and loved ones on the ground are shown to be highly questionable in light of experiments conducted in light aircraft over a typical, highly serviced urban area. The author conducted three such experiments in single-engine light aircraft, supplemented by a fourth experiment in a twin-engine light aircraft financed by the ASAHI Television Network of Japan.

The acceptance of such claims by a broad segment of the public revealed a general ignorance of the powers and limitations of cellphone technology, an ignorance which is not surprising in view of a) a lack of knowledge about radio technology generally and b) the ban on cellphone calls from airliners imposed by the Federal Aviation Authority (FAA) since the early 1990s, when cellphones first began to come into general use. Given the operational realities of cellphone technology, the ban would appear to have been unnecessary, an issue that will be revisited at the end of the article.

The experiments reveal a "cellphone ceiling" of approximately 7000 feet for single-engine light aircraft and a ceiling of approximately 6000 feet for twin-engine light aircraft. These results are supplemented by numerous anecdotal accounts by passengers on commercial airliners ("heavies") of the kind used in the attacks of 9/11. The latter reveal a consistent loss of signal shortly after takeoff, leading one to assert an even lower ceiling for commercial airliners, generously overestimated at 2000 feet. The operational definition of the cellphone ceiling for a given aircraft is the altitude above which a cellphone call from that aircraft has no chance of making any connection with the ground, let alone allowing a conversation to take place.

The Technology

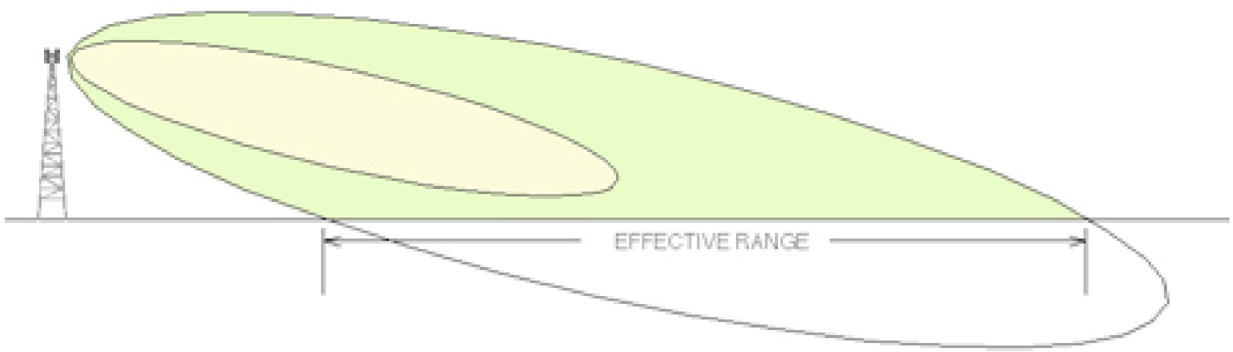
Cellphone technology is based on radio signals passing back and forth between cellphones and cellsites. By now everyone knows what a cellphone looks like. Since 9/11 they have decreased in size, packing more functionality into a smaller space, but they operate on exactly the same principles. The user's voice is converted into digital radio signals that are transmitted in all directions by a built-in antenna and caught by the larger, more sensitive antennas of the nearest cellsite. Once a call is picked up by a cellsite, it is transmitted over land lines that connect with the regular telephone network.

The cellsite is a steel tower with an array of three antennas at the top, as in the following photograph of a typical installation.

Cellphones communicate with cellsites

The three antennas are all vertical because all cellphone networks are designed solely as terrestrial communication networks; a linear antenna of the type shown sends and receives signal optimally at right angles to its length. The vertical signal is about as weak above the antenna as below it. If you stand under a cellsite and try to place a call, your signal is more likely to be picked up by the antenna of a neighboring cellsite than the ones above you. It is even possible to fail to get a signal out entirely from such a location.

The antennas of a cellsite are all simply radio antennas and, like all linear antennas, their patterns of transmission and reception have the shape of an elongated lobe, as in the following schematized figure.



transmit/receive lobe of a cellsite antenna

In reality, the power lobe is an abstraction related to a given level of receptivity or transmittivity. In other words, the lobe shown in the figure above might represent the 90 percent level, where the signals passing back and forth between a cellphone in the area and the antenna enjoy a 90 percent signal strength, easily strong enough to ensure solid communication. The 80 percent lobe would be slightly wider and longer, the 70 percent lobe wider and longer again, and so on. A cellphone inside the 10 percent lobe might well fail to get through. The lobes are nested, as shown in the figure. Indeed, for every possible level of reception, one can trace a lobe on the boundary of which the signal strength is exactly at that level. Inside the lobe, it is stronger, of course, and outside weaker. Each antenna on a cellsite is given a slight downtilt (exaggerated in the figure above) to enhance coverage by the antenna.

The antennal lobe within which effective cellphone communication is possible will be called the "effective lobe" without denying the possibility of occasional or broken communication beyond this lobe. On an urban scale, the effective power lobe would have the approximate shape and size shown (in cross-section) in the landscape below. The further your cellphone is from the nearest cellsite, the lower the level (percentage) of receptivity or transmittivity your call will enjoy. At such low levels, the signals in either direction must compete with background signals ("noise") from other sources and the call is dropped abruptly, owing to the all-or-none character of digital communication.

Vertically, the lobes are nested more closely together, rather like a flattened onion. The effective lobe evidently extends to no more than a thousand feet vertically.

The effective lobe of a cellsite antenna

As one can see, lobes extend primarily in a horizontal direction, since this is how cellsites are designed to operate. Looking down on a cellsite, we might imagine the lobes to be made visible, as in the wire-frame diagrams below. Since there are three antennas at each cellsite, there are three lobes.

some cellsites with 90 percent power lobes made visible

The cellsites shown in the image above would represent approximately half the cellsites that would be present in such a landscape. I have shown the 90 percent lobes as non-overlapping for clarity. However, they do overlap slightly.

Looking down from such a height, one may well ask, “How on Earth could my cellphone work way up here?” It can’t.

The Experiments

In all, four aerial experiments were performed, including a “shakedown flight” in which the fundamental thesis was tested and potential problems were noted and the experimental protocol was modified. The first two experiments were conducted in a rather small, light, low-wing single-engine aircraft, the Diamond Katana (manufactured in London, Ontario, with sales to the US Airforce as a trainer, among other customers). The third experiment was conducted in a Cessna 172-R, a somewhat heavier, high-wing, single-engine aircraft.

After the results of these experiments was published, the author received a communication from a producer at ASAHI, Japan's major television network. The executive expressed an interest in sending over a video crew to film a fourth experiment. The test vehicle selected was the Piper Aztec, a heavier "light" aircraft, owing to its twin engines. The effect of the two large engines was noticeable, lowering the cellphone ceiling by approximately 1000 feet.

Disclaimer: The companies hired to assist in this experiment, namely Empire Aviation and Cellular Solutions, both of London, Ontario, Canada, acted as disinterested commercial parties, with no stake in the outcome -- or even knowledge of the ultimate purpose of the tests.

Experiment 1: shakedown flight

date: January 23 2003; 4:35 - 5:40 pm
place: Civic Airport, London, Ontario, Canada
aircraft: Diamond DA20/C1 Katana two-seater
pilot: Corey Barrington
cellphones: one Motorola model "120 CDMA" cellphone (A) two Motorola "i1000 plus" cellphones (B & C) (all fully charged at flight time) All calls were handled by the Bell Mobility Network, with some 25 cellsites operating in the London area at the time of the experiment. The following website has a map of these cellsites: **www.arcx.com/sites/**

flight plan: The flight plan consisted of four "laps," elongated circuits (shaped like a paperclip) over London, Ontario airspace. Each lap was about seven to eight miles long and two to three miles wide. The laps would have a vertical separation of approximately one thousand feet.

protocol: Three calls were to be made on each of two straight legs of each lap. Calls would be sequenced A, B, C, A, B, and so on. (See Experiment 2 for a similar flight plan with circular laps.) Each call was to be placed to my office telephone, where the message system would provide a convenient record of the success of an call that got through. Each message would state the cellphone being used and the altitude and position of the aircraft on its flight path.

note: Noise in the cockpit kept me from hearing the office phone message system, so calls from No. 4 onward were placed to the home number. The second i1000 cellphone slipped to the cockpit floor early in the flight and could not be retrieved in those cramped quarters, leaving me with phones A and B only.

In what follows, the word “altitude” refers to above ground altitude or aga altitude, not the height above sea level, as recorded by an altimeter.

results:

altitude: 1100 feet

leg	cellphone	target	result
1	A	office	no connection
1	B	office	1 min. complete
1	A	office	1 min. complete
2	B	home	no connection
2	A	home	connection dropped
2	B	home	connection dropped

altitude: 2100’ feet

leg	cellphone	target	result
1	A	home	no connection
1	B	home	a beeping noise
1	A	home	no connection
2	B	home	1 minute. complete
2	A	home	connection, no voice

2	B	home	connection, no voice

altitude: 3100’ feet

leg	cellphone	target	result
1	A	home	no call made
1	B	home	system “busy”
1	A	home	no connection
2	B	home	“please wait,” dropped call
2	A	home	call dropped
2	B	home	call dropped

altitude: 3500 feet

1	A	home	call dropped
1	B	home	complete, breaking up

Calls to the business number were recorded by the message system. Two calls made it through. Of the 17 calls to the home number, only 11 calls got through. In three of these, we had a conversation (of sorts) and the rest were just white noise. (no record of which).

Summary: In the preliminary test, only five of the 16 (attempted) calls resulted in any meaningful voice contact. In at least two of the 16 calls, no connection whatever could be established with cellsites below us. The composition of the Diamond Katana makes it almost transparent to EM radiation at radio wavelengths and the results of this experiment are therefore optimal.

low altitude (1100–2100’): 4/12 or 33 percent
mid altitude (3100 – 3500’): 1/7 or 14 percent

Conclusion: the purpose of this experiment was to probe the effect of altitude on cellphone service and to iron out wrinkles in experimental procedure. In the first instance, it appeared that there was a decline in service with increasing altitude. The phenomenon would have to be explored more carefully in a subsequent flight. The protocol would be modified to involve a home operator who would log each call that was successfully placed, recording any noise, broken signals or dropped calls.

Experiment 2: first full test

date:	February 25 2003; 5:15 – 6:15 pm
place:	Civic Airport, London, Ontario, Canada
aircraft:	Diamond DA20/C1 Katana four-seater
pilot:	Corey Barrington of Empire Aviation
operator:	Darren Spicknell technician for Wireless Concepts Inc.)
cellphones:	C1, C2, C3, C4 (see Appendix A for specifications) (all fully charged at flight time)

Weather: unlimited ceiling, light scattered cloud at 3,000 and 25,000 feet, visibility 15 miles, wind 5 knots from NW, air temperature -12 C.

Flight Plan: We flew a circular route, instead of the elongated oval. The circle centred on the downtown core and took us over most of the city suburbs. All locations below are referred to the city centre and are always about three miles distant from it.

flight path for cellphone experiment #2

Protocol: At times specified by the director, the operator made a call to a specified number, stating the code number of the cellphone (1 to 4) and the altitude. The receiver recorded whatever was heard and the time the call was received. At the first three altitudes of 2000, 4000, and 6000 feet aga each cellphone was used once. At 8000 feet aga, only C2 and C3 were tried, C1 and C4 having become useless.

Results

altitude: 2000 feet

time (pm)	call no.	C#	location	outcome
5:15	1	C1	north	complete: unclear
5:17	2	C2	west	complete: unclear
5:19	3	C3	southwest	failure
5:21	4	C4	south	complete: unclear

altitude: 4000 feet

time (pm)	call no.	C#	location	outcome
5:25	5	C1	northeast	failure
5:26	6	C2	north	complete: clear
5:27	7	C3	northwest	failure
5:29	8	C4	west	failure

altitude: 6000 feet

time (pm)	call no.	C#	location	outcome
5:34	9	C1	southeast	failure
5:36	10	C2	east	failure
5:37	11	C3	northeast	failure
5:38	12	C4	north	failure

altitude: 6000 feet (cont'd.)

time (pm)	call no.	C#	location	outcome
5:39	13	C1	northwest	failure
5:40	14	C2	southwest	complete: clear
5:42	15	C3	south	failure
5:43	16	C4	southeast	failure

altitude: 6000 feet (cont'd)

time (pm)	call no.	C#	location	outcome

5:44	17	C1	east	failure
5:45	18	C2	northeast	failure
5:45	19	C3	northeast	complete: unclear
5:46	20	C4	north	failure

altitude: 6000 – 8000 feet, climbing (C2 & C3 only)

time (pm)	call no.	C#	location	outcome
5:50	21	C2	west	failure
5:50	22	C3	southwest	failure
5:51	23	C2	south	complete: unclear
5:58	24	C3	southeast	failure

altitude: 8000 feet

time (pm)	call no.	C#	location	outcome
5:58	25	C2	east	failure
5:58	26	C3	east	failure
5:59	27	C2	northeast	failure
6:00	28	C3	north	failure

altitude: 8000 feet (cont'd.)

time (pm)	call no.	C#	location	outcome
6:01	29	C1	north	failure
6:01	30	C2	northwest	failure
6:02	31	C3	northwest	failure

6:00	32	C4	northwest	failure

6:15 land at airport

Conclusions:

To the extent that the cellphones used in this experiment represent types in general use, it may be concluded that from this particular type of aircraft, cellphones become useless very quickly with increasing altitude. In particular, two of the cellphone types, the Mike and the Nokia, became useless above 2000 feet. Of the remaining two, the Audiovox worked intermittently up to 6000 feet but failed thereafter, while the BM analog cellphone worked once just over 7000 feet but failed consistently thereafter. We therefore conclude that ordinary cellphones, digital or analog, will fail to get through at or above 8000 feet aga.

It should be noted that several of the calls rated here as “successes” were difficult for the Recorder to hear, with descriptions such as “breaking up” or “buzzy.”

Summary table

altitude	calls tried	successes	% successes
2000	4	3	75
4000	4	1	25
6000	12	2	17
8000	12	1	8*

* includes three calls made while climbing; last successful call was made from just over 7000 feet.

The four cellphones operated via four different cellular networks (cellsites). Because calls were made from a variety of positions for each network, it cannot be said that failures were the fault of cellsite placement. The London, Ontario region is richly supplied with cellsites belonging to five separate networks. The results would be virtually identical over any large (or larger) urban area.,

It may be noted in passing that this experiment was also conducted in a radio-transparent aircraft with carbon-fibre composite construction. Failure to make a call from such an aircraft with any particular brand of cellphone spells automatic failure for the same cellphone from a metal-clad aircraft flying at the same altitude. A future experiment will determine the degree of such attenuation.

It may safely be concluded that cellphone calls from slow-moving light aircraft are physically impossible above 8000 feet aga and statistically unlikely below it.

Experiment 3: second full test

date:	April 19 2003 time?
place:	Civic Airport, London, Ontario, Canada
aircraft:	Cessna 172-R four-seater
pilot:	Corey Barrington of Empire Aviation
operator:	Darren Spicknell (technician for Wireless Concepts Inc.)
cellphones:	C1, C2, C3, C4, C5, all fully charged at flight time (see Appendix A for technical specifications)

The purpose of Experiment 3 was to test the effects of what might be called "Faraday attenuation" on the strength and success of calls. The presence of a metallic shell around some electronic devices can alter their behavior by its ability to attract and store electrons, and to affect electromagnetic waves, accordingly. For this reason, the experimental craft was switched from the Katana, which is supposed to be relatively transparent to em radiation, to an aircraft with an aluminum skin, as below.

Weather: unlimited ceiling, light scattered cloud at 5,000, solid/broken 24,000 feet, visibility 12 miles, wind 11 knots from SSW, air temperature +19 C.

Flight path: For this experiment, we flew the same circular route as we did in Part Two. The circle centered on the downtown core and took us over most of the city suburbs. All locations below are referred to the city centre and are always about two miles distant from it.

Protocol: At times specified by the director, the operator made a call to a specified number, stating the code number of the cellphone (1 to 5) and the altitude. The ground recorder noted whatever was heard and the time the call was received. At the first two altitudes of 2000, 4000 above ground altitude (aga) each cellphone was used once. At 6000 and 8000 feet aga, each cellphone was used twice only C2, C3, and C5 were tried, C1 and C4 having become useless.

Results

takeoff 7:12 pm

altitude: 2000 feet

time (pm)	call no.	C#	location	outcome
7:17	1	C1	north	success: clear
7:18	2	C2	west	success: clear
7:20	3	C3	southwest	success: clear
7:22	4	C4	south	success: (2nd try)
7:23	5	C5	southeast	success: clear

altitude: 4000 feet

time (pm)	call no.	C#	location	outcome
7:28	6	C1	north	success: clear
7:30	7	C2	north	success: clear
7:31	8	C3	northwest	success: clear
7:32	9	C4	south	failure*
7:34	10	C5	southwest	success: clear

*unintelligible

altitude: 6000 feet

time (pm)	call no.	C#	location	outcome
7:39	11	C1	southeast	success: clear
7:41	12	C2	east	success: clear
7:42	13	C3	east	success: unclear
7:44	14	C4	northeast	failure: no connection
7:44	15	C5	northeast	failure: no connection

altitude: 6000 feet (cont'd.)

time (pm)	call no.	C#	location	outcome
7:50	21	C1	west	failure: no connection
7:51	22	C2	southwest	failure: no connection
7:52	23	C3	southwest	failure: no connection
7:53	24	C4	south	failure: no connection
7:54	25	C5	south	success: clear

altitude: 6000 – 8000 feet, climbing (C2, C3, C5 still operational

time (pm)	call no.	C#	location	outcome
7:55	26	C2	southeast	failure: no connection
7:57	27	C3	east	failure: no connection
7:59	28	C5	east	success: unclear

altitude: 8000 feet

time (pm)	call no.	C#	location	outcome
8:01	29	C2	northeast	failure: no connection
8:02	30	C3	northeast	failure: no connection
8:03	31	C5	north	failure: no connection

altitude: 8000 feet (cont'd.)

time (pm)	call no.	C#	location	outcome
8:04	32	C2	northwest	success: clear
8:05	33	C3	northwest	failure: no connection
8:07	34	C5	west	failure: no connection

8:20 – landed at airport

The following table summarizes the results:

altitude (ft)	attempts	successes	percent
2000	5	8	100
4000	5	3	60
6000	15	6	40
8000	15	2	13

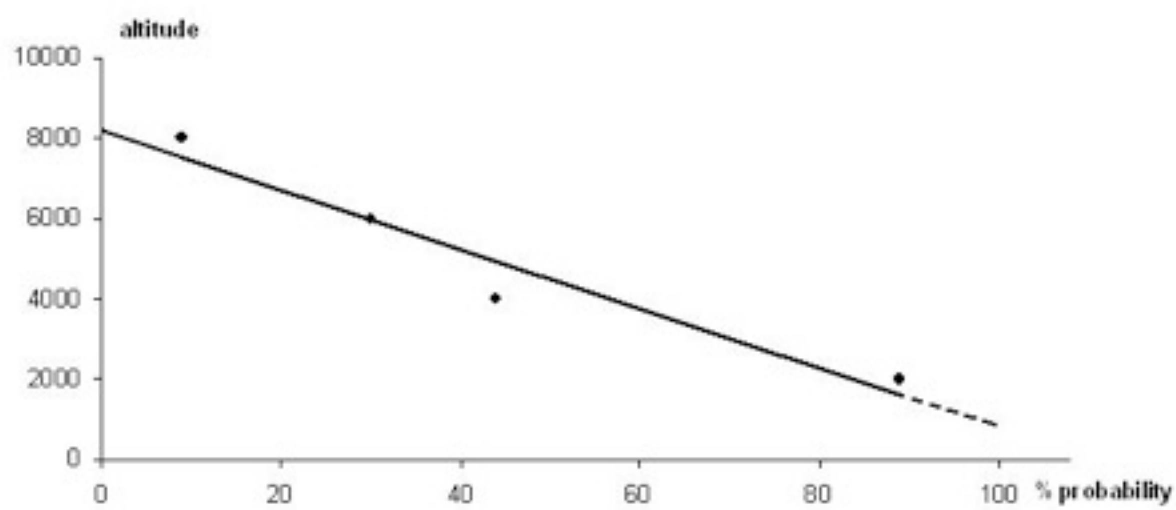
Note: calls "tried" includes retired cellphones C1 and C4 above the altitude of 4000 feet where, in the opinion of the cellphone expert, they would have failed to get through, in any case. Failure to include them in the count would make the results at different altitudes non-comparable.

Analysis

Since the (1.5 mm) skin of the Cessna appears to have made little difference to the outcome of the experiment, the data of Parts Two and Three may be combined, as follows, to produce more reliable figures for the battery of test phones that were used in the experiment:

altitude (ft)	**attempts**	**successes**	**percent**
2000	9	8	89
4000	9	4	44
6000	27	8	30
8000	35	3	9

A simple linear model fits these data rather well. Using a regression line, the best fit to the data indicated a cellphone ceiling for single-engine aircraft at approximately 6000 feet, as can be seen in the figure below.



cellphone success as a function of altitude

At 8000 feet the pilot will not get through at all unless he or she happens to be using a cellphone with the same capabilities as C5 (See appendix A.) But even that cellphone begins to fail at 6000 feet.

The results just arrived at apply only to light aircraft and are definitely optimal in the sense that the success rate from large, heavy-skinned, fast-moving jetliners is apt to be considerably worse. Indeed, one can already discern a difference in cellphone ceiling imposed by the heavier Piper Aztec, as opposed to single-engine light aircraft.

Experiment 4: final test

date:	August 21 2004 time?
place:	Civic Airport, London, Ontario, Canada
aircraft:	Piper Aztec six-seater
pilot:	Richard Moon of Empire Aviation
operator:	Lee Bennett (cellphone technician)
cellphones:	C1, C2 (see notes at end of section for specs) (all fully charged at flight time)

altitude: 1000 feet

call no.	**time**	**C#**	**location**	**quality**	**comment**
1	1:10	C1	urban	good	low static
2	1:18	C2	urban	good	low static
3	1:19	C3	urban	good	1-sec. break
4	1:20	C1	rural	good	static
5	1:22	C2	rural	good	3-sec. break
6	1:23	C3	rural	good	echoes & break
7	1:24	C1	rural	good	noise
8	1:24	C2	urban	good	

altitude: 1000 - 2000 feet, climbing

call no.	time	C#	location	quality	**comment**
9	1:24	C1	urban	good	

altitude: 2000 feet

call no.	time	C#	location	quality	comment
10	1:25	C2	urban	good	
11	1:26	C3	urban	good	
12	1:28	C1	urban	poor	call dropped
13	1:28	C2	rural	good	
14	1:30	C1	rural	good	
15	1:30	C2	rural	good	
16	1:31	C3	rural	poor	call dropped
17	1:32	C1	rural	good	
18	1:33	C2	rural	good	

altitude: 2500 feet, climbing

call no.	time	C#	location	quality	comment
19	1:34	C1	urban	good	

altitude: 3000 feet, climbing

call no.	time	C#	location	quality	comment
20	1:35	C2	urban	failure	call dropped

altitude: 3500 feet, climbing

call no.	time	C#	location	quality	comment
21	1:35	C3	urban	poor	call dropped

altitude: 4000 feet

call no.	time	C#	location	quality	comment
22	1:37	C1	urban	good	
23	1:38	C2	rural	failure	low static
24	1:39	C1	rural	poor	breaking up
25	1:40	C2	rural	failure	call dropped
26	1:42	C1	rural	poor	cross talk
27	1:43	C2	rural	good	

altitude: 4500 feet, climbing

call no.	time	C#	location	quality	comment
28	1:44	C1	urban	failure	call dropped

altitude: 5000 feet, climbing

call no.	time	C#	location	quality	comment
29	1:44	C2	urban	poor	call dropped

altitude: 6000 feet

call no.	time	C#	location	quality	comment
30	1:45	C	urban	failure	
31	1:48	A	rural	good	
32	1:49	B	rural	failure	no signal
33	1:49	C	rural	poor	breaking up

34	1:50	A	rural	failure	
35	1:51	B	rural	failure	no signal
36	1:51	C	rural	poor	breaking up
37	1:52	A	rural	poor	(false) busy signal
38	1:53	B	rural	failure	no signal

altitude: 7000 feet

call no.	**time**	**C#**	**location**	**quality**	**comment**
39	1:53	A	urban	failure	no signal
40	1:54	B	urban	failure	no signal
41	1:54	C	urban	poor	
42	1:55	A	urban	failure	no signal

altitude: 8000 feet

call no.	**time**	**C#**	**location**	**quality**	**comment**
43	1:56	B	rural	failure	no signal
44	1:58	B	rural	failure	no signal
45	1:59	A	rural	failure	no signal
46	1:59	B	rural	failure	no signal
47	2:00	C	rural	failure	no signal

altitude: 5600 feet, descending

call no.	**time**	C#	**location**	**quality**	**comment**
48	2:03	A	rural	failure	no signal

altitude: 4300 feet, descending

call no.	time	C#	location	quality	comment
49	2:03	C	rural	failure	unintelligible

altitude: 3000 feet, descending

call no.	time	C#	location	quality	comment
50	2:05	A	rural	good	

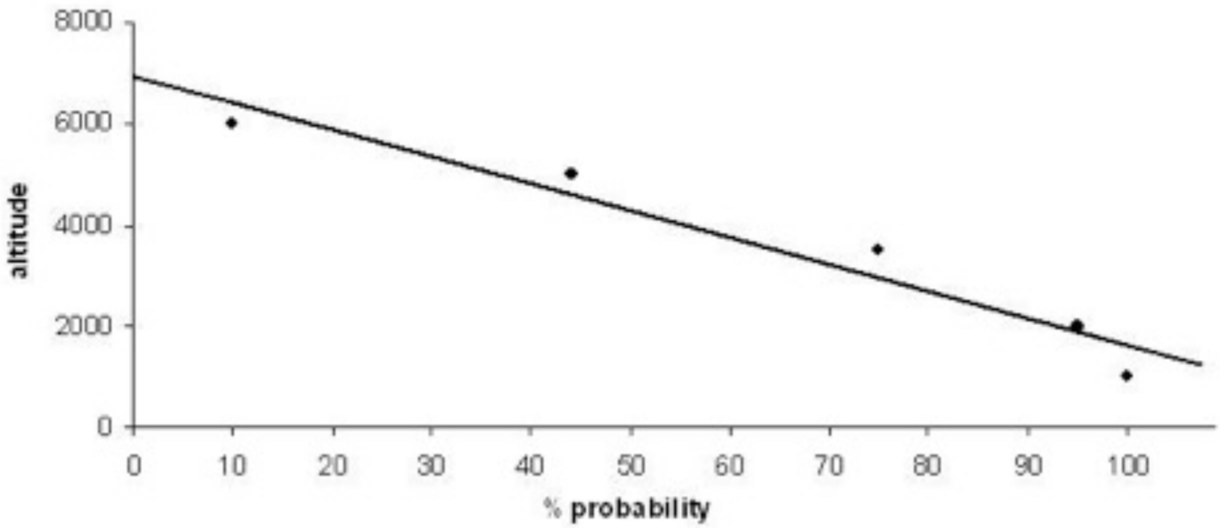
altitude: 2300 feet, descending

call no.	time	C#	location	quality	comment
51	2:06	B	rural	good	

2:10 pm landed at airport

Summary of results

The following graph indicates an absolute ceiling of just over 7000 feet for cellphones being operated from a twin-engine Piper Aztec. The lone cellphone that made a momentary connection at 7000 feet was an analog model. (see Appendix A.) The ceiling for digital phones is almost certainly lower.



Cellphone success as a function of altitude

Note: the cellphone segment of the DVD Loose Change features this flight

Acknowledgments: The author wishes to thank Brad Mayeux for discussions about cellphone technology and Jonathan Dewdney and Pablo Jaramillo for graphic design work.

APPENDIX A: Technical Information

Experiment 2

The following cellphones were used in Experiment 2:

C1 – Motorola i95cl – Telus Mike Network – 800 Mhz IDEN
C2 – Motorola StarTac – Bell Mobility – 800 Mhz Analog
C3 – Audiovox 8300 – Telus PCS Network – 1.9 Ghz CDMA / 800 MHz
C4 – Nokia 6310i – Rogers AT&T – 1.9 Ghz GHz GSM. (Tri-Band – Has a 1.8 GHz and 900 Mhz GSM these are European frequencies)

IDEN – Integrated Digital Enhanced Network
CDMA – Code Division Multiple Access
GSM – Global Systems for Mobile Communications

Power output: "The Nokia 6310i and Audiovox 8300 when in digital mode will output 0.2 Watts. The Analog Motorola StarTac operates at 0.6 Watts optimal. When and IF the Audiovox 8300 is in analog mode it will operate at 0.6 Watts (However, this is not normally the case - you will see wattage levels around 0.52 - 0.45 approximately)

Frequency: "Both the Telus Mike (C1) and Motorola StarTac (C2) operate in the 800 MHz range. This will allow the signal to travel a great distance. However, the IDEN (Mike) network has fewer site locations and is a newer Digital network. Most digital technologies operate on a "all or none" basis. When it has signal it will work well. As the signal fades, one hears no static, but some digital distortion just before the call drops.

Networks:

"Mike Network: Newer, all-digital network with modern antenna design, and fewer cellsites
Bell Mobility Analog: Older, analog network with less focused antenna design but many cellsites
Telus PCS: Newer, digital network with multiple frequencies, modern antenna design, and many cellsites
Rogers GSM: Our newest digital network with modern antenna design and many cellsites"

Darren Spicknell, Wireless Solutions

Experiment 3

The following cellphones were used in this experiment:

C1 - Motorola i95cl - Telus Mike Network - 800 Mhz IDEN
C2 - Motorola StarTac - Bell Mobility - 800 Mhz Analog
C3 - Audiovox 8300 - Telus PCS Network - 1.9 Ghz CDMA / 800 MHz
C4 - Nokia 6310i - Rogers AT&T - 1.9 Ghz GHz GSM. (Tri-Band - Has a 1.8 GHz and 900 Mhz GSM these are European frequencies)
C5 - Motorola Timeport 8767 - Bell Mobility - 800 MHz Analog (CDMA Tri-Mode 1.9 GHz CDMA / 800 Mhz CDMA)

Experiment 4

The following cellphones were used in Experiment 4:

C1 – Nokia 6225 – Bell Mobility – CDMA
C2 – Nokia 3600 – The Rogers GSM Network
C3 – Motorola i60c – IDEN network

APPENDIX B: Letters

Dear Sir

I have yet to read the entire article, but I do have a background in telecommunications. Using a cell phone on an aircraft is next to impossible. The reasons are very detailed, but basically the air craft would run major interference, as well as the towers that carry the signal would have a difficult time sending and receiving due to the speed of the air craft. As well, calling an operator? Well that is basically impossible.

Having worked for both a major Canadian and American provider I had to instruct my staff that operator assistance is not an option. Have you ever tried to use a cell phone in some public buildings? Impossible. There are too many spots that service is voided. Just a tidbit of information to share.

Megan Conley <megan_conley@hotmail.com>

Hi,

I am an RF design engineer, having built out Sprint, Verizon and another network in New Orleans. You are absolutely correct. We have trouble making these things work for cars going 55 mph on the ground. If you need another engineer's testimony for any reason, let me know I will corroborate.
my engineering site: http://www.geocities.com/rf_man_cdma/
Brad Mayeux <cdmaman@engineer.com

Further Comments from Mr, Mayeux that illuminate the connection process: "Often in urban areas, the phone can pick up and use signals from more than one site at a time, although, when in motion (as in a car, plane etc...) the phone will constantly pickup new (stronger) signals and drop weaker ones. The phone constantly "scans" for stronger signals, the problem here is that by the time the new signal gets added to the group of signals that the phone can use, it is possible that this "new" signal has already dropped off in power. The phone then may try to go to this signal which is no longer strong enough to use, and the call can drop. This is known to happen in cars on highways going 70mph, and could easily happen with a plane going 500mph+ A very similar scenario happens in placing the call as well."

Sir,

Yours is the first article I've read which focuses on those dubious 'cell phone calls'. Last month my Wife and I flew to Melbourne, about 1000 miles south of here. Cell phones are Verboten in Airliners here, but on the return journey I had a new NOKIA phone, purchased in Melbourne, and so small I almost forgot it was in my pocket. I furtively turned it on. No reception anywhere, not even over Towns or approaching Brisbane. Maybe it's different in the US, but I doubt it.
There has to be an investigation into this crime. Justice for the thousands of dead and their families demands it.
Best
Bernie Busch <bbusch@iprimus.com.au>

Hi Prof

I have repeatedly tried to get my cell phone to work in an airplane above 2-3000 feet and it doesn't work. My experiments were done discreetly on [more than] 20 Southwest Airlines flights between Ontario, California and Phoenix, Arizona. My experiments match yours. Using sprint phones 3500 and 6000 models, no calls above 2500 ft [succeeded], a "no service" indicator at 5000 ft (guestimate).
There seem to be two reasons. 1. the cell sites don't have enough power to reach much more than a mile, 2. The cell phone system is not able to handoff calls when the plane is going at more than 400 mph. This is simply experimental data. If any of your contacts can verify it by finding the height of the Pennsylvania plane and it's speed one can prove that the whole phone call story is forged.
Rafe <rafeh@rdlabs.com> (airline pilot)

Greetings,

I write in praise of your report, as I have felt from day one that the cell phone ‘evidence’ was perhaps the flimsiest part of the story, and am amazed that nobody has touched it until now. I’d also like to bring up the point of airspeed, which is what made the cell calls a red-flag for me in the first place. I’m not sure what your top speed achieved in the small plane was, but, in a large airliner traveling at (one would think) no less than 450 mph, most cell phones wouldn’t be able to transit cells fast enough to maintain a connection (at least, from what i understand of the technology) .. and we’re talking 2001 cell technology besides, which in that period, was known to drop calls made from cars traveling above 70 mph on the freeway (again, due to cell coverage transits)
Anyway, thanks for shining the light, keep up the good work
Ben Adam

Dear Professor,

Responding to your article, I’m glad somebody with authority has taken the trouble to scientifically prove the nonsense of 9/11.
I was traveling between two major European cities, every weekend, when the events in the US occurred. I was specifically puzzled by the reports that numerous passengers on board the hijacked planes had long conversations with ground phone lines, using their mobile phones (and not on board satellite phones). Since I traveled every weekend, I ignored the on board safety regulations to switch off the mobile phone and out of pure curiosity left it on to see if I could make a call happen.

First of all, at take off, the connection disappears quite quickly (ascending speed, lateral reception of ground stations etc.), I would estimate from 500 meters [1500 feet approx.] and above, the connection breaks.

Secondly, when making the approach for landing, the descent is more gradual and the plane is traveling longer in the reach of cellphone stations, but also only below 500 meters. What I noticed was that, since the plane is traveling with high speed, the connection jumps from one cellphone station to another, never actually giving you a chance to make a phone call. (I have never experienced this behaviour over land, e.g. by car). Then, if a connection is established, it takes at least 10-30 seconds before the provider authorizes a phone call in the first place. Within this time, the next cellstation is reached (travel speed still > 300KM/h) and the phone , always searching for the best connection, disconnects the current connection and tries to connect to a new station.

I have done this experiment for over 18 months, ruling out weather conditions, location or coincidence. In all this time the behaviour was the same: making a phone call in a plane is unrealistic and virtually impossible.
Based on this, I can support you in your findings that the official (perhaps fabricated) stories can be categorized as nonsense.

With kind regards.
Peter Kes <kpkes@yahoo.com>

Sir,

It must be clearly understood that Prof. Dewdney's tests were conducted in slow-moving (<150kts) light aircraft at relatively low altitudes (<9000ft AGL). The aircraft from which the alleged calls were made on 9/11 were flying at over 30,000 ft at speeds of over 500 MPH. During a recent round-trip flight from Orange County, CA to Miami, FL (via Phoenix, AZ), I personally conducted an unofficial "test" using a brand new Nokia 6101 cellular phone [NB: 2005 technology]. En route, I attempted (discretely, of course) a total of 37 calls from varying altitudes/speeds. I flew aboard three types of aircraft: Boeing 757, 737, and Airbus 320. Our cruising altitudes ranged from 31-33,000ft, and our cruising speeds, from 509-521 MPH (verified post-flight by the captains). My tests began
immediately following takeoff. Since there was obviously no point in taking along the wrist altimeter I use for ultralight flying for reference in a pressurized cabin, I could only estimate (from experience) the various altitudes at which I made my attempts. Of the 37 calls attempted, I managed to make only 4 connections - and every
one of these was made on final approach, less than 2 minutes before flare, i.e., at less than 2,000ft AGL.

Approach speeds varied from 130-160 kts (Vref, outer marker), with flap and gear extension at around 2,000ft (again, all speeds verified by flightdeck crews). Further, I personally spoke briefly with the captains of

all four flights: I discovered that in their entire flying careers, NOT ONE of these men had EVER been successful in making a cell phone call from cruising altitude/speed in a variety of aircraft types. [NB: Rest assured the ubiquitous warnings to “turn off all electronics during flight” are completely unfounded. All modern aircraft systems are fully shielded from all forms of RF/EMF interference (save EMP, of course). This requirement was mandated by the FAA many years ago purely as a precautionary measure while
emerging advanced avionics systems were being flight tested. There is not a single recorded incident of interference adversely affecting the performance of airborne avionics systems.]

Obviously, my casual, seat-of-the-pants attempt at verifying a commonly known fact can hardly be passed off as a “scientific” test. Ergo, I shall offer Prof. Dewdney?s conclusion, excerpted from his meticulously detailed and documented paper re slow-flying light aircraft at low altitudes.

Nila Sagadevan

Prof. Dewdney:

I do not pretend to be any sort of expert of cellular communications, but I am an electronics engineer and hold both amateur and commercial FCC licenses, so I do have some understanding of the relevant principles of radio communication systems.
I read with interest your analysis of terrestrial contact probabilities via cellphones from aircraft. I believe your conclusions are sound, but would like to comment on an element which you pondered regarding the sort of apparent discontinuity in what seems otherwise to be an inverse-square relation beyond a certain altitude.

Cellphones operate by Frequency Modulation, and as such the (apparent) signal strength is not discernible to the listener because the intelligence is contained only in the frequency and phase information of the signal before demodulation. Hence, the system works pretty well until it is so weak that it is abruptly lost. That is, the system can no longer “capture” the signal. It does not get louder and softer with signal strength -until the signal is below the detection level of the receiver, at which point it is essentially disappears. The cellphone also adjusts the transmit power according to the signal level received at the tower end of the link. Once it is at maximum output, if the signal diminishes beyond some minimum threshold depending on the receiver design, it is lost altogether and not simply degraded in quality. Analogous behavior is experienced with FM broadcast stations; as you travel away from the transmitter the station is received with good fidelity until at some distance it rather suddenly cannot even be received any longer at all.

Additionally, cellphone towers are certainly not optimally designed for skyward radiation patterns. Since almost all subscribers are terrestrial that is where the energy is directed, at low angles.
In summary, if your observed discontinuous behavior is real, and I believe there is technical reasoning for such, the probability of making calls beyond some threshold altitude is not simply predictably less, but truly impossible with conventional cellphones under any condition of aircraft etc. because of the theoretical limits of noise floor in the receiving systems. I think the plausibility of completing the calls from 30,000+ ft. is even much lower than might be expected from extrapolations of behavior at lower altitudes which you investigated.

Thank you for your thoughtful work in this area.

Sincerely,

Kevin L. Barton

Dear Dr Dewdney

I too can verify that on a private charter airline, Champion Air, which was a 737-300, I believe that is correct or it might have been a 727-300. But regardless of that, we took off from Dallas/Ft. Worth International Airport at 0735 in July of 2003. As we were taxiing to the run way the pilot told us to please turn off all electronic equipment, i.e. Cell Phones, Laptops, etc. I did so, but shortly after take off and before the pilot said we could use our “electronic equipment” I thought I would call my mom and let her know we were in the air. We had not been off the ground for more than 2 minutes. I would guess between 2000 and 5000 ft. I was using at the time one of Motorola’s top of the line phones, a V60t. My cell phone carrier is Cingular which is quite a widespread carrier as you probably know, I had absolutely no signal at all. Since we were flying to Cozumel, Mexico I kept trying and watching for a signal until we got out past the coast line of Texas, when then I knew for sure I wouldn't get a signal again until we landed in Cozumel. Again in June 2004 we flew out of DFW, same airline, same type of plane, and the same thing occurred. This time I left my phone on from take off and up until it lost the signal. Again we couldn't have been more than 2000 to 3000 ft. off the ground. I lost the signal and never again got a signal until the plane landed in Cozumel. I find it highly unlikely that anyone could have used a cell phone on 9/11/01 at above 2000 feet.

Sincerely,

Brad Taylor

Sir

I've been using Nokia phones with automatic nationwide roaming, and Cingular before it was Cingular and long before 9/11. I confess to having turned my cell phone on while flying commercial airlines several times prior to 9/11, just to see if signals were available. At 2,000 feet the phone went totally flat. No calls out or in were ever possible. Of course all these stories are anecdotal, but cell phone engineers who have cared to comment have stated that commercial aircraft fly far too fast and far too high to expect that folks on flight 93 ever managed to get a call out on their own phones. They've said that the towers can't transition or hand over private cell phones fast enough. I hope we can hear from other ATPs on this subject.

George Nelson (Col. USAF ret.)

Note: no message denying the conclusions of these experiments was ever received.

Intelligence Note

If one reads any textbook on avionics (relating to the structure and function of aircraft electronic systems) one quickly discovers that all navigation and other "delicate electronic instruments" aboard any modern airliner are heavily shielded against stray electromagnetic (EM) radiation. This includes heavy radiation from the aircraft's antenna system in the forward belly of the aircraft. That system operates at a level of 30 to 50 Watts and is much closer to the avionics of concern than the passenger compartment. Cellphones operate at a power level of 0.2 to 0.6 Watts maximum.

It must therefore be asked whether the general cellphone ban that was implemented as cellphones came into general use in the late 1990s had the protection of "delicate electronics" as its main purpose.