



# FCC Update on AirCell System Compatibility Tests

July 1, 2004

# Overview

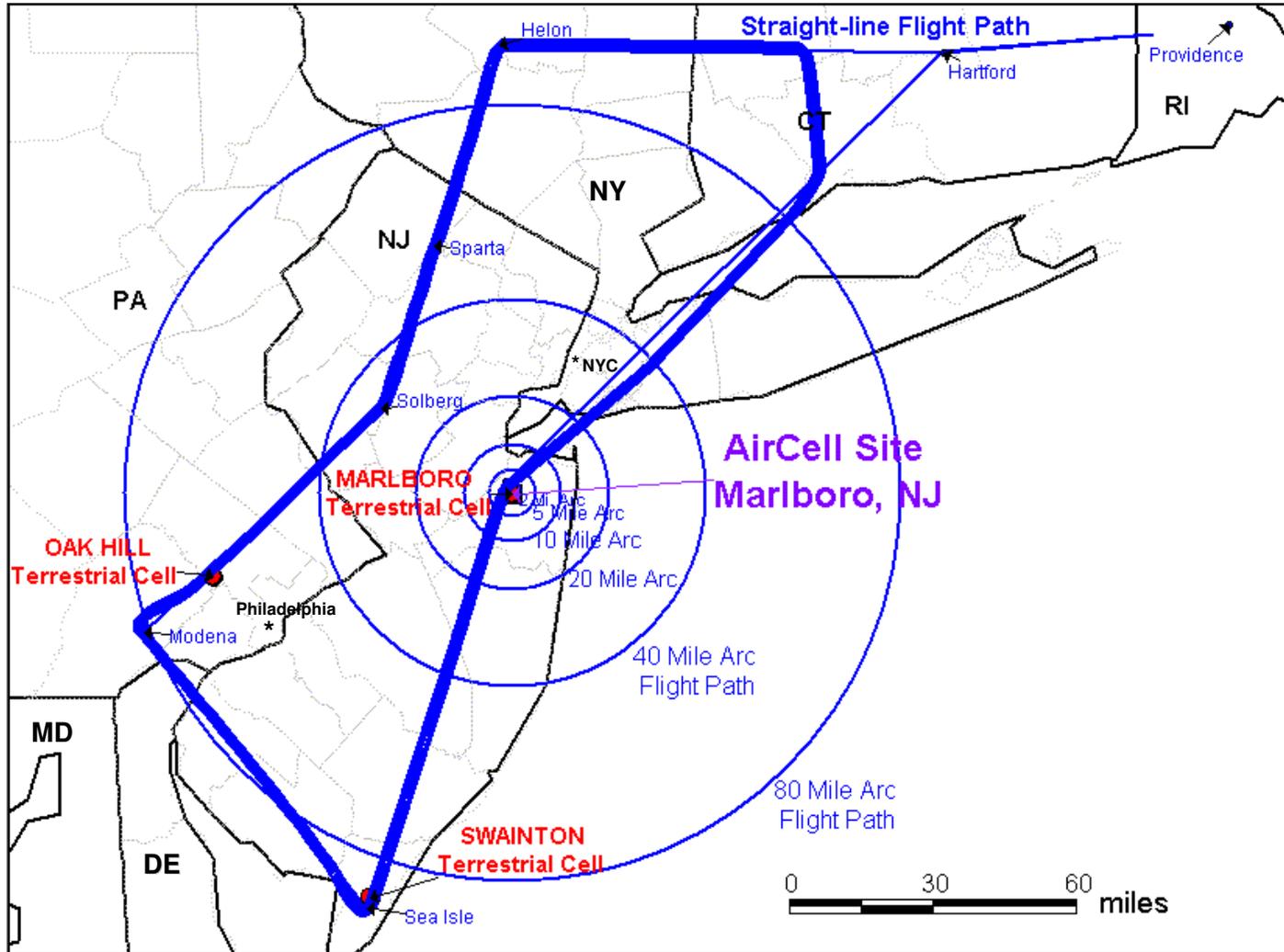
- Companies Involved in our tests
- Our Tests & AirCell's Criticisms
- Significant Flaws of AirCell's Tests
- Transmit Power Levels of Airborne Units
- Conclusions

# Who's involved in our tests

- V-COMM
  - Served as independent expert engineering firm to perform tests and document findings
  - Executed plans in coordination with cellular service providers, Lucent Technologies, AirCell, and the FAA
- Lucent Technologies (manufacturer of cell equipment)
  - Provided insight to tests, methods, interpretation of data
- Cingular, AWS & Verizon Wireless (Service Providers)
  - Facilitated access to cell site equipment in cellular markets
- AirCell
  - Optimized & configured base stations - for our flight tests
  - Inspected AirCell phone installation - for our piston aircraft
  - Verified AirCell phone antenna type - for two jet aircraft

# V-COMM's Flight Tests

(Straight-line flight route uses VOR stations)



# Overview of V-COMM's Flight Tests

- Flight patterns were typical & representative
  - Used standard FAA VOR Stations as “roadways in the sky”
  - FAA coordinated and approved (*AirCell claims it's impossible*)
- Utilized AirCell's “standard” antenna system
  - Receive antennas were NOT obstructed by tree line (*AirCell incorrectly depicts its receive antennas, and impact to DPC*)
  - Only 1 transmit antenna obstructed - Not used in tests!
  - Smart Antenna testing was refused by AirCell (*Smart antenna represents a special case; only 3 in 135 sites*)
- Consisted of typical AirCell service range (80-90 miles)
  - AirCell added more sites after tests were completed, however it would not have significantly impacted results

# Overview of V-COMM's Flight Tests (Cont.)

- Utilized DPC Off tests to capture full impact of interference potential (which includes worst case), and quantify path loss component
- Utilized DPC On tests to measure full impact of airborne unit transmit power levels; performed after ...
  - AirCell configured and optimized ALL parameters - including DPC target, window and maximum settings
  - AirCell performed on-air flight tests; verified site optimization and operation according to AirCell standards
  - AirCell did not setup handoffs, nor say it was required
    - Handoffs not normally implemented in non-adjacent cellular markets
    - If implemented, it wouldn't have impacted results (hysteresis)
- All co-channels and adjacent channels were cleared from area, to ensure measurement of AirCell signals

# Overview of V-COMM's Flight Tests (Cont.)

- AirCell inspected & verified piston aircraft phone installation ... but declined inspecting jet aircraft
  - No reason to suspect any are not working properly
  - AirCell verified the correct antenna type was used in all aircraft
  - All were installed at AirCell's authorized installation facilities
- Our flight tests includes significantly more data than previous 1997 flight tests:
  - Variety of terrestrial antennas (Hpol, Vpol, SL45, Omni)
  - Variety of airplane altitudes & orientations to sites (1997 tests only included 1 flight path orientation; the best case)
  - Both types of aircraft antennas (vs. 1997 tests with VOR only)
- Utilized 3 victim terrestrial sites (with no antenna down-tilting)
  - That's typical, 66% of sites in suburban & rural areas not down-tilted

# V-COMM's flight tests with DPC Fixed

- AirCell asserts its 1997 flight data compares with our fixed DPC flight data ...

**Comparison of Circular Flight Data from V-Comm Tests and AirCell 1997 Tests at 5000' MSL and DPC Fixed at Step 2, (V-Pol Omni Antenna)**

Flight Radius	V-Comm Average Level	AirCell Average Level	Difference
5 miles	-108 dBm	-107.8 dBm	0.2 dB
10 miles	-113 dBm	-113 dBm	0 dB
20 miles	-118 dBm	-117.7 dBm	0.3 dB
		Total Average Difference	0.17 dB

**AirCell's Table 2.3.c.1**

**No dispute regarding these results!**

[These flight tests were performed along arc-pattern routes around victim terrestrial sites, with airborne units transmitting at their fixed DPC Step 2]

# Flight Test Results with DPC fixed to Step 2

- Represent airborne units transmitting at full power, occurs ...
  - Control channels ALL the time (No DPC on control channels)
  - Voice channels for a significant portion of time (up to 44%)
  - When aircraft are further away from serving sites, closer to neighboring terrestrial markets
  - On busier flight tracks in urban areas, which are further from AirCell sites (typically located in rural markets)
- Represent airborne unit signals received at victim terrestrial sites ...
  - Reaching as high as -72 dBm; frequently in -90 to -100 dBm range; often *well above* -110 dBm level
  - Clear evidence of Harmful Interference (*even exceeds harmful interference threshold defined within FCC's Order on Remand*)

# AirCell *incorrectly* depicts its receive antennas at Marlboro

Recent Photo of Marlboro Site showing AirCell Receive Antennas below the tree line

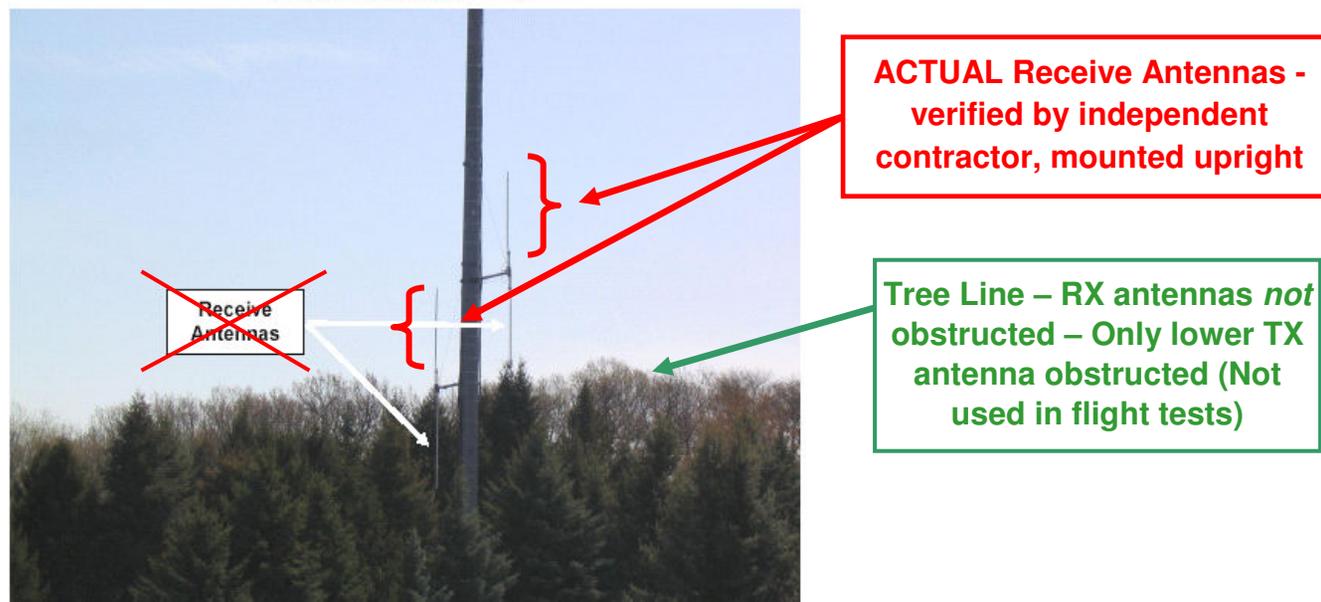
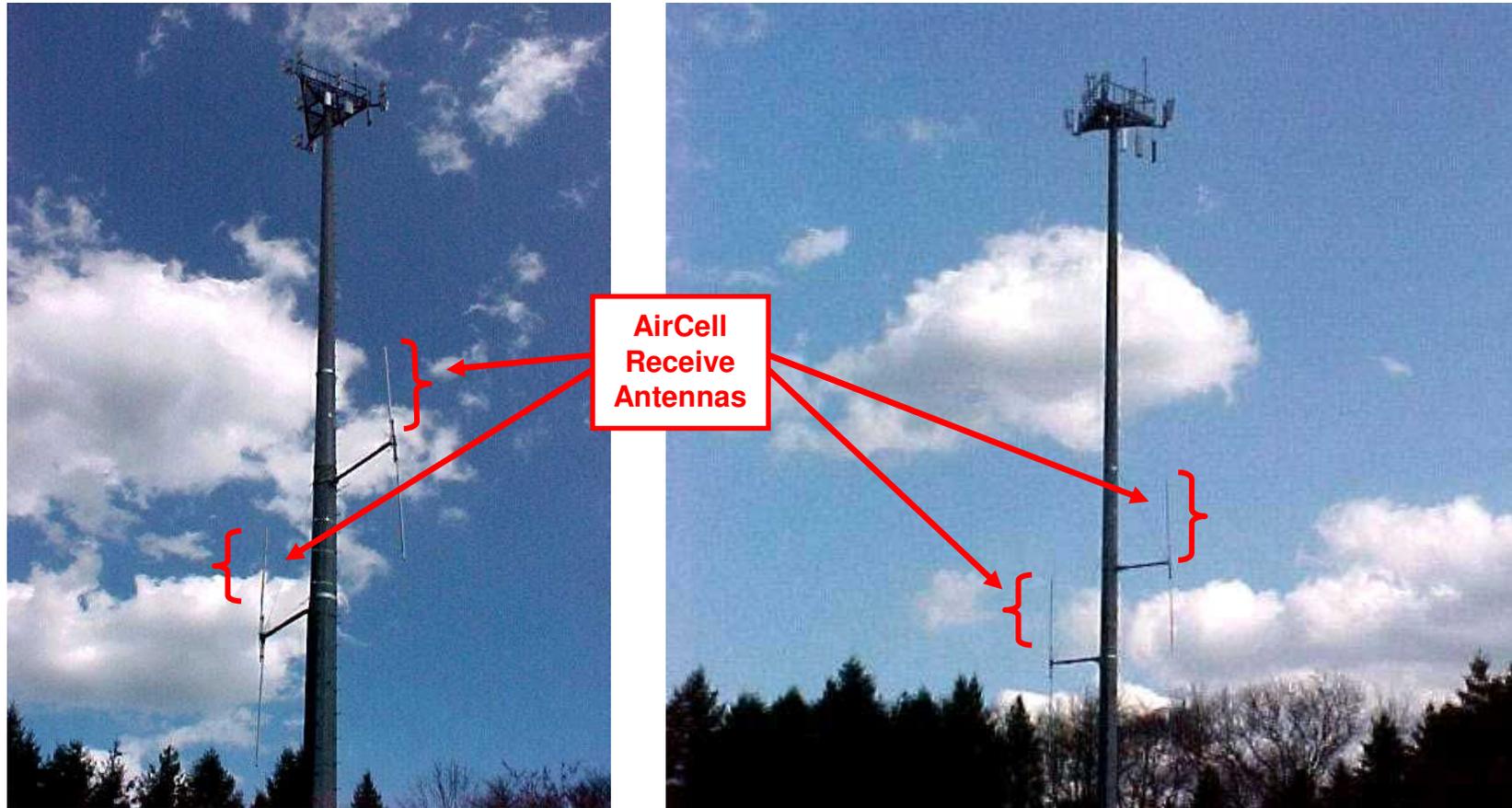


Figure 2.3.b.13

→ Low antennas force much higher DPC levels and loss of diversity

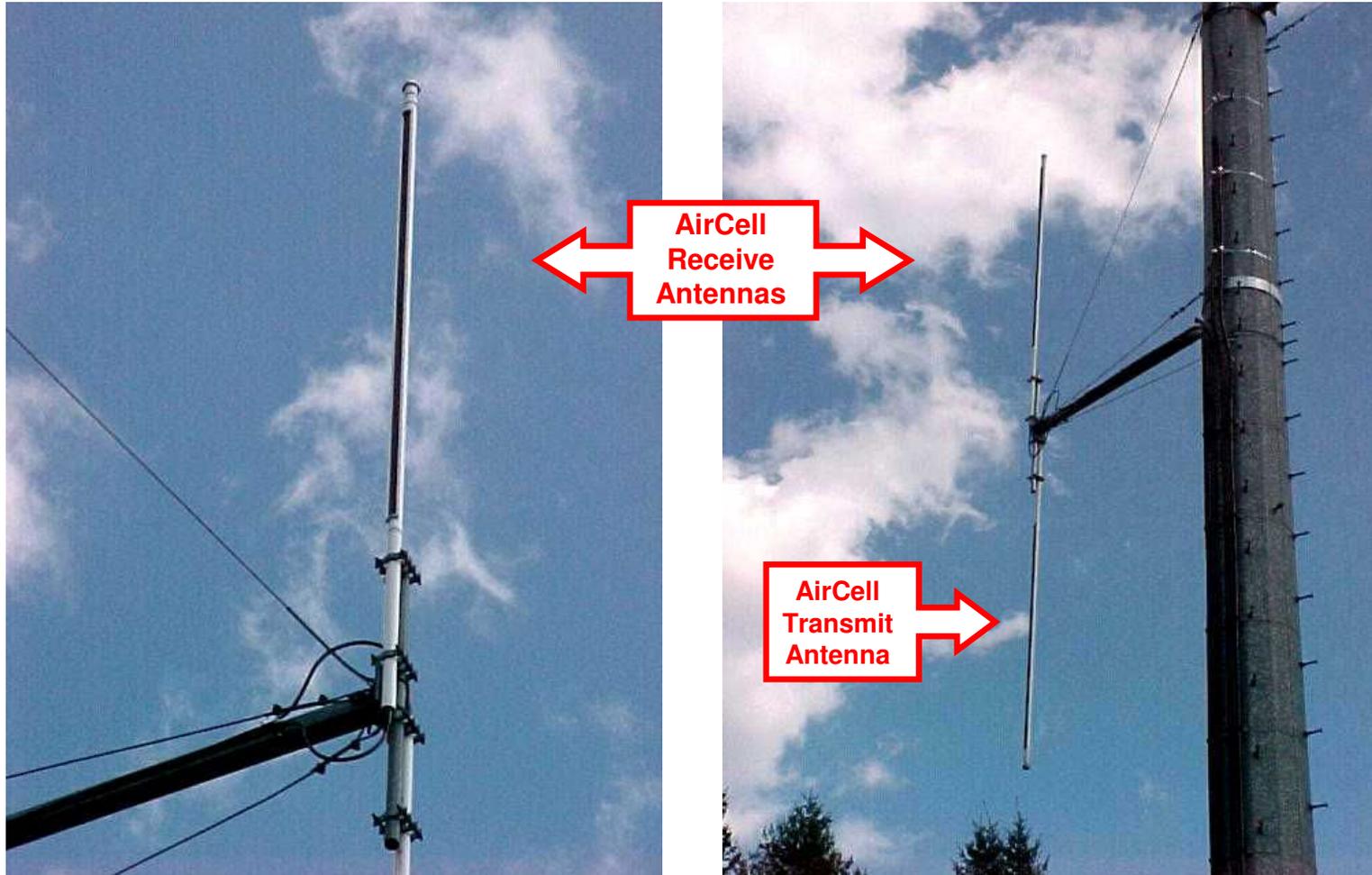
⇒ AirCell's Exhibit to FCC - AirCell points to wrong antennas, draws incorrect conclusion of DPC impact

# Other photos of receive antennas at Marlboro AirCell site



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# Close-up photo of AirCell receive antenna



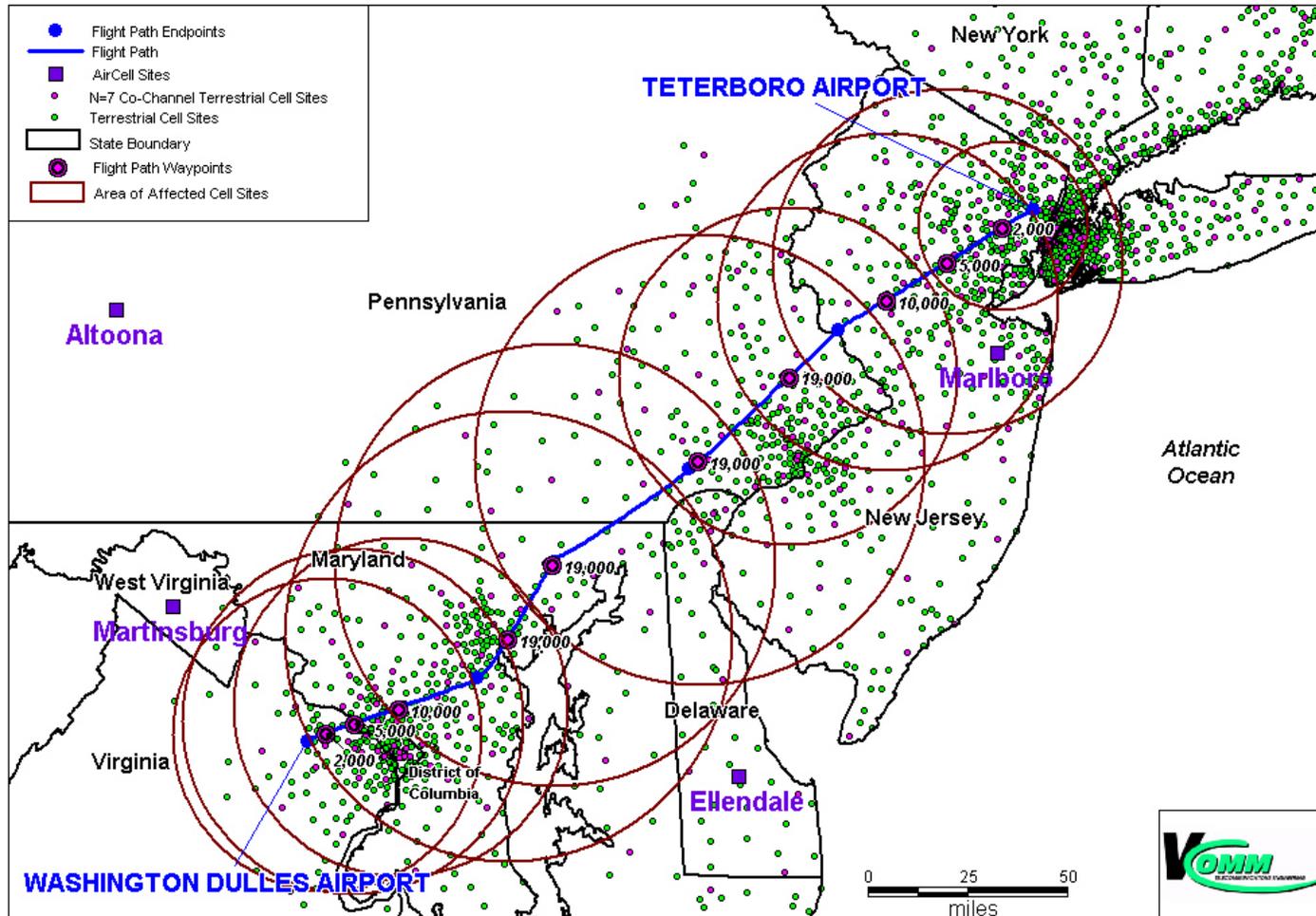
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# Overview of our Case Study

- Demonstrates impact of AirCell air-to-ground operations on terrestrial cellular networks
- Utilized the *most common* flight route in the U.S.
  - Wash DC to NY metro route, >113 flights per day
- Utilized empirical data from flight test & interference compatibility test results:
  - Data from DPC enabled flight tests – used to assess AirCell mobile transmit power levels
  - Data from DPC fixed flight tests – used to assess path loss component
  - Data from interference compatibility drive tests – used to assess point of harmful interference (at -114 dBm)
- Provided Case Study at -110 dBm to the Commission, as well, showing significant harmful interference

# Case Study Flight Route

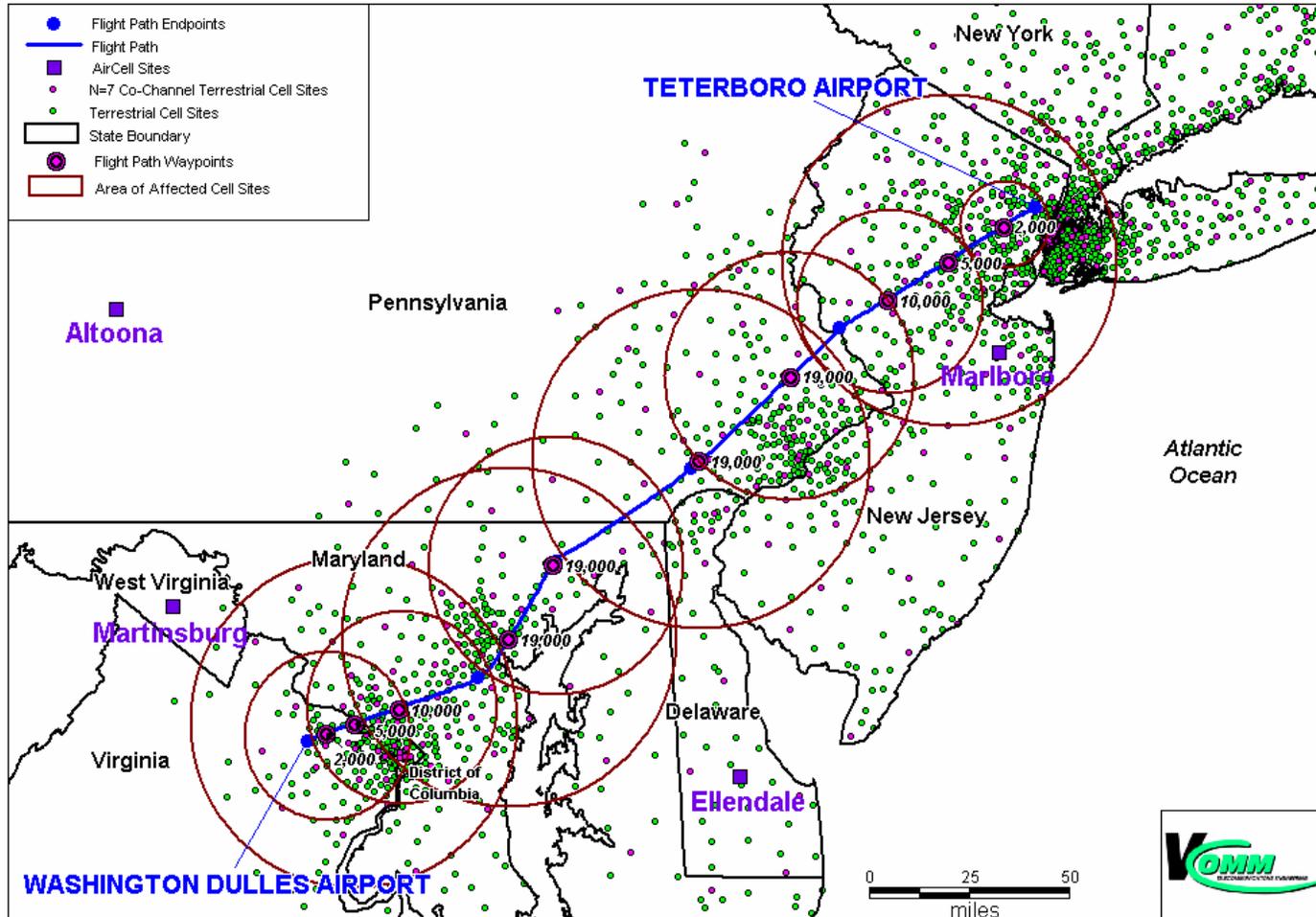
Jet Aircraft Flight Profile & Affected Terrestrial Cell Sites, 90% Signal, *IAP -114 dBm*  
SL45 Antenna, Washington Dulles to Teterboro, NJ Airport



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# Case Study Flight Route

Jet Aircraft Flight Profile & Affected Terrestrial Cell Sites, 90% Signal, *IAP -110 dBm*  
SL45 Antenna, Washington Dulles to Teterboro, NJ Airport



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# AirCell's criticisms of Case Study

- Provides criticisms that are not relevant, instead just rehash criticisms of other tests
  - i.e. Noise floor study *does not* impact Case Study
- Claims its million-mile database & internally used model show otherwise ...
  - *However, it does not provide its million-mile database, nor its model, to the Commission*
- Claims handoffs were not assumed in Case Study
  - *However, they're incorrect.* Handoffs were assumed for the Case Study flight profile, with the nearest AirCell site serving the call (best-case condition).

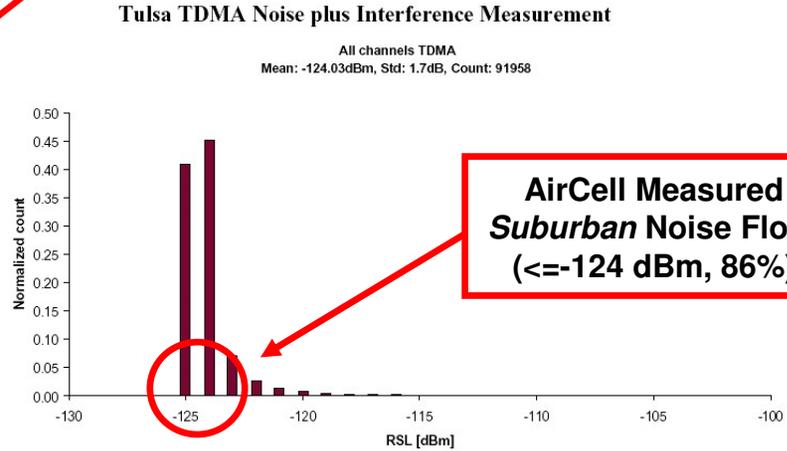
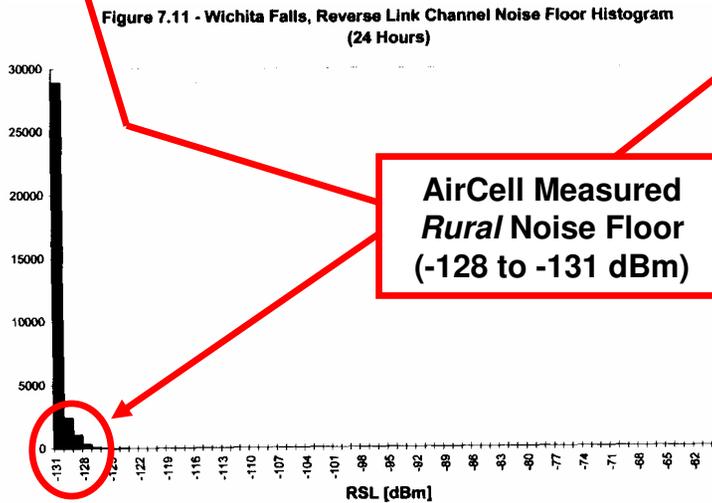
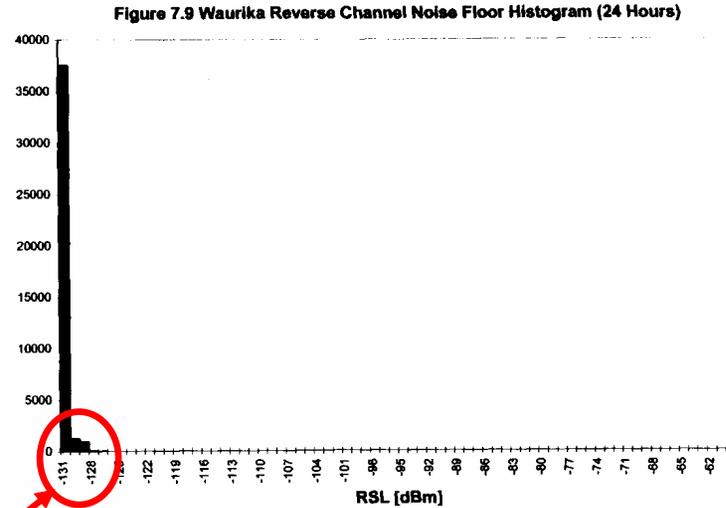
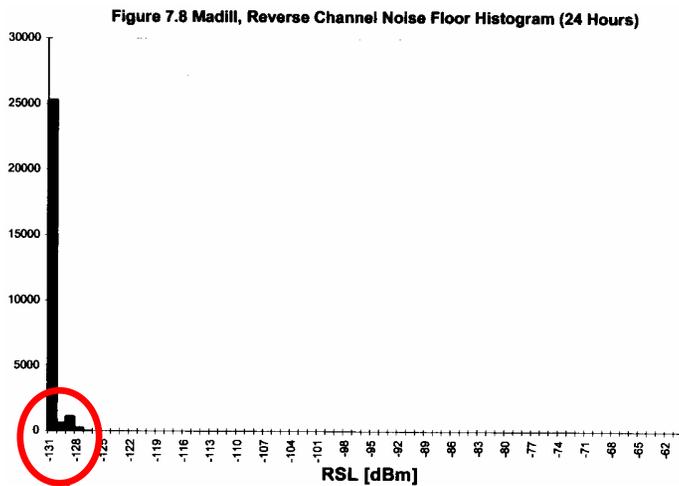
# Our Terrestrial Noise Floor Studies

- Represents real-world measurements of terrestrial interference plus noise levels
  - Includes 18 terrestrial AMPS cell sites; from rural, suburban, urban & dense urban markets
- Noise studies demonstrate very low operating conditions
  - As low as -127 dBm, *allowing quality AMPS calls to -110 dBm*
- AirCell ‘re-casts’ our noise data --> significantly flawed manipulation of valid data
  - *Misinterpreted* quote from old AT&T manual
  - *Wrongly* calculated noise figure at *incorrect* reference point
  - *Misapplied* NTIA study results (used offset value)
- Lucent confirms AirCell *misinterpreted* manual; and *disagrees* with AirCell’s re-casting

# Our Terrestrial Noise Floor Studies (Cont.)

- AirCell's other criticisms are incorrect -> our test setup, calibration and measurements were valid and correct
  - Explained with detailed test procedures
  - Confirmed by additional tests; verified previous results
- AirCell only focuses on the *highest peak* terrestrial noise level; not the operating level for the majority of the day
  - Peak level is *not* statistically significant (<0.1% time) - typical or median operating noise level should be used for consideration of secondary services
- AirCell *misunderstands* how practical wireless systems operate
  - Incorrectly asserts that 100% of calls must be 17 dB above the *highest peak* noise level, 100% of time (this is *highly impractical*)
  - Absurdly asserts cellular phones must increase power by 22 dB (Cell phones at full power; impossible to power up to *95 Watts ERP*)
  - These are invalid manipulations of real-world signal data (similar to invalid 'recasting' of noise data)

# AirCell's noise measurements *do not* support its assertions... (however they agree with ours)



**AirCell Measured  
Rural Noise Floor  
(-128 to -131 dBm)**

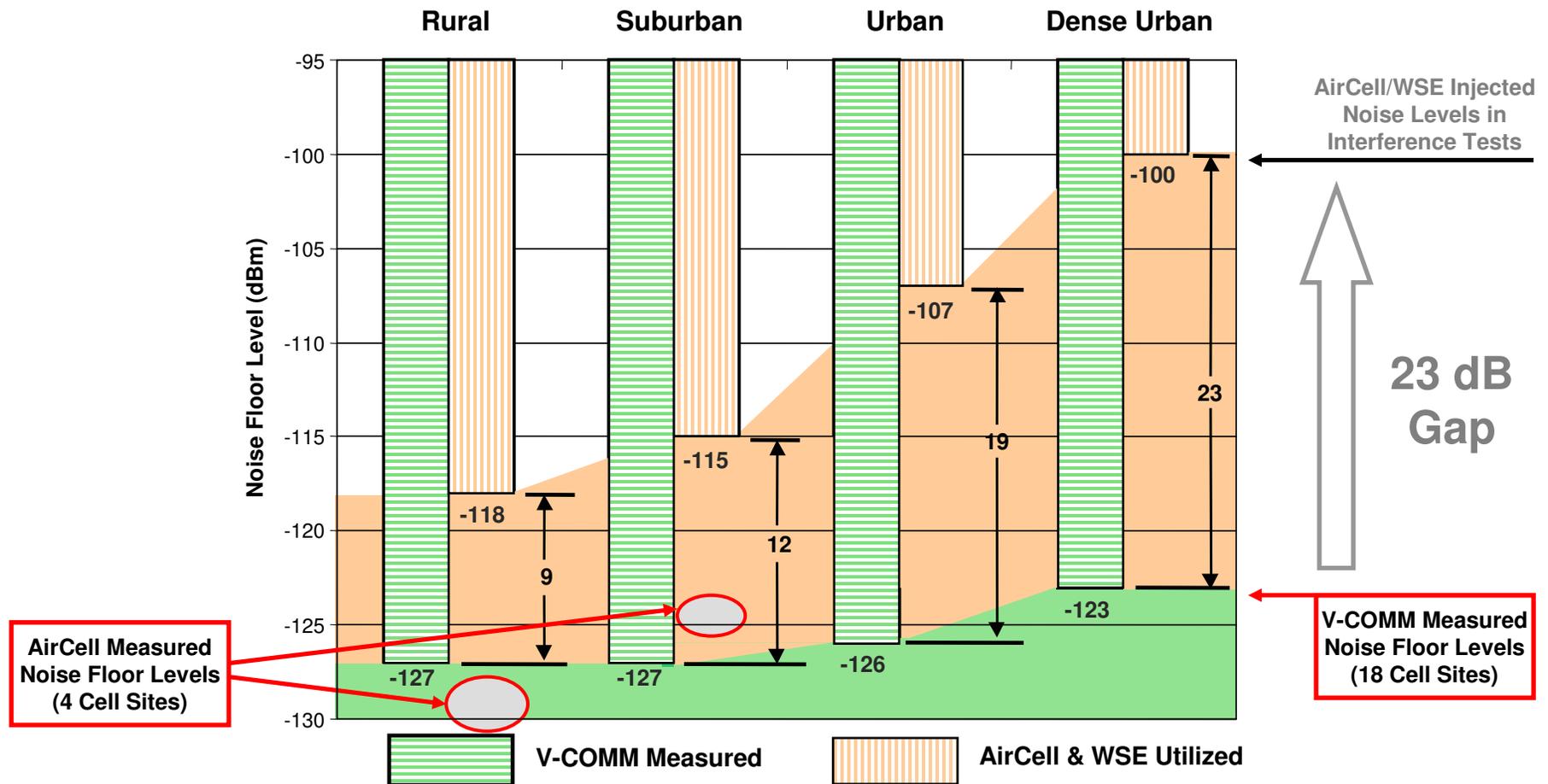
**AirCell Measured  
Suburban Noise Floor  
( $\leq -124$  dBm, 86%)**

Figure 2.6.c.2

# Comparison of noise level measurements

## AirCell's data matches ours

V-COMM vs. AirCell Terrestrial Noise Floor Levels



# Our Interference Compatibility Tests

- Represent actual network operating conditions
  - Utilized typical & standard settings & configuration (consistent with Vendor recommendations; *contrary to AirCell's claims*)
  - Exhibited consistent traffic & noise levels, exact same roads driven, yielding repeatable results
  - 10 Performance Metrics included to assess full impact
  - Utilized a typical suburban cell site (1.5 mile coverage radius, conservative-case impact assessed)
- AirCell offers non-relevant criticisms, instead just rehash criticisms of other tests (not relevant to these tests)
  - AirCell argues against drive tests (due to “uncontrollable” variables), despite that fact they *are* real-world tests

# AirCell's Tests are Flawed & Inconclusive

- AirCell relies upon extremely limited flight data
- AirCell relies upon its flawed Interference Tests
- AirCell's noise measurements matches our results; but does not match levels injected in AirCell's tests

# AirCell relies upon extremely limited flight data

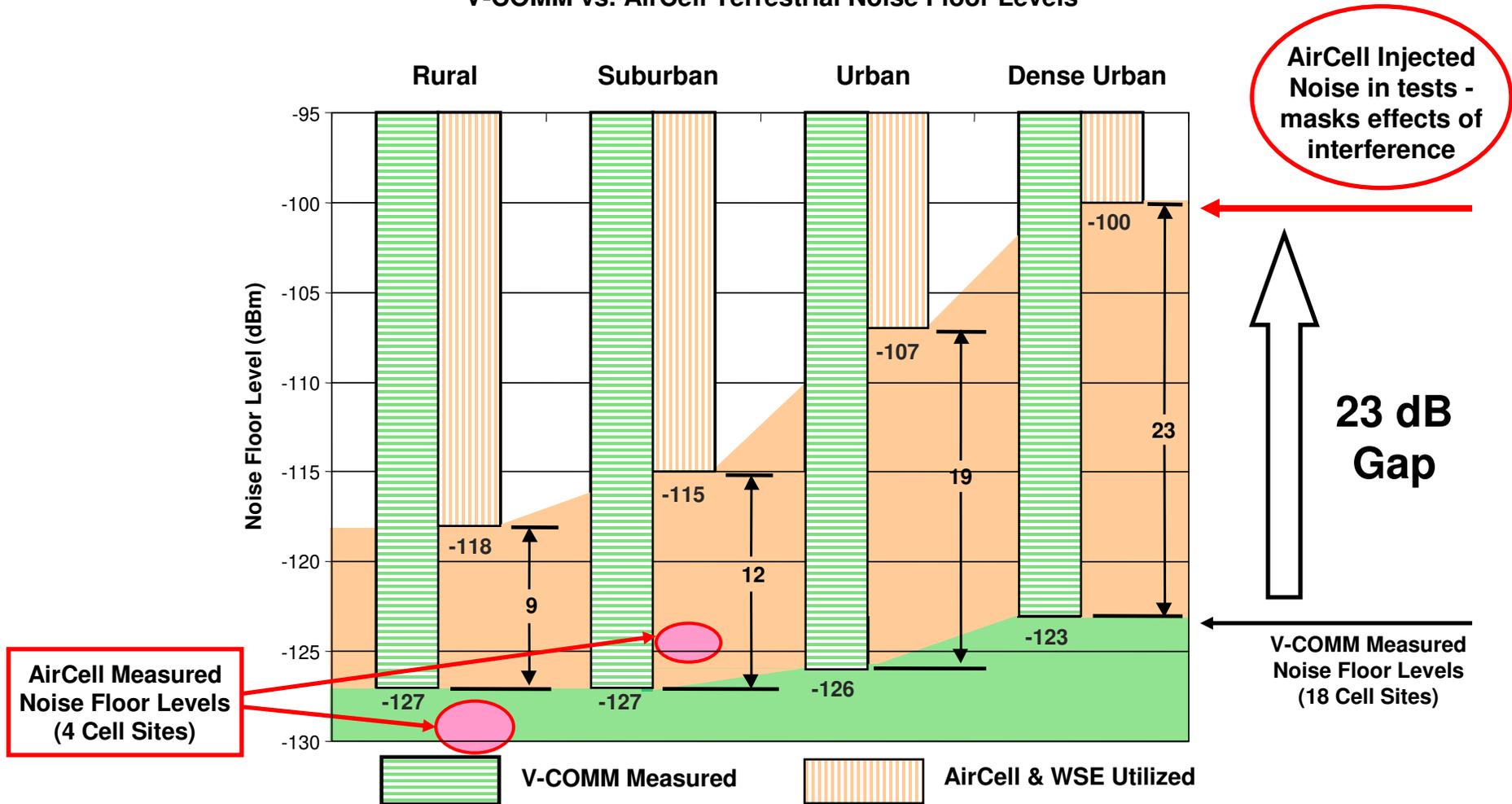
- AirCell's 1997 flight test represents only best-case scenario
  - Orientation to serving AirCell site optimized for lowest power
  - Orientation to victim terrestrial site optimized for lowest power
  - Victim antenna polarity (vertical) optimized for lowest power
- AirCell provides two new flight data ... but not enough details
  - AirCell selectively chooses *not* to show when interference *is* likely (i.e. <10 miles & parallel to victim, at service range of serving site)
- AirCell does not provide its 'claimed' million-mile database, but instead only provides these best-case scenarios

## AirCell relies on flawed interference tests

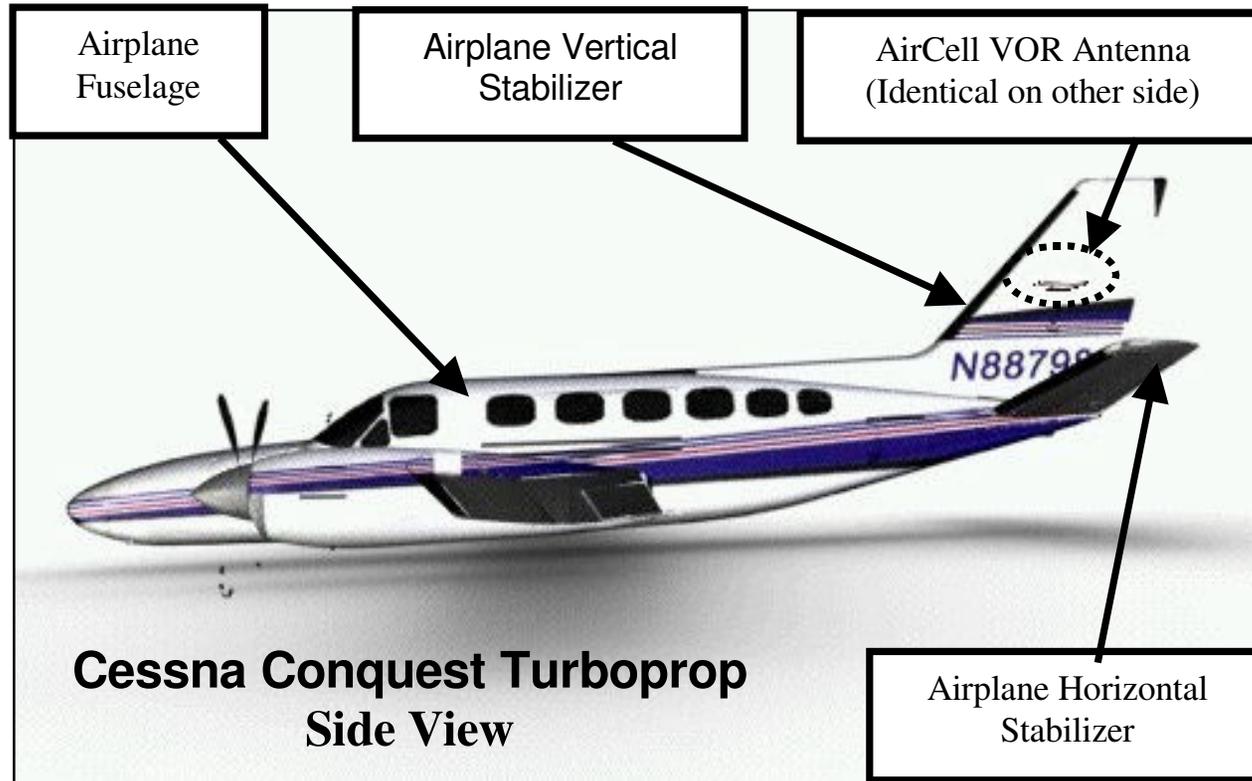
- Injected abnormally high noise levels, masking effects of the AirCell interference (rendering results irrelevant)
- Utilizes static, laboratory-like test setup with antennas disconnected & static terrestrial voice signals (does not take into account signal fading, antenna diversity, soft handoff, & other effects)

# Noise levels used by AirCell vs. measured by AirCell

V-COMM vs. AirCell Terrestrial Noise Floor Levels



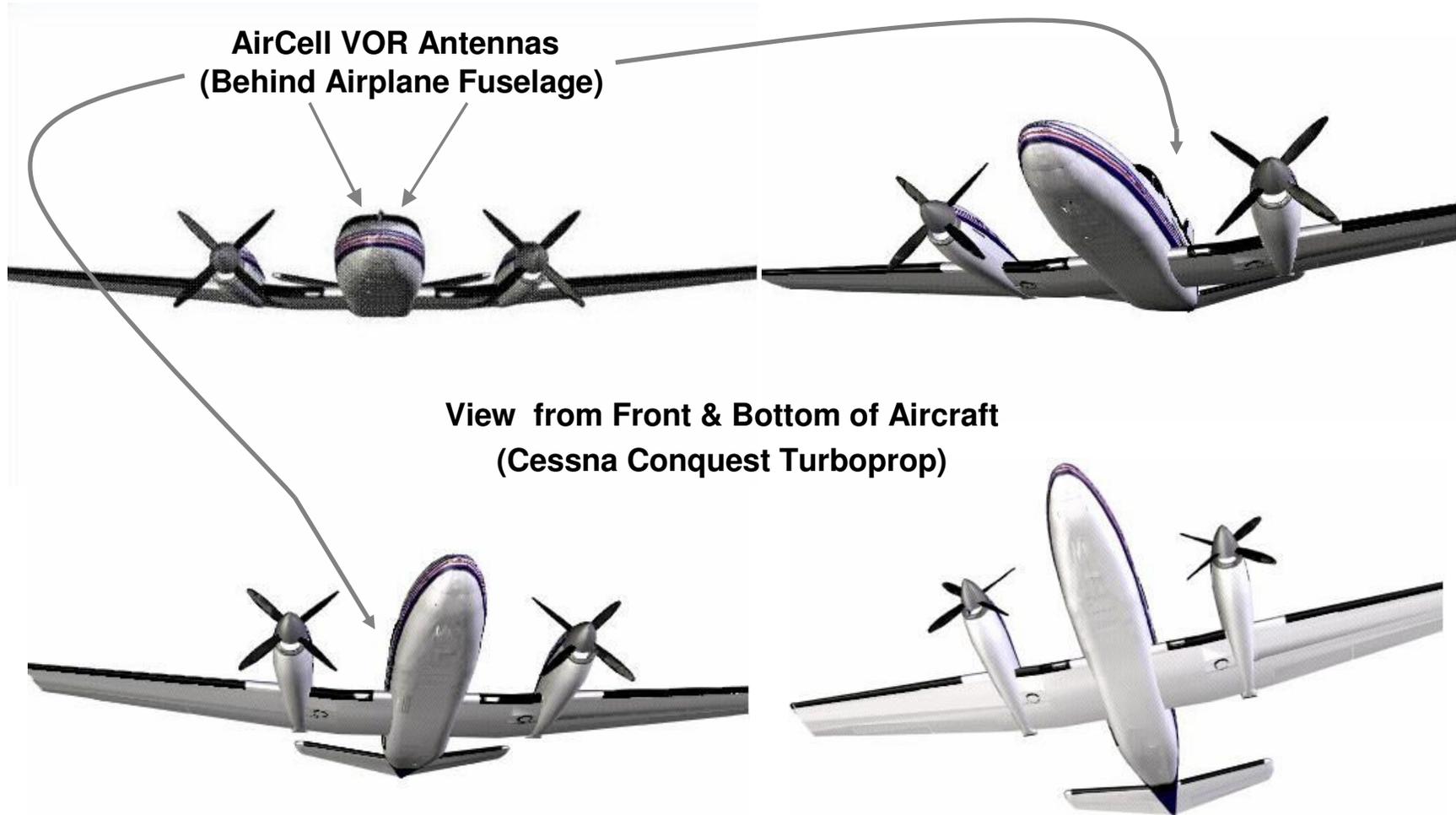
# Orientation of airplane in 1997 tests



Best-case aircraft orientation resulting in lower transmit power, with AirCell antenna having an unobstructed view toward its serving site

# Orientation of airplane in 1997 tests

⇒ Airplane fuselage blocks signal path toward victim terrestrial site. 1997 flight path was toward & over victim site, represents *only* the best case scenario.



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# Orientation of airplane in 1997 tests

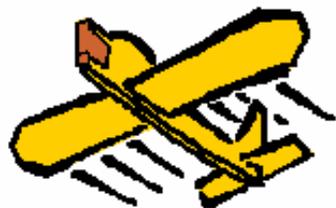


Figure C-4 View of Vertical Stabilizer

**AirCell's clipart incorrectly illustrates aircraft orientations from 1997 tests**



**Actual orientation over victim sites illustrates VOR antenna blocked by horizontal stabilizer**

# AirCell Mobile Transmit Power Levels

Recordings from Jan-Feb 2004

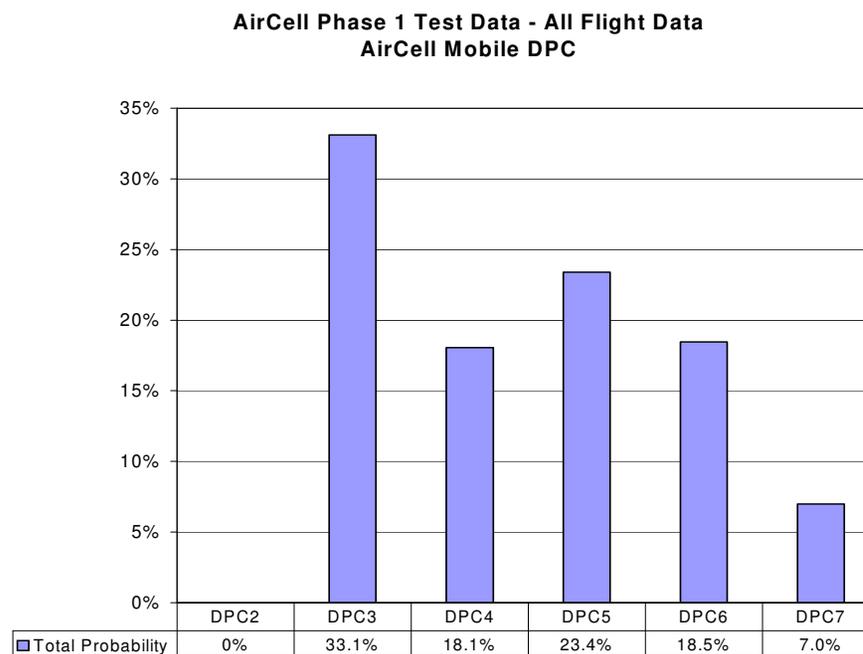
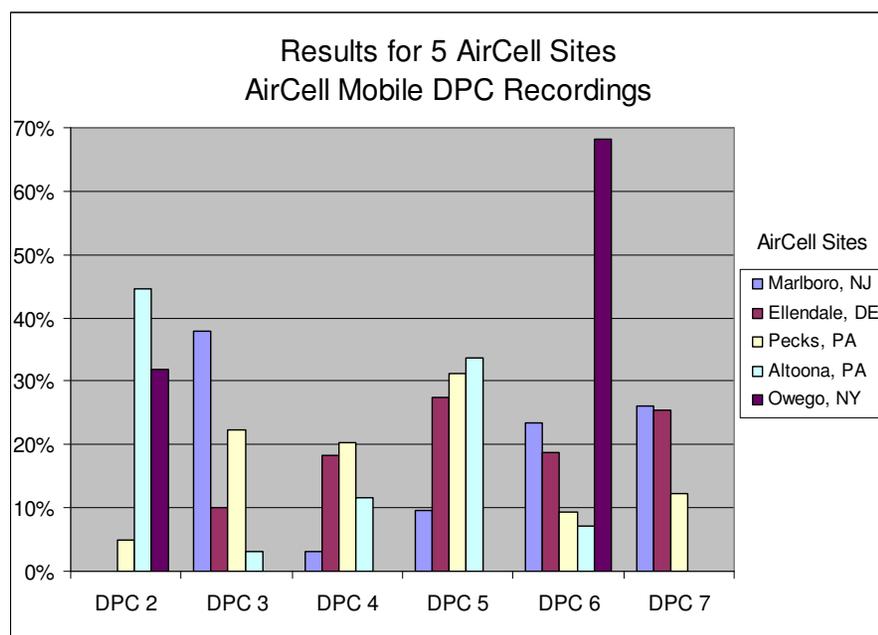
Actual Customers on 5 AirCell Sites

[Totaling 33 days, 98 calls, 134 minutes of call data]

vs. V-COMM's Flight Tests

Results of V-COMM's Flight Tests

[Marlboro AirCell site, Straight-line route, Alt: 4-35k ft]



⇒ V-COMM's flight test results well within range of *actual* customer data

# Summary / Conclusion

- Our compatibility tests and results are valid
  - Our flight tests include 10,000 air miles, 4 terrestrial antennas, 2 aircraft antenna types, variety of altitudes & orientations
  - Our interference tests utilize a typical suburban site, in a real-world test environment, variety of performance metrics
  - Our Case Study represents highest used corridor & flight in U.S. (>113 times day), empirical data from tests
  - Results show substantial evidence of significant harmful interference to terrestrial cellular networks
- AirCell's tests are flawed and limited
  - 1997 flight tests only represent best case path
  - Interference tests inject abnormally high noise levels (unsupported by measurements), mask interference effects
- AirCell's waiver should not be extended - its operation causes harmful interference to terrestrial cellular networks