Satellite vs. Cellular Inflight Wi-Fi

Why the satellite-based broadband solution for commercial airlines is higher speed, less expensive, more expandable and more profitable than air-to-ground solutions.

[A Row 44, Inc. White Paper]

Row 44's Satellite-based In-Flight Broadband

Row 44 provides in-flight broadband connectivity to commercial aircraft – a Wi-Fi hotspot in the sky.

Row 44's satellite-based broadband solution is supported by Hughes Network Systems' global infrastructure, serving a million terrestrial customers in over 100 countries. We offer uninterrupted Wi-Fi service over oceans and national borders virtually anywhere in the world. Our satellite solution also means significantly faster service – a true broadband experience that passengers are used to on the ground.

Two major US carriers – Alaska Airlines and Southwest – have signed on to Row 44's solution and are beginning passenger flight trials aboard their planes. Both airlines have committed to equip their entire fleets with our system upon successful trial completion. This will place Row 44's in-flight broadband on over 600 planes – representing 120 million passengers a year with only our first two customers.

With Row 44's service, passengers can use any Wi-Fi-enabled device to enjoy:

- Web browsing
- Text messages
- Live television
- Email
- Shop
- Video games
- VoIP-enabled phone calls (where permitted)

Air-to-Ground Connectivity

But Row 44's satellite-based solution is not the only method of equipping a commercial aircraft with in-flight Wi-Fi. Today, a few providers have entered the market with a cellular, air-to-ground solution. The most notable air-to-ground player to date is AirCell – which, like Row 44, is in flight trials with US carriers.

A provider of in-flight connectivity services for over a decade, AirCell's true core competencies are delivering cellular services to military and business-jet aircraft. Recently, with a $31 million purchase at FCC auction of a portion of RF spectrum, AirCell has entered the commercial aircraft market – although Row 44 estimates they still have $150 million in infrastructure costs ahead of them.

Differentiating Satellite and Air-to-Ground In-Flight Offerings

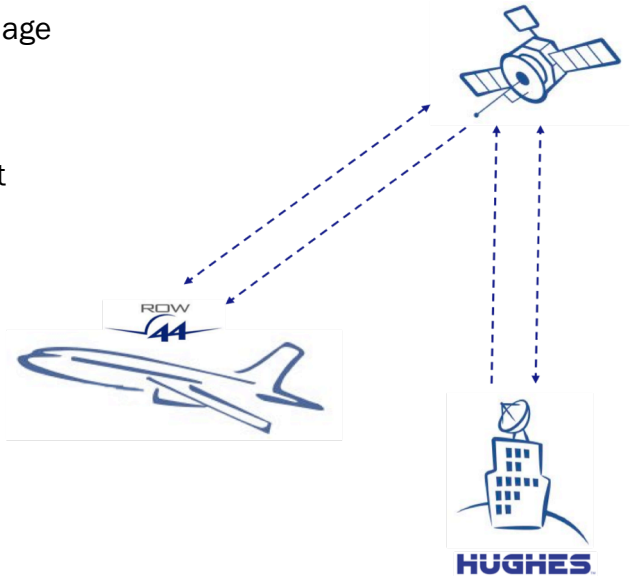
This paper will examine the differences between satellite and air-to-ground solutions for in-flight broadband aboard commercial aircraft. The discussion will center on the strengths and weaknesses of these two technologies – in terms of bandwidth, coverage, expandability, cost, profitability, and quality of passenger experience.

Satellite (Row 44)

Row 44's satellite-based solution uses a Ku-band satellite antenna mounted atop the aircraft fuselage, putting this directional antenna in constant communication with a geostationary satellite in Hughes' global network. Data is transmitted from a Hughes Ground Earth Station (GES), to the satellite, then to the plane.

Hardware:

- Ku-band antenna atop the fuselage (in a fiberglass radome)
- Four LRUs installed in the cabin
  - Antenna Control Unit
  - Server Management Unit
  - High Power Transceiver
  - Modem Data Unit
- Cabin Wireless LAN Units
- Cabin crew control panel

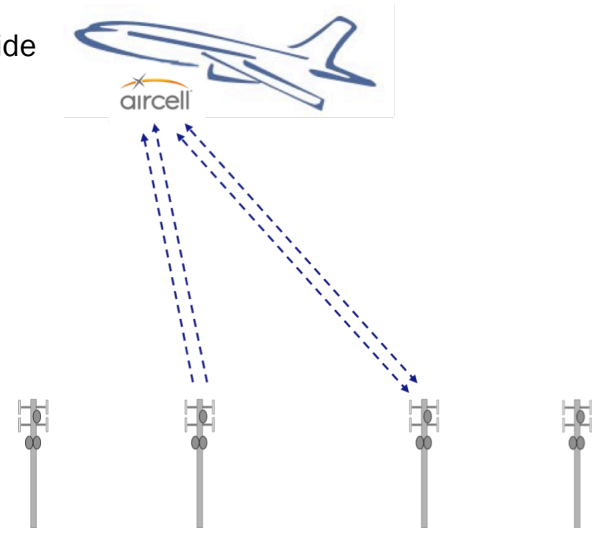


Cell-based Air-to-Ground (AirCell)

AirCell's air-to-ground (ATG) technology uses a blade antenna mounted on the underside of the fuselage, to communicate with a series of ground-based cell towers in the company's domestic US network. The signal is passed from one cell tower to another along a plane's route.

Hardware:

- Two antennas on the fuselage underside
  - Air-to-ground (ATG) antenna
  - GPS/PCS antenna
- ABS communications unit
- ABS control processor unit
- Wireless access point
- Cabin and flight-deck phones



Which Solution is Better?

We'll start with a side-by-side comparison of what we see as the key factors in determining the feasibility of an in-flight broadband solution. We'll then discuss each of these factors in detail.

	Aircell	Row 44
Download Speed	2.1Mbps to the aircraft	15-30Mbps to the aircraft
Upload Speed	100-200Kbps	100-200Kbps
Expandable	No	Yes
Congestion Issues	Yes	No
Antenna Placement	Underside of fuselage	Atop fuselage
Weight	125 pounds	150 pounds
Drag	Unknown	56 pounds
Coverage	Global	US Only
Channel Interference	Yes	No

Broadband Speeds

Row 44's satellite-based system delivers the fastest broadband speeds of any provider in the industry. Our solution can deliver up to 30Mbps to the plane, if the satellite transponder is dedicated entirely to the outroute (the signal from the satellite to the plane). And this data rate is limited only by the antenna we've built to service our 737-700 airline customers. With larger planes and a corresponding larger antenna, Row 44's system can deliver up to 81Mbps to the plane.

We have configured our transponders to dedicate only half of the bandwidth to the outroute, producing a 15Mpbs data rate, and our modem is configured to support a constant data rate of 4Mbps, allowing traffic to burst to higher rates. Our system allows for quickly and cost-effectively increasing capacity, enabling Row 44 to reach the 15-30Mbps data rates as demand increases.

AirCells' solution uses the Evolution-Data Optimized (EVDO) technology. When used for an air-to-ground solution, this standard will produce, at best, a 2.1Mbps data rate to the plane. Keep in mind, however, that this represents *the entire available bandwidth* for a given cell tower. Thus, 2.1Mbps will need to be shared among all aircraft within sight of the tower (about a 150 mile radius).

This means that as AirCell's system begins flying on more aircraft, each of those planes will find themselves competing for less bandwidth – and the quality of the Wi-Fi experience will decrease for passengers.

We believe the upload speeds (the rate passengers can send data from the plane) will be roughly the same for both satellite and air-to-ground solutions. But hey, how fast do you need your email to travel?

Expandability

Row 44's system is supported by the global Hughes Network Systems satellite infrastructure. We currently have transponders on three earth-orbiting satellites – each transponder capable, we estimate, of supporting 300 aircraft – regardless of where those planes fly in the world – at 30Mbps per plane. Thus, our current infrastructure – which has relatively low fixed costs – can support upwards of 900 planes around the world.

If we experience increased demand and need additional capacity, Row 44 can quickly add transponders. Additionally, if an aircraft enters into an area of heavy coverage, Row 44's system can automatically reassign that plane to a less crowded transponder. Our system is expandable, dynamically configurable, and global.

AirCell's service, by contrast, is limited in several ways. When the company paid the FCC $31.7 million in a 2006 auction for 3MHz of available RF spectrum previously controlled by Verizon Airfone, the company secured itself a fixed amount of bandwidth – about 2.1Mbps, perhaps slightly more – that it will need to share among all the planes using its service in range of a given cell tower in its network.

Even if AirCell added another cell tower in a given "zone," it would raise the noise floor and reduce the overall data rate in that zone.

It's also worth noting that the spectrum on either side of the frequency assigned to AirCell and other ATG providers is already licensed for other uses. This leaves AirCell constrained in its total available US bandwidth – and that brings us to another limitation.

AirCell's solution works only over land. Unlike Row 44'sw solution, which can provide uninterrupted Wi-Fi over oceans and across international borders, AirCell is constrained by the need to have ground-based cell towers along its route.

Congestion Issues

Because Row 44's satellite system can increase capacity at any time by simply adding satellite transponders to meet customer demand, the Row 44 solution suffers in no way from congestion.

AirCell, on the other hand, relies on a single carrier that cannot be multiplexed (reused) and cannot meet increasing customer demand by acquiring additional spectrum. This means that as AirCell's customer adoption increases, its quality of service will decrease.

Antenna Placement

The placement on the plane of the broadband antenna can have a material effect on the plane's performance. Cell-based air-to-ground services like AirCell's require placing the antenna on the plane's belly to let the signal travel uninterrupted to and from the cell towers on the ground. This creates drag and downward lift – in airline-speak, a significant "carriage penalty" – which can slow the plane and increase fuel costs.

Conversely, Row 44's antenna is mounted atop the fuselage, giving it a direct communication line to the earth-orbiting satellite. This also creates a drag effect but also an offsetting positive lift, for a significantly lower carriage penalty.

Weight

AirCell's onboard hardware system weighs approximately 125 pounds. On AirCell's website, the company notes the entire system is "Lighter than three checked bags."

Okay, they've got us here. Row 44's system weighs approximately 150 pounds – or, "About the same as three checked bags."

In terms of carriage penalty and other issues concerning the airlines, however, these two weights are substantially equivalent.

> Note: Both AirCell's and Row 44's lightweight systems represent a significant improvement from the broadband offering from Connexion by Boeing (CBB), which weighed nearly 1,000 pounds and did present a carriage-penalty issue.

Drag

Row 44's system produces 56 pounds of drag in cruise on a 737-700. This is the net figure from the "induced drag" (which is a force trying to lift the antenna up and therefore helping the plane to fly) and "parasitic drag" (a force trying to slow the plane down).

AirCell's drag weight is less clear. Currently the company is in test flights on several aircraft, using a single-blade antenna that AirCell claims produces no measurable drag. But for any flight that takes a route other than a perfectly straight line across the country, AirCell will need an array of directional antennas mounted on the underside of the fuselage, so the plane can find a cell tower within its radius.

It's also worth noting that because AirCell's antenna is mounted on the belly of the plane, its drag factor is higher than Row 44's top-mounted antenna. So any additional weight added to an AirCell solution will produce significantly greater drag weigh than would an addition to Row 44's antenna – perhaps hundreds of pounds more.

Coverage

As noted earlier, Row 44's system is supported by the global HughesNet satellite infrastructure – meaning we can provide our system to any airline and provide uninterrupted service virtually anywhere in the world.

AirCell, by contrast, is limited to the United States. Ironically, AirCell would need to add a satellite component to its solution to be able to provide coverage over oceans or outside North America.

Channel interference

Because Row 44's solution uses dedicated transponders aboard earth-orbiting satellites, our airline customers will not experience any channel interference issues. That is, Row 44's broadband signal won't interfere with any other communications systems, nor will any other signals interfere with the broadband we're supplying to passengers.

AirCell's technology, which relies on cell towers that are also providing signals to mobile phone customers on the ground, faces the serious issue of "bleed" into side spectrum, where a plane sending down a broadband signal from an AirCell-equipped plane could create interference for cell phone users on the ground.

This could also create challenges for AirCell or other air-to-ground providers trying to lease cell-tower usage, because the cell providers who own these towers know the risk that airlines and their broadband suppliers pose to their customers' service.

Conclusion

Both the satellite and air-to-ground solutions available today for in-flight broadband aboard commercial aircraft are superior to the technologies of the previous generations of would-be providers in this space.

But when it comes to virtually all factors that could affect an airline's bottom line – from expandability to bandwidth to potential congestion to creating passenger loyalty with a superior broadband experience – we believe Row 44's satellite-based solution has proven it is the smarter, more sensible choice.