Satcom Shakeout

Three mainstream technologies are emerging, each with its own advantages and shortcomings.

By Fred George

Remember all that hype about the "Office in the Sky" concept over the last two decades? It's been waiting for cost-effective voice and broadband connections between airplanes and the ground. Now, it's finally becoming a reality because of a revolution in three satcom technologies. These three technologies, supplemented by a couple of others, are quickly making most conventional air-to-ground telecommunications links as obsolete in the cabin as LORAN and VLF/Omega receivers are in the cockpit. Some business aircraft makers, as a result, are on the verge of dropping conventional air-to-ground radiotelephones from their options catalogs.

Need to call a client while en route? Basic satcom telephone service now is available all the time, anywhere on the planet for as little as $1 or $1.25 per minute depending upon service plan, inclusive of long-distance charges. Shop carefully and you'll get those rates when calling from overhead Paris, Texas, to Paris, France; above Cape Horn to Cape Town; or while en route from Abidjan to Auckland.

Contrast that coverage area and those rates to conventional air-to-ground, inflight radiotelephone service. It's no contest. Satcom wins hands down. In the next decade, satcom voice and data services will make air-to-ground radiotelephones and data links all but vanish from business aircraft.

Much has changed since 15 years ago, when the International Maritime Satellite (Inmarsat) consortium had a monopoly on satcom services. Inmarsat launched its first generation of four geostationary communications satellites in the early 1980s to support safety and administrative communications between ships at sea and their home bases. A decade later, avionics were developed for airliners that provided voice and low-rate data link communications for transoceanic missions. Early satcom avionics cost $500,000 or more and weighed 250 to 300 pounds, and all the boxes couldn't fit into a outsized steamer trunk. So, only a select few large-cabin, long-range business aircraft operators could stomach their price, weight and size.

Inmarsat online charges still run $8 to $10 per minute for its best quality services, placing the satcom off-limits to all but the top brass aboard the aircraft. No wonder the service never caught on with business aircraft travelers, let alone mainstream airliner passengers.

Eventually, Inmarsat broadened the range of its aeronautical communication services, thereby enabling avionics manufacturers to develop smaller, lighter and less expensive satcom systems. Online charges for these other services also were reduced, but their coverage areas were considerably smaller.

Such evolutionary changes continued until about four years ago. Then alternative satcom systems started to provide fierce competition for Inmarsat, igniting a revolution in satcom services for business aircraft operators. Since 2000, for example, Iridium has provided cost-effective basic satcom telephone service, putting a large dent in Inmarsat's aeronautical satcom phone business used by passengers.

In 2002, broadband communications satellites began to provide satcom data link services that offer as big a data transfer pipe as any landline in your office on the ground. In the next several months, these systems will start to appear on business aircraft. This, too, is putting pressure on Inmarsat to offer higher value services and more competitive prices.

This three-way competition is heating up, and business aircraft operators are the beneficiaries. Here are the details of what these three satcom technologies can offer you today and in the near future.

Iridium: The Platinum Standard in LEO

Back before the proliferation of cell phones around the world, a consortium led by Motorola launched a bold plan to develop the ultimate satcom phone service. The plan called for launching 77 low Earth orbit (LEO) satellites, hence the name Iridium, reflecting the atomic number of that element. The satellites were positioned in six polar orbits at an altitude of about 420 nm. The constellation was later reduced to 66 LEO space vehicles, plus in-orbit spares, to

save cost, but that still was plenty sufficient to provide continuous, worldwide satcom phone service. This would provide telecommunications to millions of folks without access to landline phones.

LEO satcom phones must continuously scan for other satellites because of the relatively rapid movement of each satellite. Before the satellite being used travels out of signal coverage, the satcom phone must complete a handoff to the next most suitable satellite. These phones automatically compile a list of the satellites with the strongest available signals so that the handoff can be made without interrupting a call.

Iridium's "internetwork" architecture assures seamless coverage around the globe. Each satellite can relay phone calls to the four nearest adjacent satellites. Calls are relayed from satellite to satellite until they can be beamed down to one of the network's ground Earth stations. Iridium's internetwork relay capability puts it in a class by itself.

Its main LEO competitor, GlobalStar, uses "bent pipe" relay technology, so named because it requires the specific satellite being used by the satcom phone to be in direct line-of-sight range of a ground Earth station to relay the signal. As a result, GlobalStar is limited in coverage area because each of the ground stations is located on land. In addition, bent pipe system satcom providers typically add roaming charges for long distance because it must be provided by landline telephone service providers.

Iridium, in theory, needs only one ground station to handle the signals relayed from "internetworked" satellites from end users, anywhere in the world. Based solely upon ground station call handling capacity, though, Iridium's original business model planned for up to 12 ground stations to serve the millions of customers expected to use the system.

The revenue projections, though, estimated that each consumer would be willing to pay steep rates just for basic telephone service. Moreover, first-generation Iridium telephones were expensive and bulky, costing upward of $3,000 and barely fitting into a shoebox.

But then the cell phone industry spread its coverage throughout most populated areas, offering customers considerably lower prices for compact mobile phones and much lower online charges. This siphoned off thousands of potential Iridium customers each month.

By then, Iridium had spent about $5 billion on nonrecurring expenses and was incurring well over $40 million per month in operating expenses. With a trickle of revenue and a flood of debt, Iridium LLC declared bankruptcy in 1999. GlobalStar sank into Chapter 11 bankruptcy a year later.

Daniel A. Colussy, former operations director for Iridium, organized a group of investors known as Iridium Satellite LLC and offered five cents on the dollar for the system. Motorola balked at the $25 million bid, but in late 2000, the bankruptcy judge OK'd the deal and Iridium Satellite LLC became the new owner. Iridium satcom services were relaunched in March 2001.

Colussy immediately terminated a $42 million per month contract with Motorola to operate the system and hired Boeing for $3.5 million per month for essentially the same range of services. He also slashed Iridium's bloated staff by several hundred people, further stemming negative cash flow.

Iridium Satellite LLC then was on a solid footing to break even with 50,000 to 60,000 subscribers. And the firm already had 25,000 long-term U.S. government subscribers as

anchor customers. It's the only truly global telephone system available for U.S. military, diplomatic and intelligence agency personnel. Even the best Inmarsat systems lose coverage above 75 to 85 degrees north or south latitude.

Subsequently, Colussy turned over the reigns to new chairman and CEO Carmen Lloyd in October 2003. Iridium Satellite LLC now has more than 100,000 subscribers and it's generating positive cash flow. Lloyd claims the firm is adding 2,000 to 3,000 new subscribers each month.

"We had a 44-percent increase in revenue from 2002 to 2003. And we've experienced 17-percent growth in the first half of 2004," Lloyd told *B/CA*. "The aeronautical business is one of our more significant growth areas."

For folks concerned about system capacity limits, Lloyd assured *B/CA* that the present system has enough margin to accommodate "millions of subscribers."

Lloyd also claims that the present group of satellites should last until 2014, even though their being in low Earth orbit causes them to expend rocket fuel reserves to compensate for atmospheric drag. He plans to embark on a "replenishment strategy" in the next four to five years to ensure uninterrupted service. "However, we won't need to launch any satellites until eight or nine years from now," Lloyd commented.

The present Iridium system is capable of voice and 2.4 kbps data transfer, so it's not practical for data link use beyond simple text messaging or basic flight tracking for flight departments. Lloyd is "definitely thinking" about more bandwidth in the next generation of satellites.

There are plenty of Iridium equipment manufacturers and service retailers vying for your business, so pricing is very competitive. Major Iridium avionics suppliers include AeroData, Aircell, Blue Sky Network, Orb'Phone, Honeywell, Icarus and International Communications Group, among others. Aircell, Blue Sky and Honeywell are also among the many Iridium satcom service providers. Uninstalled prices for a single-channel system range from about $7,500 to $30,000, with many offered for about $20,000. Multi-channel receivers are available, some offering separate phone numbers and credit card readers at each passenger seat in the cabin. Several firms also offer portable Iridium phones, mostly manufactured by Motorola, for $1,500 to $3,000. Reconditioned Motorola 9505 portables cost less than $1,000. Alternatively, they can be rented for $80 per week. These units can plug into external antenna jacks and power outlets in the aircraft.

Please note that portable Iridium phones potentially may interfere with GPS and other L-band avionics systems. It's advisable to mount the external Iridium phone antenna at least three feet away from any other L-band avionics antenna. Potential interference from portable Iridium phones should be checked thoroughly on the ground before using them in flight.

A wide variety of satcom service providers compete for Iridium customers, but many equipment manufacturers lock customers into long-term service contracts, so it's advisable to read all the fine print in sales contracts. Most added value service providers don't charge extra for long-distance calls. Surf the Internet and you may be able to find Iridium service for as low as $0.90 per minute.

Inmarsat: Fourth Generation Promises Much More

Inmarsat, founded in 1979, is a consortium of 79 member countries whose original purpose was to provide vital satcom safety services communications with vessels at sea. These services later were expanded to include aeronautical, land and land mobile users.

The consortium invested several hundred million dollars in developing a satcom system with clearly defined and predictable coverage areas, high reliability and rock-solid integrity. Commercial satcom services were almost an afterthought. Following the advent of maritime safety services, ICAO certified Inmarsat as the sole provider of aeronautical safety services in the early 1990s because of system coverage area, reliability and integrity.

Most of the government-sponsored organizations that composed the original consortium eventually sold out to private companies. U.S.-based COMSAT, for example, sold out to Lockheed Martin Global Telecommunications in 2000. London-based Inmarsat Group Holdings Ltd. now owns a controlling interest in Inmarsat, with the International Mobile Satellite Organization providing government-to-government liaison between consortium members.

Privatization has resulted in Inmarsat's becoming more business-oriented, so now the organization offers a broader range of commercial communications services. Safety services, though, remain Inmarsat's highest priority. Each satellite has finite communications capacity. Low-priority functions can be shed to protect safety services, if needed. The consortium's Aero H/H+ high-gain service is given the highest priority, so it remains the only satcom

XM Radio Weather

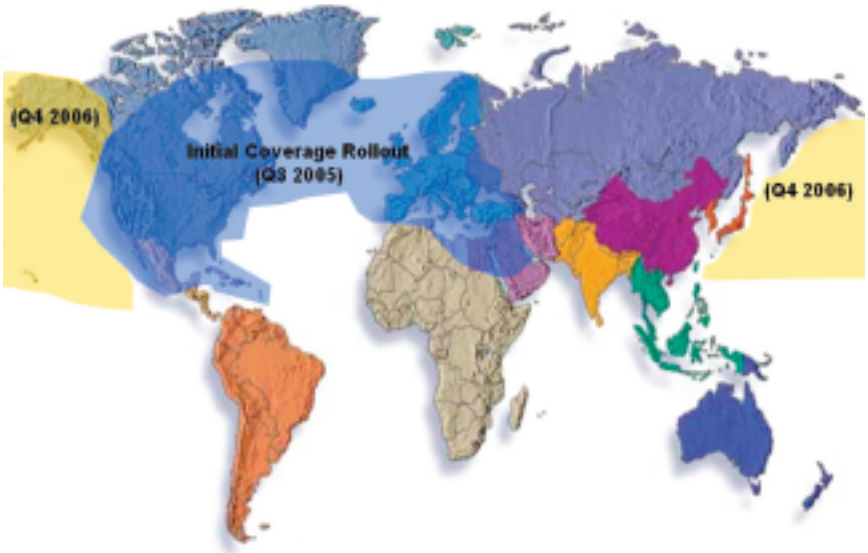
Air-to-ground weather data links, such as those provided by VDL Mode 2, AFIS/ACARS, radiotelephones and aeronautical cellular service, are yesterday's technologies. Practically all major avionics manufacturers are embracing "Rock" and "Roll" for high-speed satcom broadcast weather for pilots flying over the continental United States. We're not talking about a musical genre, but graphical weather services for pilots beamed down from XM Radio's Western U.S. ("Rock") and Eastern U.S. ("Roll") geostationary satellites.

Baron Services, a Huntsville, Ala., firm that specializes in ground weather radar, storm detection and weather information dissemination services for TV broadcasters, has teamed with XM Radio to provide near-real-time graphical weather for $50 per month for aeronautical users. Five-minute update cycle NEXRAD weather, lightning detection, winds aloft, echo tops and METAR/TAFs are available. The weather graphics are geographically referenced so that they can be overlaid on a moving map display with the aircraft's flight plan route.

In contrast, most other weather services don't provide geographically referenced weather, so you must guess where your route will take you by viewing a U.S. national or regional weather chart. Honeywell's ground-based FIS-B 32.2 kbps service and ORBCOMM's 2.4 kbps satcom weather services are two of the few exceptions. This pair does provide georeferenced weather graphics.

With XM Radio, you not only get weather — you also receive 100-plus channels of music and audio entertainment, so while pilots can track the weather, passengers can listen to one of 68 music channels, 33 channels of news, sports or entertainment, or even local weather and traffic broadcasts.

Worldwide Satellite Coverage (Rockwell Collins eXchange)



Coverage is 90-degree maximum scan angle with 5-degree angle-of-attack margin. It is based on antenna performance parameters provided by Rockwell Collins. Actual coverage may vary with demonstrated antenna performance, transponder selection and regulatory approvals.

link sanctioned by ICAO for safety services such as voice communications with oceanic air traffic control agencies and rapidly emerging data link services, including addressable and broadcast automatic dependent surveillance (ADS-A and ADS-B) and controller-to-pilot data link communications (CPDLC). ADS-A, ADS-B and CPDLC eventually will replace most voice communications on transoceanic routes. These services are text-based, so the 4.8 kbps to 9.6 kbps offered by Aero H/H+ provides sufficient speed.

Aero H avionics must meet ARINC 741 specifications for performance and reliability. The original jetliner-size systems typically had a 6MCU satellite data unit (SDU), a 4MCU radio frequency unit (RFU) and an 8MCU high-power amplifier (HPA). Second-generation systems were developed for business aircraft that were less expensive and more compact, but operators still had to budget $500,000 and 100-plus pounds for installation, although this was a 150-pound weight savings over first generation systems. Today, though, fully integrated, 8MCU Aero H satcom systems are available at a cost of $350,000 to $375,000 installed and weight of about 60 to 70 pounds, including the antenna.

Leading Aero H/H+ avionics manufacturers include Honeywell-Thales, Rockwell Collins and Thrane & Thrane. Honeywell builds the largest, most powerful and most expensive satcom systems, with Rockwell Collins offering smaller, lighter and less-expensive systems in the middle market. Thrane & Thrane builds the smallest, lightest, lowest power and least-expensive Inmarsat satcom systems.

Each of these systems requires electronically or mechanically steered, high-gain antennas provided by makers such as Ball Aerospace, Chelton, EMS Technologies and Honeywell-Thales. Plan on spending $80,000 to $100,000 for a high-gain antenna system.

Inmarsat now offers a wide variety of lower-cost communications services, but none have the coverage area and guaranteed integrity of Aero H/H+.

➤Aero C — a lightweight, compact system that uses an omni-directional blade antenna and that provides basic voice and 600 bps data link communications. For use mainly over land.

➤Aero M (also known as Aero Mini-M) — lightweight, compact system that requires a steerable, high-gain antenna enabling it to use Inmarsat spot beams. Capable of 2.4 kbps data link, but intended for use over land or near coastlines.

➤Aero L — lightweight, compact system with worldwide coverage. Uses omni-directional blade antenna and supports voice and 600 bps to 1.2 kbps data link communications.

➤Aero I — intermediate gain system that provides most of the benefits of Aero H at lower weight, cost and operating expense. Certified for ATC functions and distress calls, but not aeronautical safety services. Supports voice and 4.8 kbps packet-mode data link in Inmarsat spot beams. Popular with military fleet operators.

Inmarsat introduced Swift64 service about two years ago, a voiceover Internet protocol and data link communications system capable of speeds of 56 kbps to 64 kbps. This is a high-gain, spot beam system that requires an Aero H specification high-gain antenna and high power amplifier with at least 30 to 40 watts output. Swift64 boxes typically share the high-gain antenna with the aircraft's Aero H safety services satcom system.

Swift64 supports both pay-per-minute, mobile integrated services digital network (ISDN) circuit-mode communications and pay-per-kilobit, mobile packet data service (MPDS), packet-mode functions. Fees are about $10 to $13 per minute (circuit mode) or $5.25 to $6 per megabit (packet mode), depending upon service provider. Up to four Swift64 systems can be operated in parallel to provide up to 256 kbps connection rates. (Each channel that's operated in circuit mode, though, will cost you $10 to $13 per minute.)

We've used Swift64 in flight. It provided connection speeds about the same as a dial-up landline modem. "High speed actually is closer to house speed," observed one avionics executive. However, Inmarsat will start launching its fourth-generation, geostationary satellites in May 2005 with operations slated to begin in 2006. The new spacecraft will be the largest and heaviest commercial launch payloads yet put into orbit, embracing third-generation GSM (global system for mobile communication) communications protocols that substantially increase their subscriber capacity and bandwidth.

Inmarsat-IV satellites will blanket most of the planet below 75 degrees north or south latitude with spot beams, providing connection rates as high as 432 kbps using Swift Broadband (broadband global area network) data link avionics boxes. Within those latitude limits, passengers should be able to connect to the Internet with near-DSL speeds by 2006. Couple two or more Swift Broadband boxes in parallel and connection speeds will rival landline cable modems.

Almost all of today's Swift64 boxes can be upgraded to Swift Broadband with minor hardware changes and a software update. Inmarsat will continue to support its third-generation satellite system, providing all existing services for several more years. The fourth-generation spacecraft, parked over the equator not far from the third-generation satellites, will provide the same and enhanced services using the same high gain antennas on aircraft. Today's Aero C, L, I and H satcom boxes, however, will require minor hardware and software upgrades to use the fourth-generation satellite services.

Avionics manufacturers already are preparing for Inmarsat-IV. Dual channel Swift Broadband equipment is being designed that will enable passengers to con-

nect at 864 kbps. Best of all, Inmarsat officials predict that online per-minute charges will drop to $2 to $3 per minute and per-megabit packet-mode fees may drop by as much as 90 percent.

Ku-Band: The Digital Fire Hose

Inmarsat-IV's new capabilities and lower fees didn't just happen because of the consortium's generosity. The organization soon will face stiff competition from Ku-band satcom service providers.

Want T1 line broadband connections in the air? Nothing comes close to Ku-band satcom data link. Its fire hose capacity makes some other satcom data links seem like squirt guns. Ku-band satcom has the potential for at least 512 kbps aircraft-to-satellite upload speeds and 10 Mbps satellite-to-aircraft download speeds.

The downside of Ku-band is that it's currently available only in limited areas, typically over large land masses with plenty of ground-based customers. As one pundit observed, "Fish don't need broadband." As you fly farther from population centers, the signal gets weaker, and baud rates slow to a trickle and finally stop.

However, there's enough surplus Ku-band transponder capacity that some satellite operators now are looking at providing the service to cruise ships and other mobile users. And airlines flying over the Pacific are eyeing Ku-band connectivity as a value-added passenger service. It's already available over most of the North Atlantic, albeit at slower speeds than over Europe and the United States. This could open the door to a considerably larger coverage area.

Fourth-generation Inmarsat space vehicles, in contrast, will provide Swift Broadband service in two to three years around the globe below 75 degrees north or south latitude, but at slower connect speeds than Ku-band satellite transponders.

Ku-band avionics also are relatively expensive to install. And online charges range from $3 to $6 per minute, depending on service plan. But that's considerably less expensive per megabit of data sent or received than narrower band satcom connections.

Two main aeronautical system providers have emerged, the first being Connexion by Boeing. In the late 1990s, Boeing foresaw large-scale airliner passenger demand for high-speed e-mail and Internet access, but only if online charges could be kept down to reasonable rates. Boeing also realized there was a surplus of Ku-band transponder capacity aboard dozens of communications satellites. So, it lobbied the United Nations' International Telecommunications Union (ITU) to open up the Ku-band between 14.0 and 14.5 Ghz for aeronautical uses.

With ITU approval, Boeing then developed Ku-band electronics, capable of uplinking from aircraft to satellites at 512 kbps on one channel and downlinking from satellites to aircraft at 5 Mbps, or faster, on a second channel. The system is branded as Connexion by Boeing and it uses leased Ku-band transponder service aboard existing communications satellites, such as the geostationary Telstar, Intelsat and Eutelsat space vehicles above the equator. Airlines plan on charging passengers about $25 to $35 per flight for high-speed Internet and e-mail access.

We've evaluated Connexion by Boeing in flight. For downloads, it's as fast as any T1 line service we have in our home office and it has enough capacity to handle dozens of passengers using it simultaneously.

"There's enough surplus Ku-band transponder capacity that some satellite operators now are looking at providing the service to cruise ships and other mobile users."

The early 2000s depression in the airline industry stifled sales of the system. Finally, in mid-May 2004, Lufthansa became the first airline to offer Connexion by Boeing service on its Airbus 340 flights between Los Angeles and Munich. Connexion has turned plenty of heads in the business aircraft community. But its jumbo-jet sized avionics are far too bulky to be installed in most business jets.

Rockwell Collins sensed opportunity. The firm's engineers reasoned that its receive-only, Ku-band Tailwind 500 satellite TV antenna could be modified to incorporate a transmit and receive Ku-band Connexion by Boeing satcom data link capability. Rockwell Collins negotiated an agreement with Boeing to use the Connexion system and network, but with more compact electronics suitable for installation in large-cabin business jets. Rockwell Collins' downsized Connexion system, called eXchange, uses a modified Tailwind TV dish antenna along with a 6MCU Ku-band data link transmitter-receiver unit (TRU). The result is a Ku-band system that can either receive up to 475 direct broadcast system (DBS) satellite TV channels or send and receive Ku-band signals using the Connexion by Boeing satellite network.

Rockwell Collins' eXchange system will be capable of uploading data at 256 kbps and downloading at 5 Mbps. Installed system weight ranges from 150 to 200 pounds, with a full-up system price pushing $1 million. Service plans will cost between $3,000 per month for 10 hours of connection time to $6,000 for 40 hours. Extra minutes will run between $3 and $7 per minute, inversely related to the cost of the basic service plan. Satellite DBS costs an additional $450 to $500 per month. At present, eXchange is bundled with Tailwind TV. It's not available as a stand-alone, Ku-band data link package.

A limited number of cable TV channels will be re-broadcast on eXchange, enabling folks to both surf the Net and watch popular business programs. Likely channels include CNN, Bloomberg Financial, the Weather Channel and ESPN.

Tailwind TV has one dual-channel receiver decoder unit (RDU) enabling passengers to receive two separate cable TV programs from potentially hundreds that are available from the satellites, depending upon licensing agreements in the coverage region. Additional RDUs can be added to the system, each providing two additional channels that can be simultaneously received.

Bombardier's Global 5000, with its fully integrated Rockwell Collins Air Show 21 cabin environment, will be one of the first production aircraft to be offered with Tailwind TV and eXchange broadband connectivity. Rockwell Collins marketers believe that 75 percent of the eXchange market will come from new aircraft and 25 percent will be retrofit.

ARINC's SKYLink Ku-band system is the second main broadband data link product being offered for business aircraft operators. This second-generation system uses a 34-pound Ku-band TRU developed by ViaSat and a specially designed swept volume dish antenna to send and receive data. ARINC has partnered with SES Americom, another Ku-band satellite operator, as a co-investor in SKYLink. SES Americom expects its Ku-band aeronautical data link services to be up and running over the continental United States by the end of this year, according to Bob Thompson, ARINC's senior director of satellite services. Full North Atlantic coverage is slated for mid-2005, with Europe, Middle East and Africa coverage planned shortly thereafter. SES Americom also plans to have full Pacific Ocean region Ku-band coverage, from China to the U.S. West Coast, from Alaska to Australia, by late 2005, Thompson said. That would make SKYLink broadband's coverage area

available over the most frequently traveled overwater and overland air routes before Connexion by Boeing or eXchange become fully operational.

SKYLink uses proprietary "Arc/Light" technology using one Ku-band satellite transponder for both up- and downloading. Connexion and eXchange, in contrast, need separate satellite transponders for uploading and downloading. Thompson claims this could halve connection charges, but they're actually close to what Rockwell Collins envisions for eXchange. ARINC's plans range from $3,500 per month for 10 hours of connect time to $6,500 for 40 hours. "It's a bucket of hours and all you can eat," explained Thompson.

Gulfstream Aerospace will be the first airframe manufacturer to offer SKYLink systems as factory options. Pending avionics certification is expected to pave the way for SKYLink service over the continental United States by the end of the year. Cessna also is eyeing SKYLink as an option for the Citation X, but its plans are less well-developed.

Pilots can look forward to visiting their favorite Web sites for weather, winds and other preflight briefing services. Back in the cabin, passengers will be able to surf the Internet or log onto secure Web sites using SKYLink's virtual private network (VPN) capability.

Potential buyers please note: When you opt for Connexion, eXchange or SKYLink avionics, you're also locked into using Boeing, Rockwell Collins or ARINC as the only service providers as long as the equipment is aboard your aircraft, according to current contracts. It's not like having a cell phone, where you can switch service providers if you find a better deal.

Future Competition Bodes Well for Customers

Satcom, once a novelty aboard business aircraft, could become as commonplace in the cabin as reading lights, power outlets and air vents. Business travelers have become accustomed to broadband connectivity in their offices, homes and hotels at a time when aeronautical satcom equipment is becoming more versatile, more capable and less expensive.

If you need basic telephone service in the cabin, we recommend you look closely at the Iridium solutions because they're so cost-effective and the services are available anywhere on the planet.

For aeronautical safety services, Inmarsat's Aero H system remains the only choice. This technology is a key part of ICAO's 21st-century CNS/ATM strategy. Passengers also can use Aero H for voice communications, but it's far more expensive than Iridium and offers little additional benefit.

For cabin connectivity, Swift64, also from Inmarsat, is an excellent interim solution, particularly with the coming of Swift Broadband (broadband global area network — BGAN) in two years. BGAN offers 432 kbps per channel and it's availability is practically guaranteed because of the financial strength of Inmarsat.

Ku-band connectivity offers the most potential bandwidth for truly high-speed connectivity. With Connexion by Boeing and ARINC's SKYLink fighting for market share, competition should improve coverage area and pricing in the future. At present, however, it's not clear whether Ku-band coverage will be extended to include all frequently flown overland and overwater routes.

These three satcom technologies promise to transform the ways folks in the cockpit and cabin communicate and connect with air traffic controllers, business clients and computers on the ground. The business aircraft community finally is acquiring the tools it needs to make the "office in the sky" become a reality. **B/CA**

Satcom Hardware Providers

AirCell, Inc.
1172 Century Dr., Bldg. B, Ste. 280
Louisville, CO 80027-9417
Phone: (800) 328-0200
Fax: (303) 926-8970
www.aircell.com

ARINC, Inc.
2551 Riva Rd.
Annapolis, MD 21401
Phone: (800) 633-6882
www.arinc.com

Blue Sky Network
1298 Prospect St., Ste. 1D
La Jolla, CA 92037
Phone: (858) 551-3894
Fax: (858) 551-3891
www.blueskynetwork.com

CMC Electronics Inc.
415 Legget Dr.
P.O. Box 13330
Ottawa, Ontario
K2K 2B2 Canada
Phone: (613) 592-7466
Fax: (613) 592-7417
www.cmcelectronics.ca

EMS Technologies
1725 Woodward Dr.
Ottawa, Ontario
K2C 09P Canada
Phone: (613) 727-1771
Fax: (613) 727-1200
www.ems-t.com

Honeywell Inc.
Commercial Aviation Systems
5353 W. Bell Rd.
Glendale, AZ 85308
Phone: (602) 436-0272
Fax: (602) 436-8200
www.honeywell.com

International Communications Group Inc.
200 Enterprise Dr.
Newport News, VA 23603
Phone: (757) 947-1030 or (800) 279-1991
Fax: (757) 947-1035
www.intcomgrp.com

Orb'Phone — Euro-GSM Ltd.
P.O. Box 5
Brussels 1200 Belgium
Phone: +32-2-35-03-33
Fax: +32-2-633-49-32
www.euro-gsm.com

Rockwell Collins
400 Collins Rd. N.E.
Cedar Rapids, IA 52498
Phone: (319) 295-1000
Fax: (319) 295-2297
www.cca.rockwell.com

SAGEM Avionics, Inc. (formerly ARNAV)
Pierce County Airport
16923 Meridian E.
Puyallup, WA 98373
Phone: (253) 848-6060
Fax: (253) 848-3555
www.sagem.com

Sky Connect LLC — Icarus Instruments
6930 Carroll Ave., Ste. 501
Takoma Park, MD 20912
Phone: (703) 404-4400
www.skyconnect.aero

Teledyne Controls
12333 E. Olympic Blvd.
Los Angeles, CA 90064
Phone: (310) 820-4616
Fax: (310) 442-4324
www.teledynecontrols.com

Thrane & Thrane, Inc.
509 Viking Dr., Ste. K, L & M
Virginia Beach, VA 23452
Phone: (866) SATCOMS
or (757) 463-9557
Fax: (757) 463-9581
www.tt.dk

Universal Avionics Systems Corp.
3260 E. Universal Way
Tucson, AZ 85706
Phone: (520) 295-2300
Fax: (520) 295-2395
www.uasc.com

ViaSat
6155 El Camino Real
Carlsbad, CA 92009-1699
Phone: (760) 476-2200
Fax: (760) 929-3941
www.viasat.com