eXchange™

Rockwell Collins
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Rockwell Collins
Building trust every day

Introduction

In-flight broadband Internet and data connectivity is emerging as one of the most desired capabilities in Business Aviation from both the OEM and end customer perspectives. In fact, just as they experience in the office or when traveling via ground transportation, the modern Business Aircraft traveler expects the same degree of access to their information systems, Internet and email while traveling aboard their aircraft. They demand ubiquitous access to broadband data anywhere, anytime and during any phase of travel.

Customer's access to rapidly evolving consumer electronics and communication technology coupled with the increased speed of the business cycle due to globalization are fueling these requirements. This creates new habits, dependencies and expectations regarding information access which has spilled over into Business and Commercial Aviation. Fortunately technology is evolving to enable solutions for the growing appetite for connectivity onboard business aircraft.

One of the most promising solutions for airborne, broadband connection is eXchange™ with service by SKYLink™, by Rockwell Collins, Inc. This Ku-band system answers the needs of the high data user to employ a cost effective connectivity tool that offers extensive global coverage. eXchange is an end-to-end solution that provides the equipment onboard the aircraft, access to satellite based connectivity (through service packages) and the support necessary to ensure exceptional access and dependability demanded by the most ardent information consumers.

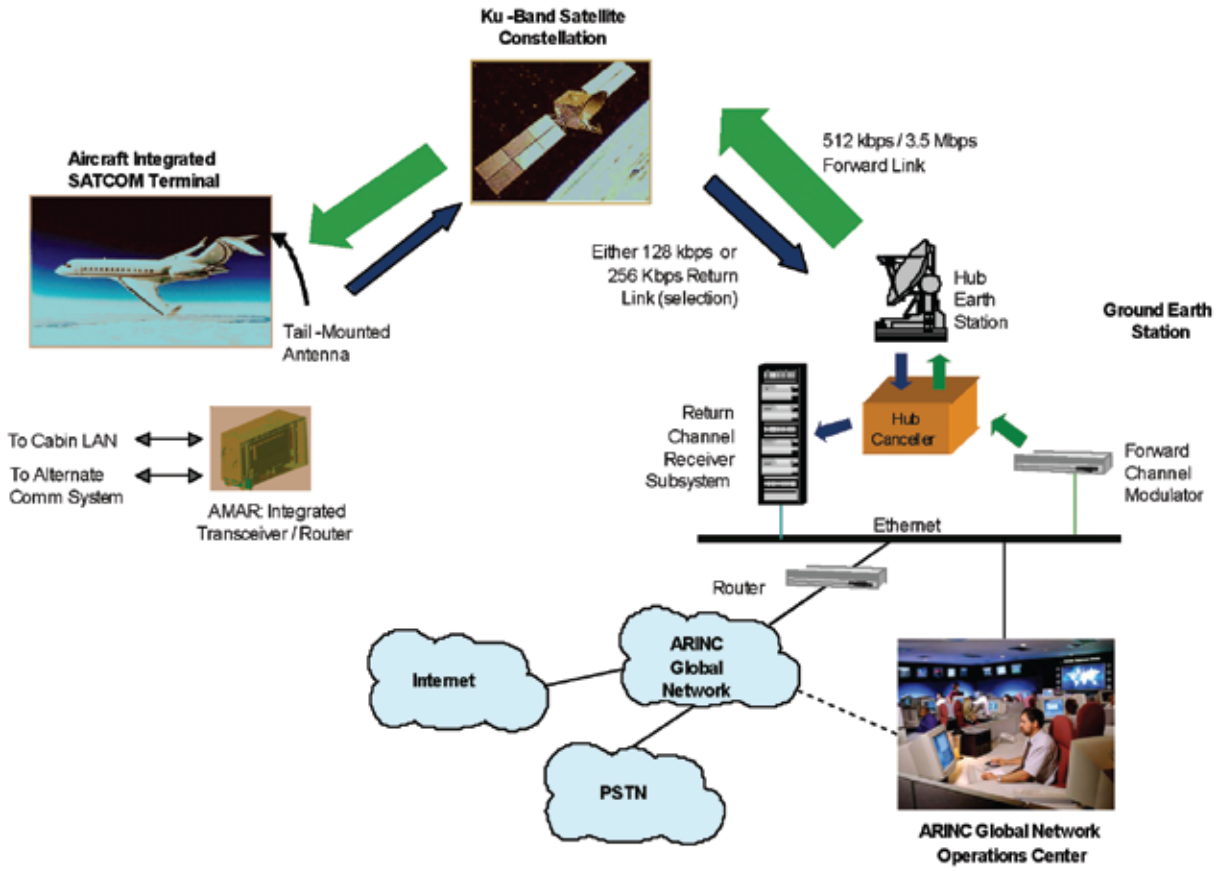
Capabilities and value of eXchange include:

1. Real time, two way, high speed broadband service
2. Simple and full Internet connectivity via a PC or Wi-Fi enabled Smartphone
3. Personal and Corporate E-mail via PC or Wi-Fi Smartphone
4. VPN/VoIP/FoIP/Video Conferencing
5. Available when aircraft is on the ground and in the air
6. Soft handoffs: Seamless transition from Ku-satellite to an L-band satellite
7. Extensive global coverage
8. Cost effective for high data users

What Is eXchange?

eXchange, coupled with the SKYLink service, is a real time, two-way connectivity system providing true broadband speeds of up to 3.5Mbps to the aircraft. It enables customers to access e-mail, corporate intranets (VPN), and the Internet, with options for Voice over IP (VoIP) telephone service and videoconferencing. eXchange supports data connectivity for select Wi-Fi enabled smartphones, such as a RIM's Blackberry models 8320 and 8820, allowing users to access e-mail and other data services beyond just using their personal computer.

The SKYLink network employs a constellation of Ku-band satellites and a Ground Earth Station providing the data interface to the Internet, which is managed and supported 24/7 by the ARINC Global Network Support Center.



eXchange Hardware

To appreciate eXchange's capabilities and value, it is important to understand the four components that make up eXchange.

1) **Tail Mounted Antenna Gen III Subsystem (TMASS)**

   Tail mounted antenna assembly providing Ku-band satellite tracking. Installed inside the top portion of the aircraft tail, the TMASS has the ability to simultaneously send to and receive data from the communications satellite. Additionally, the antenna system is stabilized to enable it to track satellites and send and receive data to/from satellites during aircraft maneuvers up to 15 degrees per second (which is five times greater than the standard turn rate of the aircraft).

   The antenna subassembly is the most critical element for the performance of the system. The key antenna performance numbers are G/T and EIRP. G/T is a convenient figure to merit ratio for antenna gain vs. system noise temperature, which is important for receiving very low level signals. For the transmit function, EIRP (effective isotropically radiated power) is the other measure.

2) **Aircraft Integrated Transceiver/Router (AITR)**

   The AITR provides the signal (data) processing for both transmission and reception to and from the antenna. This component offers Ethernet 100 baseT interface, is over-the-air downloadable and possesses a web-based use interface for remote configuration and maintenance.

3) **Antenna Control Unit (ACU)4) VPN/VoIP/FoIP/ Video Conferencing**

   The ACU provides direction guidance to the antenna and ensures it is accurately pointed at the desired satellite. To accomplish this, the ACU receives constant position data from the aircraft navigation system to merge with satellite position data for synchronized direction guidance to the antenna.

4) **ARINC Mobile Access Router (AMAR)**

   The AMAR functions as the main interface between the Ku-band ARINC's SKYLink system and all devices on the cabin network. With the installation of the AMAR, an aircraft becomes Ethernet enabled, providing both wired and wireless ports. Access to the Internet is simplified by the built-in web server, making log-in very easy. The AMAR also features a built-in print server, which allows printouts to be made onboard the aircraft, and provides fax send and receive capability. More importantly, the AMAR provides unbroken, automatic transfer of voice and data communications for aircraft moving from one satellite coverage area to another. When used in conjunction with ARINC's L-band Inmarsat Satellite Services it can provide seamless communications beyond Ku-band satellite coverage. ARINC's Inmarsat service requires a separate service plan and the use of (existing) Swift 64, HSD-128, HSD-400 or SBB hardware.

   The AMAR is packaged in a standard 4 Modular Control Unit (MCU) and is DO-160D/DO-178B certified. It comes with a wireless LAN antenna, mounting tray with cooling fan, and includes the below additional features:

   - Security and Intrusion Detection
   - Touch-screen maintenance panel
   - Built In Test
   - TCP Accelerator
   - System Monitoring & Diagnostics

AMAR Specifications

- Ku-band SATCOM Terminal Interface via Ethernet
- L-band SATCOM Terminal Interface via ISDN
- Data routing to and from Ethernet connected client computers and devices via wired 10/100 Base-T Ethernet connections or via Wireless Ethernet connections using 1 or 2 channel Mobile
- Built in Ethernet Switch with nine 10/100 Base-T Ethernet Ports
- Built-in Wireless Access Point (IEEE 802.11 b/g standards)
- Integrated Series Digital Network (ISDN)
- ARINC-429 ports (4 receive, 2 transmit)
- Console/Maintenance Front Panel
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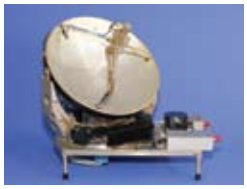
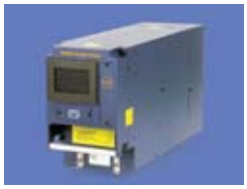
eXchange Components

	Tail-Mounted Antenna Gen III Subsystem (TMASS)	Aircraft Integrated Transceiver/Router (AITR)	Antenna Control Unit (ACU)	ARINC Mobile Access Router (AMAR)
				
Size	12.9” x 14.3” x 16”	5” x 8” x 15” (4MCU)	3” x 8” x 11”	5” x 8” x 15” (4MCU)
Weight	16 lbs	10 lbs	4 lbs	12 lbs
Features	› Simultaneous transmit and receive › Tracks satellite during aircraft maneuvers up to 15° per second	› Receive, transmit processing › Ethernet 100 baseT interface › Over-the-air (OTA) downloadable › Web-based use interface for configuration and maintenance	› Accepts navigation data from the aircraft › Keeps antenna pointed at satellite	› Interfaces to other onboard systems, including transceiver, wireless/wired LAN, and cockpit subnetwork › Enables continuous communications between multiple satellite networks, even while aircraft is in motion or transitioning between satellite transponders (SKYLink to Inmarsat)

SKYLink Service

There are numerous advantages to eXchange's employment of SKYLink that are described as follows:

1. **SKYLink provides seamless handoffs**

   SKYLink provides seamless handoffs from one satellite to another as the onboard eXchange components communicate with orbiting satellites while the aircraft is moving either at high speed or stationary on the ground. A past technical challenges was "data interruptions" caused by the aircraft's data systems' inability to quickly transition from one satellite or constellation to another. eXchange, through SKYLink, has solved this and provides "soft handoffs" which means a user's IP (Internet) session is not interrupted and no data is lost while the aircraft transitions through different networks. eXchange provides "soft handoffs" when also using ARINC's Inmarsat services and transitioning between the following:

   a. Ku-band satellite to Ku-band satellite

   b. Ku-band satellite to L-band satellite

      An L-band connectivity hardware and a subscription to ARINC's Inmarsat service is required for this function.

2. **SKYLink provides easy access and robust security**

   The SKYLink experience is as simple as interacting with the Internet from any home of office wired or wireless network. To access the Internet, the customer only needs their own computer or Wi-Fi enabled PDA, exchange hardware and a SKYLink account.

   From a security perspective, eXchange with service by SKYLink provides the necessary protections to ensure high data security. SKYLink only accepts connections from authorized eXchange terminals. This means the system is essentially closed to outside participants and is further enforced by the mandate of a user ID and password. As a further service, data encryption can be applied to a user subscription as an end-to-end application. ARINC considers user's present and past travel locations proprietary so the ARINC Global Network Operations Center treats customer's aircraft position information as if it were "private".

As of October 1, 2009

3. SKYLink's extensive global coverage

SKYLink coverage continues to grow as demand requires it. Current coverage areas include:

- Continental USA
- Canada
- Mexico
- Europe
- Partial South and Central America
- Caribbean
- Across the Atlantic
- Across the North Pacific (including Northeast and Southeast Asia and Hawaii)

4. SKYLink billing though ARINC

With ARINC as the service provider for both Inmarsat and SKYLink, the customer benefits from a global service that answers the call for one provider, one invoice for all services and one contact for service support. Additional benefits associated with ARINC's billing approach include:

a. Billing is accomplished by user ID not necessarily aircraft specific. This allows for appropriate billing to fit fractional models or corporate cost sharing/accounting by enabling the billing of separate users by individual ID numbers.

b. For flexibility the same User ID and PIN number can be authenticated and allowed to operate on multiple terminals simultaneously.

c. Most importantly, billing time for a single aircraft, with one User ID and PIN number used by multiple users, starts when the first user logs on and ends when the last user logs off. This means that multiple users can be logged on at the same time but count for billing as only one person logged on.

d. System has a configurable "Idle Time-Out". If the service is not used for 10 minutes, it will time out and the inactive 10 minutes will be credited back to the account.

e. SKYLink Service Plan.
ARINC offer choices of SKYLink service plan to cover the various usage needs of customers. The agreement is managed on an annual basis.

Service Plans	Monthly subscription fee for data only	Monthly subscription fee for data and VoIP	Total annual minutes	Additional per minute rate	Roaming rate per minute
Silver	$3,850/month	$3,925/month	132	$6.00	$6.50
Gold	$4,950/month	$5,075/month	264	$4.00	$6.50
Gold Plus	$6,125/month	$6,250/month	264	$4.75	No charge
Platinum	$6,600/month	$6,850/month	528	$2.75	$6.50
Platinum Plus	9,350/month	$9,600/month	528	$3.50	No charge

- Roaming occurs when an aircraft not on a "Plus" plan logs-on outside of the satellite home region which they originally signed up for
- Simultaneous or multiple VoIP and data users on an aircraft count as a single user – there is no extra charge for additional users on the aircraft
- Unused SKYLink minutes roll over from month-to-month within each 12-month service period
- Fleet subscribers with two aircraft may choose individual plans per aircraft or pool their usage under one Platinum Plus plan. Each additional aircraft will, at a minimum, be added as a Silver plan; additional minutes will apply at the Platinum plus rate

Platforms suitable for eXchange

eXchange is best suited for super mid to large aircrafts due to the installation requirement for the TMASS on the tail of the aircraft. The antenna radome also has a profound impact on overall performance and must be considered as a critical element of the installation. Below are applicable eXchange platforms.

Installed or pending installation*

Gulfstream A GENERAL DYNAMICS COMPANY BBML Installations	Cessna A Textron Company	BOMBARDIER	BOEING
> GIII > GIV > GIV-SP > G4xx > GV > G5XX	> Citation X	> CL604	> BBJ – TIOS

Applicable Platforms

BOMBARDIER	DASSAULT FALCON SERVICE
> Global Express > 5000 > XRS > CL601 > CL605 > CRJ	> F7X

* As of September 2009

eXchange Value Equation

One of the initial objections presented by customers is the acquisition cost for eXchange when compared with Swift Broadband (SBB). While, the initial expense to install eXchange is higher, the life cycle cost for the system for high data users are markedly lower and when the quality of service is entered in the selling equation, eXchange provides a superior value.

From a basic cost and recurring expense perspective the acquisition comparison between SBB, Air-to-Ground (ATG) and eXchange need to be evaluated from three perspectives:

- Initial Acquisition and Installation Expense
- Service Expense (cost to use) and Bandwidth speed
- Total Life Cycle Expense

1. **Initial Acquisition and Installation Expense**
   When weighing the initial acquisition expense of eXchange compared with SBB the delta for the purchase is approximately $150K which breaks down in the following when viewed through a five year depreciation schedule and a 35% Corporate Tax Rate.

Product	Acquisition Price	Price Post Depreciation
eXchange	$600K installed	$390K
SBB	$350K installed	$228K

Product	Acquisition Cost	Depreciation YR1	Depreciation YR2	Depreciation YR3	Depreciation YR4	Depreciation YR5
eXchange	$600K	$42K	$42K	$42K	$42K	$42K
SBB	$350K	$24.5K	$24.5K	$24.5K	$24.5K	$24.5K
eXchange and SBB	$950K	$66.5	$66.5	$66.5	$66.5	$66.5
SBB/eXchange Difference	$250K	$17.5K	$17.5K	$17.5K	$17.5K	$17.5K

Prices are rounded for example purposes

Given the above acquisition table, the comparable return based on a normal depreciation schedule of 5 years is $210K for eXchange and $122K for SBB. Subsequently, the difference in primary system acquisition is reduced to $162K from the initial outlay prices. Additionally, not covered in the cost comparison is the difference in usage expense for heavy users and the value associated with improved data transmission rates.

As demonstrated above, while eXchange's initial acquisition expense is higher, when tax effects are applied, the initial acquisition expense is reduced considerably. Furthermore, when the equipment re-sale effect on the airplane is considered, then the acquisition expense from the outside will be further marginalized.

2. **Technology Comparison**

eXchange represents the best value when the consumer considers the actual cost of service associated with data volumes while traveling across multiple regions. Once an acquisition scenario is established the next consideration is the actual cost of ownership, or the cost to use the system.

SKYLink provides the unique selling proposition of offering the fastest downlink speed to the intercontinental business jet consumer. In fact, the download data rates are up to 8 times faster for eXchange than SBB. Additionally, this speed and volume is offered at the lowest cost per bit of any satellite information system. Although Air to Ground is faster than SBB and charges a monthly fee for unlimited usage, its coverage is limited to the contiguous USA. The following chart provides solid comparisons of eXchange and SBB from a minute-by-minute usage expense perspective.

Features	Swift64	SBB	ATG	eXchange (Ku-Band)
Bandwidth speed	64 Kbps symmetrical	Up to 432 Kbps symmetrical	2 Mbps downlink, 1 Mpbs uplink	3.5 Mbps downlink, 128 Kbps/ 256 Kbps uplink
Service fee	$7.95 ~ $8.95/min	From $12.95/min	~ $1,395 monthly, unlimited	$3,850 + ($2.50 to $5.80/min, depending on monthly plan selected
Coverage	Global	Global	CONUS only	Extensive intercontinental coverage
System size and weight	Light	Light	Lightest	Medium
Platform	Super mid	Mid-size and up	Lights and up	Long range and Ultra long range
Flight paths	Intercontinental	Intercontinental	U.S. only	Intercontinental
Typical data usage	Low	Low to medium	Medium to high	High

3. **Cost Analysis**

When considering a high speed connectivity solution with intercontinental coverage, the solution that meets this requirement are SBB or eXchange, or a combination of both. From a financial perspective, based on the life cycle of both technologies and the service cost to support high volume connectivity usage, eXchange emerges as the best solution. This conclusion was reached after comparing the initial acquisition with an eight-year service cost for an SBB solution to a combined eXchange and SBB solution. The eXchange and SBB combined system was used for this analysis since it is highly possible that the consumer may already have an SBB system in his business jet when installing eXchange.

For this cost analysis we used the business jet connectivity yearly usage data provided by ARINC and identified a low data consumer to use 18 hours per year, an average consumer to use 32 hours, and a high data consumer to use 72 hours. For the high data user the life cycle expense for SBB will quickly eclipse that of eXchange due to the very high per minute usage charges associated with SBB. For the low data user the delta between SBB falls close to $100K over an eight year period which after the effects of depreciation (not included in the analysis) creates a situation of almost parity in life cycle expense.

Even though the higher initial acquisition cost of a combined eXchange and SBB solution gives it an unfair advantage when compared to a standalone SBB system, it emerges as a better packaged solution for high data users when compared against a standalone SBB solution.

The following graphs depict low, average and high SBB usage transferring data at two different rates, 1MB/min and 2MB/min.*

Based on available connectivity solutions on a business jet, we created two types of users shown by the blue and pink lines. The blue line reflects a user utilizing the eXchange service 90% of the time. For the other 10% when real time data is not critical or if they want to stay connected in regions where eXchange coverage is not available, they will employ SBB background IP service.

The pink line reflects a user utilizing SBB background IP service 90% of the time to save cost. However, they may experience a need to stream data and receive information real time 10% of the time. In this situation the user will most likely minimize the use of SBB streaming since its service cost is much higher than background IP or eXchange.

User Profile

Low Data User	18 hours/month
Medium Data User	32 hours/month
High Data User	79 hours/month

Hardware and Technology Utilization

SBB+ eXchange	10% SBB BIP + 90% eXchange
SBB	90% SBB BIP + 10% SBB streaming

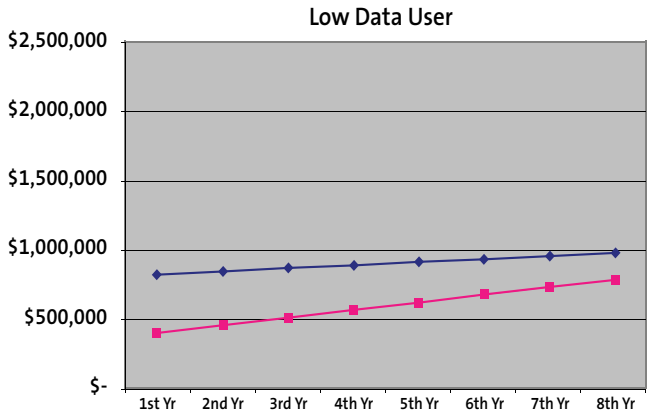
Reference

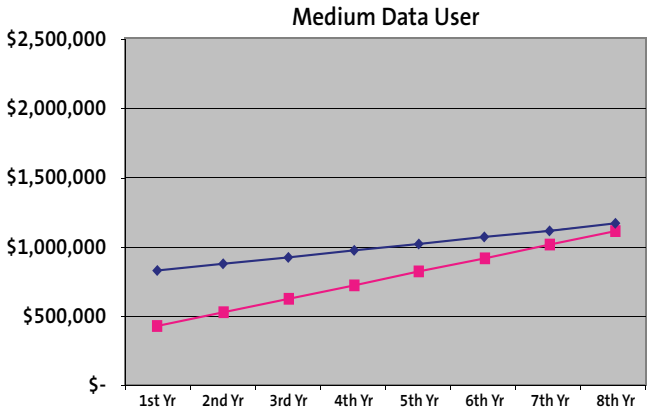
Hardware and installation costs:
SBB + eXchange: $800,000
SBB: $350,000
1 MB = 100 basic text e-mail with no attachment
10 MB = 1 digital photo

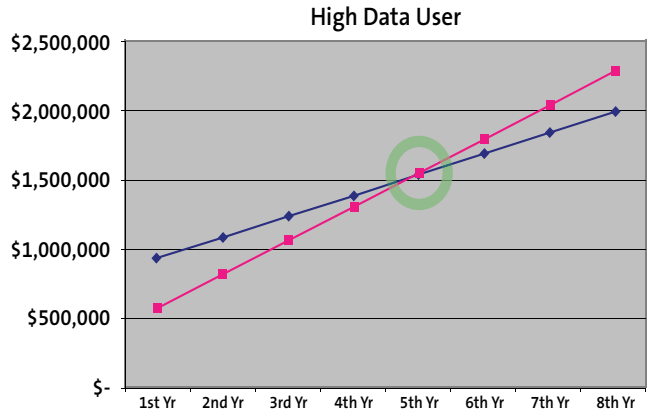
SBB+eXchange SBB

SBB vs. eXchange Cost Analysis

SBB Transfer Rate: **1 MB/min***

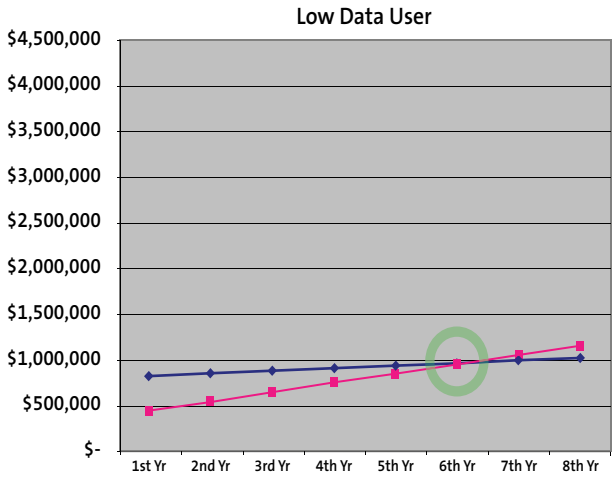


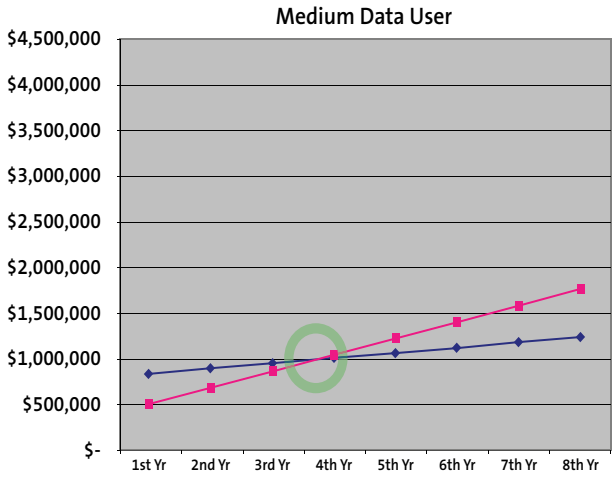


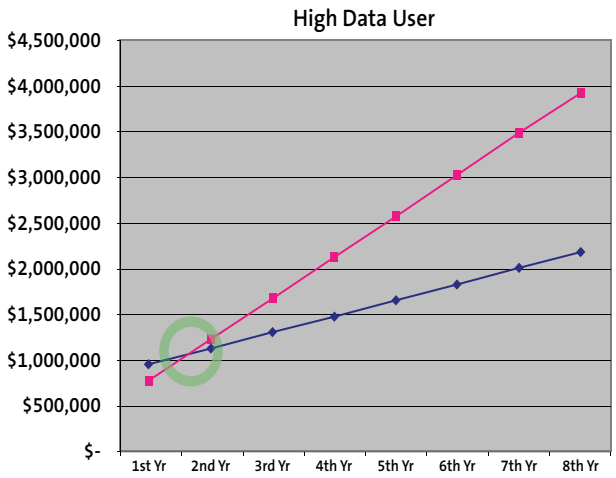


SBB vs. eXchange Cost Analysis

SBB Transfer Rate: **2 MB/min***







High data users will

- Break even on their initial eXchange acquisition cost within two years
- Experience future service plan savings and faster downlink speed, over SBB

SBB+eXchange SBB

*Since SBB is normally billed by the amount of data used, while eXchange is billed by amount of connection time, assumptions were made on the rate of data used per minute in order to equate the cost basis of both technologies.

Summary

eXchange with service by SKYLink offers state-of-the-art information access to the intercontinental business aviation traveler through a comprehensive application of the aircraft hardware and service offerings. eXchange offers broadband connection for in-flight access through the most prominently traveled areas in the northern hemisphere, including the North Atlantic and the Pacific routes between North America and Japan. If the aircraft is equipped with Inmarsat hardware and eXchange, and ARINC is the service provider for both services, eXchange provides a seamless transition to Inmarsat in regions where SKYLink service is not available.

eXchange offers distinct advantages to the marketplace when compared to other service offerings:

1. The highest available downlink connectivity speed of any service, over land or ocean
2. Broadband connectivity across the North Atlantic and Pacific ocean
3. Service in high traffic areas such as the U.S., Mexico, Canada, Europe, across the North Atlantic and Pacific, Caribbean and portions of South and Central America
4. In conjunction with Inmarsat interface, provides truly global connectivity
5. Enables “Office in Sky” including video conferencing, rapid access to information etc.
6. Internet access look and feel like the “office”
7. eXchange is supported by Rockwell Collins, Inc.
8. SKYLink is supported 24/7 by ARINC.

When cost is considered, eXchange provides the most value for the moderate and high data user. eXchange offers the most cost effective solution possible for the customer, especially if they are using the data while flying across multiple continents. Consequently, when the acquisition price, cost of usage and the life cycle costs roll up, eXchange is the clear choice for the demanding, international business aviation traveler. Examples of the financial value of eXchange are as follows:

1. Provides a cost advantage within 2 years for the high data rate user (transferring data a 2Mb/min or more)
2. Lower service cost for high data transfer at a data rate that is over 7X faster than SBB
3. eXchange improves the resale value of the jet over just Inmarsat
4. eXchange offers a lower cost voice data plan compared to SBB ($0.10/min vs. $1.45/min)

ViaSat

Satellite communication hardware provided by ViaSat.

Building trust every day.

Rockwell Collins delivers smart communication and aviation electronic solutions to customers worldwide. Backed by a global network of service and support, we stand committed to putting technology and practical innovation to work for you whenever and wherever you need us. In this way, working together, we build trust. Every day.

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